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Human Resource Management and Intra-Industry Trade

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Abstract

Purpose – The purpose of this paper is to develop a tractable general-equilibrium model of examining the impact of human resource management on intra-industry trade. Commonly, managers of Korean firms are promoted internally. It necessitates a study of human resource management and its impact on an industrial equilibrium.

Design/methodology – This paper relies on theoretical analysis. We build a model in firms are hierarchical; an entrepreneur, managers, and workers. All individuals have heterogeneous managerial talents, which are the main source of managerial quality. Firms search talents for prospect managers, and eventually delegate them to supervise workers. The searching incurs a sunk cost.

Findings – Our finding is as follows. Country 1, relatively abundant of managerial talents, can gain more from trade than Country 2, relatively scarce of managerial talents. This is because the higher searching cost leads to the lower survival rate of firms in Country 2. Implicatively, good jobs are destroyed, and aggregate income falls in Country 2.

Originality/value – According to our study, relative abundance of managerial talents affects distribution of firm size and determines trade gain. This study can contribute to the literature of organization management and trade.

Keywords: Firm Organization, Firm Selection, Human Resource Management, Talent Development
JEL Classifications: C73, F12, L13

1. Introduction

This paper examines the impact of human resource management on intra-industry trade. In this paper, talent is heterogeneous, and firm productivity stems mainly from human resources; an entrepreneur, managers and workers. The terms of entrepreneur and owner are interchangeable. In Korea, human resource is primarily important in forming firm productivity. In process, institutional mechanism involves. One firm provides circumstance for workforces to express personal opinions freely, while another firm emphasizes collective collaboration and commitment. Traditionally, Korean firms are closer to the latter case although many firms are changing. In many Korean firms, managers of higher layer are promoted from lower layer. That is, managers of Korean firms heavily rely on internal promotion so that internal labor market is a compelling issue for human resource management in Korea. Kang Sung-Choon and Lee Jeong-Yeon (2017) argued that internal labor market facilitates organizational innovation through engendering trust in knowledge sharing and integration. With analyzing 233 firms[1] listed in KOSDAQ, they found evidence that internal labor market is positively associated with organizational innovation. Their empirical finding necessitates a study for the cost of internal labor market. In the current paper, we provide a theoretic model to explain how internal labor market and human

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resource management can affect the impact of trade on intra-industry resource allocation.

Our study is motivated with Korean firms that Kang Sung-Choon and Lee Jeong-Yeon (2017) analyzed. Our aim is to develop a tractable general-equilibrium model, which can be applied to all economies. In our model, firms establish internal labor market or farm for prospect managers. Accordingly, firms set minimum talent requirement for internal labor market, and search eligible individuals. In process, the problem of adverse selection can occur because all individuals have heterogeneous talent. Thus, the selection of prospect managers incurs a cost. Through internal labor market, prospect managers would be promoted to managers and be delegated to monitor workers.[2] In our paper, internal labor market is needed for only managers. Managers contribute to firm productivity through their talents, and they do not engage in production. Unlike managers, workers produce themselves, and contribute to firm productivity through their working efforts. Their shirking (i.e. moral hazard) reduces output production. Finally, the entrepreneur converts talents of the managers into a firm productivity. In process, entrepreneur skill is required. To resolve informational asymmetry, entrepreneurs use incentive pay. That is, they write contracts with managers for incentive pay. Similarly, managers write contracts with workers for incentive pay.[3] That is, when the firm successfully produces, the managers and workers receive incentive payments. If the firm is an entrant, production implies successful entry. If the firm is an incumbent, production implies survival from firm selection. Informational asymmetry prevails in the labor market. That is, heterogeneous talents sort into managers and workers. Searching talents incurs a cost; searching cost.[4] Searching is less costly when talents are abundant. Searching cost is sunk before production so that it should affect firm mass within an industry.

In an open economy, our result is more interesting. Country 1, relatively abundant of talents, gains more from trade than Country 2, relatively scarce of talents. The reason is that higher searching cost leads to lower survival rate of firms in Country 2. With incentive pay, well-paying jobs should be less available in Country 2 than in Country 1. In the absence of searching and incentive pay, our model shrinks to that of Melitz (2003). Indeed, the result of Melitz is a special case of our result. With the seminal paper, Melitz examined how trade openness allocates resources from less productive firms to more productive firms. In his model, firm productivity was randomly drawn. Preceding studies show that firm productivity arises primarily from two sources; 1) technology and 2) management. From our view-point, technology is part of management. The reason is that managers lauch projects for techno-

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[1] Kang Sung-Choon and Lee Jeong-Yeon (2017) used the data from the Human Capital Corporate Panel's (HCCP) 2007 survey, which were collected by the Korean Research Institute for Vocational Education and Training (KRIVET). KRIVET distributed the survey to 1,899 firms that had more than 100 employees and were listed in KOSDAQ (Korean Securities Dealers Automated Quotations). The HCCP measured HRM (Human Resource Management) practices through a survey administered to HRM managers, general managers, or owners. The final HCCP data were constructed from surveys returned by 467 firms. Kang and Lee mentioned that they could analyze 233 firms after eliminating firms with incomplete survey and archival data.

[2] Antras, Garicano and Rossi-Hansberg (2006) analyzed occupational choices of individuals for managers and workers. They found the complementarity between managers and workers. Hence, better-managers always work with better-workers. The complementarity is empiricallysupported by Bloom, Sadun, and Van Reenen (2018)

[3] Lee Yang-Seung (2018) discussed that one sector might be more dependent on contract than another sector. In line with his work, the incentive pay should be higher in a contract-dependent sector. However, we assume that incentive pay is available only in the sector of differentiated products.

[4] It was Helpman, Itskokhi and Redding (2010) who incorporated searching cost into a trade model. They modeled that searching cost occurs for hiring production workers. They did not consider managerial quality. In our study, searching cost occurs for hiring managers instead of production workers.

logical innovation. Following this context, we propose a study of analyzing the effect of human resource management[5] on firm productivity[6]. Throughout this study, tasks are decomposed into task of managemt and task of production[7], and two sunk costs are considered. One (fixed cost) occurs from facility establishment for production, whereas the other (searching cost) occurs from human resource management. The latter sunk cost occurs from incomplete information. Melitz (2003) considered the former sunk cost only. Our study encompasses the latter sunk cost into the analysis. Melitz (2003) did not take into account the possibility that total sunk cost can differ across countries. Simply, difference in distributional property of talents leads to difference in total sunk cost across countries. In an open economy, difference in total sunk cost impacts the trade pattern between two countries. In this study, two countries are symmetric but differ only in distributions of talent. In the Melitz's model, trade openness enhances firm-selection effect. In the model of Marin and Verdier (2012), trade openness generates a 'war of talents'. That is, it intensifies the competition for recruiting talents. Using incentive pay, firms can resolve informational asymmetry in the labor market. In detail, firms pay base wages to managers and workers, initially. After firm productivity turns out, firms pay incentives for workforces.[8] In the Melitz's model, all firms, regardless whether survivial firms or non-survival firms, pay same wage. In our study, non-survival firms pay less than survival firms. That is, if firm productivity is sufficiently low, the firm cannot survive. Then, the workers and managers of the firm lose the incentive pay. Thus trade openness not only enhances firm selection but also stratifies wages within an industry.

This study relates with three strands of literature. First, it contacts the literature of organization and trade. Idson and Oi (1999) showed that firms of better organization establish higher effort standards, and retain more productive workforces. So, the higher labor productivity leads to the higher firm productivity. According to Garicano and Rossi-Hansberg (2006), individuals of heterogeneous skill specialize in either production or management (i.e. problem-solving), and a manager is matched with workers. Firm organization leads to greater difference in wage. In the model of Antràs, Garicano and Rossi-Hansberg (2006), low-quality labors specialize in production while high-quality labors in management. They studied the equilibrium of a North-South trade model, where countries differ in distribution of labor qualities. Trade openness leads to better matches for all workers within the South but only for best workers within the North. As a result, wage disparity widens in the South but not necessarily in the North. Caliendo and Rossi-Hansberg (2012) emphasized that the firm productivity stems from the organization. In their model, production requires both labor and knowledge, and managing position needs greater knowledge. Entrepreneur decides the number of managerial layers. Trade openness increases the knowledge span of managers for exporting firms. When production scale is sufficiently large, managers do not produce themselves but make workers to be productive. The addition of managerial layer impacts wage distribution within firms because managers receive higher

[5] loom and Van Reenen (2010) used the abbreviation of HRM to represent human resource management.

[6] Recent studies provide empirical evidence that firms allocate resources towards management (Bloom, Sadun, and Van Reenen (2018), and Bloom and Van Reenen (2010)). Using Norweian firm data, Irarrazabal, Moxnes and Ulltevit-Moe (2013) empirically showed that 40 to 25 percent of the productivity improvement is attributed to high-quality labors that exporters employ. Their finding supports endogenous firm productivity. In addition, Lee (2019) analyzed the impact of factor market imperfection on trade pattern.

[7] The problem of occupational choice dates back to the work of Lucas (1978).

[8] Eggers and Kreickmeier (2009) incorporated the mechanism of rent-sharing into a general equilibrium framework with heterogeneous firms. In their model, firms implement fair-wage to prevent workers from shirking. In our model, the mechanism of cost-sharing induces workers to self-select.

wages. To highlight the roles of managerial practice, Lee Yang-Seung (2019) categorized firms into the group of large firms and the group of small firms, and explained why large firms would have higher managerial quality than small firms. The main reason was that large firms hire talented managers for efficient management at costs while small firms do not. The higher managerial qualities have large firms to outperform small firms.

Second, this study contacts the literature of skill diversity, and trade. The literature predicts that trade openness increases skill premium in all countries. That is, trade widens wage inequality between the skilled and the unskilled. In Acemoglu (2003), skill premium is determined by endogenous technology and skill supply. Thus an increase in skill supply induces a technological change, and hence increases the skill demand. That is, trade induces skill-biased technical change, leading to wage inequality in all countries. In Zhu and Trefler (2005), technological catch-up generates wage inequality. The least skill-intensive industries are relocated from the North to the South, where the industries become the most skill-intensive ones in the South. Catch-up widens wage inequality in all countries. Burnstein and Vogel (2012) incorporated difference of skill-intensity into a trade model. A reduction in trade cost reallocates factors towards the sectors of comparative advantage within a country. Skill premium is enhanced in the sectors and reduced in the other sectors (the H-O mechanism). A reduction in trade cost also reallocates factors towards more productive and skill-intensive firms within the sector (firm selection) and toward skill-intensive sectors (sector selection) within the country. Skill premium is enhanced in all countries (skill-biased productivity mechanism). In Harrigan and Reshef (2015), trade openness raises the demand of skill-intensive firm. In their paper, firms differ in productivity and skill intensity, and only lowest-cost firms can export. They estimated a correlation between skill intensity and firm productivity using the Chilean firm-level data. Their prediction is that trade openness enhances skill demand, and induces lowest-cost (highest-cost)/most-skilled (less-skilled) firms to expand (contract). For skill premium, Yeaple (2005) took into account endogenous technology. According to him, trade openness drives exporters to adopt more skilled technologies, and raises the skill demand. So skill premium is enhanced.

Third, this study contacts the literature of labor market friction, and trade. Incompleteness of labor market can leave significant effect on trade pattern. To explain wage inequality, Albrecht and Vroman (2002) established a model of labor matching in which not only skill differs across workers but also skill requirement differs across jobs. In their model, ex-ante identical firms become heterogeneous by adopting different technology. The firm of basic technology pays the lowest wage, whereas the firm of an advanced technology pays a high wage. Advanced technology requires managers of high skill. Helpman, Itskhoki and Redding (2010) addressed Intra-industry reallocation under labor market friction, where workforce composition differs across firms. They predicted that trade openness widens wage inequality while gradual openness can reduce wage inequality eventually. More productive firms not only pay higher wages but also share their rents with workers. That is, trade openness generates wage inequality between exporting firms and non-exporting firms, and between workforces. We attend on the role of manager in improving firm productivity. In our study, firms have recruiting advantage in labor market. So rent-sharing is not needed. Some papers nested the problem of hidden action into trade models. Davis and Harrigan (2007) and Egger and Keieckmeir (2009) analyzed efficiency wage using a Shapiro-Stiglitz (1984) model. In Davis and Harrigan (2007), different monitoring technology generates wage inequality across firms. In Egger and Keickmire (2009), different productivity generates wage inequality across firms. In both papers, trade increases firm profits and unemployment rate, simultaneously. Our study does not consider monitoring technology. Instead, managers are delegated to monitor workers. The monitoring cost should be lower for the firm of higher managerial

quality; shirking occurs less times in the firm. Main concerns of firms are to 1) adversely select managers at lower cost and to 2) prevent workers from shirking. The remainder of this paper is structured as follows. Section II presents the basics of the model. Section III analyzes autarky general equilibrium in a closed economy. Section IV analyzes trade equilibrium between symmetric countries. The section also analyzes trade between asymmetric countries, which differ only in distribution of talent. Section V will provide concluding remarks.

2. Basics of the Model

2.1. Consumption

The preference of consumer is defined similarly as in Melitz (2003).[9] That is, utility is a function of the consumed goods, which are produced in two industries $i \in \{1,2\}$: $U = Q_1^{\beta_1} Q_2^{\beta_2}$. Industry 1 produces a continuum of differentiated varieties while Industry 2 produces a homogeneous good. Preference takes CES as follows.

$$Q_1 = \left[\int_{\omega\in\Omega_1} q_1(\omega)^{\rho_1} d\omega\right]^{\frac{1}{\rho_1}}, \rho_1 > 1. \tag{2-1}$$

M denotes income. The Cobb-Douglas utility function implies that the share of total expenditure on Industry 1 is constant. Within Industry 1, the demand for a variety ω is obtained as

$$q_1(\omega) = \left(\frac{p_1(\omega)}{P_1}\right)^{-\sigma_1} \frac{X_1}{P_1}. \tag{2-2}$$

Denoting Industry 1's price index, P_1 is defined as $P_1 = \left[\int_{\omega\in\Omega_1} p(\omega)^{1-\sigma_1} d\omega\right]^{\frac{1}{1-\sigma_1}}$. Within Industry 1, all firms have negligible sizes. So each firm takes X_1 as given.

2.2. Technology and Production

We consider only one production factor; labor. All individuals have heterogeneous talents, which are unobservable. Production requires human resources; entrepreneur, managers and workers. In assumption, managers and workers are used in fixed proportion. For managing positions, talents are selected at cost. With skill, entrepreneur converts talents of managers into firm productivity. Thus, entrepreneur skill represents how he can coordinate and integrate individual managers. Let φ_M denote managerial quality.[10] In our study, managerial quality results from talents of managers. As mentioned, it is entrepreneur who translates managerial quality into firm productivity. Thus, firm productivity can be represented as composition of entrepreneur skill and managerial quality. That is, φ is defined as $\psi\varphi_M$. Under fixed proportion, production technology can be given as

$$F(L, M) = (\psi\varphi_M) \min\left\{\frac{L}{\alpha}, M\right\}, \tag{2-3}$$

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[9] By assuming quadratic preference, Melitz and Ottaviano (2008) showed that price mark-up is endogenous. They derived indirect utility that depends negatively on average of variety prices and positively on variance of the prices.

[10] Samson (2014) considered labor productivity and firm productivity, separately, to examine how firm selection affects income distribution across heterogeneous factors. In our work, firm productivity is the result of factor selection.

where L denotes worker, and M denotes manager. One manager monitors α workers. The function of production technology seems equipped with the productivity term $\psi\varphi_M$.[11] At equilibrium, $L = \alpha M$. For firm j, the productivity is denoted as

$$\varphi_i = \psi_i \varphi_{Mi}. \tag{2-4}$$

2.2.1. Heterogeneous Talents

For production, there are two types of tasks; task of management (manager) and task of production (worker).[12] The task of management requires talent while the task of production effort. Firms adversely select talents for managers, and those who are not selected can be hired as workers. According to talent, individuals sort into managers and workers. Individuals of highest talent should take managing positions. However, talent is not publicly observable but education level is. Thus, using education levels, individuals signal their talents to firms. There should be exaggerating signals so that firms must interpret the signals at cost. From now, the cost of interpreting signals is called as searching cost. Searching cost is a sunk cost. In this paper, sunk cost occurs in two directions. First, one sunk cost occurs from establishment of production facilities (fixed cost). Second, another sunk cost occurs from human resource management. All sunk costs should be paid prior to entry. The former sunk cost is equivalent as the fixed cost in Melitz (2003). The latter sunk cost is searching cost. Firms adversely select talents from the pool of individuals. If the pool is full of talent, the latter sunk cost should be low. Melitz (2003) did not take into account the latter sunk cost, which arises from management. From our view-point, the latter sunk cost also can impact trade pattern. To avoid confusion, the former sunk cost (or fixed cost) is denoted as f, while the latter sunk cost is denoted as ϕ. In our study, the adverse selection problem is simple. With higher searching cost, higher talents can be hired. Managers of the higher talents lower the monitoring cost. In equilibrium, monitoring costs are transferred to workers of no bargaining power. Unlike searching cost, monitoring cost is not a sunk cost.

2.2.2. Endogenous Managerial Quality

In this paper, we have two random variables such as entrepreneur skill ψ and talent φ_L. Entrepreneur skill is drawn from $[\widehat{\psi}, \infty]$, and talent drawn from $[\widehat{\varphi}_L, \infty]$. Greater index indicates greater value. In assumption, talent follows a Pareto distribution, $G(\varphi_L) = 1 - (\widehat{\varphi}_L/\varphi_L)^k$ for $\varphi_L > \widehat{\varphi}_L > 0$, and $k > 1$. $\widehat{\varphi}_L$ denotes the lowest level of talent. For simplicity, let $\widehat{\varphi}_L = 1$. Unlike entrepreneur skill, managerial quality is endogenous. Managerial quality can be chosen by firms in the following way. Using education level, firms set the minimum eligibility for managers. Education level is observable while talent is not. Here, education level represents academic degree. It extends to college ranking when individuals have the same academic degree. For example, if two individuals have MBA, the firm selects the one from the

[11] Grossman, Helpman and Kircher (2016) modelled that production technology depends on abilities of managers and workers and exhibits decreasing return to the input of worker. In our study, production exhibits constant return, and productivity is a linear combination of manager's ability and worker's ability. They assumed two different distributions for selection of managers and workers. Thus, selection of managers does not affect average quality of workers. From our view-point, managers and workers are selected from the same pool of labors. That is, all individuals can work as managers if they are selected. However, the selection incurs a cost. In the work of Lee Yang-Seung (2019a), a 2-2-2 model was analyzed. Labor and capital had heterogneity and the fator markets were imperfect. So, difference in institutional quality caused diference in the marginal productivities of the factors across countries.

[12] The occupational choice mechanism dates back to the work of Lucas (1978).

higher-ranking program. In this way, all individuals can be ranked. Suppose that a firm decides the minimum eligibility to be φ_L^m. Then, individuals within the interval $[\widehat{\varphi}_L, \varphi_L^m]$ can be hired as workers.

Remark: The minimum eligibility determines not only managerial quality but also average talent of workers. That is, higher minimum eligibility leads to higher managerial quality and higher average talent of workers. However, searching is imperfect so that individuals of low talent can be mixed into eligible individuals.

Suppose that a firm hires m measure of managers. Let m_E denote a measure of talented managers. Then, there is diminishing return to the measure of talented managers; $0 < \gamma < 1$. Firm productivity can be defined as $\varphi_M = \psi(m_E)^\gamma(\overline{\varphi}_L^m)$, where ψ denotes entrepreneur skill (or initial productivity), and $\overline{\varphi}_L^m$ denotes average talent of managers. Given the minimum eligibility φ_L^m, $m_E = m(\varphi_L^m)^{-k}$. Average talent of managers is $\overline{\varphi}_L^m = \frac{k\varphi_L^m}{k-1}$. Thus, the managerial quality of firm i can be achieved as

$$\varphi_{Mi} = m_{Ei}^\gamma \overline{\varphi}_L^m = [m(\varphi_L^m)^{-k}]^\gamma \left(\frac{k\varphi_L^m}{k-1}\right). \tag{2-5}$$

The implication of (2-5) is straightforward. Initially, firm productivity relies on entrepreneur's ability. Altogether, managers create a productivity gain. Thus, firm productivity is comprised of initial productivity and productivity gain. Productivity gain represents managerial quality, which can be obtained at searching cost. The productivity gain of firm i is achieved as $m_{Ei}^\gamma \overline{\varphi}_L^m = [m(\varphi_L^m)^{-k}]^\gamma \left(\frac{k\varphi_L^m}{k-1}\right)$, where the searching cost is $\phi = b\frac{(\varphi_L^m)^\mu}{\mu}$.[13]

As mentioned, entrepreneur converts talents of managers into firm productivity. To raise the level of managerial quality, the firm should raise the minimum eligibility, and face a higher searching cost. There is a tradeoff between managerial quality and searching cost. Firm i can optimize firm productivity as follows.

$$\text{Max}_{\varphi_{iL}^m} \frac{\psi_i k(m)^\gamma (\varphi_{iL}^m)^{1-\gamma k}}{k-1} - b\mu(\varphi_{iL}^m)^\mu. \tag{2-6}$$

The first order condition is

$$\frac{\psi_i k(m)^\gamma (\varphi_{iL}^m)^{-\gamma k}}{(1-\gamma k)(k-1)} - b\mu(\varphi_{iL}^m)^{\mu-1} = 0. \tag{2-7}$$

$$\text{Then } \varphi_{iL}^{m*} = \left[\frac{(1-\gamma k)(k-1)}{\psi_i k(m)^\gamma} b\mu\right]^{\frac{1}{1-\gamma k-\mu}}. \tag{2-8}$$

That is, the optimal minimum eligibility for firm i is $\varphi_{iL}^{m*} = \left[\frac{(1-\gamma k)(k-1)}{\psi_i k(m)^\gamma} b\mu\right]^{\frac{1}{1-\gamma k-\mu}}$. At the optimum, searching cost is $\phi_i^* = b\mu(\varphi_{iL}^{m*})^\mu$. If all firms hire m managers in same manner, they would have the same minimum eligibility. That is, $\varphi_L^{m*} = \varphi_{Li}^{m*} = \varphi_{L(-i)}^{m*}$, and $\phi^* = \phi_i^* = \phi_{-i}^*$. Then, firm productivity is achieved as

[13] The function of searching cost is borrowed from Helpman et al. (2010).

$$\varphi_i^*(\varphi_{iL}^{m*}) = \frac{\psi_i k(m)^\gamma (\varphi_{iL}^{m*})^{1-\gamma k}}{k-1}, \text{ where } \varphi_{iL}^{m*} = \left[\frac{(1-\gamma k)(k-1)}{\psi_i k(m)^\gamma} b\mu\right]^{\frac{1}{1-\gamma k-\mu}}.$$

$$\varphi_i^*(\varphi_{iL}^{m*}) = \frac{\left[[\psi_i]^{\frac{-\mu}{1-\gamma k-\mu}}\right][k(m)^\gamma]^{\frac{-\mu}{1-\gamma k-\mu}}\left[[(1-\gamma k)(k-1)b\mu]^{\frac{1-\gamma k}{1-\gamma k-\mu}}\right]}{k-1}. \quad (2\text{-}9)$$

By definition, firm productivity is achieved as

$$\varphi_i = \psi_i m^\gamma \bar{\varphi}_L^m(\varphi_{iL}^{m*}). \quad (2\text{-}10)$$

Then the production cost of firm i is

$$C_i(f, q_i) = \left(f + \phi_i + \frac{q_i}{\varphi_i}\right)[\alpha w_L + w_M], \quad (2\text{-}11)$$

where w_M denotes manager's wage, and w_L denotes worker's wage. Under monopolistic competition, each firm sets the optimal price given sectoral demand. For expositional simplicity, firm subscript i is omitted. With a constant elasticity σ, the price for each variety should be a mark-up over the marginal cost, $(\alpha w_L + w_M)$. That is, all firms face the same marginal cost but end up with having different firm productivity according to entrepreneur skill. Minimum eligibility directly affects firm productivity. If the minimum rises, managerial quality increases at searching cost. That is, when a firm selects managers of high (low) talent, its firm productivity improves (falls). The improvement (fall) of firm productivity lowers (raises) the price, and provides the firm an advantage (disadvantage) of competition. In assumption, all firms are under joint production.[14]Thus, a firm pays all workers same wage.

Proposition 1: Across two firms $(i = h, k)$, $\frac{r_h(\varphi_h)}{r_k(\varphi_k)} = \left(\frac{\psi_h}{\psi_k}\right)^{\frac{(1-\sigma)\mu}{1-\gamma k-\mu}}$.

Proof: When the productivity of firm i is φ_i, $p(\varphi_i) = \left(\frac{\alpha w_L + w_M}{\rho\varphi_i}\right)$, and $q(\varphi_i) = \left[\frac{p(\varphi_i)}{P}\right]^{-\sigma} Y$. Then the firm's revenue can be found as

$$r(\varphi_i) = p(\varphi_i)q(\varphi_i) = [p(\varphi_i)]^{1-\sigma} P^\sigma Y = \left[\frac{\alpha w_L + w_M}{\rho\varphi_i}\right]^{1-\sigma} P^\sigma Y.$$

Suppose two firms, firm h and firm k. Then the ratio of revenue is

$$\frac{r_h(\varphi_h)}{r_k(\varphi_k)} = \left(\frac{\varphi_h}{\varphi_k}\right)^{\sigma-1} = \left(\frac{\varphi_h^*(\varphi_{hL}^{m*})}{\varphi_k^*(\varphi_{kL}^{m*})}\right)^{\sigma-1}, \quad (2\text{-}12)$$

where

$$\varphi_h^*(\varphi_{hL}^{m*}) = \frac{\left[[\psi_h]^{\frac{-\mu}{1-\gamma k-\mu}}\right][k(m)^\gamma]^{\frac{-\mu}{1-\gamma k-\mu}}\left[[(1-\gamma k)(k-1)b\mu]^{\frac{1-\gamma k}{1-\gamma k-\mu}}\right]}{k-1},$$

$$\text{and } \varphi_k^*(\varphi_{kL}^{m*}) = \frac{\left[[\psi_k]^{\frac{-\mu}{1-\gamma k-\mu}}\right][k(m)^\gamma]^{\frac{-\mu}{1-\gamma k-\mu}}\left[[(1-\gamma k)(k-1)b\mu]^{\frac{1-\gamma k}{1-\gamma k-\mu}}\right]}{k-1}.$$

[14] Grossman (2004) assumed both team production and individual production. Automobile industry is a typical example of team production while software industry an example of individual production.

$$\text{Thus, } \frac{r_h(\varphi_h)}{r_k(\varphi_k)} = \left(\frac{\psi_h}{\psi_k}\right)^{\frac{(1-\sigma)\mu}{1-\gamma k-\mu}}.$$

3. Closed Economy

3.1. Mass of Firms and Aggregation

Similarly as in Melitz (2003), there are a mass M of firms (hence M varieties) in the industry. With the probability density $g(\psi)$, aggregate price can be defined as

$$P = \left[\int_0^{\infty} [\varphi]^{1-\sigma} g(\varphi)\, d\varphi\right]^{\frac{1}{1-\sigma}} = \left[\int_0^{\infty} [\psi A(\varphi_L^{m*})]^{1-\sigma} g(\psi)\, d\psi\right]^{\frac{1}{1-\sigma}},$$
$$= A(\varphi_L^{m*}) M^{\frac{1}{1-\sigma}} p(\bar{\psi}), \tag{3-1}$$

where

$$A(\varphi_L^{m*}) = \frac{k(m)^{\gamma}(\hat{\varphi}_L)^{\gamma k}(\varphi_L^{m*})^{1-\gamma k}}{k-1}, \text{ and } \bar{\psi} = \left[\int_0^{\infty} [\psi]^{1-\sigma} g(\psi)\, d\psi\right]^{\frac{1}{1-\sigma}}. \tag{3-2}$$

In (3-1), we see that the price index is a function of average entrepreneur skill and average managerial quality. Average managerial quality is determined by distributional property of talents. Unlike in Melitz (2003), firm productivity is endogenous. That is, firm productivity reflects entrepreneur skill and distribution of talents. If talent is abundant in a country, the domestic firms have an advantage in having higher managerial quality. From (2-18), average firm productivity is given as

$$\bar{\varphi} = \bar{\psi} A(\varphi_L^{m*}) = \bar{\psi} m^{\gamma} \bar{\varphi}_L^{m}(\varphi_L^{m*}). \tag{3-3}$$

Average firm productivity is decomposed into average entrepreneur skill and average talent of managers. As long as the distributional property of talent is known, average firm productivity is predictable. For the industry, aggregate quantity can be defined as

$$Q = \left[\int_0^{\infty} Mq(A(\varphi_L^{m*})\psi)^{\rho} d\psi\right]^{\frac{1}{\rho}} = \left(MA(\varphi_L^{m*})\right)^{\frac{1}{\rho}} q(\bar{\psi}). \tag{3-4}$$

Then average firm revenue is

$$R(\bar{\psi}) = P(\bar{\psi})Q(\bar{\psi}) = MA(\varphi_L^{m*}) p(\bar{\psi}) q(\bar{\psi}) = Mr(\bar{\psi}). \tag{3-5}$$

Average firm profit is

$$\Pi(\bar{\psi}) = MA(\varphi_L^{m*})\pi(\bar{\psi}). \tag{3-6}$$

All the aggregates are functions of average entrepreneur skill and average talent of managers. Management incurs the additional sunk cost (searching cost), ϕ, and reduces firm profit. The additional sunk cost lowers survival rate of firms, and raises average firm productivity.

3.2. Firm Entry and Exit

Prior to entry, all firms should pay the sunk costs such as fixed cost and searching cost.

Establishment of facilities incurs fixed cost (f) whereas management incurs searching cost (ϕ). Thus, entry cost should be $(f+\phi)$. After the cost $(f+\phi)$ is sunk, firm productivity turns out. In consistency with Melitz (2003), there should exist a cut-off level φ^*, where $\varphi^* = \psi^* A(\varphi_L^{m*})$. Thus existence of a cut-off firm productivity φ^* implies existence of a cut-off entrepreneur skill ψ^*. Cut-off eligibility can be optimally chosen. The optimal value determines the managerial quality. Then ex-ante probability of successful entry can be found as $p(\psi > \psi^*) = 1 - p(\psi < \psi^*)$. Average firm productivity is obtained as

$$\begin{aligned}\bar{\varphi}(\psi^*) &= \left[\frac{1}{P(\psi>\psi^*)}\int_0^{\infty}[\psi A(\varphi_L^{m*})]^{\sigma-1}p(\psi)d\psi\right]^{\frac{1}{\sigma-1}},\\ &= \left[\frac{1}{P(\psi>\psi^*)}\right]^{\frac{1}{\sigma-1}} A(\varphi_L^{m*})\left[\int_0^{\infty}[\psi]^{\sigma-1}P(\psi)d\psi\right]^{\frac{1}{\sigma-1}},\end{aligned} \tag{3-7}$$

where $p(\psi > \psi^*) = 1 - p(\psi < \psi^*) = 1 - \left[\frac{\hat{\psi}}{\psi^*}\right]^k$.

For simplicity, let $\hat{\psi} = 1$. Then $p(\psi > \psi^*) = 1 - [\psi^*]^{-k}$.

$$\begin{aligned}\bar{\varphi}(\psi^*) &= [1-[\psi^*]^{-k}]^{\frac{-1}{\sigma-1}} A(\varphi_L^{m*})\left[\int_0^{\infty}[\psi]^{\sigma-1}P(\psi)d\psi\right]^{\frac{1}{\sigma-1}},\\ &= [1-[\psi^*]^{-k}]^{\frac{-1}{\sigma-1}}\bar{\psi}A(\varphi_L^{m*}).\end{aligned} \tag{3-8}$$

3.3. Zero Cutoff Profit Condition

Average firm profit is determined by the cut-off value ψ^* at which firm profit should be zero. If entrepreneur skill is lower than ψ^*, the firm falls into exit. Let $r(\psi^*)$ denote firm revenue at ψ^*. Then, firm profit is obtained as

$$\pi(\psi^*) = \frac{r(\psi^*)}{\sigma} - (f+\phi^*), \tag{3-9}$$

where $\phi^* = b\mu[\varphi_L^{m*}]^{\mu}$, and $\varphi_L^{m*} = \left[\frac{(1-\gamma k)(k-1)}{k(m)^{\gamma}(\hat{\varphi}_L)^{\gamma k}}b\mu\right]^{\frac{1}{1-\gamma k-\mu}}$.

Under free entry, firm profit should be zero; $r(\psi^*) = \sigma(f+\phi^*)$. Due to searching cost, firms must earn higher revenue to survive. Using the ratio, $\frac{r_h(\varphi_h)}{r_k(\varphi_k)} = \left(\frac{\psi_h A(\varphi_L^{m*})}{\psi_k A(\varphi_L^{m*})}\right)^{\sigma-1} = \left(\frac{\psi_h}{\psi_k}\right)^{\sigma-1}$, average firm revenue can be found as $r(\bar{\psi}) = \left(\frac{\bar{\psi}}{\psi^*}\right)^{(\sigma-1)} r(\psi^*)$.

Then average firm profit can be found as

$$\pi(\bar{\psi}) = \left(\frac{\bar{\psi}}{\psi^*}\right)^{(\sigma-1)}\frac{r(\psi^*)}{\sigma} - f - \phi^*, \text{ where } r(\psi^*) = \sigma[f+\phi^*]. \tag{3-10}$$

(3-10) can be simplified as

$$\pi(\bar{\psi}) = \left[\left(\frac{\bar{\psi}}{\psi^*}\right)^{(\sigma-1)} - 1\right](f+\phi^*). \tag{3-11}$$

3.4. Free Entry and Value of Firm

One manager is matched with α_L workers. The ex-ante probability of successful entry is $p_s = P(\psi > \psi^*) = 1 - [\psi^*]^{-k}$. So net value v_e of entry can be obtained as $v_{ej} = p_j\bar{v} - f_e = \frac{1}{\delta}[1 - [\psi^*]^{-k}]\bar{\pi}(\cdot) - f_e$, where f_e is investment cost. In equilibrium, firms face the two conditions. First, firm profit should be zero at the cut-off level ψ^*. Second, net value of entry should be zero under perfect competition. Implicatively, the following two conditions should be satisfied.

$$1)\ \pi(\bar{\psi}) = \left[\left(\frac{\bar{\psi}}{\psi^*}\right)^{(\sigma-1)} - 1\right](f + \phi^*). \tag{3-12}$$

$$2)\ \pi(\bar{\psi}) = \frac{\delta[f+\phi^*]}{[\psi^*]^{-k}}. \tag{3-13}$$

The two conditions imply existence of stationary equilibrium $(\bar{\pi}, \psi^*)$. In equilibrium, $\varphi^* = \psi^* A(\varphi_L^{m*})$. The cut-off value reflects the optimal managerial quality. In every period, a mass M_e of new firms attempt to enter the industry. Among those firms, only a mass $p_s M_e$, can succeed to enter and substitute the mass δM, which are forced to exit due to an exogenous shock[15]. Thus, $p_s M_e = \delta M$.

Proposition 2: The cut-off value of entrepreneur skill is $\psi^* = \left[\left(\frac{\gamma(\sigma-1)}{\delta(k-\gamma(\sigma-1))}\right)\right]^{\frac{1}{k}}$, and the cut-off firm productivity is $\varphi^* = \frac{k(m)^{\gamma}(\hat{\varphi}_L)^{\gamma k}(\varphi_L^{m*})^{1-\gamma k}}{k-1}\left[\frac{\gamma(\sigma-1)}{\delta(k-\gamma(\sigma-1))}\right]^{\frac{1}{k}}$.

Proof: (3-13) can be written as

$$\pi(\bar{\psi}) = \frac{\delta[f+\phi^*]}{[\psi^*]^{-k}} = (\psi^*)^k \delta[f + \phi^*]. \tag{3-14}$$

As already, $\bar{\psi}$ was defined as

$$\bar{\psi}(\psi^*) = \left[\int_{\psi^*}^{\infty} [\psi]^{1-\sigma} \mu(\psi)\, d\psi\right]^{\frac{1}{1-\sigma}}, \tag{3-15}$$

where $\mu(\psi) = \frac{g(\psi)}{[1-G(\psi^*)]} = \frac{k}{\psi}\left(\frac{\psi^*}{\psi}\right)^k$ if $\psi \geq \psi^*$.

The integral (3-15) gives

$$\bar{\psi}(\psi^*) = \left[\frac{k}{k-\gamma(1-\sigma)}\right]^{\frac{1}{1-\sigma}} \psi^*. \tag{3-16}$$

By plugging (3-16) into (3-12), we have

$$\bar{\psi}(\psi^*) = \left[\left(\frac{\bar{\psi}}{\psi^*}\right)^{\gamma(\sigma-1)} - 1\right](f + \phi^*) = \left[\left(\frac{\gamma(\sigma-1)(f+\phi^*)}{k-\gamma(\sigma-1)}\right)\right]. \tag{3-17}$$

[15] The exogenous shock might be a political event, which can cause sudden changes of regulations for production factor.

From (3-13) and (3-17), we have an equation such as

$$(\psi^*)^k\delta[f+\phi^*] = \left[\left(\frac{\gamma(\sigma-1)(f+\phi^*)}{k-\gamma(\sigma-1)}\right)\right]. \tag{3-18}$$

$$\text{Then } \psi^* = \left[\left(\frac{\gamma(\sigma-1)}{\delta(k-\gamma(\sigma-1))}\right)\right]^{\frac{1}{k}}. \tag{3-19}$$

At the cut-off entrepreneur skill, cut-off firm productivity can be found as

$$\varphi^* = A(\varphi_L^{m*})\left[\left(\frac{\gamma(\sigma-1)}{\delta(k-\gamma(\sigma-1))}\right)\right]^{\frac{1}{k}} = \frac{k(m)^{\gamma}(\hat{\varphi}_L)^{\gamma k}(\varphi_L^{m*})^{1-\gamma k}}{k-1}\left[\frac{\gamma(\sigma-1)}{\delta(k-\gamma(\sigma-1))}\right]^{\frac{1}{k}}. \tag{3-20}$$

3.5. Market Clearing Conditions

In the economy, labor supply is a pool of individuals and denoted as $\bar{L}$. The individuals sort into workers and managers. Following Melitz (2003), P and I denote production and investment, respectively. At equilibrium, $L_P + L_I + m_p + m_I = \bar{L}$. The fixed proportion implies that $L_P = \alpha m_p$, and $L_I = \alpha m_I$, where $\alpha > 1$. Managers do not produce themselves but monitor workers. After hiring managers, firms hire workers for production. With contract, all firms pay workers the base wage w_L and managers the base wage w_m. Upon successful entry, entrant firms pay workers the incentive (extra payment) θ_L, and managers the incentive θ_m. Similarly, upon survival, incumbent firms pay workers the incentive θ_L, and managers the incentive θ_m. As in Melitz (2003), time preference is not considered; the incentive payments bear no interest rate. The labor cost for production is $L_p(w_L + \theta_L) + m_p(w_m + \theta_m)$. Aggregate payment for managers and workers should match the difference between aggregate revenue and firm profit; the labor cost for production equals $R - \Pi$. For production, market clearing condition is

$$L_p(w_L + \theta_L) + m_p(w_m + \theta_m) = R - \Pi. \tag{3-21}$$

The labor cost for investment is $L_I w_L + m_I w_M$, where $m_I = m\frac{\delta M}{p_s}$. The labor cost equals $M_e(f_e + \phi_e)$. For investment, market clearing condition is

$$L_I w_L + m_I w_M = M_e(f_e + \phi_e). \tag{3-22}$$

In stability, $p_s M_e = \delta M$, and, with free entry, $\bar{\pi} = \frac{\delta(f_e+\phi_e)}{p_s}$.

(3-22) can be rewritten as

$$L_I w_L + m_I w_M = M_e(f_e + \phi_e) = \frac{\delta M}{p_s}(f_e + \phi_e) = M\bar{\pi} = \Pi. \tag{3-23}$$

The equation implies that, at equilibrium, all profits within industry are allocated into entry investment. Then average firm revenue is $\bar{r} = \sigma(\bar{\pi} + f + \phi^*)$.

The mass of firms is obtained as

$$M = \frac{R}{\bar{r}} = \frac{[(w_L)L_I^* + (w_M)m_I^*] + [(w_L+\theta_w)L_P^* + (w_M+\theta_M)m_p^*]}{\sigma(\bar{\pi}+f+\phi^*)},$$

$$= \frac{[(w_L)\alpha + (w_M)]m_I^* + [(w_L+\theta_w)\alpha + (w_M+\theta_M)]m_p^*}{\sigma(\bar{\pi}+f+\phi^*)}. \tag{3-24}$$

Since $L_p^* = \alpha m_p^*$, $L_p^* + m_p^* = \alpha m_p^* + m_p^* = \bar{L}_p = (1-\delta)\bar{L}$.

Thus, $m_p^* = \frac{(1-\delta)\bar{L}}{(\alpha_L+1)}$. (3-25)

Similarly, $L_I^* = \alpha m_I^*$. So, $L_I^* + m_I^* = \alpha m_I^* + m_I^* = \bar{L}_I = \delta\bar{L}$.

Thus, $m_I^* = \frac{\delta\bar{L}}{(\alpha_L+1)}$. (3-26)

Plugging (3-24) and (3-25) into (3-23), the mass of firms is found as

$$M^* = \frac{R}{\bar{r}} = \frac{[\alpha w_L + w_M]\left(\frac{\delta\bar{L}}{\alpha+1}\right) + [\alpha(w_L+\theta_w) + (w_M+\theta_M)]\left(\frac{(1-\delta)\bar{L}}{\alpha+1}\right)}{\sigma(\bar{\pi}+f+\phi^*)}, \quad (3\text{-}27)$$

where $\phi^* = b\mu[\varphi_L^*]^\mu$.

In Melitz (2003), all firms pay the same wage although a bad shock drives some firms to exit. In our paper, the exit firms pay workers less. That is, incumbent firms pay more than entrant firms. Managerial hierarchy also stratifies wage. That is, base wage is greater for managers than workers. Searching cost reduces the mass of active firms. Unlike fixed cost, searching cost is a variable sunk cost.

4. Open Economy

The equilibrium can be analyzed similarly as in Melitz (2003). Exporting incurs cost in two directions. First, it requires additional fixed cost. Second, marginal cost increases due to transportation cost. Owing to the additional costs, exporting price should be higher than domestic price. Let d and x denote domestic and export, respectively. Then

$$p_d(\psi) = \frac{1}{\rho}\left[\frac{\alpha w_L + w_M}{\psi A(\varphi_L^{m*})}\right]. \quad (4\text{-}1)$$

$$p_x(\psi) = \frac{\tau}{\rho}\left[\frac{\alpha w_L + w_M}{\psi A(\varphi_L^{m*})}\right], \quad (4\text{-}2)$$

where τ is the per-unit trade cost.

Simply, $p_X(\cdot) = \tau p_d(\cdot)$. From domestic market, firm revenue is $r_d(\cdot)$. From exporting, firm revenue becomes $r_X(\cdot) = \tau^{1-\sigma} r_d(\cdot)$. Overall, total firm revenue is

$$r_T(\cdot) = r_d(\cdot) + r_X(\cdot) = (1+\tau^{1-\sigma}) r_d(\cdot). \quad (4\text{-}3)$$

Let ψ_x^* denote the cut-off entrepreneur skill for exporting. Only incumbent firms can export. With exporting, a firm earns $\pi_d(\cdot)$ from domestic sale and $\pi_x(\cdot)$ from international sale. Then the firm profit becomes $\pi_T(\cdot) = \pi_d(\cdot) + \pi_x(\cdot)$. Similarly as in the closed economy, firm value is given as $v(\cdot)$. On the one hand, φ^* represents the cut-off firm productivity for production; $\varphi^* = \psi^* A(\varphi_L^{m*})$. On the other hand, φ_x^* represents the cut-off firm productivity for exporting; $\varphi_x^* = \psi_x^* A(\varphi_{Lx}^{m*})$. By definition, the cut-off values should satisfy $\pi(\psi^*) = 0$ and $\pi_x(\psi_x^*) = 0$. Using the ratio, $\frac{r_h(\varphi_h)}{r_k(\varphi_k)} = \left(\frac{\psi_h A(\varphi_L^{m*})}{\psi_k A(\varphi_L^{m*})}\right)^{\sigma-1} = \left(\frac{\psi_h}{\psi_k}\right)^{\sigma-1} = \frac{r_h(\psi_h)}{r_k(\psi_k)}$, the cut-off value ψ_x^* can be found.

$$\frac{r_X(\varphi_X^*)}{r(\varphi^*)} = \tau^{1-\sigma}\left(\frac{\psi_X A(\varphi_L^{m*})}{\psi A(\varphi_L^{m*})}\right)^{\sigma-1} = \tau^{1-\sigma}\left(\frac{\psi_X^*}{\psi^*}\right)^{\sigma-1} = \frac{f_X}{f+\phi^*}. \quad (4\text{-}4)$$

From

$$(4\text{-}4),\ \psi_X^* = \tau\left(\frac{f_X}{f+\phi^*}\right)^{\frac{1}{\sigma-1}}\psi^*. \quad (4\text{-}5)$$

From the equations above, we can find that the cut-off value is greater for exporting than production. The difference arises from the fixed costs. In the closed economy, ex-ante probability of successful entry is $[1-p(\psi<\psi^*)] = [\psi^*]^{-k}$. In the open economy, ex-ante probability of exporting is $p_X = \frac{[1-p(\psi<\psi_X^*)]}{[1-p(\psi<\psi^*)]} = \left(\frac{\psi_X^*}{\psi^*}\right)^{-k}$. Thus, mass of exporting firms is determined as $M_X = p_x M$. Then total mass of firms is $M_T = M + M_X$. Aggregate productivity is obtained as

$$\bar{\varphi}_T = \left[\frac{1}{M_T}[M(\varphi^*)^{\sigma-1} + M_X(\tau^{-1}\varphi_X^*)^{\sigma-1}]\right]^{\frac{1}{\sigma-1}}. \quad (4\text{-}6)$$

Given $\bar{\varphi}_T$, other aggregates can be found as follows.

$$P_T = M_T(\bar{\varphi}_T)^{\frac{1}{1-\sigma}}p(\bar{\varphi}_T),\ Q_T = (M_T)^{\frac{1}{\rho}}p(\bar{\varphi}_T), \text{ and } R_T = P_T Q_T = M_T\bar{r}_T(\bar{\varphi}_T).$$

Average firm profit is $\bar{\pi}_T(\bar{\varphi}_T) = \bar{\pi}(\bar{\varphi}) + p_X n\pi_X(\bar{\varphi}_X)$, whereas average firm revenue is $\bar{r}_T(\bar{\varphi}_T) = \bar{r}(\bar{\varphi}) + p_X n\bar{r}_X(\bar{\varphi}_X)$,
where $\bar{r}(\bar{\varphi}) = \sigma[\bar{\pi} + f + \phi^*]$, and $\bar{r}_X(\bar{\varphi}_X) = \sigma[f_X]$.
Then $\bar{r}_T(\bar{\varphi}_T) = \sigma[\bar{\pi} + f + \phi^*] + p_X\sigma[f_X]$.
With exporting, average firm revenue and mass of firms increase by $p_X\sigma[f_X]$ and M_X, respectively. As a bad shock hits the economy, only a mass, $p_X M_X$ out of all incumbents can survive. Then, total mass of firms increases to $M_T = M + p_X M_X$ within the industry when the economy is open.

$$M_T = \frac{R_T}{\bar{r}_T} = \frac{R_d + R_X}{\sigma([\bar{\pi}+f+\phi^*]+p_X f_X)},$$
$$= \frac{(1+\tau^{1-\sigma})\left[[\alpha w_L + w_M]\left(\frac{\delta\bar{L}}{\alpha+1}\right) + [\alpha(w_L+\theta_w)+(w_M+\theta_M)]\left(\frac{(1-\delta)\bar{L}}{\alpha+1}\right)\right]}{\sigma([\bar{\pi}+f+\phi^*]+p_X f_X)}. \quad (4\text{-}7)$$

Under the assumption of symmetric country, total mass of firms is the same in both countries. By symmetry, the countries have same distribution of talents. As the distribution is different between countries, the total mass of firms should be different. In the next section, we will consider asymmetric countries.

5. Discussion: Asymmetric Countries

In this section, we consider asymmetric countries, which differ only in distributional property of talents. That is, k differs between two countries. Higher k means that distribution is skewed toward higher talents. Thus, the searching cost ϕ should differ. If one country is

relatively abundant of high talents, the searching cost should be lower. The smaller searching cost implies the lower cut-off firm productivity. We will show that difference in distributional property can affect trade pattern. Let us say that Country 1 is relatively abundant of talent than Country 2. Then k is higher in Country 1 than Country 2. In Country 1, searching cost is $\phi_1^* = b\mu[\varphi_{L1}^*]^{\mu}$, whereas, in Country 2, searching cost is $\phi_2^* = b\mu[\varphi_{L2}^*]^{\mu}$.

Proposition 3: The cut-off entrepreneur skill of exporting is higher in Country 2 than in Country 1.

Proof: from the ratio, $\frac{r_{iX}(\varphi_{iX}^*)}{r_i(\varphi_i^*)} = \tau^{1-\sigma}\left(\frac{\psi_{iX}^*}{\psi_i^*}\right)^{\sigma-1} = \frac{f_X}{f+\phi_i}$, cut-off entrepreneur skills of exporting for Country 1 and Country 2 can be found as $\psi_{1X}^* = \tau\left(\frac{f_X}{f+\phi_1}\right)^{\frac{1}{\sigma-1}}\psi_1^*$, and $\psi_{2X}^* = \tau\left(\frac{f_X}{f+\phi_2}\right)^{\frac{1}{\sigma-1}}\psi_2^*$, respectively. Since $k_1 > k_2$, it implies that $\phi_1^* < \phi_2^*$, and $\psi_1^* > \psi_2^*$. Thus, $\psi_{2x}^* > \psi_{1x}^*$.

Since the cut-off values of exporting differ between two countries, the ex-ante probability of successful entry should differ. Let p_{ix} denote the probability for Country i. That is, $p_{ix} = \frac{[1-p(\psi<\psi_{iX}^*)]}{[1-p(\psi<\psi_i^*)]}$. Then, $p_{1x} > p_{2x}$. Trade openness raises the cut-off firm value of exporting more sharply in country 2 than in country 1. Implicatively, survival rate of firms is lower in Country 2 than in Country 1. For Country i, mass of exporting firms is determined as $M_{iX} = P_{iX}M_i$. Then total mass of firms is $M_{iT} = M_i + M_{iX}$. With exporting, average firm revenue and mass of firms increase by $p_{iX}\sigma[f_X]$ and M_{iX}, respectively, for each Country i. Like M_i, M_{iX} is determined with average firm revenue and fixed cost. As a bad shock hits the economy, only a mass, $p_{iX}M_{iX}$ out of all incumbents can survive in country i. Thus, total mass of firms increases to $M_i^T = M_i + p_X M_{iX}$ in Country i when the economy is open. For both countries, total masses of firms are obtained as follows.

For country 1,

$$M_1^T = \frac{R_{1T}}{\bar{r}_{1T}} = \frac{R_{1d}+R_{1X}}{\sigma([\bar{\pi}_1+f+\phi_1^*]+p_{1X}f_X)} = \frac{(1+\tau^{1-\sigma})R_{1d}}{\sigma([\bar{\pi}_1+f+\phi_1^*]+p_{1X}f_X)},$$

$$= \frac{(1+\tau^{1-\sigma})\left[[\alpha w_L+w_M]\left(\frac{\delta\bar{L}}{\alpha+1}\right)+[\alpha(w_L+\theta_w)+(w_M+\theta_M)]\left(\frac{(1-\delta)\bar{L}}{\alpha+1}\right)\right]}{\sigma([\bar{\pi}_1+f+\phi_1^*]+p_{1X}f_X)}. \quad (5\text{-}1)$$

For country 2,

$$M_2^T = \frac{R_{2T}}{\bar{r}_{2T}} = \frac{R_{2d}+R_{2X}}{\sigma([\bar{\pi}_2+f+\phi_2^*]+p_{2X}f_X)} = \frac{(1+\tau^{1-\sigma})R_{2d}}{\sigma([\bar{\pi}_2+f+\phi_2^*]+p_{2X}f_X)},$$

$$= \frac{(1+\tau^{1-\sigma})\left[[\alpha w_L+w_M]\left(\frac{\delta\bar{L}}{\alpha+1}\right)+[\alpha(w_L+\theta_w)+(w_M+\theta_M)]\left(\frac{(1-\delta)\bar{L}}{\alpha+1}\right)\right]}{\sigma([\bar{\pi}_2+f+\phi_2^*]+p_{2X}f_X)}. \quad (5\text{-}2)$$

When all things are equal, firm mass is reduced more sharply in Country 2 than in Country 1. Due to reduction of firm mass, income decreases in Country 2. This is because incumbent

firms pay more than entrant firms. Reduction of firm mass implies destruction of good jobs. That is, higher searching cost leads to lower income. Welfare per worker is given as

$$W = M^{\frac{1}{\sigma-1}} p^{-1} = M^{\frac{1}{\sigma-1}} \rho \bar{\varphi}. \quad (5\text{-}3)$$

For both countries, trade openness improves aggregate productivity, and lowers aggregate price. However, firm mass is greater in country 1 than in Country 2. That is, good jobs are more available in Country 1 than in Country 2. Thus, welfare is higher in Country 1 than in Country 2. Both countries still can gain from trade. However, the trade gains are asymmetric. Country 1 gains more than Country 2.

6. Conclusion

In this paper, firm productivity arises primarily from human resource management. Thus, distribution of talent plays important role in aggregate productivity and aggregate income. We have examined how human resource management would impact intra-industry resource allocation. In the model, firms decide a cut-off eligibility to hire prospect managers for internal labor market. When prospects are promoted to managing positions, they contribute to improving firm productivity with their talents. In process, entrepreneur skill is rquired. That is, entrepreneur converts talents of managers into firm productivity. Thus firms acheive firm productivities differently according to entrepreneur skill, which is exogenously distributed. One point is that firm productivity is a composition of entrepreneur skill and managerial quality. Unlike entrepreneur skill, managerial quality can be optimally chosen. Optimal managerial quality depends on distributional property of talents. This study examined wage stratification. Hierarchy of management generates wage inequality between managers and workers within firms. Under incompleteness of labor market, incentive contract generates wage inequality between incumbent firms and entrant firms. That is, entrant firms pay less than incumbent firms. When distribution of talent is identical between two countries, the main implication is similar as that of Melitz (2003). However, when distribution of talent differs between two countries, we predict the following. The country of talent abundance gains from trade more than the country of talent scarcity. Due to the higher searching cost, survival rate of firms is lower in the country of talent scarcity. That is, the mass of incumbent firms should be reduced more in the country of talent scarcity. Implicatively, good jobs are more available in the country of talent abundance. So, aggregate income is greater in the country of talent abundance. This paper provides new implication. Conclusively, distribution of talent plays the important role of determining trade gain and welfare.

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