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The Effect of Distortions on Managerial Incentives and Competition in a Global Market*

Tom Reijnen
342782

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Abstract

This thesis examines the impact of competition and international trade on managerial incentives when there exist contractual distortions. The manager can decide to exert effort on a cost-reducing or a non-contributory task, where the owner does not observe the total level of effort and the distribution of effort among both tasks. I show that when managerial effort is imperfectly verifiable, the likelihood that trade-openness increases the degree of market competition, and consequently total consumer welfare, is higher than in the first-best situation. When the degree of contractual distortions for a given industry is allowed to differ across countries, countries that experience the least amount of distortions are the most likely to benefit from trade. Secondly, at the first-best level of effort, over-incentivized managers cause the degree of market competition to decrease over time, which reduces the amount of available varieties in equilibrium. When firms experience contractual distortions, this effect is reduced. Less efficient firms are then able to survive in the market, which increases the degree of market competition and as a result the amount of available varieties and aggregate consumer welfare.

Keywords: managerial incentives, productivity, competition, trade, distortions

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1 Introduction

Since the 1970s, economist's interest has been directed at studying the impact of competition on firm productivity and managerial incentives. It is common economic wisdom that increased competition requires firms to be more productive in order to survive. This relationship increasingly holds in an ever expanding global market. Yet, the impact of increased trade-openness on incentive provision for managers is a subject that has only recently received some attention. More specifically, how distortions in incentive contracts affect managerial incentives in a global market place has, to my knowledge, not been researched presently. It is important to understand how contractual frictions influence managerial incentives when firms are exposed to international trade, for various reasons. Firstly, it allows us to draw conclusions on how beneficial trade is when firm-level efficiency is relatively low (i.e. distortions are large). Opening up the economy introduces two counterforcing effects. On the one hand, resources are shifted from the least productive to the most productive firms, reducing the amount of surviving firms (Melitz, 2003; Bernard et al., 2003). On the other hand, it raises the expected benefits of entering the industry, which increases the amount of firms in the industry over time (Raith, 2003; Vives, 2008). How these dynamics change when firms operate under contractual inefficiencies is presently unknown. Analysis of the former could provide valuable information on whether trade-openness is beneficial for an industry.

Secondly, large contractual distortions push owners to set lower incentives, which potentially increases managerial slack (Gibbons, 1998). How does an industry where distortions reduce the equilibrium level of managerial effort compare to an industry where the owner is able to perfectly verify managerial output? A reduced degree of average industry productivity will make it more likely a firm will survive. Yet, when an industry opens up for trade, will firms be able to compete with very productive foreign firms?

The purpose of this thesis is to understand how imperfectly verifiable effort of the manager affects the equilibrium outcomes in a heterogeneous trade model à la Melitz. I introduce a multi-task agency problem, similar to that of Baker (2002) in an adaptation of the model by Yu (2012). In this model, the owner is neither able to perfectly observe the output of the manager, nor the level of effort of the manager, which gives rise to the moral hazard problem. The owner employs an imperfect performance measure to incentivize the manager to exert cost-reducing, which simultaneously elicits distorting effort.[1] The main finding is that economies characterized by a high degree of firm-level distortions are more likely to benefit from trade-openness than economies which operate more closely to the first-best solution. In equilibrium, it depends on the magnitude of the business stealing effect and the scale effect

[1] In the remainder of this thesis, when I refer to distortions, I refer to the case where the performance measure incentivizes the manager to (also) exert distorting effort.

whether opening up for trade leads to an increase in consumer welfare. In the case where firm-level contractual distortions are present, the former is more likely to dominate than the latter, resulting in a higher degree of market competition, consequently increasing aggregate consumer welfare. In cases where the scale effect dominates, opposite effects arise.

These results change when countries are allowed to differ in their initial degree of contractual distortions. Countries that are more efficient (i.e. experience less distortions) are more likely to gain from trade than countries with a high degree of inefficiency. In the extreme case where a very efficient country engages in trade with a very inefficient country, the former is sure to achieve benefits from trade, whereas the latter unambiguously experiences a loss in consumer welfare from trade-openness.

Lastly, distortions in the economy act as a means to reduce the average productivity which is too high from a social perspective. This problem resembles closely the "tragedy of the commons", as individual firms do not take into account the marginal costs of a reduction in the amount of available varieties when setting the optimal level of incentives. In the case of complete autarky, I therefore observe an unambiguous positive effect of contractual distortions on consumer welfare, although at the cost of higher industry costs. The effects on total welfare are dependent on the value of parameters in the model and is hence outside the scope of this thesis.

This thesis is closely related to the economic literature on incentive pay within the firm. It is well understood how incentive provision increases employee performance. Lazear (1996) provided the first tangible evidence that pay-for-performance plans increase employee productivity. Yet, the applicability and effectiveness of performance-related pay (PRP) to all organizations (Beer and Cannon, 2004) or even occupancies (Prendergast, 1999) has been contested. A manager's output is, generally spoken, hardly verifiable and difficult to measure. Distortions in performance measurement are found in a variety of situations (Kerr, 1975) and leads to potentially unwanted results. These problems also persist in cases where perfect performance measures are available, but managers have multiple tasks (Holmstöm and Milgrom, 1991). This paper supplements the mostly isolated literature on pay-for-performance and its distortions, by evaluating how distortions affect the outcome variables in a general equilibrium model.

A second theme to which this thesis relates is how competition influences managerial effort. Generally, economists agree that competition reduces managerial slack (Hart, 1983; Schmidt, 1997; Raith, 2003; Vives, 2008). Dependent on the size of the business stealing effect and the scale effect, incentives for managers are adjusted upwards or downwards respectively. Conditions under which the business stealing effect dominates the scale effect are reliant on the manner in which competition is stimulated. How foreign trade affects these dynamics has been researched by Yu (2012), where it is shown that opening up for trade monotonically increases incentives. Whether this result holds when firms experience contractual distortions, is examined here.

Lastly, this thesis follows closely the literature on trade-openness and the effect on firm-productivity. It has been shown that trade-openness reallocates resources from the least efficient to the most efficient firms in the industry in a variety of empirical studies (Tybout, 2003). Moreover, Bernard et al. (2006) show that not only do resources shift to the most efficient firms, but within-firm productivity is also raised when a county is exposed to foreign competition. One contributor to the increased firm-level productivity is found to be an increase in managerial incentives in medium to highly productive firms upon trade-openness (Tello-Trillo, 2015). Their findings are substantiated in this thesis. Within-firm productivity and managerial incentives are both found to increase when countries engage in trade. To what extent and under which conditions contractual distortions lower the *ex post* productivity of the firm and incentives for managers is something that will be discussed.

The remainder of this thesis will be as follows. In section 2, I will provide a more extensive summary of the related literature. Section 3 and 4 proceed with an adaptation of the model presented in Yu (2012) and its formal derivation. In section 5, I will examine how the introduction of an imperfect performance measure alters the results from the previous sections. Lastly, the conclusion is presented in section 6.

2 Related Literature

This section provides a comprehensive overview of the literature on incentives within organizations and the effect of distortions, competition and international trade on the optimal level of incentives. In the context of the firm, the need for economic incentives stems from the need to align the interest of owners and managers. In the classical principal-agent setting there exists a conflict of interest between the owner and the manager, caused by the separation of ownership and control. Whereas the owner is concerned with maximizing firm value, the manager is only interested in maximizing his own utility. Moreover, the owner is unable to perfectly observe the direct level of effort put forth by the manager, making it impossible to write a complete contract. The former gives an incentive for the manager to shirk at the costs of the owner. To reduce (or eliminate) managerial slack, the owner constructs an incentive contract, which rewards the manager based on *ex post* observed performance.

In the simple setting described above, it is optimal for the owner to offer a contract where the manager is appointed residual claimant in return for a fixed payment exactly equal to the manager's total costs. This "franchising" solution perfectly aligns the interests of the owner and the manager and hence eliminates any moral hazard issues. However, as Sappington (1991) mentions, this simple resolution depends heavily on the strong assumptions of risk-neutrality, similar precontractual beliefs and publicly observable output by the manager. These assumptions are fairly strong and do not necesarily represent most principal-agent relationships. In a survey of the literature by Prendergast (1999), a multitude of variations on the canonical principal-agent relationship including risk-sharing, subjective performance evaluation, relative performance evaluation, career concerns and efficiency wage effects is discussed. Although some models are highly stylized, they provide some valuable insights on the effectiveness of incentives under several different (distorted) scenarios.

Theoretically it has been shown that incentives do matter. Incentive contracts (in various forms) can resolve many issues arising from the conflict of interest between the principal and the agent. Yet, until the seminal paper by Lazear (1996), there was surprisingly little empirical evidence that incentive contracts are beneficial. At Safelite Glass Corporation in the U.S., a company specialized in (re)placing automobile windshields, Lazear observed an increase in worker output in the range of $20\% - 36\%$ when the company switched from a fixed wage to a piece-rate system. Half of the increase in productivity was shown to be driven by increases in average worker productivity and the other half by the ability to hire the most productive workers in the industry. Subsequent research has generally found supportive evidence on the positive effects of performance pay on employee productivity (see for instance Smoot & Duncan, 1997; Booth & Frank, 1999; Gerhart & Rynes, 2003; Atkinson et al., 2009; Lavy, 2010).

While incentive pay has proven to increase performance in settings where performance is easily verfiable, questions remain on the applicability of incentive pay in every setting. Prendergast (1999) suggests that more (empirical) research is required to determine how incentive pay influences workers who's output is not readily measurable. Lazear (2000) also acknowledges that rewarding managers according to a piece-rate plan will prove difficult as managerial performance is multifaceted and cannot be contracted upon. In addition to the difficulty of rewarding the manager appropriately, the immeasurable nature of managerial work also raises the potential risks of incentive pay. Wrongly designed incentive contracts can give rise to dysfunctional behaviour, as is convincingly argued by Kerr (1975). In his paper "On the folly of rewarding A, while hoping for B" he describes several contexts in which the reward of the agent is misaligned with expectation of the principal. More often than not this leads to rational, but dysfunctional behaviour by the agent. Fast and Berg (1975) describe an exemplary situation of how wrongly designed incentives can lead to undesirable behaviour. Management at the Lincoln Electric Company revoked an incentive plan that rewarded secretaries on the amount of key strokes they achieved within a given time frame. Reason for the abandonement of this incentive plan was the discovery that secretaries were found to tap the same key over and over during their lunch time.

Even in situations where good performance indicators are available, dysfunctional behaviour can arise if the agent has multiple tasks. Holmström and Milgrom (1991) were the first to formalize this incentive problem, which has become known as the multi-tasking problem. They consider a multi-dimensional principal-agent relationship where the agent can allocate his perfectly substitutable effort among a vector of equally important, but different tasks. When tasks are complementary in the agent's cost function, high powered incentives in only one task are still desirable. However, when tasks are subsitutes in the agent's cost function, rewarding the agent substantially for one task will reduce effort exertion in the other. Whenever this performance measure does not accurately reflect the performance of the manager, this dysfunctional effect is magnified. Hence, even when perfectly objective performance measures are available, it might be optimal for the owner to refrain from incentive pay.

Using an adapted version of the multitask-agency model by Holmström and Milgrom (1991), Slade (1996) empirically examines how differences between tasks affects the incentive scheme offered to agents in the gasoline retailing business. She exploits the fact that consumers view convenience stores as more complementary to gasoline stations than repair shops. She finds that gasoline stations with a convenience store as a secondary activity offer their employees higher-powered incentive contracts than gasoline stations where a repair shop is the second activity. Slade's (1996) results show that the the multitask-agency model has some empirical validity.

Although the multi-tasking model by Holmstöm and Milgrom (1991) has some explanatory power, the assumptions that the principal perfectly observes effort exertion and that effort is substitutable or complementary in the agent's cost function have been contested. Baker (1992) achieves similar results to that of Holmström and Milgrom (1991), using a state-contingent model, where effort need not be observable by the principal. He specifies a model where the marginal effect of effort on a performance measure (P_e) and a value function (V_e) is dependent on the state of the world. If the marginal products of effort on both P_e and V_e are highly correlated, the owner will set high incentives, because the performance measure accurately reflects true value added. Note that P_e and V_e are not necessarily equal. Important is only that P_e correctly corresponds to variations in V_e, where the variability of value added can be much higher as long as this does not affect the agent's actions. When P_e

does not correlate with V_e, the agent's effort choice does not match the principal's desired level of effort in most situations. Because it is expensive to provide incentives due to the agent's convex cost of effort function, the owner optimally sets lower incentives. Baker's (1992) results also extend to the case where the agent can allocate his effort among a vector of tasks.

In addition to incentivizing the wrong behaviour, rewarding managers based on a performance measure that does not accurately reflect performance also leads to dysfunctional behaviour. Baker (2002) asserts that it is not always possible to reward the agent according to the "correct" performance measure. Sometimes the performance measure is non-contractible (e.g. how to determine the objective of a non-profit organization?) or the performance indicator is unknown (what is the firm value of a non-publically traded company?). Baker (2002) shows that the owner optimally reduces the weight placed on performance measures that are more distorted. Intuitively, these performance measures tell the principal less about the true performance of the agent and are therefore not particularly useful. Distortions are the main reason why organizations refrain from incentives, even when there are many low-risk performance measures available to assess performance.

This thesis also relates closely to the literature on the effect of competition on the optimal level incentives. Leibenstein (1966) was one of the first to suggest that competition might be an important mechanism through which, what he called, *X-inefficiency* is reduced. X-inefficiency is a form of firm inefficiency largely driven by *motivational* or *incentive* inefficiency.[2] He concludes that monopolies experience X-inefficiency to a greater extent than firms which operate in a perfectly competitive market, which provides suggestive evidence that competition reduces managerial slack.

Jensen and Meckling (1976) discard the X-inefficiency argument, mentioning that both the owner of a monopoly and a competitive firm have equal incentives to reduce agency costs. Holmström (1982) shows that competition per se does not reduce agency costs, but can be used as a device to optimally use all information available. Evaluating agents relative to each other (and hence create within-firm competition for higher compensation), allows the principal to extract meaningful information on the state of the world. Lazear and Rosen (1981) show that this intuition holds under different conditions and assumptions.

Nalebuff and Stiglitz (1983) argue that product market competition can also provide the owner with additional information on the performance of the manager. When the cost functions of firms are correlated (i.e. they operate in the same environment) and firm's profits are perfectly observable, competitive firms are forced to exert the correct amount of effort or

[2] Which stems mostly from the inability to align the interests of the owner and manager as described previously.

otherwise be forced out of the market. A monopoly does not face these competitive forces and hence enables the manager to extract rents from the relationship whenever the state of nature allows him to.

In addition to providing additional information, Hart (1983) asserts that the market mechanism itsself acts as an incentive device. Moreover, the information required by the models in Holmström (1982), Lazear and Rosen (1981) and Nalebuff and Stiglitz (1983) is not always observable in reality, rendering competition as an information extraction mechanism useless. Hart (1983) develops a model in which managerial and entreneurial firms exist in the market. At the former, a manager is appointed to run the firm on behalf of the owner, whereas the latter is run by the owner himself. When firm's costs are unrelated,[3] the value of a cost reduction at a managerial firm can be completely absorbed by the manager through shirking, because it does not lead to an increase in the degree of product market competition. Yet, if firm's cost functions have common components, increased competitive pressure of entrepreneurial firms lowers the amount of managerial slack.

To achieve his results, Hart (1983) employs some strong assumptions. First, he assumes that managerial firms employ a production target, incentivizing the manager to work hard when productivity is low, but shirk whenever productivity is high. Second, the manager is assumed to be infinitely risk-averse and attach no value to income above some threshold. Scharfstein (1988) shows that when managerial preferences are specified differently, the effects of an increase in competition are ambiguous and can either be beneficial or harmful to the firm.

Hermalin (1992) provides more context on the situations in which incentives lead to desirable results. When the income-effect is relatively large compared to the change-in-information effect, risk adjustment effect and change-in-the-relative-value-of-actions effect, competition reduces the amount of managerial slack. In contrast to Nalebuff and Stiglitz (1983), he shows that when the former condition is not met, increasing the informedness of the principal does not necessarily lead to a reduction of agency costs. In cases where the cost reduction for the agent from switching to an easier action is larger than that of switching to a harder[4] action, increased informativeness leads to an increase in managerial shirking.

Contrary to the informational argument, Schmidt (1997) focuses on the threat of liquidation and the effect thereof on managerial slack. He finds that the threat-of-liquidation effect unambiguously decreases the costs of high-powered incentives as the degree of market competition rises. However, if the optimal incentive contract requires rents to be payed out

[3] Related cost functions refer to a situation where firms operate in a similar environment. Hence, when firm's cost functions are unrelated, firms operate in different environments.

[4] In Hermalin (1992), an "easy" action is similar to engaging in more shirking, whereas a "harder" action implies more effort exertion by the manager.

to the manager, the effect of increased competition remains ambiguous.

Treating the degree of market competition endogenously, Raith (2003) was able to shed light on the ambiguous predicitions provided by theory. Firms experience a *business stealing* and *scale effect*[5] which simultaneously increase and decrease the value of managerial effort. Whereas the former effect enhances the value of effort exertion because the elasticity of substitution has increased, the latter decreases it, because the residual demand of each individual firm shrinks. When the market structure is given, the outcome of the two effects is ambiguous, in line with the results found by Schmidt (1997). Yet, when the market structure is considered to be endogenous, the *business stealing effect* unambiguously dominates the *scale effect*. An increase in product substitutability drives down firm profits, forcing the least profitable firms out of the market until marginal profits are again zero. The residual demand for the surviving firms has increased, unequivocally raising the value of managerial effort, which results in a higher equilibrium level of incentives. When the degree of market competition is stimulated through a decrease in entry costs (and thus more firms enter the market), the opposite holds and firms will provide weaker incentives. Hence, whether or not managerial slack is reduced by (perfect) competition is therefore crucially dependent on how the market structure is embedded in the model.[6] These results were later supported in a more general model on firm innovation and competition by Vives (2008).

Early empirical research on this subject focused on the relationship between competition and firm productivity. Using data from a sample of 680 UK companies active during $1975-1986$, Nickell (1996) finds that total factor productivity growth of firms increases and the level of rents decreases in the degree of competition. Firms in a competitive industry experienced between 3.8% and 4.6% more productivity growth than firms that did not face similar levels of competition. These results were found to be robust to different specifications of competition. Repeating this research with data from 580 from the original 680 UK firms for the years $1982-1995$, Nickell et al. (1997) replicate the results by Nickell (1996), although the magnitude of effects has changed somewhat.[7]

Burgess and Metcalfe (2000) more closely investigate how incentive pay relates to the intensity of product market competition. Using the data from the extensive Workplace Employee Relations Survey (WERS) covering 2,191 British firms, they find a statistically significant relationship between competition and the presence of PRP. When industry ef-

[5] Similar to the change-in-relative-value-of-actions effect in Hermalin (1992).

[6] In a related stream of literature, Vickers (1985), Fershtman (1985), Fershtman and Judd (1987), Sklivas (1987) and Aggerwal and Samwick (1999) show that the type of competition should also be considered. They demonstrate that there exist strategic considerations in determining the optimal level of incentives when firms operate in an oligopolistic market.

[7] Relative to Nickel (1996) the reduction in rents is smaller.

fects are included, this significance disappears.[8] Although their paper provides suggestive evidence that competition serves an informational role, theory also predicts that incentives increase under a higher degree of market competition. Because the data did not include PRP sensitivities, it remained undetermined what the exact effect of competition is on managerial incentives.

Using equity based compensation Karuna (2007) estimates the pay-performance sensitivity of CEOs and changes therein caused by differences in product market competition. He finds that greater product substitutability, a larger market size, and lower entry costs are all associated with stronger incentives. Yet, how the degree of market concentration affects incentives remains ambiguous. Karuna's (2007) results confirm the multi-dimensional aspect of competition on incentives, as different specifications of competition have a different relationship with managerial incentives.

Cuñat and Guadalupe (2005) provide one of the first pieces of evidence that support causality between the degree of market competition and managerial incentives. Treating a sudden appreciation of the Pound Sterling in 1996 exogenously,[9] they demonstrate that the performance pay sensitivity of CEOs and directors increases when product market competition rises. Although the reported pay-for-performance sensitivity is trivial, the relative increase in sensitivity of 300% is statistically significant. Moreover, industries that were relatively shielded from increased foreign competition reported a lower increase in sensitivity than those industries that did not enjoy this protection.

In a subsequent paper on the subject, exploiting the deregulation in the financial industry in the U.S. during the 1990s, Cuñat and Guadalupe (2009a) confirm their previous results. The elimination of restrictions on interstate banking through the Gramm-Leach-Bliley Act[10] reduced the barriers to enter and thus increased competition in the banking sector. Using a difference-in-difference estimation, they find that the deregulation reduced the fixed component of compensation, while increasing the variable component and sensitivity to PRP. Combining the empirical and theoretical research on incentive provision and competition it appears there is strong evidence that the pay-for-performance sensitivity increases in the degree of product market competition.

The last strand of literature to which this thesis relates is to that on the effect of globalization on firm-productivity and incentives. In his work-horse general equilibrium model, Krugman (1979) shows that scale economies are a major driver of international trade. Un-

[8] Burgess and Metcalfe (2000) mention that this is not necessarily an issue, as industry effects and competition are themselves highly correlated.

[9] This appreciation of the pound is viewed as a proxy for a positive shock in the degree of market competition, as it makes the British market more attractive for foreign firms.

[10] This Act revoked previous legislation on the separation of banking, insurance and securities underwriting.

der the assumptions of increasing returns to scale and monopolistic competition, Krugman (1979) finds that different factor endowments are not necessarily required to increase overall welfare through trade. Adding firm heterogeneity, Melitz (2003) proves that firms with different productivity levels can coexist in the same industry, because they *both* face initial uncertainty about their *ex post* productivity before incurring substantial entry costs. In equilibrium, only the most productive firms will decide to engage in international trade, after having observed their realized productivity.

In a similar model to that of Melitz (2003), Bernard et al. (2003) find empirical evidence that reconciles with the empirical observations that firms experience considerable productivity differences. His model is able to explain the observations that exporting firms are more productive on average and are also significantly larger than purely domestic firms. In a survey on the empirical evidence of firm-level productivity, there appears to be a general consensus that foreign competition reallocates profits from inefficient to the most efficient firms (Tybout, 2003).

Bernard et al. (2006) demonstrate that a reduction in trade costs not only realizes a shift of resources to the most efficient firms, but also raises within-firm productivity of the surviving firms. They find a statistically significant negative relationship between plant-level productivity and industry-level trade costs, which indicates that firm-level productivity increases with trade-openness. More recently, economists attributed part of this within-firm productivity gains due to foreign competition to increased managerial incentives and competition. Wu (2011) develops a model in which he shows the effects of globalization on the provision of incentives within the firm. Interestingly, within-firm productivity is a major determinant of whether firms will increase or decrease incentive pay for managers. Similar to the *business stealing* and *scale effect* in Schmidt (1997) and Raith (2003), for the most productive firms, the former dominates the latter which increases the value of managerial effort. For the least productive firms, the opposite holds, making it too costly for these firms to maintain a high level of incentive pay. The subsequent effects on firm productivity are significant, further increasing productivity of the most efficient firm, whilst reducing the productivity of the least efficient firms. Yu (2012) shows that there might exist causality in this relationship, where trade-openness increases the value of managerial effort regardless of initial productivity. Moreover, he emphasizes that the type of trade liberalization also affects managerial incentives. Whereas a reduction in variable trade costs unambiguously increases the value of managerial effort, a reduction in fixed trade costs can have a negative effect on managerial incentives.[11]

Tello-Trillo (2015) is the first to provide empirical evidence on the connection between

[11] Note that this result resembles closely the observations by Raith (2003).

firm-level productivity gains and managerial effort. She finds that firms that are initially relatively unproductive will, after the economy opens up for trade, set lower incentives. On the contrary, firms of medium and high initial productivity will increase incentives, where the former shows the largest increase in managerial incentives. Tello-Trillo's (2015) results are remarkably similar to those of Wu (2011), yet run opposite to the results found by Yu (2012) where effort monotonically increases in the degree of (trade-induced) market competition. Their different findings are driven by diverging assumptions on the timing of events. Whereas Tello-Trillo (2015) and Wu (2011) assume the effort decision by the manager takes place after the marginal cost realization stage, Yu (2012) assumes this decision occurs before marginal costs are realized. Tello-Trillo's (2015) empirical results show that stronger managerial incentives induced by trade-openness explain around $13\% - 16\%$ of firm-level and $5\% - 8\%$ of aggregate productivity growth in the U.S. over the period $1993 - 1998$. Additionally, Cuñat and Guadalupe (2009b) empirically show that increased import penetration leads firms to include more performance pay in their manager's contracts and that the sensitivity of pay for performance increases. They conclude that as firms experience a higher degree of foreign competition, they demand more talent and are more "willing" to compensate talented managers for increased effort exertion.

Although recently the effects of increased (international) competition on managerial incentives have received more and more attention, it has not yet been examined how distortions in performance measures affects the equilibrium outcomes of models such as that of Yu (2012). In the following, I will examine how contractual distortions in the principal-agent relationship change the derived conditions in an adapted version of the model by Yu (2012).

3 Closed Economy

In this section, I will follow mostly the model of Yu (2012) and present some of his key insights. This serves the purpose of providing a good basis of comparison for the situation in which I present my extension. The model by Yu (2012) builds largely on the intra-industry trade model by Melitz (2003). Moreover, it incorporates a principal-agent relationship between the owners of the firm and the manager, as represented in Schmidt (1997) and Raith (2003). The timing of events is as follows. In stage I, each firm decides whether to enter the industry and pay a fixed cost of entry, representing the investment costs of setting up production facilities. Then, in stage II, the principal of the firm designs an incentive contract to induce managers to undertake marginal cost reducing effort. Upon accepting the contract, the manager decides on the optimal level of effort, after which firm-level marginal costs are realized and become publically observable. In stage III, firms set prices and quantities to optimize their profits, given *realized* marginal costs. In the following, I will solve the model by backwards induction, providing more details and insights of every stage in the following.

3.1 Production and Demand

In the standard trade model à la Melitz, consumer preferences are assumed to represent CES utility

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

where $\omega \in \Omega$ represents the mass of varieties available to the consumer and σ is the elasticity of substitution between varieties. Consumer utility is assumed to be equal to consuming the aggregate product $Q \equiv U$ with price index:

$$P = \left[\int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}} \tag{2}$$

Solving for the optimal demand per variety gives us

$$q(\omega) = \left(\frac{p(\omega)}{P} \right)^{-\sigma} \frac{R}{P} \tag{3}$$

where R $(= PQ)$ is aggregate spending and $p(\omega)$ the price each a firm charges for each variety ω. I assume that a continuum of firms each produces a unique variety ω. Moreover, labour is the only factor of production, which is inelastically supplied at mass L. The production function is characterized by increasing returns to scale with a total cost function: $TC_i = w\left(f_e + \frac{q(\omega)}{\varphi(\omega)}\right)$, where $\frac{q(\omega)}{\varphi(\omega)} \equiv c_i$ represents the marginal costs of production, w is the common wage rate, $\varphi(\omega)$ is firm specific productivity, f_e the one-time investment cost of production expressed in labour units, and subscript i represents the individual firm. The former allows us to specify the profit function of the individual firm:

$$\pi_i = p(\omega)q(\omega) - w\left(f_e + \frac{q(\omega)}{\varphi(\omega)}\right) \tag{4}$$

Taking the first order condition of (4) w.r.t. $p(\omega)$ yields the optimal price an owner will charge for variety ω:

$$p(\omega) = \frac{\sigma}{\sigma - 1} \frac{w}{\varphi(\omega)} \tag{5}$$

Proof. See Appendix A. ■

By substituting (3) and (5) into (4) the profit function of the firm can be rewritten to

$$\begin{aligned} \pi_i &= \frac{R}{\sigma} \left(\frac{\sigma}{\sigma - 1} \frac{w}{\varphi(\omega)} \right)^{1-\sigma} P^{\sigma-1} - f_e \\ \Leftrightarrow \pi_i &= B c_i^{1-\sigma} - f_e \end{aligned} \tag{6}$$

where

$$B = \frac{R}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}P^{\sigma-1}, \text{and } \varphi(\omega) = \frac{1}{c_i} \tag{7}$$

Similar to Yu (2012), B is an exogenously given inverse measure of the degree of market competition in a given industry. Intuitively, a higher B is associated with a lower value of P, which implies that expected firm profits are lower, corresponding with fewer firms entering the industry and hence less competion. Moreover, similar to the intra-industry trade model by Melitz (2003), productivity is assumed to have a negative relationship with per unit marginal costs following $\varphi_i = \frac{1}{c_i}$. As such, I assume that a reduction of firm-level marginal cost is the only measure to the firm's disposal to increase profits.

3.2 The Optimal Incentive Contract

In stage II, each principal hires an identical manager who exerts effort to realize production and marginal costs of the firm. Where the model departs from the standard model à la Melitz, is that productivity, and hence marginal costs, is endogenously determined by the level of effort e_i exerted by the manager. Moreover, there exists a moral hazard problem. Effort is not directly observable by the principal and the outcome of e_i is uncertain due to a random influence α_i on marginal costs c_i. This random influence reflects inherent technological differences in the initial productivity of firms. In assumption 1, the relationship between effort and marginal costs is presented.

Assumption 1 $c_i = \frac{\alpha_i}{\kappa e_i}$, where $e_i \in [0, \infty)$, $\kappa \in [0, 1]$ is a variable that specifies the effect of effort on the realization of c_i, and α_i is an i.i.d. distributed variable with cumulative distribution function $F(\alpha)$.

For expositional ease and without loss of generality, I assume that $\kappa = 1$ in section 3 and 4. Assumption 1 implies that c_i is i.i.d. distruted along the cumulative distribution function $G(c_i; e) = F(\kappa e \alpha)$. Since it holds that $\varphi_i = \frac{1}{c_i}$, it is easy to verify that productivity increases in the amount of effort e_i exerted by the manager. I assume that both the owner and the manager are risk-neutral. Moreover, where Yu (2012) follows the assumption of limited liability, I will allow the manager's wage to become negative. The main purpose of eliminating the notion of limited liability is to perform comparative statics when I introduce distortions in the performance measure in section 5.

The owner's pay-off function equals $\Pi_i = \pi_i - W_i$, where W_i denotes the payment to the manager. It is assumed that the utility of the owner solely depends on the profits made by the firm, i.e. $\Pi_i \equiv U_P$, where index P denotes the owner. The utility function of the manager is represented by $U_M = W_i - C(e_i)$, where index M denotes the manager and $C(e)$ represents the disutility of providing effort, with $C'(e_i) > 0$, $C''(e_i) > 0$ and $C(0) = 0$.

Since there exists a moral hazard problem, the owner must motivate the manager to exert effort. To accomplish effort exertion by the manager, the owner devices an incentive contract dependent on *ex post* marginal costs c_i, following

$$W_i = s_i + b_i \left(\frac{\overline{\alpha}_i}{c_i} \right) \tag{8}$$

where s_i is the fixed wage payment, $\overline{\alpha}_i \equiv E(\alpha_i)$ and b_i represents the incentive pay component of the manager's wage. Since $\overline{c}_i \equiv E(c_i) = \frac{\overline{\alpha}_i}{e_i}$, the expected wage of the manager is equal to

$$E(W_i) \equiv \overline{W_i} = s_i + b_i e_i \tag{9}$$

The owner 's expected pay-off is given by

$$E(\Pi_i) \equiv \overline{\pi}_i - \overline{W_i} \tag{10}$$

where, using (6), we can write $\overline{\pi}_i$ as

$$\overline{\pi}_i = \int_0^\infty \pi_i(c) dG(c; e) = BV(e) - f_e \tag{11}$$

with $V(e) = \int_0^\infty c^{1-\sigma} dG(c; e)$. Formal derivation starts with the decision by the manager, which optimizes effort exertion for a given s_i and b_i (index i surpressed hereafter). Given the level of effort chosen by the manager, the owner optimally chooses an s and b that will maximize his pay-off:

$$\max_{s,b,e} \{E(U_P) = \overline{\pi} - \overline{W}\} \tag{12}$$

Subject to:

$$\textbf{IC} \quad e \in \arg\max_e \{E(U_M) = \overline{W} - C(e) = s + be - C(e)\} \tag{13}$$

$$\textbf{PC} \quad \overline{W} - C(e) = s + be - C(e) \geq U_{out} \tag{14}$$

where U_{out} is the outside utility of the manager, known to both the owner and manager. To ensure that the optimization problem has an internal solution, I impose the following assumption:

Assumption 2

$$\frac{C''(e)}{C'(e)} > \frac{V''(e)}{V'(e)}$$

Solving the former by backwards induction gives us the optimal level of effort by the manager and contract choice for the owner, which is summarized by Lemma 1.

Lemma 1 *Under assumptions* $1-2$*, for a given* B*, the first-best level of effort by the manager in the closed economy* $\left(e^{FB}\right)$ *is determined by*

$$BV'(e^{FB}) = C'(e^{FB}), \quad \textit{\textbf{(Optimal Incentive (OI))}} \tag{15}$$

where the optimal contract choice is

$$b^* = C'(e^{FB}), \qquad s^* = U_{out} - e^{FB}C'(e^{FB}) + C(e^{FB}) \tag{16}$$

and total expected managerial compensation is given by $\overline{W} \equiv D(e^{FB}) = U_{out} + C(e^{FB})$*.*

Proof. See Appendix B. ■

Lemma 1 demonstrates that, at the first-best level of effort, the owner effectively "sells the store" to the manager. By making the manager the residual claimant in the relationship, the owner perfectly aligns his interests with those of the manager. In return for letting all profits from business flow to the manager, the owner requires a "fee", which is resembled here by s^*, implying that at the first-best level of effort $s^* < 0$. Optimally, the owner sets s^* such that the owner is just indifferent between accepting the contract or going for his outside option.

Looking more closely at (15), we see that competition has a negative relationship with effort and, therefore, the amount of incentives.[12] When the degree of market competition drops (i.e. B rises), the total marginal benefits of effort increase. Consequently, the value of managerial effort has suddenly risen for the owner and he will want the manager to exert more effort. To induce additional effort exertion, the owner has to provide more incentives to the manager. Optimally, the owner increases b to the level at which the **OI** as per (15) holds again; i.e. total marginal benefits are again equal to total marginal costs.

3.3 General Equilibrium

Finally, we consider stage I, where the owner decides whether to enter the industry or not. Readers familiar with the standard Melitz model, might notice that I do not consider the case where firms exit the market directly after entering. In defining the general equilibrium, I follow Yu (2012) by abstracting away from the Zero-Profit Cut-Off Condition (**ZCP**). The **ZCP** ensures that only firms that have positive expected profits after entry stay in the market, whereas the firms that expect negative profits will leave the market before production. The main reason for firms to exit the industry immediately after entry is that although the *ex ante* expectation of profits can be positive, after entry they are allocated an α on the upper scale of the distribution, making *ex ante*[13] profits negative for a given e^{FB}.

[12] Note that because of assumption 2, e^{FB} is increasing in B since it holds that $\frac{\partial B}{\partial e} = \frac{C''(e)V'(e)-C(e)V''(e)}{[V'(e)]^2} > 0$.

[13] Note that *ex ante* here means before production, not before entry.

In the setting examined here, I assume that all firms will decide to produce upon entry. This assumption simplifies the general model, while not changing any of the qualitative results.[14]

In addition to assuming that firms will produce after entry, I assume that there is an unbounded mass of prospective owners who are willing to enter the market. This Free Entry Condition (**FE**) assures that owners are free to enter the market and will continue do so until the expected pay-off from entry is driven to zero:

$$E(\Pi) \equiv BV(e) - f_e - \overline{W} = 0 \tag{17}$$

which can be rewritten to:

$$BV(e) = D(e) + f_e \tag{18}$$

Substituting (15) into (18) will yield an equilibrium level of effort e for which holds:

$$J(e) \equiv \frac{C'(e)}{V'(e)} V(e) - D(e) = f_e \tag{19}$$

Where it can be shown that $J'(e) \geq 0$, $J(0) = 0$ and $\lim_{e \to \infty} J(e) = \infty$, implying there exists a unique internal solution for e^{FB}. The former can be summarized by proposition 2.

Proposition 2 *Under assumptions* $1 - 2$*, for a given* B*, there exists a unique industry equilibrium level of effort in the closed economy, where firms enter the market if*

$$BV\left(e^{FB}\right) = D\left(e^{FB}\right) + f_e \tag{20}$$

and where the optimal contract choice is given by (16)*.*

Proof. See Appendix C. ■

Proposition 2 shows the market condition for which the individual firms decide to enter the market, given that they will have to provide incentives as shown in Lemma 1. This condition shows that the equilibrium value of B is determined by e^{FB}, making B an implicit function of e^{FB}. Moreover, since e^{FB} also determines the equilibrium level distribution of marginal costs, we can write all aggregate variables as functions of e^{FB}.[15]

$$\begin{aligned}
M &= \frac{R}{\sigma BV(e^{FB})} && (21)\\
R &= \sigma MBV(e^{FB}) && (22)\\
P &= \left(\frac{B}{\frac{R}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}}\right)^{\frac{1}{\sigma-1}} && (23)\\
\bar{c} &= \int_0^\infty c dG(c; e^{FB}) = \left(e^{FB}\right)^{-1} \int_0^\infty \alpha dF(\alpha) && (24)\\
U &= \left(\frac{\left(\frac{\sigma}{\sigma-1}\right)^{\sigma-1}}{\sigma B}\right)^{\frac{1}{1-\sigma}} R^{\frac{\sigma}{\sigma-1}} && (25)
\end{aligned}$$

[14] Yu (2012) also examines the situation in which a fraction of firms exits the market directly after entering, which added significant mathematical complexity, but did not change the qualitative results.

[15] See Appendix D for derivations.

Inspecting (21) – (25) yields some interesting insights. An increase in the equilibrium level of effort, decreases industry costs, number of firms (and hence varieties) and consumer welfare, but increases the price index and total income. It seems rather counterintuitive that, although the total industry costs of the market decrease, the aggregate price increases. As we would expect, a higher level of managerial effort reduces firm-level marginal costs (i.e. increases productivity), lowering the price of all firm varieties, and hence the aggregate price (business stealing effect). Yet, because the productivity of incumbents has increased, competition in the market has increased forcing out the least productive firms. Moreover, the market has become less attractive for potential entrants. Over time these two forces leads to a reduction of varieties and a higher price index (scale effect). In equilibrium, the scale effect dominates the business stealing effect, implying that although the surviving firms are more productive, the total number of varieties and consumer welfare decrease. As Yu (2012) notes, this result runs contrary to the results shown in the traditional model by Melitz (2003), where consumer welfare monotonically increases with firm-level productivity.

4 Open Economy

I now examine the case where the closed economy opens up for trade. Again, this section will mostly follow Yu (2012), to provide context for later extensions. The addition of foreign trade somewhat alters the timeline specified previously. Stage I and II remain unchanged in the open economy case. Yet, before firms decide on the optimal price and quantity in stage IV, they decide whether or not to export their products in stage III. Before we derive the equilibrium variable outcomes, it is first demonstrated how the profit function of the individual firm is altered by the introduction of foreign exports.

4.1 Adjusted Production Function

In the global market where firms operate, I assume that there exist $m+1$ identical countries. The former implies that the wage rate, price index and total income is equal across countries. Moreover, exporting firms incur both a fixed cost of entering into the export market, denoted by f_x and a variable trade cost τ, similar to Samuelson's (1954) notion of transport costs.

Because these trade costs are borne at the product-level, firms that export will have to charge different prices for the products they export than those they sell in the domestic market. The optimal pricing rule for exporting firms is derived from the following adjusted profit function:

$$\pi = p(\omega)q(\omega) + p_x(\omega)q_x(\omega) - w\left[f_e + \frac{q(\omega)}{\varphi(\omega)} + m\left(f_x + \frac{q_x(\omega)}{\varphi(\omega)}\tau\right)\right] \tag{26}$$

where index x denotes exports and m the amount of countries a single firm exports to. Taking first order conditions w.r.t. $p_x(\omega)$ yields the following optimal pricing rule for export products:

$$p_x(\omega) = \frac{\sigma}{\sigma - 1} \frac{w}{\varphi(\omega)} \tau \tag{27}$$

Similar to the autarky situation, we can derive export quantities:

$$q_x(\omega) = \left(\frac{\sigma}{\sigma - 1} \frac{w}{\varphi(\omega)} \tau \right)^{-\sigma} \frac{R}{P^{1-\sigma}} \tag{28}$$

Moreover, using (6), we can rewrite the profit function given by (26) to represent

$$\pi = Bc^{1-\sigma} \left(1 + m\tau^{1-\sigma}\right) - f_e - mf_x \tag{29}$$

where the additional profits of exporting to m countries equals:

$$\pi_x = m \left[B \left(\tau c\right)^{1-\sigma} - f_x \right] \tag{30}$$

Although the market has opened up for exports, not every firm will be able to export. Because exporting firms will have to incur additional fixed costs to enter the export market and a per unit variable trade cost, it is only profitable for firms below some threshold value of c to export. Therefore, there must exist some upper threshold value of c, denoted by c_x which must satisfy:

$$\pi_x(c_x) = 0 \Leftrightarrow c_x = B^{\frac{1}{1-\sigma}} \Phi^{-1} \tag{31}$$

where $\Phi \equiv f_x^{\frac{1}{\sigma-1}} \tau$ represents the costs of trade. Firms with $c < c_x$ will export to all countries, whereas firms with $c \geq c_x$ will remain completely domestic.[16] Firm-level profit can be summarized by the following system of equations:

$$\pi(c) = \begin{cases} \pi_d(c) = Bc^{1-\sigma} - f_e, & \alpha \geq \alpha_x \\ \pi_d(c) + \pi_x(c) = Bc^{1-\sigma}(1 + m\tau^{1-\sigma}) - f_e - mf_x, & \alpha < \alpha_x \end{cases} \tag{32}$$

where index d, denotes the domestic profits. The former implies that total expected profits per firm equals:

$$\overline{\pi} = \int_0^\infty \pi_d(c) dG\left(c; e\right) + \int_0^{c_x} \pi_x(c) dG(c; e) = BV(e) + Y(B, e, \tau, f_x) - f_e \tag{33}$$

where the additional profit from trade is given by:[17]

$$Y(B, e, \tau, f_x) = mf_x \int_0^{ec_x} \left[\left(\frac{e}{\alpha} c_x \right)^{\sigma-1} - 1 \right] dF(\alpha) \tag{34}$$

[16] Note that firms with $c = c_x$ are actually indifferent between exporting to all countries or remaining completely domestic.

[17] Using (27) and (28), we derive that $\int_0^{c_x} \pi_x(c) dG(c; e) = \int_0^{c_x} m \left[B \left(c\tau\right)^{1-\sigma} - f_x \right] dG(c; e) = mf_x \int_0^{ec_x} \left[\left(B \left(\frac{\alpha}{e}\right)^{1-\sigma} \phi^{1-\sigma} \right) - 1 \right] dF(\alpha) = mf_x \int_0^{ec_x} \left[\left(\frac{e}{\alpha} c_x \right)^{\sigma-1} - 1 \right] dF(\alpha)$.

Similar to in the closed economy case, we can now derive the optimal contract design by substituting (33) into (12), subject to (13) and (14). To ensure an internal solution to the problem, I make the following assumption:

Assumption 3

$$\frac{\partial\left[Y_e(B,e,\tau,f_x)/V'(e)\right]}{\partial e} < \left(\frac{C'(e)}{V'(e)}\right)' \tag{35}$$

Under analogous reasoning as in the closed economy case and under assumptions $1-3$, the optimal level of effort and contract choice is provided in Lemma 3.

Lemma 3 *Under assumptions $1-3$, for a given B, the first-best level of effort by the manager in the open economy $\left(e_O^{FB}\right)$ is determined by*

$$BV'(e_O^{FB}) + Y_e(B, e_O^{FB}, \tau, f_x) = C'(e_O^{FB}), \qquad \textbf{\textit{(OI)}} \tag{36}$$

where the optimal contract choice is given by

$$b^* = C'(e_O^{FB}), \qquad s^* = U_{out} - e_O^{FB}C'(e_O^{FB}) + C(e_O^{FB}) \tag{37}$$

and total expected managerial compensation by $\overline{W} \equiv D(e_O^{FB}) = U_{out} + C(e_O^{FB})$. Moreover, $e_O^{FB} > e^{FB}$.

Proof. See Appendix E. ■

Comparing Lemma 3 with Lemma 1, we see that the total marginal benefits for the firm have increased in moving to an open economy. However, total marginal costs have remained constant. Hence, for a given B, it is optimal for the owner to set a higher level of incentive pay when the country opens up for trade. This leads to an effort exertion by the manager e_O^{FB}, where $e_O^{FB} > e^{FB}$ and index O denotes the open economy.

4.2 General Equilibrium

We now turn to examining the **FE** condition in an open economy. What is new here, is that firms will take into account the additional expected profits from potentially exporting. The **FE** therefore becomes:

$$E(\Pi) \equiv \overline{\pi} - \overline{W} = BV(e) + Y(B, e, \tau, f_x) - f_e - D(e) = 0 \tag{38}$$

Similar to the case of the closed economy, there exists a unique level of e_O^{FB}, determined by the **FE** and **OI** in equilibrium. Substituting (36) into (38) gives:

$$Z(B, e, \tau, f_x) \equiv J(e) + H(B, e, \tau, f_x) = f_e \tag{39}$$

where $H(B, e, \tau, f_x) \equiv Y(B, e, \tau, f_x) - \left(\frac{Y_e(B,e,\tau,f_x)}{V'(e)}\right) V(e)$. It can be shown that $Z_e(B, e, \tau, f_x) \geq 0$, $Z(B, 0, \tau, f_x) = 0$ and $\lim_{e\to\infty} Z(B, e, \tau, f_x) = \infty$. Proposition 4 summarizes the former:

Proposition 4 *Under assumptions* $1-3$*, for a given* B*, there exists a unique industry equilibrium level of effort in the open economy, where firms enter the market if*

$$BV(e_O^{FB}) + Y(B, e_O^{FB}, \tau, f_x) = D(e_O^{FB}) + f_e \tag{40}$$

and where the optimal contract choice is given by (37)*.*

Proof. See Appendix F. ■

The effects of trade-openness are two-fold. From Lemma 3, we know that opening up for trade increases managerial effort $\left(e_O^{FB} > e^{FB}\right)$ for a given degree of market competition, because incumbent firms set higher incentives (business stealing effect). Additionally, in the open economy, more firms are willing to enter the industry due to the increased *ex ante* expected benefits from potentially engaging in the export market. On the other hand, the increased productivity of incumbents and the raised degree of market competition also forces the least efficient firms out of the market, over time reducing the degree of market competition (scale effect). Moreover, exporting foreign firms bring their varieties to the domestic market, further reducing the survival probability of inefficient domestic firms. Hence, we see that trade-openness magnifies both the business stealing effect and the scale effect. In an autarkical economy, it has been demonstrated that the scale effect dominates the business stealing effect. In the open economy, which effect dominates is more ambiguous and depends on whether or not the gains from trade are sufficiently large, which is captured by the following condition:

$$\frac{Y(B, e_O^{FB}, \tau, f_x)}{D(e^{FB})} > \frac{D(e_O^{FB})}{D(e^{FB})} - \frac{V(e_O^{FB})}{V(e^{FB})} \tag{41}$$

Eq. (41) states that when the *ex ante* expected gains from trade are larger than the *ex ante* expected costs associated with the increased level of equilibrium effort, the average firm will decide to enter the industry with the expectation that it will be able to profitably export its products. In the following, I will refer to this condition as the Sufficient Gains from Trade condition **(SGT)**. When the **SGT** holds, trade-openness lowers the barriers to enter the industry such that in equilibium the business stealing effect dominates the scale effect. This implies that firms become more productive and the degree of market competition increases, because of the entrance of firms in the market $(B_O < B)$.[18] When the **SGT** does not hold, opening up for trade complements the scale effect. Potential entrants observe an increased productivity of incumbents, which is not outweighed by the expected potential benefits of engaging in the export market. Over time, the increased productivity of incumbents and foreign competition also force out the least efficient firms. Combined with the increased barriers to entry, the former leads to a lower degree of market competition $(B_O > B)$. Note that the **SGT** becomes more stringent when the given level of incentives increases, because

[18] Note that $B_O = \frac{D(e_O^{FB})+f_e-Y(B,e_O^{FB},\tau,f_x)}{V(e_O^{FB})} < \frac{D(e^{FB})+f_e}{V(e^{FB})} = B$, when the **SGT** holds.

the cost of effort function of the manager is convexly increasing in e, whereas firm profits are linearly increasing in e.

How does the addition of foreign trade influence the equilibrium values? The cut-off marginal cost as per (31) determines the fraction of firms that will export, which is given by $G(c_x) \equiv p_{ex}$. Rewriting (21), to include all exporting firms, we can express the number of firms and varieties (N) in the open economy as follows:

$$M = \frac{R}{\sigma BV(e_O^{FB})\left(1 + mp_{ex}\tau^{1-\sigma}\right)} \tag{42}$$

$$N = M\left(1 + mp_{ex}\right) = \frac{R}{\sigma BV(e_O^{FB})}\left(\frac{1 + mp_{ex}}{1 + mp_{ex}\tau^{1-\sigma}}\right) \tag{43}$$

All other aggregate variables are given by (22) $-$ (25), where the level of effort in the open economy is e_O^{FB}. Let us first examine the case where the equilibrium level of effort does not change.[19] First note that when the equilibrium value of managerial effort does not change, the **SGT** always holds, because $\frac{Y(B, e_O^{FB}, \tau, f_x)}{D(e^{FB})} > 0$ for $e_O^{FB} = e^{FB}$. Moreover, at this level of effort, the degree of market competition ($B_O < B$) and the number of firms in equilibrium is lower ($M_O < M$),[20] whereas the number of varieties in the market has increased ($N > M$). Intuitively, because the costs of providing incentives has remained stable, firm's *ex ante* expected profits have unequivocally increased due to trade-openness. Consequently, more firms are induced to enter the market, raising competition and the total amount of varieties. Yet, if more firms enter the industry, why does the amount of domestically active firms drop? Because the market is now open for foreign competitors, there will be some highly efficient foreign firms that are now able to export their products to the domestic market. These foreign competitors force some (unproductive) domestic firms out of the market. In equilibrium, the amount of foreign varieties brought to the domestic market outweighs the loss of varieties due to domestic firm death, raising aggregate consumer welfare ($U_O > U$).[21]

When the first-best level of effort in an open economy is greater than that in autarky, as per Lemma 3, the **SGT** might not hold. Dependent on the specific levels of effort e_O^{FB} and e^{FB}, the cost of higher incentives might outweigh the benefits from potentially exporting. First, we examine the case where the **SGT** holds and $e_O^{FB} > e^{FB}$. As mentioned, when the **SGT** holds, the business stealing effect dominates the scale effect and hence $B_O^b < B$, where superscript b denotes the situation where the business stealing effect dominates. Hence, even though productivity in the market has increased, the amount of firms willing to enter the

[19] The following result is similar to that of Yu (2012), where it is given that the owner optimally does not increase incentives due to the limited liability assumption.

[20] See Yu (2012) Appendix H for the proof that $B_O(1 + mp_{ex}\tau^{1-\sigma}) > B$.

[21] Since U decreases in B as shown in (24), if $B_O < B$, then it must be that $U_O > U$.

industry drives up the competition in the market sufficiently to realize a gain in consumer welfare compared to the closed economy. Analogous to the case where $e_O^{FB} = e^{FB}$, we therefore observe fewer domestic firms in the market $\left(M_O^b < M\right)$, more varieties $\left(N^b > M\right)$ and a higher equilibrium level of consumer welfare $\left(U_O^b > U\right)$.

Whenever the **SGT** does not hold and $e_O^{FB} > e^{FB}$, the *ex ante* expected costs of providing incentives is larger than the expected profits from exporting. In this case, the most efficient firms become even more productive, which forces more less efficient incumbents out of the market. Simultaneously, potential entrants shy away from the market. Both effects reduce the amount of market competition and hence we observe that $B_O^s > B$, where superscript s denotes the situation where the scale effect dominates. Because only the most productive firms survive in the market, we observe that $M_O^s < M_O^b < M$. Moreover, because fewer foreign firms find it profitable to export their products to the domestic market, the total amount of varieties decreases $(N^s < M)$ and aggregate consumer welfare is reduced $(U_O^s < U)$. Clearly, opening up for trade in this situation makes the country worse off.

How do these equilibrium values compare to those of Yu (2012), where the optimal level of managerial incentives remains constant? We know that through the scale effect, the barriers to enter are raised whenever the equilibrium level of effort is increased. It must therefore be the case that $B_O < B_O^b < B < B_O^s$. Consequently, we know that $M_O^s < M_O^b < M_O < M$, $N^s < M < N^b < N$ and $U_O^s < U < U_O^b < U_O$. It appears that Yu's (2012) results that trade-openness monotonically increases welfare crucially depends on the fact that the equilibrium value of managerial effort remains constant. Although consumer welfare still increases relative to the autarky situation when the **SGT** holds, the opposite is true when this condition is not met. Whether or not the marginal benefit of trade is larger than the costs of providing incentives depends on the specification of model parameters.

Thus far, we have assumed that the owner can perfectly observe the realized output of the manager, although there is some uncertainty about the effort exertion of the manager. Yet, as described in section 2, the output of a manager is not as easily measured as that of a line-worker (Prendergast, 1999). In the next section, I will introduce an imperfect measure of performance for the manager, to capture the fact that output is often not perfectly verifiable. How this distorted performance measure will impact the equilibrium conditions derived in sections 3 and 4 will be discussed in the following section.

5 The Case of Contractual Distortions

In this section, I turn to the main contribution of this thesis. Here, I assume that the owner is no longer able to perfectly verify *ex post* marginal costs and can only rely on a distorted performance measure to assess the performance of the manager. I assume that the manager can either engage in cost-reducing effort denoted by e or in some other task denoted by e_D, where index D indicates the distortion. Inputs of the manager are regarded as perfectly substitutable in the manager's cost function, assuring that rewarding effort e_D does not incentivize the manager to exert more effort e. The new distorted performance measure is defined by γ where the relation between *real ex post marginal costs* and *observed performance* is as follows:

Assumption 4 Let $c = \chi\gamma \Leftrightarrow \gamma = \frac{c}{\chi}$ represent the relationship between the employed performance measure and realized marginal costs, where $\gamma = \frac{\alpha}{\kappa e+(1-\kappa)e_D}$, $\kappa \in (0,1)$, and $\chi = \frac{\kappa e}{\kappa e+(1-\kappa)e_D}$ represents the actual noise in the performance measure..

Previously, I have adopted $\kappa = 1$ for expositional ease. In the current setting I assume $\kappa \in (0,1)$. The former eliminates the possibility that the performance measure perfectly corresponds to actual performance, as is the case when $\kappa = 1$. Moreover, $\kappa \neq 0$, as this would imply the performance measure does not measure performance at all. Consequently, the manager will always allocate some of his time to e_D, which gives rise to contractual inefficiencies. For sake of simplicity and without loss of generality, I assume that the cost of effort function for exerting e_D is equal to that of e; i.e. $C(e_D) = C(e)$.

How the manager chooses to allocate his effort among both tasks depends crucially on the factor κ. It is easy to derive that when $\kappa \to 1, \chi \to 1$, indicating that $\gamma \to c$ and no noise is present; i.e. the performance measure adequately represents *realized* marginal costs. However, when $\kappa \to 0$, $\chi \to 0$ which implies that $\gamma_i \ll c_i$, suggesting that the performance of the manager is greatly exagerated.

Although firms are heterogeneous with respect to the type of product they bring into the market, it is assumed that the degree of distortion is equal across firms in an industry. The main validation for this assumption is that firms which experience a high degree of distortions, will be unable to compete with firms which have a low degree of contractual distortions. Hence, in reality there will only be a narrow distribution of κ for which firms can survive in the domestic market. For expositional ease, I therefore assume that κ is equal across firms in an industry. I further assume that the extent of the distortion (i.e. the magnitude of κ) is known to both the owner and the manager. How the introduction of this "noisy" performance measure alters the results of section 3 and 4, will be demonstrated in the following section.

5.1 Closed Economy

Since the owner cannot contract upon *ex post* realized marginal costs, he incorporates the new distorted performance measure into the contract. Because the manager's pay-off is now dependent on the *ex post realized* value of γ and not on c, the wage of the manager is represented by:

$$W_D = s + b\left(\frac{\overline{\alpha}}{\gamma}\right) \tag{44}$$

where $E(\gamma) \equiv \overline{\gamma} = \frac{\overline{\alpha}}{\kappa e + (1-\kappa) e_D}$. Substituting $\overline{\gamma}$ into (44) then gives:

$$E(W_D) \equiv \overline{W}_D = s + b(\kappa e + (1-\kappa)\, e_D) \tag{45}$$

Analogous to the case without distortions, the owner faces an optimization problem where the optimal effort exertion by the manager is given. Formally, the problem of the owner is:

$$\max_{s,b,e}\{E(U_P) = \overline{\pi} - \overline{W}_D\}$$

Subject to

$$\textbf{IC} \quad e \in \arg\max_{e}\{E(U_A) = \overline{W}_D - C(e, e_D) = s + b(\kappa e + (1-\kappa)\, e_D) - C(e, e_D)\} \tag{46}$$

$$\textbf{PC} \quad \overline{W}_D - C(e) = s + b(\kappa e + (1-\kappa)\, e_D) - C(e, e_D) \geq U_{out} \tag{47}$$

where $C(e, e_D) = C(e) + C(e_D)$. Before formal derivation, I make the following simplifying assumption:

Assumption 5

$$\frac{C''(e)}{C''(e_D)} = \theta \tag{48}$$

where θ is normalized to 1 in the following.

Assumption 5 ensures that the ratio with which the disutility of effort on both tasks increases remains stable as the manager's effort decision changes. Solving for the optimal incentive through backward induction yields Lemma 5.

Lemma 5 *Under assumptions* $1-5$*, for a given* B*, the second-best level of effort by the manager in the closed economy* $\left(e^{SB}\right)$ *is determined by*

$$BV'(e^{SB}) = C'(e^{SB}) \times \frac{\kappa^2 + (1-\kappa)^2}{\kappa^2}, \qquad \textbf{\textit{(OI)}} \tag{49}$$

where the optimal contract choice is

$$b^* = \frac{C'(e^{SB})}{\kappa}, \qquad s^* = U_{out} - e^{SB}C'(e^{SB}) - e_D^*C'(e_D^*) + C(e^{SB}, e_D^*) \tag{50}$$

and total managerial compensation is given by $\overline{W} = D(e^{SB}, e_D^*) \equiv U_{out} + C(e^{SB}, e_D^*)$*. Moreover,* $e^{SB} < e^{FB}$*.*

Proof. See Appendix G ■

Comparing Eqs. (15) – (16) and (49) – (50), we see a clear impact of distorted performance measures on the optimal bonus and fixed wage. Relative to the case without distortions, the incentives the owner has to set to elicit a specific level of cost-reducing effort have increased. Moreover, as the performance measure gets more distorted (i.e. $\kappa \to 0$), the costs of incentives approaches infinity ($b \to \infty$).

Equation (49) shows that the marginal costs of providing incentives have increased compared to the **OI** as per (15). Intuitively, for each additional unit of e, the owner now also incentivizes the manager to exert e_D. Because the owner faces additional costs of providing incentives, the previous equilibrium level of incentives where $e = e^{FB}$ is no longer profitable. Consequently, the owner will reduce incentives to the level $e = e^{SB}$, where it holds that $e^{SB} < e^{FB}$. Note that the costs of eliciting an equal amount of managerial effort rises as the distortion increases. Hence, the owner optimally downwardly adjusts incentives as κ decreases, reducing the level of effort e^{SB}.

Knowing that the owner will reduce the optimal level of incentives when there exist contractual distortions, we need to determine under which conditions firms decide to enter the market. Analogous to the closed economy case, the **FE** is given by:

$$E(\Pi) = BV(e) - f_e - \overline{W} = 0 \tag{51}$$

Which can be rewritten to:

$$BV(e) = D(e, e_D) + f_e \tag{52}$$

To obtain the equilibrium level of e^{SB} we substitute (49) in (52), which gives

$$J(e, e_D) = \frac{C'(e) \times \frac{\kappa^2 + (1-\kappa)^2}{\kappa^2}}{V'(e)} V(e) - D(e, e_D) = f_e \tag{53}$$

where it can be shown that $J_e(e, e_D) \geq 0$, $J(0,0) = 0$ and $\lim_{e \to \infty} J(e, e_D) = \infty$, implying there exists a unique internal solution for e^{SB}. The former is summarized in proposition 6.

Proposition 6 *Under assumptions* $1-5$*, for a given* B*, there exists a unique industry equilibrium level of effort in the closed economy with distorted performance measures, where firms enter the market if*

$$BV(e^{SB}) = D(e^{SB}, e_D^*) + f_e \tag{54}$$

and where the optimal contract choice is given by (50).

Proof. See Appendix H. ■

How does the equilibrium with distortions compare to the equilibrium without distortions? From Lemma 5, we know that with distortions, the owner optimally sets incentives such that

$e^{SB} < e^{FB}$. Substituting the new level of effort into (21) − (25), we observe increased industry costs, a larger number of active firms ($M_D > M$) and higher consumer welfare ($U_D > U$). Yet, at the equilibrium level of effort e^{SB}, the price index and total income in the country is lower than under the first-best level of managerial effort. These effects run exactly opposite to the effects described in section 3.3, because here we consider a decrease in the equilibrium level of effort as opposed to an increase. Because owners now set lower incentives, firms become less efficient, which increases the price of all varieties (reversed business stealing effect). The increased variety price stimulates firms to enter the market and ensures the survival of somewhat less efficient firms (reversed scale effect). From an aggregate utility perspective, the latter effect dominates in equilibrium, implying that the addition of more varieties outweighs the utility loss of increased inefficiency at the firm-level. Additionally, because the amount of surviving firms in the market is higher at the second-best level of effort, we hence observe that $B_D < B$.

Because M and U monotonically increase in the amount of contractual distortions,[22] there exists a positive relationship between the amount of contractual distortions and the amount of firms and consumer welfare. Interestingly, the second-best level of managerial effort leads to better equilibrium outcomes in terms of consumer utility than does the first-best level of effort. The resemblence to what is known as "tragedy of the commons" is striking. Every firm decides in isolation to set an optimal level of incentives. In their decision, owners do not take into account the marginal costs of losing varieties from the market. Hence, at the first-best level of effort managers are over-incentivized,[23] which leads to a reduction of total varieties and a loss of consumer welfare due to firm-level productivity increases. However, when the individual firm is forced to employ a lower level of incentives the market becomes less "over-exploited", raising consumer welfare. How the results presented here are influenced by the introduction of foreign trade is discussed in the next section.

5.2 Open Economy

Formally, the optimization problem of the manager has not changed by introducing the possibility for firms to export and hence the **OI** is still given by (49). Moreover, distortions do not affect the *ex ante* expected profits from exporting. The owner's pay-off function is therefore still given by (10), where the *ex ante* expected profits are equal to (33). Optimizing the expected pay-off of the owner w.r.t e yields the optimal level of incentives in the open economy, which is summarized in Lemma 7.

[22] Note that M and U monotonically increase in the amount of contractual distortions, as they both decrease in κ.

[23] From the perspective of the social planner incentives are set too high. From the perspective of the individual firm, this is the optimal level of effort.

Lemma 7 *Under assumptions* $1-5$*, for a given* B*, the second-best level of effort by the manager in the open economy* $\left(e_O^{SB}\right)$ *is determined by*

$$BV'(e_O^{SB}) + Y_e(B, e_O^{SB}, \tau, f_x) = C'(e_O^{SB}) \times \frac{\kappa^2 + (1-\kappa)^2}{\kappa^2}, \quad \textbf{\textit{(OI)}} \tag{55}$$

where the optimal contract choice is given by

$$b^* = \frac{C'(e_O^{SB})}{\kappa}, \qquad s^* = U_{out} - e_O^{SB} C'(e_O^{SB}) - e_{D,O}^* C'(e_{D,O}^*) + C(e_O^{SB}, e_{D,O}^*) \tag{56}$$

and total managerial compensation is by $\overline{W} = D(e_O^{SB}, e_{D,O}^*) \equiv U_{out} + C(e_O^{SB}, e_{D,O}^*)$*. Moreover,* $e_O^{FB} > e_O^{SB} > e^{SB}$*.*

Proof. See Appendix I. ■

Analogous to the case without distortions, the total marginal profits of the firm increase relative to the autarky situation. In comparison to the first-best outcome in the open economy, the owner will set lower incentives. Because of the distortions, it is too costly to set incentives such that $e = e_O^{FB}$. Therefore, the owner reduces the optimal bonus and hence elicits a lower level of managerial effort $e = e_O^{SB}$, implying that $e_O^{FB} > e_O^{SB}$. As the amount of distortion increases, the second-best level of effort is lowered, because the owner further decreases incentives.

Whereas the second-best level of effort is lower than the first-best level of effort, compared to the autarkical economy with distortions, effort exertion has increased. The *ex ante* expected profits for the individual firm have increased, because there exists a possibility that the firm will be able to compete in the export market. The increased expected marginal benefits increases the slope of the profit function, consequently raising the value of managerial effort to the owner. Hence, the owner will increase incentives, thereby eliciting a level of managerial effort for which holds that $e_O^{SB} > e^{SB}$. To determine how the relative increase in the second-best level of effort influences the equilibrium, we need to evaluate how this affects the **FE** condition.

The **FE** in the open economy is similar to that specified in Eq. (52), where the difference lies in the addition of the expected profits from export. The **FE** in this situation is given by:

$$E(\Pi) \equiv BV(e) + Y(B, e, \tau, f_x) - D(e, e_D) - f_e = 0 \tag{57}$$

To ensure the optimization problem is globally concave and has an internal solution, I impose the following assumption:

Assumption 6

$$\frac{\partial \left[Y_e(B, e, \tau, f_x)/V'(e)\right]}{\partial e} < \frac{\partial \left[D'(e, e_D)/V'(e)\right]}{\partial e} \tag{58}$$

To determine whether there exists a unique equilibrium, we substitute the **OI** as per (55) in the **FE** as per (57), which yields:

$$Z(B, e, e_D, \tau, f_x) \equiv J(e, e_D) + H(B, e, \tau, f_x) = f_e \tag{59}$$

where $H_e(B, e, \tau, f_x) \equiv Y(B, e, \tau, f_x) - \left(\frac{Y_e(B,e,\tau,f_x)}{V'(e)}\right) V(e)$. It can be shown that $Z_e(B, e, e_D, \tau, f_x) \geq 0$, $Z(B, 0, 0, \tau, f_x) = 0$ and $\lim_{e\to\infty} Z(B, e, e_D, \tau, f_x) = \infty$, proving e_O^{SB} is unique. Proposition 8 summarizes the former.

Proposition 8 *Under assumptions* $1-6$*, for a given* B*, there exists a unique industry equilibrium level of effort in the open economy with distorted performance measures, where firms enter the market if*

$$BV(e_O^{SB}) + Y(B, e_O^{SB}, \tau, f_x) = D(e_O^{SB}, e_{D,O}^*) + f_e \tag{60}$$

where the optimal contract choice is given by (56)*.*

Proof. See Appendix J. ■

Because the "steepness" of the profit function has increased due to trade-openness, owners set higher incentives for their managers, resulting in a higher firm-level productivity (business stealing effect). Additionally, trade-openness causes the *ex ante* expected profits to increase, in turn causing more firms to enter the industry and thus raising the degree of market competition (scale effect). Parallel to the situation without distortions, which effect dominates under trade-openness, depends on whether the **SGT** holds. In an economy where firms face contractual distortions, the **SGT** is given by:

$$\frac{Y(B, e_O^{SB}, \tau, f_x)}{D(e^{SB}, e_D^*)} > \frac{D(e_O^{SB}, e_{D,O}^*)}{D(e^{SB}, e_D^*)} - \frac{V(e_O^{SB})}{V(e^{SB})} \tag{61}$$

In the case where the **SGT** holds, the gains from trade are such that the average firm will decide to enter the industry with the *ex ante* expectation that it will be able to export its products. When the **SGT** holds, the business stealing effect dominates the scale effect which causes the equilibrium level of market competition to increase $\left(B_{D,O}^b < B_D\right)$. Although we know that e increases in B (and hence would expect a decrease in the degree of market competition), the barriers to enter are lowered such that sufficiently many firms find it profitable to enter the industry, ultimately raising the degree of market competition.

When the gains from trade are too low the **SGT** does not hold. Trade-openness increases the value of managerial effort to the owner, because the firm might be possible to capture profits from overseas sales. This leads owners to set higher incentives, raising the productivity of each firm (business stealing effect). Potential entrants now experience an increased productivity of incumbents, lowering their *ex ante* expected profits from entry. Ultimately, the *ex ante* expected profits from potentially exporting do not outweigh the increased competition in the domestic markets and hence firms shy away from the market. Additionally, there are now also foreign competitors who force the least efficient firms out of the market (scale effect). Over time, this reduces the degree of market competition $\left(B^s_{D,O} > B_D\right)$, which eliminates any benefits from opening up the economy.

The equilibrium number of firms and varieties have not changed by introducing distortions and hence are still given by (42)−(43), where the level of effort equals e^{SB}_O. Moreover, all other equilibrium values are still given by (22) − (25), where $e = e^{SB}_O$. Comparing these values to those the equilibrium values in the autarkical economy, we observe that when the **SGT** holds, the number of domestic firms decreases $\left(M^b_{D,O} < M_D\right)$,[24] the number of varieties increases $\left(N^b_D > M_D\right)$ and consumer welfare increases $\left(U^b_{D,O} > U_D\right)$. When the gains from trade are not sufficiently large, the scale effect dominates the business stealing effect, which leads to a worsening of the equilibrium values. In this case number of firms $\left(M^s_{D,O} < M^b_{D,O} < M_D\right)$, the number of varieties $\left(N^s_D < M_D < N^b_D\right)$ and aggregate consumer welfare $\left(U^s_{D,O} < U_D < U^b_{D,O}\right)$ are brought down to lower levels than before opening up the economy. From the previous section we know that $U_D > U$, which must mean that $U < U_D < U^b_{D,O}$ when the gains from trade are sufficiently large. Whether or not trade-openness at the first-best level of effort yields higher consumer welfare than under the second-best level of effort depends on the exact specification of model parameters. Hence, I cannot definitively conclude that trade-openness is more or less desirable when the economy experiences a high degree of firm-level contractual distortions.

5.3 The Implication of Contractual Distortions

To what extent do contractual distortions change the dynamics compared to the case where distortions are not present? To determine the impact, we look more closely at the **SGT** for different levels of effort. We know that firm profits decrease linearly in e, whereas the wage of the manager decreases convexly in e. The former implies that the **SGT** is more easily satisfied as κ decreases (i.e. the degree of distortions increases), thereby increasing the likelihood that trade-openness will realize an increase in welfare. Consequently, countries which experience a high degree of contractual distortions are more likely to benefit from trade than countries which do not experience these distortions. The former is summarized by proposition 9.

[24] See footnote 21.

Proposition 9 *Under assumptions* $1-6$*, the importance of trade-openness increases in the amount of distortions present in the industry. That is, when* $e \to 0$*, in the extreme case where* $\kappa \to 0$*, the gains from trade significantly outweigh the costs of incentive provision at that level of effort, increasing the likelihood that aggregate consumer welfare will increase when the economy opens up for trade.*

Proof. We know that $Y(B, e, \tau, f_x)$ and $V(e)$ are linear and $D(e, e_D)$ is convex in e. That must mean that $\frac{Y(B,e,\tau,f_x)}{D(e,e_D)}$ decreases in e, whereas $\frac{D(e,e_D)}{D(e,e_D)} - \frac{V(e)}{V(e)}$ increases in e.[25] Therefore, as the owner sets lower incentives when the amount of distortion increases, as per Lemma 7, the **SGT** becomes less stringent. The former implies that the likelihood that the business stealing effect dominates the scale effect increases *ceteris paribus*, resulting in a higher equilibrium level of consumer welfare. ■

The intuition behind proposition 9,[26] is remarkably simple. Whenever an industry experiences a high degree of distortions, firms are more likely to enter the industry, because the overall survival rate is higher. If the economy opens up for trade, this leads incumbents to set higher incentives, thereby raising their productivity and deterring potential entrants. Although the increased level of incentives will decrease the survival rate, there still exists a large range of initial marginal cost levels for which a firm can profitably compete in the market. Hence, the level of effort associated with attaining a level of marginal costs which will ensure survival does not deter many firms from the market. Additionally, firms are potentially able to compete in the export market. The associated marginal benefits outweigh the marginal costs of setting incentives, which leads firms to enter the market. In cases where the average productivity of incumbents is already high, the *ex ante* survival probability is relatively low. Hence, there is only a small range of marginal cost levels for which firms can profitably operate in the market. Opening up for trade further reduces this range, eventually raising the barriers to enter such that no firm is willing to enter the industry, even though there exists the probability that a firm will be able to compete in the export market. There must therefore be a threshold value of industry productivity,[27] for which it is more likely that the business stealing effect dominates the scale effect, resulting in a welfare increase. When κ is relatively low, average industry productivity is low, increasing the likelihood that trade will result in a consumer welfare gain. Countries that experience a high degree of contractual distortions are therefore more likely to gain from trade than countries which do not have this level of contractual distortions.

[25] Note that the latter term only increases in e for diverging levels of effort and otherwise remains equal.

[26] Note that this proposition also holds when the equilibrium levels of effort do not diverge ($e_O = e$) as is the case in Yu (2012). When the equilibrium level of effort is decreased from e^{FB} to e^{SB}, the right-hand side of the **SGT** remains constant, whereas the left-hand side increases.

[27] Determined by both the distribution of c and the level of κ.

5.4 Heterogeneity of Management Practices

In the model presented above, I have made the assumption that the degree of contractual inefficiency was equal across firms in an industry, even though firms are assumed to be heterogeneous. Moreover, I have assumed that all countries have similar characteristics. Therefore, I have implicitly assumed that all firms across all countries experience the same degree of contractual distortions. Although it is reasonable to assume that the degree of contractual distortions within a country is relatively similar, for reasons mentioned in section 5.1, this is unlikely to hold for all firms across the globe. Bloom and van Reenen (2006) find strong evidence that management practices differ significantly between the U.S. and Europe, where firms from the U.S. are better managed on average. If significant differences in the quality of management between two "Western" regions exist, it is plausible that there exist larger differences between regions with different cultures and historical backgrounds. In this section, I will analyze the effects of heterogeneous management quality on the derived propositions and equilibrium outcomes.

Bloom and van Reenen (2006) mention that there are two general types of management practices models. The first type considers management practices as a choice variable for the firm. The second type assumes that differences in management practices correspond to variations in efficiency. The former would require substantial alterations in the presented model, whereas the latter is easily incorporated. Let good management practices be defined by an overall high degree of efficiency. A high degree of efficiency implies that the owners of the firm are able to adequately assess performance of the manager. Hence, good management practices correspond to a high degree of κ. The opposite holds for bad management practices, which corresponds to a low degree of κ.

I assume that the exact level of κ_j, where j denotes the individual country, is only observed by the principal upon entry, and hence cannot be taken into account in the decision on whether or not to enter the industry. All else equal, it should then be the case that firms in countries with good management practices are able to provide more incentives to managers than firms in countries with poor management practices (see Lemmas 5 and 7). In an isolated economy, increasingly better management practices can be viewed as an increase in the level of κ, the effects of which have already been thoroughly discussed in section 3. More interesting is the case where the economy opens up for trade.

For the sake of simplicity, I begin the analysis by assuming there exist only two countries. Let there be a country S that opens up for trade with country T. According to proposition 9, the likelihood that country S and T would benefit from trade decreases in

κ.[28] To determine how diverging levels of κ influence this result I assume that country S is characterized by overall good management practices, whereas country T is characterized by bad management practices. Consequently, the extent of the contractual distortions for a given industry in country S, is lower than the amount of distortions in country T, which is denoted by $\kappa_S > \kappa_T$. If country S and country T were to engage in trade, it would decrease the probability that country T would experience a benefit from trade, compared to the situation where the extent of contractual distortions was equal to that of country S ($\kappa_S = \kappa_T$).

This intuition holds also for an unbounded mass of countries, where κ is i.i.d at the country level according to the distribution function $F(\kappa)$. As long as the individual country's value of κ is larger than the expected value of κ, the country will more likely benefit from opening up for trade. The former is summarized in proposition 10.

Proposition 10 *Under assumptions* $1-6$, *where the degree of distortion* κ_j *is i.i.d distributed across countries with a cumulative distribution function* $G(\kappa)$, *the probability that trade-openness increases total consumer welfare for countries that are characterized by industries with low levels of* κ *(i.e.* $\kappa_j < E[F(\kappa)]$*) is reduced, whereas the opposite holds for countries that are characterized by industries with a high level of* κ ($\kappa_j > E[F(\kappa)]$) *compared to the situation where the degree of distortions* κ *is equal across countries.*

Proof. by inspection of the **SGT** as per (61). ■

Examining the **SGT** in the two-country situation, we observe two effects of opening up for trade by country T. First, it is important to note that opening up for trade with country S now increases the average productivity level firms need to attain to survive in the market of country T *more* than it did when all countries were similar. Reason for this is that country S is, on average, more productive than country T. Because average productivity has increased, the value of managerial effort for owners of a firm in country T increases, which is shown by an increase on the right-hand side of the **SGT**. Secondly, less firms from country T, are able to profitably export to country S, because the threshold value for which firms are able to profitably export is determined by country S. Hence, the *ex ante* expected profits from trade is reduced, which decreases the left-hand side of the **SGT**. Intuitively, what matters in a global market is not the level of productivity of a firm relative to all domestic competitors, but relative to that of all competitors. The combination of these two effects leads to a more stringent **SGT**. Because it is less likely that the business stealing effect dominates the scale effect, *ceteris paribus*, we observe that the likelihood that country T experiences gains from trade is significantly reduced when it will engage in trade with country S.

Along similar lines of reasoning the exact opposite holds for country S, which is more

[28] Remember that as $\kappa \to 0$, the degree of distortions increases.

likely to experience benefits from trade when engaging in trade with countries where management practices are worse. Analogous reasoning can be applied to the $m + 1$ case, where countries with a higher average productivity due to a higher level of κ, are more likely to gain from trade than countries with a low value of κ.

In the extreme case where $\kappa_S \rightarrow 1$ and $\kappa_T \rightarrow 0$, trade-openness will lead to an unequivocal loss of welfare in country T, whereas country S surely benefits from trade-openness. Hence, there must be a threshold value of κ, below which it is unprofitable to engage in trade. Assuming that developing countries have worse management practices than first world countries, this result is in line with the body of literature that contests the unambiguous gains from trade for developing countries (Abramovitz, 1986; Sachs and Warner, 1998; Dowrick and De Long, 2003; Dowrick and Golley, 2004). Moreover, it could explain why many developing countries still employ many protectionist measures (Baldwin et al., 2000).

6 Conclusion

How international trade affects firm-level productivity and alters a country's industry dynamics has been studied extensively. To what extent managerial incentives contribute to within-firm productivity increases and shifts in market resources has only recently received some attention. Yet, this latest body of literature does not take into account that performance related pay for managers is plagued by immeasurability.

This thesis contributes to the latter by examining how contractual distortions affect the number of domestic firms, varieties and the level of consumer welfare in equilibrium. In an adapted version of the model by Yu (2012), I show that the presence of firm-level contractual distortions increase the likelihood that opening up for trade with similar countries will lead to an increase in aggregate consumer welfare. Although trade increases the average productivity of all firms in the market, it also motivates firms to enter the industry. In a situation where the industry is characterized by a high degree firm-level contractual distortions, it is more likely that the latter effect dominates the former, increasing the amoung of available varieties and hence total consumer welfare. This result also holds when incentives do not increase under trade-openness.

When countries are assumed to experience heterogeneity with respect to the extent of experienced distortions, these results change. Countries that experience little contractual distortions, are more likely to gain from trade than do countries with a high degree of contractual distortions. The main driver for this result is that the least distorted economies determine the threshold value of productivity for which it is profitable to export products. The latter requires that the least efficient economies become more productive, forcing some unproductive firms out of the domestic market. Moreover, a smaller share of firms will be able to compete in the global market, reducing the *ex ante* expected profits from entering the industry. The combined effect of firms exiting the industry and unwillingness of firms to enter the industry, is not compensated (enough) by an increased amount of foreign varieties in the market. Consequently, these dynamics ensure a reduction of aggregate consumer welfare. In line with Abramovitz (1986), these results show that countries that have not reached a threshold level of development (in management practices) might be unable to enjoy the positive effects from opening up for trade.

Secondly, I find that the presence of contractual distortions improves the equilibrium level of consumer welfare in autarky. At the first-best level of managerial effort, owners provide managers with too much incentives from a social perspective. At this level of incentives, average industry productivity is increased such that a large fraction of the least productive firms is forced out of the market, reducing aggregate consumer welfare. This counterintuitive result is easily explained through the "tragedy of the commons". The individual firm does not take into account the marginal cost of reducing the amount of varieties a consumer can choose from, consequently setting too high incentives.

Lastly, I observe that there must be some threshold value of κ, dependent on the exact distribution, which is optimal from a social welfare perspective. A too high degree of distortions will negatively affect the likelihood with which trade-openness leads to welfare gains, whereas a too low degree of distortions leads owners to over-incentivize managers in equilibrium. This thesis also highlights that opening up for trade with similar countries increases the likelihood that trade will lead to welfare gains. Engaging in trade with a significantly more efficient country is not always optimal from the viewpoint of the less efficient country.

Further research is encouraged to empirically assess the impact of contractual distortions on managerial incentives, international trade and competition. Although this thesis presents some interesting findings, the model employed is highly stylized and might be insufficiently capable to explain real world dynamics. Hence, empirical validation might provide some additional evidence on the effect of contractual distortions in an international trade setting. Additionally, future research should be directed at incorporating more complex interactions between managerial incentives and international trade, such as team-work and the dynamics of managerial behaviour over time to better understand the dynamics at play.

Secondly, I have assumed that firm-level management practices are assumed to be relatively similar. In the model, this is represented by similar levels of κ. It is plausible to assume that efficiency between firms in the domestic market cannot vary too much, due to competitive pressure. Yet Bloom and van Reenen (2006) observe that there exists a long tail of extremely badly managed firms within countries. Although this seems to contradict the assumption that firm efficiency cannot vary too much within the individual country, their data is limited to only one observation year. Nonetheless, it remains to be examined how differences firm-level productivity influence the results presented here.

Lastly, this thesis has approached consumer welfare as a measure of country welfare. Although this is the definition of CES utility, total country welfare, including firm-level costs, is a better indicator of welfare. Hence, it is encouraged to incorporate more extensive and complex utility functions to more adequately measure total welfare.

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Appendix

Appendix A: Proof of Demand and Production Function

I derive demand by optimizing utility, with R as a constraint, giving the following Lagrangian:

$$\Gamma = \left[\int_{\omega \in \Omega} q(\omega)^{\frac{\sigma}{\sigma-1}} d\omega \right]^{\frac{\sigma-1}{\sigma}} - \lambda \left[p(\omega) q(\omega) - I \right] \tag{A.1}$$

where I represents an individual household's total income. Taking first order conditions gives:

$$\frac{\partial \Gamma}{\partial q(\omega)} = \left(\frac{\sigma}{\sigma - 1} \right) \left[\int_{\omega \in \Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{1}{\sigma-1}} q(\omega)^{-\frac{1}{\sigma}} - \lambda p(\omega) \tag{A.2}$$

Which means in optimum:

$$\left(\frac{\sigma}{\sigma - 1} \right) \left[\int_{\omega \in \Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{1}{\sigma-1}} q(\omega)^{-\frac{1}{\sigma}} - \lambda p(\omega) = 0$$

yielding the following equalities

$$q(\omega)^{-\frac{1}{\sigma}} U^{\frac{1}{\sigma}} = \lambda p(\omega) \tag{A.3}$$

$$\Leftrightarrow p(\omega) q(\omega) = U \lambda^{-\sigma} p(\omega)^{1-\sigma} \tag{A.4}$$

Rewriting $(A.3)$ we get:

$$\left[\int_{\omega \in \Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}} = U \lambda^{-\sigma} \left[\int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{\sigma}{\sigma-1}}$$

$$\Leftrightarrow Q = U \lambda^{-\sigma} \left[\int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{\sigma}{\sigma-1}} \tag{A.5}$$

Then, integrating $(A.4)$ over ω yields:

$$\int_{\omega \in \Omega} p(\omega) q(\omega) d\omega = U \lambda^{-\sigma} \int_{\omega \in \Omega} p(\omega)^{1-\sigma} \tag{A.6}$$

We know that $R = \int_{\omega \in \Omega} p(\omega) q(\omega) d\omega = PQ$. Substituting the former in $(A.6)$ and subsequently substitute $(A.5)$ for Q, gives the price index as per (2) after rewriting. Then by substituting (2) in $(A.6)$ we get

$$R = U \lambda^{-\sigma} P^{1-\sigma} \tag{A.7}$$

Substituting $(A.7)$ in $(A.4)$ we get the demand function for the individual variety ω as per (3) after rearranging. Then substituting (2) and (3) into (4) and taking taking the derivative w.r.t. $p(\omega)$ yields

$$\frac{\partial \pi(\omega)}{\partial p(\omega)} = \frac{R}{P^{1-\sigma}} \left[(1 - \sigma) p(\omega)^{-\sigma} + \left(\frac{w\sigma}{\varphi(\omega)} \right) p(\omega)^{-\sigma-1} \right] = 0 \tag{A.8}$$

which gives the optimal pricing rule as per (5) after rearranging. ■

Appendix B: Proof Lemma 1

We can solve for the optimal incentive contract by using backward induction. First, we determine the optimal effort the manager will exert for given levels of b and s. Hence we take the first order conditions of the utility function of the manager w.r.t. e:

$$\begin{aligned} U_A &= \overline{W} - C(e) \\ U_A &= s + be - C(e) \\ \frac{\partial U_A}{\partial e} &= 0 \qquad \Rightarrow \qquad b = C'(e) \end{aligned} \tag{B.1}$$

Secondly, we determine the optimal contract design for the owner. To ensure the manager will accept the contract, his participation constraint (**PC**) must be met. This implies that his expected wage should be higher or equal to his outside option given by:

$$\min\{s + be - C(e) \geq V\} \qquad \Rightarrow \qquad s + be - C(e) = U_{out} \tag{B.2}$$

Substituting $(B.1)$ into $(B.2)$and rearranging gives us the **PC** of the manager:

$$s = U_{out} - eC'(e) - C(e) \tag{B.3}$$

Next we determine the optimal incentive pay, by substituting $(B.1)$, $(B.3)$ into (9) and then (9) together with (11) into (10) yields the following optimal bonus:

$$\begin{aligned} \overline{\pi} &= BV(e) - f_e - [V - eC'(e) - C(e) + eC'(e)] \\ \frac{\partial \overline{\pi}}{\partial e} &= BV'(e) - C'(e) = 0 \qquad \Rightarrow \qquad BV'(e) = C'(e) \end{aligned} \tag{B.4}$$

where it is optimal for the owner to set marginal benefit equal to marginal costs, i.e. $b = C'(e)$ and $s = U_{out} - eC'(e) - C(e)$. ∎

Appendix C: Proof Proposition 2

Given the **OI** as per (15) and the **FE** as per (18), we can derive a unique pair of e^{FB} and B. Rewriting (15) as a function of B and subsequently substituting in (18) gives:

$$J(e) \equiv \frac{C'(e)}{V'(e)} V(e) - D(e) = f_e \tag{C.1}$$

We then need to show that $J'(e) \geq 0, J(0) = 0$ and $\lim_{e \to \infty} J(e) = \infty$, to ensure there is a unique solution for e^{FB}. Remembering that $D'(e) = C'(e)$ and taking first order conditions w.r.t. e yields

$$J'(e) = \left(\frac{C'(e)}{V'(e)}\right)' V(e) + \frac{C(e)}{V'(e)} V'(e) - D'(e) = \left(\frac{C'(e)}{V'(e)}\right)' V(e) > 0 \tag{C.2}$$

which always holds because of assumption 2. Furthermore, we can easily derive that $J(0) = 0$ and $\lim_{e\to\infty} J(e) = \infty$, proving that e^{FB} is unique. ■

Appendix D: Proof of Equilibrium Variable Derivation

We can rewrite the aggregate price index P to express it as a function of M and e:

$$\begin{aligned} P &= \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}} \\ &= \left[\int_{o}^{\infty} \left(\frac{\sigma}{\sigma-1} wc\right)^{1-\sigma} M dG(c;e)\right]^{\frac{1}{1-\sigma}} \\ &= M^{\frac{1}{1-\sigma}} \left(\frac{\sigma}{\sigma-1} w\right) V(e)^{\frac{1}{1-\sigma}} \end{aligned} \tag{D.1}$$

Substituting $(D.1)$ into (7) yields:

$$B = \frac{R}{\sigma}\left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma}\left[M^{\frac{1}{1-\sigma}}\left(\frac{\sigma}{\sigma-1}w\right)V(e)^{\frac{1}{1-\sigma}}\right]^{\sigma-1} \tag{D.2}$$

Which yields the equilibrium number of firms after rearranging as per (21). Moreover, rewriting (7) as a function of P we get the equation as per (23). Remembering that $U \equiv Q$, and $Q = \frac{R}{P}$, we get (25) after substituting (22) and (22) into the former. ■

Appendix E: Proof of Lemma 3

The manager's compensation schedule is still determined by $(B.1)$ and $(B.3)$. However, the profit function of the owner has changed to the function given by Eq. (33). Taking first order conditions of (33) w.r.t. e yields the following:

$$\begin{aligned} E(\Pi) \equiv \overline{\pi} = BV'(e) + Y_e(B,e,\tau,f_x) - C'(e) &= 0 \\ BV'(e) + Y_e(B,e,\tau,f_x) &= C'(e) \end{aligned} \tag{E.1}$$

where it is optimal for the owner to set incentives as per (16). ■

Appendix F: Proof of Proposition 4

Again, we need to show that there exist a unique equilibrium level of e^{FB}. Analogous to the closed economy case, we substitute the new **OI** as per (36) into the **FE** given by (38), yielding:

$$Z(B,e,\tau,f_x) \equiv \frac{C'(e)}{V'(e)}V(e) - D(e) + Y(B,e,\tau,f_x) - \left(\frac{Y_e(B,e,\tau,f_x)}{V'(e)}\right)V(e) = f_e \tag{F.1}$$

Taking first-order conditions w.r.t. e gives:

$$\begin{aligned} Z_e(B,e,\tau,f_x) \quad \equiv \quad & \left(\frac{C'(e)}{V'(e)}\right)' V(e) + \left(\frac{C'(e)}{V'(e)}\right) V'(e) + Y_e(B,e,\tau,f_x) \\ & - \left[\left(\frac{\partial\left[Y_e(B,e,\tau,f_x)/V'(e)\right]}{\partial e}\right) V(e) + \left(\frac{Y_e(B,e,\tau,f_x)}{V'(e)}\right) V'(e)\right] \\ & - D'(e) \end{aligned} \quad \text{(F.2)}$$

Remembering that $D'(e) = C'(e)$ and rewriting yields:

$$Z_e(B,e,\tau,f_x) \equiv \left(\frac{C'(e)}{V'(e)}\right)' - \left(\frac{\partial\left[Y_e(B,e,\tau,f_x)/V'(e)\right]}{\partial e}\right) > 0 \quad \text{(F.3)}$$

which always holds because of assumption 3. Hence, it holds that $Z_e(B,e,\tau,f_x) \geq 0$, $Z(B,0,\tau,f_x) = 0$ and $\lim_{e\to\infty} Z(B,e,\tau,f_x) = \infty$, which implies that there exists a unique level of effort e^{FB}. ■

Appendix G: Proof of Lemma 5

First, we determine the optimal level of effort by the manager. Taking first order conditions of the manager's utility function w.r.t. e and e_D yields the **IC** of the manager:

$$U_A = \overline{W} - C(e,e_D) = s + b(\kappa e + (1-\kappa)e_D) - C(e,e_D) \quad \text{(G.1)}$$

$$\frac{\partial U_A}{\partial e} = 0 \quad \Rightarrow \quad b = \frac{C'(e)}{\kappa} \quad \text{(G.2)}$$

$$\frac{\partial U_A}{\partial e_D} = 0 \quad \Rightarrow \quad b = \frac{C'(e_D)}{1-\kappa} \quad \text{(G.3)}$$

Which implies that:

$$\frac{C'(e)}{\kappa} = \frac{C'(e_D)}{1-\kappa} \Leftrightarrow C'(e_D) = C'(e) \times \frac{1-\kappa}{\kappa} \quad \text{(G.4)}$$

Substituting $(G.2)$ and $(G.3)$ back into $(G.1)$ and setting this equal to his outside utility U_{out} yields the **PC** of the manager:

$$\begin{aligned} U_A &= s + eC'(e) + e_D C'(e_D) - C(e,e_D) \geq U_{out} \\ s &\geq U_{out} - eC'(e) - e_D C'(e_D) + C(e,e_D) \end{aligned} \quad \text{(G.5)}$$

Which means that the expected wage of the manager equals:

$$\overline{W} \equiv D(e,e_D) = U_{out} + C(e,e_D) \quad \text{(G.6)}$$

The owner then faces the optimization problem as per (10). Taking first order conditions of Π w.r.t. e yields:

$$\begin{aligned} \frac{\partial \Pi}{\partial e} &= \frac{\partial \left(\overline{\pi} - \overline{W}\right)}{\partial e} = \frac{\partial \overline{\pi}}{\partial e} - \frac{\partial \left[U_{out} + C\left(e, e_D\right)\right]}{\partial e} = 0 \\ &= \frac{\partial \overline{\pi}}{\partial e} - \frac{\partial C\left(e, e_D\right)}{\partial e} = 0 \\ &= \frac{\partial \overline{\pi}}{\partial e} - C'\left(e\right) + \frac{\partial C\left(e_D\right)}{\partial e} = 0 \end{aligned} \tag{G.7}$$

Using $\frac{\partial C(e_D)}{\partial e} = \frac{\partial C(e_D)}{\partial b}\frac{\partial b}{\partial e}$ and $\frac{\partial C(e_D)}{\partial b} = \frac{\partial C(e_D)}{\partial e_D}\frac{\partial e_D}{\partial b}$ and substituting this into $(G.7)$ gives the following:

$$\frac{\partial \Pi}{\partial e} = \frac{\partial \overline{\pi}}{\partial e} - C'\left(e\right) - \frac{\partial C\left(e_D\right)}{e_D} \times \frac{\partial e_D}{\partial b} \times \frac{\partial b}{\partial e} = 0 \tag{G.8}$$

Using $(G.2)$, we can derive the following condition:

$$\begin{aligned} b &= \frac{C'\left(e\right)}{\kappa} \\ \partial b &= \frac{C''\left(e\right)\partial e}{\kappa} \\ \frac{\partial b}{\partial e} &= \frac{C''\left(e\right)}{\kappa} \end{aligned} \tag{G.9}$$

Analogously, we can derive:

$$\frac{\partial b}{\partial e_D} = \frac{C''\left(e_D\right)}{1-\kappa} \tag{G.10}$$

Using $(G.3)$. Substituting $(G.9)$ and $(G.10)$ back into $(G.8)$, using assumption 6, gives:

$$\begin{aligned} \frac{\partial \Pi}{\partial e} &= \frac{\partial \overline{\pi}}{\partial e} - C'\left(e\right) + C'\left(e_D\right) \times \frac{1-\kappa}{\kappa} = 0 \\ &= BV'\left(e\right) - C'\left(e\right) - C'\left(e_D\right) \times \frac{1-\kappa}{\kappa} = 0 \end{aligned} \tag{G.11}$$

Substituting $(G.4)$ then yields

$$BV'(e) = C'(e) - C'(e) \times \left(\frac{1-\kappa}{\kappa}\right)^2 \tag{G.12}$$

which is equal to the **OI** condition shown as per (49). ■

Appendix H: Proof of Proposition 6

Substituting the **OI** condition as per (49) into the **FE** condition given by (52) yields the following equation:

$$J(e, e_D) = \frac{C'\left(e\right) \times \frac{\kappa^2 + (1-\kappa)^2}{\kappa^2}}{V'\left(e\right)} V\left(e\right) - D\left(e, e_D\right) = f_e \tag{H.1}$$

Remembering that $D\left(e, e_D\right) = U_{out} + C\left(e, e_D\right)$ and taking first order conditions with respect to e yields:

$$J_e(e, e_D) = \frac{\left[C''\left(e\right) \times \frac{\kappa^2 + (1-\kappa)^2}{\kappa^2}\right] V'\left(e\right) - \left[C'\left(e\right) \times \frac{\kappa^2 + (1-\kappa)^2}{\kappa^2}\right] V''\left(e\right)}{\left[V'\left(e\right)\right]^2} V\left(e\right) > 0 \tag{H.2}$$

which always holds because of assumption 2. Again, it can be shown that $J(0,0) = 0$ and $\lim_{e\to\infty} J(e, e_D) = \infty$, indicating that e^{FB} is unique. ■

Appendix I: Proof of Lemma 7

Since the optimization problem for the manager has not changed, the **OI** is still given by $(G.2)$ and $(G.3)$. Moreover, the pay-off function of the owner is given by:

$$\begin{aligned} E(\Pi) \equiv \overline{\pi} &= BV(e) + Y(B, e, \tau, f_x) - D(e, e_D) - f_e \\ \overline{\pi} &= BV(e) + Y(B, e, \tau, f_x) - U_{out} - C(e, e_D) - f_e \end{aligned} \tag{I.1}$$

Taking first order conditions of $(I.1)$ w.r.t e yields the following:

$$\frac{\partial \overline{\pi}}{\partial e} = BV'(e) + Y_e(B, e, \tau, f_x) - C'(e) \times \frac{\kappa^2 + (1-\kappa)^2}{\kappa^2} = 0 \tag{I.2}$$

which yields (55) after rearranging. Where the optimal contract choice for the owner is as per (50). ■

Appendix J: Proof of Proposition 8

We need to show that there exist a unique equilibrium level of e_O^{SB}. Analogously to the closed economy case, we substitute the new **OI** as per (55) into the **FE** given by (57), yielding:

$$\begin{aligned} Z(B, e, e_D, \tau, f_x) \equiv & \frac{C'(e) \times \frac{\kappa^2+(1-\kappa)^2}{\kappa^2}}{V'(e)} V(e) - D(e, e_d) \\ & + Y(B, e, \tau, f_x) - \frac{Y_e(B, e, \tau, f_x)}{V'(e)} V(e) = f_e \end{aligned} \tag{J.1}$$

Remembering that $D'(e, e_D) = C'(e) \times \frac{\kappa^2+(1-\kappa)^2}{\kappa^2}$ and taking first-order conditions w.r.t. e yields:

$$\begin{aligned} Z_e(B, e, e_D, \tau, f_x) \equiv & \frac{\partial\left[D'(e, e_D/V'(e_i)\right]}{\partial e} + Y_e(B, e, \tau, f_x) \\ & - \frac{\partial\left[Y_e(B, e, \tau, f_x)/V'(e)\right]}{\partial e} - D'(e, e_D) \\ = & \frac{\partial\left[\left(C'(e) \times \frac{\kappa^2+(1-\kappa)^2}{\kappa^2}\right)/V'(e)\right]}{\partial e} - \\ & \frac{\partial\left[Y_e(B, e, \tau, f_x)/V'(e)\right]}{\partial e} > 0 \end{aligned} \tag{J.2}$$

which always holds because of assumption 6. Additionally, it holds that $Z(B, 0, 0, \tau, f_x) = 0$ and $\lim_{e\to\infty} Z(B, e, e_D, \tau, f_x) = \infty$, which implies that there exists a unique level of effort e_O^{SB}. ■