Agency Problem, Trade Liberalization and Aggregate Productivity: Theory and Evidence

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Abstract

Evidence shows that trade liberalization mitigates the agency problem inside the firm and improves firm productivity, which does not square well with the existing literature. I propose a general equilibrium model to explain this finding. When an economy opens up to trade, managers of unproductive surviving *non-exporters* are incentivized to exert more effort, which leads to a within-firm productivity improvement. Furthermore, this effect only applies to unproductive firms that are *subject to the agency problem*, which is a new channel through which trade liberalization improves firm productivity. Despite of this new channel, gains in aggregate productivity *might* be smaller in a world with the agency problem, since the improvement of inefficient firms retards resource reallocation toward efficient firms after trade liberalization. Using Colombia plant-level data, I show that the agency problem matters for gains in aggregate productivity and welfare gains from trade liberalization quantitatively. In addition, I provide evidence to support a key empirical prediction of the model.

Key words: trade liberalization, firm-level and aggregate productivity, agency problem

JEL Classification: D21, D23, F12, F14, L22, L26

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1 Introduction

Recent empirical research studying the impact of trade liberalization on firm productivity finds substantial productivity gains coming from within-firm improvements following trade liberalization (e.g., Pavnick (2002), Trefler (2004), and Schmitz (2005)). These findings do not square well with a recent literature that emphasizes the importance of improved market access for productivity improvements at the firm level (e.g., Lileeva and Trefler (2010) and Bustos (2011)), since firms seem to face *shrinking* market size when foreign competitors arrive. Furthermore, Griffith (2001) finds that in U.K., only establishments whose managerial control and ownership were separated improved productivity after the introduction of the European Union Single Market Program. Why, therefore, does productivity of *some* firms increase when they face tougher competition? At the firm level, how does the existence of the agency problem affect productivity gains after trade liberalization? At the aggregate level, does it matter for gains in overall productivity and welfare after trade liberalization? The purpose of this paper is to analyze how the existence of the agency problem affects firm-level as well as aggregate-level productivity gains from trade both theoretically and quantitatively.

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 agency problem within the firm. An investor (i.e., a firm owner) has enough resources to form a firm and a rough idea to start a business. However, she needs to be matched with a manager who has knowledge and experience to make this rough idea implementable. The overall quality of an *implementable* idea depends on two components. First, after the firm owner meets and discusses the rough idea with the manager, an *initial* quality of the idea is randomly realized. Second, the manager has to exert effort to develop this implementable idea after the initial quality is realized. In the end, the overall quality of the implementable idea pins down the efficiency of production, which eventually determines firm productivity.

In this paper, I propose a general equilibrium model consisting of one industry. 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 firm owners who can enter this industry by paying a fixed cost and a large pool of managers who can be matched with the owners to form firms. The timing of the game is as follows. First, a firm owner can enter the industry by paying a fixed entry cost, and then she is randomly matched with a manager. After the match, a firm is set up, and the initial quality of an implementable idea is randomly realized. Second, the manager chooses between becoming a worker and working for the owner. In the latter case, he has to exert effort to develop the implementable idea, which leads to a blueprint for a product. Third, if the manager works for the firm owner, the owner decides whether to pay a fixed production cost to start production. Fourth, if the production starts, the manager (or the owner) decides output and employment. Then, firms compete in the market, and the operating profit is received. Finally, the owner and the manager receive their income from the operating profit. Following the incomplete contract approach to modelling the managerial compensation (i.e., Bolton and Scharfstein (1990), and Hart and Moore (1998)), I assume that the manager and the owner obtain income via ex post bargaining.[1] Shares of the operating profit received by the two agents are assumed to be the solution to a generalized Nash bargaining game, which are α (for the manager) and $1 - \alpha$ (for the firm owner).

How do the manager and the firm owner make their decisions in autarky? At the fourth stage, the choice of output is to maximize the operating profit, since the manager and the owner bargain over the operating profit at the final stage. At the third stage, the owner is willing to start production, if and only if the fraction of operating profit she receives from the ex post bargaining at least covers the fixed production cost. The manager's decision at the second stage consists of three cases. First, if the initial quality is low, the optimal choice of the manager is to quit the firm and become a worker, which is his outside option. Second, if the initial quality is high, the manager chooses an effort level to maximize the fraction of operating profit he receives minus the effort cost. There is under-provision of the effort in this case, although the owner is still willing to produce under the second-best level of effort.[2] When the initial quality is in the middle range, the owner would not start production if the manager exerted effort at

[1]This approach assumes that complete contracts that base the managerial compensation on the manager's effort and performance measures (e.g., operating 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 second-best level, since the initial quality is not too high. However, there is room for both agents to achieve a Pareto improvement, since the initial quality is not too low and the second-best level of effort does not maximize the total payoff. In equilibrium, the manager exerts effort at a level that makes the owner break even (i.e., zero profit). As a result, the owner is willing to produce, and the manager earns a payoff higher than his outside option.[3] In total, the manager's effort decreases first and increases afterwards with the initial quality draw (i.e., "U"-shaped). At the first stage, the owner enters the monopolistically competitive industry if and only if the expected profit from entering is non-negative. Since there is a large pool of firm owners who can enter the industry, the expected profit from entering is zero in equilibrium.

I extend the model described above into an international context à la Melitz (2003) to s-tudy how opening up to trade affects the manager's effort choice. Opening up to trade triggers within-industry resource reallocation and generates productivity gains for two types of firms. First, the least productive non-exporting firms exit the market due to the selection effect. Second, productivity of the least productive surviving non-exporters increases, even though market size *shrinks* for them. After opening up to trade, the minimum productivity level under which the owner breaks even goes up (due to tougher competition). When the manager earns substantial rents and his owner breaks even in autarky, he is willing to scarify a part of his rents and continue to incentivize his owner to produce by exerting more effort 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-exporter. Finally, productivity of the least productive exporters also increases after opening up to trade, for two reasons. First, the second-best level of effort increases, since the market size and the marginal return to exerting effort increases for exporters. Second, managers of the least productive exporters exert effort higher than the second-best level in order to incentivize their owners to export, while they exert effort at the second-best level in autarky. In total, managers whose firms' initial quality draws are close to the exit cutoff or the exporting cutoff exert more effort after opening up to trade.

Next, although the above model considers firms whose ownership is separate from control (i.e., the agency firms), there probably are firms that do not have the agency problem in reality

[3]The purpose of deviating from the second-best level of effort is to induce the owner to produce. Thus, any further *upward* deviation from the effort level under which the owner breaks even is suboptimal for the manager.

(e.g., proprietorship firms run by family members). In order to take this into account and highlight the importance of the agency problem for productivity improvement, I consider an alternative world where there is *no* such a problem as well. In such a world, managers of *all* non-exporting firms exert less effort after opening up to trade, since market size shrinks and there is no conflict of interests inside the firm. In short, the existence of the agency problem leads to a new channel through which trade liberalization improves firm productivity.

Despite of the new channel for productivity improvement after trade liberalization, gains in aggregate productivity *might* be lower in a world with the agency problem compared to a world without such a problem. Gains in aggregate productivity after trade liberalization come from two sources: the within-firm channel and the between-firm channel. In a world with the agency problem, productivity improvement of unproductive firms hinders resource reallocation toward productive firms after trade liberalization. This finding points out a tension between the within-firm and the between-firm productivity gains after aggregate shocks such as the trade shock. Specifically, if there are many inefficient firms, which improve productivity but still cannot reach productivity levels of efficient firms after the shock, this firm-level gain actually *dampens* gains in aggregate productivity due to the lack of resource reallocation. In sum, this new insight shows that which type of firm improves productivity and relative share of different types of firms gaining and losing in productivity are the keys to evaluating changes in *aggregate productivity* after trade liberalization. And, it also helps explain why within-firm productivity gains might go against between-firm productivity gains after trade liberalization.

Then, I use Colombia plant-level data to calibrate the model and show how the agency problem affects gains in aggregate productivity and welfare after bilateral trade liberalization. A simple counterfactual experiment shows that a 10% reduction in the variable trade cost leads to a 7.76% increase in aggregate productivity and a 1.16% increase in the worker's welfare. Moreover, these gains are 1.05% and 0.25% larger than a world without the agency problem. Why do the numerical example and the calibration exercise yield *qualitatively* different result-s? The key is the share of constrained non-exporters (i.e, non-exporting firms whose managers exert effort higher than the second-best level) in the whole population of firms. Since the share of these firms is substantially smaller in the calibration, resource reallocation toward exporting firms (i.e., the most productive firms) is not hindered after trade liberalization in the agency world. Moreover, in the calibration, there is a bigger fraction of constrained exporters, (i.e, exporting firms whose managers exert effort higher than the second-best level) which increase productivity discontinuously after a infinitesimally small reduction in the trade costs. The existence of this type of firm enlarges aggregate productivity gains from trade in the agency world, since they are productive *and* improve productivity substantially after trade liberalization. In short, which type of firm improves productivity (i.e., not just how much it improves) is a key to evaluating gains in aggregate productivity after trade liberalization.

Finally, using the data from world management survey (WMS), I provide evidence to support a key prediction of my model.[4] That is, the managerial effort (loosing speaking, management quality) is "U"-shaped with respect to the firm's initial quality draw. First, I use the average score on 18 management practices documented in WMS to measure the managerial effort, and firm size (i.e., employment) is used as a proxy for the initial quality draw. Then, I plot the average management score against firm size for non-exporting (or small) firms that are subject to the agency problem at the cross sectional level. The data shows that in all countries I consider, the average management score is the lowest for medium-sized non-exporting firms. In addition, the largest firms receive the highest average management score. In total, these evidence together supports my model's prediction concerning the relationship between the managerial effort and the quality draw of the firm.

The rest of this paper is organized as follows. Section two reviews the literature. Section three analyzes the model for a closed economy. Section four analyzes the model for an open economy. Section five investigates how the existence of the agency problem affects aggregate productivity gains from trade quantitatively. Section six presents evidence to support the model's prediction. Section seven concludes. Proofs of the main results are relegated to the appendices.

[4] For details about the data set, see `http://worldmanagementsurvey.org/`.

2 Literature Review

This article aims to speak to the empirical literature on the response of firm productivity to trade liberalization. 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.[5] These two findings are consistent with the prediction of my model. Moreover, my paper points out a new channel through which import competition makes *some* firms improve productivity via incentivizing their managers to exert effort.

The relationship between market competition and firm productivity is an old question in economics. A Schumpeterian view suggests that intensified competition destroys firms' profit and, accordingly, their incentive to improve productivity.[6] 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.[7] 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.[8] This paper bridges the gap between the partial equilibrium analysis of the manager's effort choice and the general equilibrium analysis of market competition under firm heterogeneity.

This paper is related to a literature arguing that internal firm organization matters for aggregate trade statistics and aggregate productivity gains from trade. Papers in this literature have investigated how the choice of the number of hierarchical layers (e.g., Caliendo and Rossi-Hansberg (2012) and Chen (2014)) and the delegation decision inside the firm (e.g., Marin and Verdier (2008, 2010)) affect productivity gains from trade liberalization. However, none of

[5] Trefler (2004), Biesebroeck (2006), De Loecker (2007), and Fernandes (2007) document similar evidence.

[6] Seminal papers in this literature include Grossman and Helpman (1991), Aghion and Howitt (1992), and others.

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

[8] Wu (2001) is one exception. In that paper, he considers the role of manager in production explicitly and derives interesting results on changes in managerial remuneration schemes after trade liberalization. However, his paper does not focus on the impact of trade liberalization on firm productivity.

these work has looked at how the existence of the separation of ownership and control inside the firm affects gains in productivity after trade liberalization. Furthermore, this problem is a dominant feature for a majority of firms. My paper fills this gap by investigating this issue both qualitatively and quantitatively.

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 exerted by the manager is a *non-monotonic* function of the initial quality of the implementable idea.

3.1 Environment

There are three types of agents in the economy: workers, potential managers who can choose to be either managers or workers, and investors. Their endowments are L, M, and I, respectively, and they are fixed throughout the paper. I assume that the measure of investors (i.e., M) is big enough such that the free-entry condition discussed below holds as an equality. Workers are homogeneous and used as inputs to production and receive a uniform wage from employment. Investors are homogeneous and have rough business ideas and enough resources to form firms. Managers are also homogeneous, and some of them are matched with the investors after the investors enter the industry.

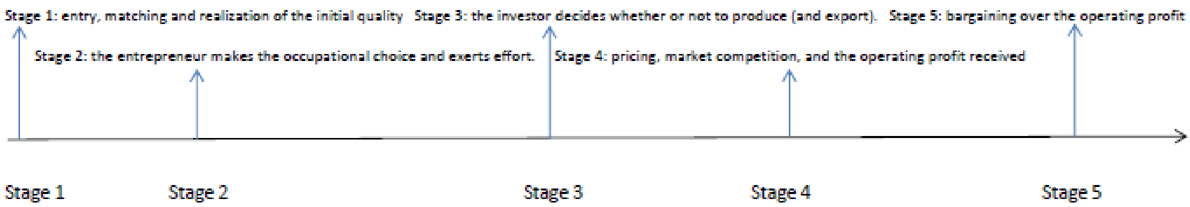
There is one industry populated by firms that produce differentiated products under conditions of monopolistic competition à la Dixit and Stiglitz (1977). Each variety is indexed by ω, and Ω is the set of all varieties. Consumers derive utility from consuming these differentiated goods according to

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

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 illustrated in Figure 1 and can be described as follows. First, an investor can enter the industry by paying a fixed entry cost, denoted by f_e, and then she is

Figure 1: The Timing of the Game



randomly matched with a manager. After the match, a firm is set up, and the manager and the investor discuss an implementable idea whose initial quality, ρ, is randomly realized. Second, the manager chooses between becoming a worker and working for the owner. In the latter case, he has to exert effort (denoted by ψ) to develop the implementable idea, which leads to a blueprint for a product. Third, after the manager exerts the effort, the investor decides whether or not to pay a fixed production cost, f, to start production. I assume that the investor observes the overall quality of the implementable idea, which equals $\rho\psi$, when deciding whether or not to start production. The overall quality of the implementable idea determines the labor productivity of the firm in the subsequent production.[9] Fourth, if the production starts, the manager (or the owner) decides the output level and employment. At that point, firms compete in the market, revenue and the operating profit are received, and the variable cost is paid.[10] Finally, the investor and the manager bargain over the operating profit. For simplicity, I assume that they play a generalized Nash bargaining game. As a result, the manager and the investor receive fractions α and $1 - \alpha$ of the operating 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. One point worth mentioning is that the manager's effort considered here does not *literally* mean the amount of time he works. It represents the amount of time the manager works and how hard he works *in the interest of the firm*.[11] In order to exert effort, the manager must incur a cost (i.e., disutility) in terms of the numeraire of ψ^{θ_0}. Parameter θ_0 $(> \sigma - 1)$ measure the cost of exerting effort.

[9]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.

[10]It is irrelevant who decides on the output and pricing level at this stage, since both parties' incentives are perfectly aligned to maximize operating profits at stage four.

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

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

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

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

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

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 operating profit he receives, the optimal price determined at the fourth stage is to maximize the operating profit. As a result, the optimal pricing rule is the same across firms and can be written as

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

where w is the worker's wage and $\lambda \equiv (\sigma - 1)/\sigma$ is the inverse of the markup. I choose the worker's wage w to be the numeraire. From equations (2) and (3), I derive the operating profit 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.

At stage three, the investor is willing to start production, if and only if the fraction of operating profit he receives is larger than or equal to the fixed production cost. Formally, the participation constraint of the investor is

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

The manager's effort choice at stage two is more involved. I discuss it case by case. If the investor is willing to produce, the objective function of the manager is

$$\max_{\psi} \quad \frac{\alpha}{\sigma}(\rho\psi\lambda P)^{\sigma-1}Y - \psi^{\theta_0}$$
$$s.t. \qquad \frac{\alpha}{\sigma}(\rho\psi\lambda P)^{\sigma-1}Y - \psi^{\theta_0} \geq 1,$$

which can be transformed into

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

where $\phi \equiv \rho^{\sigma-1}$, $\beta \equiv \psi^{\sigma-1}$, $\theta \equiv \frac{\theta_0}{\sigma-1}$, and $\eta(P,Y) \equiv \frac{1}{\sigma}(\lambda P)^{\sigma-1}Y$. Note that the inequality inside the above optimization problem is the manager's participation constraint. The solution to this optimization problem is

$$\beta_a(\phi) = \beta_{a2}(\phi) \equiv \Big(\frac{\alpha\eta(P,Y)\phi}{\theta}\Big)^{\frac{1}{\theta-1}}, \tag{6}$$

which is defined as the second-best level of effort.

Two things are worth noting here. First, 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 is a cutoff, $\phi_a^{'}$, such that the manager cannot compensate his investor by exerting effort at the second-best level, if the initial quality, ϕ, is below this cutoff. Formally, the cutoff $\phi_a^{'}$ is defined as

$$(1-\alpha)\pi(\phi_a^{'}\beta_{a2}(\phi_a^{'})) = f. \tag{7}$$

Second, the manager with an implementable idea whose initial quality is $\phi_a^{'}$ chooses to be a worker if his payoff from running the firm is less than his outside option, or[12]

$$\frac{\theta-1}{\theta}\alpha\pi(\phi_a^{'}\beta_{a2}(\phi_a^{'})) < 1.$$

[12]The mathematical expression for this statement is when $(1-\alpha)\pi(\phi_a^{'}\beta_a(\phi_a^{'})) = f$, $\frac{\theta-1}{\theta}\alpha\pi(\phi_a^{'}\beta_a(\phi_a^{'})) < 1$. This expression can be further simplified to $\frac{\theta-1}{\theta}\frac{\alpha f}{(1-\alpha)} < 1$. When the fixed investment cost is big, this condition cannot be satisfied.

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 firm owners (i.e., investors) barely make profit, their managers still obtain 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 earning zero profit obtain payoffs that are strictly larger than their outside option. The following assumption guarantees the existence of such a case, and I adopt this assumption in the subsequent analysis.[13]

Assumption 1

$$\alpha > \frac{1}{1 + f[1 - \frac{1}{\theta}]}.$$

How does the manager with an implementable idea whose initial quality is below $\phi_a^{'}$ make the effort choice? First, choosing an effort level lower than $\frac{\phi_a^{'}\beta_{a2}(\phi_a^{'})}{\phi}$ is suboptimal for him, since the investor would not start production at the third stage. Second, choosing an effort level higher than $\frac{\phi_a^{'}\beta_{a2}(\phi_a^{'})}{\phi}$ is suboptimal for the manager as well. The investor is induced to start production if the effort level equals $\frac{\phi_a^{'}\beta_{a2}(\phi_a^{'})}{\phi}$. Any further upward deviation from this effort level reduces the manager's payoff, since this effort level is already above the second-best level of effort. Finally, if the initial quality of the idea is too low, exerting effort at the level of $\frac{\phi_a^{'}\beta_{a2}(\phi_a^{'})}{\phi}$ gives the manager a payoff lower than his outside option. As a result, this type of manager chooses to become the worker. Thus, there is another cutoff (i.e., ϕ_a^{*}) such that if the initial quality is below this cutoff, the manager chooses to become a worker. In total, I have three cases for the manager's optimal effort choice summarized by the following lemma.

Lemma 1 *Assume that Assumption 1 is satisfied. Define two cutoffs as follows:*

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

[13]In an alternative setup in which the manager's occupational choice is made at stage one, this assumption is not needed. When the occupational choice is made at stage one, the outside option of the manager at stage two is zero. In this case, the manager must receive a positive payoff, when his owner breaks even under the second-best level of the managerial effort. Of course, the manager's expected payoff of choosing to be a manager at stage one has to be bigger than or equal to the worker's wage rate in equilibrium. Otherwise, there would be no managers in equilibrium. This is true under some loose restrictions on parameter values.

and

$$\phi_a^* \equiv \frac{\phi_a^{'}(\alpha f)^{\frac{1}{\theta}}}{\left(\theta[\alpha f - (1-\alpha)]\right)^{\frac{1}{\theta}}} < \phi_a^{'}. \tag{8}$$

If the initial quality of the implementable idea is larger than $\phi_a^{'}$, the optimal effort level is

$$\beta_a(\phi) = \beta_{a2}(\phi) \equiv \left(\frac{\alpha\eta(P,Y)\phi}{\theta}\right)^{\frac{1}{\theta-1}}.$$

If the initial quality is between ϕ_a^* and $\phi_a^{'}$, the optimal effort level is

$$\beta_a(\phi) = \beta_{a0}(\phi) \equiv \frac{\beta_{a2}(\phi_a^{'})\phi_a^{'}}{\phi}. \tag{9}$$

If the initial quality is lower than ϕ_a^*, the manager chooses to become a worker.

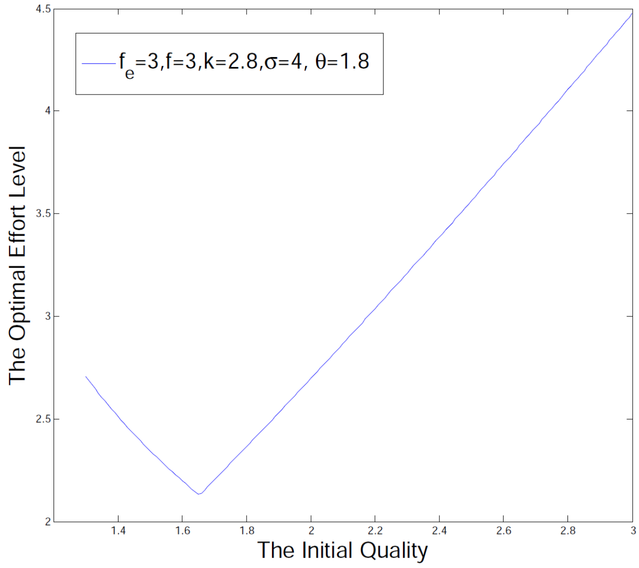
Proof: See Appendix 9.1. QED.

The relationship between the initial quality of the implementable 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 the initial quality, as a higher initial quality increases the marginal return to exerting effort. I call firms whose quality draws are within this range "unconstrained firms", since their owners' participation constraint does not bind in equilibrium. However, when the initial quality of the implementable idea is in the middle range, the optimal effort *decreases* with the initial quality, since a higher initial quality coupled with a lower effort level can make the investor break even. For this downward-sloping part, the fixed production cost acts as a disciplining device. I call firms whose quality draws are in this range "constrained firms", since their owners' participation constraint binds in equilibrium. In total, the relationship between the initial quality of the implementable idea and the optimal effort level is "U" shaped.

For future use, I derive the manager's payoff ($V_m(\phi)$) from equations (6) and (9) as follows:

$$V_m(\phi) = \frac{\alpha f}{1-\alpha} - \left(\frac{\phi_a^{'}}{\phi}\right)^{\theta}\frac{1}{\theta}\frac{\alpha f}{1-\alpha}, \tag{10}$$

Figure 2: The Initial Quality and the Optimal Effort Choice



when $\phi \in [\phi_a^*, \phi_a^{'})$, and

$$V_m(\phi) = \frac{\alpha(\theta - 1)}{\theta}\phi\beta_{a2}(\phi)\eta(P, Y), \tag{11}$$

when $\phi \geq \phi_a^{'}$.

3.3 Aggregation in the Closed Economy

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

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

where the shape parameter k is negatively related to the variance of the distribution.[14]

There are three sets of equilibrium conditions. The first set is related to the cutoffs. The zero cutoff profit condition (ZCP) indicates that firms whose products' initial quality is $\phi_a^{'}$ break even in equilibrium, or

$$(1 - \alpha)\phi_a^{'}\beta_a(\phi_a^{'})\eta(P, Y) = f. \tag{12}$$

The free entry (FE) condition indicates that the investors make zero expected profit upon entry,

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

or

$$f\int_{\phi_a'}^{\infty}\Big[\Big(\frac{\phi}{\phi_a'}\Big)^{\frac{\theta}{\theta-1}}-1\Big]g(\phi)d\phi = f_e. \tag{13}$$

Since there are a large group of investors and a large group of managers (i.e., $I >> E$ and $M >> E$), every investor who enters the industry is matched with a manager for sure, and the FE condition holds as an equality. Note that firms whose products' initial quality is between ϕ_a^* and ϕ_a' make zero profit in equilibrium. Thus, I do not include the expected profit of these firms in the FE condition. Finally, the exit cutoff for the manager (i.e., ϕ_a^*) is pinned down by equation (8).

The second set of equilibrium conditions is related to the effort choice. As Lemma 1 states, the optimal effort is determined by equation (6) when $\phi \geq \phi'$ and by equation (9) when $\phi \in [\phi^*, \phi')$.

The final set of equilibrium conditions is about market clearing. The demand for labor contains three parts: labor used for firm entry, for the fixed production cost, and for the variable cost. The supply of labor is the sum of workers and managers who are not matched with the investors or who choose to be workers. Therefore, the labor-market-clearing condition is

$$Ef_e + Ef[1-G(\phi_a^*)] + \int_{\phi_a^*}^{\infty}\lambda R(\phi\beta_a(\phi))Eg(\phi)d\phi = L + M - E[1-G(\phi_a^*)]. \tag{14}$$

For the product market, the FE condition implies that the value of entry equals the sunk entry cost. Therefore, the total income of the economy equals total revenue of firms, or

$$\begin{aligned} Y \equiv & L + M - E[1-G(\phi_a^*)] + \int_{\phi_a^*}^{\infty}\Big[V_m(\phi) + (\beta_a(\phi))^{\theta}\Big]Eg(\phi)d\phi \\ & + \int_{\phi_a^*}^{\infty} V_f(\phi)Eg(\phi)d\phi - Ef_e \\ = & \int_{\phi_a^*}^{\infty} R(\phi\beta_a(\phi))Eg(\phi)d\phi, \end{aligned} \tag{15}$$

where $V_f(\phi) \equiv (1-\alpha)\phi\beta_a(\phi)\eta(P,Y) - f$ is the owner's profit after entry, and $V_m(\phi)$ is defined in equations (10) and (11).

The general equilibrium of the economy is characterized by the zero profit cutoff, ϕ_a', the mass of entrants, E, the exit cutoff, ϕ_a^*, the effort choice, $\beta_a(\phi)$, the worker's wage, w, and the total income, Y. These variables are obtained by solving equations (6), (8), (9), and (12) to (15). One equilibrium condition is redundant due to Walras' law, and I normalize the worker's wage to one. It is straightforward to use the method that is employed in Melitz (2003) to show that a unique equilibrium exists. I omit the discussion here to save space.

4 The Open Economy

In this section, I analyze the properties of managerial effort and firm productivity in the open economy. The focus of my analysis is to explore the *differential* impact of the opening up to trade (and 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 trade cost means that the firm (i.e., the investor) must incur an additional fixed cost in order to export.[15]

4.1 The Optimal Effort Choice in the Open Economy

The analysis for the behavior of the manager and the investor is similar to before. First, the optimal price decided by the manager at the fourth stage is still designed to maximize the expected profit. Second, the investor's participation constraint (i.e., the decision to start production at the third stage) is still governed by equation (5). Third, similar to the closed economy case, there are two types of firms among non-exporters in the open economy. For unproductive surviving non-exporters, their managers exert effort higher than the second-best level in order to induce their owner to produce. For productive non-exporters, their managers exert effort at the second-best level, and their owners make strictly positive profit.

A given level of effort brings more profit to the firm if the initial quality of its product is higher. Thus, there is an exporting cutoff ϕ_x^*, meaning that if the initial quality of the implementable idea is higher than this cutoff, the investor chooses to export. I consider the case in

[15]Similar to the timing assumed in the closed economy, I assume that the investor decides whether or not to export at stage three in the open economy.

which there is selection into exporting among firms making a positive profit (i.e., the exporting cutoff, ϕ_x^*, is bigger than the zero profit cutoff, $\phi_f^{'}$), and a sufficiently large fixed trade cost ensures it is the case.[16] Empirical evidence motivates this choice.[17]

I analyze how the manager makes his effort choice at the second stage, case by case. The analysis in the closed economy applies to non-exporters in the open economy, since these firms do not have the access to the foreign market. Specifically, I derive two cutoffs similar to those derived in Lemma 1, as follows:

$$\phi_f^{'} \equiv \Big(\frac{f}{(1-\alpha)}\Big)^{\frac{\theta-1}{\theta}} \Big(\frac{\theta}{\alpha\eta(P,Y)^{\theta}}\Big)^{\frac{1}{\theta}} \tag{16}$$

and

$$\phi_f^{*} \equiv \frac{\phi_f^{'}(\alpha f)^{\frac{1}{\theta}}}{\Big(\theta[\alpha f-(1-\alpha)]\Big)^{\frac{1}{\theta}}} < \phi_f^{'}. \tag{17}$$

The only difference here is 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_f^* and $\phi_f^{'}$ is still governed by equation (9), and the analysis for a firm whose product's initial quality is much higher than $\phi_f^{'}$ is more involved, since its manager realizes that he can exert effort at a level higher than the one specified in equation (22) to induce his investor to not only produce but also export. I adopt the following assumption and use the proposition below to summarize the manager's optimal effort choice in the open economy.

Assumption 2

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

Proposition 1 *Assume that Assumption 2 is satisfied in what follows. When $\phi \geq \phi_x^{'}$, the optimal effort choice is given by*

$$\beta_x(\phi) = \beta_{x2}(\phi) \equiv \Big(\frac{\alpha\eta(P,Y)\phi}{\theta}(1+\frac{1}{\tau^{\sigma-1}})\Big)^{\frac{1}{\theta-1}}, \tag{18}$$

[16] Subscript "f" is for firms serving only the domestic market in the open economy, subscript "x" is for firms serving both markets in the open economy, and subscript "a" is for firms in autarky.

[17] 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, Redding, and Schott, 2007).

where

$$\phi_x^{'} \equiv \Big(\frac{(f_x\tau^{\sigma-1})^{\theta-1}\theta}{\alpha(1-\alpha)^{\theta-1}\eta(P,Y)^{\theta}(1+\frac{1}{\tau^{\sigma-1}})}\Big)^{\frac{1}{\theta}}. \tag{19}$$

When $\phi_x^{'} > \phi \geq \phi_x^*$, the optimal effort level is

$$\beta_x(\phi) = \beta_{x0}(\phi) \equiv \frac{\beta_{x2}(\phi_x^{'})\phi_x^{'}}{\phi}, \tag{20}$$

where

$$\phi_x^* \equiv \frac{\phi_x^{'}}{\left[\theta - \frac{\theta-1}{\left(1+\frac{1}{\tau^{\sigma-1}}\right)^{\frac{\theta}{\theta-1}}}\right]^{\frac{1}{\theta}}} \tag{21}$$

is the exporting cutoff such that the investor decides to export, if her product's initial quality is higher than this threshold. When $\phi_x^* > \phi \geq \phi_f^{'}$, the optimal effort level is

$$\beta_{f2}(\phi) \equiv \Big(\frac{\alpha\eta(P,Y)\phi}{\theta}\Big)^{\frac{1}{\theta-1}}, \tag{22}$$

and his investor produces but does not export. When $\phi_f^{'} > \phi > \phi_f^*$, the optimal effort is

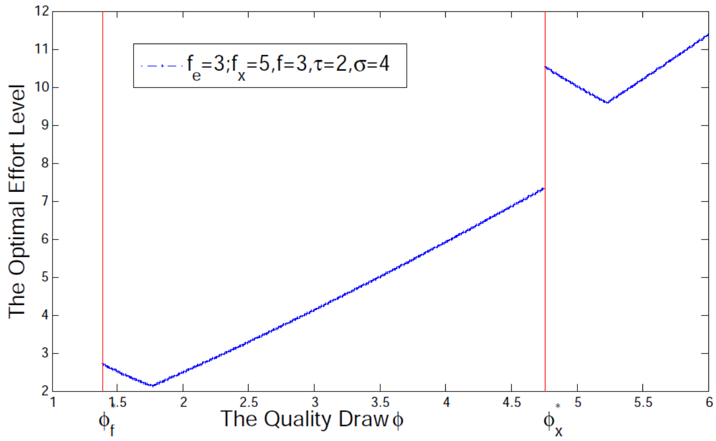
$$\beta_{f0}(\phi) \equiv \frac{\beta_{f2}(\phi_f^{'})\phi_f^{'}}{\phi}, \tag{23}$$

and his investor produces but, again, does not export. When $\phi \leq \phi_f^*$, the manager chooses to become a worker.

Proof: See Appendix 9.2. QED.

Figure 3 illustrates how the optimal effort varies with the initial quality in the open economy. It contains two "U"-shaped curves. For firms whose initial quality draws are between ϕ_f^* and $\phi_f^{'}$ (i.e., the constrained non-exporters), their managers choose effort levels higher than the second-best level in order to induce their investors to produce. Similarly, for firms whose initial quality draws are between ϕ_x^* and $\phi_x^{'}$ (i.e., constrained exporters), their managers choose effort levels higher than the second-best level, since they want to induce their investors to export. As it is the owner who pays the fixed exporting cost, beginning to export increases the manager's

Figure 3: The Optimal Effort Choice in the Open Economy



income discontinuously. For the unconstrained non-exporters (i.e., $\psi \in [\phi_f^{'}, \phi_x^*]$) and exporters (i.e., $\psi \geq \phi_x^{'}$), the change in the managerial effort is purely driven by the change in the market size. Thus, managers of unconstrained non-exporters (and exporters) lower (and raise) their effort levels respectively. In total, the fixed costs (i.e., f and f_x) act as disciplining devices for managers in *the least productive* non-exporting *and* exporting firms. Assumption 2 ensures that the exporting cutoff, ϕ_x^*, is bigger than the zero profit cutoff, $\phi_f^{'}$. Vast empirical evidence suggests that exporters are rare and most of them make positive profit, which motivates this assumption.

4.2 Aggregation in the Open Economy

Similar to the case of the closed economy, there are again three sets of equilibrium conditions in the open economy. The first set is still related to the cutoffs. First, the zero profit cutoff ($\phi_f^{'}$) and the exit cutoff (ϕ_f^*) are given by equations (16) and (17). Second, the exporting cutoff (ϕ_x^*) and the zero exporting cutoff ($\phi_x^{'}$) are determined by equations (21) and (19).[18] Third, the FE

[18]The zero exporting cutoff is defined as the one under which the firm makes zero profit from exporting given the second-best level of managerial effort.

condition now becomes

$$f\int_{\phi_f'}^{\phi_x^*}\Big[\Big(\frac{\phi}{\phi_f'}\Big)^{\frac{\theta}{\theta-1}}-1\Big]g(\phi)d\phi+f\int_{\phi_x^*}^{\phi_x'}\Big[\Big(\frac{\phi_x'}{\phi_f'}\Big)^{\frac{\theta}{\theta-1}}(1+\frac{1}{\tau^{\sigma-1}})^{\frac{1}{\theta-1}}-1\Big]g(\phi)d\phi$$
$$+f\int_{\phi_x'}^{\infty}\Big[\Big(\frac{\phi}{\phi_f'}\Big)^{\frac{\theta}{\theta-1}}(1+\frac{1}{\tau^{\sigma-1}})^{\frac{\theta}{\theta-1}}-1-\frac{f_x}{f}\Big]g(\phi)d\phi=f_e, \tag{24}$$

which can be simplified to

$$f\int_{\phi_f'}^{\phi_x^*}\Big[\Big(\frac{\phi}{\phi_f'}\Big)^{\frac{\theta}{\theta-1}}-1\Big]g(\phi)d\phi+f\int_{\phi_x'}^{\infty}\Big[\Big(\frac{\phi}{\phi_f'}\Big)^{\frac{\theta}{\theta-1}}(1+\frac{1}{\tau^{\sigma-1}})^{\frac{1}{\theta-1}}-1\Big]g(\phi)d\phi$$
$$+f_x\int_{\phi_x'}^{\infty}\Big[\Big(\frac{\phi}{\phi_x'}\Big)^{\frac{\theta}{\theta-1}}-1\Big]g(\phi)d\phi+\int_{\phi_x^*}^{\phi_x'}[f_x\tau^{\sigma-1}-f]g(\phi)d\phi=f_e. \tag{25}$$

The second set of equilibrium conditions is related to the manager's effort choice. Equations (22), (23), (18), and (20) pin down the manager's equilibrium effort choice. The third set is related to market clearing. First, the labor-market-clearing condition indicates that

$$Ef_e+Ef[1-G(\phi_f^*)]+Ef_x[1-G(\phi_x^*)]+\int_{\phi_f^*}^{\phi_x^*}\lambda R(\phi\beta_f(\phi))Eg(\phi)d\phi$$
$$+\int_{\phi_x^*}^{\infty}\lambda R(\phi\beta_x(\phi))Eg(\phi)d\phi=L+M-E[1-G(\phi_f^*)]. \tag{26}$$

There is also a product-market-clearing condition similar to the one derived in the closed economy (i.e., equation (15)), which I omit here.

The general equilibrium of the open economy is characterized by the zero profit cutoff, ϕ_f', the mass of entrants, E, the exit cutoff, ϕ_f^*, the exporting cutoffs, ϕ_x^*, the cutoff, ϕ_x', the effort choices, $\beta_f(\phi)$ and $\beta_x(\phi)$, the worker's wage (normalized to one), and the total income, Y. These variables are obtained by solving equations (16) to (26).

4.3 Opening Up to Trade and Firm Productivity

In this subsection, I discuss how opening up to trade affects the optimal effort choice as well as 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 non-exporting and exporting firms. The following proposition summarizes the main result of the paper.

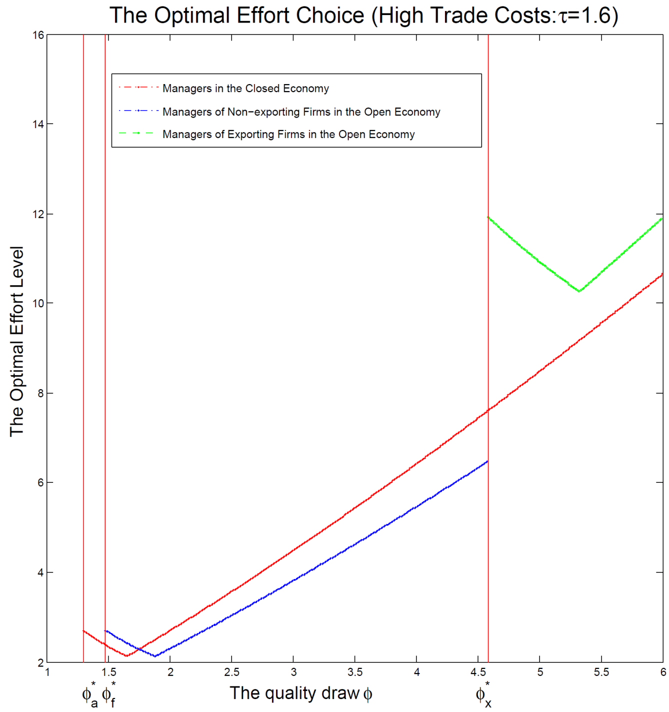
Proposition 2 *After opening up to trade, the exit cutoff (ϕ^*_f) and the zero profit cutoff (ϕ'_f) both increase. Productivities of the least productive exporters and the equilibrium effort level of managers working in these firms are higher in the open economy than in the closed economy. When trade costs are not too small in the open economy, there exists a cutoff on the initial quality draw, $\phi''_f \in (\phi^*_f, \phi'_f)$, such that, for surviving non-exporters with $\phi \leq \phi''_f$, the equilibrium effort level and firm productivity are higher in the open economy than in the closed economy. For surviving non-exporters with $\phi > \phi''_f$, the equilibrium effort level and firm productivity are lower in the open economy than in the closed economy.*

Proof: See Appendix 9.3. QED.

Figure 4 shows how the optimal effort changes after the economy opens up to trade. Managers of the least productive surviving non-exporters and exporters increase their effort levels, when the economy moves from autarky to an open economy. This is mainly due to the disciplining effect. In order to incentivizes 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 the least productive exporting firms exert more effort for two reasons. First, enlarged market size increases the marginal return to exerting effort and the second-best level of effort. Second, the disciplining effect works for them as well. I.e., managers in these firms exert effort higher than the second-best level to induce their investors to export. Since changes in the manager's effort level directly translate into changes in firm productivity, productivities of the least productive surviving non-exporters and exporters increase after opening up to trade.

There are two points worth mentioning before I proceed. First, the main insight of this paper applies to other types of economic reforms, such as industry deregulation and privatization, as well. It is straightforward to observe that market competition becomes tougher, and the exit cutoff on the initial quality draw increases, if the government reduces the entry cost f_e. Then,

Figure 4: Impact of Trade on the Optimal Effort (Small Reduction in Trade Costs)



the same logic applies to the least productive surviving firms as well: namely, managers of these firms exert more effort in order to induce their investors to produce and continue to receive rents after industry deregulation. Second, the firm's problem is set up in a particular way in terms of the sequence of moves in the model, although qualitative results of this paper does not depend on this particular timing assumption. The model can be re-written in such a way that it is the manager who pays the entry cost and receives the initial quality draw. The manager then needs to exert effort to develop the idea, and seek for financing from an outside investor in order to take the idea to market and commence production. See Appendix 9.6 for more details.

Why does the validity of the above proposition need the condition that trade costs are not too small? The key observation is that if the reduction in trade costs is not too big, there are managers who are constrained in both the closed economy and the open economy.[19] It is exactly this type of managers who exert 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 managers working in *all* non-exporters exert less effort when the economy opens up to trade. Despite of

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

this, the decrease in log productivity is still smaller for unproductive surviving non-exporters than for productive surviving non-exporters, which is summarized in the following proposition summarizes this result.

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

Proof: See Appendix 9.4. 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 of $\beta_0(\phi)$ both before and after the opening up to trade (see Figure 4). 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 of $\beta_0(\phi)$ 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 (see Figure 9). 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 10), which is summarized by Proposition 3. In total, a robust prediction of the model is the differential impact of opening up to trade on firm productivity. That is, the decrease in log productivity is always smaller for the least productive surviving non-exporters than for the most productive surviving non-exporters.[20]

[20]The discussion of how bilateral trade liberalization affects firm productivity is similar to what I have discussed above. Interested readers are referred to Appendix 9.7 for more details.

4.4 The Role of the Agency Problem

In this subsection, I explore how the agency problem affects changes in firm productivity after trade liberalization, since there are firms that are not subject to the agency problem in reality.[21] In order do this, I consider a world without the agency problem now. As there is no separation of ownership and control for firms in this alternative world, the manager (i.e., the owner) chooses the effort to maximize the total profit. Since the analysis is straightforward, I use the following proposition to summarize how firm productivity changes after the economy opens up to trade (see Figure 8 for a graphical representation).

Proposition 4 *Consider a world without the agency problem, After the economy opens up to trade,* all *neoclassical non-exporters decrease productivity, and all neoclassical exporters increase productivity.*

Proof: See Appendix 9.5. QED.

The change in market size is the only factor that affects the manager's effort choice in a world without the agency problem. Since the market size shrinks for non-exporters, managers of non-exporters reduce their effort provision. Meanwhile, managers of exporters increase their effort provision, as their market size increases. This results in a productivity loss for non-exporters and a productivity gain for exporters. Importantly, there is no heterogeneous impact on non-exporters' productivity change in a world without the agency problem, which differs from the prediction derived in the world with the agency problem. In total, the new channel through which opening up to trade improves firm productivity (i.e., the disciplining effect) hinges on the existence of the agency problem. However, whether this extra *firm-level* gain in productivity enlarges gains in aggregate productivity in the agency world (compared with the world without the agency problem) is not trivial. I investigate this issue extensively in the next section.

[21] For instance, small proprietorship firms run by family members are unlikely to be subject to the agency problem.

5 Quantification

In this section, I show that the existence of the agency problem can either increase *or* decrease gains in aggregate productivity after trade liberalization. The key to understanding this is the share of constrained firms in the economy. I use a numerical example to show that gains in aggregate productivity are smaller in the agency world, when the share of constrained non-exporters is big in the open economy. On the contrary, gains in aggregate productivity are larger in the agency world, when the share of constrained non-exporters is small. This is the case for the calibration exercise.

5.1 Within-Firm and Between-Firm Productivity Gains: A Numerical Example

Despite of the new channel for productivity improvements discussed above, gains in aggregate productivity after opening up to trade *might* be smaller in a world with the agency problem (compared to a world without). Gains in aggregate productivity come from two sources: the within-firm and between-firm channels. In a world with the agency problem, productivity improvement of the least productive firms (i.e., the constrained non-exporters) dampens resource reallocation toward the most productive firms (i.e., exporters) after opening up to trade. First, productivity levels of the constrained non-exporters do not increase that much and still cannot reach the productivity levels of efficient firms (i.e., unconstrained non-exporters and exporters) after opening up to trade. Moreover, if there are *many* such inefficient firms in a world with the agency problem, the share of exporting firms will be small in the open economy, since a substantial fraction of resource (i.e., labor) is trapped in these unproductive firms in the open economy. The above two forces together reduce gains in aggregate productivity after opening up to trade in the agency world.

I use the the following numerical example to substantiate the above insight. Parameter values for this example are reported in Table 1, and I consider a scenario in which the economy moves from autarky to a costly trade regime (i.e., $f_x = 10$ and $\tau = 2$). It is clear from Table 2 that although there are *much more* firms increasing productivity in the agency world (after opening up to trade), the increase in both un-weighted and weighted average of firm productivity is *smaller* in the agency world.[22] Due to the existence of too many constrained non-exporters in the economy (58.28%), the selection effect and resource reallocation are dampened in the world with the agency problem. As a result, the increase in the exit cutoff and the share of exporters are smaller in such a world, when the economy moves from autarky to an open economy.

Table 1: Parameter Values

σ	k	θ	α	f	f_x	τ	f_e	$L+M$
4	3.1	3.5	0.3	10	10	2	3	300

Table 2: Results

	Agency	No Agency
Share of firms improving productivity	> 58.9%	2.22%
Increase in un-weighted average productivity	1.00%	1.31%
Increase in weighted average productivity	13.66%	14.62%
Share of constrained non-exporters	58.28%	Not applicable
Increase in exit cutoff (selection)	0.67%	0.71%
Share of exporting firms	0.62%	2.22%
Overall welfare gains	0.25%	Not applicable
Welfare gains for workers	0.23%	0.24%

This above finding points out a tension between within-firm and between-firm productivity gains after aggregate shocks such as the trade shock. Specifically, if there are many inefficient firms which improve productivity but still cannot reach the levels of efficient firms after an aggregate shock, this firm-level gain actually dampens aggregate gains in productivity (due to the lack of resource reallocation between firms). I.e., gains in aggregate productivity would be larger, if these inefficient firms did not improve productivity and exited the market after the shock. In sum, this new insight shows that which type of firm gains in productivity is the key to evaluating *aggregate gains* in productivity after trade liberalization.[23] Moreover, it warns us that government policies that are used to incentivize small and inefficient firms to improve productivity and grow might reduce gains in aggregate productivity.[24] In addition, it also helps

[22] I use employment share as the weight when calculating the weighted average of firm productivity.

[23] For instance, if exporters and importers (instead of non-exporters and importers) improve productivity after bilateral trade liberalization, this enlarges gains in aggregate productivity, since these firms are productive firms in the open economy.

[24] Subsidies to small firms and size-dependent policies are examples of these policies.

explain why within-firm productivity gains might go against between-firm productivity gains after trade liberalization.

5.2 Calibration

In this subsection, I use Colombia plant-level data to calibrate the model and show how the existence of the agency problem affects gains in aggregate productivity and welfare after bilateral trade liberalization.[25] Contrary to the result obtained from last subsection, the existence of the agency problem amplifies gains in aggregate productivity and welfare after trade liberalization.

For the quantitative exercises, the following set of parameters is required: σ, α, θ, k, τ, f_x, f, f_e, $L + M$. I specialize the model to a world with two symmetric countries and calibrate the parameters such that the model matches several moments in the Colombia data for 1986. I set the elasticity of substitution to 4 following Bernard et al. (2003) and Melitz and Redding (2015). $L+M$ is chosen to be $457,196$, which is the total employment of firms in the data set in 1986.[26] I set τ equal to the 90th. percentile of the tariff distribution across industries in 1986. I choose this high percentile, since τ in the model includes non-tariff barriers and transportation costs as well. For details, see Table 3.

Table 3: Preset Parameters

	Value	Sources
f	5	Normalization
σ	4	Bernard et al. (2003); Melitz and Redding (2015)
τ	1.581	Tariff data in 1986
$L + M$	457,196	Total employment in 1986

I normalize $f = 5$ and calibrate the values of α, θ, k, f_x, f_e to match five moments in the Colombia data. Two unique moments are used to back out two key parameters of the model. First, the share of managerial compensation in total wage bill in the data is used to identify the value of α. In the model, this value equals $\frac{\alpha}{\alpha+(\sigma-1)}$. Thus, I can directly calculate the value of α from the data. Second, I use the share of the smallest firms (i.e., firms with employment

[25] This data set is the same as the one used in Roberts and Tybout (1997). Special thanks are given to Prof. Stephen Redding who shared the dat with me.

[26] Since there is no unemployment and managers are also included in the labor force, I set $L + M$ to be equal to the total employment in the data. In the data, a Colombian firm hired 1.977 managers on average. Therefore, I set the number of mangers per firm to this number in the calibration exercise.

less than or equal to ten) in the data which is equivalent to the constrained non-exporters in the model to identify the value of θ.[27] Other parameters of the model are identified using standard moments used in the literature.

I search over the parameter space for parameter values that match the discussed moments, using as a loss function the norm of the percentage deviation difference between the model and the data. Values of calibrated parameters are presented in Table 4. Table 5 reports the moment conditions that I match and the values they take in my calibration.

Table 4: Calibrated Parameters

	Value	Targets
α	0.277	$\frac{\text{managerial compensation}}{\text{total wage bill}}$
θ	2.197	Share of firms with ten employees or less (the smallest firms)
f_x	6.858	share of exporting firms (the biggest firms)
k	3.177	share of exports in total sales
f_e	6.492	average employment

Table 5: Moments from the Model and the Data

	Model	Data
Share of exports in total sales	10.26%	10.26%
Share of exporting firms	11.33%	11.92%
Average employment (i.e., average firm size)	68.40	68.40
$\frac{\text{managerial compensation}}{\text{total wage bill}}$	8.45%	8.46%
Share of firms having ten employees or less	6.81%	6.82%

Now, I implement a counterfactual experiment by lowering the iceberg trade cost, τ, by 10% percent (i.e., bilateral trade liberalization). Table 6 shows changes in aggregate productivity and welfare in a world with the agency problem and a world without. Compared with a world without the agency problem, gains in average firm productivity and worker's welfare are 1.05% and 0.25% larger in a world with the agency problem,[28] which are quantitatively sizable. The key to understanding this is the share of constrained non-exporters and exporters. Since

[27] Given values of f, α, k, and the share of the smallest firms in the data, we can use equation (10) to calculate the value of θ. Note that in equation (10), $V_m(\phi^*_f) = 1$ and $1 - (\phi^*_f/\phi'_f)^k$ is the share of the smallest firms.

[28] Calibrated parameter values imply that $k < \frac{2\theta}{\theta-1}$. Thus, weighted average of firm productivity is not well defined in the calibration (with the Pareto assumption). Welfare calculation in the world with the agency problem includes the manager's welfare as well. In order to make a fair comparison between the two worlds, I use the worker's real wage (i.e., $\frac{1}{P}$) when comparing the welfare gains. Actually, both the overall welfare gains and the welfare gains for workers are larger in the world with the agency problem.

the share of constrained non-exporters is small (6.81%) in the calibrated economy, resource reallocation toward exporting firms is not dampened after trade liberalization in the agency world. This can be seen from that the percentage change in the share of exporting firms and the increase in the exit cutoff are bigger in the agency world. Moreover, there is a non-negligible fraction of constrained exporters, which increase productivity much more than unconstrained exporters in the agency world and *all* exporters in the non-agency world after trade liberalization. The existence of this type of exporter enlarges gains in aggregate productivity, since they are productive, and they improve productivity substantially more than others. In short, which type of firm improves productivity is a key to evaluating gains in aggregate productivity after trade liberalization.

Table 6: Counterfactual Experiment: A 10% Reduction in the Variable Trade Cost

	Agency	No agency
Increase in the un-weighted average productivity	7.76%	6.71%
Increase in the exit cutoff	3.27%	2.76%
Change in the number of varieties	−2.97%	−1.90%
Overall welfare gains	1.33%	Not applicable
Welfare gains for workers	1.16%	0.91%
Percentage change in the share of exporting firms	58.62% = ($\frac{17.94\%}{11.31\%}$)	45.35%(= $\frac{26.44\%}{18.19\%}$)
Change in the share of constrained exporters	3.22%	Not applicable
Share of constrained non-exporters (invariant to τ)	6.81%	Not applicable

6 Evidence

In this section, I present evidence to support the model's key prediction concerning 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.[29] Using the data from WMS, I show that the average management score of non-exporting firms is indeed "U'-shaped with respect to firm size which is a proxy for the initial quality draw.[30]

[29]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 to one or many countries. Therefore, I focus on non-exporting firms to do the empirical analysis.

[30]The data set used in this paper is the same as the one used in Bloom and Van Reenen (2010), and it contains both management and accounting information for nearly 5,700 firms across 16 countries.

I construct variables as follows. First, I use average score on 18 management practices documented in WMS to measure the level of managerial effort. Quality of many management practices in WMS directly measures the level of managerial effort. For instance, good monitoring requires high levels of the managerial effort. In addition, managers have to exert enough effort in order to design appropriate targets for the firm and a good system of rewarding (and punishing) good (and bad) performers. Second, firm size (i.e., log employment) is used as a proxy for the initial quality draw of the firm.

Then, I plot the average management score against firm size for non-exporting firms that are subject to the agency problem.[31] In WMS, Brazil is the only country where there are enough firms that report their exporting status. Therefore, I do the plot for Brazilian non-exporting firm that are subject to the agency problem first.[32] Figure 5 clearly shows that the average management score is the lowest for medium-sized non-exporting firms. In addition, the largest firms have the highest average management score. In total, these evidence supports my model's prediction concerning the relationship between the level of the managerial effort and the initial quality draw of the firm.

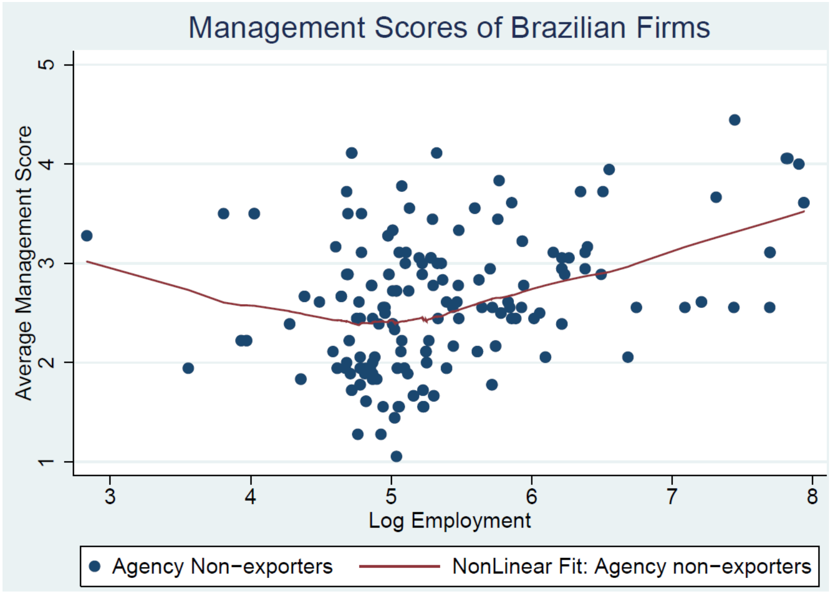
The pattern documented in Figure 5 is universally true in WMS data. I use Figure 6 to show that the average management score is "U"-shaped with respect to firm size for the small agency firms (i.e,, firms that are subject to the agency problem) from six major economies (Brazil, Canada, France, Germany, Great Britain and the US). It is a stylized pattern in the data that big firms are much more likely to be exporters than small firms. Therefore, although firms in the five remaining countries do not report exporting status in WMS, I focus on small firms when drawing Figure 6 (i.e., firms whose employment is below the 70*th* percentile of the employment distribution of firms that come from the same country and exist in WMS).[33] Again, the scatter

[31]WMS provides information on the ownership of the firm. I define family firms that have family CEOs and firms that are owned by managers as firms that are not subject to the separation of ownership and control. The agency firms include firms having more than five shareholders, family firms that hire outside CEOs. Firms owned by government or private equity (or founders or private individuals) are also clarified as agency firms. The empirical results are robust to different ways that are used to define the agency firms.

[32]In WMS, information on exporting status is available for 10% observations only.

[33]Since the "U"-shaped curve exists only when we look at *all* agency non-exporters, I need to choose a high enough cutoff to include firms into the figure. The US data shows that only 18% firms exported in 2002. Since average firm size in the WMS survey is larger than the average firm size in the US census data, I set this cutoff to be the 70*th* percentile. Setting the cutoff to be the 60*th* percentile or the 50*th* percentile yields the same empirical findings.

Figure 5: Management Quality of Brazilian Agency Non-exporters



plot of the average management score against the log employment is “U”-shaped in all the six countries.

In order to further convince readers the existence of the “U”-shaped curve, I run regressions of the average management score on firm size and the square term of it. Specifically, the regressions equations I run is

$$
\begin{aligned}
AverageManagementScore_i &= \nu_0 + \nu_1 \ln(employment)_{i,t} + \nu_2 \ln(employment)^2_{i,t} \\
&\quad + sic_{j,t} + location_{i,t} + MNE_{i,t} + \epsilon_{i,t},
\end{aligned}
$$

where i indicates the firm, t denotes the year, and j indicates the three-digit ISIC industry which the plant belongs to. In order to be consistent with the theory's prediction, I only include the agency firms whose firm size is *smaller* than a certain threshold. Regression results are reported in Table 7, and these results show that ν_1 and ν_2 are indeed negatively and positively significant respectively. These findings together imply that the managerial effort is indeed “U”-shaped with respect to firm size.

Figure 6: Management Quality of Small Agency Firms from Six Countries

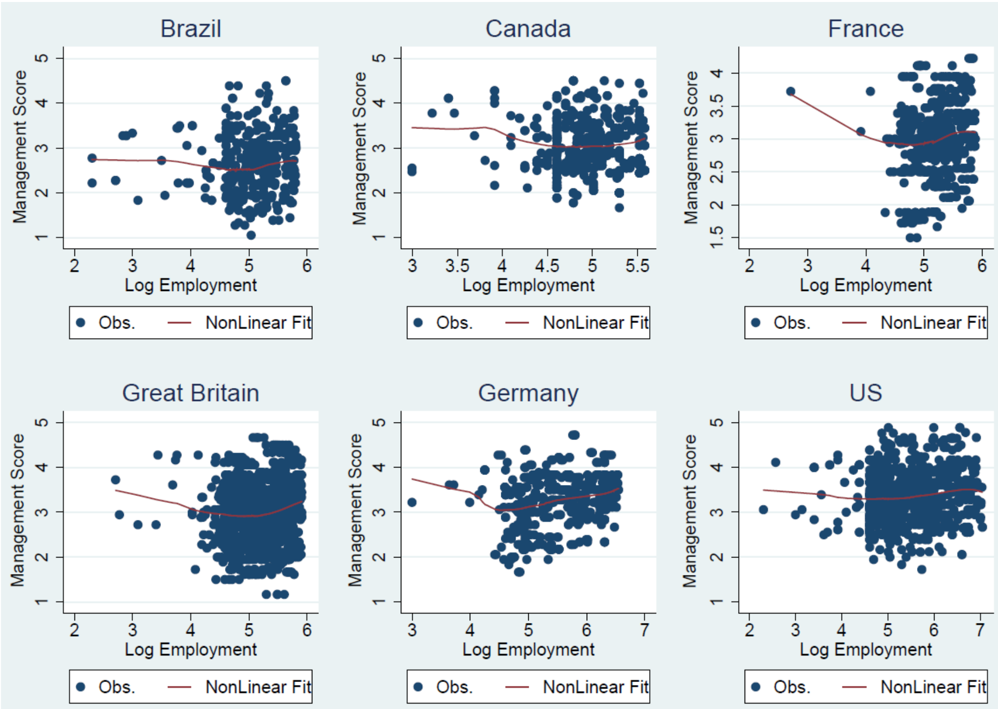


Table 7: Managerial Effort and Firm Size: An "U"-shaped Curve

	(1)	(2)	(3)
		Management Score	
ln(*empl*)	-0.142**	-0.234***	-0.209***
	(-2.04)	(-3.47)	(-3.34)
ln(*empl*)^2	0.0157*	0.0314***	0.0289***
	(1.65)	(3.68)	(3.97)
Constant	3.181***	3.277***	3.192***
	(15.95)	(16.06)	(16.43)
Cutoff	50%*th*. percentile	60%*th*. percentile	70%*th*. percentile
Country Dummy	Y	Y	Y
MNEs Dummy	Y	Y	Y
Industry Dummy	3-digit ISIC	3-digit ISIC	3-digit ISIC
N	5076	6074	7163
R^2	0.287	0.281	0.283
adj. R^2	0.264	0.261	0.266

Standard errors are clustered at the firm level. t statistics in parentheses.
Management score: constant for a firm across years. Years covered: 2003-2008.
ln(*empl*): log employment.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

7 Concluding Remarks

This paper presents a model that captures the agency problem inside the firm in order to explain why *some* of the agency firms improve productivity after trade liberalization. The main prediction of the model is that the least productive surviving agency non-exporters increase productivity after trade liberalization, since managers of these firms are incentivized to exert more effort in order to induce their owners to produce and continue to receive rents after the trade shock. Furthermore, this disciplining effect *does not* apply to firms that are not subject to the agency problem. However, this new channel for productivity improvement does not *necessarily* lead to larger gains in aggregate productivity in the agency world. The reason is that resource reallocation toward the most productive firms might be dampened due to the existence and non-exit of these least productive firms after trade liberalization.

Use Colombia plant-level data, I quantitatively assess how the existence of the agency problem affects gains in aggregate productivity and welfare from trade liberalization. The calibration exercise shows that, after a 10% reduction in the variable trade cost, gains in aggregate productivity and welfare are larger in the agency world compared with the world without the agency problem. Moreover, these larger gains are quantitatively sizable.

Using WMS data, I provide evidence to support the model's prediction on the relationship between the managerial effort and firm size. In the data, firms that receive the lowest average management scores are indeed the medium-sized firms. In addition, the biggest firms have the highest average management scores. All these findings are consistent with the model's predictions.

Nevertheless, much remains to be done. From a theoretical point of view, there are at least two issues that can be investigated further. First, this 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 see how other types of economic reforms (e.g., industry deregulation) affect firm productivity is also an interesting topic for future research. From an empirical point of view, data on managerial efforts is needed to test the model's predictions directly.

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9 Appendix: For Online Publication

9.1 Proof of Lemma 1

Proof. The proof proceeds in the following way. First, $\beta_{a2}(\phi)$ is the optimal effort choice when $\phi > \phi_a^{'}$, since the operating profit the investor receives is bigger than the fixed cost. Assumption 1 assures that the manager receives a payoff higher than his outside option when $\phi > \phi_a^{'}$ and $\beta = \beta_{a2}(\phi)$. Second, when $\phi < \phi_a^{'}$, the effort level of $\beta_{a0}(\phi)$ is the minimum effort level under which the investor breaks even. Furthermore, this is also the optimal effort level for the manager, if he wants to induce the investor to produce.[34] Now, the question becomes whether or not this effort provision yields a higher payoff to the manager than his outside option, or

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

where the first part of the above inequality is the manager' profit when $\phi = \phi_a^{'}$, and the second term is his effort cost. Solving this inequality, I obtain the result that when $\phi_a^{'} > \phi \geq \phi_a^{*}$, the manager chooses to run the firm and exerts effort at the level of $\beta_{a0}(\phi)$. He chooses to become a worker, if $\phi < \phi_a^{*}$. QED.

9.2 Proof of Proposition 1

Proof. First, I consider the manager whose product's initial quality is very high in the sense that his investor is willing to export (and start production), even if the manager exerts effort at the second-best level. More specifically, the manager's objective function in this case is

$$\max_{\beta} \quad \alpha\eta(P,Y)\phi\beta\Big(1 + \frac{1}{\tau^{\sigma-1}}\Big) - \beta^{\theta}, \tag{27}$$

which yields the solution that

$$\beta_{x2}(\phi) = \Big(\frac{\alpha\eta(P,Y)\phi}{\theta}(1 + \frac{1}{\tau^{\sigma-1}})\Big)^{\frac{1}{\theta-1}}. \tag{28}$$

[34] Remember that $\beta_{a0}(\phi) > \beta_{a2}(\phi)$ and the payoff function of the manager is concave in ϕ.

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

$$\phi\beta_x(\phi) = \phi\beta_{x2}(\phi) \equiv \Big(\frac{\alpha\eta(P,Y)\phi^\theta}{\theta}(1+\frac{1}{\tau^{\sigma-1}})\Big)^{\frac{1}{\theta-1}}. \tag{29}$$

Based on equation (29), I derive a cutoff on the initial quality as

$$\phi_x^{'} = \Big(\frac{(f_x\tau^{\sigma-1})^{\theta-1}\theta}{\alpha(1-\alpha)^{\theta-1}\eta(P,Y)^\theta(1+\frac{1}{\tau^{\sigma-1}})}\Big)^{\frac{1}{\theta}} = (\frac{f_x}{f})^{\frac{\theta-1}{\theta}}\frac{\tau^{\sigma-1}}{(1+\tau^{\sigma-1})^{\frac{1}{\theta}}}\phi_f^{'}. \tag{30}$$

In total, if the initial quality of the implementable idea is bigger than $\phi_x^{'}$, the manager exerts effort at the second-best level denoted by $\beta_{x2}(\phi)$, and the investor chooses to both produce and export.

Second, if the initial quality is below $\phi_x^{'}$, the manager realizes that if he exerts effort at the level of $\beta_{x2}(\phi)$, his investor will not start to export. However, there is room for achieving a potential Pareto improvement. That is, the manager can exert effort at the level under which productivity equals $(\beta\phi)_x$. Under this level of effort, the investor is willing to export which generates more operating profit.[35] Alternatively, the manager can exert effort at the level specified in equation (22), and his investor will not export since $\beta_{f2}(\phi) < \beta_{x2}(\phi)$, which validates the manager's effort choice. Now, the question becomes which option yields the highest payoff to the manager. First, if the manager chooses to exert effort at the level of $\beta_{f2}(\phi)$, his payoff is

$$\frac{\theta-1}{\theta}\frac{\alpha f}{(1-\alpha)}\Big(\frac{\phi}{\phi_f^{'}}\Big)^{\frac{\theta}{\theta-1}}, \tag{31}$$

where $\frac{\theta-1}{\theta}\frac{\alpha f}{(1-\alpha)}$ is the payoff received by the manager whose product's initial quality is $\phi_f^{'}$. Second, if the manager wants to induce his investor to export, he has to exert effort at the level of

$$\beta_{x0}(\phi) \equiv \frac{\beta_{x2}(\phi_x^{'})\phi_x^{'}}{\phi} = \Big(\frac{\alpha\eta(P,Y)\phi_x^{'\theta}}{\theta\phi^{\theta-1}}(1+\frac{1}{\tau^{\sigma-1}})\Big)^{\frac{1}{\theta-1}}.$$

[35] Similar to the reasoning used in the closed economy, the manager has no incentives to exert effort at a level under which the investor strictly prefers exporting over not exporting.

When $\phi = \phi_x^{'}$ and the effort level equals $\beta_{x2}(\phi)$, the manager's payoff is

$$\frac{\theta - 1}{\theta} \frac{\alpha f}{(1-\alpha)} \Big(\frac{\phi}{\phi_f^{'}}\Big)^{\frac{\theta}{\theta-1}} (1 + \frac{1}{\tau^{\sigma-1}})^{\frac{\theta}{\theta-1}}. \tag{32}$$

The second choice yields the payoff for the manager as follows:

$$\frac{\theta - (\frac{\phi_x^{'}}{\phi})^{\theta}}{\theta} \frac{\alpha f}{(1-\alpha)} \Big(\frac{\phi}{\phi_f^{'}}\Big)^{\frac{\theta}{\theta-1}} (1 + \frac{1}{\tau^{\sigma-1}})^{\frac{\theta}{\theta-1}}. \tag{33}$$

By comparing equation (31) with equation (33), I conclude that a manager with $\phi < \phi_x^{'}$ chooses the effort level of $\beta_{x0}(\phi)$, if and only if

$$\phi \geq \phi_x^* \equiv \frac{\phi_x^{'}}{\left[\theta - \frac{\theta-1}{\left(1+\frac{1}{\tau^{\sigma-1}}\right)^{\frac{\theta}{\theta-1}}}\right]^{\frac{1}{\theta}}} \tag{34}$$

and $\phi \leq \phi_x^{'}$. Since exporters are rare in the data and most of them make positive profit, I adopt an assumption to assure that all exporters make positive profit in what follows. This implies that $\phi_x^* \geq \phi_f^{'}$. By comparing equation (34) with equation (16), I obtain the following condition:

$$\frac{f_x \tau^{\sigma-1}}{f} \geq (1 + \frac{1}{\tau^{\sigma-1}})^{\frac{1}{\theta-1}} \left[\theta - \frac{\theta - 1}{(1 + \frac{1}{\tau^{\sigma-1}})^{\frac{\theta}{\theta-1}}}\right]^{\frac{1}{\theta-1}}. \tag{35}$$

Note that the above inequality holds, if either the variable trade cost or the fixed trade cost is big enough.

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

$$\beta_f(\phi) = \beta_{f2}(\phi) \equiv \Big(\frac{\alpha\eta(P, Y)\phi}{\theta}\Big)^{\frac{1}{\theta-1}},$$

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

$$\beta_f(\phi) = \beta_{f0}(\phi) \equiv \frac{\beta_{f2}(\phi_f^{'})\phi_f^{'}}{\phi},$$

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

9.3 Proof of Proposition 2

Proof. I prove this proposition by contradiction. Suppose the exit cutoff decreases when the economy opens up to trade (i.e., $\phi^{'}_a > \phi^{'}_f$). This immediately implies that

$$\eta(P_a, Y_a) < \eta(P_f, Y_f).$$

However, I will show that the value from entry must be bigger than the fixed entry cost, if the above inequality holds. I show it in four steps.

First, it is straightforward to observe that

$$\beta_{x2}(\phi) > \beta_{a2}(\phi)$$

for all $\phi \geq \phi^{'}_x$, since $\eta(P_a, Y_a) < \eta(P_f, Y_f)$ and $1 + \frac{1}{\tau^{\sigma-1}} > 1$. Furthermore, I have

$$\beta_{x0}(\phi) > \beta_{x2}(\phi) > \beta_{a2}(\phi)$$

for all $\phi \in [\phi^*_x, \phi^{'}_x)$ and

$$\beta_{f2}(\phi) > \beta_{a2}(\phi)$$

for $\phi \in [\phi^{'}_f, \phi^*_x)$.

Next, for $\phi \geq \phi^{'}_x$, I must have

$$\begin{aligned} & (1-\alpha)\eta(P_f, Y_f)\phi\beta_{x2}(\phi)(1 + \frac{1}{\tau^{\sigma-1}}) - f - f_x \\ \geq \ & (1-\alpha)\eta(P_f, Y_f)\phi\beta_{x2}(\phi) - f \\ > \ & (1-\alpha)\eta(P_a, Y_a)\phi\beta_{a2}(\phi) - f, \end{aligned}$$

where the first inequality comes from the result that exporters prefer exporting over not exporting, and the second one comes from the result that $\eta(P_a, Y_a) < \eta(P_f, Y_f)$ and the result derived above.

Third, for $\phi \in [\phi_x^*, \phi_x^{'}]$ (if $\phi_x^* > \phi_a^{'}$), I also have

$$
\begin{aligned}
& (1-\alpha)\eta(P_f, Y_f)\phi\beta_{x0}(\phi)(1 + \frac{1}{\tau^{\sigma-1}}) - f - f_x \\
= \; & (1-\alpha)\eta(P_f, Y_f)\phi\beta_{x0}(\phi) - f \\
> \; & (1-\alpha)\eta(P_a, Y_a)\phi\beta_{a2}(\phi) - f,
\end{aligned}
$$

where the second inequality hold since $\eta(P_f, Y_f) > \eta(P_a, Y_a)$ and $\beta_{x0}(\phi) > \beta_{a2}(\phi)$ for $\phi \in [\phi_x^*, \phi_x^{'}]$. The above two results together imply that for firms with $\phi \geq \phi_x^*$, their owners must earn high payoff in the open economy than in the close economy.

Fourth, for firms with $\phi \in [\phi_a^{'}, \phi_x^*]$, I have

$$
(1-\alpha)\eta(P_f, Y_f)\phi\beta_{f2}(\phi) - f > (1-\alpha)\eta(P_a, Y_a)\phi\beta_{a2}(\phi) - f,
$$

since $\eta(P_a, Y_a) < \eta(P_f, Y_f)$, and $\beta_{f2}(\phi) > \beta_{a2}(\phi)$. For firms with $\phi \in [\phi_f^{'}, \phi_a^{'}]$,

$$
(1-\alpha)\eta(P_f, Y_f)\phi\beta_{f2}(\phi) - f > 0,
$$

since all surviving firms must earn non-negative profit. The above two inequalities together imply that firms with $\phi \in [\phi_f^{'}, \phi_x^*)$ also earn higher payoff in the open economy than in the close economy, if $\phi_a^{'} > \phi_f^{'}$. However, the FE condition cannot hold if $\phi_a^{'} > \phi_f^{'}$, since the entry cost is the same in the open economy as in the closed economy. Therefore, it must be true that $\phi_a^{'} < \phi_f^{'}$, which implies that $\eta(P_a, Y_a) > \eta(P_f, Y_f)$. Namely, the zero profit cutoff increases after the economy opens up to trade. Furthermore, since the relationship between the exit cutoff and the zero profit cutoff is unchanged when the economy opens up to trade, the exit cutoff increases as well. Namely, I have $\phi_a^* < \phi_f^*$.

Next, 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, simple calculation shows that the manager on the zero profit cutoff exerts the same level of effort in the open economy as in the closed economy, or

$$\beta_a(\phi_a^{'}) = \Big[\frac{\alpha f}{\theta(1-\alpha)}\Big]^{\frac{1}{\theta}} = \beta_f(\phi_f^{'}),$$

which implies that

$$\beta_f(\phi_f^{'}) = \beta_a(\phi_a^{'}) < \beta_a(\phi_f^{'}).$$

Namely, managers with the random draw of $\phi_f^{'}$ exert less effort in the open economy than in the closed 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 must be true. First, it is the case that $\phi_f^* < \phi_a^{'}$ when trade costs are not sufficiently small.[36] Or, I have $\phi_f^* \geq \phi_a^{'}$ and[37]

$$\beta_f(\phi_f^*) = \beta_{f0}(\phi_f^*) = \beta_a(\phi_a^*) = \beta_{a0}(\phi_a^*) > \beta_a(\phi_f^*) = \beta_{a2}(\phi_f^*).$$

In the first case above, for firms with the random draw of $\phi_a^{'}$, I must have

$$\beta_f(\phi_a^{'}) > \beta_f(\phi_f^{'}) = \beta_a(\phi_a^{'}).$$

Since $\beta_f(\phi)$ decreases continuously with ϕ when $\phi \in [\phi_a^{'}, \phi_f^{'}]$, and $\beta_a(\phi)$ increases continuously with ϕ when $\phi \in [\phi_a^{'}, \phi_f^{'}]$, it must be true that there exists a cutoff $\phi_f^{''} \in (\phi_a^{'}, \phi_f^{'})$ such that the effort level of managers whose products' initial quality is between $\phi_a^{'}$ and $\phi_f^{''}$ is higher in the open economy than in the closed economy.

In the second case, for firms with the random draw of ϕ_f^*, I have

$$\beta_f(\phi_f^*) > \beta_a(\phi_f^*)$$

and $\phi_f^* \geq \phi_a^{'}$. Since $\beta_f(\phi)$ decreases continuously with ϕ when $\phi \in [\phi_f^*, \phi_f^{'}]$, and $\beta_a(\phi)$ increases continuously with ϕ when $\phi \in [\phi_f^*, \phi_f^{'}]$, it must be true that there exists a cutoff $\phi_f^{''} \in (\phi_f^*, \phi_f^{'})$ such that the effort level of managers whose products' initial quality is between ϕ_f^* and $\phi_f^{''}$ is

[36] Figure 4 represents this case.
[37] Figure 9 represents this case.

higher in the open economy than in the closed economy.

Finally, I prove that at least the effort level of managers of the least productive exporting firms is higher in the open economy than in the closed economy. Suppose it is not. This would imply

$$\beta_{x0}(\phi) < \beta_{a2}(\phi)$$

for $\phi \in [\phi_x^*, \phi_x^{'}]$ and

$$\beta_{x2}(\phi)(< \beta_{x0}(\phi)) < \beta_{a2}(\phi)$$

for $\phi > \phi_x^{'}$. Then, for firms with $\phi \in [\phi_x^*, \phi_x^{'}]$, I have

$$\begin{aligned}
& (1-\alpha)\eta(P_f, Y_f)\phi\beta_{x0}(\phi)(1 + \frac{1}{\tau^{\sigma-1}}) - f - f_x \\
= & \ (1-\alpha)\eta(P_f, Y_f)\phi\beta_{x0}(\phi) - f \\
< & \ (1-\alpha)\eta(P_a, Y_a)\phi\beta_{a2}(\phi) - f,
\end{aligned}$$

where the equality comes from the result that these firms are indifferent between exporting and not exporting, and the inequality comes from the assumption that $\beta_{x0}(\phi) < \beta_{a2}(\phi)$. Next, for firms with $\phi > \phi_x^{'}$, I have

$$\begin{aligned}
& (1-\alpha)\eta(P_f, Y_f)\phi\beta_{x2}(\phi)(1 + \frac{1}{\tau^{\sigma-1}}) - f - f_x \\
= & \ \frac{(1-\alpha)\theta}{\alpha}\beta_{x2}(\phi)^{\theta} - f - f_x \\
< & \ \frac{(1-\alpha)\theta}{\alpha}\beta_{a2}(\phi)^{\theta} - f \\
= & \ (1-\alpha)\eta(P_a, Y_a)\phi\beta_{a2}(\phi) - f,
\end{aligned}$$

due to the result that $\beta_{x2}(\phi) < \beta_{a2}(\phi)$. The above two inequalities together imply that firms with the quality draw of $\phi(\geq \phi_x^*)$ earn less profit in the open economy than in the closed economy. Furthermore, since $\eta(P_a, Y_a) > \eta(P_f, Y_f)$, non-exporters also earn less profit in the open economy than in the closed economy. Therefore, these two results together contradict that the investor earns zero expected profit both in the closed economy and in the open economy. In total, managers of the least productive exporters exert more effort in the open economy than in the closed economy. QED.

9.4 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

$$\eta(P_a, Y_a) > \eta(P_f, Y_f).$$

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 $\phi_f^* > \phi_a^{'}$ and

$$\beta_f(\phi_f^*) = \beta_{f0}(\phi_f^*) = \beta_a(\phi_a^*) = \beta_{a0}(\phi_a^*) < \beta_a(\phi_f^*) = \beta_{a2}(\phi_f^*).$$

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

$$\beta_f(\phi) = \beta_{f0}(\phi) \leq \beta_{f0}(\phi_f^*) = \beta_f(\phi_f^*) < \beta_a(\phi_f^*) = \beta_{a2}(\phi_f^*) \leq \beta_{a2}(\phi) = \beta_a(\phi).$$

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

$$\beta_f(\phi) = \beta_{f2}(\phi) < \beta_{a2}(\phi) = \beta_a(\phi).$$

In total, log productivity of all non-exporters decreases. Figure 10 represents this case.

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

$$\begin{aligned} & \log(\phi\beta_f(\phi)) - \log(\phi\beta_a(\phi)) = \log(\phi\beta_{f2}(\phi)) - \log(\phi\beta_{a2}(\phi)) \\ = & \frac{1}{\theta - 1}[\log(\eta(P_f, Y_f)) - \log(\eta(P_a, Y_a))] \end{aligned}$$

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

$$\begin{aligned} & \log(\phi\beta_f(\phi)) - \log(\phi\beta_a(\phi)) = \log(\phi\beta_{f0}(\phi)) - \log(\phi\beta_{a2}(\phi)) \\ > \; & \log(\phi\beta_{f2}(\phi)) - \log(\phi\beta_{a2}(\phi)) = \frac{1}{\theta-1}[\log(\eta(P_f, Y_f)) - \log(\eta(P_a, Y_a))] \end{aligned}$$

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

9.5 Proof of Proposition 4

Prof. When there is no separation of ownership and control, the manager (and the owner)'s objective function is

$$\begin{aligned} \max_{\beta} \quad & \varphi\beta\eta(P, Y) - \beta^{\theta} \\ s.t. \quad & \varphi\beta\eta(P, Y) - \beta^{\theta} \geq f, \end{aligned}$$

where the inequality above is the owner's participation constraint.

In the closed economy, the optimal effort level is

$$\beta_{aw}(\varphi) = \Big(\frac{\eta(P, Y)\varphi}{\theta}\Big)^{\frac{1}{\theta-1}}. \tag{36}$$

The resulting firm profit is

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

and the payoff for the owner is

$$\varphi\beta(\varphi)\eta(P, Y) - \beta(\varphi)^{\theta} = \frac{\theta-1}{\theta}\pi(\varphi, \beta(\varphi)) = (\theta-1)\Big(\frac{\eta(P, Y)\varphi}{\theta}\Big)^{\frac{\theta}{\theta-1}}.$$

In a world without the agency problem, the introduction of the manager's effort choice into Melitz (2003) does not change the property of the Melitz model. Namely, the ratio of the payoff for two owners with differential initial draws (i.e., different ϕ) is still proportional to the ratio of the initial quality draws. Therefore, all the results obtained in Melitz (2003) also work here. For example, non-exporters face shrinking market size, while exporters face increasing market size when the economy open up to trade. This implies that

$$\eta(P_a, Y_a) > \eta(P_f, Y_f)$$

and

$$\eta(P_a, Y_a) < \eta(P_f, Y_f)(1 + \frac{1}{\tau^{\sigma-1}}).$$

Therefore, managers working in surviving non-exporting firms exert less effort when the economy opens up to trade, while managers working in exporting firms exert more effort when the economy opens up to trade. Of course, this leads to a productivity loss for non-exporters and a productivity gain for exporters when the economy opens up to trade. QED.

9.6 Extensions

The firm agency problem is set up in a particular way in terms of the sequence of moves in the above model, although qualitative results of this paper does not hinge on this particular timing assumption. The model can be re-written in such a way that it is the manager who pays the entry cost and receives the initial idea draw. The manager then needs to exert effort to develop the idea, and seek for financing from an outside investor (e.g., a venture capitalist) in order to take the idea to market and commence production. For simplicity, I still assume that the outside investor pays the overhead fixed production cost, and the operating profit is shared between the two agents via a Nash bargaining ex post. In this alternative setup, the manager breaks even in equilibrium, and chooses to be a worker if the ex post payoff is smaller than the outside option.

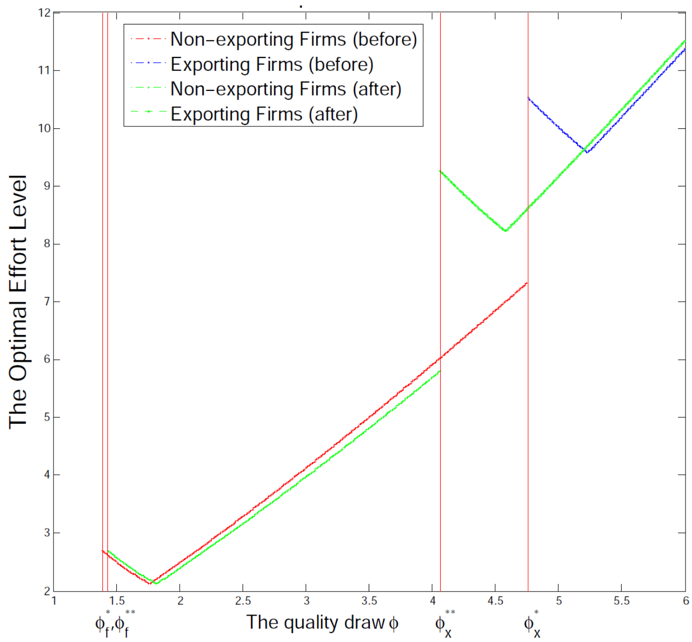
All qualitative results derived above remain unchanged. First, the managerial effort would still be "U" shaped with respect to the initial quality draw, since the separation of ownership and control prevents the manager from receiving the *full* return to exerting the effort. As a result, the least "productive" managers are willing to exert relatively more effort (i.e., higher than the second-best level) to make their firms stay in business. Second, the zero profit cutoff and the exit cutoff would still increase after opening up to trade or bilateral trade liberalization due to the selection effect. Third, the least productive surviving non-exporters would still receive a productivity improvement, since tougher competition makes surviving harder, and accordingly incentivizes managers of these firms to exert more effort. Finally, exporters gain in productivity due to the market size effect after opening up to trade. In particular, new exporters gain in productivity also because of the disciplining effect, which applies to both the least productivity non-exporters and the least productive exporters. In total, qualitative results of this paper do not depend on the specific assumptions used in the main context of the paper.

9.7 Trade Liberalization and Productivity Gains

In this subsection, I discuss how bilateral trade liberalization (i.e., a reduction in the variable trade cost τ) generates heterogeneous impact on firm productivity which is demonstrated in Figure 7. The overall impact is similar to the impact of opening up to trade on firm productivity. First, the least productive firms (i.e., firms with quality draws between ϕ_f^* and ϕ_f^{**}) exit the market. Second, managers of the least productive surviving firms (i.e., non-exporters) exert more effort when the reduction in trade costs is not too big. And, the decrease in firm's log productivity is smaller for the least productive surviving non-exporters than for the most productive surviving non-exporters, when the reduction in trade costs is sufficiently large.[38] Third, managers of new exporters (i.e., firms with quality draws between ϕ_x^{**} and ϕ_x^*) exert more effort because of the market size effect and(/or) the disciplining effect. One key difference of trade liberalization compared with opening up to trade is that managers of continuing exporters do *not* necessarily increase their effort provision as shown by Figure 7. In particular, managers of the least productive continuing exporters (i.e., firm with quality draws slightly above ϕ_x^*) actually exert *less* effort after bilateral trade liberalization. Managers of these firms are incentivized to choose effort levels higher than the second-best levels in order to induce their owners to export before the liberalization. However, they can induce their owners to export by exerting effort at the second-best level after the liberalization, since the variable trade cost goes down. This explains why these managers reduce their effort provision after bilateral trade liberaliza-

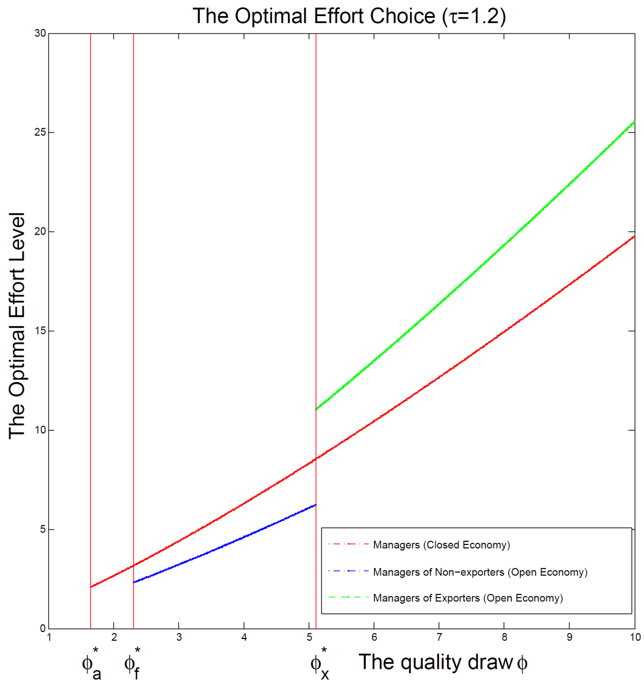
[38] In order to save space, I don't draw figures to show the three cases discussed above.

Figure 7: Bilateral Trade Liberalization and the Optimal Effort Choice



tion, even though the market size faced by their firms increases. In short, the model does *not* predict that continuing exporters improve productivity after bilateral trade liberalization. This theoretical result is consistent with one empirical finding from Bustos (2011) that there is no evidence that continuing exporters of Argentina improved productivity after the enactment of MERCOSUR.

Figure 8: Trade Liberalization and the Optimal Effort Choice: No Agency Problem



10 Tables and Figures: For Online Publication

Figure 9: Impact of Trade on the Optimal Effort (Moderate Reduction in Trade Costs)

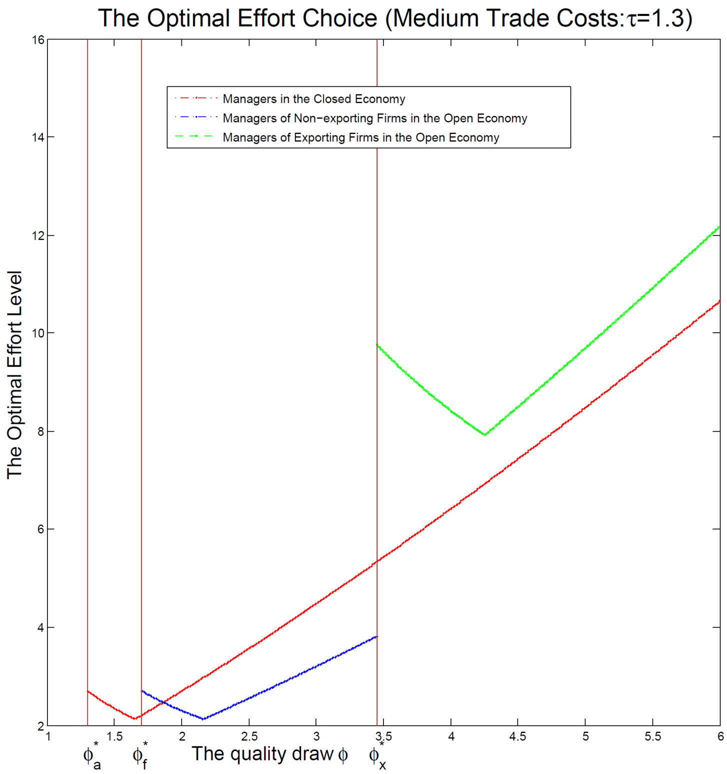


Figure 10: Impact of Trade on the Optimal Effort (Large Reduction in Trade Costs)