

Schymik, Jan

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Trade, Technologies and the Talent Organization

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Trade, Technologies, and the Talent Organization

Jan Schymik*

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Abstract

This paper introduces the choice of managerial power and performance pay into a general equilibrium model of international trade with heterogeneous agents and technologies. Skills, technologies and market characteristics determine outside options and thus affect contracts. The model explains variation in managerial power and performance pay within and between industries. While less productive firms offer low performance pay and little power, relatively more productive firms use performance pay and the delegation of managerial power as complements to keep their managers participating in the firm. The model explains how managerial entrenchment increases due to strong trade integrations or skill-biased technological change.

JEL Classification: F12, L22, G34, O33

Keywords: firm organization and product markets, executive compensation, managerial entrenchment and globalization,

*Department of Economics, University of Munich, Ludwigstr. 28, 80539 Munich, Germany, E-mail: jan.schymik@econ.uni-muenchen.de
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1 Introduction

Top executive payments in large quoted U.S. companies increased by about 650% during the last three decades.¹ These strong increases have spurred an intense public debate about the nature of the pay-setting process itself and akin to controversial debates in the public, three major strands of research have emerged that can explain those rises in managerial compensation. Bebchuk and Fried (2004) argue that the rise of managerial compensation is due to more powerful managers who can extract rents from the firm. Gabaix and Landier (2008) and Tervio (2008) show instead that complementarities between skills and firm size and an increased competition for scarce managerial talent can fully explain the observed patterns in executive compensation. Rajan and Zingales (2000), among others, make the argument that changes in the nature of the corporation itself have triggered the so-called 'war for talents'. Firms need skilled managers to adapt to new market situations and productivity is often directly associated with innovative ideas and a better knowledge. Additionally, human capital even became more critical than physical capital for some corporations since improvements in financial markets have facilitated physical investments. Unlike physical investments, human capital cannot be owned by shareholders and is free to leave the firm. Organizations whose success depends on the quality of its human capital are required to design their corporate governance not only to solve the classical agency problem between owners and managers but also to attract and retain their talented workforce.

The empirical literature on executive remuneration finds support for all three hypotheses. For instance Fabbri and Marin (2012) find that German executives are often rewarded for luck and thus find support for the managerial power hypothesis. Gabaix and Landier (2008) calibrate their CEO assignment model and show that it is consistent with the evolution of CEO payments in the U.S. between 1994 and 2004. Additionally, Cunat and Guadalupe (2009) show that import competition increases the pay to performance sensitivity in U.S. S&P 1500 firms and also pay differentials within firms rise due to tougher import competition.

This suggests that all three factors, managerial power, complementarities between size and scarce skill and changes in the organization of firms have an effect on the pay-setting process. Figure 1 unveils a pattern between performance pay, managerial power and the importance of talented workforce in European and U.S. firms using management survey data from Bloom et al. (2011). Talent firms provide more performance payment and more power to their managers.²

¹See Frydman and Jenter (2010).

²I use the z-score of people management developed in Bloom et al. (2012) to proxy the talent intensity inside firms.

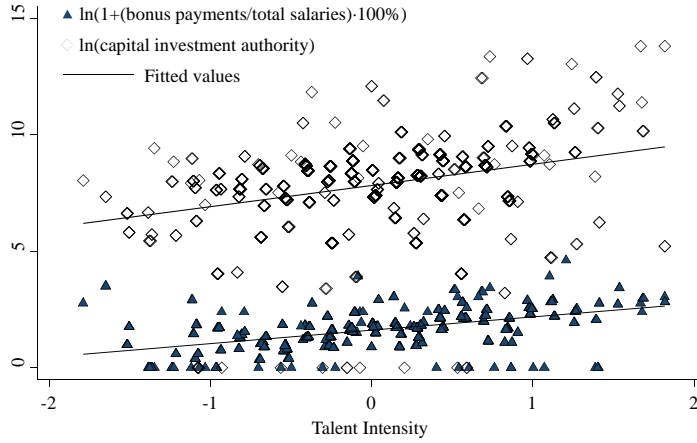


Figure 1: The figure plots the talent intensity of firms on measures of managerial empowerment through the delegation of decision rights and financial incentives using data from Bloom et al. (2011). The sample contains information on the organization of about 975 mostly U.S. and European firms. While the fitted values represent linear regression lines at the firm level, each square and triangle represents the average level of decentralization and financial incentives for a given value of talent intensity.

The aim of this paper is to show that managerial power, complementarities and changes in organizations are not mutually exclusive explanations for the rise of executive compensation. I formulate a model that explains differences in the allocation of power and performance pay across firms and industries. In particular, I introduce firms with moral hazard contracting and an endogenous choice of managerial power in a monopolistic competition model of trade with heterogeneous agents and technologies. Both, performance pay and the allocation of power depend on the values of agents' outside options and the value of an outside option depends on talent and industry characteristics. Specifically, I assume that agents are able to develop their own ideas and thus may capture profits if no contractual agreement between the owners and a manager is reached.

Model Preview The model has the following structure. The economy is endowed with heterogeneous ideas and agents with heterogeneous skill levels. A firm consists of three parts: an idea that describes a production technology, an agent that is employed as manager and agents employed as production workers. The idea is owned by a principal and the quality of the idea and the level of managerial talent determine the productivity of the firm. There are complementarities between the quality of ideas and managers such that a positive assortative assignment arises in equilibrium similar to Monte (2011).

In contrast to Monte (2011), where wages are the outcome of a bargaining solution, I introduce incentive

The z-score is a normalized score of organizational practices to hire, develop or retain talented workforce. My measure of power is the maximum autonomous capital investment that can be undertaken by the plant manager of the firm (in natural logarithms of USD PPP). The bonus share in wage payments (in natural logarithms of %) proxies the strength of financial incentives inside firms.

contracts and an endogenous choice of managerial empowerment. In particular, I follow Acharya et al. (2012) in modelling the contracting of performance pay and managerial power inside the firm. After principals and managers have been assigned to each other, principals offer a contract to their prospective managers. Contracts include a prospective financial performance payment and a degree of empowerment. The objective of such a contract is twofold: First, the performance pay should incentivize managers to take the right action from the principal's perspective. Second, the expected performance pay and power should make the participation in the firm sufficiently attractive for a manager given his outside option.

In order to quantify the value of this managerial outside option, I assume that managers may develop an own idea when they decline the contract offer. Therefore, outside options depend on both, the individual managerial talent and product market characteristics. The allocation of power and the provision of performance pay depends on managerial outside options. Firms that employ managers with fewer skills may use performance pay and less empowerment to provide incentives. Since managers of these firms have relatively low outside options, their incentive constraints bind whenever their participation constraints are satisfied. The situation is different in human-capital intensive talent organizations. Here, the skilled managers have very valuable outside options such that their participation constraint binds and the incentive compatibility constraint is relaxed in the optimum. Contracts in those organizations are written to satisfy the manager's participation constraint and keep them in the firm. Consequently, empowering managers and additionally offering large performance pay become complements such that owners intentionally give up power to make participation for agents more attractive and save on performance pay. The downside of those savings on performance pay is that the delegation of power to managers distorts managerial incentives since personal benefits can be extracted more easily.

Results The main focus of the paper is the effect of skill-biased technological change and globalization through stronger international trade integration on the allocation of power and performance pay inside organizations. Both, trade integrations and skill-biased technological change disperse the value of managerial outside options across talents. Outside options increase for the relatively talented managers: they become relatively more productive because of skill-biased technological change or they face better opportunities to export because of lower trade costs. In contrast, outside options decline for the relatively low talented managers: they face a tougher selection either from more productive domestic competitors or import penetration. These effects force firms with the least skilled managers to leave the market.

I then show that skill-biased technological change and strong trade integrations increase the share of

firms with powerful managers in equilibrium.

Related Literature This paper contributes in particular to the literature on the theory of the firm in general equilibrium models. Several empirical and theoretical contributions link either the delegation of power or the provision of financial incentives to international trade and the technological frontier. Marin and Verdier (2012a,b, 2008) show how globalization affects the delegation of formal and real authority in organizations. In their research agenda they embed firm organization à la Aghion and Tirole (1997) into models of international trade and explain how economic integration can lead to the delegation of power inside firms. Since agents are infinitely risk-averse in their model, performance payments cannot be used to incentivize agents. Therefore, their models do not allow to draw inferences on the choice between the delegation of power and performance pay. Additionally, the quality of talent is homogenous such that variation in the choice of organization across firms within industries is absent. In Marin et al. (2013), we analyze how the allocation of power inside Aghion-Tirole firms is affected by managerial and production worker offshoring in a small open economy. Acemoglu et al. (2007) analyze how technology diffusion affects firm decentralization. They argue that decision rights are more decentralized when private information of agents are crucial. Consequently, the delegation of authority is more likely when firms are relatively close to the technological frontier such that technologies are not public knowledge. Compared to their model, technologies play a different role in this paper. While the quality of ideas and managerial skills are modeled as complementary inputs in my model, the complexity of technologies and the quality of the managerial talent is exogenous in Acemoglu et al. (2007). Caliendo and Rossi-Hansberg (2012) show that exporting firms increase the number of management layers within their hierarchies after trade liberalizations. Acemoglu and Newman (2002) consider the impact of labour supply and demand on the corporate structure of firms and show how the outside option of production workers affect organizational choices.

The effects of product markets on managerial power and performance payment have also been analyzed in empirical papers. Here, the literature has mainly focused on a particular source of managerial power, namely the delegation of decision authority. Bloom et al. (2010) and Guadalupe and Wulf (2010) use data on the organization of firms to show how more import penetration leads to flatter firm hierarchies and more decentralized decision making. Cunat and Guadalupe (2005) consider the sudden appreciation of the British pound as a quasi-natural experiment to quantify the effect of product market competition on executive performance pay within a panel of British manufacturing firms. They found that this exogenous

increase of competition led to more sensitive pay to performance for managers in more open sectors. Marin and Verdier (2012a) show that German and Austrian multinationals have a more decentralized organization when they are faced by stronger trade exposure.

Recent papers by Wu (2011) and Chen (2012) focus on the managerial incentive provision in firms with moral hazard in general equilibrium models of intra-industry trade and firm heterogeneity à la Melitz (2003). The focus of these models is the effect of trade integrations on the dispersion of incentive contracts. Since owners do not face an endogenous choice of managerial empowerment, their models cannot explain how international trade increases managerial entrenchment through the delegation of power towards managers.

Outline The remainder of the paper is organized as follows. Section 2 develops the model in the closed economy and characterizes the equilibrium solution. Section 3 addresses the effects of skill-biased technological change in a closed economy setting. Section 4 deals with the open economy case and considers the effects of globalization through a decline in trade costs. Section 5 concludes.

2 Theoretical Framework

In this section I describe the model in a closed economy setting. I follow Acharya et al. (2012) in modelling the organization of firms subject to moral hazard. This partial equilibrium model of the firm is then introduced into an industry environment with heterogeneous skills and technologies. The structure of the general equilibrium model of international trade borrows from Monte (2011).

The timing structure of the model is as follows. At date 0 the principal (owner) of a firm needs to hire an agent (manager). The principal makes a 'take it or leave it' contract offer to the agent. An offer specifies a bonus payment and a certain degree of managerial power. Managerial power allows the agent to obtain private rents whenever the firm does not produce output and thus distorts the agent's incentives away from working in the principal's interest. The agent then may decide to accept or decline this offer depending on his outside options. Managerial outside options are a function of managerial skills and product market characteristics. Specifically, agents may copy the principal's idea and produce independently such that the agent's expected rent from working for the firm must be weakly larger than his rents from breaking up the relationship with the principal. After an agent accepts his offer, he chooses to either behave (exert effort) or misbehave (shirk) at date 1. At date 2 there is a positive probability that the firm produces output only if the manager chose to behave at date 1. After production occurred, agents are compensated

and profits are realized at date 3.

2.1 Consumer Preferences, Managerial Skills, and Ideas

Consumer preferences can be described by a standard CES utility function over a set of differentiated varieties J

$$U = \left[\int_{j \in J} y(j)^{(\sigma-1)/\sigma} dj \right]^{\sigma/(\sigma-1)}, \quad (1)$$

where $y(j)$ is the amount that is consumed of variety j and $\sigma > 1$ is the constant elasticity of substitution. This implies that each consumer spends $x(j) = X \left(\frac{p(j)}{P} \right)^{1-\sigma}$ on each variety that is produced, where $P \equiv \left[\int_{j \in J} p(j)^{(1-\sigma)} dj \right]^{1/(1-\sigma)}$ is the price index in the economy and X the aggregate consumption expenditure. A firm needs three inputs in order to exist: an idea, a skilled manager and production labor in proportion to the firm's output. All firms are considered as single product firms. The production costs of a variety depends on the skill of the manager and the available production technology. This production technology is manifested in the quality of an idea.

The economy is populated by a mass L of agents which can be employed either as production workers or as managers. Agents differ in their managerial skill but they are equal in the skills that they provide as production workers. The distribution of managerial skills is described by $L(s) = L/s$, where $s \in [1, \infty)$ is an agent's skill level and $L(s)$ is the measure of agents with managerial skills that are at least as good as the skill level s . Agents that fill an occupation as production worker provide one efficiency unit of production labor, independently of their managerial skills. The occupational choice between production work and managerial work will be endogenized later in the model. Similar to Wu (2011), the allocation of agents into production worker jobs and managerial jobs endogenously determines the supply of production labor, unlike in Melitz (2003), where the production labor supply is fixed.

The quality of the idea influences the productivity of the firm. The quality distribution of ideas is given by $G(z) = T/z$, where $z \in (0, \infty)$ is the quality of an idea and $G(z)$ is the measure of ideas that are at least as good as an idea with quality z . This implies that the number of available (however, bad) ideas is sufficient to accommodate any number of managers in the equilibrium. Managerial skills and the quality of ideas are complementary in determining the productivity of the firm.

2.2 Production and the Assignment of Managers and Ideas

Managerial talents and technologies complement each other regarding the production of output. This is implied by the firm's unit cost of production $\varphi(z, s) = w/(z^\kappa s^\mu)$, where w is the production labor wage which is chosen as the numéraire. The parameter $\mu > 0$ measures the influence of the manager's skill and the parameter $\kappa > 0$ the impact that the quality of an idea has on firm productivity. Let $x(p(j)) - \frac{x(p(j))}{\varphi(z,s)p(j)}$ be the operating profits (revenues net of production costs) of a firm that chooses the price level $p(j)$ for its variety. Standard optimization yields that the firm charges a constant markup over production costs: $p(j) = p(z, s) = \frac{\sigma}{\sigma-1} \frac{w}{z^\kappa s^\mu}$. The revenue function $x(j)$ and the optimal price $p(z, s)$ can now be used to state the operating profits that a firm can obtain if it produces successfully, denoted by $Y(z, s)$, as

$$Y(z, s) = M \left(\frac{z^\kappa s^\mu}{w} \right)^{\sigma-1}. \quad (2)$$

The term $M \equiv \frac{1}{\sigma} \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} X P^{\sigma-1}$ captures the size of the market from the perspective of the individual firm. Markets are large if the elasticity of substitution between varieties is low and the aggregate expenditure level X or the price index P are large.

A marginal increase in the managerial skill s increases the operating profits (2) for all firms but due to complementarities between skills and ideas the increase of operating profits is larger, the better the quality of the idea z : $\partial^2 Y(z, s) / (\partial s \partial z) > 0$. Thus, the complementarity between the quality of an idea z and managerial skill s creates relative stronger incentives for the firms with better ideas to hire the more skilled managers. I proceed under the tentative ex-ante assumption that the assignment of managers and ideas is positive assortative. Then, I show that it is ex-post stable in the sense that no manager-firm pair mutually wishes to rematch with another manager-firm pair. Due to the positive assortative assignment of skills to ideas, the measure of the upper tail of the skill and the idea distribution need to be of equal size for each matched pair (s, z) :

$$L/s = T/z \quad \Leftrightarrow \quad z = ts,$$

where $t \equiv T/L$ is a relative measure of the technology size in the economy. Hence, the operating profits can be restated as a function of the managerial skill and model parameters only:

$$Y(s) = M (t^\kappa s^{\kappa+\mu})^{\sigma-1}. \quad (3)$$

2.3 The Value of Managerial Outside Options

In order to describe how firms organize in equilibrium when managerial outside options are a function of skill and market characteristics, the value of a manager's outside option $O(s)$ needs to be tied to his level of managerial talent and product market conditions. I proceed under the following assumption regarding the values of outside options: after the principal has made a take-it-or-leave-it contract offer to the agent, the agent may decide whether he wants to accept the offer or not. If he chooses to decline the offer, he can possibly develop an idea on his own. The potential earnings that an agent with an own idea could obtain on the market form his outside option.

Specifically, agents can pay a fixed imitation cost i which allows them to obtain an idea of quality λz , where the term $0 < \lambda \leq 1$ captures the effect that the agents' ideas have lower qualities compared to their originals. If he decides to copy the idea, he realizes profits with probability ε .³ Additionally, the numéraire production worker wage $w = 1$ gives a lower bound on the managerial outside option since an agent can always choose to be employed as a production worker. Hence, the value of an outside option $O(s)$ is given by

$$O(s) \equiv \max \left\{ 1, \varepsilon M [(t\lambda)^\kappa s^{\kappa+\mu}]^{\sigma-1} - i \right\} \quad (4)$$

and depends on the managerial skill s , the market size M and model parameters. Outside options affect the contracting between owners and managers and consequently, different outside options will lead to different organizational forms. In the following subsection, I introduce a simple model of the firm à la Acharya et al. (2012) and thus endogenize the decision of firm organization as a function of managerial outside options.

2.4 Moral Hazard and Power in the Firm

In this section, I endogenize the contracting between the owner of an idea (the principal) and a manager (the agent) and show that the optimal contract can be derived as a function of the agent's outside option. In order to become active on the market, the principal needs an agent to run the firm. A contract between both parties consists of a performance payment $\alpha \geq 0$ and a level of managerial power $\beta \in [0, 1]$ that is delegated to the agent.

³An anecdotal reference how the possibility to imitate an idea after the interaction in a principal-agent context affects outside options is the 'ConnectU' against 'Facebook' lawsuit (2004). In 2003 Mark Zuckerberg, the subsequent founder of 'Facebook', was approached by the founders of the 'ConnectU' project to develop their website. The lawsuit alleged that Zuckerberg had copied the idea of the 'ConnectU' project and illegally used source code for his own project 'Facebook' which was originally intended for the 'ConnectU' website that he was hired for to create.

After a contract is signed, the agent chooses an unobservable and hence incontractible action $a \in \{m, s\}$. Either he behaves and manages the firm ($a = m$) or he misbehaves and shirks ($a = s$). Whenever the agent behaves ($a = m$), there still remains some positive probability $1 - \varepsilon$ that the firm does not produce output. If the agent misbehaves instead ($a = s$), the probability that the firm produces output is zero and the agent obtains some non-pecuniary benefit from shirking which is normalized to 1.⁴ Therefore, there remains ex-post uncertainty about the agent's action choice if the firm does not produce. Consequently, the principal can only tie the performance payment α to the observable state of the world, i.e. whether the firm produces output or not.

Besides the agent's benefits from shirking, there is another source of conflict in the organization which introduces the role of managerial power in the model. Whenever the firm does not produce output the agent may try to misuse the firm's assets in his own interest. If the agent misuses corporate assets, he obtains a non-pecuniary benefit S . The managerial power index β that is part of the contract reflects the agent's chance to obtain this benefit. A higher chance to obtain rents when the firm does not produce distorts the agent's incentives away from the principal's interests since it increases the agent's payoff for misbehaviour.

In firms with low values for β the principal exercises control very strictly such that managers only have little power to abuse the corporate assets of the organization. In contrast, managers in firms with high values for β are relatively powerful since they are controlled less strictly such that misuse of the corporate assets is relatively easy. The degree of managerial power β could possibly reflect the share of insiders on the board of directors who exercise less control on the executive compared to outside board members. Alternatively it could represent the inaccuracy with that the decisions of a manager are audited in the case of failure. Or it embodies possible inefficiencies of some supervisory committee. The degree of managerial power p eventually captures the weakness of corporate governance within the organization. Principals and agents are both considered to be risk-neutral and agents are protected by limited-liability.

The principal needs to offer a contract that induces the agent to behave in order to produce output and obtain profits on the market. Thus, contracts need to be incentive compatible and they need to satisfy the agent's participation constraint. The incentive compatibility constraint for the agent is given by

$$\varepsilon\alpha + (1 - \varepsilon)\beta S \geq 1 + \beta S. \tag{5}$$

⁴A normalization of the shirking benefit is not necessary for the existence of a meaningful equilibrium solution but it facilitates comparative statics in an open economy equilibrium since wages then become a continuous function of managerial skills. Therefore, I leave the derivation of an equilibrium solution with a general shirking benefit for the appendix.

On the left hand side of (5) is the agent's expected payoff from providing effort ($a = m$) which needs to be weakly larger than his expected payoff from shirking ($a = s$) on the right hand side. In order to make the agent accept the contract, the offer must be sufficiently attractive for him. Consequently, the expected benefit that an agent receives from the action that the contract implements must be weakly larger than his outside option:

$$\varepsilon\alpha + (1 - \varepsilon)\beta S \geq O(s). \quad (6)$$

Restate both constraints as functions $\alpha(\beta)$ in order to highlight the role of power and performance pay from the agent's perspective:

$$\begin{aligned} \alpha_{IC}(\beta) &\geq \frac{1}{\varepsilon} + \beta S \\ \alpha_{PC}(\beta) &\geq [O(s) - (1 - \varepsilon)\beta S] / \varepsilon. \end{aligned}$$

The function $\alpha_{IC}(\beta)$ describes the incentive constraint and is increasing in the degree of managerial power. Intuitively, more managerial power requires a higher performance pay in order to incentivize the agent to behave. However, the function $\alpha_{PC}(\beta)$ that captures the participation constraint is decreasing in the degree of managerial power. Both, more power and performance pay make the participation in the organization more attractive for the agent. The principal's problem is to choose the cheapest contract that satisfies both, incentive compability and the participation constraint. Intuitively, the optimal contract depends on the agent's reservation utility O and a case distinction whether the incentive constraint is binding or not is needed.

2.4.1 The Incentive Organization

If the value of the agent's outside option is relatively low $O(s) \in [1, 1 + S]$, the agent's incentive constraint is binding in the optimum. Intuitively, it depends on the principal's choice of managerial power β which constraint (5) or (6) is binding. For low levels of power $0 \leq \beta \leq (O(s) - 1) / S$, incentive compability is always ensured if the participation constraint is fulfilled since $\alpha_{PC}(\beta) \geq \alpha_{IC}(\beta)$. The opposite is true for high levels of power $(O(s) - 1) / S < \beta \leq 1$: the strong empowerment implies that incentive compability is sufficient to satisfy the agent's participation constraint because $\alpha_{PC}(\beta) < \alpha_{IC}(\beta)$.

In this case, principals optimally balance incentive payment with the provision of managerial power in order to keep both constraints binding and pay the lowest amount of performance pay that still implements

the agent's behaviour.

Lemma 1. *Suppose that managerial outside options are relatively low such that $O(s) \in [1, 1 + S]$. The principal then needs to consider the agent's incentive compability constraint and offers the following contract to the agent:*

$$\alpha = O(s) + \frac{1 - \varepsilon}{\varepsilon}, \beta = \frac{O(s) - 1}{S}.$$

This case will be denoted an 'incentive organization' in the remainder of the paper, since the organization needs to satisfy the agent's incentive compability constraint.

2.4.2 The Power Organization

Next, consider the opposite case where the value of the agent's outside option is relatively large $O(s) > 1 + S$. Here, the value of the agent's outside option is sufficiently large such that, whenever the participation constraint (6) is satisfied, the incentive compability constraint becomes redundant for all levels of power delegation : $\alpha_{PC}(\beta) > \alpha_{IC}(\beta) \forall \beta \in [0, 1]$. Since the required performance pay to keep the agent participating at the firm then decreases with the delegation of power ($\alpha'_{PC}(\beta) < 0$), it is optimal for the owner to allocate the maximum level of power to the manager to save on performance pay α . Plugging $\beta = 1$ into (6) yields the optimal peformance pay in power organizations.

Lemma 2. *Suppose that managerial outside options are relatively large such that $O(s) > 1 + S$. The principal then may neglect incentive provision and only needs to consider the agent's participation constraint and offers the following contract to the agent:*

$$\alpha = \frac{O(s) - (1 - \varepsilon)S}{\varepsilon}, \beta = 1.$$

This case will be denoted a 'power organization' in the remainder of the paper. This organization only cares about empowering the agent to keep him in the firm.

Figure 2 provides a graphical intuition for organizational choice. The IC curve is upward sloping in the (α, β) locus since more bonus and less managerial power increase incentive provision. In contrast, the PC is downward sloping since bonus and power are complements regarding participation. An increase in $O(s)$ shifts the PC curve upwards. If both curves intersect, the principal chooses the 'incentive organization' and offers exactly the contract (α, β) at the intersection to keep both constraints binding. If $O(s)$ is very large, the PC curve is always above the IC curve such that IC is always slack when PC binds. The

principal then chooses the 'power organization' and offers the cheapest contract (α, β) with $\beta = 1$ to save on bonus compensation. See the appendix for a more formal proof of the optimal organizational choice.

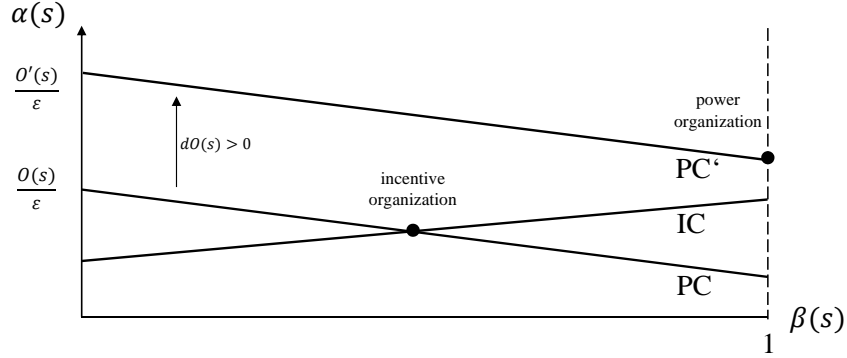


Figure 2: Graphical illustration of the contracting problem.

2.5 Equilibrium

In this section I establish the market equilibrium and characterize the distribution of organizations in the economy. An equilibrium solution needs to satisfy the following conditions: (i) firm owners offer the optimal performance pay and managerial power according to their manager's outside option; (ii) the least productive firms make zero profits such that only firms with non-negative profits are active in the market; (iii) production worker labor markets clear; (iv) all manager-firm matches are stable in the sense that there are no two pairs who mutually prefer to rematch.

I proceed under the assumption that the least productive firms employ managers with relatively low outside options $O(s) = 1$. The performance payment in these incentive organizations is thus given by $\alpha = 1/\epsilon$ according to Lemma 1. In equilibrium the marginal firm with technology and managerial skill $(\underline{z}, \underline{s})$ just breaks even. This condition is given by

$$\epsilon [Y(\underline{s}) - \alpha(\underline{s})] = \epsilon M \left(\frac{t^\kappa \underline{s}^{\kappa+\mu}}{w} \right)^{\sigma-1} - 1 = 0. \quad (7)$$

Since the market size M depends on the price index which again depends on the cutoff skill level \underline{s} , I restate M in terms of the aggregate expenditure X and the cutoff skill \underline{s} . The CES price index can be written as function of fundamentals and the managerial ability cutoff \underline{s} itself, using $\underline{z} = t\underline{s}$ for the marginal firm⁵:

$$P = \frac{\sigma}{\sigma-1} t^{-\kappa} w \left(\frac{\psi}{\epsilon L} \right)^{1/(\sigma-1)} \underline{s}^{\psi/(\sigma-1)}, \quad \psi \equiv 1 - (\sigma-1)(\kappa + \mu). \quad (8)$$

⁵See A.2 in the appendix for a more detailed derivation of the price index in the closed economy.

Here, I assume that $(\sigma - 1)(\kappa + \mu) < 1$ to ensure the existence of the improper integral for the price index. More intuitively, there is no single firm with a productivity level high enough to push the price index towards zero.⁶ Plugging (8) and X into (7) and rearranging terms, the zero cutoff earnings condition boils down to the following function $X(\underline{s})$:

$$X = \frac{L\sigma}{\psi} \underline{s}^{-1}. \quad (9)$$

This curve is downward sloping in the (X, \underline{s}) locus since an increase in \underline{s} increases the supply for production labor and thus makes production cheaper. To restore zero earnings of the marginal firm, the aggregate expenditures X must fall.

The second necessary condition to determine the equilibrium is the labor market clearing condition. In contrast to the classical Melitz (2003) heterogeneous firms model, labor supply is not fix here since the mass of production workers depends on the number of managers, respectively firms. Aggregate expenditure for production labor must equal the aggregate earnings of production workers:

$$\int_{\underline{s}}^{\infty} \frac{\varepsilon q(s)}{t^{\kappa} s^{\kappa + \mu}} L s^{-2} ds = L(1 - \underline{s}^{-1}),$$

where the right hand side is the supply of production workers and the left hand side the aggregate demand for production workers. Integrating the production labor demand of an individual firm with managerial skill s over all active managerial skills gives the aggregate demand $\varepsilon \frac{\sigma - 1}{\sigma} X$.⁷ Therefore, labor market clearing is satisfied if

$$X = \frac{L}{\varepsilon} \frac{\sigma}{\sigma - 1} (1 - \underline{s}^{-1}). \quad (10)$$

The labor market curve is upward sloping in the (X, \underline{s}) locus. Intuitively, a rise in \underline{s} increases production labor supply. Then X needs to rise as well which increases production labor demand to keep the labor market in equilibrium.

Figure 3 illustrates the zero cutoff earnings and the labor market clearing curve graphically. There exists a unique equilibrium solution since the zero cutoff curve is falling, the labor market curve is rising and the zero cutoff curve has a positive intercept $L\sigma\psi^{-1}$ and converges to zero.⁸

Next, the organizational cutoff skill level \tilde{s} can be found. Since the assignment of managerial talents to ideas is positive assortative, the value of the managerial outside options is also increasing in managerial skills which gives rise to a mix of organizations in the economy. Organizations that employ a manager

⁶Also see Monte (2011) for a more detailed discussion.

⁷See the appendix for a detailed derivation of the aggregate expenditure on production labor.

⁸Also see Monte (2011) for a description of the equilibrium solution.

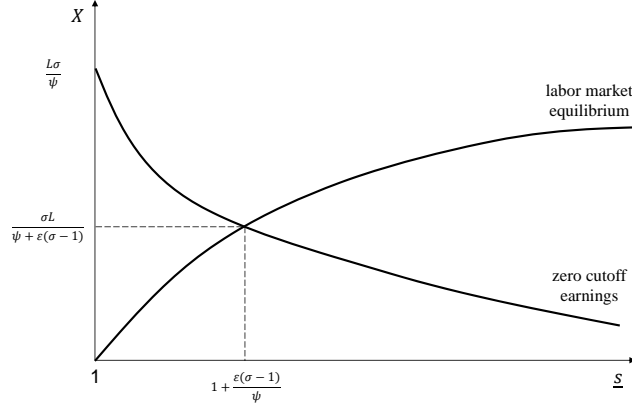


Figure 3: Determination of the closed economy equilibrium in the (X, \underline{s}) locus.

with relatively low skills $s \in [\underline{s}, \tilde{s}]$ choose to become incentive organizations. These firms offer contracts that incentivizes their managers and principals choose performance pay and managerial power such that both constraints, incentive compability and participation, are kept binding. Organizations that employ the relatively high skilled managers with skill levels $s > \tilde{s}$ choose to become power organizations and endogenously provide the maximum degree of power to their managers in order to focus on managerial participation and save on compensation. Using (4), the organizational cutoff skill level \tilde{s} is implicitly defined by

$$\varepsilon M \left[(t\lambda)^\kappa \tilde{s}^{(\kappa+\mu)} \right]^{\sigma-1} - i = 1 + S.$$

The simple structure of this model allows for an explicit equilibrium solution which is summarized in the following proposition.

Proposition 1. *The zero cutoff condition and the labor market clearing condition uniquely determine the equilibrium solution in the closed economy $\{X, \underline{s}, \tilde{s}\}$ which is given by*

$$\begin{aligned} X &= \frac{\sigma L}{\psi + \varepsilon(\sigma - 1)} \\ \underline{s} &= 1 + \frac{\varepsilon(\sigma - 1)}{\psi} \\ \tilde{s} &= \left[\frac{1 + S + i}{\lambda^\kappa(\sigma-1)} \right]^{\frac{1}{1-\psi}} \underline{s}. \end{aligned}$$

It follows immediately from proposition 1 that the share of power organizations in the economy is equal to

$$\theta = \left[\frac{\lambda^\kappa(\sigma-1)}{1 + S + i} \right]^{\frac{1}{1-\psi}}. \quad (11)$$

There are relatively more firms with powerful managers in the economy when either the managers' private

benefits from the misuse of corporate assets is relatively small (S is small) or when managerial outside options are high, which occurs when managers can easily develop own ideas (λ is large) or the fix cost of developing an idea i is low.

3 Skill-Biased Technological Change

In this section I analyze the effects of a skill-biased technological change on the share of power organizations within a closed economy. Skill-biased technological change increases the effectiveness of technologies that disproportionately benefit the productivity of firms that employ relatively high skilled agents. This can be modeled as an exogenous increase in the parameter κ that measures the influence of the idea on firm productivity. A higher value for κ immediately translates into a more dispersed productivity distribution since the productivity of firms with higher skilled agents improves disproportionately.⁹ First, I consider the effects of skill-biased technological change on aggregate expenditure and the zero cutoff earnings skill level in equilibrium. Then I proceed with the change in the share of power organizations in the economy.

First, consider the effects of a skill-biased technological change on X and \underline{s} . An increase in κ leaves the labor market equilibrium clearing condition (10) unaffected. Changes in the effectiveness of technologies neither affect the aggregate production labor expenditure nor the earnings on production labor. However, a larger κ affects the zero cutoff earnings condition (9). A skill-biased increase in the effectiveness of technologies has two opposing effects on the operating profits $Y(\underline{s})$ of the marginal firm. First, there is a positive productivity effect since the marginal costs ($t^\kappa \underline{s}^{\kappa+\mu} w^{-1}$) decrease. Second, there is a negative market size effect that is due to a lower price index because all other firms also become more productive. Since an increase in κ disproportionately benefits firms that employ relatively high skilled agents, the negative effect on the price index dominates the positive productivity effect for the marginal firm. To restore zero earnings for a given cutoff skill \underline{s} , the marginal firm requires a larger expenditure share X to cover the costs for managerial incentive compensation. This mechanism turns the zero cutoff earnings curve outward while the labor market curve is left unaffected which unambiguously increases X and the cutoff skill \underline{s} in the new equilibrium.

Consider now the effects of a skill-biased technological change on the share of power organizations within the economy. I restate the value of managerial outside options from (4) to get an intuition how

⁹The elasticity of the firm productivity with respect to changes in κ is increasing in the employed skill level s since $e(\kappa) = \kappa \ln(ts)$.

skill-biased technological change affects managerial outside options:

$$O(s) = \max \left\{ 1, \lambda^{\kappa(\sigma-1)} \left(\frac{s}{\underline{s}} \right)^{(\sigma-1)(\kappa+\mu)} - i \right\}. \quad (12)$$

First, there is a negative impact on the factor λ that accounts for the lower quality of developed ideas. This quality discount on the value of the outside option becomes more severe when technologies become more effective in general. Second, there is a negative effect on outside options that arises from the increase of the zero cutoff skill \underline{s} which unambiguously reduces the market size M . Third, there is a positive productivity effect because marginal costs decrease. These three effects lead to an overall effect of skill-biased technological change on managerial outside options that is generally ambiguous. In order to evaluate the effects of skill-biased technological change on the share of power organizations within the economy, I analyze how changes in κ affect θ in equilibrium. The following proposition captures the effect of a skill-biased technological change on the equilibrium.

Proposition 2. *Skill-biased technological change unambiguously increases the aggregate expenditure level in the economy and toughens the selection into market entry ($\partial X/\partial \kappa > 0$ and $\partial \underline{s}/\partial \kappa > 0$). The share of power organizations θ rises due to skill-biased technological change if and only if*

(i) *the managers' private benefits from the misuse of corporate assets S are relatively large*

(ii) *the fix cost of developing an idea are relatively high*

(iii) *the factor λ is relatively large*

such that $(1 + S + i)^{\frac{1}{1-\sigma}} < \lambda^\mu$.

Intuitively, the share of power organizations θ rises if the organizational cutoff \tilde{s} decreases and this decrease outweighs the increase of \underline{s} due to tougher selection. The cutoff skill \tilde{s} decreases strongly if the outside options of high skilled managers increase strongly due to skill-biased technological change. This effect occurs whenever \tilde{s} is sufficiently large such that all managers in power organizations benefit from a skill-biased technological change. Note, that there is an unambiguous increase in the share of power organizations if agents can perfectly match the principals' technologies such that $\lambda = 1$.

4 The Open Economy

In this section I consider an open economy with intra-industry trade. International trade takes place between two identical countries. Economic activities on the domestic market are denoted with a subscript d and exporting activities with subscript x . An exporting firm needs to produce $\tau > 1$ units of a good

for 1 unit to reach the foreign destination. Additionally, a firm needs to make a fixed investment f in production labor to sell to the export market. Formally, a firm that employs a manager with skill s in the open economy faces the following objective function:

$$\max_{\alpha, \beta, p(s), I_x} \varepsilon (Y_d(s) + I_x Y_x(s) - \alpha(s, \beta)) - I_x f, \quad (13)$$

where I_x is an endogenous export participation indicator. Firms again choose bonus payment α and level of managerial power β according to Lemma 1 and 2. Since exporting firms face identical demand elasticities on both markets, the exporting price is a constant multiplier of the domestic price adjusted by the variable trade cost: $p_x(s) = \tau p_d(s)$. Therefore, the operating profits from exporting are $Y_x(z, s) = \tau^{1-\sigma} Y_d(z, s) = \tau^{1-\sigma} M (t^\kappa s^{\kappa+\mu})^{\sigma-1}$.

Denote \underline{s}_d the minimum managerial skill of a local firm and \underline{s}_x the minimum managerial skill of an exporting firm. Firms will choose to export whenever their productivity is large enough to cover the fix costs of exporting. Thus, the marginal exporter obtains operating profits from exporting $Y_x(\underline{s}_x)$ that are just sufficiently large to cover the fixed costs of entering the export markets such that $\varepsilon M (t^\kappa \underline{s}_x^{\kappa+\mu})^{\sigma-1} = \tau^{\sigma-1} f$. The managerial skill level of the marginal exporter \underline{s}_x can be written as a function of the marginal skill level of a domestic firm manager \underline{s}_d

$$\underline{s}_x = \underline{s}_d [\tau^{\sigma-1} f]^{\frac{1}{1-\psi}}, \quad (14)$$

where I assume that $[\tau^{\sigma-1} f]^{\frac{1}{1-\psi}} > 1$ in order to assure a meaningful exporting behavior of firms with $\underline{s}_x > \underline{s}_d$. The open economy price index can now be written as

$$P = \frac{\sigma}{\sigma-1} w t^{-\kappa} \left(\frac{\psi}{\varepsilon L} \right)^{\frac{1}{\sigma-1}} \underline{s}_d^{\frac{\psi}{\sigma-1}} [1 + \Delta^{-1}]^{1/(1-\sigma)}, \quad (15)$$

where $\Delta \equiv \tau^{\frac{1}{\kappa+\mu}} f^{\psi/(1-\psi)}$ is an index that captures the distance between both countries. The additional term $[1 + \Delta^{-1}]^{1/(1-\sigma)}$ captures the effect of foreign competition on the price index. If the economic distance between the two countries is small (low values for Δ), competition from foreign exporters lowers the domestic price index. Note that economic distance is small when either fix and variable trade costs are low (f and τ small) or when managerial skills and ideas generate strong firm heterogeneity such that $\kappa + \mu$ is large.

An equilibrium in the open economy again requires that labor markets clear. The aggregate expenditure

on production labor now consists of three components: expenditure on labor to produce for the domestic market, expenditure on labor to produce for the export market and additionally, the production labor that is required to cover the fixed investments f . The aggregate demand for production labor can again be found by integrating the labor demand of an individual firm over all active firms and now includes the additional fixed exporting labor requirements f :

$$\int_{\underline{s}_d}^{\infty} \frac{\varepsilon q_d(s)}{t^\kappa s^{\kappa+\mu}} L s^{-2} ds + \int_{\underline{s}_x}^{\infty} \frac{\varepsilon q_x(s)}{t^\kappa s^{\kappa+\mu}} L s^{-2} ds + f L \underline{s}_x^{-1} = L(1 - \underline{s}_d^{-1}).$$

Similar to the closed economy case, the production labor demand can be simplified to $\varepsilon X (\sigma - 1) \sigma^{-1} + f L \underline{s}_x^{-1}$ such that labor markets clear in the open economy if

$$\varepsilon \frac{\sigma - 1}{\sigma} X + f L \underline{s}_x^{-1} = L (1 - \underline{s}_d^{-1}).$$

Replacing \underline{s}_x with (14) leads to

$$X = \frac{\sigma}{\sigma - 1} \frac{L}{\varepsilon} [1 - (1 + \Delta^{-1}) \underline{s}_d^{-1}]. \quad (16)$$

Equation (16) is the open economy version of the labor market clearing condition in the closed economy (10). Here, the additional factor Δ^{-1} captures the labor demand for exporting activities. The more integrated the two economies are, the more firms become exporters and thus the expenditure on labor to cover the fix trade costs rises. Therefore, a lower aggregate expenditure level is needed to balance labor supply and demand.

Consider the zero cutoff earnings condition in the open economy. The zero cutoff earnings firm is only active on the domestic market and faces competition from foreign exporters through a smaller price index (15). Plugging (15) into (7) yields the open economy version of the zero cutoff earnings condition:

$$X = \frac{\sigma L}{\psi} (1 + \Delta^{-1}) \underline{s}_d^{-1}. \quad (17)$$

The equilibrium in the open economy is illustrated graphically in figure 4. Equations (16) and (17) determine the equilibrium solution for X and \underline{s}_d in the open economy which is summarized by the following proposition.

Proposition 3. *The zero cutoff earnings condition and the labor market clearing condition uniquely de-*

termine the equilibrium solution in the open economy $\{X, \underline{s}_d, \underline{s}_x\}$ which is given by

$$\begin{aligned} X &= \frac{\sigma L}{\psi + \varepsilon(\sigma - 1)} \\ \underline{s}_d &= [1 + \Delta^{-1}] \left[1 + \frac{\varepsilon(\sigma - 1)}{\psi} \right] \\ \underline{s}_x &= [f(1 + \Delta)] \left[1 + \frac{\varepsilon(\sigma - 1)}{\psi} \right]. \end{aligned}$$

4.1 Trade Integration

Figure 4 shows the effects of a trade integration on the aggregate expenditure level X and the domestic cutoff skill level \underline{s}_d . A reduction of the trade distance index Δ ($d\tau < 0$ or $df_x < 0$) has an effect on the labor market and on the zero cutoff firm. If the economies become more integrated, the labor market curve shifts downwards since better opportunities to export allow the labor market to clear at lower expenditure levels. Simultaneously, more integration moves the zero cutoff earning curve upwards. A trade integration fosters import competition such that the marginal domestic producer requires a higher expenditure level to break even. These two effects, let the domestic cutoff \underline{s}_d unambiguously increase. Additionally, the cutoff skill of the marginal exporting firm \underline{s}_x falls since a lower productivity level becomes sufficient to cover the trade costs and a larger share of firms become exporters since $\partial [\underline{s}_d/\underline{s}_x] / \partial \Delta < 0$.

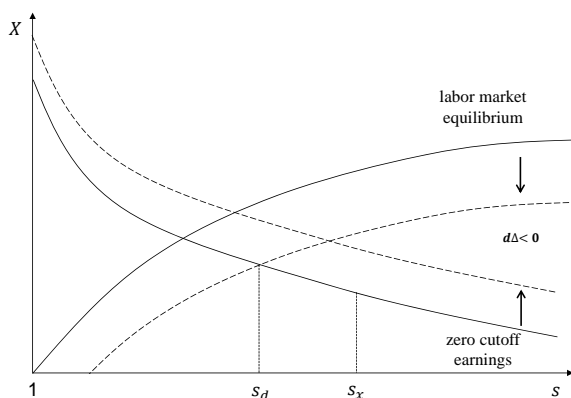


Figure 4: The effects of a trade integration ($d\tau < 0$ and/or $df < 0$) in the (X, \underline{s}_d) locus.

In order to make a statement on the comparative statics of firm organization in an open economy, I distinguish two polar cases. First, I consider a trade liberalization when the two countries are very remote such that only the most productive firms are exporters such that all exporters choose the power organizational form (i.e. $\underline{s}_d < \tilde{s} < \underline{s}_x$). Then, I analyze effects of a trade liberalization in the opposite case when the two countries are sufficiently integrated such that a larger share of firms already exports such

that some exporting firms also choose the incentive organizational form (i.e. $\underline{s}_d < \underline{s}_x < \tilde{s}$). The effect of a trade liberalization on managerial outside options are substantially different in these two cases which has opposite effects on the distribution of organizations in equilibrium.

4.1.1 Low Trade Openness

Suppose that the barriers to trade are relatively large such that only few top firms are sufficiently productive to cover the export costs all. Then, the cutoff skill of the marginal exporting firm \underline{s}_x is relatively large such that the organizational cutoff skill is below the exporting cutoff, $\underline{s}_d < \tilde{s} < \underline{s}_x$. The organizational cutoff \tilde{s} can again be evaluated as the skill levels that obtain outside options from domestic production of $1 + S$ and is similar to the closed economy case :

$$\tilde{s} = \left[\frac{1 + S + i}{\lambda^{\kappa(\sigma-1)}} \right]^{\frac{1}{1-\psi}} \underline{s}_d.$$

Obviously, tougher selection through a trade integration lets \tilde{s} increase since \underline{s}_d increases. Nevertheless, the share power organizations in the economy remains unaffected since both cutoff skill levels rise.

4.1.2 High Trade Openness

Now suppose that both countries are already relatively integrated such that the cutoff skill of the marginal exporting firm \underline{s}_x is relatively low and therefore below the organizational cutoff skill level, $\underline{s}_d < \underline{s}_x < \tilde{s}$. Here, a further trade integration has an effect on the share of power organizations in the economy. Note that $\underline{s}_x < \tilde{s}$ means that managers with skills $s \geq \tilde{s}$ have outside options that are sufficiently productive to participate in international trade. Then \tilde{s} is implicitly defined by $\lambda^{\kappa(\sigma-1)} (1 + \tau^{1-\sigma}) \left(\frac{\tilde{s}}{\underline{s}} \right)^{(\sigma-1)(\kappa+\mu)} = 1 + S + i + f$ such that

$$\tilde{s} = \left(\frac{1 + S + i + f}{\lambda^{\kappa(\sigma-1)} (1 + \tau^{1-\sigma})} \right)^{\frac{1}{1-\psi}} \underline{s}_d.$$

Note that a reduction of fix or variable trade costs has two effects on the organizational cutoff. First, the tougher selection lets \underline{s}_d increase which reduces the effective market size such that outside options decrease and the organizational cutoff rises. Second, the outside option of the organizational cutoff becomes more valuable because trade cost declined which leads to a decrease of the organizational cutoff. Although the absolute effect on \tilde{s} is generally ambiguous, the share of power organizations unambiguously increases since $\theta = [(\lambda^{\kappa(\sigma-1)} (1 + \tau^{1-\sigma})) / (1 + S + i + f)]^{\frac{1}{1-\psi}}$ rises when f or τ decrease.

The following proposition summarizes the comparative statics effects of trade integrations.

Proposition 4. *A reduction of fix and/or variable trade costs unambiguously increases the domestic cutoff skill level \underline{s}_d since the selection into market entry becomes tougher. The effect of a trade integration on the share of power organizations θ depends on the openness of the economy:*

(i) *If the barriers to trade are relatively large such that $\tau^{\sigma-1}f > \frac{1+S+i}{\lambda^{\kappa(\sigma-1)}}$, the share of power organizations remains unaffected by a reduction of the trade costs.*

(ii) *If the barriers to trade are relatively low such that $\tau^{\sigma-1}f < \frac{1+S+i}{\lambda^{\kappa(\sigma-1)}}$, a reduction of the trade costs increases the share of power organizations in the economy.*

5 Conclusion

In this paper I integrated a stylized model of firm organization into a general equilibrium model of intra-industry trade with heterogeneous skills and technologies. Since technologies and skills are complementary in terms of productivity, a positive assortative assignment of skills to technologies arises in equilibrium. The most productive firms endogenously choose a decentralized organization where the manager has the power to extract a private surplus if the firm does not produce output in the bad state of the world. This choice of firm organization arises because the managers of these firms have very valuable outside options such that their participation constraint is binding. In order to save on compensation, firm owners ease the extraction of the private surplus in the bad state. The outside options of managers in less productive firms have less value compared to their more talented peers because these managers obtain less if they do not accept the contractual relation with their principal and produce independently on the product market. Therefore, the provision of incentives matters more for them. Firm owners keep more control to make private rent extraction harder for their managers which induces them to take the right actions.

Skill-biased technological change disproportionately favors the outside options of the relatively high skilled managers and thus increases the share of organizations with empowered managers in the economy. Depending on how integrated the economy already is, trade liberalizations may have different effects on the organization of firms. If trade barriers are very large, the tougher selection through trade increases the cutoff skill of the least productive firm and the cutoff skills of the different organizational types leaving the overall distribution of organizations unchanged. If instead the world is already very integrated, the tougher selection through trade also increases the cutoff skill of the least productive firm but now the cutoff skills of the different organizational types decrease since these firms are exporters and benefit from a further reduction of trade costs. Therefore, also the corresponding managerial outside options increase and consequently the share of firms with empowered managers increases.

These theoretical results possibly demand rigorous empirical investigation. While all the empirical literature that was discussed in the introduction focuses on either the allocation of power or the provision of incentives, there is a gap of econometric studies where both is considered. Empirical evidence on firm and industry effects that determine the elasticity of substitution between incentives and power in organizations could help our understanding on the interaction of firm organization and executive compensation today.

A Appendix

A.1 The Optimal Choice of Power and Performance Pay

The sketch of the proof is similar to Acharya et al. (2012). A case distinction is necessary to see which choice of $\{\alpha, \beta\}$ is optimal.

(i) Power Organizations: For large levels of outside options ($O(s) > 1 + S$) the incentive constraint is never binding and therefore the participation constraint binds in the optimum, instead. The owner's objective is to ensure the manager's participation in the cheapest way. Since $\alpha'_{PC}(\beta) < 0$, it is then optimal to give managers the maximum level of power $\beta = 1$ to ensure participation and thus save on bonus compensation. Hence, the optimal contract is $\{\alpha = [O(s) - (1 - \varepsilon)S] / \varepsilon, \beta = 1\}$.

(ii) Incentive Organizations: Consider the case for low levels of outside options ($O(s) \in [1, 1 + S]$). The participation and the incentive constraint intersect at $\beta = \frac{O(s)-1}{S}$. For relatively high levels of managerial power, the incentive constraint is binding and for relatively low levels of managerial power, the participation constraint is binding instead. It is never optimal to choose β such that only the manager's incentive constraint binds because the owner can induce managerial effort cheaper by choosing a lower level of power at the same level of bonus compensation such that the manager's participation constraint just binds. Hence, the optimal contract is at the intersection of both constraints α_{IC} and α_{PC} , $\left\{ \alpha = O(s) + \frac{1-\varepsilon}{\varepsilon}, \beta = \frac{O(s)-1}{S} \right\}$.

A.2 Closed Economy Equilibrium

The equilibrium in the closed economy found in two steps. In a first step, the managerial cutoff skill \underline{s} and the aggregate expenditure X are determined. Afterwards, the organizational cutoff skill \tilde{s} can be found. Organizations with managerial skills $s > \tilde{s}$ become power organizations. Organizations with managerial skills $s \in [\underline{s}, \tilde{s}]$ become incentive organizations instead.

First, the equilibrium solution (X, \underline{s}) can be pinned down by the zero cutoff earnings and the labor market clearing curve: the marginal firm with skill level \underline{s} just breaks even and the aggregate expenditure on production labor must equal the aggregate production labor earnings.

A.2.1 Closed Economy Price Index

The price index can be restated in terms of the model fundamentals and the cutoff talent level \underline{s} . After exchanging variables and integrating over the skill distribution, the price index P may be written as follows:

$$\begin{aligned} P &= \left[\int_{\underline{s}}^{\infty} \left(\frac{\sigma}{\sigma-1} w t^{-\kappa} s^{-(\kappa+\mu)} \right)^{1-\sigma} d\varepsilon L(1-s^{-1}) \right]^{1/(1-\sigma)} \\ &= \frac{\sigma}{\sigma-1} t^{-\kappa} w \left(\frac{\psi}{\varepsilon L} \right)^{1/(\sigma-1)} \underline{s}^{\psi/(\sigma-1)}, \end{aligned}$$

where $\psi \equiv 1 - (\sigma - 1)(\kappa + \mu)$. In order to ensure existence of the improper integral, I need to assume that $(\sigma - 1)(\kappa + \mu) < 1$ which intuitively means that there does not exist any firm that is sufficiently efficient to bring the price index down to zero.

A.2.2 Zero Cutoff Earnings Condition

The expected operating profits can be written in terms of X and \underline{s} such that the ZCE curve is a decreasing function $X(\underline{s})$:

$$\begin{aligned} \varepsilon [Y(\underline{s}) - \alpha(\underline{s})] &= \varepsilon M \left(\frac{t^\kappa \underline{s}^{\kappa+\mu}}{w} \right)^{\sigma-1} - 1 \\ &= X \frac{\psi}{\sigma L} \underline{s} - 1 \end{aligned}$$

which yields

$$X = \frac{\sigma B L}{\psi} \underline{s}^{-1}.$$

A.2.3 Labor Market Clearing Condition

The labor market clearing condition requires that the aggregate expenditure on production labor is equal to the aggregate earnings of the production workers. The aggregate expenditure on production workers is equal to $L(1 - \underline{s}^{-1})$. The aggregate demand for production workers can be obtained by integrating up the demand of an individual firm over all producing firms in the economy. A firm uses $1/\varphi(j)$ units of labor per unit of output and produces $q(j)$ units of output with probability ε . The

demand for production labor of an individual firm can be written in terms of prices since $q(j) = x(j)/p(j) = XP^{\sigma-1}p(j)^{-\sigma}$ and $1/\varphi(j) = \frac{\sigma-1}{\sigma}p(j)$. Demand for production labor is thus given by

$$\varepsilon \frac{q(j)}{\varphi(j)} = \varepsilon \left[\frac{\sigma-1}{\sigma} XP^{\sigma-1} p(j)^{1-\sigma} \right].$$

Integrating the production labor demand for the individual firm over all active firms of the economy yields

$$\begin{aligned} \int_0^{L\underline{s}^{-1}} \left[\varepsilon \frac{\sigma-1}{\sigma} XP^{\sigma-1} p(j)^{1-\sigma} \right] dj &= \varepsilon \frac{\sigma-1}{\sigma} XP^{\sigma-1} \int_0^{L\underline{s}^{-1}} p(j)^{1-\sigma} dj \\ &= \varepsilon \frac{\sigma-1}{\sigma} X. \end{aligned}$$

Setting this expression equal to the aggregate supply from above gives the labor market clearing condition

$$X = \frac{L}{\varepsilon} \frac{\sigma}{\sigma-1} (1 - \underline{s}^{-1}).$$

A.2.4 Equilibrium Solution for $(X, \underline{s}, \tilde{s})$ in the Closed Economy

Solving for the cutoff skill \underline{s} by setting the two conditions equal yields

$$\frac{L}{\varepsilon} \frac{\sigma}{\sigma-1} (1 - \underline{s}^{-1}) = \frac{\sigma L}{\psi} \underline{s}^{-1} \Leftrightarrow \underline{s} = 1 + \frac{\varepsilon(\sigma-1)}{\psi}.$$

Solving for the expenditure share X by plugging the solution for \underline{s} into the labor market clearing condition yields

$$X = \frac{L}{\varepsilon} \frac{\sigma}{\sigma-1} \left[1 - \left(1 + \frac{\varepsilon(\sigma-1)}{\psi} \right)^{-1} \right] \Leftrightarrow X = \frac{\sigma L}{\psi + \varepsilon(\sigma-1)}.$$

The equilibrium market size M of a firm can be stated as follows:

$$\begin{aligned} M &\equiv \frac{1}{\sigma} \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} XP^{\sigma-1} \\ &= \frac{1}{\sigma} \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} \left[\frac{\sigma L}{\psi + \varepsilon(\sigma-1)} \right] \left[\frac{\sigma}{\sigma-1} t^{-\kappa} w \left(\frac{\psi}{\varepsilon L} \right)^{1/(\sigma-1)} \underline{s}^{\psi/(\sigma-1)} \right]^{\sigma-1} \\ &= \frac{1}{\varepsilon} t^{-\kappa(\sigma-1)} \underline{s}^{\psi-1} \end{aligned}$$

An increase in the cutoff talent \underline{s} decreases the size of the individual market share. Intuitively, an increase in \underline{s} has two opposite effects on the market share of the individual firm: (i) there is a positive price index effect since there are less active firms in the economy which increases P ; (ii) there is a negative aggregate expenditure effect on X since the industry becomes more productive on average such that labor demand and therefore the earnings and hence expenditures decrease. In my model, the size of the prize index effect is strictly smaller than the expenditure share effect such that an increase in \underline{s} unambiguously reduces the market share M . Larger values for ε unambiguously decrease M since there are more firms producing output in equilibrium.

Consider next the organizational cutoff skill level \tilde{s} . This cutoff is implicitly defined by $\varepsilon Y(\tilde{s}) - i = 1 + S$ and may be stated as a function of the equilibrium cutoff skill level \underline{s} after plugging the equilibrium values of \underline{s} and X into M :

$$\begin{aligned} \varepsilon M \left[(t\lambda)^\kappa \tilde{s}^{(\kappa+\mu)} \right]^{\sigma-1} - i &= 1 + S \\ \lambda^{\kappa(\sigma-1)} \left(\frac{\tilde{s}}{\underline{s}} \right)^{1-\psi} &= 1 + S + i \\ \Rightarrow \tilde{s} &= \left[\frac{1 + S + i}{\lambda^{\kappa(\sigma-1)}} \right]^{\frac{1}{1-\psi}} \underline{s} \end{aligned}$$

A.2.5 Stability of the Assignment

Finally, consider if the positive assortative assignment of managers to ideas is indeed stable. The assignment is stable if there are no two idea-manager pairs (z', s') and (z'', s'') that mutually wish to rematch to (z', s'') and (z'', s') .

To be completed ...

A.2.6 Share of Power Organizations

There is a mass of $L\underline{s}^{-1}$ firms in equilibrium and a mass of $L\tilde{s}^{-1}$ firms choose to become power organizations. Hence, the share of power organizations is given as follows:

$$\theta = \frac{L\tilde{s}^{-1}}{L\underline{s}^{-1}} = \frac{\underline{s}}{s^{**}} = \left[\frac{\lambda^{\kappa(\sigma-1)}}{1+S+i} \right]^{\frac{1}{1-\psi}}.$$

A.3 The Effects of Skill-Biased Technological Change

Consider the effects of an increase in κ in the model. While the labor market clearing condition is left unaffected, there are two opposing effects on the zero cutoff earnings conditions: a positive productivity effect and a negative price index effect. Since an increase in κ disproportionately benefits the productivity of the competing firms, skill-biased technological change toughens selection. Consider the selection effect $\partial\underline{s}/\partial\kappa$:

$$\begin{aligned} \frac{\partial\underline{s}}{\partial\kappa} &= \frac{\partial\psi}{\partial\kappa} \frac{\partial\underline{s}}{\partial\psi} \\ &= \frac{\partial[1 - (\sigma-1)(\kappa+\mu)]}{\partial\kappa} \frac{\partial[1 + \psi^{-1}(\varepsilon(\sigma-1))]}{\partial\psi} \\ &= [-(\sigma-1)] [-\psi^{-2}(\varepsilon(\sigma-1))] \\ &= \varepsilon \left(\frac{\sigma-1}{\psi} \right)^2 > 0. \end{aligned}$$

Next consider the effect of skill-biased technological change on the expenditure level:

$$\begin{aligned} \frac{\partial X}{\partial\kappa} &= \frac{\partial\psi}{\partial\kappa} \frac{\partial X}{\partial\psi} \\ &= \frac{\partial[1 - (\sigma-1)(\kappa+\mu)]}{\partial\kappa} \frac{\partial[\sigma L(\psi + \varepsilon(\sigma-1))^{-1}]}{\partial\psi} \\ &= [-(\sigma-1)] [-\sigma L(\psi + \varepsilon(\sigma-1))^{-2}] \\ &= \frac{\sigma L(\sigma-1)}{(\psi + \varepsilon(\sigma-1))^2} > 0. \end{aligned}$$

In order to evaluate how skill-biased technological change affects the share of power organizations within the economy, the effects on θ needs to be analyzed.

Consider how a change in κ affects θ . The share θ can be restated in the following way

$$\begin{aligned} \left[\frac{\lambda^{\kappa(\sigma-1)}}{1+S+i} \right]^{\frac{1}{1-\psi}} &= (1+S+i)^{\frac{1}{-(\kappa+\mu)(\sigma-1)}} \lambda^{\frac{\kappa(\sigma-1)}{(\kappa+\mu)(\sigma-1)}} \\ &= (1+S+i)^{\frac{1}{-(\kappa+\mu)(\sigma-1)}} \lambda^{\frac{\kappa}{\kappa+\mu}}. \end{aligned}$$

Define two functions $u(\kappa) \equiv (1+S+i)^{\frac{1}{-(\kappa+\mu)(\sigma-1)}}$ and $v(\kappa) \equiv \lambda^{\frac{\kappa}{\kappa+\mu}}$ and consider the effects of a change in κ on $u(\kappa)$ and $v(\kappa)$ separately:

$$\begin{aligned} \frac{\partial u(\kappa)}{\partial\kappa} &= (\kappa+\mu)^{-2} (\sigma-1)^{-1} (1+S+i)^{\frac{1}{-(\kappa+\mu)(\sigma-1)}} \ln(1+S+i) > 0 \\ \frac{\partial v(\kappa)}{\partial\kappa} &= \frac{\mu}{(\kappa+\mu)^2} \lambda^{\frac{\kappa}{\kappa+\mu}} \ln(\lambda) < 0. \end{aligned}$$

Then the derivative of θ with respect to κ can be stated as follows:

$$\begin{aligned} \partial\theta/\partial\kappa &= u'(\kappa)v(\kappa) + u(\kappa)v'(\kappa) \\ &= \left\{ (\kappa+\mu)^{-2} (\sigma-1)^{-1} (1+S+i)^{\frac{1}{-(\kappa+\mu)(\sigma-1)}} \ln(1+S+i) \right\} \left\{ \lambda^{\frac{\kappa}{\kappa+\mu}} \right\} \\ &\quad + \left\{ (1+S+i)^{\frac{1}{-(\kappa+\mu)(\sigma-1)}} \right\} \left\{ \frac{\mu}{(\kappa+\mu)^2} \lambda^{\frac{\kappa}{\kappa+\mu}} \ln(\lambda) \right\} \end{aligned}$$

and consequently θ increases iff

$$\begin{aligned} (\sigma - 1)^{-1} \ln(1 + S + i) &> -\mu \ln(\lambda) \\ [1 + S + i]^{\frac{1}{\sigma-1}} &> \frac{1}{\lambda^\mu} \\ \lambda^\mu &> [1 + S + i]^{\frac{1}{1-\sigma}}. \end{aligned}$$

A.4 Open Economy Equilibrium

A.4.1 Marginal Exporters and Marginal Local Firms

Since firms face identical demand elasticities in both markets, the operating profit ratio of a marginal exporter and a marginal local firm can be stated as

$$\frac{\varepsilon Y_x(\underline{s}_x)}{\varepsilon Y_d(\underline{s}_d)} = \frac{\varepsilon \tau^{1-\sigma} M(t^\kappa \underline{s}_x^{\kappa+\mu})^{\sigma-1}}{\varepsilon M(t^\kappa \underline{s}_d^{\kappa+\mu})^{\sigma-1}} = \frac{f}{1}$$

which pins down a linear relation between the cutoff talents \underline{s}_x and \underline{s}_d :

$$\underline{s}_x = \underline{s}_d [\tau^{\sigma-1} f]^{\frac{1}{1-\psi}}.$$

A.4.2 Open Economy Price Index

After exchanging variables and integrating over the skill distribution, the price index P in the open economy with two identical countries can be written as

$$\begin{aligned} P &= \left[\int_{\underline{s}_d}^{\infty} \left(\frac{\sigma}{\sigma-1} w t^{-\kappa} s^{-(\kappa+\mu)} \right)^{1-\sigma} d\varepsilon L(1-s^{-1}) + \int_{\underline{s}_x}^{\infty} \left(\tau \frac{\sigma}{\sigma-1} w t^{-\kappa} s^{-(\kappa+\mu)} \right)^{1-\sigma} d\varepsilon L(1-s^{-1}) \right]^{1/(1-\sigma)} \\ &= w t^{-\kappa} \frac{\sigma}{\sigma-1} \left(\frac{1}{\varepsilon L} \right)^{\frac{1}{\sigma-1}} \left[\int_{\underline{s}_d}^{\infty} s^{(\kappa+\mu)(\sigma-1)-2} ds + \tau^{1-\sigma} \int_{\underline{s}_x}^{\infty} s^{(\kappa+\mu)(\sigma-1)-2} ds \right]^{1/(1-\sigma)} \\ &= w t^{-\kappa} \frac{\sigma}{\sigma-1} \left(\frac{\psi}{\varepsilon L} \right)^{\frac{1}{\sigma-1}} \left[\underline{s}_d^{-\psi} + \tau^{1-\sigma} \underline{s}_x^{-\psi} \right]^{1/(1-\sigma)} \\ &= w t^{-\kappa} \frac{\sigma}{\sigma-1} \left(\frac{\psi}{\varepsilon L} \right)^{\frac{1}{\sigma-1}} \left[\underline{s}_d^{-\psi} + \tau^{1-\sigma} \underline{s}_d^{-\psi} (\tau^{\sigma-1} f)^{\frac{-\psi}{1-\psi}} \right]^{1/(1-\sigma)} \\ &= w t^{-\kappa} \frac{\sigma}{\sigma-1} \left(\frac{\psi}{\varepsilon L} \right)^{\frac{1}{\sigma-1}} \underline{s}_d^{\frac{\psi}{\sigma-1}} \left[1 + \tau^{1-\sigma} (\tau^{\sigma-1} f)^{\frac{-\psi}{1-\psi}} \right]^{1/(1-\sigma)}. \end{aligned}$$

Next, use the index of bilateral distance $\Delta \equiv \tau^{\frac{1}{\kappa+\mu}} f^{\psi/(1-\psi)}$ to restate the open economy version of P as follows:

$$P = \frac{\sigma}{\sigma-1} w t^{-\kappa} \left(\frac{\psi}{\varepsilon L} \right)^{\frac{1}{\sigma-1}} \underline{s}_d^{\frac{\psi}{\sigma-1}} [1 + \Delta^{-1}]^{1/(1-\sigma)}.$$

A.4.3 Labor Market Clearing Condition in the Open Economy

The aggregate earnings of production workers remains unchanged compared to the closed economy case at $\varepsilon L(1 - \underline{s}_d^{-1})$. The expenditure on production labor now is comprised of three components: (i) labor expenditure required to produce for the domestic market, (ii) labor expenditure required to produce for the foreign market, and (iii) labor expenditure to cover the fixed export investment:

$$\int_0^{L \underline{s}_d^{-1}} \left[\varepsilon \frac{\sigma-1}{\sigma} X P^{\sigma-1} p(j)^{1-\sigma} \right] dj + \int_0^{L \underline{s}_x^{-1}} \left[\varepsilon \frac{\sigma-1}{\sigma} X P^{\sigma-1} \tau^{1-\sigma} p(j)^{1-\sigma} \right] dj + f L \underline{s}_x^{-1}.$$

This term for the aggregate production labor expenditure may be simplified as follows:

$$\begin{aligned}
&= \varepsilon \frac{\sigma-1}{\sigma} X P^{\sigma-1} \left\{ \int_0^{L \underline{s}_d^{-1}} p(j)^{1-\sigma} dj + \tau^{1-\sigma} \int_0^{L \underline{s}_x^{-1}} p(j)^{1-\sigma} dj \right\} + f L \underline{s}_x^{-1} \\
&= \varepsilon \frac{\sigma-1}{\sigma} X P^{\sigma-1} \left\{ \int_0^{L \underline{s}_d^{-1}} p(j)^{1-\sigma} dj + \tau^{1-\sigma} \int_0^{L \underline{s}_x^{-1}} p(j)^{1-\sigma} dj \right\} + f L \underline{s}_x^{-1} \\
&= \varepsilon \frac{\sigma-1}{\sigma} X P^{\sigma-1} \left\{ \left(\frac{\sigma}{\sigma-1} w t^{-\kappa} \right)^{1-\sigma} \left(\frac{\psi}{\varepsilon L} \right)^{-1} \underline{s}_d^{-\psi} [1 + \Delta^{-1}] \right\} + f L \underline{s}_x^{-1} \\
&= \varepsilon \frac{\sigma-1}{\sigma} X P^{\sigma-1} P^{1-\sigma} + f L \underline{s}_x^{-1} \\
&= \varepsilon \frac{\sigma-1}{\sigma} X + f L \underline{s}_x^{-1}
\end{aligned}$$

Setting supply and demand equal leads to

$$\varepsilon \frac{\sigma-1}{\sigma} X + f L \underline{s}_x^{-1} = L(1 - \underline{s}_d^{-1});$$

and after replacing \underline{s}_x one obtains

$$\begin{aligned}
\varepsilon \frac{\sigma-1}{\sigma} X + f_x L \underline{s}_x^{-1} &= L(1 - \underline{s}_d^{-1}) \\
\varepsilon \frac{\sigma-1}{\sigma} X + L \underline{s}_d^{-1} f [\tau^{\sigma-1} f]^{-\frac{1}{\psi-1}} &= L(1 - \underline{s}_d^{-1}) \\
\varepsilon \frac{\sigma-1}{\sigma} X + L \underline{s}_d^{-1} \Delta^{-1} &= L(1 - \underline{s}_d^{-1}) \\
X &= \frac{\sigma}{\sigma-1} \frac{L}{\varepsilon} [1 - \underline{s}_d^{-1} (1 + \Delta^{-1})].
\end{aligned}$$

A.4.4 Zero Cutoff Earnings Condition in the Open Economy

Again, the marginal firm is an incentive organization and just breaks even such that $\varepsilon Y(z_d, \underline{s}_d) = 1$. The expected operating profits can be written in terms of X and \underline{s}_d such that the zero cutoff curve is a decreasing function in the $X(\underline{s}_d)$ locus:

$$\begin{aligned}
\varepsilon Y(z_d, \underline{s}_d) &= \varepsilon M \left(\frac{t^\kappa \underline{s}_d^{\kappa+\mu}}{w} \right)^{\sigma-1} \\
&= \varepsilon \left[\frac{1}{\sigma} \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} X P^{\sigma-1} \right] \left(\frac{t^\kappa \underline{s}_d^{\kappa+\mu}}{w} \right)^{\sigma-1} \\
&= \varepsilon \left\{ \frac{1}{\sigma} \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} X \left[\frac{\sigma}{\sigma-1} w t^{-\kappa} \left(\frac{\psi}{\varepsilon L} \right)^{-\frac{1}{\sigma-1}} \underline{s}_d^{-\frac{\psi}{\sigma-1}} [1 + \Delta^{-1}]^{1/(1-\sigma)} \right]^{\sigma-1} \right\} \left(\frac{t^\kappa \underline{s}_d^{\kappa+\mu}}{w} \right)^{\sigma-1} \\
&= \frac{1}{\sigma} X \frac{\psi}{L} [1 + \Delta^{-1}]^{-1} \underline{s}_d.
\end{aligned}$$

Setting this equal to 1 yields the zero cutoff condition for the open economy

$$X = \frac{\sigma L}{\psi} (1 + \Delta^{-1}) \underline{s}_d^{-1}.$$

A.4.5 Explicit Equilibrium Solution for $(X, \underline{s}_d, \underline{s}_x)$ in the Open Economy

Solve first for the cutoff \underline{s}_d :

$$\begin{aligned}
\frac{\sigma L}{\psi} (1 + \Delta^{-1}) \underline{s}_d^{-1} &= \frac{\sigma}{\sigma-1} \frac{L}{\varepsilon} [1 - \underline{s}_d^{-1} (1 + \Delta^{-1})] \\
(1 + \Delta^{-1}) \underline{s}_d^{-1} &= \frac{\psi}{\varepsilon(\sigma-1)} - \underline{s}_d^{-1} (1 + \Delta^{-1}) \frac{\psi}{\varepsilon(\sigma-1)} \\
(1 + \Delta^{-1}) \underline{s}_d^{-1} [\varepsilon(\sigma-1) + \psi] &= \psi \\
\underline{s}_d &= [1 + \Delta^{-1}] \left[1 + \frac{\varepsilon(\sigma-1)}{\psi} \right].
\end{aligned}$$

Note that $\lim_{\Delta \rightarrow \infty} \underline{s}_d = s$. The cutoff skill for the marginal exporter is then

$$\begin{aligned}
\underline{s}_x &= \left[1 + \left(\tau^{\frac{1}{\kappa+\mu}} f^{\psi/(1-\psi)} \right)^{-1} \right] \left[1 + \frac{\varepsilon(\sigma-1)}{\psi} \right] [\tau^{\sigma-1} f]^{\frac{1}{1-\psi}}. \\
&= \left[1 + \frac{\varepsilon(\sigma-1)}{\psi} \right] [\tau^{\sigma-1} f]^{\frac{1}{1-\psi}} + f \left[1 + \frac{\varepsilon(\sigma-1)}{\psi} \right] \\
&= \left[1 + \frac{\varepsilon(\sigma-1)}{\psi} \right] \left[\tau^{\frac{1}{\kappa+\mu}} f^{\frac{1}{1-\psi}} + f \right]
\end{aligned}$$

Plug the solution for \underline{s}_d into the zero cutoff earnings condition:

$$\begin{aligned}
X &= \frac{\sigma L}{\psi} (1 + \Delta^{-1}) \left[(1 + \Delta^{-1}) \left(1 + \frac{\varepsilon(\sigma-1)}{\psi} \right) \right]^{-1}. \\
&= \frac{\sigma L}{\psi + \varepsilon(\sigma-1)}
\end{aligned}$$

which is equal to the aggregate expenditure level in the closed economy case.

A.4.6 The Size of the Market Share M in the Open Economy Equilibrium

The equilibrium market share M of a firm can again be stated as follows:

$$\begin{aligned}
M &\equiv \frac{1}{\sigma} \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} X P^{\sigma-1} \\
&= \frac{1}{\sigma} \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} \left[\frac{B\sigma L}{\psi + \varepsilon B(\sigma-1)} \right] \left[\frac{\sigma}{\sigma-1} w t^{-\kappa} \left(\frac{\psi}{\varepsilon L} \right)^{\frac{1}{\sigma-1}} \underline{s}_d^{\frac{\psi}{\sigma-1}} \left[1 + \left(\frac{B}{\varepsilon} \right)^{\frac{\psi}{1-\psi}} \Delta^{-1} \right]^{1/(1-\sigma)} \right]^{\sigma-1} \\
&= \frac{BL}{\psi} \left[w t^{-\kappa} \left(\frac{\psi}{\varepsilon L} \right)^{\frac{1}{\sigma-1}} \underline{s}_d^{\frac{\psi}{\sigma-1}} \right]^{\sigma-1} \left[1 + \left(\frac{B}{\varepsilon} \right)^{\frac{\psi}{1-\psi}} \Delta^{-1} \right]^{-1} \frac{\psi}{\psi + \varepsilon B(\sigma-1)} \\
&= \frac{B}{\varepsilon} t^{-\kappa(\sigma-1)} \underline{s}_d^{\psi-1}.
\end{aligned}$$

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