Effects of Globalization on Educational Choice and Unemployment under Search Friction

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Abstract

Trade liberalization increases the import of foreign goods fosters the penetration of foreign firms into the local markets and makes local markets more competitive. To survive the severer competition, local firms must improve the qualities of production factor,goods and employ more highly skilled workers more. An increase in the demand for skilled workers encourages workers to pursue higher education. Despite that the world economy has witnessed the trend of freer international transactions in decades, However, the recent trend of the employment of highly educated workers is seems stagnant in many countries, in particular, in developed countries globally. Although trade liberalization enhances the demand for skilled workers, it may does not necessarily contribute to increasing an improvement of their employment.

I analyze how trade liberalization affects the local employment of both skilled workers, and unskilled workers, occupational choices by workers, and the wage inequality between skilled and unskilled workers. If When firms a firm start to production enters the market, they it must has to employ one unit of skilled worker labor to develop its own variety of the differentiated good in advance of actual production and some unskilled workers. The abilities of Each skilled workers has are heterogeneous ability, so that the ex post productivities of firms are become different heterogeneous ex post. The unskilled workers, whose abilities are homogeneous, are used for the production of the good. However, due to search friction, matches between firms and to unskilled and skilled workers (either skilled or unskilled)

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are not always successful. With this knowledge, knowing all this, workers choose make their educational choices: and either to remain to be unskilled workers or to get educated to be skilled workers learn skills. Trade liberalization changes affects the wage rates of unskilled and skilled workers and the successful probability of successful matching, which may encourage unskilled workers to learn skill but increase the number of the skilled workers after trade liberalization. Therefore, the unemployment rate of the skilled workers may increase after globalization.

1 Introduction

The volume of world trade increased after World War II, and globalization increased rapidly through various free trade agreements. Simultaneously, the level of education also increased in many developed countries. In Japan, for example, the university enrollment rate was approximately 15 % in the 1950s, increased to 51% in 2013. The main reason for the increase in the university enrollment rate is the improvement of household incomes. Recently, the trend of globalization promotes firms to demand well-educated workers to survive severe competition by foreign firms. Some firms requires people with the communication skills to negotiate with the foreign companies. Others require those with a high education to advance ahead of the market competition. Many countries introduce foreign language course work in compulsory education and invite foreign engineers and businessmen to attend to these courses. Consequently, trade liberalization accelerates the popularization of higher education.

How do the trend of globalization and the popularization of higher education affect the domestic labor market? The results of basic survey of Japanese schools show that the university advancement rate has increased in Japan, but the employment rate is flattening out. Furthermore, the employment rate of those who graduated from higher education professional schools is also not increasing. Not only Japan, but other OECD countries face the similar situation. In Korea, only about 60 % of young people who graduated from university can get a job.[1] The

[1] Han, H. (2016) Envious of Japanese young people whose employment markets have been opened widely = South Korea, Korean Joongang Daily translated by Japanese, Retrieved from November 22, 2016 from http://japanese.joins.com/article/593/213593.html.

university enrollment rate is 70% in Korea, which is higher than Japan in 2010[2]. Moreover, jobless rate for young people is 12.5% in 2016. In the United States, Associated Press (AP) reported that 1 in 2 (53%) new graduates are jobless or underemployed or underemployed in 2012[3]. Although the university enrollment rate is 74%, many young people faces the problem of unemployment.

Consequently, the recent trend of globalization and popularization of higher education does not always get good effects on the local labor market. This article considers the relationship between popularization of higher education and the employment rate from the aspect of international trade. In particular, we investigates how globalization affects various types of jobs and the unemployment rate (and the employment rate). There are two symmetric countries that produce differentiated goods with labor. We consider two types of labor: skilled and unskilled workers. Unskilled workers are used for the production of the differentiated good. Skilled workers have heterogeneous abilities, and a firm must employ one skilled worker to start a business. The ability of the hired skilled labor also determines the firm's productivity. Therefore, the firm that succeeds in hiring a skilled worker with a higher ability realizes a higher productivity. As we assumed the abilities of the skilled workers are distributed over a certain range, firm's productivity varies according to the distribution of the abilities of the hired skilled workers. In other words, the firms in the market become heterogeneous *ex post*, which is similar to Melitz's (2003) model.

We introduce information asymmetry between firms and workers in the both skilled and unskilled labor market. To find a skilled worker and some unskilled workers, the firm has to pay a search cost and it can randomly meet the workers. After matching, the firm and the skilled worker negotiate the skilled wage. If the negotiation between a firm and a skilled worker succeeds, the firm can start producing the differentiated goods, and workers earn the higher negotiated wage income. On the other hand, we assume that the unskilled labor wage is competitively determined, where the unskilled labor demand of the firms equals to the

[2]OECD (2012) "Education at a Glance 2012."

[3]Yen, H. (2012, April 24) 1 in 2 new graduates are jobless or underemployed Associated Press Retrieved November 22th, 2016 from https://www.yahoo.com/news/1-2-graduates-jobless-underemployed-140300522.html.

unskilled labor supply. Workers can choose whether to take an education at the beginning of the period. Unskilled workers enter the labor force without education, while the income of the unskilled workers is independent of their ability. When unskilled workers pursue an education with education cost, they can realize their ability and become skilled workers. If the skilled workers are successfully employed, they earn a more proportionately higher income. Comparing with the unskilled and skilled income, which depend on workers own ability, workers decide whether to be unskilled and skilled.

Our model have two ability cutoffs: educational cutoff and production cutoff. Educational cutoff is a ability boundary between skilled worker and unskilled worker. A person with ability above educational cutoff becomes a skilled labor, and otherwise the person works as an unskilled labor. Educational cutoff is determined by educational choice, where a worker with educational cutoff is indifferent between being skilled and unskilled. On the other hand, production cutoff is determined by firm's free entry, which is familiar with Melitz (2003)'s cutoff productivity. If a firm matches with a skilled worker who has a ability above production cutoff, the firm can continue operation with a positive profit. However, firms which employ a skilled worker below production cutoff ability face the negative profit and exit the market. Therefore, the skilled workers have two reasons of unemployment: search friction and ability below production cutoff. First, since the matching with skilled worker and firm is stochastic, some skilled workers fails to meet a firm. This type of unemployment is common to search and matching model of Pissarides (2000). Secondly, due to free entry, skilled workers with lower ability than productivity cutoff must be unemployed even if they are able to meet firm. Since the skilled workers' ability is distributed over education cutoff, the skilled workers between education cutoff and productivity cutoff are certainly unemployed.

We consider international trade between two symmetric countries; additionally, there are ice-berg costs for exporting the differentiated goods to the foreign country. Trade liberalization raises demand of the differentiated goods, and the profit of the goods increases. Since the profit is distributed to a firm and skilled workers through negotiation, the increase in profit leads to an increase in the bargaining wage rate. The increase in the profit of the firms attracts the potential firm to enter the search for the skilled workers. Therefore, the demand of the skilled worker increases. The increase of the bargaining wage rate and the demand for skilled workers increases the incentive to become the skilled worker. However, these changes raise the total income of a country, and the value of unskilled workers also increases. The effect of globalization is ambiguous on educational choices. However, we find it possible that globalization may increase skilled unemployment.

Our study relates to the literature of international trade with the labor-search model. Davis (1998) and Davidson and Matusz (2004) introduced incompleteness of labor market into neoclassical trade model and investigated the effect of trade pattern and unemployment. Recently, researches introducing incompleteness of labor market into monopolistic competition model has increased. For example, Helpman and Itskhoki (2009), Helpman et al. (2010a,b), Egger and Kreickemeier (2009, 2012), and Ferlbermayr et al. (2010) investigated the effects of globalization on local unemployment. They showed that there are two contradictory effects international trade on the labor market. First, globalization increases the average productivity of the industry through the selection of low-productivity firms, which increases employment. Secondly, since an increase in the average productivity means an increase in the effective firms, the rise in employment is not much greater than the increase in production. Consequently, the employment contracts. However, their model does not determine the firm's productivity in the labor market. In their model, the lottery determines the productivity of a firm. A firm with relatively high productivity negotiates with skilled workers, whereas another firm with relatively low productivity exits from the market. Although the entry and exit of a firm depend on the productivity lottery and labor matching, productivity and the industry structure are not affected as much by labor matching.

This article also relates to the choice between skilled and unskilled workers. Furusawa et al. (2021), Falvey et al. (2010), and Danziger (2017) introduce the endogenous decision of skilled and unskilled workers. Furusawa et al. (2021) assumes that the firm's productivity is depends on the ability of the skilled workers. Trade liberalization raises the profit of the firm with well-skilled workers and expands the income inequality between unskilled and skilled labor. Falvey et al. (2010) and Danziger (2017) assume that workers have heterogeneous ability but they do not realize their ability unless education. They have concluded that trade increases the demand for educated workers and induces workers more schooling decisions. However, Furusawa et al. (2021), Falvey et al. (2010), and Daniziger (2017) assume full employment, so that they do not consider effect of trade liberalization on unemployment problem.

Zenou (2008) introduced the labor search model into the skilled labor market and investigated the worker's job choices between skilled and unskilled workers. Some may argue that the unemployment problem with the unskilled workers is more important than that of skilled workers . However, Zenou noted that the laws of regarding skilled workers are stricter and that their position is more affected by policy change than that of unskilled workers. Because we focus on the relationship between the popularization of higher education and the low employment rate of highly skilled workers, it is reasonable to consider the unemployment problem of skilled workers. Zenou addresses this problem only with a partial equilibrium and in an autarky economy and considers only the unemployment of the skilled worker. It is important to consider not only the unemployment problem of the skilled labor but the unemployment of the unskilled labor. Therefore, we introduce the unemployment the unskilled labor and consider the effect of globalization.

The remainder of the paper is organized as follows. Section 2 explains the base of the model and the equilibrium under autarky. Section 3 analyzes the effect of globalization. Section 4 concludes with a summary and a discussion of future research.

2 The Model

2.1 Preference

The differentiated good consists of a continuum of varieties; the set of differentiated varieties is denoted by Ω. We assume a CES utility function:

$$u = \left[\int_{\omega \in \Omega} x(\omega)^{\frac{\sigma-1}{\sigma}} \mathrm{d}\omega \right]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where $x(\omega)$ denotes the consumption level of variety $\omega \in \Omega$ and $\sigma > 1$ denotes the elasticity of substitution. Normalizing the total nominal expenditure on the differentiated good equal to unity, we obtain the following demand function for each differentiated variety: for $\omega \in \Omega$,

$$x(\omega) = \frac{p(\omega)^{-\sigma}}{P^{1-\sigma}}, \tag{2}$$

where $p(\omega)$ denotes the price of variety $\omega \in \Omega$ and P is the price index of the differentiated good defined as follows:

$$P \equiv \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma}\mathrm{d}\omega\right]^{\frac{1}{1-\sigma}}. \tag{3}$$

2.2 Distributions of Potential and Realized Abilities

There is a continuum of potential workers; the measure of them is denoted by N. Every potential worker shares an equal basic ability to serve as an unskilled worker. At the same time, each worker has its own "potential educated ability" that makes it possible for the worker to serve as a skilled worker. The potential educated ability of a worker, however, is realized only after the worker gets educated by incurring the cost of education. Potential workers can always enter the unskilled labor market without any additional cost of education. In contrast, if potential workers want to enter the skilled labor market (seeking for higher skilled wage rates), they have to pay the costs of education to realize their educated abilities.

The potential educated abilities are distributed over the range of nonnegative reals: $\mathbb{R}_+$. The cumulative distribution function of the potential educated ability is denoted by $G\colon \mathbb{R}_+ \to [0, 1]$. The corresponding density function is denoted by $g\colon \mathbb{R}_+ \to \mathbb{R}_+$. Not all potential workers want to get educated. In other words, the distribution G (or g) is not necessarily realized on the whole domain.

Suppose, for the moment, that there is a lower boundary $\underline{\alpha} > 0$ of the potential educated ability such that every worker with the potential educated ability α lower than $\underline{\alpha}$ chooses not to be educated, while every worker with the potential educated ability α no less than $\underline{\alpha}$ chooses to get educated. Then, given the educational choices by the potential workers, we obtain the distribution of the realized educated abilities. The distribution function of the realized educated abilities, denoted by $F\colon \mathbb{R}_+ \to [0,1]$, becomes as follows:

$$F(\alpha) \equiv \begin{cases} \dfrac{G(\alpha) - G(\underline{\alpha})}{1 - G(\underline{\alpha})} & \text{if } \alpha \geq \underline{\alpha}, \\ 0 & \text{if } \alpha < \underline{\alpha}. \end{cases} \tag{4}$$

The corresponding density function, denoted by $f\colon \mathbb{R}_+ \to \mathbb{R}_+$, is

$$f(\alpha) \equiv \begin{cases} \dfrac{g(\alpha)}{1 - G(\underline{\alpha})} & \text{if } \alpha \geq \underline{\alpha}, \\ 0 & \text{if } \alpha < \underline{\alpha}. \end{cases} \tag{5}$$

It should be noted that both the distribution function F and the density function f depend upon the lower boundary $\underline{\alpha}$, which, in turn, depends upon the workers' educational choices. In a later section, we will show that there exists such a lower boundary of the potential educated ability as described above.

2.3 Matching Technology

Suppose, for the moment, there are H skilled workers and L unskilled workers in this economy. We denote the measure of unemployed skilled workers by u_H and that of unemployed unskilled workers by u_L. In turn, firms want to hire certain amounts of skilled workers and unskilled workers and, therefore, post their vacancies to each of the labor markets. The total vacancy posted by the firms for the skilled labor is denoted by v_H and that for the unskilled labor by v_L.

Both the skilled and unskilled labor markets are not perfect. We adopt the framework of the search-matching labor market friction model developed by Pissarides (2000). The labor market frictions are represented by the following matching functions, through which firms and workers are matched randomly: for $i = H, L$,

$$M_i(u_i, v_i).$$

The matching function represents the flow rate of realized matches between firms and workers. We assume that the matching technology is increasing and exhibits constant-returns-to-scale (CRS). In each of the markets, when the number of unemployed workers increases, it becomes easier for the firms to be matched with workers. Similarly, an increase in the vacancies makes it easier for workers to find their jobs. If both the number of unemployed workers and the number of vacancies increase proportionally, the number of the matched pairs also increases at the same proportion.

For $i = H, L$, let $\theta_i \equiv v_i/u_i$ be the ratio of the numbers of the unmatched firms and the unemployed workers, which is called the labor market tightness. Consider the unskilled labor market. The probability of successful matching for a firm can be written as a function m of the labor market tightness θ_L:

$$m(\theta_L) \equiv \frac{M_L(v_L, u_L)}{v_L} = M_L(v_L/v_L, u_L/v_L) = M_L(1, 1/\theta_L). \tag{6}$$

The second equality follows from the CRS matching technology. Since M_L is increasing in its arguments, m is decreasing in θ_L. Similarly, the probability of successful matching for a worker can be written as a function of θ_H as follows:

$$\theta_L m(\theta_L) \equiv \frac{M_L(v_L, u_L)}{u_L} = \frac{M_L(v_L, u_L)/v_L}{u_L/v_L} = \frac{M_L(1, 1/\theta_L)}{1/\theta_L}. \tag{7}$$

It is easy to verify that $\theta_L m(\theta_L)$ is increasing in θ_L. From a single firm's point of view, an increase in the labor market tightness means an increase in the number of competitors in search of workers and, therefore, induces a lower probability of successful matching. In contrast, from a single worker's point of view, an increase in the labor market tightness means an increase in the number of job offers and induces a higher probability of successful matching.

Similar to the unskilled labor market, the probabilities of successful matching in the skilled labor market for a single firm and that for a single worker can be written as functions of the labor market tightness θ_H:

$$n(\theta_H) \equiv \frac{M_H(v_H, u_H)}{v_H} = M_H(1, 1/\theta_H), \qquad \text{[for a firm]} \tag{8}$$

$$\theta_H n(\theta_H) \equiv \frac{M_H(v_H, u_H)}{u_H} = \frac{M_H(1, 1/\theta_H)}{1/\theta_H}. \qquad \text{[for a worker]} \tag{9}$$

We can show that $n(\theta_H)$ is decreasing in θ_H and $\theta_H n(\theta_H)$ is increasing in θ_H.[4]

[4]Sometimes, the Inada-like conditions are required: $\lim_{\theta\to+\infty} m(\theta) = \lim_{\theta\to+\infty} n(\theta) = 0$ and $\lim_{\theta\to+0} m(\theta) = \lim_{\theta\to+0} n\theta) = +\infty$

2.4 Behavior of a Firm

There is a huge pool of potential firms, which are homogeneous *ex ante*. Each potential firm is contemplating entering the market of the differentiated good. To enter the market, each firm has to pay a fixed entry cost once and for all.[5] In addition, when a firm enters the market, it has to hire one unit of skilled labor in order to develop its own differentiated variety. The ability of the skilled labor hired by a firm also determines the firm's productivity. Therefore, the firm that succeeds in hiring a skilled worker with a higher ability can realize a higher productivity. As we assumed the abilities of the skilled workers are distributed over a certain range, the productivity of firms varies according to the distribution of the abilities of the hired skilled workers. In other words, the firms in the market become heterogeneous *ex post*.

Suppose that a firm has succeeded both in the entry and in the employment of a skilled worker with the educated ability α. To produce the differentiated variety developed by the skilled worker, the firm has to employ a certain number of unskilled workers. We assume that the input-coefficient of unskilled labor of a firm is equal to the inverse of the skilled worker's ability employed by the firm, that is, $1/\alpha$. Accordingly, to produce $x(\omega)$ units of the differentiated variety ω, the firm needs to employ $\ell = x(\omega)/\alpha$ units of unskilled workers; equivalently, if the firm employs ℓ units of unskilled workers, it can produce $x(\omega) = \ell\alpha$ units of variety ω. Given the demand function for a certain variety ω (i.e., Eq. (2)), the total revenue accruing to the firm when it employs ℓ units of unskilled workers becomes a function R of ℓ and α as follows:

$$R(\ell, \alpha) \equiv [\ell\alpha P]^{\frac{\sigma-1}{\sigma}}. \tag{10}$$

Strictly speaking, R depends upon the price index P, but we omit P from the expression of R for simplicity.

Consider an operating firm matched with ℓ units of unskilled workers[6] and a certain skilled worker whose educated ability being α. In each period, the firm and the employed workers are hit by two independent idiosyncratic shocks: (i)

[5] We will discuss the nature of the fixed entry cost more in detail later.

[6] We identify ℓ with the number of jobs conducted by the unskilled workers in this firm

with probability s_H, the matched pair of the firm and the skilled worker breaks up and, then, the firm leaves the market immediately and the skilled worker becomes unemployed; (ii) with probability χ, each job is destroyed because of some match-specific shocks, in other words, χ portion of ℓ unskilled workers (i.e., $\chi\ell$ workers) are fired due to these shocks. For each of the employed unskilled workers, the probability of losing his/her job is $s_L \equiv 1-(1-s_H)(1-\chi) = s_H + \chi - s_H\chi$, which we call the rate of job separation.

Optimal vacancy posting In each period, taking the unskilled wage rate w_L as given, each firm decides the optimal number of vacancy posting. Let $J(\ell,\alpha)$ be the optimal value function of a firm with productivity α who employs ℓ units of unskilled workers (at the beginning of a period). The dynamic programming problem of the firm is formulated as follows:

$$J(\ell_t,\alpha) = \max_{k_t} \frac{1}{1+r}\left[R(\ell_t,\alpha) - w_L\ell_t - c_L k_t - w_H + (1-s_H)J(\ell_{t+1},\alpha)\right] \tag{11}$$

$$\text{s.t.} \quad \ell_{t+1} = (1-\chi)\ell_t + m(\theta_L)k_t. \tag{12}$$

The FOC for the maximization of the RHS of Eq. (11) is

$$\frac{c_L}{m(\theta_L)} = (1-s_H)\frac{\partial J(\ell_{t+1},\alpha)}{\partial \ell}. \tag{13}$$

Applying the Envelope Theorem to Eqs. (11) and (12), we obtain

$$\frac{\partial J(\ell_t,\alpha)}{\partial \ell} = \frac{1}{1+r}\left[\frac{\partial R(\ell_t,\alpha)}{\partial \ell} - w_L + (1-\chi)(1-s_H)\frac{\partial J(\ell_{t+1},\alpha)}{\partial \ell}\right]. \tag{14}$$

In the steady state where $\ell_t = \ell_{t+1} = \ell$ for all t, we have $\partial J(\ell_t,\alpha)/\partial\ell = \partial J(\ell_{t+1},\alpha)/\partial\ell = \partial J(\ell,\alpha)/\partial\ell$. Therefore, by substituting Eq. (13) into Eq. (14), we obtain

$$\frac{\partial R(\ell,\alpha)}{\partial \ell} = w_L + \frac{(r+s_L)c_L}{(1-s_H)m(\theta_L)}. \tag{15}$$

Taking account of the definition of $R(\ell,\alpha)$, we can solve the above equation for ℓ, which can be regarded as a function of α:

$$\begin{aligned}\ell(\alpha) &= \left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\left[w_L + \frac{(r+s_L)c_L}{(1-s_H)m(\theta_L)}\right]^{-\sigma} P^{\sigma-1}\alpha^{\sigma-1} \\ &= \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} A^{-\sigma}P^{\sigma-1}\alpha^{\sigma-1},\end{aligned} \tag{16}$$

where

$$A \equiv w_L + \frac{(r + s_L)c_L}{(1 - s_H)m(\theta_L)}. \tag{17}$$

Because the RHS depends negatively upon the unskilled wage rate w_L, then $\ell(\alpha)$ can be regarded as the firm's demand function for unskilled workers.[7] The equation of motion, Eq. (12), in the steady state implies $k = \chi\ell/m(\theta_L)$. Then, the optimal vacancy posting of the firm with productivity α, denoted by $k(\alpha)$, becomes proportional to $\ell(\alpha)$:

$$k(\alpha) = \frac{\chi}{m(\theta_L)}\ell(\alpha). \tag{18}$$

Value of a firm Substituting Eq. (16) and Eq. (18) into Eq. (11), we can solve it for $J(\ell(\alpha), \alpha)$, which is the "value" of a firm. As can be easily seen from Eq. (11), the value of a firm depends not only on the firm's productivity α but also on the skilled wage rate w_H. For the ease of subsequent analysis, we shall write the value of a firm as a function $\hat{J}$ of the firm's productivity α and the skilled wage rate w_H:

$$\begin{aligned} \hat{J}(\alpha, w_H) &= \frac{1}{r + s_H}\left[R(\ell(\alpha), \alpha) - w_L\ell(\alpha) - c_L k(\alpha) - w_H\right] \\ &= \frac{1}{r + s_H}\left[R(\ell(\alpha), \alpha) - \left\{w_L + \frac{c_L\chi}{m(\theta_L)}\right\}\ell(\alpha) - w_H\right] \end{aligned} \tag{19}$$

Note that Eq. (19) only considers the value of operating firms. The firms pay vacancy costs for simultaneously searching ℓ's unskilled workers and have wait one period to recruit their workers. In this period, they can be hit by a destruction shock, with probability s_H till starting production, so that they never start producing. Using Eq. (19), we define the value of the entering firm, $\Pi(\alpha, w_H)$ as

$$\begin{aligned} \Pi(\alpha, w_H) &\equiv (1 - s_H)\hat{J}(\alpha, w_H) - \frac{c_L}{m(\theta_L)}\ell(\alpha) \\ &= \frac{1 - s_H}{r + s_H}\left[R(\ell(\alpha), \alpha) - w_L\ell(\alpha) - \frac{(r + s_L)c_L}{(1 - s_H)m(\theta)}\ell(\alpha) - w_H\right] \end{aligned} \tag{20}$$

Obviously, Π is increasing in α, but decreasing in w_H. For the convenience of the subsequent analysis, let us define

$$\pi(\alpha) \equiv \frac{1}{\sigma}\left\{\frac{(\sigma - 1)P}{\sigma A}\right\}^{\sigma-1}\alpha^{\sigma-1}$$

[7] We omit the explicit indication of the dependence of $\ell(\alpha)$ on w_L.

Then, Eq. (20) can be simplified to

$$\Pi(\alpha, w_H) = \frac{1 - s_H}{r + s_H}\left[\pi(\alpha) - w_H\right]. \tag{21}$$

2.5 Unskilled Labor Market Equilibrium

Let Z be the measure of firms operating in the market. Then, the number of unskilled workers employed at the beginning of each period, denoted by L_e, becomes

$$L_e = Z\int_0^{+\infty} f(\alpha)\ell(\alpha)\mathrm{d}\alpha = Z\left(\frac{\sigma-1}{\sigma}\right)^{\sigma} A^{-\sigma}P^{\sigma-1}\tilde{\alpha}^{\sigma-1},$$

where $\tilde{\alpha}$ denotes the average productivity of the operating firms:

$$\tilde{\alpha} \equiv \left[\int_0^{+\infty} f(\alpha)\alpha^{\sigma-1}\mathrm{d}\alpha\right]^{\frac{1}{\sigma-1}} \equiv \left[\frac{1}{1-G(\underline{\alpha})}\int_{\underline{\alpha}}^{+\infty} g(\alpha)\alpha^{\sigma-1}\mathrm{d}\alpha\right]^{\frac{1}{\sigma-1}}. \tag{22}$$

It should be noted that $\tilde{\alpha}$ depends upon the lower boundary $\underline{\alpha}$ of the realized educated abilities, which plays important roles in our analysis later.

Let L be the measure of unskilled workers. By the definition of the matching technology, the number of successful (i.e., matched) unskilled workers is $\theta_L m(\theta_L)L$. Therefore, in equilibrium, we must have

$$L_e = \theta_L m(\theta_L)L,$$

which can be solved for the unskilled wage rate:[8]

$$w_L = \left(\frac{\sigma-1}{\sigma}\right)\left[\frac{Z}{\theta_L m(\theta_L)L}\right]^{\frac{1}{\sigma}} P^{\frac{\sigma-1}{\sigma}}\tilde{\alpha}^{\frac{\sigma-1}{\sigma}} - \frac{(r+s_L)c_L}{(1-s_H)m(\theta_L)}. \tag{23}$$

Using Eq. (23) and (16), we can rewrite $\pi(\alpha)$ as

$$\pi(\alpha) = \frac{1}{\sigma}\left\{\frac{\theta_L m(\theta_L)LP}{Z\tilde{\alpha}}\alpha^{\sigma-1}\right\}.$$

The total vacancy for unskilled workers, v_L, is the sum of the vacancies of firms:

$$\begin{aligned} v_L &= Z\int_0^{+\infty} f(\alpha)k(\alpha)\mathrm{d}\alpha = \frac{\chi}{m(\theta_L)}\cdot Z\int_0^{+\infty} f(\alpha)\ell(\alpha)\mathrm{d}\alpha \\ &= \frac{\chi}{m(\theta_L)}\cdot L_e = \frac{\chi}{m(\theta_L)}\cdot\theta_L m(\theta_L)L = \chi\theta_L L \end{aligned}$$

[8] The derivation of Eq. (23) is relegated to an appendix.

The measure of unemployed unskilled workers is u_L and that of employed unskilled workers is $L - u_L$. In each period, $\theta_L m(\theta_L)u_L$ units of unemployed unskilled workers get their jobs through the matching technology and, at the same time, $s_L(L - u_L)$ units of employed unskilled workers lose their jobs due to the idiosyncratic shocks. In the steady state, we must have $\theta_L m(\theta_L)u_L = s_L(L - u_L)$, implying

$$u_L = \frac{s_L L}{\theta_L m(\theta_L) + s_L}.$$

The tightness of the unskilled labor market, θ_L, is defined as the ratio of v_L and u_L. Therefore, we have

$$\theta_L \equiv \frac{v_L}{u_L} = \frac{\chi \theta_L L}{\left(\dfrac{s_L L}{\theta_L m(\theta_L) + s_L}\right)} \quad \Leftrightarrow \quad \theta_L m(\theta_L) = \frac{1-\chi}{\chi} \cdot s_L \tag{24}$$

In equilibrium, the probability that an unemployed unskilled worker is matched with a firm and gets his/her job is solely determined by the exogenous probabilities of the idiosyncratic shocks.

2.6 Skilled Labor Market

Before entering the differentiated good market, each potential firm has to hire a skilled worker to develop its own differentiated variety. The potential firm has to pay a search cost to post a vacancy for a skilled worker. Once a firm and a skilled worker have been matched through the matching mechanizm at the skilled labor market, they negotiate on the wage rate for the skilled worker. We adopt the framework of a generalized Nash bargaining to examine the negotiation between the matched pair of a firm and a skilled worker.

2.6.1 Skilled Wage Negotiation

Suppose that a firm is matched with a skilled worker of ability α. First, consider the firm's payoff from the negotiation. If the pair reaches an agreement on the skilled wage rate w_H, the firm obtain the value $\Pi(\alpha, w_H)$ as defined in Eq. (20). If, on the other hand, the negotiation fails, the firm has to leave the market and receive nothing; the firm's reservation payoff is zero. Therefore, the firm's net gain from the negotiation is $\Pi(\alpha, w_H) - 0$.

Next, consider the skilled worker's payoff. Let W_H be the skilled worker's benefit from being employed by the firm (i.e., the value of employment) and let U_H be the value of remaining to be unemployed (i.e., the value of unemployment). If the negotiation ends up with the skilled wage rate w_H, the skilled worker receives w_H in each period. At the same time, the skilled worker knows that he or she faces the possibility of being fired due to the idiosyncratic shocks with the probability of s_H in each period. In other words, the state of the skilled worker changes from the employed to the unemployed with the probability of s_H; the "capital loss" due to the idiosyncratic shocks is $s_H(U_H - W_H)$. Therefore, in the steady state, W_H can be defined as the discounted sum of $w_H + s_H[U_H - W_H]$ over time:

$$W_H \equiv \sum_{t=1}^{+\infty} \frac{w_H + s_H[U_H - W_H]}{(1+r)^t} = \frac{w_H - s_H[W_H - U_H]}{r}.$$

By solving the above equation for W_H, we obtain

$$W_H = \frac{1}{r + s_H}\left[w_H + s_H U_H\right]. \tag{25}$$

At this stage of the negotiation, the skilled worker regards the value of unemployment, U_H, as being independent of the skilled wage rate under consideration. That is, if the skilled worker succeeds in raising the wage rate by one unit in the negotiation, then he or she thinks that the value of employment, W_H, increases by the amount of $1/(r + s_H)$. The skilled worker's net gain from the negotiation is $W_H - U_H$.

The Nash bargaining over the skilled wage rate is described by the following maximization problem of the generalized Nash product:

$$\max_{w_H} [W_H - U_H]^{\beta}[\Pi(\alpha, w_H)]^{1-\beta}, \tag{26}$$

where β $(0 < \beta < 1)$ represents the relative bargaining power of the skilled worker. Taking account of Eq. (21) and Eq. (25), the FOC for the above maximization with respect to w_H is

$$\beta\Pi(\alpha, w_H) = (1 - s_H)(1 - \beta)[W_H - U_H], \tag{27}$$

which is equivalent to

$$\beta[\pi(\alpha) - w_H] = (1 - \beta)[w_H - rU_H]. \tag{28}$$

Solving it for w_H yields

$$\begin{aligned} w_H &= \beta\pi(\alpha) + (1-\beta)rU_H \\ &= \beta\left[\pi(\alpha) - rU_H\right] + rU_H. \end{aligned} \tag{29}$$

Here, rU_H is the amortized value of unemployment and, hence, it can be seen as the reservation wage rate for the skilled worker. If the skilled worker accepts the job with the negotiated wage rate w_H, the pair of the firm and the skilled worker will be able to create the total surplus of $\pi(\alpha)$ in each period. Then, the difference between $\pi(\alpha)$ and rU_H represents the net surplus for the pair. Accordingly, Eq. (29) means that the skilled worker receives the β-fraction of the net surplus in addition to the reservation wage rate. One important thing to be noted is that the negotiated skilled wage rate w_H depends on both the ability of the skilled worker (i.e, α) and the reservation wage rate (i.e, rU_H); with a slight abuse of notation, we write this relation as $w_H(\alpha, rU_H)$. By substituting this into Eq. (20), we can write the value of a firm as a function of α and rU_H:

$$\Pi^{\circ}(\alpha, rU_H) \equiv \Pi(\alpha, w_H(\alpha, rU_H)). \tag{30}$$

2.6.2 Entry of Firms

Consider a potential firm contemplating the entry to the market. The firm is randomly matched with a skilled worker with the probability $n(\theta_H)$ through the matching mechanizm as defined in Eq. (8). However, not every matched firm can operate in the market. Remember that for a firm, the ability of the matched skilled worker determines the firm's productivity. As shown by Melitz (2003), there is a production cutoff level of productivity, denoted by α^*, below which the value of the firm is negative. If a firm is matched with a skilled worker with the ability lower than α^*, the firm exits immediately from the market, avoiding a negative profit. Hence, the combined probability of a successful matching and starting business becomes $n(\theta_H)[1 - G(\alpha^*)]$.

Let V be the value of vacancy (i.e., the value of non-entry) and Π be the value of a firm.[9] When a potential firm posts a vacancy, it has to pay the search cost of

[9] The variable Π here is not a function, but signifies a simple number. The reader should not be confused.

c_H. In each period, the firm can move from the non-operation (i.e., outside of the market) to the market operation (i.e., inside of the market) with the probability of $n(\theta_H)[1 - G(\alpha^*)]$. Then, the value of vacancy satisfies the following relation:

$$rV = -c_H + n(\theta_H)[1 - G(\alpha^*)][\Pi - V]. \tag{31}$$

Free entry in the supply of vacancies implies $V = 0$. Then, in the steady state, we have

$$\Pi = \frac{c_H}{n(\theta_H)[1 - G(\alpha^*)]} \tag{32}$$

In turn, consider an unemployed skilled worker. In each period, an unemployed skilled worker receives an unemployment insurance b and, in a unit time, he or she can move from the unemployed situation to the employed situation with the probability $\theta_H n(\theta_H)$ through the matching mechanizm. Then, the value of unemployment, U_H, satisfies

$$rU_H = b + \theta_H n(\theta_H)[W_H - U_H]. \tag{33}$$

By replacing $\Pi^\circ(\alpha, rU_H)$ in Eq. (27) with Π in Eq. (32) and substituting Eq. (33) into Eq. (27), we obtain[10]

$$rU_H = b + \frac{\beta c_H \theta_H}{(1-\beta)(1 - s_H)[1 - G(\alpha^*)]} \tag{34}$$

Substituting Eq. (34) into Eq. (29), we obtain the Wage Determination equation:

$$w_H(\alpha) = b + \beta\left[\pi(\alpha) - b + \frac{c_H \theta_H}{(1 - s_H)[1 - G(\alpha^*)]}\right] \tag{35}$$

Combining Eq. (21), Eq. (32) and Eq. (35), we obtain the Job Creation equation:

$$\frac{1 - s_H}{r + s_H}[\pi(\alpha) - w_H(\alpha)] = \frac{c_H}{n(\theta_H)[1 - G(\alpha^*)]} \tag{36}$$

2.7 Product Market Equilibrium

To solve the value of the production cutoff, α^*, and the ratio of vacancy and unemployment, θ_H, we consider the market equilibrium condition for the differentiated

[10]Whatever the actual value of a firm in Eq. (27) is, it has to satisfy the transition equation Eq. (31). This justifies the replacement of $\Pi^\circ(\alpha, rU_H)$ in Eq. (27) with Π in Eq. (32).

goods. Since firms' productivities are heterogeneous, we can use the Zero Cutoff Profit condition and the Free Entry condition as Melitz (2003). First, the cutoff productivity α^* are such that $\Pi(\alpha^*_D) = 0$ in Eq. (20):

$$\pi(\alpha^*) = \frac{1}{\sigma}\left[\frac{\theta_L m(\theta_L) LP}{Z\tilde{\alpha}^{\sigma-1}}\right]^{\frac{\sigma-1}{\sigma}} (\alpha^*)^{\sigma-1} = w_H(\alpha^*) \tag{37}$$

Substituting Eq. (37) into Eq. (20) at the average ability $\tilde{\alpha}$, we obtain the following Zero Cutoff Profit (ZCP) conditions

$$\Pi(\tilde{\alpha}) = \frac{1-s_H}{r+s_H}\left[\left(\frac{\tilde{\alpha}}{\alpha^*}\right)^{\sigma-1} w_H(\alpha^*) - w_H(\tilde{\alpha})\right] \tag{38}$$

Substituting $w_H(\alpha)$ in Eq. (37) into Eq. (35), the wage of cutoff ability α^* is derived as

$$w_H(\alpha^*) = b + \frac{\beta c_H \theta_H}{(1-\beta)(1-s_H)[1-G(\alpha^*)]} \tag{39}$$

From Eq. (35) and Eq (39), the wage with average ability, $w_H(\tilde{\alpha})$ becomes

$$w(\tilde{\alpha}) = \left[\beta\left(\frac{\tilde{\alpha}}{\alpha^*}\right)^{\sigma-1} + 1 - \beta\right]\left\{b + \frac{\beta c_H \theta_H}{(1-\beta)(1-s_H)[1-G(\alpha^*)]}\right\} \tag{40}$$

Using Eq. (40) and the Zero Cutoff Profit in Eq. (38), we obtain a condition which describes the relationship between the production cutoff productivity α^* and the ratio of vacancy and unemployment θ_H:

$$\frac{(1-\beta)(1-s_H)}{r+s_H}\left\{b[1-G(\alpha^*)] + \frac{\beta c_H \theta_H}{(1-\beta)(1-s_H)}\right\}\left[\left(\frac{\tilde{\alpha}}{\alpha^*}\right)^{\sigma-1} - 1\right] = \frac{c_H}{n(\theta_H)} \tag{41}$$

In equilibrium, total expenditure on the differentiated good equals total revenues of all firms serving the demand in this sector. Note the total expenditure on the differentiated good is an *numéraire* and that there are operation firms with the skilled worker whose ability over α^*, the expenditure condition is

$$\int_{\alpha^*}^{+\infty} p(\alpha)x(\alpha)\frac{g(\alpha)}{1-G(\alpha^*)}\mathrm{d}\alpha = 1$$

Using the demand function of the differentiated goods in Eq. (2) and the optimal firm size in Eq. (15), we obtain another relationship euqation between α^* and θ_H:

$$\int_{\alpha^*}^{+\infty} \alpha^{\sigma-1}\frac{g(\alpha)}{1-G(\alpha^*)}\mathrm{d}\alpha \left\{\frac{\theta_L m(\theta_L) LP}{Z}\right\}^{\frac{\sigma-1}{\sigma}} \tilde{\alpha}^{-\frac{(\sigma-1)^2}{\sigma}} = 1 \tag{42}$$

Given the production productivity α^*, Eq, (37) determines the price index, P. Substituting the price index condition in Eq. (37) into the revenue condition in Eq. (42), we rewrite the revenue condition omitting the price index:

$$\sigma\left(\frac{1}{\alpha^*}\right)^{\sigma-1}\left\{b+\frac{\beta c_H\theta_H}{(1-\beta)(1-s_H)[1-G(\alpha^*)]}\right\}\int_{\alpha^*}^{+\infty}\alpha^{\sigma-1}\frac{g(\alpha)}{1-G(\alpha^*)}\mathrm{d}\alpha=1. \quad (43)$$

As given $\underline{\alpha}$, two equations of Eq. (41) and Eq. (43) determine the production cutoff productivity α^* and the ratio of vacancy and unemployment θ_H.

To analyze the the equilibrium value of α^* and θ_H, we assume that workers' abilities are distributed according to a Pareto distribution[11]. Setting the scale parameter of that distribution to unity, the probability density is . The shape parameter γ governs the rate of decay of the distribution. We need to impose $\gamma > \sigma - 1$ to ensure that variance of the scales distribution is finite. Using this Pareto distribution, Eq. (41) and Eq. (43) are modified as

$$\frac{(1-\beta)(1-s_H)}{r+s_H}\left\{b\left(\frac{1}{\alpha^*}\right)^{\gamma}+\frac{\beta c_H\theta_H}{(1-\beta)(1-s_H)}\right\}\left\{\left(\frac{\tilde{\alpha}}{\alpha^*}\right)^{\sigma-1}-1\right\}=\frac{c_H}{n(\theta_H)} \quad (44)$$

$$b+\frac{\beta c_H\theta_H\{\alpha^*\}^{\gamma}}{(1-\beta)(1-s_H)}=\frac{\gamma-(\sigma-1)}{\sigma\gamma} \quad (45)$$

Determining the equilibrium of α^* and θ_H, we set the below assumptions around the equilibrium of α^* and θ_H:[12]

$$-\frac{n'(\theta_H)}{n(\theta_H)^2}<\frac{\beta}{r+s_H}\left\{\left(\frac{\tilde{\alpha}}{\alpha^*}\right)^{\sigma-1}-1\right\} \quad (46)$$

When the above assumptions are satisfied, Eq. (44) has a positive relationship between α^* and θ_H, and Eq. (45) has a negative relationship between α^* and θ_H. Fig. 1 illustrates the Eq. (44) and Eq. (45).

2.8 Educational choice

A worker with ability α determine whether to get an education at the beginning of the term. Unskilled workers enter the labor force without education, while the

[11] Bernard et al. (2007), Ghironi and Melitz (2005), and Helpman et al. (2004) assume that firm productivities are distributed according to Pareto distribution.

[12] We explain derivation of the assumptions at Appendix.

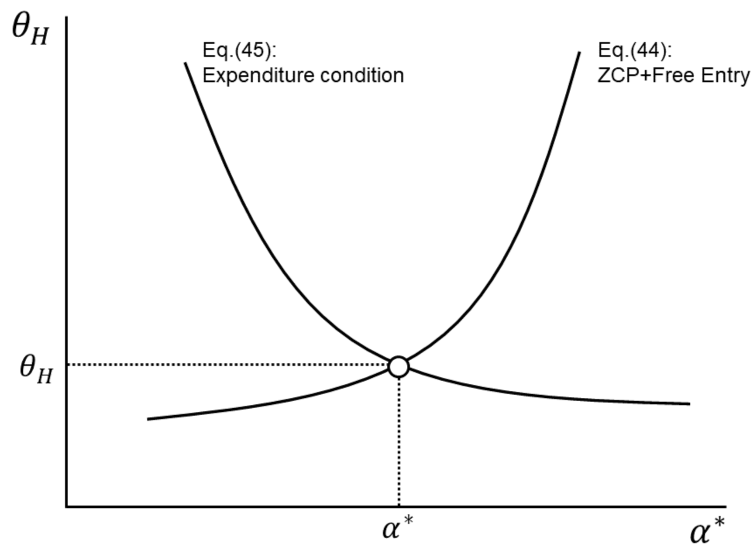

Figure 1: Determinant of α^* and θ_H

income of the unskilled workers is independent of their ability. When unskilled workers pursue an education with education cost, e, they can realize their ability and become skilled workers. Substituting Eq. (37) into Eq. (35), we obtain $w_H(\alpha^*)$:

$$w_H(\alpha) = \left\{\beta\left(\frac{\alpha}{\alpha^*}\right)^{\sigma-1} + 1 - \beta\right\}\left[b + \frac{\beta c_H \theta_H (\alpha^*)^{\gamma}}{(1-\beta)(1-s_H)}\right] - e$$

Let us consider w_L in Eq. (23). Z is the number of firms and equal to the number of the matched-skilled workers. The flow of the skilled unemployment is $u_{H,t+1} = s_H(H - u_{H,t}) - \theta_H n(\theta_H) u_{H,t}$, and at the steady state $u_{H,t+1} = u_H, t$, so that the number of the firm is

$$Z = \frac{\theta_H n(\theta_H)}{\theta_H n(\theta_H) + s_H} H$$

Suppose that the total number of labor is N. Since the workers' ability is distributed according Pareto distribution, the pool of skilled and unskilled labor, H and L, is calculated as

$$H = \int_{\underline{\alpha}}^{\infty} \alpha g(\alpha) \mathrm{d}\alpha = \alpha^{-\gamma} N, \quad L = \int_{0}^{\underline{\alpha}} \alpha g(\alpha) \mathrm{d}\alpha = (1 - \alpha^{-\gamma}) N$$

Using Eq. (37) and the value of Z, H, and L, and substituting, we obtain the unskilled wage, w_L:

$$w_L = \frac{\gamma(\sigma-1)\chi}{\{\gamma-(\sigma-1)\}(1-\chi)s_L}\left\{\frac{\theta_H n(\theta_H)}{\theta_H n(\theta_H)+s_H}\right\}\frac{\underline{\alpha}^{-\gamma+\sigma-1}\{\alpha^*\}^{-(\sigma-1)}}{1-\underline{\alpha}^{-\gamma}}$$
$$\times\left\{b+\frac{\beta c_H\theta_H(\alpha_D^*)^\gamma}{(1-\beta)(1-s_H)}\right\}-\frac{(r+s_L)c_L}{(1-s_H)m(\theta_L)}$$

If the wage of the worker with α in the skilled labor market, which detects educational cost, is higher than that of the unskilled labor market, $w_H(\alpha)-e > w_L$, the worker shift to the skilled labor pool from the unskilled labor market. On the other hand, if the wage earned by the skilled labor market is lower that of the unskilled labor market, $w_H(\alpha)-e < w_L$, the worker remain in the unskilled labor market. In equilibrium, there is an educational cutoff ability $\underline{\alpha}$, where the expected wage rate for unskilled worker, w_L, has to be equal with the expected income of skilled worker $w_H(\underline{\alpha})-e$. Therefore, the education cutoff, $\underline{\alpha}$ is determined in the following equation:

$$w(\underline{\alpha})-e = w_L \tag{47}$$

Since w_L is decreasing in $\underline{\alpha}$ and $w_H(\underline{\alpha})$ is increasing in $\underline{\alpha}$, there exists an equilibrium educational cutoff, $\underline{\alpha}$.

3 Open Economy

We investigate the effect of globalization on a worker's job choice and the the number of unemployment of a country. There are two symmetric countries with the same preferences, production technology, number of workers, and characteristics of the labor market. We assume that the systems of the labor market are independent from each other. Suppose that the firms face fixed market access cost $f > 0$ if they start exporting, and that it costs an ice-berg type tariff, $\tau \geq 1$, to exporting goods. We denote the index of X, D as exporting and domestic sales. Operating revenues from sales on a foreign market are equal to $p_X x_X/\tau$. By symmetry, demands on the domestic and foreign market are given by Eq. (2). Equating marginal revenues across market yields $p_X(\alpha) = \tau p_D(\alpha)$ and $x_X(\alpha) = \tau^{1-\sigma}x_D(\alpha)$. Therefore, total revenues of the exporting sales is $R_X(\alpha) = \tau^{\sigma-1}R_D(\alpha)$.

Unskilled labor market Considering the total revenue, the optimal employment of unskilled workers in Eq. (15)

$$\ell_X = \tau^{\sigma-1}\ell_D = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} A^{-\sigma}P^{\sigma-1}\alpha^{\sigma-1}\tau^{1-\sigma}$$

The potential firms, which have not matched any workers yet, consider the expected value of operating both domestic and exporting. Since labor supply, given as educational cutoff $\underline{\alpha}$, is not changed, the wage of unskilled worker becomes

$$w_L = \left(\frac{\sigma-1}{\sigma}\right)\left[\frac{Z}{\theta_L m(\theta_L)L}\right]^{\frac{1}{\sigma}} P^{\frac{\sigma-1}{\sigma}}\tilde{\alpha}^{\frac{\sigma-1}{\sigma}}(1+\tau^{1-\sigma}) - \frac{(r+s_L)c_L}{(1-s_H)m(\theta_L)}. \qquad (48)$$

Substituting w_L into the optimal employment, ℓ, we obtain the equilibrium employment of each firm as

$$\ell = \frac{\theta_L m(\theta_L)L}{Z}\left(\frac{\alpha}{\tilde{\alpha}}\right)^{\sigma-1}.$$

Hence, $\pi_D(\alpha)$ and $\pi_X(\alpha)$ are rewritten as

$$\pi_D(\alpha) = \frac{1}{\sigma}\left(\frac{\theta_L m(\theta_L)LP}{Z\tilde{\alpha}^{\sigma-1}}\right)^{\frac{\sigma-1}{\sigma}}\alpha^{\sigma-1},$$

$$\pi_X(\alpha) = \frac{1}{\sigma}\left(\frac{\theta_L m(\theta_L)LP}{Z\tilde{\alpha}^{\sigma-1}}\right)^{\frac{\sigma-1}{\sigma}}\alpha^{\sigma-1}\tau^{1-\sigma}.$$

Since it costs f to export, the value of the firms with an α's skilled worker is modified as

$$\Pi(\alpha, w_H) \equiv \frac{1-s_H}{r+s_L}[\pi_D(\alpha)+\pi_X(\alpha)-f-w_H]. \qquad (49)$$

Skilled labor market The structure of skilled labor market is also the same in Section 2.6. The firms entry the market and search a skilled worker with cost of c_H, After matching, they recognize the matched-skilled worker's ability α. Given firm's revenues are increasing in α, there exists a threshold α_D^* below which firms do not take up production. Similarly, firms with a productivity level between α_D^* and α_X^* will serve only their domestic market. The firms calculate their actual profit after recognizing α, and decide whether their activity policy: exit, only domestic sale, or both domestic and exporting sales. The firms negotiate w_H with the skilled worker, and the wage schedule becomes the same one in Eq. (35).

Product Market Equilibrium At a threshold of α_D^*, the value of firms which only sell their variety in domestic market go to zero, $\Pi(\alpha_D^*, w_H) = 0$:

$$\pi_D(\alpha_D^*) = \frac{1}{\sigma}\left(\frac{\theta_L m(\theta_L) LP}{Z\tilde{\alpha}^{\sigma-1}}\right)^{\frac{\sigma-1}{\sigma}} (\alpha_X^*)^{\sigma-1} = w_H(\alpha_D^*) \tag{50}$$

From Eq. (35), the wage of α_D^*-ability worker is the same of Eq. (39). On the other hand, the profit of exporting sales is zero at the threshold of α_X^*, and we obtain $\pi_X(\alpha_X^*) - f = 0$. Therefore, it can be shown that the condition for α_D^* and α_X^*:

$$\begin{aligned} \tau^{1-\sigma}\left(\frac{\alpha_X^*}{\alpha_D^*}\right) &= \frac{f}{w_H(\alpha_D^*)} \\ &= f \cdot \left\{b + \frac{\beta c_H \theta_H}{(1-\beta)(1-s_H)[1-G(\alpha_D^*)]}\right\}^{-1} \end{aligned} \tag{51}$$

Given α_D^*, Eq. (51) determines α_X^*. To guarantee $\alpha_X^* > \alpha_D^*$, we assume

$$\tau^{\sigma-1} f > b + \frac{\beta c_H \theta_H}{(1-\beta)(1-s_H)[1-G(\alpha_D^*)]}.$$

Notice that $\pi_X(\alpha) = \tau^{1-\sigma}\pi_D(\alpha)$, the wage of α_X^*-ability skilled worker is calculated with Eq. (35):

$$\begin{aligned} w_H(\alpha_X^*) &= \beta[\pi_D(\alpha_D^*) + \pi_X(\alpha_X^*) - f] + (1-\beta)b + \frac{\beta c_H \theta_H}{(1-s_H)[1-G(\alpha_D^*)]} \\ &= \beta\tau^{\sigma-1} f + (1-\beta)\left\{b + \frac{\beta c_H \theta_H}{(1-\beta)(1-s_H)[1-G(\alpha_D^*)]}\right\} \end{aligned} \tag{52}$$

Using Eq. (35) and the feature of α_D^* and α_X^*, we obtain The ZCP condition as

$$\begin{aligned} \Pi(\tilde{\alpha}) &= \frac{1-s_H}{r+s_H}\left[\pi(\tilde{\alpha}) - f - \left\{\beta[\pi(\tilde{\alpha}) - f] + (1-\beta)b + \frac{\beta c_H \theta_H}{(1-s_H)[1-G(\alpha_D^*)]}\right\}\right] \\ &= \frac{(1-\beta)(1-s_H)}{r+s_H} \\ &\times \left[\left\{\left(\frac{\tilde{\alpha}}{\alpha_D^*}\right)^{\sigma-1} + \left(\frac{\tilde{\alpha}}{\alpha_X^*}\right)^{\sigma-1} - 1\right\}\left\{\frac{\beta c_H \theta_H}{(1-\beta)(1-s_H)[1-G(\alpha_D^*)]}\right\} + f\left\{\beta\tau^{\sigma-1}\left(\frac{\tilde{\alpha}}{\alpha_X^*}\right)^{\sigma-1} - 1\right\}\right] \end{aligned}$$

With the ZCP and the free entry condition is given in Eq. (32), so that we obtain the first condition which describes the relationship between the production cutoff productivity α^* and the ratio of vacancy and unemployment θ_H.

$$\begin{aligned}\left\{\left(\frac{\tilde{\alpha}}{\alpha_D^*}\right)^{\sigma-1} + (1-\beta)\left(\frac{\tilde{\alpha}}{\alpha_X^*}\right)^{\sigma-1} - 1\right\}\left\{b + \frac{\beta c_H \theta_H}{(1-\beta)(1-s_H)[1-G(\alpha_D^*)]}\right\} \\ +f\left\{\beta\tau^{\sigma-1}\left(\frac{\tilde{\alpha}}{\alpha_X^*}\right)^{\sigma-1} - 1\right\} = \frac{(r+s_H)c_H}{(1-\beta)(1-s_H)[1-G(\alpha_D^*)]n(\theta_H)}\end{aligned} \tag{53}$$

In equilibrium, total expenditure on the differentiated good equals total revenues of all firms serving the demand in this sector.

$$\int_{\alpha_D^*}^{+\infty} p_D(\alpha)x_D(\alpha)\frac{g(\alpha)}{1-G(\alpha_D^*)}\mathrm{d}\alpha + \int_{\alpha_X^*}^{+\infty} p_X(\alpha)x_X(\alpha)\frac{g(\alpha)}{1-G(\alpha_X^*)}\mathrm{d}\alpha = 1$$

The price index, P, is determined by Eq. (50). Using the value of P with the expenditure condition gives us the second condition which describes the relationship between α_D^* and θ_H.

$$\begin{aligned}\left\{b + \frac{\beta c_H\theta_H}{(1-\beta)(1-s_H)[1-G(\alpha_D^*)]}\right\} \\ \times\sigma\left[\left(\frac{1}{\alpha_D^*}\right)^{\sigma-1}\int_{\alpha_D^*}\alpha^{\sigma-1}\frac{g(\alpha)}{1-G(\alpha_D^*)} + \left(\frac{1}{\tau\alpha_D^*}\right)^{\sigma-1}\int_{\alpha_X^*}\alpha^{\sigma-1}\frac{g(\alpha)}{1-G(\alpha_X^*)}\right] = 1\end{aligned} \tag{54}$$

For given $\underline{\alpha}$, conditions in Eq. (51), (53), and (54) allow to solve α_D^*, α_X^*, and θ_H. By symmetry, the three conditions together allow to solve for the cutoffs and demand levels simultaneously. To clarify the later discussion, we assume that the workers' ability follows the Pareto distribution, so that Eq. (53) and Eq. (54) become

$$\begin{aligned}\left\{\left(\frac{\tilde{\alpha}}{\alpha_D^*}\right)^{\sigma-1} + (1-\beta)\left(\frac{\tilde{\alpha}}{\alpha_X^*}\right)^{\sigma-1} - 1\right\}\left\{b\left(\frac{1}{\alpha_D^*}\right)^{-\gamma} + \frac{\beta c_H\theta_H}{(1-\beta)(1-s_H)}\right\} \\ + f\left(\frac{1}{\alpha_D^*}\right)^{-\gamma}\left\{\beta\tau^{\sigma-1}\left(\frac{\tilde{\alpha}}{\alpha_X^*}\right)^{\sigma-1} - 1\right\} = \frac{(r+s_H)c_H}{(1-\beta)(1-s_H)n(\theta_H)}\end{aligned} \tag{55}$$

$$b + \frac{\beta c_H\theta_H(\alpha_D^*)^{\gamma}}{(1-\beta)(1-s_H)} + f = \frac{\gamma-(\sigma-1)}{\gamma\sigma} \tag{56}$$

Eq. (55) is a decreasing function of θ_H even if the assumption of Eq. (46) is satisfied. The raise of α_D^* decreases Eq.(55) as long as α_X^* is larger than α_D^*. Therefore, Eq. (55) has a positive relationship between α_D^* and α_X^*, such as closed economy. On the other hand, Eq. (56) always has a negative relationship between α_D^* and θ_H.

Trade Liberalization Trade liberalization (decreasing τ) only affects Eq. (55). We first consider the effect of decreasing ice-berg cost on α_D^*, α_X^* and θ_H as given the education cutoff, $\underline{\alpha}$. Fig. 2 draws the change in decreasing τ which shifts Eq. (55) to right, and trade liberalization increases the production cutoff, α_X^*, and decreases the ratio of vacancy and unemployment, θ_H. This change has two effects on unemployment: probability effect and middle class effect. Decreasing θ_H reduces the matching probability for skilled labor, which increases unemployment. Larger α_X^* expands the range that the skilled workers with relatively lower ability are unemployed. The decrease in τ makes market competition more severe, and the firms which matched the lower-ability skilled worker exit from the market, while trade liberalization increases the operating profit of exporting sales. In results, the number of skilled unemployment increases, especially the lower-skilled worker may be damaged by trade liberalization.

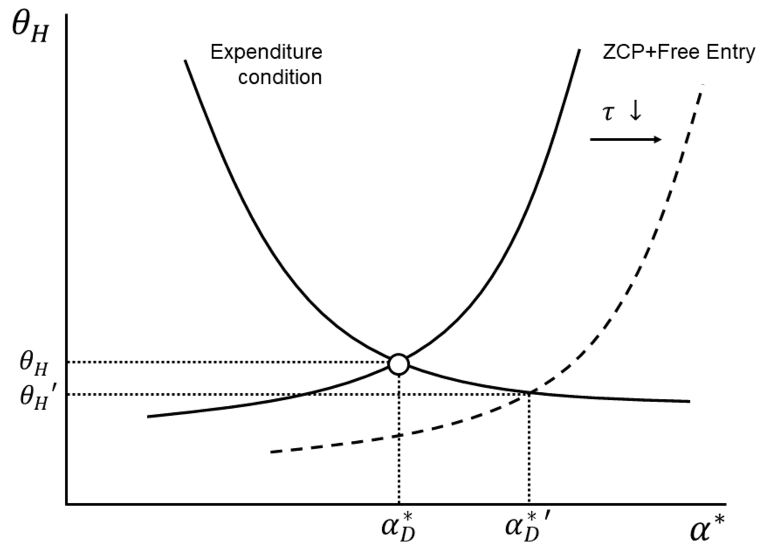

Figure 2: Effect of a reduction of τ on α^* and θ_H

Next, we also allow the change of educational choice, $\underline{\alpha}$. From Eq. (48), trade liberalization raises the demand of the unskilled labor because of easier to export their goods. To solve Eq. (48), let us consider the condition of the price index. Since we assume that total expenditures are *numéraire*, the price index must be satisfied as

$$\left(\frac{\theta_L m(\theta_L) LP}{Z}\right)^{\frac{\sigma-1}{\sigma}} \tilde{\alpha}^{-\frac{(\sigma-1)^2}{\sigma}} \int_{\alpha_X^*}^{+\infty} \alpha^{\sigma-1} \frac{g(\alpha)}{1-G(\alpha_X^*)} \mathrm{d}\alpha = 1.$$

Substituting this condition into Eq. (48), we obtain the unskilled wage under international trade:

$$\begin{aligned} w_L = & \frac{\gamma(\sigma-1)\chi}{\{\gamma-(\sigma-1)\}(1-\chi)s_L} \left\{\frac{\theta_H n(\theta_H)}{\theta_H n(\theta_H)+s_H}\right\} \frac{\underline{\alpha}^{-\gamma+\sigma-1}\{\alpha^*\}^{-(\sigma-1)}}{1-\underline{\alpha}^{-\gamma}} \\ & \times \left\{b + \frac{\beta c_H \theta_H (\alpha_D^*)^{\gamma}}{(1-\beta)(1-s_H)}\right\} (1+\tau^{\sigma-1}) - \frac{(r+s_L)c_L}{(1-s_H)m(\theta_L)}. \end{aligned} \tag{57}$$

With Eq. (35), (50), and $\pi_X(\alpha_X^*) = f$, the skilled wage is calculated as

$$\begin{aligned} w_H(\alpha) &= \beta[\pi_D(\alpha)+\pi_X(\alpha)-f] + (1-\beta) + \frac{\beta c_H \theta_H}{1-G(\alpha_D^*)} \\ &= \left\{\beta\left(\frac{\alpha}{\alpha_D^*}\right)^{\sigma-1} + 1-\beta\right\}\left\{b + \frac{\beta c_H \theta_H}{(1-\beta)(1-s_H)[1-G(\alpha_D^*)]}\right\} + \left\{\left(\frac{\alpha}{\alpha_X^*}\right)^{\sigma-1} - 1\right\} f \\ &= \left\{(\beta+\tau^{1-\sigma})\left(\frac{\alpha}{\alpha_D^*}\right)^{\sigma-1} + 1-\beta\right\}\left\{b + \frac{\beta c_H \theta_H (\alpha_X^*)^{\gamma}}{(1-\beta)(1-s_H)}\right\} - f, \end{aligned} \tag{58}$$

where we use Eq. (51) and Pareto distribution in the last line. The educational cutoff, $\underline{\alpha}$, determined by Eq. (47), Eq. (57), and Eq. (58).

Trade liberalization affects the determination of θ_H and α_D^* in Eq. (55) and Eq. (56), and also changes the educational cutoff, $\underline{\alpha}$, thorough the comparison of w_H and w_L. To see the effect of trade liberalization on some variables, we define an implicit function, $E(\alpha^*, \theta_H, \underline{\alpha}, \tau) \equiv w_H(\underline{\alpha}) - e - w_L = 0$, which is derived by the educational choice condition. From Eq. (55) and Eq. (56), α_D^* and θ_H can be solved as a function of $\underline{\alpha}$ and they are affected by τ. $\underline{\alpha}$ is solved by educational condition and can be expressed as a function of τ, so that the implicit function can be modified $E(\alpha_D^*(\underline{\alpha}, \tau), \theta_H(\underline{\alpha}, \tau), \underline{\alpha}(\tau), \tau)$. By implicit function theory, the effect of decreasing τ on the education cutoff is

$$\frac{\partial \alpha}{\partial \tau} = -\frac{\frac{\partial E}{\partial \alpha^*}\frac{\partial \alpha_D^*}{\partial \tau} + \frac{\partial E}{\partial \theta_H}\frac{\partial \theta_H}{\partial \tau} + \frac{\partial E}{\partial \tau}}{\frac{\partial E}{\partial \alpha_D^*}\frac{\partial \alpha_D^*}{\partial \underline{\alpha}} + \frac{\partial E}{\partial \theta_H}\frac{\partial \theta_H}{\partial \underline{\alpha}} + \frac{\partial E}{\partial \underline{\alpha}}}.$$

Note that $\partial\alpha_D^*/\partial\tau < 0$, $\partial\theta_H/\partial\tau > 0$, $\partial\alpha_D^*/\partial\underline{\alpha} < 0$ and $\partial\theta_H/\partial\underline{\alpha} < 0$ $\partial\alpha_D^*/\partial\underline{\alpha} > 0$ from Eq. (55) and Eq. (56). Deceasing in τ gives an ambiguous effect on the education cutoff, $\underline{\alpha}$. If the sign of the above equation is positive, trade liberalization decreases the education cutoff, and the production cutoff, α_D^*, also increases from (55) and Eq. (56). The expand of the range between $\underline{\alpha}$ and α_D^* means that the skilled workers with low ability are easy to become unemployment while the number of the skilled workers increase. This model cannot solve the total effects on the unemployment analytically. However, we show the possibility that globalization may increase the number of unemployment. .

4 Conclusion

This article analyzes the effects of globalization on the worker' choice of jobs and employment. We assume that search friction exists in the skilled and unskilled labor market and that workers can choose to be skilled or unskilled worker. If a firm succeeds in matching with a skilled worker, it can start a business and the productivity of the firm depends on the ability whose matched-skilled worker has. Trade liberalization among two symmetry countries increases the profit of the operating firms, which raises the entry of firms and the demand for skilled workers. These effects attract both skilled and unskilled workers. We obtain ambiguous effects of globalization on the worker's education choice. However, we find a possibility where the globalization promotes the popularization of high education and the unemployment of skilled workers. Future research would be to consider heterogeneous countries. Our model assume symmetric countries, but this assumption does not depict the real world. Since we adopt a search-matching model in this study, it is difficult to consider heterogeneous countries. Although heterogeneous countries could complicate the model , the implication of heterogeneity gives us the new insight into the international trade and labor market literature.

A Derivation of Eq. (23)

$$
\begin{aligned}
& L_e = \theta_L m(\theta_L) L \\
\Leftrightarrow \quad & Z\left(\frac{\sigma-1}{\sigma}\right)^{\sigma} A^{-\sigma} P^{\sigma-1} \tilde{\alpha}^{\sigma-1} = \theta_L m(\theta_L) L \\
\Leftrightarrow \quad & \left(\frac{\sigma-1}{\sigma}\right)\left[\frac{Z}{\theta_L m(\theta_L) L}\right]^{\frac{1}{\sigma}} P^{\frac{\sigma-1}{\sigma}} \tilde{\alpha}^{\frac{\sigma-1}{\sigma}} = w_L + \frac{(r+s_L)c_L}{(1-s_H)m(\theta_L)} \\
\Leftrightarrow \quad & w_L = \left(\frac{\sigma-1}{\sigma}\right) B^{\frac{1}{\sigma}} P^{\frac{\sigma-1}{\sigma}} \tilde{\alpha}^{\frac{\sigma-1}{\sigma}} - \frac{(r+s_L)c_L}{(1-s_H)m(\theta_L)},
\end{aligned}
\tag{59}
$$

B Derivation of assumptions for Eq. (45)

Totally differentiating Eq. 45 with respect to α^* and θ_H, we obtain

$$
\begin{aligned}
& -\frac{1-\beta}{r+s_H}\left[b\gamma\left(\frac{1}{\alpha}\right)^{\gamma+1}\left\{\left(\frac{\tilde{\alpha}}{\alpha^*}\right)^{\sigma-1} - 1\right\} + (\sigma-1)\left\{b\left(\frac{1}{\alpha^*}\right)^{\gamma} + c_H\theta_H\right\}\left(\frac{1}{\alpha^*}\right)^{\sigma}\tilde{\alpha}^{\sigma-1}\right] \mathrm{d}\alpha^* \\
& \qquad = \left[-\frac{n'(\theta_H)}{n(\theta_H)^2} - \frac{1-\beta}{r+s_H}\left\{\left(\frac{\tilde{\alpha}}{\alpha^*}\right)^{\sigma-1} - 1\right\}\right] c_H \mathrm{d}\theta_H
\end{aligned}
$$

Note that the sign of the left hand side is negative, the sign of the brace for the right hand side must be negative to get the positive relationship between α^* and θ_H. Considering the numerical value of the parameter used by Bernard et al. (2007), Petrongolo and Pissarides (2001), and Shimer (2001), those assumptions are easy to be satisfied.

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