Trade Liberalization, Agency Problem and Aggregate Productivity*

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Abstract. Evidence shows that trade liberalization mitigates the agency problem inside firms that face bad production conditions and incentivizes these firms to improve management quality. In order to strengthen our understanding of this phenomenon, I propose an industry equilibrium trade model with heterogeneous firms. When an economy opens up to trade, managers of the least productive surviving firms are incentivized to exert more effort, although they face shrinking market size in the open economy. This leads to improved productivity within these firms. I then study how the level of managerial incentives affects gains in aggregate productivity from trade and find that it has a *non-monotonic* impact. Finally, I calibrate the model using plant-level data from Colombia and find that the interaction between the managerial incentive and trade liberalization for gains in aggregate productivity is quantitatively sizable.

Keywords. trade liberalization, firm productivity, separation of ownership and control, managerial incentives

JEL Classification. L22, L23, D23, F12

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1 Introduction

Recent empirical research regarding the impact of trade liberalization on firm productivity finds substantial productivity gains that come from improvements within the firm. For instance, Brandt *et al.* (2017) document that surviving Chinese manufacturing firms increased productivity after China joined the WTO and substantial reductions in output tariffs were made. Echoing this finding, Bloom, Draca, and Van Reenen (2016) show that European firms increased productivity after imports from China surged or quotas imposed on Chinese imports were removed. Moreover, empirical studies also document that the pro-competitive effect of trade liberalization is heterogeneous across firms and related to the firm's management quality. For instance, Schmitz (2005), Bloom and Van Reenen (2010), and Bloom, Draca, and Van Reenen (2016) find that firms improve managerial efficiency (or organizational methods) when facing tougher competition after trade liberalization. Why, therefore, do productivity and management quality of firms increase when they face tougher competition? At the firm level, how does the existence of the agency problem affect productivity gains after opening up to trade? At the aggregate level, does it matter for gains in aggregate productivity after trade liberalization? This paper tries to answer these three questions.

Following the tradition dating back to Berle and Means (1932), I open the black box of the firm and treat the separation of ownership and control as the fundamental problem within the firm. Separation of ownership and control creates conflicts of interests, which exist not only in big corporations, but also in small partnership firms. An investor (i.e., a firm owner) has enough financial resources to form a firm, but has no business idea and managerial ability to run the firm. Therefore, she needs to be matched with a manager who has the business idea and managerial ability to create a successful firm. After the firm owner is matched with the manager, a firm is created. Then, the manager has to exert effort to develop the business idea. In the end, the overall quality of the business idea depends on two components: the initial quality of the idea and the manager's effort. This overall quality pins down the efficiency of production, which eventually determines firm productivity.

In this paper, I propose an industry equilibrium model based on Lucas (1978). The industry is populated by firms that produce differentiated products with a constant elasticity of substitution (CES) under conditions of monopolistic competition à la Dixit and Stiglitz (1977). There is a large pool of investors who have enough financial resources to form firms, and their outside option is normalized to zero. In addition to the investors, there are agents who have business ideas to create firms. These agents differ in the quality of their ideas, which are random draws from a distribution. The investors need to be matched with managers for the creation of firms, and the agent needs to choose between becoming a worker and becoming a manager before the match. Agents who choose to be workers earn wages as their payoff and constitute the (endogenous) labor supply in the model. The agent who chooses to be a manager must exert effort to develop his idea, which leads to a product blueprint with an overall quality. Next, the investor decides whether to pay a (fixed) sunk entry cost to enter the industry for production after observing the overall quality of the business idea. If the production starts, the manager (or the investor) decides on the profit maximizing output and employment. Finally, firms compete in the market, and the investor and the manager receive their income from ex post profit which is operating profit minus fixed production cost. For simplicity, I assume that the fixed (domestic) production cost is zero, while the fixed exporting cost is assumed to be high enough. Following the incomplete contract approach to modeling managerial compensation (i.e., Grossman and Hart 1986; Bolton and Scharfstein 1990; Hart and Moore 1990, 1994 and 1998), I assume that the manager and the owner obtain income via ex post bargaining.[1] Shares of the profit received by the the manager and the investor are assumed to be the solution to a generalized Nash bargaining game, which sum up to one.

How do the manager and the investor make their decisions in autarky? At the fourth stage, the choice of output is to maximize the profit, since the manager and the owner bargain over the profit. At the third stage, the owner is willing to enter the industry for production, if and only if the fraction of profit she receives at least covers the fixed entry cost. The agent's occupational and effort choices at the first two stages consist of three cases. If the initial quality of the idea is low, the agent becomes a worker, as running the firm would result in a lower payoff than the wage. If the initial quality of the idea is high, the agent becomes a manager and exerts effort at the second-best level due to profit sharing.[2] However, the investor is still willing to enter the industry under this low level of effort, as the profit she receives ex post is high enough to cover the entry cost. I call these firms "unconstrained firms". When the initial quality of the idea does not belong to the above two cases, the agent still chooses to become a manager but exerts effort higher than the second-best level. In this case, the investor would not enter the industry if the manager exerted effort at the second-best level, as the ex post profit received by the investor would be smaller than the entry cost. However, there is room for the manager and the investor to achieve a Pareto improvement by making the production happen, as the second-best level of effort does not maximize the total payoff and the initial quality is not too low. In equilibrium, the manager exerts effort at the level that makes the investor break even ex ante. As a result, the investor is willing to produce, and the manager earns a payoff higher than his outside option. I call these firms "constrained firms". Finally, matching at the first stage consists of a set of investor and manager pairs. Within each pair, ex ante transfer is made from the investor to the manager to sustain the stable match, and every investor earns zero payoff in equilibrium.

The model yields a unique prediction concerning how the managerial effort varies with the initial quality of the business idea. When the initial quality of the idea is *far* above the exit

[1]This approach assumes that complete contracts that base the managerial compensation on the manager's effort and performance measures (e.g., profits) are infeasible, since these measures are either non-verifiable or manipulatable.

[2]The second-best level of effort is defined as the one that maximizes the profit the manager receives from the ex post bargaining minus the cost of exerting effort, *given* that the production is carried out. The first-best level of effort is defined as the one that maximizes the total profit minus the cost of exerting effort.

cutoff (of becoming a manager), the participation constraint of the investor does not bind. Thus, the manager exerts effort to maximize his own payoff. As there is a complementarity between the effort and the quality of the idea, the managerial effort increases with the initial quality of the idea. Conversely, the participation constraint of the investor binds when the initial quality of the idea is *slightly* above the exit cutoff. Therefore, the objective function of this type of manager is to make the investor break even. Naturally, it is easier for the investor to break even, when the initial quality draw is higher. Thus, the (required) managerial effort goes down with the initial quality draw when the initial quality is not too high. In total, the manager's effort decreases first and increases afterwards with the initial quality draw.

Then, I extend the closed-economy model into an international context à la Monte (2011) to study how trade liberalization affects the managerial effort and firm productivity. If the firm wants to export in the open economy, it has to incur both a fixed exporting cost and an iceberg trade cost. Opening up to trade triggers within-industry resource reallocation, causing the least productive non-exporting firms to exit. Importantly, it also generates productivity gains for two types of firms. First, productivity of the least productive surviving non-exporters increases, even though their market size *shrinks*. After opening up to trade, the minimum productivity level under which the investor breaks even increases due to tougher competition. When the manager earns substantial rents and his investor breaks even in autarky, he is willing to exert more effort to make his investor still break even and enter the industry in the open economy. As a result, he is still able to receive some rents by being a manager in the open economy. Therefore, tougher competition mitigates the agency problem and results in a disciplining effect on managers who work for *the least productive* surviving (non-exporting) firms. Second, productivity of exporters also increases after opening up to trade, as the market size they face increases. This is the market size effect on firm innovation which has been extensively studied by the existing literature (e.g., Lileeva and Trefler 2010; Bustos 2011). As the fixed exporting cost is *not* a sunk cost (paid at the third stage) and has to be deducted from firm's profit when the investor and the manager bargain over the profit, the existence of this fixed cost does *not* create another disciplining effect (among the least productivity exporters). In short, the pro-competitive effect of tougher competition on firm productivity works for the least productive *non-exporting* firms in the current model, and this is the key innovation of this paper.

Using the data from world management survey (WMS), I provide an empirical pattern that is consistent with the key prediction of the model: the managerial effort is "U"-shaped with respect to the firm's initial quality draws. First, I use the average score on management practices that are closely related to the manager's effort to measure the level of managerial effort. Second, firm size (i.e., employment or sales) is used as the proxy for the initial quality draw. Then, I utilize observations of non-exporting firms whose managerial effort is predicted by the closed-economy model to run regressions. Specifically, I cut the sample into quintiles or quartiles (based on firm size) and run a non-parametric regression by regressing the average management score (related to the managerial effort) on a full set of dummy variables for size quantiles (and industry and year fixed effects). I find that firms in the middle quantiles indeed have lower management score than those at the higher or lower end of the firm size distribution.

Next, I explore how the agency problem affects *aggregate gains* in firm productivity after the economy opens up to trade. The key parameter I focus on is the bargaining power of the manager (i.e., the managerial incentive), as a change in it affects both the investor's incentive of entering the industry and the manager's incentive of exerting effort. A change in the managerial incentive generates two offsetting effects. On the one hand, the ratio of the number of constrained firms to that of unconstrained firms increases with the manager's incentive. As the investor compares a smaller fraction of profit to the entry cost when making the entry choice now, there are more managers (with mediocre quality draws) who can incentivize their investors to enter the industry by making them break even ex ante. The larger fraction of the constrained firms hinders resource reallocation after opening up to trade, as they are the least productive firms and *do not* increase productivity substantially after the economy opens up. On the other hand, the share of exporting firms among *unconstrained firms* increases with an increase in the managerial incentive, as the misalignment of interests (between the investor and the manager) only exists at the margin of market entry. The larger share of exporting firms in the open economy facilitates resource reallocation, as exporting firms are the most productive firms and increase productivity substantially after the economy opens up. When the manager's bargaining power increases, the two effects work in opposite directions. In particular, the first effect dominates the second one, when the managerial incentive increases from a low level, and vice versa when it increases from a high level. As a result, the increase in aggregate productivity from opening up to trade goes down with an increase in the manager's bargaining power when the power is small, while it goes up with the bargaining power when the power is big. In total, the productivity-enhancing effect of trade interacts with the level of managerial incentive in a non-monotonic way.

Finally, I use Colombian plant-level data to calibrate the model and implement counterfactual analysis. The Colombian plant-level dataset covers all manufacturing plants above a certain threshold on size. It contains information on managerial compensation and the number of management staffs. These information enables me to calibrate two key parameters of the model: the level of the managerial incentive and the cost function of managerial effort. After calibrating the model, I use the calibrated parameters to consider bilateral trade liberalization by reducing the iceberg trade cost by 20%. Then, I vary the value of the managerial incentive from 0.05 to 0.8 and study how this value affects the gain in average firm productivity from the reduction in the trade cost. The result shows that the increase in average firm productivity is "U"-shaped with respect to the level of the managerial incentive, and the driving force is the selection effect which changes non-monotonically with the level of the managerial incentive. If we double the managerial incentive from 0.322 to 0.644, the gain in average firm productivity increases from 4.82% to 5.25% which is quantitatively sizable.

The rest of this paper is organized as follows. Section 2 reviews the literature. Section 3 analyzes the model for a closed economy. Section 4 analyzes the model for an open economy. Section 5 investigates how the agency problem and the level of managerial incentive affect aggregate productivity gains from trade. Section 6 concludes. Proofs of the main results are relegated to the appendices.

2 Literature Review

The relationship between market competition and firm productivity is an old question in economics. A Schumpeterian view suggests that intensified competition destroys firms' profitability and, accordingly, their incentive to improve productivity.[3] However, this seems to stand at odds with a vast set of empirical findings and case studies showing that competitive pressure *does* make firms produce more efficiently and managers work harder. Therefore, economists have constructed various models in order to explain these findings.[4] However, none of them takes firm heterogeneity into account. Furthermore, most of these papers derive results from partial equilibrium analysis without worrying about *endogenous* changes in market competition.[5] This paper bridges the gap between the partial equilibrium analysis of the manager's effort choice and the industry equilibrium analysis of market competition under firm heterogeneity.

My work contributes to the literature studying internal firm organization in the industry equilibrium framework. Existing research focuses either on the choice between outsourcing and FDI (e.g., Antràs 2003, 2005; Antràs and Helpman 2004; Alfaro et al. 2016) or on how market price and wealth distribution affect firm boundary and size (Legros and Newman 2008, 2013, 2014; Conconi, Legros, and Newman 2012; Legros, Newman and Proto 2014). Some other papers in this literature investigate how globalization affects the delegation of decision making inside the firm (Marin and Verdier 2008, 2014; Schymik 2017) and how the hierarchical structure of the firm (Chen 2017) affects productivity gains from globalization. Different from the existing studies, this paper focuses on how the separation of ownership and control inside the firm affects gains in productivity when import competition increases. Furthermore, this problem (i.e., the separation of ownership and control) is a dominant feature for most firms in reality. My paper fills this gap in the literature.

This article aims to speak to the literature on the firm-level response to tougher import competition. A series of work has documented that within-firm productivity increases in industries where substantial reductions in output tariffs are observed (Pavnick 2002; Trefler 2004; Brandt

[3] Seminal papers in this literature include Grossman and Helpman 1991; Aghion and Howitt 1992 and others.

[4] Seminal papers include Hart (1983), Hermalin (1992), Aghion, Dewatripont, and Rey (1997), Schmidt (1997), Raith (2003), and Vives (2008). Aghion *et al.* (2005) show that the relationship between competition and innovation is non-monotonic.

[5] Wu (2011, 2017) are exceptions. In his two papers, he considers the role of manager in production explicitly and derives interesting results on changes in managerial remuneration schemes after trade liberalization. However, his papers do not focus on the impact of trade liberalization on firm productivity. Antoniades (2015) studies endogenous quality and markup choices of heterogeneous firms in general equilibrium.

et al. 2012; Bloom, Draca, and Van Reenen 2016). In addition, firm's heterogeneous responses to tougher import competition have been identified as well.[6] Furthermore, some recent work has linked the change in organizational or managerial efficiency to tougher import competition (Schmitz 2005; Bloom and Van Reenen 2010; Bloom, Draca, and Van Reenen 2016)). A recent paper by Bloom *et al.* (2016) studies how management quality affects firm's exporting performance and product quality. Complementary to this literature, this article proposes a new channel through which tougher import competition incentivizes some managers to improve managerial efficiency and provides evidence for the key prediction of the model.

Finally, this paper is also related to the study on how better market access affects within-firm productivity. Lileeva and Trefler (2010) document that new Canadian exporting firms experienced productivity gains after the enactment of the Canada-U.S. Free Trade Agreement. Bustos (2011) finds that Argentinean firms whose size is in the third quartile of the size distribution received productivity gained after MERCOSUR went into effect, and these firms were most likely to be the smallest exporters.[7] The above two findings are consistent with the prediction of my model. Importantly, the focus of my paper is on the disciplining effect of tougher import competition, which is different from the focus of this literature.[8]

3 The Closed Economy

In this section, I characterize the equilibrium in the closed economy. The key feature of the model is that the equilibrium effort of the manager is a *non-monotonic* function of the initial quality of the business idea.

3.1 Environment

There are three types of players in the economy: workers, managers, and investors. Workers and managers come from a common pool of agents with a fixed mass, L. The agents differ in the initial quality of their business ideas, which are realizations of random draws from an underlying distribution. Agents make their occupational choice based on realizations of the initial quality draw. As a result, agents with good draws choose to be managers in equilibrium. There is a large pool of investors who have financial resources to form firms, and their outside option is normalized to zero. For simplicity, I assume that the total amount of financial resources

[6] For example, Schor (2004) finds that only the least productive surviving firms had improved productivity after output tariffs were reduced in Brazil.

[7] Biesebroeck (2006), De Loecker (2007), and Fernandes (2007) document similar empirical findings.

[8] An alternative mechanism to mine is that opening up to trade reduces the cost of consumption (i.e., the ideal price index) and increases the benefit of working as real wage goes up. Therefore, agents choose to work harder after opening up to trade, which makes firms more productive under tough competition (Trindade 2008). However, this argument does not emphasize firm heterogeneity which is the key emphasis of the current paper.

available is I, which is more than the (aggregate) ex ante payments for forming various firms.[9] As a result, investors are on the long side of the matching market when they get matched with the managers. And, they earn zero payoff which is their outside option in equilibrium.

There is one industry populated by firms that produce differentiated products under conditions of monopolistic competition à la Dixit and Stiglitz (1977). Each variety is indexed by ω, and Ω is the set of all varieties. Consumers derive utility from consuming these differentiated goods according to

$$U = \Big[\int_{\omega \in \Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \Big]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where $q(\omega)$ is the consumption of variety ω, and σ is the constant elasticity of substitution (CES) between differentiated goods.

The timing of the game is described in Figure 1. First, investors are matched with agents who choose to be managers in the market for managers. After the match, an ex ante transfer is made from the investor to the manager to ensure that every investor earns a zero payoff in equilibrium, as investors are on the long side of the matching market. Agents who choose to be workers work for firms and constitute the labor supply. Next, the agent who chooses to be the manager exerts effort (denoted by ψ) to develop the quality of the business idea (denoted by ρ), which leads to a blueprint for a product with the overall quality of $\psi\rho$. Third, the investor decides whether or not to pay an *entry* cost, f, in order to enter the industry and start production. I assume that the investor observes the overall quality of the business idea, when deciding whether or not to enter the industry.[10] The overall quality of the implementable idea determines the labor productivity of the firm in the subsequent production.[11] Fourth, if the production starts, the manager (or the owner) decides the output level and employment. Then, firms compete in the market, and revenue and the profit (i.e., the operating profit minus the fixed production cost) are received.[12] For simplicity, I normalize the *fixed* cost of *domestic* production to zero. As a result, the investor commands domestic production, if she has paid the entry cost at the third stage. However, I assume that the fixed cost of exporting is high enough in order to generate selection into exporting. Finally, the investor and the manager bargain over the profit to receive their payoffs. For simplicity, I assume that they play a generalized Nash bargaining game. As a result, the manager and the investor receive α and $1 - \alpha$ fractions of the profit respectively.

Workers and managers are inputs to production. In order to produce q units output, a firm must employ $\frac{q}{\rho\psi(\rho)}$ units of workers. The manager's effort affects firm productivity and

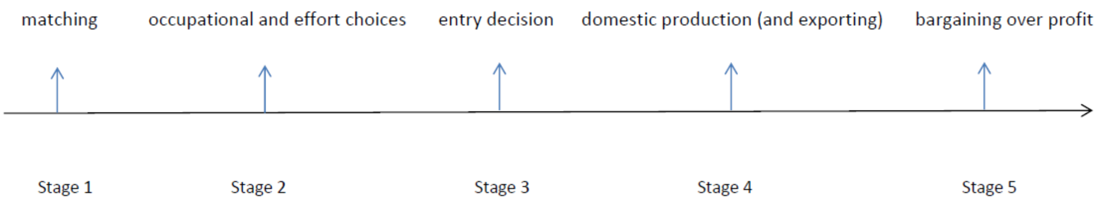
[9] These payments include the (aggregate) ex ante transfers from the investors to the managers and (aggregate) payments for the entry cost.

[10] In reality, the investor has to pay for the land rent and do due diligence in order to enter the industry and start production.

[11] Alternatively, I can assume that the overall quality of the implementable idea pins down the *quality* of the product. Qualitative results of the model are unchanged under this alternative specification.

[12] It is irrelevant who decides on the output and pricing level at this stage, since both parties' incentives are perfectly aligned to maximize profits at stage four (i.e., given the effort exerted by the manager).

Figure 1: The Timing of the Game



represents the amount of time the manager works *for the interest of the firm*.[13] In order to exert effort, the manager must incur a cost. The worker's wage is treated as the numeraire in the model, and the effort cost, ψ^{θ_0}, is denominated in terms of the numeraire. Parameter θ_0 ($> \sigma - 1$) measures the cost of exerting effort.

The justification for denominating the effort cost in the monetary term is to admit the income effect on effort provision. Naturally, it becomes harder to elicit effort, when agents become wealthier. If I assumed that the effort cost is denominated in the utility term, bilateral trade liberalization and economic growth would mechanically mitigate the incentive problem as they reduce the ideal price index and increase the real income.[14] In fact, the incentive problem would disappear in the long run in dynamic (growth) models, as the ideal price index approaches to zero and real income goes to infinity in the long run. This is counterfactual, and Romer (2006) and Davis and Harrigan (2011) have introduced income effect on effort provision into macro and trade models. This can be done by assuming that the disutility of exerting effort increases with nominal income (when the ideal price index is the numeraire) or decreases with the ideal price index (when nominal wage is the numeraire). I choose the second approach to model the effort cost in this paper.[15]

3.2 Effort Provision and the Decision to Produce

I use backward induction to solve the equilibrium and highlight the interaction between the manager's effort choice and the investor's decision to start production. Based on the utility function defined in equation (1), the demand function for a firm charging price p is derived as

$$q(p) = \left(\frac{p}{P}\right)^{-\sigma} \frac{Y}{P}, \tag{2}$$

[13]Bandiera *et al.* (2011) show that the amount of time a manager spends *inside* the firm is highly positively correlated with firm profitability.

[14]This effect has been studied by Matusz (1996) and Trindade (2008).

[15]In the current model, I assume that the agent maximizes *nominal income* $- \psi^{\theta_0}$. If I divide both sides by the ideal price index and interpret the effort cost as disutility (i.e., $\frac{\textit{nominal income}}{P} - \frac{\psi^{\theta_0}}{P}$), the effort cost (compared to the real income or consumption) decreases with the ideal price index.

where P is the ideal price index of the CES goods and defined as

$$P \equiv \Big[\int_{\omega(\rho)\in\Omega} p^{1-\sigma}(\rho) E dF(\rho)\Big]^{\frac{1}{1-\sigma}},$$

where $F(\rho)$ is the cumulative density function (c.d.f.) of the random draw, ρ, and E is the measure of varieties (or the measure of entering firms).

Since the manager's effort choice does not affect the fraction of profit he receives, the optimal price determined at the fourth stage is to maximize the profit. As a result, the optimal pricing rule is

$$p(\rho) = \frac{w}{\rho\psi(\rho)\lambda}, \tag{3}$$

where w is the worker's wage (which is the numeraire) and $\lambda \equiv \frac{\sigma-1}{\sigma}$ is the inverse of the markup. From equations (2) and (3), I derive the profit in the closed economy as

$$\pi(\rho,\psi) = \frac{1}{\sigma}R(\rho,\psi) = \frac{1}{\sigma}(\rho\psi\lambda P)^{\sigma-1}Y, \tag{4}$$

where $R(\rho,\psi)$ is the revenue, and Y is the total income earned by the managers, workers and the investors.

At stage three, the investor is willing to enter the industry and start production, if and only if the fraction of profit he receives is larger than or equal to the entry cost:

$$(1-\alpha)\pi(\rho,\psi) - f = \frac{(1-\alpha)}{\sigma}(\rho\psi\lambda P)^{\sigma-1}Y - f \geq 0. \tag{5}$$

The manager's effort choice at stage two is discussed case by case. If the investor is willing to enter the industry and produce, the objective function of the manager (after transformation of variables) is

$$\max_{\beta} \quad \alpha\eta(P,Y)\phi\beta - \beta^{\theta} \tag{6}$$

$$s.t. \quad \alpha\eta(P,Y)\phi\beta - \beta^{\theta} \geq 1,$$

where $\theta \equiv \frac{\theta_0}{\sigma-1}$, and $\eta(P,Y) \equiv \frac{1}{\sigma}(\lambda P)^{\sigma-1}Y$ is the market size (i.e., total income Y) adjusted by the ideal price index P. Variables ϕ and β are re-scaled initial quality and effort choice.[16] The inequality above is the manager's participation constraint. The solution is

$$\beta_s(\alpha,\eta,\phi) = \Big(\frac{\alpha\eta(P,Y)\phi}{\theta}\Big)^{\frac{1}{\theta-1}}, \tag{7}$$

which is defined as the second-best level of effort. When ϕ is sufficiently small, the profit the investor receives from the ex post bargaining must be smaller than f under the second-best level of effort. Therefore, there exists a cutoff, ϕ', such that the manager cannot compensate his investor by choosing the second-best level effort, if the initial quality is below this cutoff. This

[16]Specifically, $\phi \equiv \rho^{\sigma-1}, \beta \equiv \psi^{\sigma-1}$.

cutoff is defined as

$$(1-\alpha)\pi(\phi^{'}\beta_s(\alpha,\eta,\phi^{'})) = f. \tag{8}$$

The manager with a business idea better than $\phi^{'}$ chooses to be a worker if the payoff from running the firm is less than his outside option, or

$$\frac{\theta-1}{\theta}\alpha\pi(\phi^{'}\beta_s(\alpha,\eta,\phi^{'})) < 1.$$

If the above inequality is satisfied, we are in an uninteresting case in which managers of the zero-cutoff profit firm choose to be workers. In reality, it is probably true that when firms (i.e., investors) barely make a profit, their managers still receive high compensation (i.e., strictly positive payoffs) and stick to their jobs. Thus, it is more likely that we are in the case in which managers in firms whose investors earn zero profit obtain payoffs higher than their outside option. The following assumption guarantees this is the case, and I adopt this assumption in what follows.

Assumption 1

$$\alpha > \bar{\alpha} \equiv \frac{1}{1+f(1-\frac{1}{\theta})}.$$

In the following analysis, the range of variation of α is assumed to be between $\bar{\alpha}$ and one.

How does the manager with an implementable idea whose initial quality is below $\phi^{'}$ make the effort choice? First, any effort level lower than $\frac{\phi^{'}\beta_s(\alpha,\eta,\phi^{'})}{\phi}$ is suboptimal, as the investor would not start production. Second, any effort level higher than $\frac{\phi^{'}\beta_s(\alpha,\eta,\phi^{'})}{\phi}$ is suboptimal for the manager as well. The investor is induced to start production if the effort level equals $\frac{\phi^{'}\beta_s(\alpha,\eta,\phi^{'})}{\phi}$. Any further upward deviation from this level reduces the manager's payoff, since this effort level is already above the optimal level (without considering the binding participation constraint of the investor). Finally, if the initial quality of the idea is too low, the effort level of $\frac{\phi^{'}\beta_s(\alpha,\eta,\phi^{'})}{\phi}$ yields a payoff lower than the manager's outside option.[17] As a result, this type of manager chooses to become a worker. In total, there is another cutoff (i.e., $\phi^*(<\phi^{'})$) such that if the initial quality is above this cutoff but below $\phi^{'}$, the manager chooses the effort level that makes the firm owner break even.

Now, I discuss the matching process at the first stage. A stable matching consists of a set of firms which is a collection of pairs of the manager and the investor. The (overall) surplus function of the manager and the investor is specified as ($\alpha\eta\phi\beta(\alpha,\eta,\phi) - \beta^{\theta}(\alpha,\eta,\phi)$, $(1-\alpha)\eta\phi\beta(\alpha,\eta,\phi) - f$) where the effort choice of the manager in equilibrium is denoted by $\beta(\alpha,\eta,\phi)$. The ex ante transfer from the investor to the manager is specified as (ϕ, $t(\phi)$) which has to satisfy the following three conditions:

[17] As I will show later, this payoff includes both the ex post profit received by the manager and the ex ante transfer from the investor.

- Participation constraint: $(1-\alpha)\eta\phi\beta(\alpha,\eta,\phi)-f-t(\phi)\geq 0$ for the investor and $\alpha\eta\phi\beta(\alpha,\eta,\phi)-\beta^{\theta}(\alpha,\eta,\phi)+t(\phi)\geq 1$ for the manager.
- Stability of the match: For any $\phi_1 \geq \phi_2$, $t(\phi_1) \geq t(\phi_2)$.
- Equal treatment for the investors: $(1-\alpha)\eta\phi\beta(\alpha,\eta,\phi) - f - t(\phi) = 0$ for any θ.

The first condition above states that both players earn no less than their outside options from the match. The second condition is a monotonicity condition for the ex ante transfer. If it did not hold, there would exist two firm pairs such that the investor who is matched with the worse manager (but pays a high transfer) has an incentive to get rematched with the better manager who receives a lower transfer under the original match. Therefore, this condition is a necessary condition for the stable matching. The last condition comes from the fact that the investors are homogeneous and on the long side of the matching market, which implies that every investor receives zero payoff in equilibrium. In total, the ex ante transfer scheme takes the following form:

$$t(\phi) = (1-\alpha)\eta\phi\beta(\alpha,\eta,\phi) - f. \tag{9}$$

Since the investor earns zero net profit ex post when $\phi \in [\phi^*, \phi^{'}]$, the above transfer is zero for $\phi \in [\phi^*, \phi^{'}]$ and strictly positive for $\phi > \phi^{'}$. Essentially, the manager receives all the profit borne out of the production. The following lemma summarizes the transfer scheme, the occupation and effort choices of the manager:

Lemma 1 *Agents whose quality draws are above $\phi^{'}$ choose to be managers and are matched with investors who choose to start production. The cutoff, $\phi^{'}$, is defined as*

$$\phi^{'} \equiv \Big(\frac{f}{(1-\alpha)}\Big)^{\frac{\theta-1}{\theta}}\Big(\frac{\theta}{\alpha\eta(P,Y)^{\theta}}\Big)^{\frac{1}{\theta}}, \tag{10}$$

and the effort choice is at the second-best level: $\beta(\alpha,\eta,\phi) = \beta_s(\alpha,\eta,\phi)$. The transfer from the investor is strictly positive in this case: $t(\phi) = (1-\alpha)\eta\phi\beta(\alpha,\eta,\phi) - f > 0$.

Agents whose quality draws are between ϕ^* and $\phi^{'}$ choose to be managers and are matched with investors who start production as well. The cutoff, ϕ^*, is determined by

$$\phi^* \equiv \frac{\phi^{'}(\alpha f)^{\frac{1}{\theta}}}{\Big(\theta[\alpha f-(1-\alpha)]\Big)^{\frac{1}{\theta}}} < \phi^{'}, \tag{11}$$

and the effort choice is above the second-best level:

$$\beta(\alpha,\eta,\phi) = \frac{\beta_s(\alpha,\eta,\phi^{'})\phi^{'}}{\phi} > \beta_s(\alpha,\eta,\phi), \tag{12}$$

and the ex ante transfer from the investor is zero.

If the agent's initial quality draw is below ϕ^*, he chooses to become a worker and to earn wage as the payoff.

Proof: See Appendix 7.1. QED.

It is interesting that although the manager essentially receives all the profit from production, he still exerts effort lower than the first-best level. The reason is that the ex ante transfer has been made before the manager makes the effort choice. Although the investor decides the amount of transfer based on her ex post profit, the manager cannot promise the investor a higher level of effort in exchange for a higher ex ante transfer as it is not subgame-perfect. Next, it is also interesting that although the agency problem exists inside the firm, the existence of the sunk entry cost mitigates this problem for unproductive firms. The fundamental friction here is that complete contracts are infeasible.[18] As Bolton and Scharfstein (1990) and Hart and Moore (1994, 1998) have forcefully argued, complete contracts that base the managerial compensation on the manager's effort or performance measures are usually infeasible, since these measures are either non-verifiable or manipulatable. Therefore, ex post bargain shapes both players' payoffs and creates an agency problem. However, the (credible) threat of not entering the industry by the investor incentivizes the manager whose quality draw is close to the exit cutoff to exert more effort. This is the key innovation of the current paper.

The relationship between the initial quality of the idea and the manager's optimal effort choice is non-monotonic, as shown by Figure 2. When the initial quality is high, the optimal effort *increases* with it, as a higher initial quality increases the marginal return to exerting effort. Those firms are called "unconstrained firms", since their investors' participation constraint does not bind in equilibrium. In fact, this is the first type of manager analyzed by Schmidt (1997): managers who exert effort based on the returns to earn in the product market. However, when the initial quality of the idea is in the middle range, the optimal effort *decreases* with the initial quality, as a higher initial quality coupled with a lower effort level makes the investor break even. For this part, the fixed entry cost acts as a disciplining device for the manager. Those firms are called "constrained firms" in the paper, and they are the second type of manager analyzed by Schmidt (1997): managers who endogenously exert high effort as they fear the threat of liquidation. In total, the relationship between the initial quality of the idea and the optimal effort level is "U" shaped and closely related to the analysis in Schmidt (1997).

As a result of the "U"-shaped relationship between the initial quality and the effort level, firm productivity measured by $\phi\beta(\alpha, \eta, \phi)$ weakly increases with the initial quality ϕ, as shown by Figure 3. In particular, firm productivity (and size) are the same across all constrained firms and increases with the quality draw among non-constrained firms. Strictly speaking, the model predicts that there is a cluster of small firms with exactly the same productivity and size at the exit cutoff. As a result, the managerial effort varies even among these equal-sized firms. However, an extension of the current model generates the prediction that firm size increases with the initial quality draw even among the constrained non-exporters. As a result, the managerial effort is "U"-shaped with respect to firm size overall in this slightly extended

[18]Otherwise, the investor could offer a contract that makes the manager receive the *full* profit and pay the investor a fixed fee after the profit is realized.

Figure 2: Initial Quality and Effort Choice in Closed Economy

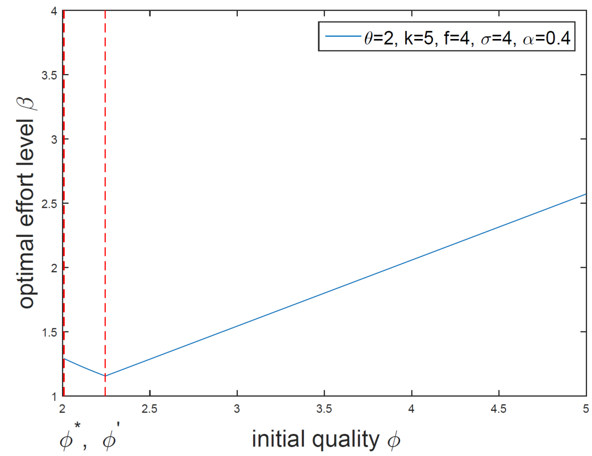
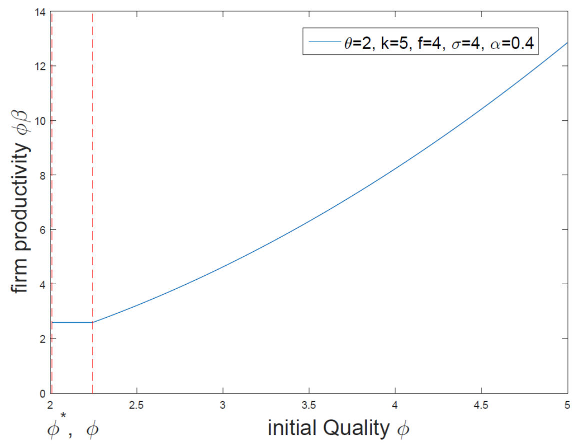


Figure 3: Initial Quality and Firm Productivity in Closed Economy



model, which is indeed consistent with the empirical finding above. For details, see Appendix 7.3.[19]

3.3 Aggregation in the Closed Economy

In this subsection, I analyze the industry equilibrium of the closed economy. In order to obtain analytical results, I assume that the initial quality of the idea is drawn from a Pareto distribution:

$$G(\phi) = 1 - \phi^{-k}, \tag{13}$$

[19]The reason why I stick to the original setting in the following analysis is the industry equilibrium nature of the model. In the extended model in Appendix 7.3, I need to introduce a non-operating profit which comes from investment profits and capital gains of the firm. I would have to introduce other factors such as capital and land into the model, if I incorporated the non-operating profit of the firm into the industry equilibrium. This would bring unnecessary complications into the equilibrium model without generating new insights.

where the shape parameter k is negatively related to the variance of the distribution.[20]

There are three sets of equilibrium conditions. The first one is related to cutoffs. The zero-profit condition (ZPC) for entry indicates that firms whose products' initial quality is ϕ' break even in equilibrium:

$$\frac{f}{(1-\alpha)} = \left(\frac{\alpha}{\theta}\right)^{\frac{1}{\theta-1}} \phi'^{\frac{\theta}{\theta-1}} \left[\frac{1}{\sigma}(\lambda P)^{\sigma-1} Y\right]^{\frac{\theta}{\theta-1}}. \tag{14}$$

The exit cutoff for the manager is denoted by ϕ^* and pinned down by equation (11). The second set of equilibrium conditions is related to the effort choices, which are determined by equation (7) when $\phi \geq \phi'$ and by equation (12) when $\phi \in [\phi^*, \phi')$.

The final set of equilibrium conditions is about market clearing. The supply of labor is simply $\left(1 - \frac{1}{\phi^{*k}}\right)L$. The demand for labor comes from the one used for paying the variable cost and the one used for paying the fixed entry cost. The first part is simply $\frac{\sigma-1}{\sigma}Y$, where Y is the total income, and the second part is

$$\frac{(1-\alpha)}{1 + \frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} \left(\frac{\alpha f}{\theta[\alpha f-(1-\alpha)]}\right)^{\frac{k}{\theta}}} \frac{Y}{\sigma},$$

which leads to the labor-market-clearing condition as

$$Y = \left(1 - \frac{\left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}}}{\phi'^k}\right) \frac{L\sigma}{(\sigma-1) + \frac{(1-\alpha)}{1+\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}}\left(\frac{\alpha f}{\theta[\alpha f-(1-\alpha)]}\right)^{\frac{k}{\theta}}}}. \tag{15}$$

This equilibrium condition pins down a positive relationship between Y and ϕ'. Total income of the economy increases when more agents become workers, as (wage) income of workers constitutes a fixed fraction of the total income. I omit the statement of the product market clearing condition due to Walras' law and normalize wage to one.

The industry equilibrium of the economy is characterized by the zero-profit cutoff, ϕ', the exit cutoff, ϕ^*, the effort choice, $\beta(\alpha, \eta, \phi)$, and the total income, Y. These variables are obtained by solving equations (7), (11), (12), (14) and (15).

The equilibrium conditions can be reduced to two equations (ZPC and the labor-market-clearing condition) and two unknowns (ϕ' and Y) after substituting the expression of the ideal price index into equation (14).[21] Specifically, ZPC now becomes:

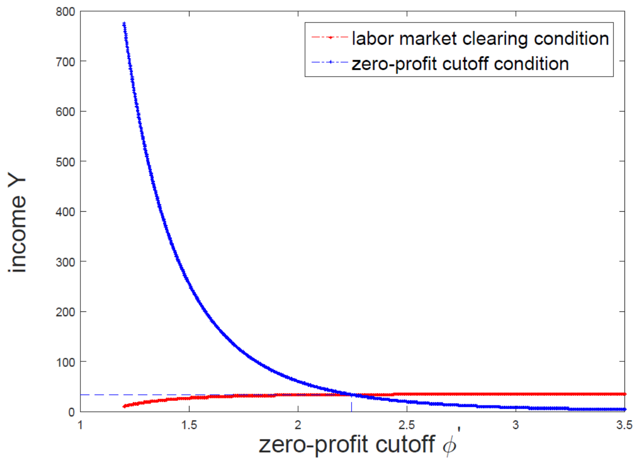
$$\frac{f}{(1-\alpha)} = \frac{\phi'^k Y}{L\sigma\left[\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}}\right]}, \tag{16}$$

which pins down a negative relationship between Y and ϕ'. When the total income decreases,

[20] In order to have a finite expected profit from entry, k has to be bigger than $\frac{\theta}{\theta-1}$.

[21] Details can be found in Appendix 7.4.

Figure 4: Equilibrium Conditions in Closed Economy



survival becomes tougher, which results in an increase in the zero-profit cutoff. Equations (15) and (16) together pin down the equilibrium, and Figure 4 represents the determination of the closed-economy equilibrium graphically. Based on Equations (15) and (16), I can solve for the zero-profit cutoff in the closed economy as

$$\phi' = \left[(1+f)\Big(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\Big)^{\frac{k}{\theta}} + \frac{f(\sigma-1)}{1-\alpha}\Big[\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \Big(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\Big)^{\frac{k}{\theta}}\Big]\right]^{\frac{1}{k}}. \quad (17)$$

Note that when the zero-profit cutoff, ϕ', approaches $(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f})^{\frac{1}{\theta}}$ (i.e., ϕ^* approaches one), Y implied by equation (15) converges to zero. While when the exit cutoff, ϕ^*, goes to infinity, Y implied by equation (16) converges to zero. Therefore, I have a unique equilibrium pinned down by the two equilibrium conditions in equations (15) and (16). Finally, a lower bound on I above which the amount of available financial resources is more than what is needed to form firms is derived in Appendix 7.4.

4 The Open Economy

In this section, I analyze the properties of managerial effort and firm productivity in the open economy. My analysis explores the *differential* impact of trade liberalization on the equilibrium effort choice and firm productivity. Similar to Melitz (2003), I assume there are two symmetric countries in the world: $\tau > 1$ is the iceberg (or variable) trade cost, and f_x is the fixed trade cost. The iceberg trade cost means that if τ units of output are shipped to the foreign market, only one unit of it arrives. The fixed exporting cost means that the firm must incur a fixed cost in order to export. I assume that the firm incurs this fixed cost of exporting at the fourth stage, which is the same timing assumption imposed on the variable cost. As a result, the investor decides whether or not to export at this stage in the open economy. Note that I assume domestic production does not incur any fixed cost. Thus, a firm that exports must produce and sell domestically as well.

A crucial point here is that there is *no* conflict of interests when the investor decides whether to export, as the investor compares the full increase in (i.e., not a fraction of) the profit from exporting to the fixed exporting cost when making such a decision. This is different from the decision on market entry in which case the investor only compares a fraction of the profit to the entry cost. There is such a difference, as I assume that the entry cost is paid (by the investor) before the production starts and the profit is generated. To the contrary, the fixed (domestic and exporting) cost is paid during the production process and deducted from sales directly, when the production generates the profit. As a result, both the manager and investor bargain over the profit which equals the operating profit minus the fixed (domestic production and/or exporting) cost, while only the investor pays for the entry cost. Due to this difference, a change in the bargaining power of the manager, α, has an impact on the selection into exporting which will be explored further in Section 5.

4.1 Optimal Effort Choice in the Open Economy

Now, I discuss the behavior of the manager and the investor in the open economy. First, the optimal price decided by the manager at the fourth stage is still to maximize the operating profit. Second, the investor's participation constraint (i.e., the decision to enter the industry) is still governed by equation (5), if she does not choose to export.[22] Third, similar to the closed economy case, there are two types of firms among non-exporting firms in the open economy.

I analyze how the manager makes his effort choice at the second stage in the open economy, case by case. The analysis in the closed economy applies to non-exporters in the open economy, as these firms do not export. Specifically, the zero-profit cutoff and the exit cutoff are still governed by equations (10) and (11), except that P and Y are the ideal price index and the total income in the open economy. Next, the effort choice of managers with ϕ between ϕ^* and $\phi^{'}$ is still governed by equation (12). When the initial quality is higher than $\phi^{'}$, the manager's payoff is

$$\max_{\beta} \quad \alpha[(1+\tau^{1-\sigma})\eta(P,Y)\phi\beta - f_x] - \beta^{\theta}, \tag{18}$$

if the investor decides to export and

$$\max_{\beta} \quad \alpha\eta(P,Y)\phi\beta - \beta^{\theta}, \tag{19}$$

if the investor decides not to export. I consider the case in which there is selection into exporting among firms that make a positive profit, and a sufficiently large fixed trade cost ensures it is the case. Empirical evidence motivates this choice.[23] The following lemma characterizes how

[22]Since the cutoff on exporting is above the zero-profit cutoff in the open economy, the participation constraint of investors in exporting firms does not bind in the open economy.

[23]Data shows that only a small fraction of firms export, and exporting firms receive higher profit and revenue than non-exporting firms. For instance, only 18% of U.S. manufacturing firms exported in 2002 (Bernard, Jensen,

the exporting cutoff and the effort of manager in exporting firms are determined in the open economy:

Lemma 2 *I assume that there is selection into exporting among firms that earn positive profits:*

Assumption 2

$$\Big(\frac{f_x}{f[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]}\Big)^{\frac{\theta-1}{\theta}}\Big(\frac{(1-\alpha)\theta}{\theta-1}\Big)^{\frac{\theta-1}{\theta}} \geq 1.$$

The exporting cutoff is determined by

$$\phi_x = \Big(\frac{f_x}{f[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]}\Big)^{\frac{\theta-1}{\theta}}\Big(\frac{(1-\alpha)\theta}{\theta-1}\Big)^{\frac{\theta-1}{\theta}}\phi'. \tag{20}$$

When $\phi \geq \phi_x$, the firm exports and the optimal managerial effort is

$$\beta(\alpha,\eta,\phi,\tau) = \beta_s(\alpha,\eta,\phi)\Big(1+\frac{1}{\tau^{\sigma-1}}\Big)^{\frac{1}{\theta-1}}. \tag{21}$$

When $\phi \in [\phi', \phi_x)$, the firm does not export and the managerial effort is governed by equation (7).

Proof: See Appendix 7.2. QED.

The following proposition summarizes the ex ante transfer scheme, the occupation choice of the manager, and the optimal managerial choice in the open economy:

Proposition 1 *The zero-profit cutoff, the exit cutoff, and the exporting cutoff (ϕ' and ϕ^*, ϕ_x) are determined by equations (10), (11) and (20). When the business idea is so good that $\phi \geq \phi_x$, the agent chooses to be a manager and exerts effort according to equation (21), and his investor exports. When the initial quality of the business idea $\phi \in [\phi', \phi_x)$, the agent becomes a manager and exerts effort at the level of*

$$\beta(\alpha,\eta,\phi) = \Big(\frac{\alpha\eta(P,Y)\phi}{\theta}\Big)^{\frac{1}{\theta-1}}, \tag{22}$$

and his investor produces but does not export. When the initial quality draw $\phi \in [\phi^*, \phi')$, the agent chooses to be a manager and exerts effort at the level of

$$\beta(\alpha,\eta,\phi) = \frac{\beta_s(\alpha,\eta,\phi')\phi'}{\phi} > \beta_s(\alpha,\eta,\phi), \tag{23}$$

and his investor sells domestically but, again, does not export. When the initial quality draw, ϕ, is smaller than ϕ^*, the agent chooses to become a worker and earns a wage income.

Redding, and Schott, 2007).

For non-exporting firms, the ex ante transfer is zero for $\phi \in [\phi^*, \phi')$ *and*

$$(1-\alpha)\eta\phi\beta(\alpha,\eta,\phi) - f$$

for $\phi \in [\phi', \phi_x)$*. For exporting firms, the ex ante transfer is*

$$(1-\alpha)\eta\phi\beta(\alpha,\eta,\phi)\Big(1 + \frac{1}{\tau^{\sigma-1}}\Big) - f - f_x$$

for $\phi \geq \phi_x$*.*

Proof: See Appendix 7.6. QED.

4.2 Aggregation in the Open Economy

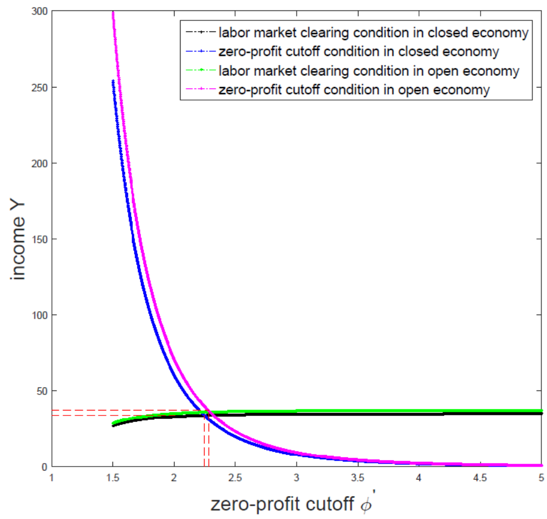
Similar to the closed economy equilibrium, the open economy equilibrium has three sets of equilibrium conditions as well. The first set is still related to the cutoffs. First, the determination of the exit cutoff, ϕ^*, is still governed by equation (11), and the exporting cutoffs, ϕ_x is determined by equation (20). Next, I can solve for the ideal price index in the open economy and derive the ZPC condition which pins down the zero-profit cutoff in the open economy as

$$\frac{f}{(1-\alpha)} = \frac{\frac{\phi'^k Y}{\sigma L}}{\left[\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}} + \frac{k}{k-\frac{\theta}{\theta-1}}\left(\frac{f_x}{f}\right)^{1-k\left(\frac{\theta-1}{\theta}\right)}[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}} - 1]^{k\left(\frac{\theta-1}{\theta}\right)}\left(\frac{(1-\alpha)\theta}{\theta-1}\right)^{1-k\left(\frac{\theta-1}{\theta}\right)}\right]}. \tag{24}$$

Comparing equation (24) with equation (16), I find that ZPC shifts to the right in the (ϕ', Y) domain. Conditioning on Y, it is tougher for a non-exporting firm to survive in the open economy than in the closed economy for two reasons. First, foreign exporting firms enter the domestic market, which reduces domestic ideal price index. Second, exporting firms from the home country increase managerial effort, which pushes down the ideal price index at home as well. In total, conditioning on Y, the zero-profit cutoff (and exit cutoff) are higher in the open economy than in the closed economy. This finding holds for bilateral trade liberalization as well. That is, the ZPC curve shifts to the right, when the trade cost (τ or f_x) goes down. This is the selection effect of bilateral trade liberalization.

The second set of equilibrium conditions is related to the manager's effort choice, and equations (21), (22) and (23) pin down the manager's effort choice in equilibrium. The third

Figure 5: Equilibrium Conditions in Closed Economy and in Open Economy



set is the labor-market-clearing condition which can be derived as

$$Y = \frac{\left(1 - \frac{\left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}}}{\phi'^k}\right)L\sigma}{(\sigma-1) + \frac{(1-\alpha)\left[\left(\frac{\phi'}{\phi^*}\right)^k + \frac{f_x}{f}\left(\frac{\phi'}{\phi_x}\right)^k\right]}{\left[\left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}} + \frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \frac{k}{k-\frac{\theta}{\theta-1}}\left[\left(1+\frac{1}{\tau^{\sigma-1}}\right)^{\frac{\theta}{\theta-1}}-1\right]\left(\frac{\phi'}{\phi_x}\right)^{k-\frac{\theta}{\theta-1}}\right]}}. \tag{25}$$

Different from the unambiguous rightward shift of the ZPC curve, the curve of labor-market-clearing condition can shift either up or down when the economy moves from autarky to the open economy.[24] The type of equilibrium in the open economy presented in Figure 5 corresponds to the scenario in which the curve of labor-market-clearing condition shifts up when the economies open up to trade. However, a counter-example is provided in Figure 14 in Appendix.

The industry equilibrium of the open economy is characterized by the zero-profit cutoff, ϕ', the exit cutoff, ϕ^*, the exporting cutoff, ϕ_x, the effort choices, $\beta(\phi)$, and the total income, Y. These variables are obtained by solving equations (11), (20), (21), (22), (23), (24), and (25). Figure 5 represents how the equilibrium is determined in the closed economy and in the open economy. For further discussion about the equilibrium conditions and the ideal price index in the open economy, see Appendix 7.5.

Similar to analysis for the closed economy, I can reduce the equilibrium conditions into two equations (ZPC and the labor-market-clearing condition) and two unknowns (ϕ' and Y)

[24]Readers can see this point by comparing equation (25) with equation (15).

and solve for the zero-profit cutoff as

$$\phi' = \left[(1+f)T_1(\alpha,f)^{\frac{k}{\theta}} + \frac{f(\sigma-1)}{1-\alpha}\left[\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + T_1(\alpha,f)^{\frac{k}{\theta}} + \frac{k}{k-\frac{\theta}{\theta-1}} T_2(f_x,\tau)^{\frac{\theta}{\theta-1}-k}[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]\right] + f_x T_2(f_x,\tau)^{-k}\right]^{\frac{1}{k}}, \tag{26}$$

where

$$T_1(\alpha,f) \equiv \frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}; \qquad T_2(f_x,\tau) \equiv \left(\frac{f_x}{f[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]}\right)^{\frac{\theta-1}{\theta}}\left(\frac{(1-\alpha)\theta}{\theta-1}\right)^{\frac{\theta-1}{\theta}}.$$

A simple comparison between equation (17) and equation (26) indicates that the zero-profit cutoff (and the exit cutoff ϕ^*) are higher in the open economy than in the closed economy. Moreover, simple calculation shows that both cutoffs decrease, when the fixed trade cost f_x or the variable trade cost τ increases. In total, I manage to derive the selection effect of trade in my extended heterogeneous firm model with the agency problem. When the trade costs go down, the exit cutoff and the zero-profit cutoff all increase due to tougher selection. At the meantime, the exporting cutoff decreases due to lower trade costs, which can be easily verified using equations (20) and (26).

4.3 Opening Up to Trade, Trade Liberalization and Firm Productivity

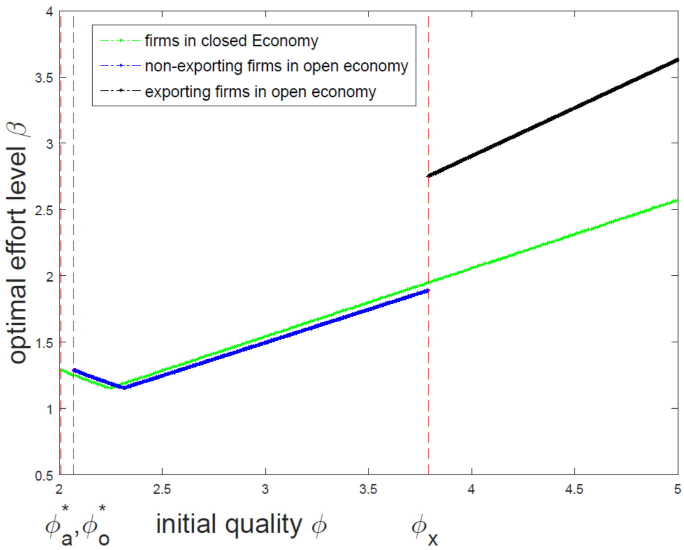
In this subsection, I discuss how opening up to trade and trade liberalization affect the managerial effort and firm productivity. The key economic insight is that intensified competition due to the introduction of international trade acts as a disciplining device for managers in the least productive surviving firms which do not export. The following proposition discusses the selection effect of bilateral trade liberalization and how managers adjust their effort choices in the open economy:

Proposition 2 *After opening up to trade, the exit cutoff and the zero-profit cutoff both increase, as market size faced by non-exporting firms shrinks. The exporting cutoff decreases when the trade costs go down. Productivities of exporting firms and effort levels of managers working in these firms increase when the economy opens up to trade. When the trade costs are not too small in the open economy, the least productive surviving (non-exporting) firms increase their productivity and managerial effort after opening up to trade. For the remaining surviving non-exporters, they reduce their productivity and managerial effort after opening up to trade.*

Proof: See Appendix 7.7. QED.

Figures 6 and 7 illustrate how the managerial effort and endogenous firm productivity change from the closed economy to the open economy. There are three differences compared to the closed economy. First, managers of the least productive surviving (non-exporting) firms increase their effort and firm productivity, when the economy moves from autarky to an open

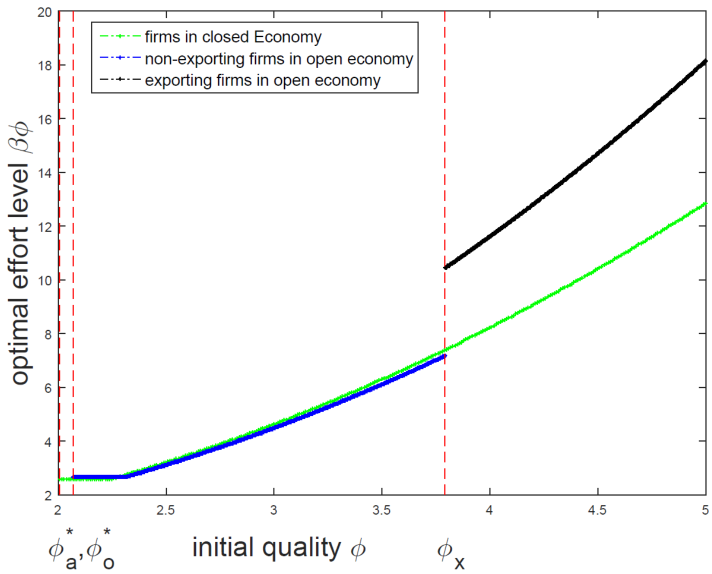
Figure 6: Managerial Effort in Closed Economy and in Open Economy



economy. In order to incentivize their investors to produce and continue to receive rents in the open economy, managers of the least productive surviving non-exporters exert more effort. The introduction of international trade reduces rents earned by managers working in these firms and mitigates the agency problem. Managers of exporting firms exert more effort and increase firm productivity when the two economies open up, as there is a complementarity between enlarged market size and the return to exerting effort. Finally, managers of productive non-exporting firms exert less effort when the two economies open up, as the return to exerting effort is lower in the open economy due to the shrinking (domestic) marker size. In total, the disciplining effect of trade on the least productive firms is the key innovation of this paper.

Different from Melitz (2003) which is an endogenous entry model, the current paper uses a model of exogenous firm entry (i.e., the mass of potential entrants is fixed at L), which is similar to Chaney (2008) and Monte (2011). Some implications are true in both the current model and in Melitz (2003). In both models, market size shrinks and the exit cutoff increases after opening up to trade. In addition, exporting firms expand and demand more labor after opening up to trade in both models as well. The key difference between the two models is labor supply. In the endogenous entry model, real wage has to increase to make labor demand equal labor supply after opening up to trade, although labor supply itself is unchanged by assumption. In the current model, as labor supply is endogenous, increasing labor demand (from exporting firms) leads to both an increase in real wage (i.e., a reduction in the ideal price index) and an increase in labor supply, which is possible only when the cutoff for becoming the manager (and entering the market) increases. In total, the current model not only generates tougher selection into the market (by non-exporting firms) after opening up to trade, but also yields tougher selection into the occupation of managers after opening up to trade.

Figure 7: Firm Productivity in Closed Economy and in Open Economy



As the current model features the occupational choice by agents, it yields implications for the distribution of payoffs (income minus effort costs) when the economy opens up to trade. In term of payoffs, workers gain as the ideal price index decreases after trade while their nominal wage stays the same. This is the conventional source for the welfare gains from trade. For managers in exporting firms, their monetary income and real income go up after trade. For managers in non-exporting firms, those unconstrained ones' monetary income shrinks while their real income might increase, thanks to the lower ideal price index in the open economy. The above two effects on managers exist in heterogeneous agent models with the occupational choice (Monte 2011; Dinopoulos and Tsoulouhas 2016), but not in heterogeneous firm models with homogeneous agents (Melitz 2003). Finally, even though constrained managers in non-exporting firms increase their effort after opening up to trade, their income stays the same and their effort costs go up. Thus, their nominal payoff (nominal income minus the effort cost) goes down, while their real payoff might go up in the open economy, thanks to lower ideal price index in the open economy as well. In total, the implication of my model for income distribution is that managers working in exporting firms gain most after opening up to trade, while those working in non-exporting firms gain least (and possibly even lose) after opening up to trade. The worker's welfare gain is in the middle.

Why does the validity of the above proposition require the condition that trade costs are not too small? The key observation is that if the reduction in trade costs is not too big, some managers would be constrained in both the closed economy and the open economy.[25] It is exactly this type of manager who exerts more effort when the economy moves from autarky to the open economy. However, if the reduction in trade costs is too large, the model predicts that

[25]These managers are constrained in the sense that second-best level of effort could not induce their investors to produce.

managers working in *all* non-exporters exert less effort when the economy opens up to trade. Despite this result, the percentage decrease in productivity is still smaller for unproductive surviving non-exporters than for productive surviving non-exporters, which is summarized in the following proposition.

Proposition 3 *After opening up to trade, the exit cutoff, ϕ^*, and the zero-profit cutoff, ϕ', both increase strictly. When trade costs are sufficiently small in the open economy, productivity of all non-exporters decrease. However, the percentage decrease in productivity is smaller for less productive surviving non-exporters than for more productive surviving non-exporters.*

Proof: See Appendix 7.8. QED.
The main difference of the above proposition compared with Proposition 2 concerns the least productive surviving non-exporters. When the reduction in trade costs is small, managers working in the least productive surviving non-exporters exert effort at the level that makes their investors break even both before and after the opening up to trade. In this case, *only* the disciplining effect plays a role. When the reduction in trade costs is in the middle range, managers of this type of firm exert effort at the second-best level in autarky and at the level that makes their investors break even after opening up to trade. Although shrinking market size pushes down the second-best level of effort, the disciplining effect incentivizes the managers to exert effort higher than the second-best level in the open economy. In the end, the disciplining effect dominates the market size effect, and managers of this type of firm exert more effort. Finally, the market size effect dominates the disciplining effect when the reduction in trade costs is sufficiently large. This results in reduced effort provision for managers of the least productive surviving non-exporters (see Figure 15). In total, a robust prediction of the model is that the percentage decrease in firm productivity is always smaller for the least productive surviving non-exporters than for the most productive surviving non-exporters.

My model's prediction on productivity improvements by initially unproductive firms applies well to several recent trade liberalization episodes. Figure 1 in Trefler (2004) documents that the annual drop in output tariff is 1% by the Canadian government (against the U.S.) and 0.5% by the U.S. government (against Canada) after the enactment of NAFTA (1989-1996). Figure 1 in Brandt et al. (2017) shows that the annual drop in output tariff is roughly 1.5% by the Chinese government after China joined WTO (2001-2007). In total, the two famous episodes of bilateral trade liberalization all feature gradual and small reductions in tariffs year by year, and this is exactly the scenario my model applies to. In addition, both papers do find that firms that were hit by import competition had increased productivity. These findings square well with my model's prediction on how import competition incentives non-exporting firms to improve productivity.

In the paper, the return to investor's assets is normalized to zero. This is used to move the analysis away from investment market and to focus the analysis on the product market. I keep the same assumption in the open economy as in the closed economy, which implies that I consider trade liberalization in product market only. Following trade liberalization, there might be financial liberalization which affects investors' asset returns in reality, However, financial liberalization only affects the investor's and manager's choices at the *entry margin* and does not affect the manager's effort choice after entry, as the cost and benefit of exerting effort is independent of the outside option of the investor. In other words, the model's predictions on the managers' effort choices and firm productivity do not depend on the non-existence of financial liberalization (following trade liberalization).

4.4 Evidence

4.4.1 Data

In the end of this section, I present evidence which is consistent with the model's key prediction on the relationship between the managerial effort and firm size. The model predicts that among (non-exporting) firms, the managerial effort is "U"-shaped with respect to the initial quality draw of the firm. Note that in an open economy with multiple countries, which is the case in the data, there are multiple cutoffs for exporting. As a result, the model *does not* have a clear prediction on how the managerial effort varies with firm size among firms that export. Therefore, I focus on non-exporting firms to implement the empirical analysis. Using the data from WMS, I show that the average score of management practices that are closely related to the managerial effort is indeed "U'-shaped with respect to firm size among non-exporting firms (i.e., a proxy for the initial quality draw). Of course, the caveat here is that the empirical findings below are not causal evidence for my model's prediction.

The two datasets I am using are downloaded from WMS website, and they are the same as the ones used in Bloom and Van Reenen (2010). The first dataset includes the score on each of the 18 management practices defined by Bloom and Van Reenen (2010).[26] For a subset of firms in the dataset, it also has some additional information on the exporting status of the firm. Note that the first dataset only contains *cross-sectional* information on scores of management practices, as the management survey was conducted only once for each firm. The second (panel) dataset has production and financial information (e.g., employment, sales etc.) for each firm surveyed in the first dataset and covers the period of 2003-2008. Using a common firm identifier, I merge the two datasets to obtain the dataset that is used in the following empirical analysis. Details of the merging and summary statistics of the merged dataset can be found in Appendix 7.11.

I construct variables as follows. First, I investigate the 18 management practices in WMS and find that eight of them are closely related to the managerial effort. In total, the 18 questions surveyed can be grouped into four categories: operations (3 questions), monitoring (5 questions), targets (5 questions) and incentives (5 questions). Some practices such as "removing

[26]The link to WMS is `http://worldmanagementsurvey.org/`. For detailed discussion of the survey and variables constructed in the dataset, see Bloom and Van Reenen (2007, 2010).

poor performers" and "promoting high performers" are related to how the incentive system is set up (instead of to the managerial effort). Therefore, I exclude these practices from the average management score I construct for measuring the managerial effort. In total, I have three sets of practices which are closely related to the effort of the manager(s): attracting and retaining human capital (2 questions), documenting, tracking, reviewing and improving employees' performance (4 questions), adoption of learn production (2 questions). The management team probably needs to spend effort to recruit and maintain high-quality employees. In addition, how well the management team tracks, reviews and improves its employees' performance also depends on the management team's effort.[27] Finally, the adoption of lean production also needs managerial effort. I calculate the average score of these eight management practices and use it as the main measure for the managerial effort. As a robustness check, I exclude the two questions on the adoption of lean production which might reflect the quality of management technology, and take the average score of the remaining six management practices as the second measure for the managerial effort. Second, as the initial quality draw is unobservable, I use firm size to proxy for the quality draw. Strictly speaking, the model predicts that there is a cluster of small firms with exactly the same size at the exit cutoff. However, in a slightly extended version of the model, the model can generate the prediction that firm size increases with the initial quality draw even among the constrained non-exporters. [28] This validates the empirical analysis in this section. Third, in order to avoid a substantial loss of observations, I treat the average management score of each firm unchanged overtime and use all observations (across different years) to implement the empirical analysis.

4.4.2 Regressions

The regression is a non-parametric regression with a full set of size quantile dummy variables for non-exporting firms:

$$\begin{aligned} MS_i &= \nu_0 + \sum_{i=1}^{5} \nu_i \, quintile_i \\ &\quad + Non-MNE_{i,t} + Domestic\ MNE_{i,t} + sic_j + country_c + year_t + \epsilon_{i,t}, \end{aligned} \tag{27}$$

where i indicates the firm; t denotes the year; c indicates the country where the firm is located; j denotes the firm's three-digit ISIC industry affiliation. Variable MS_i is the average score of the eight management practices (denoted as MS_{eff}) or the average score of the six management practices (denoted as MS_{sub}). Variables sic_j, $country_c$, $year_t$ are industry, country and year fixed effects. Since existing research (Bloom and Van Reenen 2007, 2010) documents that MNEs have better management quality than non-MNEs, I add two dummy variables related to MNEs into the regression: $Domestic\ MNE_{i,t}$ for the domestic firm that has affiliates(s) in

[27]This is especially true for the frequency of conducting these activities.

[28]For details, see Appendix 7.3.

foreign countries and $Non - MNE_{i,t}$ for the firm that is not an MNE. Thus, the group of foreign MNEs that have affiliates in the domestic market is the omitted group.

The key variables I focus on are the quintile dummy variables. For each industry-country pair, I group non-exporting firms into five categories based on their employment (or sales). The omitted group is the fourth quintile for the regression of employment and the third quintile for the regression of sales. As 4.6% observations report zero export value[29], and some firms that report zero export value do not have information on their sales and(/or) employment, I end up with 468 observations for the regression of employment and 277 observations for the regression of sales. Regression results reported in Table 1 support the "U"-shaped prediction yielded by the model. Specifically, the coefficient of the lowest quintile and that of the highest quintile are always positive (relative to the third or fourth quintile) and statistically significant. Moreover, the estimated coefficients for the five quintiles indeed display an "U"-shaped pattern.[30] Finally, the same pattern holds, if I divide the sample into quartiles. This can be seen from the regression results presented in Table 2. In total, the managerial is indeed correlated to firm size in an "U"-shaped manner, as suggested by WMS data.

5 Within-Firm and Between-Firm Productivity Gains

In this section, I explore how the existence of the agency problem affects changes in firm productivity after trade liberalization. The key parameter I focus on is the bargaining power of the manager (i.e., α), as a change in it affects both the investor's incentive of entering the industry and the manager's incentive of exerting effort.

A change in α brings about two effects on market competition, as both decision makers (i.e., the manager and the investor) do not receive the full profit of production. First, the incentive power faced by the investor is reduced when α increases, as she compares a *smaller* fraction of the profit with the entry cost when making the entry decision. As a result, there is more room for managers with mediocre quality draws (i.e., $\phi \in [\phi^*, \phi^{'}]$) to incentivize their investors to enter the industry by making them break even ex ante. This in turn results in a larger share of constrained firms, when α goes up (see equation (11)), which leads to *less tough* selection into the market.[31] Second, as there is *no* misalignment of interests when the investor decides whether to export,[32] selection into exporting becomes easier (compared to making zero profit) when α increases. This leads to *tougher* selection into the market, as exporting firms are the most productive firms in the economy. When the bargaining power of the manager increases from its lower bound (i.e., $\bar{\alpha}$), the first effect dominates the second effect, which leads to less tougher selection. However, when the bargaining power increases and approaches one, the

[29] 13.5% observations report non-missing value of exports.

[30] The omitted quintile has the coefficient of zero.

[31] Remember that constrained non-exporters are the least productive firms in the economy.

[32] I.e., the investor compares the full increase in profit from exporting to the fixed exporting cost when deciding whether to export.

Table 1: Managerial effort and firm size: quintile regressions

	(1) MS_{sub}	(2) MS_{eff}	(3) MS_{sub}	(4) MS_{eff}
$Quin1_e$	0.169*	0.181*		
	(1.70)	(1.78)		
$Quin2_e$	0.150	0.140		
	(1.47)	(1.35)		
$Quin3_e$	0.0842	0.0958		
	(0.89)	(0.99)		
$Quin5_e$	0.318***	0.333***		
	(2.78)	(3.05)		
$Quin1_s$			0.345***	0.340***
			(3.00)	(2.81)
$Quin2_s$			0.0857	0.0953
			(0.68)	(0.73)
$Quin4_s$			0.292**	0.330***
			(2.51)	(2.67)
$Quin5_s$			0.402***	0.443***
			(3.81)	(4.51)
MNE FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
Year FEs	yes	yes	yes	yes
Industry FEs	yes	yes	yes	yes
N	468	468	277	277
R^2	0.556	0.576	0.716	0.742
adj. R^2	0.443	0.467	0.617	0.653

Robust standard errors are calculated. t statistics in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Years covered: 2003-2008.

MS_{eff}: average score on 8 management practices.

MS_{sub}: average score on 6 management practices.

$Quin1_s - Quin5_s$: quintiles based on sales.

$Quin1_e - Quin5_e$: quintiles based on employment.

Table 2: Managerial effort and firm size: quartile regressions

	(1) MS_{sub}	(2) MS_{eff}	(3) MS_{sub}	(4) MS_{eff}
$Quar1_e$	0.267**	0.273**		
	(2.37)	(2.39)		
$Quar2_e$	0.179*	0.173		
	(1.71)	(1.64)		
$Quar4_e$	0.373***	0.400***		
	(3.01)	(3.25)		
$Quar1_s$			0.197	0.181
			(1.54)	(1.26)
$Quar2_s$			-0.0192	-0.0413
			(-0.14)	(-0.28)
$Quar4_s$			0.258**	0.280***
			(2.55)	(3.12)
MNE FEs	yes	yes	yes	yes
Country FEs	yes	yes	yes	yes
Year FEs	yes	yes	yes	yes
Industry FEs	yes	yes	yes	yes
N	468	468	277	277
R^2	0.568	0.589	0.702	0.730
adj. R^2	0.459	0.485	0.601	0.638

Robust standard errors are calculated. t statistics in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Years covered: 2003-2008.

MS_{eff}: average score on 8 management practices.

MS_{sub}: average score on 6 management practices.

$Quar1_s - Quar4_s$: quartiles based on sales.

$Quar1_e - Quar4_e$: quartiles based on employment.

first effect is dominated by the second effect, which leads to tougher selection. The following proposition summarizes the result.

Proposition 4 *Parameter α is the bargaining power of the manager. The share of exporting firms among active firms (a measure for the selection effect of trade) decreases first and increases afterwards when α increases. The ratio of the exit cutoff in the open economy to that in the closed economy decreases, when α increases from its lower bound. However, when α increases and approaches one, this ratio increases with an increase in α. In short, the selection effect of trade is strong when the bargaining power of the manager is either small or big.*

Proof: See Appendix 7.9. QED.

Proposition 4 states that the selection effect of trade changes non-monotonically with the bargaining power of the manager. This is reflected by the change in the share of exporting firms and the change in the ratio of the two exit cutoffs. An increase in α brings about two opposite effects to the selection effect of trade. On the one hand, the ratio of the number of constrained firms to that of unconstrained firms increases with α (see equation (11)), which hinders resource reallocation after trade. On the other hand, the share of exporting firms among unconstrained firms increases with α (see equation (20)), which facilitates resource reallocation after trade. The first effect dominates the second one, when α increases from low levels and vice versa when α increases from high levels. As a result, the selection effect of trade goes down with α when α is small and vice versa when α is big.

Now, I discuss how the agency problem affects the gain in aggregate productivity from opening up to trade. I define two measures of aggregate productivity. The first one is an unweighted average of firm productivity for firms from a given economy:

$$ATFP^{i}_{unweighted} = \frac{1}{1 - G(\phi^*)} \int_{\phi^*}^{\infty} \phi\beta(\alpha, \eta_i, \phi) g(\phi) d\phi, \tag{28}$$

where $i \in \{a, o\}$ refers either to autarky or to the open economy. $g(\phi)$ and $G(\phi)$ are the probability density function (PDF) and the cumulative density function (CDF) of ϕ respectively. Obviously, this measure does not take into account differences in market shares of various firms. In order to capture how international trade impacts aggregate productivity via affecting market shares of various firms, I construct the following weighted average of firm productivity:

$$ATFP^{i}_{weighted} = \frac{1}{1 - G(\phi^*)} \int_{\phi^*}^{\infty} \phi\beta(\alpha, \eta_i, \phi) \frac{R(\phi, \eta_i)}{R(\phi^*, \eta_i)} g(\phi) d\phi, \tag{29}$$

where $i \in \{a, o\}$ refers either to autarky or to the open economy, and $R(\phi, \eta_i)$ is firm sales (i.e., domestic sales plus exports). I include the market share of firms with the quality draw of ϕ (relative to firms on the exit cutoff) into the calculation of weighted average of firm productivity.[33] The following proposition summarizes how the bargaining power of the manager affects

[33]Remember that sales of the firm on the exit cutoff (and the zero-profit cutoff) are always $\frac{\sigma f}{(1-\alpha)}$, which do not change with trade costs.

aggregate gains in productivity after opening up to trade:

Proposition 5 *Parameter α is the bargaining power of the manager. When α increases from its lower bound, the increase in (unweighted and weighted) average firm productivity (after opening up to trade) goes down. However, when α increases and approaches one, the increase in (unweighted and weighted) average firm productivity (after opening up to trade) goes up. In short, the gain in aggregate productivity (after opening up to trade) is large when the bargaining power of the manager is either small or big.*

Proof: See Appendix 7.10. QED.

Consistent with the finding in Proposition 4, the productivity-enhancing effect of trade interacts with the level of managerial incentive (i.e., α) in a non-monotonic way as well. Although I cannot fully characterize the relationship between the manager's bargaining power and the gain in aggregate productivity from trade for each value of $\alpha \in [\bar{\alpha}, 1)$, the economic insights discussed above apply to all feasible values of α. I use a numerical example to illustrate this point. Table 3 reports the parameter values of our simulation, and I vary the value of α from $\frac{1}{3}$ (i.e., the lower bound) to 0.9. Figure 8 shows that the increase in the exit cutoff (from autarky to the open economy) is indeed "U"-shaped with respect to the manager's bargaining power. Moreover, Figure 9 shows that the gain in aggregate productivity from trade is "U"-shaped with respect to the bargaining power of the manager as well.

Table 3: Parameter Values

σ	k	θ	f	f_x	τ	L
4	3.5	3	3	15	1.6	30

Interestingly, the within-firm productivity gain can work against the between-firm productivity gain after opening up to trade in the current model. Figure 10 shows that the share of firms that improve productivity (i.e., exporters plus constrained firms) always increases with α, when the economy moves from autarky to the open economy. The driving force for this change is the existence of constrained (non-exporting) firms. Specifically, the fraction of constrained firms increases with the bargaining power of the manager, and these firms constitute the majority of firms that increase productivity after the economy opens up to trade. However, the productivity improvement of constrained firms hinders resource reallocation and dampens gains in aggregate productivity, as these firms are the least productive firms in the economy and improve productivity marginally after the economy opens up to trade.[34]

To the contrary, the improvement of productivity by exporting firms facilitates resource reallocation and magnifies gains in aggregate productivity, as these firms are the most productivity firms in the economy and improve productivity substantially after opening up to trade.

[34]Remember that the objective of these managers is to make their investors continue to break even in the open economy.

Figure 8: Managerial Incentive and Selection Effect

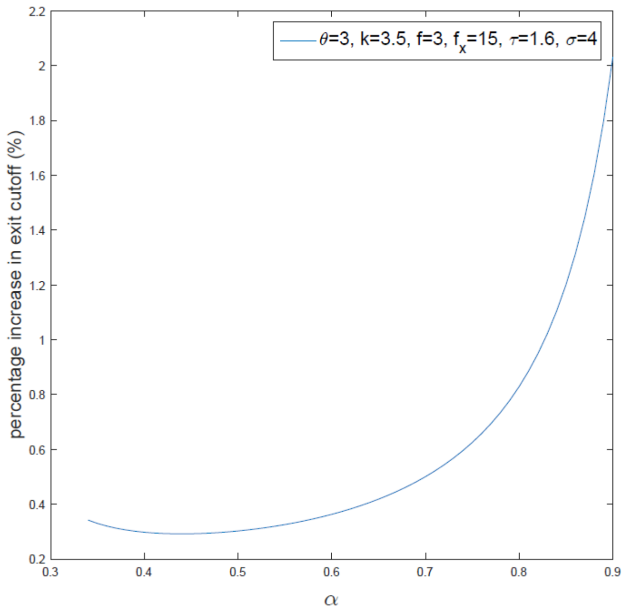


Figure 9: Managerial Incentive and Gain in Aggregate Productivity

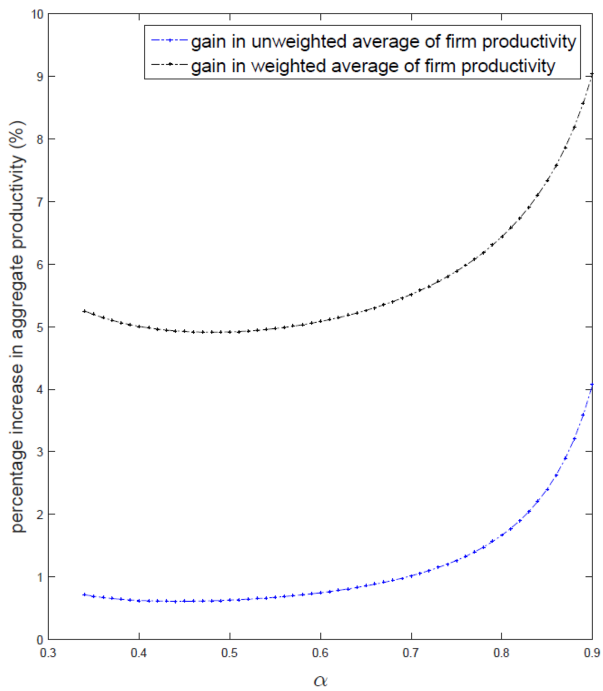
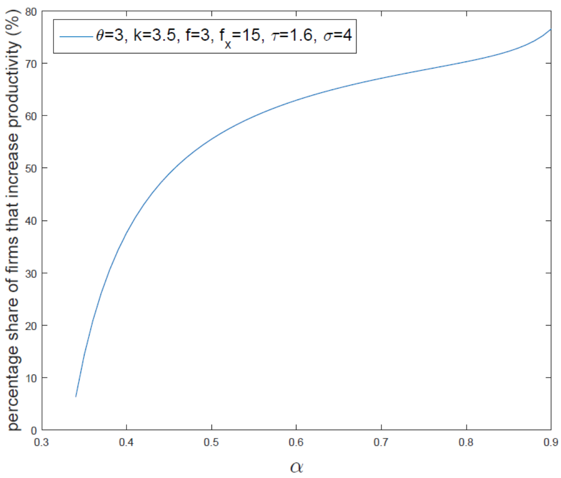


Figure 10: Managerial Incentive and Within-firm Productivity Gain



This is why the share of exporters and the gain in aggregate productivity from trade go hand in hand, when the managerial incentive changes. In summary, it is the productivity improvement by exporting firms that determines the direction of the change in aggregate productivity after opening up to trade. Importantly, firm-level gains in productivity do not necessarily translate into aggregate-level gains in productivity.

5.1 Calibration

In this subsection, I calibrate the model in order to do identify key parameters of the model and implement counterfactual analysis. The dataset I use is the same firm-level dataset as the one used in Roberts and Tybout (1997) and Fernandes (2007), which includes all manufacturing plants (above a certain threshold) in Colombia between 1986 and 1991.[35] Since my model is a static model, I choose to match cross-sectional moments in the data in order to identify key parameters of the model. I choose the data in 1988 (the middle year between 1986 and 1991) to calculate the data moments.

For the identification of parameters, I choose and calibrate the parameters in the following way. First, the total mass of agents is normalized to 100, as this is a scale parameter which has to be normalized.[36] Second, the elasticity of substitution is chosen to be 4 as in Bernard et al. (2003). It is inside the range of 2-5, which is the normal range for this parameter used in the trade literature. Third, the theory implies that the ratio of managerial compensation to total wage bill in non-exporting firms is $\frac{\alpha}{(\sigma-1)+\alpha}$ (remember that there is no fixed cost of domestic production). Since $\sigma = 4$, I have $\alpha_{88} = 0.322$.[37] Fourth, the log-rank and log firm

[35] For the description of the dataset, interested readers can read Roberts and Tybout (1997) and Fernandes (2007).

[36] Note that all the cutoffs, ϕ^*, ϕ' and ϕ_x are independent of the size of the economy.

[37] The ratio of managerial compensation to total wage bill is almost the same for all firms as for non-exporting firms in the data.

size regression regresses $\ln(probability(firm\ size \geq x))$ on $\ln(firm\ size) = x$ where firm size is measured by sales or employment. In the current model, the slope of the regression line is $-\frac{k}{\frac{\theta}{\theta-1}}$ which has to be bigger than one, as average firm sales would go to infinity if it were smaller than one in absolute value.[38] This moment is used to identify the shape parameter of the Pareto distribution, k.[39]

Next, the ratio of the exporting cutoff to the zero-profit cutoff is determined by equation (20). Therefore, the share of exporters among active firms is

$$exporters\ share = \left(\frac{\phi^*}{\phi_x}\right)^k = \left(\frac{\alpha f}{\theta[\alpha f - (1-\alpha)]}\right)^{\frac{k}{\theta}} \left(\frac{f[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}} - 1]}{f_x}\right)^{k\left(\frac{\theta-1}{\theta}\right)} \left(\frac{\theta-1}{(1-\alpha)\theta}\right)^{k\left(\frac{\theta-1}{\theta}\right)}. \tag{30}$$

This moment is used to identify the fixed exporting cost, f_x, as it affects the share of exporters (i.e., the extensive margin of trade) negatively and monotonically. Sixth, the share of exports in total sales can be derived as

$$exports\ share = \frac{\tau^{1-\sigma}(1+\tau^{1-\sigma})^{\frac{1}{\theta-1}} \frac{k}{k-\frac{\theta}{\theta-1}} \left(\frac{\phi_x}{\phi'}\right)^{-k+\frac{\theta}{\theta-1}}}{\left(\frac{\phi'}{\phi^*}\right)^k + \frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \frac{k}{k-\frac{\theta}{\theta-1}}\left((1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}} - 1\right)\left(\frac{\phi_x}{\phi'}\right)^{-k+\frac{\theta}{\theta-1}}}. \tag{31}$$

This moment is used to identify the variable trade cost, τ, as it affects the share of exports in total sales (i.e., the intensive margin of trade) negatively and monotonically.

Then, I use the comparison of two moments to identify θ. First, the sales ratio of the smallest exporters to the smallest non-exporters is

$$sales\ ratio = (1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}} \left(\frac{\phi_x}{\phi'}\right)^{\frac{\theta}{\theta-1}}, \tag{32}$$

which depends on the iceberg trade cost and the convexity of the effort cost function. Second, as θ is fundamentally related to the manager's effort cost, I need information on the effort cost in order to identify this parameter. Although I cannot directly observe these the managerial cost in the data, I can observe the number of managers in the data. I make an assumption on the relationship between the number of managers and the managerial effort. Specifically, I assume that the ratio of the managerial effort (i.e., $\frac{\beta(\alpha,\eta,\phi_1)}{\beta(\alpha,\eta,\phi_2)}$) between any two firms is proportional to the ratio of the number of managers between these two firms, as using more managers probably implies exerting more managerial effort by the management team.[40] Under this assumption, the

[38] In the original Melitz model (Melitz 2003), this slope equals $-\frac{k}{\sigma-1}$. As I have re-scaled firm's demand draws, the relevant parameters become k and θ.

[39] It is worth mentioning that this slope holds among non-exporters *and* among exporters. However, when I look across non-exporting firms and exporting firms, the slope becomes flatter, as there is a outward shift of sales (and employment) for all exporting firms when the economy moves from autarky to the open economy.

[40] The rationale for this assumption is that exerting managerial effort requires inputs of human resources such as hiring managers. This assumption does not mean that the number of managers equals the amount of managerial effort exerted.

ratio of the number of managers of the smallest exporters to that of the smallest non-exporters is

$$managers\ ratio = (1+\tau^{1-\sigma})^{\frac{1}{\theta-1}}\Big(\frac{\phi_x}{\phi'}\Big)^{\frac{1}{\theta-1}} = sales\ ratio^{\frac{1}{\theta}}. \qquad (33)$$

Therefore, by comparing equation (32) with equation (33), I can back out the value of θ directly.[41]

Finally, I use the sales ratio of the smallest exporters to that of the smallest non-exporter to identify the share of constrained (non-exporting) firms. Based on this share, I can calculate the fixed entry cost f, conditioning on σ, τ, θ, k, α and the fraction of exporters. This identification comes from the result that a higher entry cost f increases the share of constrained non-exporters among active firms and therefore reduces the ratio of the exporting cutoff to the zero-profit cutoff (i.e., $\frac{\phi_x}{\phi'}$), conditioning on the fraction of exporters (i.e., given $\frac{\phi^*}{\phi_x}$). Therefore, there is a one-to-one mapping between the fixed entry cost and the size ratio of the smallest exporters to the smallest non-exporters, implied by equation (32).

Table 4 summarizes the parameters I want to calibrate and corresponding moments used to identify these parameters. Table 5 summarizes the data moments as well as the corresponding moments implied by the calibrated model. Thanks to the closed-form solutions to all the six moments I want to match, the moments implied by the model perfectly match the data moments. Table 6 presents the calibrated parameters. For the calibrated parameters, the existence of constrained firms ($\phi' > \phi^*$) and selection into exporting ($\phi_x > \phi'$) are guaranteed. Now, I investigate how the agency problem (i.e., the level of incentive faced by the manager) interacts with aggregate gains in productivity from trade liberalization. Specifically, I use the calibrated parameters to consider bilateral trade liberalization by reducing τ from 1.968 to 1.768 (i.e., 20% percent reduction in the iceberg trade cost). Then, I vary the value of α from 0.05 to 0.7 and study how α affects the selection effect and the gain in unweighted average of firm productivity from the trade liberalization.[42]

Figure 11 shows that the increase in unweighted average of firm productivity is "U"-shaped with respect to α, which is consistent with the prediction of Proposition 4. The driving force for this relationship comes from the selection effect. Specifically, Figures 12 and 13 show that the increase in the exit cutoff and the increase in the share of exporting firms are "U"-shaped with respect to α. These two key measures for the selection effect move in the same direction as the change in the gain in unweighted average of firm productivity, which rationalizes our finding in Figure 11. If we double the managerial incentive from 0.322 to 0.644, the gain in unweighted average of firm productivity would increase from 4.82% to 5.25%, which is

[41] The smallest non-exporter (or exporter) in the model is not directly mapped to the smallest non-exporting (or exporting) firm in the data, as there are extremely small firms (i.e., outliers) in the data which can not be captured by the theory. What the smallest firms mean in the data is the group of firms that have the smallest size. In practice, I calculate the average size (and average number of managers) of firms (i.e., exporters and non-exporters) that belong to the smallest quartile as the size (and the number of managers) of the smallest firms.

[42] As $k < \frac{2\theta}{\theta-1}$ in the calibrated model, the weighted average of firm productivity cannot be defined under the Pareto distribution.

Table 4: Parameters and Moments

	value	sources
L	100	Normalization
σ	4	Bernard et al. (2003)
τ		share of exports in total sales
α		managerial compensation/total wage bill
k		log-rank and log firm size regression
θ		$\frac{number\ of\ managers\ of\ smallest\ exporters}{number\ of\ managers\ of\ smallest\ non-exporters}$
f_x		share of exporters among all firms
f		$\frac{sales\ of\ smallest\ exporters}{sales\ of\ smallest\ non-exporters}$

Table 5: Data Moments and Model Moments

	data	model
managerial compensation/wage bill (non-exporters)	9.7%	9.7%
slope of log-rank and log size plot (non-exporters)	-1.13	-1.13
share of exporting firms	11.8%	11.8%
share of exports in total sales	9.26%	9.26%
$\frac{sales\ of\ smallest\ exporters}{sales\ of\ smallest\ non-exporters}$	5.04	5.04
$\frac{number\ of\ managers\ of\ smallest\ exporters}{number\ of\ managers\ of\ smallest\ non-exporters}$	1.47	1.47

quantitatively sizable.

Table 6: Calibrated Parameters

σ	k	θ	f	f_x	τ	L	α
4	1.483	4.20	52.188	44.153	1.968	100	0.322

6 Concluding Remarks

This paper presents a model that highlights the agency problem inside the firm in order to explain why the least productive firms improve management quality and productivity after bilateral trade liberalization. The new and unique prediction of my model is that the least productive surviving non-exporters increase productivity after trade liberalization, although their market size shrinks. Managers of these firms are incentivized to exert more effort to induce their investors to continue to stay in the market. However, this new channel of firm-level productivity improvement does not *necessarily* lead to larger gains in aggregate productivity from trade liberalization. In particular, the gain in aggregate productivity from trade liberalization is “U”-shaped with respect to the level of managerial incentive, as the selection effect of trade decreases first and increases afterwards with the level of the managerial incentive. In a simple calibration exercise, I show that the interaction between the productivity gain from trade

Figure 11: Managerial Incentive and Gain in Aggregate Productivity

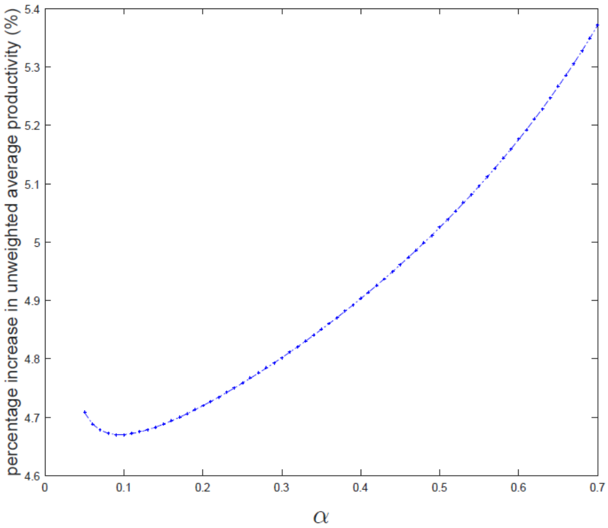


Figure 12: Managerial Incentive and the Selection Effect

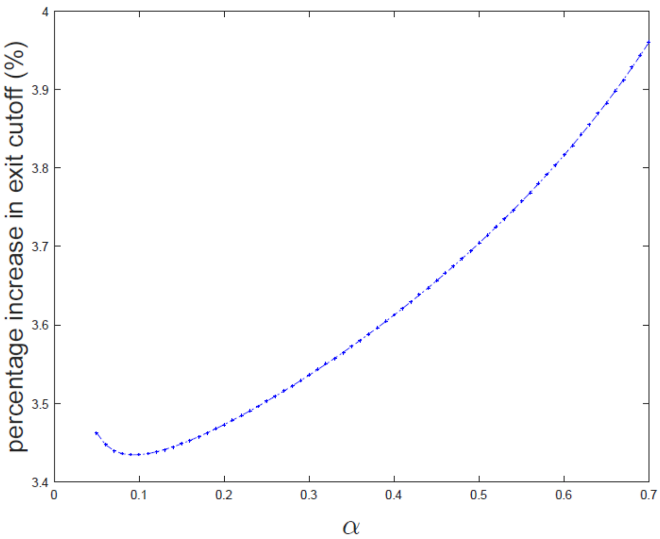
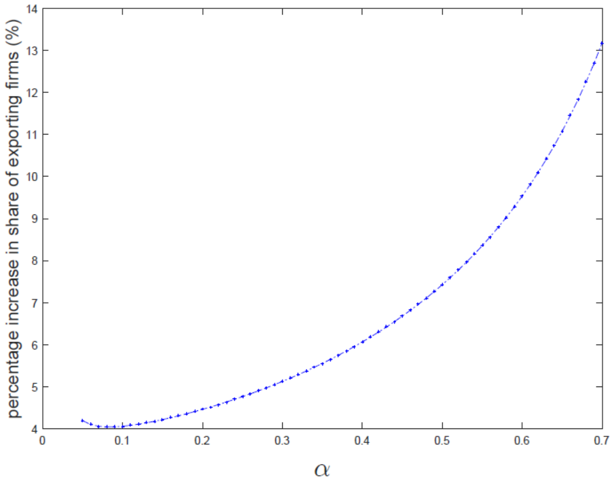


Figure 13: Managerial Incentive and the Share of Exporting Firms



liberalization and the level of the managerial incentive is quantitatively non-negligible.

Using WMS data, I provide evidence which is consistent with the model's key prediction on the relationship between the managerial effort and firm size. In the data, firms that receive the lowest average score on management practices that are closely related to the managerial effort are indeed the medium-sized firms. In addition, the biggest firms have the highest average management score.

Nevertheless, much remains to be done. First, the current model has the potential to explain changes in managerial effort in the context of *gradual* trade liberalization. It is clear that, although the least productive firms exit the market eventually, they improve productivity before exiting (in the process of gradual trade liberalization). Second, using the current model to study how other types of economic reforms (e.g., industry deregulation) affect firm productivity is also an interesting topic for future research.

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7 Appendix: For Online Publication

7.1 Proof of Lemma 1

Proof. The proof proceeds in three steps. First, I discuss agents with $\phi \geq \phi'$. For this type of agent, $\beta_s(\alpha, \eta, \phi)$ is the optimal effort choice, as the profit received by the investor is higher than the fixed entry cost under the second-best level of effort. I.e., the participation constraint of the investor does not bind. In addition, Assumption 1 assures that the type of agent (i.e., manager) receives an (ex post) payoff higher than his outside option when $\phi \geq \phi'$ and $\beta = \beta_s(\alpha, \eta, \phi)$. Moreover, the ex ante transfer to this type of manager equals the investor's net profit or

$$(1 - \alpha)\eta\phi\beta(\alpha, \eta, \phi) - f,$$

which is strictly positive. Therefore, this type of agent chooses to be the manager.

When $\phi \in [\phi^*, \phi')$, the investor's profit under the second-best level of effort is smaller than the fixed entry cost, f. As argued in the main text, the effort level of $\frac{\beta_s(\alpha,\eta,\phi')\phi'}{\phi}$ is the minimal as well as the optimal effort level for this type of manager. Under this effort level, the ex post payoff to the manager is

$$\frac{\alpha f}{1-\alpha}\Big[1 - \Big(\frac{\phi'}{\phi}\Big)^{\theta}\frac{1}{\theta}\Big],$$

which increases in ϕ and is bigger than or equal to one when $\phi \geq \phi^*$. Since the investor makes zero profit ex post, the ex ante transfer to the manager is zero. Thus, the total payoff to this type of manager increases in ϕ and equals one when $\phi = \phi^*$. Therefore, it is optimal for this type of agent to choose to be the manager.

When $\phi < \phi^*$, the agent has to exert at the level of $\frac{\beta_s(\alpha,\eta,\phi')\phi'}{\phi}$ in order to induce the investor to start production.[43] However, this would lead to a payoff (to the manager) strictly below one. Moreover, since the investor makes zero net profit ex post, the ex ante transfer to the manager is zero. Therefore, the total payoff to this type of agent would be strictly below one, if he decides to be a manager. As a result, this type of agent chooses to become the worker and receive wage income. QED.

7.2 Proof of Lemma 2

Proof. First, I assume that the investor chooses to export if and only if the manager exerts effort by taking into account the complementarity between exporting and the return to exerting effort: $1 + \frac{1}{\tau^{\sigma-1}}$. Specifically, the optimal solution to equation (18) is

$$\Big(\frac{\alpha\eta(P,Y)\phi}{\theta}\Big)^{\frac{1}{\theta-1}}\Big(1 + \frac{1}{\tau^{\sigma-1}}\Big)^{\frac{1}{\theta-1}}, \tag{34}$$

[43] It is never optimal for the agent to be a manager and have no production afterwards, as this would lead to zero or negative payoff to the manager which is strictly below the manager's outside option (i.e., the wage).

while the optimal solution to equation (19) is

$$\Big(\frac{\alpha\eta(P,Y)\phi}{\theta}\Big)^{\frac{1}{\theta-1}}. \tag{35}$$

Therefore, the manager prefers exporting over non-exporting (assuming that the investor exports if and only if the manager takes into account the effect of exporting on the managerial effort) if and only if

$$A_1(\phi) \equiv (\theta-1)\Big[\Big(1+\frac{1}{\tau^{\sigma-1}}\Big)^{\frac{\theta}{\theta-1}}-1\Big]\Big(\frac{\alpha\eta(P,Y)\phi}{\theta}\Big)^{\frac{\theta}{\theta-1}}-\alpha f_x \geq 0 \tag{36}$$

or

$$\phi \geq \phi_x \equiv \Big(\frac{\alpha f_x}{(\theta-1)[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]}\Big)^{\frac{\theta-1}{\theta}}\frac{\theta}{\alpha\eta(P,Y)}.$$

Next, I derive an exporting cutoff above which the investor is willing to export only if the manager exerts effort by taking into account the effect of exporting on the return to effort (i.e., equation (34)). In this case, the investor prefers exporting over non-exporting if and only if

$$A_2(\phi) \equiv \frac{\theta}{\alpha\tau^{\sigma-1}}\Big(1+\frac{1}{\tau^{\sigma-1}}\Big)^{\frac{1}{\theta-1}}\Big(\frac{\alpha\eta(P,Y)\phi}{\theta}\Big)^{\frac{\theta}{\theta-1}}-f_x \geq 0, \tag{37}$$

which leads to the cutoff as

$$\phi \geq \phi_x^1 \equiv \Big(\frac{\alpha f_x\tau^{\sigma-1}}{\theta(1+\tau^{1-\sigma})^{\frac{1}{\theta-1}}}\Big)^{\frac{\theta-1}{\theta}}\frac{\theta}{\alpha\eta(P,Y)}.$$

It is straightforward to verify that $\phi_x^1 < \phi_x$, as $\tau < \infty$ in the open economy.

Third, I derive an exporting cutoff above which the investor is willing to export even if the manager does not take into account the effect of exporting on the return to effort. In this case, the investor prefers exporting over non-exporting if and only if

$$A_3(\phi) \equiv \frac{\theta}{\alpha\tau^{\sigma-1}}\Big(\frac{\alpha\eta(P,Y)\phi}{\theta}\Big)^{\frac{\theta}{\theta-1}}-f_x \geq 0, \tag{38}$$

which leads to the cutoff as

$$\phi \geq \phi_x^2 \equiv \Big(\frac{\alpha f_x\tau^{\sigma-1}}{\theta}\Big)^{\frac{\theta-1}{\theta}}\frac{\theta}{\alpha\eta(P,Y)}.$$

It is straightforward to verify that $\phi_x^2 > \phi_x (> \phi_x^1)$.

Now, I discuss the manager's effort choices case by case. First, when $\phi < \phi_x^1$, the manager cannot even make the investor export by exerting effort according to equation (34). Thus, he would have to exert effort more than the one stated in equation (34) in order to incentivize the investor to export, which reduces his payoff under exporting. As the constraint in equation (36) is already violated for $\phi < \phi_x^1 (< \phi_x)$, the change in the manager's payoff from non-exporting to exporting is even smaller than $A_1(\phi)$ which is already negative when $\phi < \phi_x^1$. Therefore, exerting effort according to equation (35) and non-exporting are the optimal choices for the manager and the investor, when $\phi < \phi_x^1 (< \phi_x)$.

Second, when $\phi \in [\phi_x^1, \phi_x)$, the investor exports if and only if the manager exerts effort according to equation (34). In other words, the investor does not export if the manager exerts effort according to equation (35). However, the manager's incentive to exert effort under exporting is violated, as constraint (36) is not satisfied. Therefore, exerting effort according to equation (35) and non-exporting are the optimal choices for the manager and the investor, when $\phi \in [\phi_x^1, \phi_x)$. Third, when $\phi \in [\phi_x, \phi_x^2]$, the investor exports if and only if the manager exerts effort according to equation (34). Moreover, the manager's incentive to exert effort under exporting is satisfied in this case, as constraint (36) is met for $\phi \geq \phi_x$. Therefore, exerting effort according to equation (34) and exporting are the optimal choices for the manager and the investor, when $\phi \in [\phi_x, \phi_x^2]$.

Finally, when $\phi \geq \phi_x^2$, the investor exports even if the manager exerts effort according to equation (35). Thus, he would have to exert effort lower than the one stated in equation (35) in order to prevent the investor from exporting, which reduces his payoff under non-exporting. As the constraint in equation (36) is already met for $\phi \geq \phi_x^2 (> \phi_x)$, the change in the manager's payoff from non-exporting to exporting is even higher than $A_1(\phi)$ which is already positive when $\phi \geq \phi_x^2$. Therefore, exerting effort according to equation (34) and exporting are the optimal choices for the manager and the investor when $\phi \geq \phi_x^2$.

In total, I derive the exporting cutoff ϕ_x above which the firm exports. When $\phi \geq \phi_x$, the investor exports and the manager chooses effort according to equation (34). When $\phi < \phi_x$, the investor does not export and the manager chooses effort according to equation (35). QED.

7.3 Extension

In this subsection, I introduce a non-operating profit into the model to generate the prediction that firm size increases with the initial quality draw even among the constrained non-exporters. Slightly different from the profit function defined in the main text, I define the total profit as

$$\pi(\rho, \psi) = \alpha\eta(P, Y)\phi\beta + \mu\beta - f, \tag{39}$$

where the first term is the operating profit and the last term is the fixed production cost. These two terms are the same as in the original profit function. Additionally, the second term, $\mu\beta$ ($\mu > 0$), denotes a non-operating profit (including investment profits and capital gains on firm assets) and positively depends on the managerial effort. Under this slightly modified profit function, firm sales and employment, which are positively related to the operating profit, increase with the initial quality draw, ϕ, even among the constrained non-exporters.[44] In addition, all

[44]To see this, first note that optimal managerial effort β still decreases with ϕ among the constrained non-exporters, as it is harder for the firm with a worse quality draw to satisfy the non-bankruptcy constraint. Second,

other predictions of the original model are unchanged (e.g., the effort choice and productivity change after trade liberalization). Therefore, the managerial effort is "U"-shaped with respect to the initial quality draw and *firm size* in our slightly modified model now. This validates the empirical analysis in Section 4.4.

7.4 Equilibrium Conditions in the Closed Economy

In this subsection, I first derive the ideal price in the closed economy. The expression of the ideal price index in the closed economy is[45]

$$P = [\int_{\phi^*}^{\infty} p(\phi)^{1-\sigma} L d\phi]^{\frac{1}{1-\sigma}} = \frac{L^{\frac{1}{1-\sigma}}}{\lambda}(\beta(\alpha, \eta, \phi^{'})\phi^{'})^{\frac{1}{1-\sigma}}\Big[\int_{\phi'}^{\infty} k\Big(\frac{\phi}{\phi'}\Big)^{\frac{\theta}{\theta-1}}\phi^{-k-1}d\phi + \Big(\frac{1}{\phi^{*k}} - \frac{1}{\phi'^{k}}\Big)\Big]^{\frac{1}{1-\sigma}} \quad (40)$$

which can be rewritten as

$$P^{\frac{\theta}{\theta-1}} = \frac{L^{\frac{1}{1-\sigma}}}{\lambda}\Bigg[\frac{\frac{\theta}{\theta-1}}{k - \frac{\theta}{\theta-1}} + \Bigg(\frac{\theta[\alpha f - (1-\alpha)]}{\alpha f}\Bigg)^{\frac{k}{\theta}}\Bigg]^{\frac{1}{1-\sigma}}\Bigg[\phi^{'(\frac{\theta}{\theta-1}-k)}\Bigg(\frac{\alpha\lambda^{\sigma-1}Y}{\sigma\theta}\Bigg)^{\frac{1}{\theta-1}}\Bigg]^{\frac{1}{1-\sigma}}. \quad (41)$$

Now, I derive a lower bound on I above which the amount of available financial resources is more than what is needed to form firms. The investors need financial resources to make ex ante transfers and payments of the entry cost in order to form firms and enter the industry. The total amount of funds needed equals

$$L[1 - G(\phi^*)]f + \int_{\phi^*}^{\infty} t(\phi)g(\phi)Ld\phi = L[1 - G(\phi^*)]f + f\int_{\phi'}^{\infty}\Big[\Big(\frac{\phi}{\phi'}\Big)^{\frac{\theta}{\theta-1}} - 1\Big]g(\phi)Ld\phi.$$

Under the Pareto assumption, the above equation can be rewritten as

$$\bar{I} \equiv \frac{1}{\frac{1+f}{f\Big[1+\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}}\Big(\frac{\alpha f}{\theta[\alpha f-(1-\alpha)]}\Big)^{\frac{k}{\theta}}\Big]} + \frac{\sigma-1}{1-\alpha}} \leq \frac{I}{L}. \quad (42)$$

If the financial resources eventually come from agents' savings, equation (42) states that there is a lower bound on the average savings of agents above which total available financial resources are more than enough to fund all firms in the economy.

as $\mu\beta$ decreases with ϕ among the constrained non-exporters in equilibrium, $\alpha\eta(P, Y)\phi\beta$ has to increases with ϕ in order to meet the non-bankruptcy constraint.

[45]Note that firms with productivity draws between ϕ^* and $\phi^{'}$ choose the same price.

7.5 Equilibrium Conditions in the Open Economy

I analyze equilibrium conditions in the open economy in this subsection. First, the ideal price index in the open economy equals

$$\begin{aligned} P \;=\; & \frac{L^{\frac{1}{1-\sigma}}}{\lambda}(\beta(\alpha,\eta,\phi')\phi')^{\frac{1}{1-\sigma}}\Big[\int_{\phi'}^{\phi_x} k\Big(\frac{\phi}{\phi'}\Big)^{\frac{\theta}{\theta-1}}\phi^{-k-1}d\phi + \Big(\frac{1}{\phi^{*k}}-\frac{1}{\phi'^{k}}\Big) + (1+\tau^{1-\sigma}) \\ & \int_{\phi_x}^{\infty} k(1+\tau^{1-\sigma})^{\frac{1}{\theta-1}}\Big(\frac{\phi}{\phi'}\Big)^{\frac{\theta}{\theta-1}}\phi^{-k-1}d\phi\Big]^{\frac{1}{1-\sigma}}. \end{aligned}$$

After substituting the optimal effort choices into the above expression, I derive the price index as

$$\begin{aligned} P^{\frac{\theta}{\theta-1}} \;=\; & \frac{L^{\frac{1}{1-\sigma}}}{\lambda}\left[\phi'^{(\frac{\theta}{\theta-1}-k)}\left(\frac{\alpha\lambda^{\sigma-1}Y}{\sigma\theta}\right)^{\frac{1}{\theta-1}}\right]^{\frac{1}{1-\sigma}}\left[\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}}\right. \\ & \left. + \frac{k}{k-\frac{\theta}{\theta-1}}[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]\Big(\frac{f_x}{f[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]}\Big)^{1-k\left(\frac{\theta-1}{\theta}\right)}\Big(\frac{(1-\alpha)\theta}{\theta-1}\Big)^{1-k\left(\frac{\theta-1}{\theta}\right)}\right]^{\frac{1}{1-\sigma}} \end{aligned} \quad (43)$$

Note that the ideal price index is well defined only when $k > \frac{\theta}{\theta-1}$. Also note that the price index is smaller in the open economy than in the closed economy, conditioning on ϕ' and Y, as $\tau \geq 1$. Based on equation (43), I can rewrite ZPC in the open economy as

$$\frac{f}{(1-\alpha)} = \frac{\frac{\phi'^{k}Y}{\sigma L}}{\left[\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}} + \frac{k}{k-\frac{\theta}{\theta-1}}\left(\frac{f_x}{f}\right)^{1-k\left(\frac{\theta-1}{\theta}\right)}[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]^{k\left(\frac{\theta-1}{\theta}\right)}\left(\frac{(1-\alpha)\theta}{\theta-1}\right)^{1-k\left(\frac{\theta-1}{\theta}\right)}\right]}, \quad (44)$$

Next, I derive the labor-market-clearing condition in the open economy. It is still true that the variable cost which is eventually paid to workers constitutes $\frac{\sigma-1}{\sigma}$ fraction of the total income, Y. Also note that managers eventually receive all the profits, and the ratio of the aggregate fixed costs (the entry cost and the fixed exporting cost) to the total operating profit now becomes

$$\frac{(1-\alpha)\left[\left(\frac{\phi'}{\phi^*}\right)^{k} + \frac{f_x}{f}\left(\frac{\phi'}{\phi_x}\right)^{k}\right]}{\left[\left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}} + \frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \frac{k}{k-\frac{\theta}{\theta-1}}\left[(1+\frac{1}{\tau^{\sigma-1}})^{\frac{\theta}{\theta-1}}-1\right]\left(\frac{\phi'}{\phi_x}\right)^{k-\frac{\theta}{\theta-1}}\right]},$$

Therefore, the labor-market-clearing condition in the open economy in the open economy can be written as

$$Y = \frac{\left(1 - \frac{\left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}}}{\phi'^k}\right) L\sigma}{(\sigma-1) + \frac{(1-\alpha)\left[\left(\frac{\phi'}{\phi^*}\right)^k + \frac{f_x}{f}\left(\frac{\phi'}{\phi_x}\right)^k\right]}{\left[\left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}} + \frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \frac{k}{k-\frac{\theta}{\theta-1}}\left[\left(1+\frac{1}{\tau^{\sigma-1}}\right)^{\frac{\theta}{\theta-1}}-1\right]\left(\frac{\phi'}{\phi_x}\right)^{k-\frac{\theta}{\theta-1}}\right]}},$$

Since $\frac{\phi_x}{\phi'}$ and $\frac{\phi^*}{\phi'}$ are pinned down by parameters, I can solve for $\phi^{'}$ and Y in the open economy using equations (24) and (25) as

$$\begin{aligned}
\phi^{'} &= \Bigg[(1+f)\Big(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\Big)^{\frac{k}{\theta}} + \frac{f(\sigma-1)}{1-\alpha} \\
&\quad \Bigg[\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \Big(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\Big)^{\frac{k}{\theta}} + \frac{k}{k-\frac{\theta}{\theta-1}} T_2(f_x,\tau)^{\frac{\theta}{\theta-1}-k}[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]\Bigg] + f_x T_2(f_x,\tau)^{-k}\Bigg]^{\frac{1}{k}},
\end{aligned}$$

where

$$T_2(f_x,\tau) \equiv \Big(\frac{f_x}{f[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]}\Big)^{\frac{\theta-1}{\theta}}\Big(\frac{(1-\alpha)\theta}{\theta-1}\Big)^{\frac{\theta-1}{\theta}}$$

is the ratio of the exporting cutoff to the zero-profit cutoff (i.e., $\frac{\phi_x}{\phi'}$). Comparing equation (26) with equation (17), I immediately find that the zero-profit cutoff is higher in the open economy than in the closed economy. Moreover, simple calculation shows that the zero-profit cutoff, $\phi^{'}$, and the exit cutoff, ϕ^*, decrease with the fixed trade cost f_x and the variable trade cost τ. When trade costs go down, the exit cutoff and the zero-profit cutoff all increase due to tougher selection. At the same time, the exporting cutoff decreases due to the lower trade costs, which can be easily verified using equation (26).

Finally, I derive a lower bound on I above which the amount of available financial resources is more than what is needed to form firms. The investors need financial resources to make the ex ante transfers and payments of the fixed entry cost *and* the fixed exporting cost. The constraint now becomes

$$\frac{f}{\phi'^k}\Bigg[\Big(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\Big)^{\frac{k}{\theta}} + \frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \frac{k}{k-\frac{\theta}{\theta-1}}\Big[\Big(1+\frac{1}{\tau^{\sigma-1}}\Big)^{\frac{\theta}{\theta-1}}-1\Big]\Big(\frac{\phi_x s}{\phi'}\Big)^{\frac{\theta}{\theta-1}-k}\Bigg] \le \frac{I}{L}. \tag{45}$$

Again, if the financial resources eventually come from agents' savings, equation (45) states that there is a lower bound on average savings of agents above which total available financial resources are more than enough to fund all firms in the economy.

7.6 Proof of Proposition 1

Proof. As Lemma 2 shows, firms with the initial quality draws above ϕ_x choose to export. Therefore, their managers' objective function is

$$\max_{\beta} \quad \alpha\eta(P,Y)\phi\beta\Big(1+\frac{1}{\tau^{\sigma-1}}\Big)-\beta^{\theta}, \tag{46}$$

which yields the solution:

$$\beta(\alpha,\eta,\phi)=\Big(\frac{\alpha\eta(P,Y)\phi}{\theta}(1+\frac{1}{\tau^{\sigma-1}})\Big)^{\frac{1}{\theta-1}}. \tag{47}$$

The term $\left(1+\frac{1}{\tau^{\sigma-1}}\right)$ captures the complementarity between exporting and the manager's effort. The resulting firm productivity is

$$\phi\beta(\alpha,\eta,\phi)=\Big(\frac{\alpha\eta(P,Y)\phi^{\theta}}{\theta}(1+\frac{1}{\tau^{\sigma-1}})\Big)^{\frac{1}{\theta-1}}. \tag{48}$$

Next, when $\phi<\phi_x$, the analysis is the same as the analysis for the closed economy. If the initial quality of the idea is between $\phi^{'}$ and ϕ_x, the manager's optimal effort choice is

$$\beta(\alpha,\eta,\phi)=\Big(\frac{\alpha\eta(P,Y)\phi}{\theta}\Big)^{\frac{1}{\theta-1}},$$

and his investor starts production but does not export. If the initial quality is between ϕ^{*} and $\phi^{'}$, the optimal effort level is

$$\beta(\alpha,\eta,\phi)=\frac{\beta(\alpha,\eta,\phi^{'})\phi^{'}}{\phi},$$

and his investor starts production but does not export as well. If the initial quality ϕ is smaller than ϕ^{*}, the manager quits the firm and becomes a worker.

As investors with $\phi\in[\phi^{*},\phi^{'}]$ make zero profit, the ex ante transfer to the manager is zero for this type of manager. For $\phi\in[\phi^{'},\phi_x)$, the investors choose to produce and sell only domestically. Thus, the investor's profit which equals the ex ante transfer is

$$(1-\alpha)\eta\phi\beta(\alpha,\eta,\phi)-f.$$

For exporting firms (i.e., $\phi\geq\phi_x$), the investor's profit which equals the ex ante transfer is

$$(1-\alpha)\eta\phi\beta(\alpha,\eta,\phi)\Big(1+\frac{1}{\tau^{\sigma-1}}\Big)-f-f_x.$$

QED.

7.7 Proof of Proposition 2

Proof. I prove the changes in the cutoffs first. It is straightforward to verify that the zero-profit cutoff defined in equation (26) decreases with the trade cost (i.e., f_x and τ) and achieves its minimum when the trade cost approaches infinity. Since the relationship between the exit cutoff and the zero-profit cutoff is the same in the open economy as in the closed economy, the exit cutoff, ϕ^*, also decreases with the trade costs. For the change in the exporting cutoff, it is straightforward to verify that ϕ_x increases with the trade cost using equations (20) and (26).

Next, I prove that managers of exporting firms increase their effort and firm productivity after opening up to trade and bilateral trade liberalization. Note that $\beta(\alpha, \eta_o, \phi_o^{'}) = \beta(\alpha, \eta_a, \phi_a^{'})$ where a and o refer to autarky and the open economy respectively. Thus, I have

$$\frac{\eta_o(1+\tau^{1-\sigma})}{\eta_a} = \frac{\phi_a^{'}(1+\tau^{1-\sigma})}{\phi_o^{'}}.$$

From the manager's objective functions defined in equations (6) and (18), I find that effort level of exporting firms is higher in the open economy than in the closed economy if and only if

$$\frac{\eta_o(1+\tau^{1-\sigma})}{\eta_a} = \frac{\phi_a^{'}(1+\tau^{1-\sigma})}{\phi_o^{'}} > 1.$$

I know that $\frac{\phi_a^{'}}{\phi_o^{'}}$ increases in f_x. Thus, a necessary condition for the above inequality to hold is that $\frac{\phi_a^{'}(1+\tau^{1-\sigma})}{\phi_o^{'}} > 1$ for the lowest possible level of f_x that makes $\phi^{'} = \phi_x$. In this case, $\frac{\eta_o(1+\tau^{1-\sigma})}{\eta_a}$ is derived as

$$\frac{\eta_o(1+\tau^{1-\sigma})}{\eta_a} = \left[\frac{\phi_a^{'k} + \phi_a^{'k}((1+\tau^{1-\sigma})^k - 1)}{\phi_a^{'k} + \frac{f\left(\left(1+\tau^{1-\sigma}\right)^{\frac{\theta}{\theta-1}}-1\right)}{1-\alpha}\left(\frac{k(\sigma-1)}{k-\frac{\theta}{\theta-1}} + \frac{\theta-1}{\theta}\right)}\right]^{\frac{1}{k}}.$$

Note that the lower bound for the term of $\frac{(1+\tau^{1-\sigma})^k-1}{(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1}$ is $\frac{k}{\frac{\theta}{\theta-1}}$. Therefore, I must have

$$\frac{\phi_a^{'k}((1+\tau^{1-\sigma})^k - 1)}{\frac{f\left(\left(1+\tau^{1-\sigma}\right)^{\frac{\theta}{\theta-1}}-1\right)}{1-\alpha}\left(\frac{k(\sigma-1)}{k-\frac{\theta}{\theta-1}} + \frac{\theta-1}{\theta}\right)} > \frac{\frac{k(\sigma-1)}{k-\frac{\theta}{\theta-1}} + \frac{k(\sigma-1)}{\frac{\theta}{\theta-1}}}{\frac{k(\sigma-1)}{k-\frac{\theta}{\theta-1}} + \frac{\theta-1}{\theta}}.$$

As the usual range for σ is between 2 and 5 and $k > \frac{\theta}{\theta-1} > 1$, I must have

$$k(\sigma-1) > 1$$

and

$$\frac{\eta_o(1+\tau^{1-\sigma})}{\eta_a} = \frac{\phi_a^{'}(1+\tau^{1-\sigma})}{\phi_o^{'}} > 1.$$

As a result, managers of exporting firms exert more effort which increases firm productivity after the economy opens up to trade (and bilateral trade liberalization).

Finally, I prove that when trade costs are not sufficiently small in the open economy, managers of the least productive surviving non-exporters must exert more effort in the open economy than in the closed economy. First, calculation shows that managers with the quality draw that equals the zero-profit cutoff exert the same level of effort in the open economy as in the closed economy, or

$$\beta(\alpha, \eta_a, \phi_a^{'}) = \Big[\frac{\alpha f}{\theta(1-\alpha)}\Big]^{\frac{1}{\theta}} = \beta(\alpha, \eta_o, \phi_o^{'}),$$

which implies that

$$\beta(\alpha, \eta_o, \phi_o^{'}) = \beta(\alpha, \eta_a, \phi_a^{'}) < \beta(\alpha, \eta_a, \phi_o^{'}),$$

where variables with the subscript of a refers to their values in the closed economy, while those with the subscript of o refers to their values in the open economy. The above inequality says that managers with the draw of $\phi_o^{'}$ exert more effort in the closed economy than in the open economy. Next, when trade costs are not sufficiently small in the open economy, the increase in the zero-profit cutoff is not too large. Since the relationship between the exit cutoff and the zero-profit cutoff is unaffected by trade costs, one of the following two cases has to be true: $\phi_o^* < \phi_a^{'}$ or $\phi_o^* \geq \phi_a^{'}$ and $\beta(\alpha, \eta_o, \phi_o^*) > \beta(\alpha, \eta_a, \phi_o^*)$.

In the first case, I must have $\beta(\alpha, \eta_o, \phi_a^{'}) > \beta(\alpha, \eta_o, \phi_o^{'}) = \beta(\alpha, \eta_a, \phi_a^{'})$ for firms with the random draw of $\phi_a^{'}$. Since $\beta(\alpha, \eta_o, \phi)$ decreases continuously with ϕ when $\phi \in [\phi_a^{'}, \phi_o^{'}]$, and $\beta(\alpha, \eta_a, \phi)$ increases continuously with ϕ when $\phi \in [\phi_a^{'}, \phi_o^{'}]$, it must be true that there exists a cutoff $\phi^{''} \in (\phi_a^{'}, \phi_o^{'})$ such that the effort level of managers whose products' initial quality is between ϕ_o^* and $\phi_o^{''}$ is higher in the open economy than in the closed economy.

In the second case, I have $\beta(\alpha, \eta_o, \phi_o^*) > \beta(\alpha, \eta_a, \phi_o^*))$ and $\phi_o^* \geq \phi_a^{'}$. Since $\beta(\alpha, \eta_o, \phi)$ decreases continuously with ϕ when $\phi \in [\phi_o^*, \phi_o^{'}]$, and $\beta(\alpha, \eta_a, \phi)$ increases continuously with ϕ when $\phi \in [\phi_o^*, \phi_o^{'}]$, it must be true that there exists a cutoff $\phi^{''} \in (\phi_o^*, \phi_o^{'})$ such that the effort level of managers whose products' initial quality is between ϕ_o^* and $\phi^{''}$ is higher in the open economy than in the closed economy.

In total, I have a cutoff $\phi^{''} \in (\phi^*, \phi^{'})$ such that non-exporting firms with initial quality draws below this cutoff increase their managerial effort and productivity after opening up to trade (and bilateral trade liberalization) and vice versa for non-exporting firms with initial quality draws above this cutoff. QED.

7.8 Proof of Proposition 3

Proof. The proof is similar to the proof of Proposition 2. Using the same method, I can prove that both the exit cutoff and the zero-profit cutoff increase after the economy opens up to trade. As a result, I have

$$\eta(P_a, Y_a) > \eta(P_o, Y_o),$$

where subscript a refers to variables in autarky and subscript o refers to variables in the open economy. Namely, the adjusted market size shrinks for non-exporters when the economy opens up to trade. Next, when trade costs are sufficiently small in the open economy, the increase in the above two cutoffs is large. This must lead to $\phi_o^* > \phi_a^{'}$ and

$$\beta(\alpha, \eta_a, \phi_a^*) = \beta(\alpha, \eta_o, \phi_o^*) < \beta(\alpha, \eta_a, \phi_o^*).$$

In this case, the manager with the random draw of $\phi \in [\phi_o^*, \phi_o^{'}]$ exerts less effort, since

$$\beta(\alpha, \eta_o, \phi) \leq \beta(\alpha, \eta_o, \phi_o^*) < \beta(\alpha, \eta_a, \phi_o^*) \leq \beta(\alpha, \eta_a, \phi).$$

Moreover, the manager with the random draw of $\phi > \phi_o^{'}$ also exerts less effort, since

$$\beta(\alpha, \eta_o, \phi) = \beta_s(\alpha, \eta_o, \phi) < \beta_s(\alpha, \eta_a, \phi) = \beta(\alpha, \eta_a, \phi).$$

In total, productivity of all non-exporters decreases. Figure 15 represents this case.

Finally, I prove that the percentage decrease in productivity is smaller for non-exporting firms with $\phi \in [\phi_o^*, \phi_o^{'})$ than for non-exporting firms with $\phi \geq \phi_o^{'}$. Simple calculation shows that

$$\begin{aligned} & \log(\phi\beta(\alpha, \eta_o, \phi) - \log(\phi\beta(\alpha, \eta_a, \phi)) = \log(\phi\beta_s(\alpha, \eta_o, \phi) - \log(\phi\beta_s(\alpha, \eta_a, \phi)) \\ = \; & \frac{1}{\theta - 1}[\log(\eta(P_o, Y_o)) - \log(\eta(P_a, Y_a))] \end{aligned}$$

for $\phi \in [\phi_o^{'}, \phi_x)$ and

$$\begin{aligned} & \log(\phi\beta(\alpha, \eta_o, \phi) - \log(\phi\beta(\alpha, \eta_a, \phi)) > \log(\phi\beta_s(\alpha, \eta_o, \phi) - \log(\phi\beta_s(\alpha, \eta_a, \phi)) \\ > \; & \frac{1}{\theta - 1}[\log(\eta(P_o, Y_o)) - \log(\eta(P_a, Y_a))] \end{aligned}$$

for $\phi \in [\phi_o^*, \phi_o^{'})$. Therefore, the percentage decrease in productivity (i.e., decrease in log productivity) is smaller for less productive non-exporting firms (i.e., $\phi \in [\phi_o^*, \phi_o^{'})$) than for more productive non-exporting firms ($\phi \in [\phi_o^{'}, \phi_x)$). QED.

7.9 Proof of Proposition 4

Proof. First, using equation (11) and (20), I derive the share of exporting firms among all active firms as

$$\left(\frac{\phi^*}{\phi_x}\right)^k = \left(\frac{(\alpha f)}{\theta[\alpha f - (1-\alpha)]}\right)^{\frac{k}{\theta}} \left(\frac{f[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}} - 1]}{f_x}\right)^{\frac{(\theta-1)k}{\theta}} \left(\frac{\theta - 1}{(1-\alpha)\theta}\right)^{\frac{(\theta-1)k}{\theta}}. \tag{49}$$

After taking the log of the above share and ignoring terms that are unrelated to α, I derive that

$$Sign\left[\frac{d\left(\frac{\phi^*}{\phi_x}\right)^k}{d\alpha}\right] = Sign\left[\frac{k}{\theta}\left[\frac{1}{\alpha} - \frac{(1+f)}{\alpha f - (1-\alpha)} + \frac{\theta - 1}{1 - \alpha}\right]\right].$$

It is easy to verify that above term single-crosses zero from below. Moreover, it is negative when $\alpha = \bar{\alpha}$ and positive when α approaches one. Therefore, I conclude that there exists a cutoff $\alpha_0 \in [\bar{\alpha}, 1)$ such that $\frac{d\left(\frac{\phi^*}{\phi_x}\right)^k}{d\alpha}$ is non-positive for $\alpha \in [\bar{\alpha}, \alpha_0]$ and positive for $\alpha \in (\alpha_0, 1)$ which proves the first result.

Next, I derive the ratio of the two exit cutoffs as

$$\left(\frac{\phi_o^*}{\phi_a^*}\right)^k = \frac{T_3(\alpha) + f_x\left(\frac{\alpha f}{\theta[\alpha f-(1-\alpha)]}\right)^{\frac{k}{\theta}} T_2(f_x, \tau)^{-k}\left[1 + (\sigma - 1)k\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}}\right]}{T_3(\alpha)},$$

where

$$T_2(f_x, \tau) \equiv \left(\frac{f_x}{f[(1 + \tau^{1-\sigma})^{\frac{\theta}{\theta-1}} - 1]}\right)^{\frac{\theta-1}{\theta}}\left(\frac{(1 - \alpha)\theta}{\theta - 1}\right)^{\frac{\theta-1}{\theta}};\ T_3(\alpha) \equiv (1+f)+\frac{f(\sigma - 1)}{1 - \alpha}\left[\frac{\frac{\theta}{\theta-1}}{k - \frac{\theta}{\theta-1}}\left(\frac{\alpha f}{\theta[\alpha f - (1 - \alpha)]}\right)^{\frac{k}{\theta}}+1\right].$$

It is easy to verify that $\frac{\phi_o^*}{\phi_a^*}$ increases with α if and only if

$$\frac{(1 - \alpha)^{-k\left(\frac{\theta-1}{\theta}\right)}\left(\frac{\alpha f}{\theta[\alpha f-(1-\alpha)]}\right)^{\frac{k}{\theta}}}{T_3(\alpha)}$$

increases with α or

$$(1 + f)(1 - \alpha)^{k\left(\frac{\theta-1}{\theta}\right)}\left(\frac{\theta[\alpha f - (1 - \alpha)]}{\alpha f}\right)^{\frac{k}{\theta}} + f(\sigma - 1)(1 - \alpha)^{k\left(\frac{\theta-1}{\theta}\right)-1}\left[\frac{\frac{\theta}{\theta-1}}{k - \frac{\theta}{\theta-1}} + \left(\frac{\theta[\alpha f - (1 - \alpha)]}{\alpha f}\right)^{\frac{k}{\theta}}\right] \tag{50}$$

decreases with α. I have just shown that the first order derivative of the first term above (with respect to α) is positive for $\alpha \in [\bar{\alpha}, \alpha_0)$ and negative for $\alpha \in (\alpha_0, 1)$. Thus, the first term increases with α when α is close to its lower bound, $\bar{\alpha}$, and decreases with α when α is close to one. I redefine the second term as

$$T_4(\alpha) \equiv f(\sigma - 1)(1 - \alpha)^{k\left(\frac{\theta-1}{\theta}\right)-1}\left[\frac{\frac{\theta}{\theta-1}}{k - \frac{\theta}{\theta-1}} + \left(\frac{\theta[\alpha f - (1 - \alpha)]}{\alpha f}\right)^{\frac{k}{\theta}}\right]$$

The first order derivative of $\log(T_4(\alpha))$ with respect to α is

$$\frac{-1}{1 - \alpha}\left(k\left(\frac{\theta - 1}{\theta}\right) - 1\right) + \frac{\frac{k}{\alpha^2 f}\left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}-1}}{\frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}} + \left(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\right)^{\frac{k}{\theta}}},$$

which is positive when α is close to $\bar{\alpha}$ and negative when α approaches one. Therefore, the term in equation (50) increases with α when α is close to its lower bound and decreases with α when α is close to one. In total, the ratio of the two exit cutoffs, $\frac{\phi_o^*}{\phi_a^*}$, decreases with α when α is close to its lower bound and increases with α when α is close to one. This implies that the selection effect of trade decreases with α when α is close to its lower bound and increases with α when α is close to one. QED.

7.10 Proof of Proposition 5

Proof. I first show how the gain in unweighed average of firm productivity from trade varies with the bargaining power of the manager. Since we know that

$$\beta(\alpha,\eta_a,\phi_a^{'}) = \Big[\frac{\alpha f}{\theta(1-\alpha)}\Big]^{\frac{1}{\theta}} = \beta(\alpha,\eta_o,\phi_o^{'}),$$

it is straightforward to show that

$$\frac{ATFP^o_{unweighted}}{ATFP^a_{unweighted}} = \frac{\phi_o^{'}}{\phi_a^{'}}\Bigg[1+\frac{\frac{k}{k-\frac{\theta}{\theta-1}}[(1+\tau^{1-\sigma})^{\frac{1}{\theta-1}}-1]\Big(\frac{f_x}{f[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]}\Big)^{1-k\left(\frac{\theta-1}{\theta}\right)}\Big(\frac{\theta}{\theta-1}\Big)^{1-k\left(\frac{\theta-1}{\theta}\right)}}{T_5(\alpha)}\Bigg] > 1,$$

where

$$T_5(\alpha) \equiv (1-\alpha)^{k\left(\frac{\theta-1}{\theta}\right)-1}\Big[\Big(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\Big)^{\frac{k}{\theta}} + \frac{\frac{\theta}{\theta-1}}{k-\frac{\theta}{\theta-1}}\Big] = \frac{T_4(\alpha)}{f(\sigma-1)}.$$

In Section 7.9, I have shown that $\frac{dT_4(\alpha)}{d\alpha}$ is positive when α is close to $\bar{\alpha}$ and negative when α is close to one. Thus, the same property holds for $\frac{dT_5(\alpha)}{d\alpha}$. As $\frac{\phi_o^{'}}{\phi_a^{'}}$ decreases with α (and increases with α) when α is close to $\bar{\alpha}$ (and close to one), the gain in unweighed average of firm productivity (from opening up to trade) decreases with α when α is close to $\bar{\alpha}$ and increases with α when α is close to one.

Now, I show how the gain in weighed average of firm productivity from trade varies with the bargaining power of the manager. It is straightforward to show that

$$\frac{ATFP^o_{weighted}}{ATFP^a_{weighted}} = \frac{\phi_o^{'}}{\phi_a^{'}}\Bigg[1+\frac{\frac{k}{k-\frac{2\theta}{\theta-1}}[(1+\tau^{1-\sigma})^{\frac{\theta}{\theta-1}}-1]\Big(\frac{f_x}{f[(1+\tau^{1-\sigma})^{\frac{\theta+1}{\theta-1}}-1]}\Big)^{2-k\left(\frac{\theta-1}{\theta}\right)}\Big(\frac{\theta}{\theta-1}\Big)^{2-k\left(\frac{\theta-1}{\theta}\right)}}{T_6(\alpha)}\Bigg] > 1,$$

where

$$T_6(\alpha) \equiv (1-\alpha)^{k\left(\frac{\theta-1}{\theta}\right)-2}\Big[\Big(\frac{\theta[\alpha f-(1-\alpha)]}{\alpha f}\Big)^{\frac{k}{\theta}} + \frac{\frac{2\theta}{\theta-1}}{k-\frac{2\theta}{\theta-1}}\Big].$$

Simple calculation shows that $dT_6(\alpha)/d\alpha$ is positive when α is close to $\bar{\alpha}$ and negative when α is close to one. As $\frac{\phi_o^{'}}{\phi_a^{'}}$ decreases with α (and increases with α) when α is close to $\bar{\alpha}$ (and close to one), the gain in weighed average of firm productivity (from opening up to trade) decreases with α when α is close to $\bar{\alpha}$ and increases with α when α is close to one. QED.

7.11 Data

In this subsection, I describe how I merge and clean the datasets. In addition, I present summary statistics of the merge dataset. First, the two original datasets are the same as the ones used in Bloom and Van Reenen (2010). The first dataset is called "*basic.dta*", which contains (cross-sectional) information on the overall management score and on the individual score of each of the 18 management practices defined by Bloom and Van Reenen (2010). The second (panel) dataset is called "*paneldata.dta*" and contains production and financial information (e.g., employment, sales etc.) for most firms surveyed in the first dataset. The second dataset covers the time period of 2003-2008. Using a common firm identifier, (a variable called "code"), I merge the two datasets to obtain the dataset that is used in the empirical analysis of the paper. About 97% of the observations of the second dataset (i.e., "*paneldata.dta*") are successfully matched with observations in the first dataset (i.e., "*basic.dta*") , and I use observations that exist in both datasets and report their export value in the empirical analysis. Table 7 presents summary statistics of several key variables of the merged dataset.

Table 7: Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
$lemp$	1470	5.448254	0.8933181	0	8.517193
$lsales$	1068	10.58194	1.579166	0	17.4747
MS_{sub}	3744	2.990118	0.7156136	1	4.833333
MS_{effort}	3744	2.865184	0.7458332	1	4.875
$export$	3762	21.66443	30.61561	0	100

$lemp$: log of employment; $lsales$: log of sales (in USD).

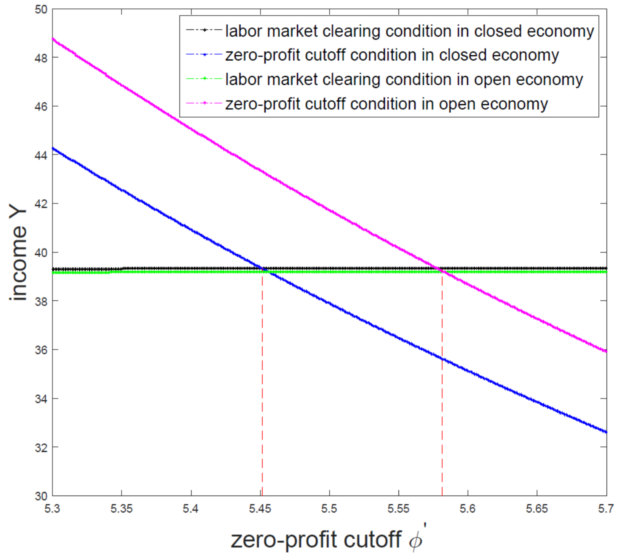
$export$: export value.

MS_{eff}: average score on 8 management practices..

MS_{sub}: average score on 6 management practices.

8 Tables and Figures: For Online Publication

Figure 14: Equilibrium in Closed Economy and in Open Economy



Different from Figure 5, the labor-market-clearing condition shifts down when the two symmetric economies open up to trade.

Figure 15: Impact of Trade on the Optimal Effort (Large Reduction in Trade Costs)