The Agency Problem, Trade Liberalization and Within-Firm Productivity Gains: Theory and Evidence*

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Abstract

Ample empirical findings show 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 highlighting the agency problem 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. Importantly, this effect only applies to unproductive firms that are *subject to the agency problem*. Finally, using Colombia plant-level data, I present evidence to support the model's unique empirical predictions.

Key words: Heterogeneous firms, firm productivity, trade liberalization, 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 seem to 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 experienced productivity improvements after the introduction of the European Union Single Market Program. Why, therefore, does the productivity of *some* firms increase when they face tougher competition? Why does the internal firm structure matter for productivity changes after trade liberalization? The purpose of this paper is (1) to present a theory whose key insight is that being in adversity incentivizes *some* managers to exert more effort and (2) to empirically test unique predictions of the model.

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 generated by these two agents is randomly realized. Second, the manager can choose to quit the firm and become a worker. Or, he can choose to work for the owner and 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 owner) decides the 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 generated at the fourth stage. 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] Furthermore, shares of the operating profit received by the two agents are assumed to be the solution to a generalized Nash bargaining game. I use α (for the manager) and $1 - \alpha$ (for the firm owner) to denote these two shares.

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 of is high, the manager chooses an effort level to maximize the fraction of operating profit he receives minus the effort cost. Obviously, there is under-provision of the effort in this case. However, the owner is still willing to start production under the second-best level of effort,[2] since the high initial quality leads to a high enough operating profit. When the

[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.

initial quality is in the middle range, the manager chooses an effort level that is higher than the second-best level in order to induce his owner to start production. Since the initial quality is not too high, the owner would not start production if the manager exerted effort at the second-best level. 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 under which the profit the owner receives exactly equals the fixed production cost. 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 study how opening up to trade affects the manager's effort choice as well as firm productivity. Opening up to trade triggers within-industry resource reallocation and generates productivity gains for two types of firms, if the reduction in trade costs is not too large. First, the least productive non-exporting firms exit the market due to the selection effect. Second, productivity of the least productive surviving firms (i.e., non-exporters) increases after opening up to trade, even though market size of these firms *shrinks*. After opening up to trade, the minimum productivity level needed to induce the owner to produce goes up due to tougher competition. When the manager earns substantial rents and his owner breaks even before trade liberalization, he is willing to scarify a part of his rents and continue to incentivize his owner to produce by exerting more effort. 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 is also higher in the open economy than in the closed economy, for two reasons. First, enlarged market size of exporters increases the marginal return to exerting effort. As a result, the second-best level of effort is higher in the open economy than in the closed economy. Second, managers of the least productive exporters exert effort higher

[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.

than the second-best level in order to incentivize their owners to export in the open economy, while they exert effort at the second-best level in autarky. This again is due to the disciplining effect. In total, managers whose firms' initial quality draws are close to the exit cutoff or the exporting cutoff exert more effort to improve firm productivity after opening up to trade.

Although the above model considers firms whose ownership is separate from control, there are firms that do not have such an agency problem in reality. In what follows, I call a firm whose ownership is separate from control the agency firm, and the neoclassical firm otherwise. In order to take this reality into account and highlight unique predictions of the model, I consider an alternative world in which there is *no* separation of ownership and control inside the firm as well. In such a world, managers of *all* non-exporting firms exert less effort after bilateral trade liberalization, since market size shrinks, and there is no conflict of interests inside the firm. Furthermore, due to the absence of the disciplining effect, there is *no* difference in the change of the log of productivity among surviving neoclassical non-exporters.

A comparison of the above two cases yields three unique empirical predictions. First, among the least productive surviving non-exporters, the agency firms increase their log productivity relative to the neoclassical firms after bilateral trade liberalization. Second, after bilateral trade liberalization, there is no difference in the change of log productivity between the most productive agency non-exporters and the most productive neoclassical non-exporters. This is because the disciplining effect works neither for the most productive agency non-exporters nor for the most productive neoclassical non-exporters. Finally, the relationship between the firm's initial log productivity and the change in it after trade liberalization is more negative for the agency non-exporters than for the neoclassical non-exporters.[4] In total, this paper emphasizes the importance of the agency problem for the productivity change after trade liberalization.

I use Colombia plant-level data from the 1980s to test the above unique predictions.[5] I chose to use Colombia data, since the impact of trade liberalization (in the late 1980s) on the economy was substantial (Fernandes, 2007). Moreover, reasons for implementing the liber-

[4]There is a well-documented empirical pattern that, after trade liberalization, less productive surviving firms have bigger increases in log productivity than more productive surviving firms. This can be explained by the mean-reversion mechanism and the selection mechanism. Therefore, the relationship between non-exporters' initial log productivity and their log productivity change after trade liberalization is always negative in the data.

[5]I use "firm" and "plant" interchangeably in the paper. However, there is no difference between a "firm" and a "plant" in both the theoretical and the empirical parts.

alization were mainly fiscal and external imbalances, which do not create severe endogeneity problems (Fernandes, 2007). I use the proxy estimator (Olley and Pakes, 1996; Levinsohn and Petrin, 2002) to estimate the production function. Following Griffith (2001), I define plants that are operated under either proprietorship or limited partnership as the neoclassical firms and the agency firms otherwise. Finally, similar to the measure used in Pavnick (2002), I define an industry whose effective rate of protection (ERP) was reduced greater than a certain threshold as an import competing industry (i.e., an industry that has experienced trade liberalization).

The evidence strongly supports the unique predictions of the model. First, a simple plot of the change in Colombian plants' log productivity (between 1985 and 1991) against their initial log productivity (in 1985) clearly reveals that the relationship between these two variables is indeed more negative for the agency non-exporters than for the neoclassical non-exporters *in import competing sectors*. Furthermore, both cross-sectional and panel regressions show that, after trade liberalization, it is the least productive agency non-exporters that increased productivity relative to the least productive neoclassical non-exporters. In addition, the regression results also show that, after trade liberalization, there is no difference in the change of log productivity between the *most productive* agency non-exporters and the *most productive* neoclassical non-exporters. Finally, the quantitative magnitude of the gain in productivity is substantial. For non-exporting plants that belong to the lowest tercile of the initial productivity distribution, the agency non-exporters had roughly a 35% increase in productivity compared with the neoclassical non-exporters. Taken together, the unique predictions of the model gain support from the data.

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.[6] These two findings are consistent with the prediction of my model. Moreover, my paper points out a new channel through which import competition

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

makes *some* firms improve productivity via incentivizing their managers to exert effort.

This paper contributes to a literature that tries to empirically document how competition affects productivity of the agency firms and the neoclassical firms differently. Using panel data on UK establishments, Griffith (2001) finds that only establishments whose managerial control and ownership were separated gained in productivity after the introduction of the European Union Single Market Program. Similar evidence can be found in Rogers (2004) as well. However, none of these studies focuses on the *heterogeneous* impact of intensified competition on firm productivity within the group of the agency firms. And, the heterogeneous impact within the group of the agency firms is the key and unique prediction of the my model.

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.[7] 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.[8] 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.[9] 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.

The rest of this paper is organized as follows. Section two analyzes the model for a closed economy. Section three analyzes the model for an open economy. Section four presents evidence to support the model's predictions on firm productivity and management activities. Section five concludes. Proofs of the main results are relegated to the appendices.

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

[8]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.

[9]Wu (2001) is one exception. In his paper, he considers the role of managers 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.

2 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.

2.1 Environment

There are three types of agents in the economy: workers, 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.

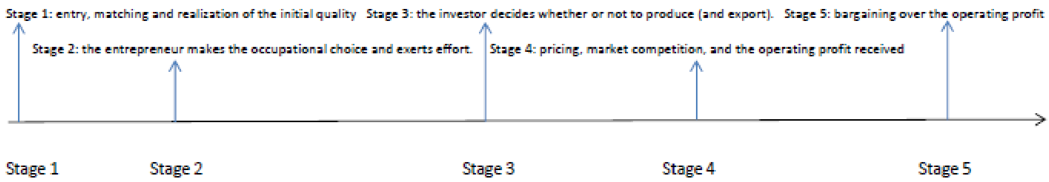
There is one industry populated by firms that produce differentiated products under conditions of monopolistic competition à la Dixit and Stiglitz (1977). Each variety is indexed by ω, and Ω is the set of all varieties. Consumers derive utility from consuming these differentiated goods according to

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

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 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 makes his occupational choice. He can quit the firm and become a worker, in which case the investor receives zero profit afterwards. Alternatively, he can choose to work for the investor and exert effort, denoted by ψ, to develop the implementable idea that leads to a

Figure 1: The Timing of the Game



blueprint for a product (i.e., variety ω). Third, if the manager chooses to work for the investor, the investor needs to decide 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.[10] Fourth, if the production starts, the manager decides the output level and the number of workers employed. At that point, firms compete in the market, revenue and the operating profit are received, and the variable cost is paid.[11] Finally, the investor and the manager bargain over the operating profit to receive income. 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, as discussed in the introduction.

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*.[12] In order to exert effort, the manager must incur a cost (i.e., disutility) in terms of the numeraire of $\gamma\psi^{\theta_0}$. The parameters $\gamma(>0)$ and θ_0 $(>\sigma-1)$ measure the cost of exerting effort.

[10]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.

[11]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.

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

2.2 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

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

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

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

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

Since the manager's effort choice does not affect the fraction of 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), the operating profit derived is

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

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

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

which can be transformed into

$$\begin{aligned} \max_{\beta} \quad & \alpha\eta(P,Y)\phi\beta - \gamma\beta^{\theta} \\ s.t. \quad & \alpha\eta(P,Y)\phi\beta - \gamma\beta^{\theta} \geq 1, \end{aligned}$$

where $\phi \equiv \rho^{\sigma-1}$, $\beta \equiv \psi^{\sigma-1}$, $\theta \equiv \theta_0^{\frac{1}{\sigma-1}}$, 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

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

which is defined as the second-best level of effort. Notice that the subscript of $a2$ indicates the second-best effort choice in autarky.

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[13]

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

[13]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 all managers exert effort at the second-best level, and all investors earn strictly positive profit. 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.[14]

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 choice of the effort level? First, choosing an effort level lower than $\frac{\phi_a^{'}\beta_2(\phi_a^{'})}{\phi}$ is suboptimal for him, since the investor would not start production at the third stage. Second, choosing an effort level higher than $\frac{\phi_a^{'}\beta_2(\phi_a^{'})}{\phi}$ is suboptimal for the manager as well. The investor is induced to start production if the effort level equals $\frac{\phi_a^{'}\beta_2(\phi_a^{'})}{\phi}$. 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 $\frac{\phi_a^{'}\beta_2(\phi_a^{'})}{\phi}$ 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:*

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

[14] 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

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

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

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

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

$$\beta_a(\phi) = \beta_{a0}(\phi) \equiv \frac{\beta_2(\phi_a^{'})\phi_a^{'}}{\phi}. \tag{9}$$

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

Proof: See Appendix 6.1. 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, because a higher initial quality increases the marginal return to exerting effort. For this upward-sloping part, a complementarity between the initial quality draw and the marginal return to exerting effort plays a role. 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. In total, the relationship between the initial quality of the implementable idea and the optimal effort level is "U" shaped.

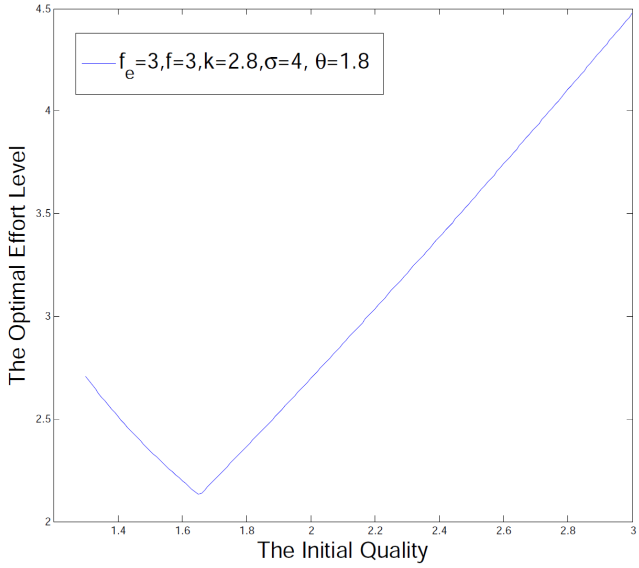
For future use, I derive the manager's payoff ($V_m(\phi)$) from equations (6) and (9) as follows:

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

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

$$V_m(\phi) = \frac{\alpha(\theta-1)}{\theta}\phi\beta_2(\phi)\eta(P,Y), \tag{11}$$

Figure 2: The Initial Quality and the Optimal Effort Choice



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

2.3 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:

$$G(\phi) = 1 - \Big(\frac{\phi_{min}}{\phi}\Big)^k,$$

where the shape parameter k is negatively related to the variance of the distribution.[15]

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, or

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

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

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 $\phi_a^{'}$ 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

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

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, $\phi_a^{'}$, 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.

3 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.[16]

3.1 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 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, ϕ_f'), and a sufficiently large fixed trade cost

[16]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.

ensures it is the case.[17] Empirical evidence motivates this choice.[18]

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:

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

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

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

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

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

[17] 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.

[18] 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

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

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

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

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

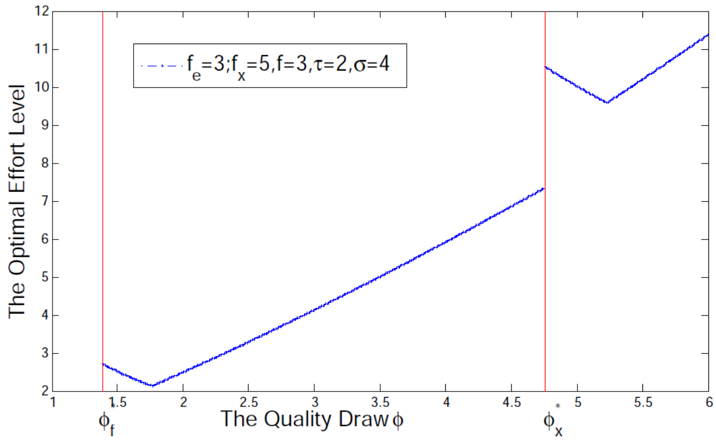
$$\beta_{f0}(\phi) \equiv \frac{\beta_{f2}(\phi_f^{'})\phi_f^{'}}{\phi}, \tag{23}$$

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

Proof: See Appendix 6.2. QED.

Figure 3 illustrates how the optimal effort level varies with the initial quality of the implementable idea in the open economy. It contains two "U"-shaped curves under Assumption 2. For firms whose products' initial quality is between $\phi_f^{'}$ and ϕ_f^{*}, their managers choose effort levels higher than the second-best level, since they want to induce their investors to produce and obtain payoffs higher than their outside option. Similarly, for firms whose products' initial quality is between $\phi_x^{'}$ and ϕ_x^{*}, 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 that pays the fixed

Figure 3: The Optimal Effort Choice in the Open Economy



exporting cost, the start of exporting increases the manager's income which is a fraction of the firm's operating profit discontinuously. As a result, managers whose products' initial quality is close to $\phi_x^{'}$ (i.e., between $\phi_x^{'}$ and ϕ_x^*) have incentives to exert effort higher than the second best level. In total, the existence of the fixed costs (i.e., f and f_x) act as a disciplining device for the least productive non-exporting firm *and* the least productive exporting firms. Assumption 2 is needed to ensure 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.

3.2 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).[19] Third, the FE

[19]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

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

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).

3.3 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.

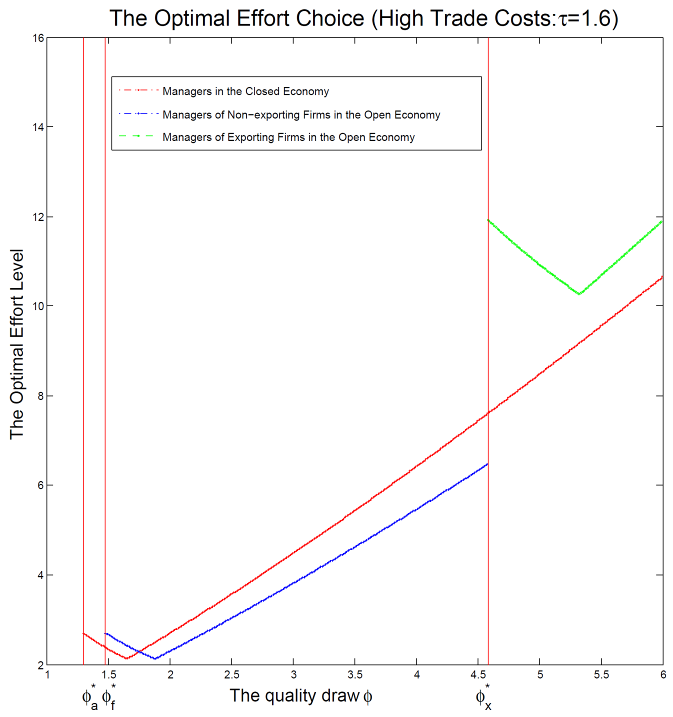
Proposition 2 *After opening up to trade, the exit cutoff (ϕ_f^*) and the zero profit cutoff ($\phi_f^{'}$) both increase. Productivities of the least productive exporters and the equilibrium effort level of managers in these firms are higher in the open economy than in the closed economy. When trade 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 6.3. QED.

Figure 4 shows how the optimal effort level changes after the economy opens up to trade. Managers of the least productive surviving non-exporters and exporters exert more effort in the open economy than in the closed economy.[20] This is mainly due to the disciplining effect. In order to make the investors start production and receive higher payoffs than their outside option, managers in the least productive surviving non-exporters have to exert more effort. In other words, the introduction of international trade reduces rents earned by managers working in these firms and mitigates the agency problem inside these firms. Managers of the least productive exporting firms exert more effort for two reasons. First, enlarged market size increases the marginal return to exerting effort (i.e., the market size effect) and the second-best level of effort. Second, the disciplining effect works for them as well, since managers of these firms exert effort higher than the second-best level to induce their investors to export. These two effects together incentivize managers of the least productive exporting firms to exert more effort. 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 will increase after opening up to trade.

[20] Although simulation results suggest that managers in *all* exporting firms increase their effort provision after the economy opens up to trade, I can only prove that the least productive exporters increase their productivities.

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



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. If the government reduces the entry cost of f_e, market competition will become tougher. As a result, the exit cutoff on the initial quality draw will increase. Then, the same logic argued above 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 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. See Appendix 6.7 for more details.

Why does the validity of the above proposition require the condition that trade costs are not too small? The key observation is that if the reduction in trade costs is small, there are managers who are constrained in both the closed economy and the open economy.[21] 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, managers of all non-exporting firms might reduce their effort levels as Figure (9) shows. In this case, the model predicts that managers working in all non-exporters exert less effort when the economy moves from autarky to the open economy, which results in a decrease in log productivity for all non-exporters. However, the decrease in log productivity is smaller for unproductive surviving non-exporters than for productive surviving non-exporters. 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 decreases. However, the decrease in log productivity is smaller for less productive surviving non-exporters than for more productive surviving non-exporters.*

Proof: Proof: See Appendix 6.4. QED.

The main difference of the above proposition compared with Proposition 2 is the prediction on less 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 $\beta_0(\phi)$ (i.e., above the second-best level) both before and after the opening up to trade. In this case, only the disciplining effect plays a role for this type of manager. This case is presented in Figure 4. When the reduction in trade costs is in the middle range, managers working in the least productive surviving non-exporters exert effort at the second-best level (i.e., $\beta_2(\phi)$) before the opening up to trade and at the level of $\beta_0(\phi)$ after the opening up to trade. The market size effect pushes down the second-best level of effort when the economy moves from autarky to trade. However, the disciplining effect incentivizes these 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. As a result, managers of the least productive surviving non-exporters exert

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

more effort when the economy opens up to trade as shown by Figure 8. Proposition 2 summarizes results in the above two cases. Finally, the market size effect dominates the disciplining effect when the reduction in trade costs is sufficiently large. This results in a reduced effort provision even for managers of the least productive surviving non-exporters.[22] Proposition 3 summarizes results in this case.

A robust prediction of the model is the different impact of opening up to trade on firm productivity. Specifically, the decrease in log productivity is always smaller for the least productive surviving non-exporters than for the most productive surviving non-exporters. Therefore, there is a negative relationship between the firm's initial log productivity and the change in it when the economy opens up to trade.[23]

3.4 Empirical Predictions: The Role of the Agency Problem

In this subsection, I derive unique predictions of the model. For the productivity change of new exporters after trade liberalization, the model does not have a unique prediction. Therefore, I focus on the productivity change of non-exporters in order to derive unique predictions of the model. Furthermore, I investigate how the productivity change differs between the agency non-exporting firms and the neoclassical non-exporting firms after trade liberalization. I consider this alternative case for two reasons. First, in reality, there are firms that are not subject to the agency problem. Second, unique predictions of the model can be derived, only when the empirical predictions in the above two cases are compared.

Now, I consider a world without the agency problem. In other words, there is no separation of ownership and control, and the manager chooses his effort to maximize the firm's profit. Since the analysis is simple, I use the following proposition to summarize the model's predictions on the change of firm productivity after the economy opens up to trade. Figure 15 illustrates the result stated in Proposition 4.

Proposition 4 *After the economy opens up to trade,* all *non-exporters decrease productivity, while all exporters increase productivity.*

[22]This case is presented in Figure 9.

[23]The discussion of how bilateral trade liberalization affects firm productivity is similar to what I have discussed above. Interested readers are referred to Appendix 6.8 for more details.

Proof: See Appendix 6.5. 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 due to the larger market size. This results in a productivity loss for non-exporters and a productivity gain for exporters. In a world without the agency problem, there is no heterogeneous impact on the change of non-exporters' log productivity when the economy opens up to trade. This prediction differs from the one derived in a world with the agency problem.

Unique empirical predictions of my model are related to the agency problem. The following testable prediction summarizes the unique predictions of the model which will be tested in the next section.[24]

Testable Prediction 1 *Consider a scenario in which there is bilateral trade liberalization between two symmetric countries. Conditional on other firm-level characteristics, the least productive (surviving) agency non-exporters increase log productivity compared with the least productive (surviving) neoclassical non-exporters. Conditional on other firm-level characteristics, there is no difference in the change of log productivity between the most productive (surviving) agency non-exporters and the most productive (surviving) neoclassical non-exporters. Moreover, the relationship between non-exporters' initial log productivity and their log productivity change is more negative for the agency non-exporters than for the neoclassical non-exporters.*

Proof: See Appendix 6.6. QED.

The intuition behind the above testable prediction is the following. When the initial productivity is high, the owner's participation constraint is not binding for the agency non-exporting firms even after the trade liberalization. Therefore, the change in log productivity is the same across the agency and the neoclassical firms. However, when the initial productivity is low and

[24]The unique predictions of my model are related to the relative change in productivity for the agency non-exporters, and there are many other confounding factors that can affect the absolute productivity of non-exporting firms. Therefore, I do not test how trade liberalization affects the absolute productivity of non-exporters.

the firm is subject to the agency problem, the manager is incentivized to exert more effort, at least after the trade liberalization, due to the disciplining effect. This leads to a bigger increase in log productivity for this type of firm relative to the least productive non-exporters that are not subject to the agency problem.[25]

4 Evidence

In this section, I use Colombia plant-level data from the 1980s to test Testable Prediction 1. I chose to use this data to implement my empirical analysis for three reasons. First, Colombia had experienced impressive trade liberalization in the late 1980s, and the impact of the liberalization on the economy was substantial.[26] Second, as argued in Fernandes (2007), the reason for implementing the liberalization was mainly due to fiscal and external imbalances. Therefore, the endogeneity problem of trade policies is probably not severe in the case of Colombia. Finally, the change in the ERP, which is my measure for the change in the variable trade costs, was heterogeneous across industries between 1985 and 1991. Therefore, I can use cross-industry variation in the change of the ERP to investigate the differential impact of the ERP reduction on firm productivity.

The Colombia plant-level data contain survey information on all registered manufacturing plants in Colombia that hire more than ten employees. The time span of the data set is from 1981 to 1991, and it has been substantially used in previous research (e.g., Roberts (1996) and Fernandes (2007)). There are $76,094$ observations across 28 industries at the three-digit International Standard Industry Classification (ISIC) level. The data set contains production information of the firm and information on the type of enterprise, which I will use to identify whether or not the firm is subject to the agency problem. I use this data set to construct my productivity measure.

I use the proxy estimator proposed by Olley and Pakes (1996) and Levinsohn and Petrin (2002) to estimate the production function for each two-digit ISIC industry. The Olley-Pakes approach is a standard approach used to estimate the production function. The basic idea is

[25] Figures 10, 11, and 12 show how log productivity of the agency and the neoclassical non-exporters changes after trade liberalization.

[26] See Fernandes (2007) for more details.

to find a variable that *monotonically* changes with the unobservable productivity and to use this as a proxy to recover the productivity. In my empirical analysis, I use the approach of Levinsohn and Petrin (2002) to estimate the production function given that more than half of the observations had zero investment. This estimation result is presented in Table 6.

The second data set I use contains information on the ERP for each three-digit ISIC manufacturing industry in Colombia.[27] The calculation of the ERP excludes the effect of reduced input tariffs on import competition. Thus, it is a better measure for import competition than tariffs. Other supplementary data sets that contain information on price deflators for investment goods, intermediate goods, and fixed assets were obtained from the website of Colombia National Administrative Department of Statistics (DANE).

The key variable used to identify whether the firm is subject to the agency problem is called "type of enterprise" in the data set. Following previous work such as that in Griffith (2001), I define plants that have the enterprise type of sole proprietorship or limited partnership as firms that are not subject to the agency problem (i.e., agency indicator=0). Plants that have the enterprise type of corporation or de facto corporation or joint stock company were identified as firms that are subject to the agency problem (i.e., agency indicator=1).[28] There are two reasons why I use the enterprise type to identify the existence of the agency problem. First, in sole proprietorship firms, the manager and the owner are probably the same person (or closely linked through family ties). Thus, these firms are not likely to be subject to the separation of ownership and control. Second, in limited partnership firms, firms are managed by *all* partners, and important decisions are made subject to *all* partners' agreements. Therefore, managerial effort in limited partnership firms probably maximizes the *total* benefit of all partners. As a result, these firms are not likely to be subject to the agency problem as well.

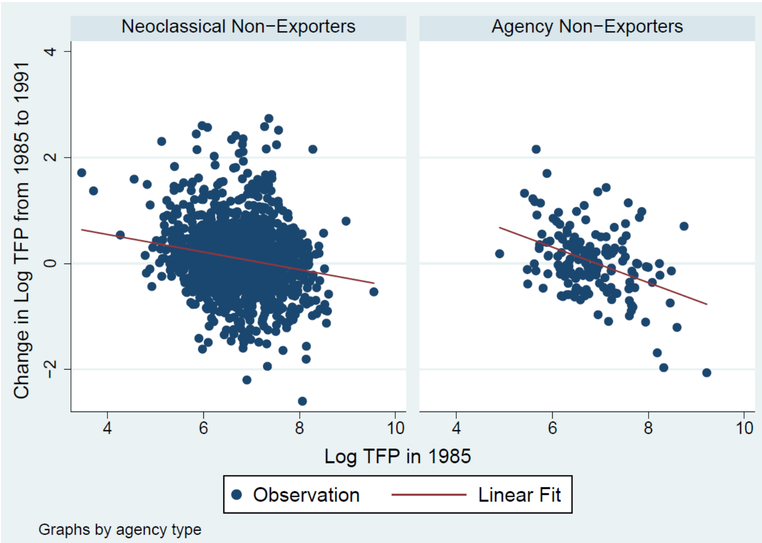
4.1 A First Look at the Data

In Figure 5, I plot the change in log productivity (between 1985 and 1991) for each plant against its initial log productivity (in 1985). The left half of the figure represents the neoclassical non-

[27] I want to thank Ana Fernandes for sharing this data set with me. For summary statistics of the ERP, see Table 7.

[28] In an alternative measure, I include joint partnership firms into the group of the agency firms as well.

Figure 5: Productivity Change and Initial Productivity: Slope Matters



Industries with reductions in the ERP > 0.3 are included.

exporters in three-digit ISIC industries with sharp reductions in the ERP between 1985 and 1991, while the right half represents the agency non-exporters in those industries. In Figure 5, I define a three-digit ISIC industry as an import competing industry if the reduction in the ERP was bigger than 0.3. However, the pattern I am going to show does not depend on this specific threshold.

A striking feature of Figure 5 is the difference in the slope of the two regression lines. First, the figure shows that, in sectors with sharp reductions in the ERP, the relationship between the firm's initial log productivity and its log productivity change is indeed more negative for the agency non-exporters than for the neoclassical non-exporters.[29] This is consistent with the key unique prediction of my model. Second, the above empirical pattern does not exist in sectors *without* sharp reductions in the ERP, which is shown in Figures 14 and 15. This finding suggests that the difference in the slope of the two regression lines (of Figures 5) crucially depends on whether there were large reductions in trade costs. Any other economy-wide shocks that do not affect various industries differently probably are not responsible for generating the above pattern. Third, the above two empirical patterns continue to exist, when I use the index-number

[29] In Figure 13, I define a three-digit ISIC industry as an import competing industry if the reduction in the ERP was bigger than 0.5. The empirical pattern revealed by Figure 13 is the same as in Figure 5. The productivity measure obtained using the index number approach reveals a pattern similar to the one obtained in Figure 5.

productivity measure instead of the Olley-Pakes productivity measure. This is shown in Figure 16. In total, a first look at the data suggests that the key unique prediction of the model has empirical support.

4.2 Cross-Sectional Analysis

In this subsection, I implement cross-sectional regression analysis to show further evidence supporting the predictions stated in Testable Prediction 1. I focus on plants that appear in the data set in both 1985 and 1991, since I can calculate the change in log productivity only for these firms. Moreover, for estimation I use plants that did not export in between 1985 and 1991, because the unique predictions of the model are about the productivity change of non-exporters after trade liberalization. Specifically, I run the following regression for plants in import competing sectors:

$$\begin{aligned}\Delta \ln(TFP_i) &= \beta_0 + \beta_1 agency_{i,85} + \beta_2 \ln(TFP_{i,85}) + \beta_3 \ln(TFP_{i,85}) * agency_{i,85} \\ &\quad + \beta_4 \Delta \ln(techper)_i + \beta_5 \Delta impsh_i + sic_{j,85} + locationagency_{i,85} + \epsilon_i,\end{aligned}$$

where i indicates the plant and j indicates the three-digit ISIC industry to which the plant belongs. Variable $\Delta prod_i$ measures the change in log productivity from 1985 to 1991 for plant i, and $agency_i$ is an indicator that takes a value of one if the plant is subject to the agency problem and zero otherwise. Variable sic_j is an industry dummy at the three-digit level, and ϵ_i is the random error term. I cluster the standard error at the location-industry level.

In order to control for confounding factors, I add three firm-level control variables into the above regression. First, technology expenditures such as purchases of new machinery and equipments probably increase firm productivity. Therefore, I include variable $\Delta \ln(techper)_i$ which is the change in log deflated technology expenditures per employee (from 1985 to 1991) into the above regression. The construction of this variable follows Bustos (2011), and it includes purchases of new machinery and equipments, expenditures on publicity and advertising, and wage payments to technicians. Second, better access to imported inputs might improve firm productivity. Therefore, I add variable $\Delta impsh_i$ which is the change in the ratio of the value of consumed foreign inputs to the value added of production (from 1985 to 1991) into the above regression. Finally, I include a location dummy interacted with the agency indicator (i.e., $locationagency_{i,85}$) into the above regression to capture the differential impact of regional shocks on the agency firms and the neoclassical firms.

There are several predictions I want to test using the above regression. First, β_3 should be negatively significant, since the unique prediction of the model is that the relationship between the firm's initial log productivity and its log productivity change is more negative for the agency non-exporters than for the neoclassical non-exporters after trade liberalization. Second, I expect the average log productivity of the least productive agency non-exporters to increase relative to the least productive neoclassical non-exporters. Finally, this result should *not* hold for the most productive non-exporting Colombian plants.

The estimation results are presented in Table 1 and support the results in Testable Prediction 1. First, β_3 is negative and statistically significant in all the regressions, which suggests that the relationship between the firm's initial log productivity and its log productivity change is indeed more negative for the agency non-exporters than for the neoclassical non-exporters. Second, β_2 is also negative and statistically significant due to the selection and mean-reversion mechanisms. Third, I calculate the change in log productivity for the agency and the neoclassical firms that belong to different terciles of the initial productivity distribution (at the industry level). I implement this exercise in order to show that average productivity increased for the least productive agency firms relative to the least productive neoclassical firms after trade liberalization. The average log productivity was about 6.19 for plants in the lowest tercile of the initial productivity distribution (i.e., in 1985). Thus, column two of Table 1 tells us that the least productive agency firms have increased log productivity relative to the least productive neoclassical firms by about 30.7% after reductions in the ERP.[30] This translates into about a 35.9% increase in the measured productivity for the agency firms that belong to the lowest tercile of the initial productivity distribution compared with the neoclassical firms that belong to the same tercile. On the contrary, the average log productivity was about 7.455 for plants that belong to the highest tercile of the initial productivity distribution. Thus, column two of

[30] This result is obtained from $0.307 = (1.904 - 0.258 * 6.19)$.

Table 1 tells us that the difference in the change of log productivity between the most productive agency non-exporters and the most productive neoclassical non-exporters is almost zero: $-0.020 = (1.904 - 0.258 * 7.455)$. These two findings are consistent with the key and unique prediction of my model. In total, the theory gains support from the empirical results.[31]

4.3 Panel Regressions

In this subsection, I implement panel regressions to verify whether Testable Prediction 1 holds in the case of Colombia's trade liberalization. I treat 1985 as the year before trade liberalization and 1991 as the year after the trade shock and implement a triple difference estimation. Furthermore, I divide Colombia plants that did not export and import between 1985 and 1991 into two groups. The first group includes plants that belong to the lower half of the (industry-level) productivity distribution in 1985, while the second group contains plants that belong to the upper half. Then, I run the following estimation equation:

$$\begin{aligned}\ln(TFP_{i,t}) &= \gamma_0 + \gamma_1 year_{91} + \gamma_2 year_{91} * agency_{i,85} + \gamma_3 year_{91} * imp_j \\ &\quad + \gamma_4 year_{91} * agency_{i,85} * imp_j + \gamma_5 \ln(techper)_{i,t} + firm_i + \epsilon_{i,t},\end{aligned}$$

where i indicates the plant, j denotes the three-digit ISIC industry the plant belongs to, and $t \in \{85, 91\}$. Variable imp_j equals one, if the reduction of the ERP in industry j (between 1985 and 1991) was larger than a certain threshold and zero otherwise. Variable $firm_i$ is the firm fixed effect, and $year_{91}$ is the post-shock indicator, which equals 1 if it is the year 1991. Variable $\ln(techper)$ is the log deflated technology expenditures per employee. Notice that variables imp_j, $agency_i$ and $agency_i * imp_j$ are omitted from the above estimation equation, since I include only plants that did not change the agency type and industry affiliation between 1985 and 1991. In order to exclude the potential impact of importing and exporting on firm productivity, I only use plants that did not import and export between 1985 and 1991 in all panel regressions.

The unique predictions of the model imply that the coefficient γ_4 is positively significant

[31] I implement several robustness checks in Appendix 6.9, and the empirical results are similar to the results presented above. I also discuss how other confounding factors might affect my empirical results in Appendix 6.9.

Table 1: Agency Problem and Productivity Change

	(1)	(2)	(3)	(4)
	$\Delta\ln(Prod)_{85,91}$			
$Agency_{85}$	2.273***	1.904***		
	(3.06)	(2.80)		
$AAgency_{85}$			1.327**	1.717***
			(2.46)	(2.78)
$\ln(TFP)_{85}$	-0.390***	-0.413***	-0.408***	-0.383***
	(-10.42)	(-12.74)	(-12.66)	(-10.41)
$Agency_{85}*$ $\ln(TFP)_{85}$	-0.305***	-0.258**		
	(-2.78)	(-2.56)		
$AAgency_{85}*$ $\ln(TFP)_{85}$			-0.186**	-0.235**
			(-2.27)	(-2.51)
$\Delta\ln(techper)$	0.0254***	0.0276***	0.0287***	0.0266***
	(3.19)	(3.97)	(4.06)	(3.23)
$\Delta impsh$	-0.00783	-0.0199	-0.0173	-0.000623
	(-0.32)	(-1.29)	(-0.98)	(-0.02)
$Constant$	2.335***	2.513***	2.551***	2.352***
	(9.42)	(10.87)	(10.72)	(9.37)
Sectors are included if $\Delta ERP_{85,91} <$	-0.5	-0.3	-0.3	-0.5
Location* Agency Dummy	Y	Y	Y	Y
Industry Dummy	3-digit ISIC	3-digit ISIC	3-digit ISIC	3-digit ISIC
N	979	1345	1361	992
R^2	0.253	0.249	0.244	0.245
adj. R^2	0.231	0.230	0.225	0.223

Standard errors are clustered at the location-industry (3-digit ISIC) level.

Agency: main agency indicator; *AAgency*: alternative agency indicator.

techper: real technology expenditure per employee. *impsh*: value of imported raw materials/VA.

TFP: Estimated productivity using the proxy estimator.

All regressions use plants that did not export between 1985 and 1991.

All regressions exclude plants that switched between the agency type between 1985 and 1991.

All regressions exclude plants that switched industry affiliation between 1985 and 1991.

t statistics are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

for the first group of non-exporting plants, while it is statistically insignificant for the second group. Empirical results reported in Table 2 show that this is indeed the case. After the ERP had decreased substantially in some industries, the least productive agency non-exporters improved log productivity relative to the least productive neoclassical non-exporters in those industries, since γ_4 is positively significant in all regressions (see columns one to three). Moreover, when we look at the most productive non-exporting firms (i.e., the upper half of the initial distribution), this pattern ceases to exist (see columns four to six), since γ_4 is statistically insignificant.

The standard mean-reversion story or the selection story would work against my theoretical predictions. For plants that belong to the same group of the initial productivity distribution (e.g., the lowest tercile or the upper half), the agency non-exporters have higher initial productivity compared with the neoclassical non-exporters. Therefore, the mean-reversion story or the selection story would predict that the agency non-exporters should achieve *smaller* productivity improvements compared with the neoclassical non-exporters in industries with sharp reductions in the ERP. This is probably why γ_4 is negative (although not statistically significant) for non-exporting plants that belong to the *upper* half of the intimal productivity distribution. However, this pattern is reversed for plants that belong to the *lower* half of the intimal productivity distribution, which can only be rationalized by my theory.

The quantitative impact of the theoretical predictions on firm productivity is possibly significant. First, for non-exporting firms belonging to the lowest tercile of the initial productivity distribution, the agency non-exporters improved productivity by roughly 35.9% relative to the neoclassical non-exporters as shown in Table 1. Second, as shown in Table 8, the positive correlation between the agency indicator and firm productivity is much smaller than the positive correlation between the agency indicator and firm size. Therefore, among unproductive surviving non-exporters, there is a nonnegligible fraction of agency firms that improved productivity after Colombia's trade liberalization. Finally, the disciplining effect also applies to the agency new exporters, which constitute a substantial fraction of exporting firms.[32]

[32] I do not test the model's prediction on new exporters, because it is hard to isolate the disciplining effect from the market size effect and other potential channels empirically. However, it does *not* mean that the disciplining effect is unimportant for new exporters.

Table 2: Panel Regressions: Agency Problems and Change in Log Productivity (First-Difference)

	Plants Belonging to the Lower Half of Productivity Distribution in 1985 ln($lprod$)			Plants Belonging to the Upper Half of Productivity Distribution in 1985 ln($lprod$)		
ln($techper$)	0.0196**	0.0198***	0.0198***	0.0109	0.0107	0.0109
	(2.57)	(2.59)	(2.60)	(1.04)	(1.03)	(1.03)
$Year_{91}$	0.160***	0.177***	0.155***	-0.210***	-0.194***	-0.204***
	(7.13)	(8.30)	(6.79)	(-6.43)	(-6.47)	(-6.06)
$Year_{91}$ $Agency$	-0.328***	-0.249***	-0.323***	0.131	0.188**	0.125
	(-3.36)	(-3.31)	(-3.30)	(1.21)	(2.22)	(1.15)
$Year_{91}*$ imp	0.0966***	0.0693**	0.100***	0.158***	0.144***	0.138***
	(2.85)	(2.00)	(2.98)	(3.46)	(3.14)	(3.03)
$Year_{91}*$ $imp*agency$	0.278*	0.465*	0.274*	-0.117	-0.368	-0.0971
	(1.81)	(1.85)	(1.79)	(-0.71)	(-1.62)	(-0.59)
$Constant$	6.069***	6.069***	6.069***	7.042***	7.042***	7.042***
	(525.01)	(521.98)	(524.37)	(388.50)	(391.14)	(386.71)
$imp = 1$ if $\Delta ERP_{84,90} <$	−0.1	−0.15		−0.1	−0.15	
$imp = 1$ if $\Delta ERP_{85,91} <$			−0.3			−0.3
Firm Fixed Effect	Y	Y	Y	Y	Y	Y
N	2354	2354	2354	1571	1571	1571
R^2	0.139	0.138	0.140	0.051	0.050	0.047
adj. R^2	0.137	0.136	0.138	0.048	0.047	0.044

Robust standard errors are in parentheses, and t statistics are in parentheses.

Variables $Agency$, imp and $Agency * imp$ are omitted due to the perfect collinearity.

All regressions use plants that did not import and export between 1985 and 1991.

All regressions exclude plants that have the value of the agency indicator changed between 1985 and 1991.

All regressions exclude plants that switched industry affiliation between 1985 and 1991.

$Agency = 1$: Corporation, de facto corporations and joint stock companies; $Agency = 0$: Proprietorship and limited partnership.

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

5 Concluding Remarks

This paper presents a model that captures the agency problem inside the firm in order to explain why *some* agency firms improve productivity after trade liberalization. The main predictions of the model are that the least productive surviving agency non-exporters increase productivity relative to the least productive surviving neoclassical non-exporters after trade liberalization, and this prediction does not apply to the most productive surviving non-exporting firms. The main economic insight is that, after trade liberalization, managers of the least productive surviving non-exporting firms that are subject to the agency problem are incentivized to exert more effort in order to induce their owners to produce and continue to receive rents by running the firms. This disciplining effect applies only to this type of manager (and firm).

The unique predictions of the model gain support from the empirical tests using Colombia plant-level data. First, among non-exporters, the average log productivity of the agency firms increased relative to the neoclassical firms after trade liberalization. Second, among non-exporting firms, the least productive agency firms increased log productivity relative to the least productive neoclassical firms after trade liberalization. Third, there is no difference in the change of log productivity between the most productive non-exporting agency firms and the most productive non-exporting neoclassical firms after trade liberalization. Moreover, the relationship between the firm's initial log productivity and its log productivity change is indeed more negative for the agency non-exporting firms than for the neoclassical non-exporting firms after trade liberalization.

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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6 Appendix: For Online Publication

6.1 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.[33] 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.

6.2 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

$$\max_{\beta} \quad \alpha\eta(P,Y)\phi\beta\Big(1 + \frac{1}{\tau^{\sigma-1}}\Big) - \gamma\beta^{\theta}, \tag{26}$$

which yields the solution that

$$\beta_{x2}(\phi) = \Big(\frac{\alpha\eta(P,Y)\phi}{\gamma\theta}(1 + \frac{1}{\tau^{\sigma-1}})\Big)^{\frac{1}{\theta-1}}. \tag{27}$$

[33] 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

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

Based on equation (28), I derive a cutoff on the initial quality as

$$\phi_x^{'} = \Big(\frac{(f_x\tau^{\sigma-1})^{\theta-1}\gamma\theta}{\alpha(1-\alpha)^{\theta-1}\eta(P,Y)^{\theta}(1+\frac{1}{\tau^{\sigma-1}})}\Big)^{\frac{1}{\theta}} = (\frac{f_x}{f})^{\frac{\theta-1}{\theta}}\frac{\tau^{\sigma-1}}{(1+\tau^{\sigma-1})^{\frac{1}{\theta}}}\phi_f^{'}. \tag{29}$$

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.[34] 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

$$\frac{\theta-1}{\theta}\frac{\alpha f}{(1-\alpha)}\Big(\frac{\phi}{\phi_f^{'}}\Big)^{\frac{\theta}{\theta-1}}, \tag{30}$$

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

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

[34]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

$$\frac{\theta - 1}{\theta} \frac{\alpha f}{(1-\alpha)} \Big(\frac{\phi}{\phi_f^{'}}\Big)^{\frac{\theta}{\theta-1}} (1 + \frac{1}{\tau^{\sigma-1}})^{\frac{\theta}{\theta-1}}. \tag{31}$$

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

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

By comparing equation (30) with equation (32), I conclude that a manager with $\phi < \phi_x^{'}$ chooses the effort level of $\beta_{x0}(\phi)$, if and only if

$$\phi \geq \phi_x^{*} \equiv \frac{\phi_x^{'}}{\left[\theta - \frac{\theta-1}{\left(1+\frac{1}{\tau^{\sigma-1}}\right)^{\frac{\theta}{\theta-1}}}\right]^{\frac{1}{\theta}}} \tag{33}$$

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 (33) with equation (16), I obtain the following condition:

$$\frac{f_x \tau^{\sigma-1}}{f} \geq (1 + \frac{1}{\tau^{\sigma-1}})^{\frac{1}{\theta-1}} \left[\theta - \frac{\theta - 1}{(1 + \frac{1}{\tau^{\sigma-1}})^{\frac{\theta}{\theta-1}}}\right]^{\frac{1}{\theta-1}}. \tag{34}$$

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

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

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.

6.3 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

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

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.[35] Or, I have $\phi_f^* \geq \phi_a^{'}$ and[36]

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

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

[35] Figure 4 represents this case.

[36] Figure 8 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

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

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.

6.4 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 9 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 ($\phi \in [\phi_f^{'}, \phi_x^{*})$).[37]
QED.

6.5 Proof of Proposition 4

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

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

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

In the closed economy, the optimal effort level is

$$
\beta_{aw}(\varphi) = \Big(\frac{\eta(P, Y)\varphi}{\gamma\theta}\Big)^{\frac{1}{\theta-1}}. \tag{35}
$$

The resulting firm profit is

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

and the payoff for the owner is

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

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

[37] This case is graphically represented in Figure 12.

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.

6.6 Proof of Testable Prediction 1

Proof: I discuss the case in which the reduction in trade costs is sufficiently large first. From the proof of Proposition 3, we know that the change in log productivity for the agency firm is

$$\begin{aligned} & \log(\phi\beta_f(\phi)) - \log(\phi\beta_a(\phi)) = \log(\phi\beta_{f2}(\phi)) - \log(\phi\beta_{a2}(\phi)) \\ = \quad & \frac{1}{\theta-1}[\log(\eta(P_f, Y_f)) - \log(\eta(P_a, Y_a))] \\ < \quad & 0. \end{aligned}$$

when $\phi \geq \phi_f^{'}$ and

$$0 > \log(\phi\beta_f(\phi)) - \log(\phi\beta_a(\phi)) > \frac{1}{\theta-1}[\log(\eta(P_f, Y_f)) - \log(\eta(P_a, Y_a))]$$

when $\phi \in [\phi_f^*, \phi_f^{'})$. From the proof of Proposition 4, we know that the change in log productivity for a neoclassical firm is

$$\log(\phi\beta_{fw}(\phi)) - \log(\phi\beta_{aw}(\phi)) = \frac{1}{\theta - 1}[\log(\eta(P_f, Y_f)) - \log(\eta(P_a, Y_a))].$$

for $\phi \geq \phi_f^*$, where ϕ_f^* is the exit cutoff after trade liberalization. Therefore, there is no difference in the change of log productivity between non-exporting agency firm and non-exporting neoclassical firm, when the initial quality draw is bigger than $\phi_f^{'}$. However, when the initial quality draw is smaller than $\phi_f^{'}$ and bigger than ϕ_f^*, I have

$$\begin{aligned}
& [\log(\phi\beta_f(\phi)) - \log(\phi\beta_a(\phi))] - [\log(\phi\beta_{fw}(\phi)) - \log(\phi\beta_{aw}(\phi))] \\
= \; & [\log(\beta_{f0}(\phi)) - \log(\beta_{a2}(\phi))] - \frac{1}{\theta - 1}[\log(\eta(P_f, Y_f)) - \log(\eta(P_a, Y_a))] \\
= \; & [\log(\beta_{f0}(\phi)) - \log(\beta_{a2}(\phi))] - [\log(\beta_{f2}(\phi)) - \log(\beta_{a2}(\phi))] \\
> \; & 0,
\end{aligned}$$

and it decreases with ϕ, since $\log(\beta_{f0}(\phi))$ (and $\log(\beta_{a2}(\phi))$) decreases (and increases) with $\phi \in [\phi_f^*, \phi_f^{'})$. In total, I have the following results. First, among the least productive non-exporting firms, the decrease in log productivity is smaller for the agency firms than for the neoclassical firms. Second, among big non-exporting firms, the decrease in log productivity is the same for the agency firms as for the neoclassical firms. Third, among the agency non-exporters, the decrease in log productivity is smaller for the least productive firms than for the most productive productive firms. Fourth, the average log productivity of the agency non-exporters increases relative to the neoclassical non-exporters. Finally, the relationship between the firm's initial log productivity and its log productivity change is more negative for the agency non-exporters than for the neoclassical non-exporters.[38] The above case is represented in Figure 12.

The proof for the case in which the reduction in trade costs is not too large is similar to the previous case. I divide the proof into two sub-cases. First, if $\phi_f^* < \phi_a^{'}$, the change in log productivity for an agency firm can be divided into three categories.

[38]the relationship between the firm's initial log productivity and its log productivity change is negative after trade liberalization in the data due to the selection effect and the mean-reversion mechanism.

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

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

and

$$[\log(\phi\beta_f(\phi)) - \log(\phi\beta_a(\phi))] - [\log(\phi\beta_{fw}(\phi)) - \log(\phi\beta_{aw}(\phi))] = 0.$$

I.e., there is no difference in the change of log productivity between the most productive agency firms and the most productive neoclassical firms.

When $\phi \in [\phi_a^{'}, \phi_f^{'})$,

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

and

$$\begin{aligned} & [\log(\phi\beta_f(\phi)) - \log(\phi\beta_a(\phi))] - [\log(\phi\beta_{fw}(\phi)) - \log(\phi\beta_{aw}(\phi))] \\ = \quad & [\log(\beta_{f0}(\phi)) - \log(\beta_{a2}(\phi))] - \frac{1}{\theta-1}[\log(\eta(P_f, Y_f)) - \log(\eta(P_a, Y_a))] \\ = \quad & [\log(\beta_{f0}(\phi)) - \log(\beta_{a2}(\phi))] - [\log(\beta_{f2}(\phi)) - \log(\beta_{a2}(\phi))] \\ > \quad & 0. \end{aligned}$$

It decreases with ϕ, since $\log(\beta_{f0}(\phi))$ (and $\log(\beta_{a2}(\phi))$) decreases (and increases) with ϕ when $\phi \in [\phi_a^{'}, \phi_f^{'})$. It approaches zero when ϕ approaches $\phi_f^{'}$ and approaches its maximum when when ϕ approaches $\phi_a^{'}$.

When $\phi \in [\phi_f^*, \phi_a^{'})$,

$$\log(\phi\beta_f(\phi)) - \log(\phi\beta_a(\phi)) = \log(\phi_f^{'}\beta_a(\phi_f^{'})) - \log(\phi_a^{'}\beta_a(\phi_a^{'})) > 0,$$

and

$$
\begin{aligned}
& [\log(\phi\beta_f(\phi)) - \log(\phi\beta_a(\phi))] - [\log(\phi\beta_{fw}(\phi)) - \log(\phi\beta_{aw}(\phi))] \\
= \; & [\log(\phi_f^{'}\beta_f(\phi_f^{'})) - \log(\phi_a^{'}\beta_a(\phi_a^{'}))] - \frac{1}{\theta-1}[\log(\eta(P_f, Y_f)) - \log(\eta(P_a, Y_a))] \\
= \; & [\log(\beta_{f0}(\phi_a^{'})) - \log(\beta_{a2}(\phi_a^{'}))] - [\log(\beta_{f2}(\phi_a^{'})) - \log(\beta_{a2}(\phi_a^{'}))] \\
> \; & 0,
\end{aligned}
$$

since $\phi_f^{'} > \phi_a^{'}$, $\beta_a(\phi_a^{'}) = \beta_f(\phi_f^{'})$, and $\eta(P_f, Y_f) < \eta(P_a, Y_a)$. In total, the (positive) difference in the change of log productivity between the agency non-exporter and the neoclassical non-exporter decreases with the initial quality draw (i.e., ϕ), and all other predictions stated in Testable Prediction 1 are straightforward to prove. This case is represented in Figure 10.

Second, if $\phi_f^* \geq \phi_a^{'}$ and $\beta_f(\phi_f^*) > \beta_a(\phi_f^*)$, only the last category of the above sub-case (i.e., $\phi \in [\phi_f^*, \phi_a^{'}))$ disappears. So, we end up with the result that as before. Namely, the (positive) difference in the change of log productivity between an agency non-exporter and a neoclassical non-exporter decreases with the initial quality draw of ϕ, and all other predictions hold as well. This case is graphically represented in Figure 11.

In total, there are several robust empirical predictions that are common across all three cases.

1. Among non-exporters, the average log productivity of agency firms increases relative to the neoclassical firms after trade liberalization.

2. Among non-exporting firms, the least productive agency firms increase log productivity relative to the least productive neoclassical firms after trade liberalization.

3. Among non-exporting firms, the least productive agency firms increase log productivity relative to the most productive agency firms after trade liberalization.

4. Among the most productive non-exporting firms, there is no difference in the change of log productivity between the agency firms and the neoclassical firms after trade liberalization.

Moreover, since the relationship between the firm's initial log productivity and its log productivity change after trade liberalization is always negative in the data,[39] this relationship should be more negative for the agency non-exporters than for the neoclassical non-exporters. QED.

6.7 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.

[39]conditional on survival, less productive firms have higher productivity growth rates than more productive firms after trade liberalization. This is due to both the selection mechanism and the mean-reversion mechanism.

6.8 Trade Liberalization and Productivity Gains

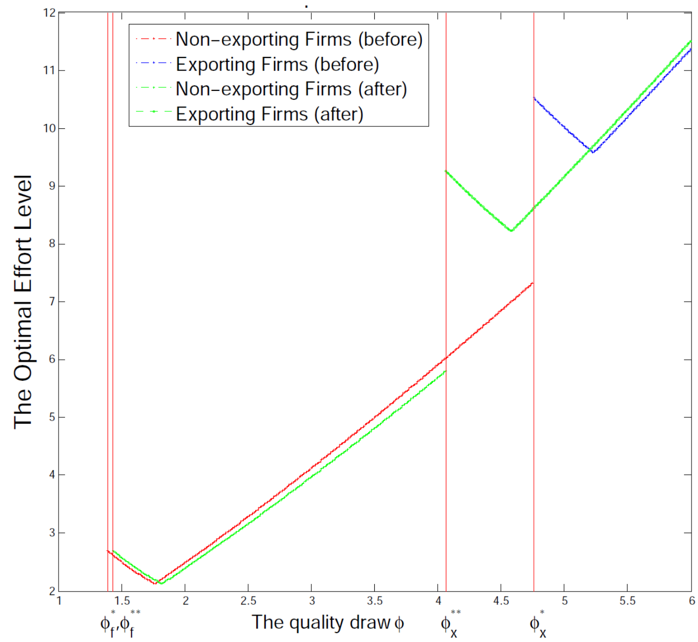
In this subsection, I discuss how bilateral trade liberalization (i.e., a reduction in the variable trade cost τ) generates heterogeneous impact on firm productivity which is demonstrated in Figure 6. The overall impact is similar to the impact of opening up to trade on firm productivity. First, the 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.[40] 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 6. 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 liberalization, 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.

6.9 Robustness Checks

In this subsection, I first implement several robustness checks for the regression results reported in Table 1. First, although the theory does not consider firms that change their agency

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

Figure 6: Bilateral Trade Liberalization and the Optimal Effort Choice



type (i.e., the agency indicator) or industry affiliation after trade liberalization, there were such plants in the Colombia data.[41] I exclude all these firms from the main regression whose results are reported in Table 1. In Table 3, I include some (or all) of these firms into the main regression and investigate whether the inclusion of these firms affects the empirical results. Second, firms probably need time to adjust to the new environment. Therefore, the measure for import protection that affects firms' behavior is possibly the lagged ERP. In the first four columns of Table 4, I use the change in the ERP between 1984 and 1990 to redefine whether an industry experienced sharp reductions in variable trade costs, and then I rerun the regressions in Table 1. Finally, in the last two columns of Table 4, I exclude plants that have either the highest or the lowest estimated productivity from the regressions to see whether this exclusion (of potential outliers) affects the estimation results substantially.[42]

As Tables 3 and 4 show, all the robustness checks lead to results similar to those reported in Table 1. First, signs of the parameters we are interested in remain unchanged. Second, β_1 remains positively significant in most regressions, which suggests that the agency non-exporters gained in log productivity relative to the neoclassical non-exporters after Colom-

[41]There were roughly 6% of plants that changed their agency type and 5% of plants that changed their industry affiliation between 1985 and 1991.

[42]As a result, roughly 1% observations are eliminated.

bia implemented trade liberalization. Third, β_3 is negative and statistically significant in most regressions. This again supports the key prediction of the model. That is, the relationship between the firm's initial log productivity and its log productivity change is more negative for the agency non-exporters than for the neoclassical non-exporters. Finally, the estimated parameter values do not differ much from those in Table 1. In short, the robustness checks confirm the key predictions of the model stated in Testable Prediction 1.

Next, I discuss several other factors that could potentially affect firm productivity after trade liberalization. The purpose is to convince readers that other potentially confounding factors do not seem to affect the validity of the above empirical results and conclusions.

First, there might be spillover effects (from exporters) that affect non-exporters' productivity. If these effects disproportionately benefit less productive agency non-exporters, the above regression results cannot be seen as supporting evidence for my model. However, this hypothetical argument does not seem to be true. First, it is still controversial in the literature that the spillover effects from exporters to non-exporters are positive. It may be the case that non-exporters can learn from exporters and accordingly improve their productivity. However, it also may be the case that a sharp increase in the number of exporting firms within an industry intensifies competition for skilled workers and other resources, which results in a negative spillover effect for non-exporters. Thus, it is less likely that the consideration of the spillover effects could reverse the conclusion based on the above empirical results. Furthermore, I calculated the change in the share of exporting firms for each region-industry pair from 1985 to 1991. Then I calculated the correlation coefficient between this change and the change in log productivity for the least productive agency non-exporters. The resulting coefficient is not statistically significant.[43] Therefore, in region-industry pairs that had sharp increases in the share of exporting firms, the least productive agency non-exporters did not seem to receive larger productivity gains. In total, the evidence for the unique predictions of my model does not seem to be affected by the consideration of the spillover effects.

Second, for public firms, trade liberalization might affect the incentive scheme offered to the manager. Furthermore, the productivity response of public firms to trade liberalization might

[43] Results are available upon request.

Table 3: Robustness Checks: Part One

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta\ln(Prod)_{85,91}$					
$Agency_{85}$		1.911***	1.631**	1.379*		1.371*
		(2.86)	(2.07)	(1.92)		(1.92)
$AAgency_{85}$	1.227***				0.981**	
	(2.64)				(2.08)	
$\ln(TFP)_{85}$	-0.415***	-0.400***	-0.382***	-0.405***	-0.409***	-0.393***
	(-12.44)	(-10.35)	(-10.48)	(-12.79)	(-12.46)	(-10.42)
$Agency_{85}$* $\ln(TFP)_{85}$		-0.259**	-0.217*	-0.188*		-0.184*
		(-2.57)	(-1.85)	(-1.75)		(-1.69)
$AAgency_{85}$* $\ln(TFP)_{85}$	-0.174**				-0.143*	
	(-2.39)				(-1.90)	
$\Delta\ln(techper)$	0.0271***	0.0242***	0.0277***	0.0283***	0.0269***	0.0264***
	(3.64)	(2.73)	(3.51)	(4.28)	(3.92)	(3.16)
$\Delta impsh$	-0.0154	-0.00603	-0.000873	-0.0191	-0.0157	-0.000382
	(-0.92)	(-0.25)	(-0.03)	(-1.09)	(-0.90)	(-0.01)
$Constant$	2.597***	2.436***	2.324***	2.511***	2.585***	2.417***
	(10.51)	(9.12)	(9.61)	(10.97)	(10.59)	(9.27)
Sectors: Included if $\Delta ERP_{85,91}$ <	−0.3	−0.5	−0.5	−0.3	−0.3	−0.5
Industry switchers included?	Y	Y	N	N	Y	Y
Agency switchers included?	N	N	Y	Y	Y	Y
Location*Agency Dummy	Y	Y	Y	Y	Y	Y
Industry Dummy	3-digit ISIC	3-digit ISIC	3-digit ISIC	3-digit ISIC	3-digit ISIC	3-digit ISIC
N	1457	1043	1028	1409	1531	1094
R^2	0.226	0.230	0.242	0.241	0.223	0.222
adj. R^2	0.208	0.209	0.221	0.223	0.206	0.201

Standard errors are clustered at the location-industry (3-digit ISIC) level. t statistics are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Agency: main agency indicator; *AAgency*: alternative agency indicator. All regressions use plants that did not export between 1985 and 1991.

techper: real technology expenditure per employee. *impsh*: value of imported raw materials/VA. TFP: Estimated productivity using the proxy estimator.

Table 4: Robustness Checks: Part Two

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \ln(Prod)_{85,91}$					
$Agency_{85}$			1.401	1.420**		1.780**
			(1.36)	(2.29)		(2.58)
$AAgency_{85}$	1.103*	1.239***			1.238*	
	(1.76)	(2.64)			(1.83)	
$\ln(TFP)_{85}$	-0.405***	-0.410***	-0.410***	-0.414***	-0.373***	-0.379***
	(-10.49)	(-12.02)	(-10.53)	(-12.06)	(-9.31)	(-9.37)
$Agency_{85}*$ $\ln(TFP)_{85}$			-0.214	-0.195**		-0.230**
			(-1.52)	(-2.08)		(-2.22)
$AAgency_{85}*$ $\ln(TFP)_{85}$	-0.189**	-0.177**			-0.160	
	(-2.16)	(-2.42)			(-1.58)	
$\Delta \ln(techper)$	0.0273***	0.0294***	0.0258***	0.0280***	0.0256***	0.0243***
	(3.31)	(3.82)	(3.17)	(3.66)	(3.05)	(2.99)
$\Delta impsh$	-0.0153	-0.0154	-0.0172	-0.0174	-0.0370	-0.0355
	(-0.88)	(-0.90)	(-1.06)	(-1.11)	(-0.51)	(-0.50)
$Constant$	2.973***	2.568***	3.008***	2.569***	2.276***	2.260***
	(10.15)	(10.19)	(10.19)	(10.23)	(8.50)	(8.61)
Sectors: Included if $\Delta ERP_{85,91} <$					−0.5	−0.5
Sectors: Included if $\Delta ERP_{84,90} <$	−0.15	−0.1	−0.15	−0.1		
Industry switchers included?	Y	Y	Y	Y	N	N
Agency switchers included?	N	N	N	N	N	N
Location*Agency Dummy	Y	Y	Y	Y	Y	Y
Industry Dummy	3-digit ISIC	3-digit ISIC	3-digit ISIC	3-digit ISIC	3-digit ISIC	3-digit ISIC
N	1206	1398	1189	1380	979	966
R^2	0.217	0.225	0.219	0.229	0.223	0.230
adj. R^2	0.197	0.207	0.199	0.210	0.200	0.207

Standard errors are clustered at the location-industry (three-digit ISIC) level. t statistics are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Agency: Main agency indicator; *AAgency*: Alternative agency indicator. All regressions use plants that did not export between 1985 and 1991.

techper: real technology expenditure per employee. *impsh*: value of imported raw materials/VA. TFP: Estimated productivity using the proxy estimator.

be different from that of private firms, since public firms have better access to external financing (i.e., the stock market). Therefore, I rerun the above regressions but exclude stock companies.[44] Empirical results with stock companies' being taken out of the sample do not differ very much from the results in Table 1. Therefore, the evidence for the unique predictions of my model does not seem to be affected by consideration of the two confounding factors.

[44] Results are available upon request.

7 Tables and Figures: For Online Publication

Table 5: Summary Statistics

	Value of Production	Employment	Value Added	Book Value of fixed assets
Obs.	76083	76083	69285	76094
Mean	629962.9	69.51	290255.5	114154.9

Table 6: The Estimated Production Function (1981-1991)

ISIC	31	32	33	34	35	36	37	38	39
ldLB	0.395***	0.221***	0.307***	0.429***	0.165***	0.452***	0.322***	0.390***	0.183***
	(0.0285)	(0.0152)	(0.0536)	(0.0507)	(0.0248)	(0.0296)	(0.0690)	(0.0203)	(0.0537)
ldLW	0.494***	0.536***	0.558***	0.477***	0.708***	0.564***	0.693***	0.603***	0.610***
	(0.0234)	(0.0133)	(0.0505)	(0.0391)	(0.0208)	(0.0296)	(0.0833)	(0.0208)	(0.0617)
ldnpt	0.254***	0.152***	0.158***	0.254***	0.158***	0.151***	0.181	0.171***	0.165
	(0.0719)	(0.0244)	(0.0546)	(0.0705)	(0.0244)	(0.0455)	(0.118)	(0.0257)	(0.127)
N	7715	9610	1940	2787	5364	2183	542	7965	867

31: food products; 32: textile, shoes and clothing; 33: wood products and furniture.
34: paper and printing products; 35: chemical, rubber, plastic and petroleum Products.
36: products of non-metallic Minerals; 37: iron, steel and and non-ferrous metals.
38: machinery, equipment and metal products; 39: miscellaneous manufacturing industries.
Standard errors in parentheses.
ldLB: ln(blue collar); ldLW: ln(white collar); ldnpt: ln(capital).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: The Effective Rate of Protection

Year	Obs.	Mean	Std. Dev.	Min	Max
1980	28	0.576	0.278	0.239	1.25
1984	28	0.766	0.384	0.304	1.64
1985	28	0.940	0.470	0.372	2.03
1990	28	0.650	0.329	0.186	1.47
1991	28	0.548	0.252	0.163	1.38

Table 8: Agency Firms and Neoclassical Firms (1985-1991)

	ln(productivity)	ln(VA)	employment	ln(capital)
Agency indicator	0.173	0.548	0.361	0.467

The number of observations with Agency=1: 9610
The number of observations with Agency=0: 39167

Table 9: Agency Firms and Neoclassical Firms (1985-1991)

	ln(productivity)	ln(VA)	ln(capital)	employment
Neoclassical Firms	6.608	8.896	7.382	38.2
Agency Firms	7.025	11.091	9.705	179.4

Figure 7: Trade Liberalization and the Optimal Effort Choice: No Agency Problem

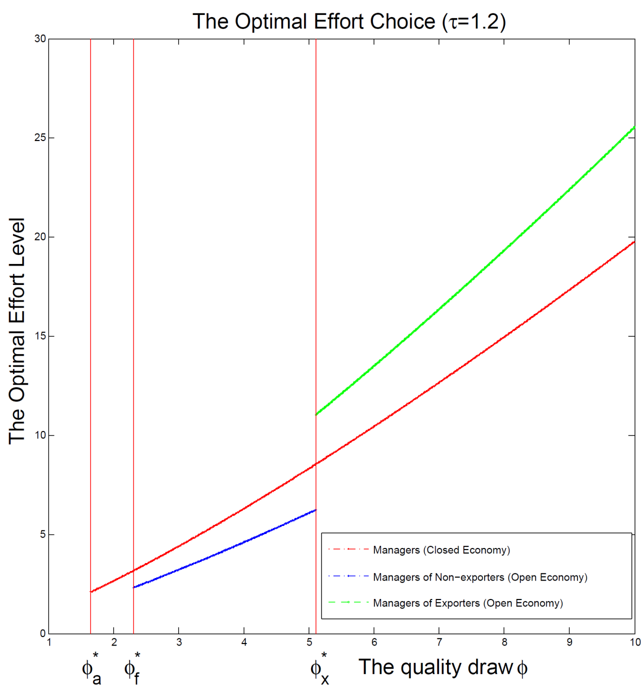


Figure 8: Impact of Trade on the Optimal Effort (Moderate Reduction in Trade Costs)

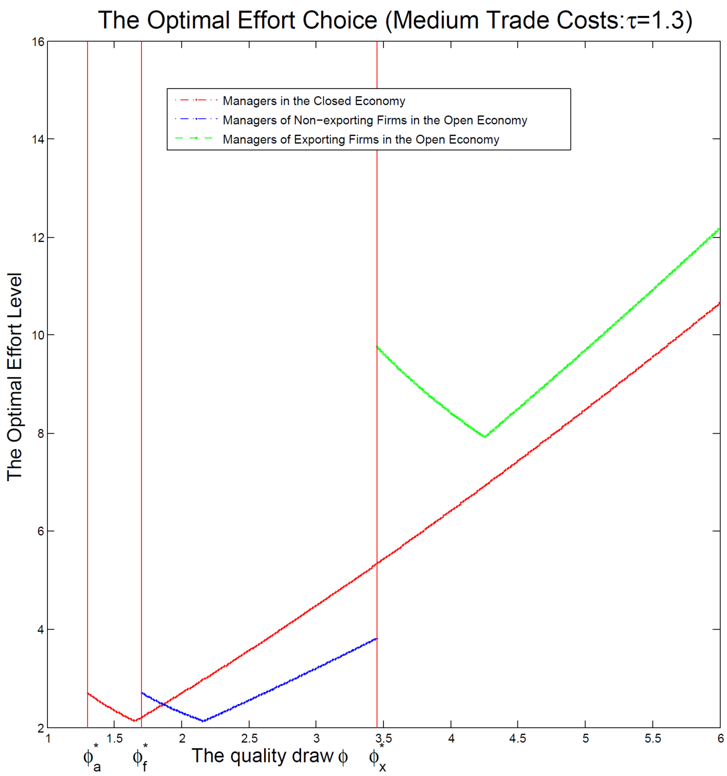


Figure 9: Impact of Trade on the Optimal Effort (Large Reduction in Trade Costs)

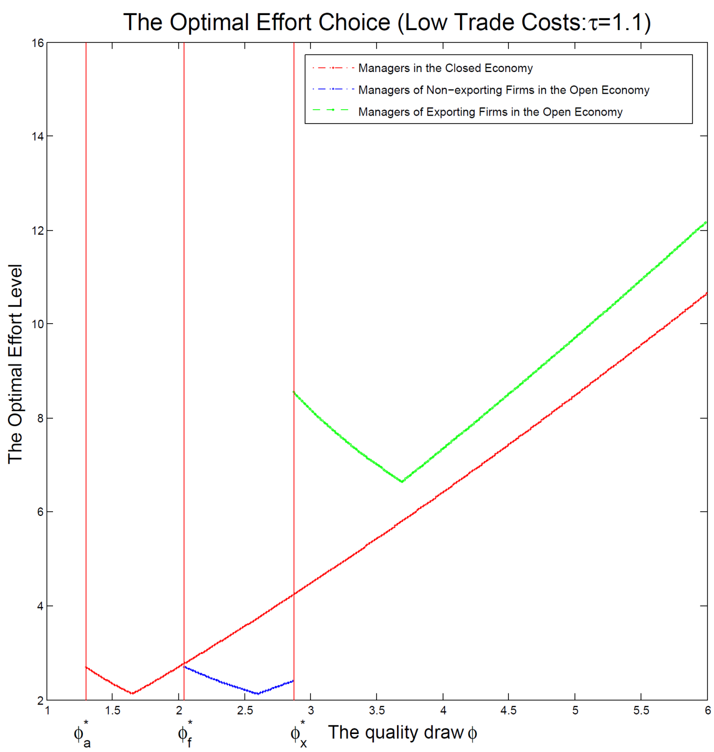


Figure 10: Change in Log Productivity (Small Reduction in Trade Costs)

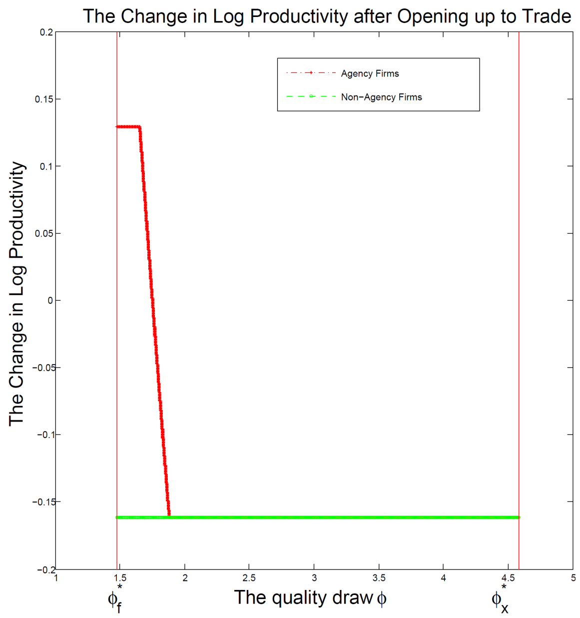


Figure 11: Change in Log Productivity (Moderate Reduction in Trade Costs)

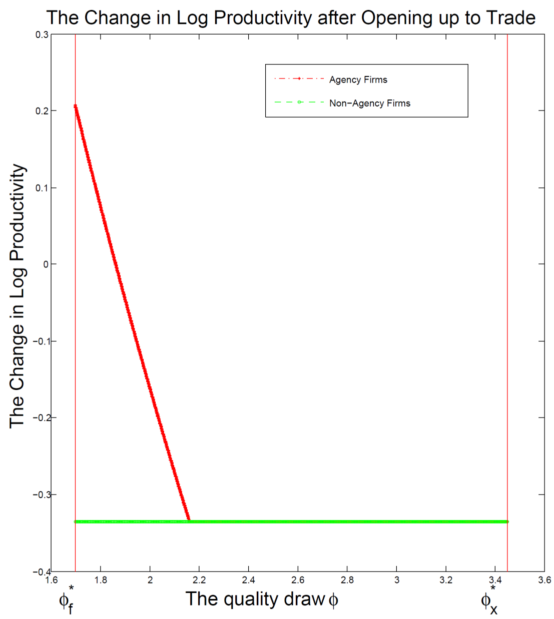


Figure 12: Change in Log Productivity (Large Reduction in Trade Costs)

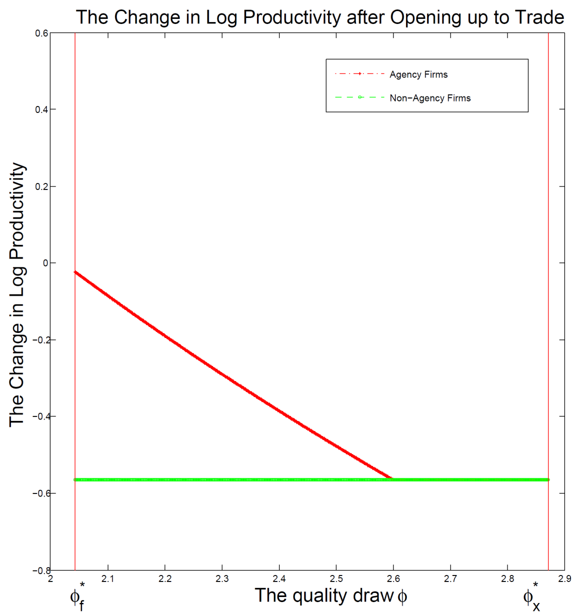
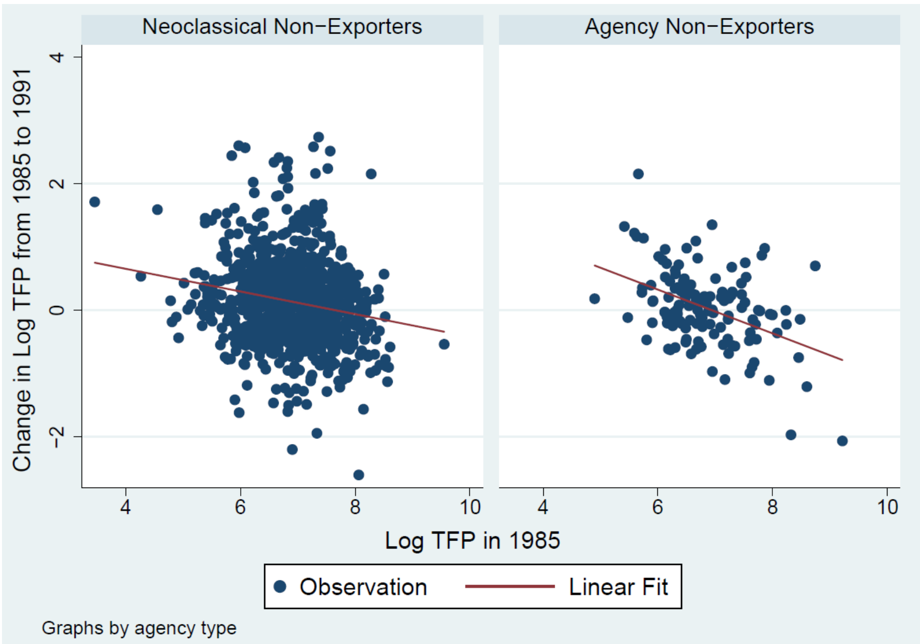
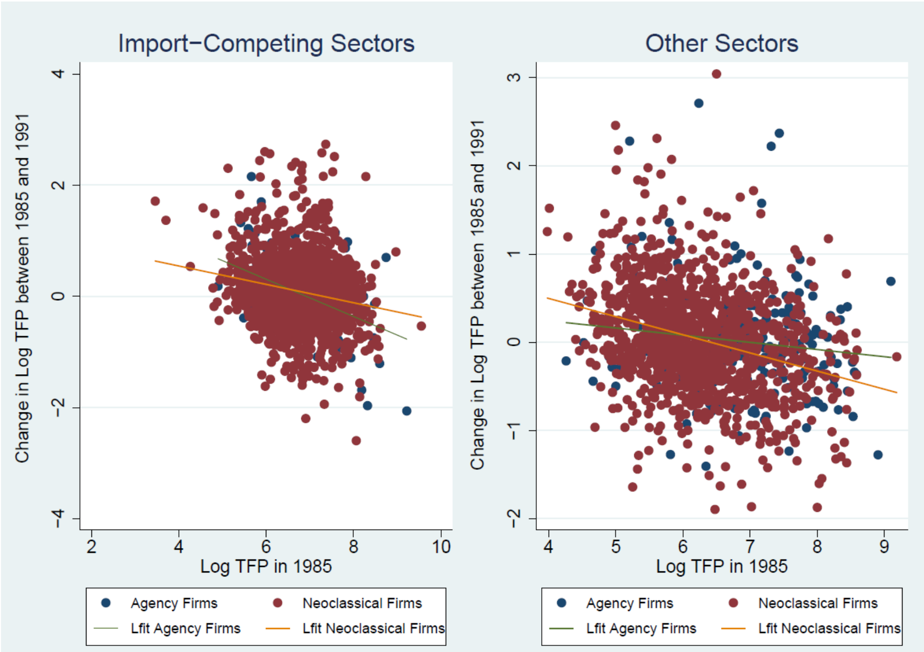


Figure 13: Productivity Change and Initial Productivity: Slope Matters



Industries with reductions in the ERP > 0.5 are included.

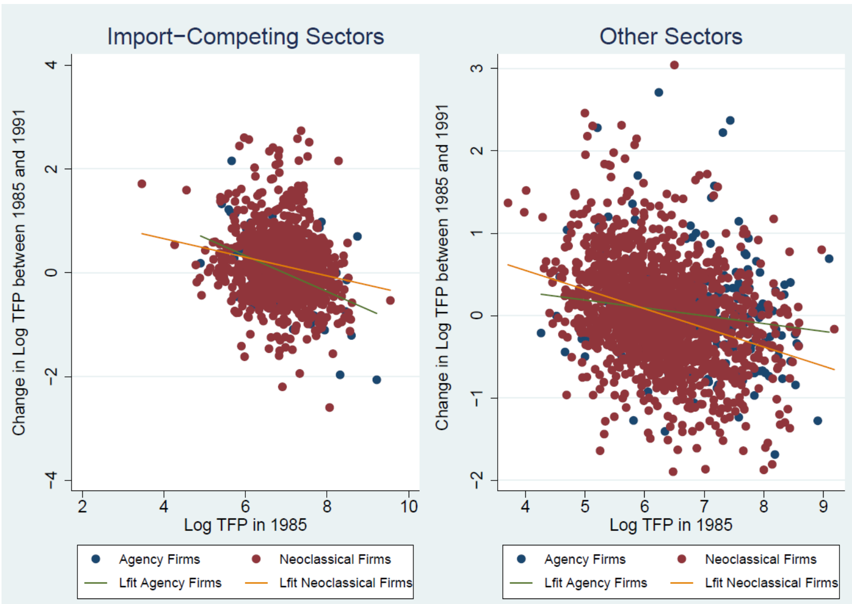
Figure 14: Productivity Change and OP Productivity: Non-Exporters Only



Import-competing sectors: Reduction in ERP > 0.3.

Other sectors: Reduction in ERP ≤ 0.3.

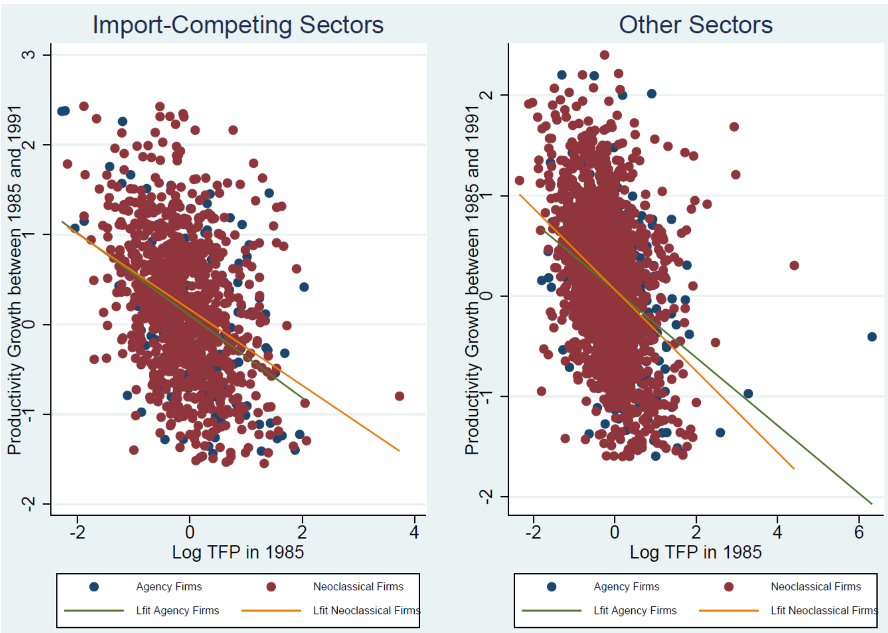
Figure 15: Productivity Change and OP Productivity: Non-Exporters Only (Cont.)



Import-competing sectors: Reduction in ERP > 0.5.

Other sectors: Reduction in ERP ≤ 0.5.

Figure 16: Productivity Change and Index-Number Productivity: Non-Exporters Only



Import-competing sectors: Reduction in ERP > 0.3.

Other sectors: Reduction in ERP ≤ 0.3.