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Getting a Job through Unemployed Friends: A Social Network Perspective

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Abstract:
We develop a model in which unemployed workers can pass along unwanted job information to other unemployed friends within social networks. Compared with the case in the absence of social networks, we first show in an economy where networks are equal in size that unemployment rate is lower. In terms of social welfare, social planner prefers workers becoming more selective than the decentralized equilibrium. When social networks differ in size, increasing the size difference is beneficial for unemployed workers with large networks but detrimental to those with small networks; in addition, the unemployment rate decreases with the size difference. However, because of the dilution effect, as the proportion of unemployed workers with large networks increases, it eventually results in losses for all unemployed workers, and the unemployment rate may follow a non-monotonic pattern.

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1 Introduction

Today, workers searching for jobs have many options: newspapers, internet, and social networks. Many reports suggest that a large proportion of jobs are filled by personal contacts.[1] Some empirical studies also demonstrate the importance of social networks in job search (see e.g. Mark Granovetter (1995) and Franzen and Hangartner (2006)). Referring to the employment status of workers who transmit job information to others, ISSP 2001 reports that 46.8% of employed and 29.7% of unemployed people helped someone they know to find a job in the past year.[2] Clearly, the unemployed contacts play a key role in job search. However, this channel has been neglected by economists so far. Most of the recent literature only focuses their analysis on the role of social contacts with employed workers. The present paper provides a first theoretical analysis that can account for this channel.

In this paper, the unemployed contacts can be helpful because unemployed workers can pass along their unwanted job information to other unemployed workers within social networks.[3] Our objective is to study the role of unemployed social networks in job search, showing how the job-worker-matching probability and the extent of unemployed workers' selectivity, which impacts the job transmission intensity interact with each other and are jointly determined. To do so, we incorporate the worker's working disutility and job transmission mechanism into the standard search model developed by Pissarides (2000) .

In our paper, we assume that working generates a disutility, or a cost, which is job-worker-specific, and this may make workers feel dissatisfied and refuse to work. This is a very natural description of the real world. For example, workers have their own preferences; workers who do not like travelling will reject transportation-related jobs. This disutility also arises when a mismatch exists between the skills required by the job and those that the worker possesses; a worker who can only speak Spanish will reject a job that requires speaking French as learning French is time consuming and too costly for him/her. The dividing line that differentiates between job acceptance and job rejection is the reservation of disutility, above which the net surplus of working for each worker is negative, and it is endogenously determined. The reservation of disutility measures the extent of selectivity of workers, which determines the intensity of job transmission through unemployed contacts. When the reservation of disutility is lower, unemployed workers are more selective, for any given job, each unemployed worker is less likely to accept it and more likely to pass the job information to friends. Hence, the intensity of job transmission becomes higher. Once an unemployed worker hears about a job, he learns a job-worker-specific disutility of working. His job acceptance decision depends on whether his net surplus of working is positive. If it is negative, he will reject the job and pass along the information to one of his friends randomly. His friend

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will do the same thing, either accepting and becoming employed instantaneously or rejecting and passing it on to someone else through unemployed social contacts, and the procedure repeats. Once an unemployed worker accepts the job offer, he becomes employed. In this case, he is not in his unemployed friends' unemployed networks anymore and the social link with him now belongs to the category of other sources of job information, for example, the employers and the employed contacts whose role have already been studied in many other literature. Additionally, we assume an identical wage for different jobs. Thus, each worker receives the same wage but has different working disutilities for different jobs. For a job that he is satisfied with, he will accept the job offer. However, for a job that he is not satisfied with, he will reject it. Our analysis is very similar to Pissarides model of stochastic job matchings, wherein each worker accepts a job only if the wage is above the reservation wage. Because the wage depends on the productivity of the job match, each worker only accepts a job if the productivity of the match is above the reservation productivity.[4] In contrast to Pissarides model, we assume a fixed wage and each worker only accepts a job if the disutility is below the reservation value.

For the first analysis, we focus on the case wherein unemployed social networks are equal in size. An unemployed worker can hear about a job either through unemployed social networks or other sources. As we have shown, when a job information arrives, accepting or rejecting it depends on whether the net surplus of working is positive or, equivalently, whether the worker's disutility of doing this job is lower than the reservation value. When the reservation disutility is lower, worker is more selective and less likely to accept a job (more likely to transmit job information to others). We find that this reservation disutility depends on a group of parameters associated with the state of the labor market. Therefore, the intensity of job transmission through unemployed contacts is endogenously determined. When wages increase, a higher reservation is present. Accordingly, unemployed workers become less selective and are more likely to accept jobs, leading to a lower intensity of job transmission. This is because higher wages can compensate more on the disutility of the job. However, when unemployed workers have a higher probability of hearing about a job from other sources, a lower reservation is present and unemployed workers become more selective and less likely to accept jobs. This is because unemployed workers place a higher value on their other job opportunities. Consequently, this leads to a higher intensity of job transmission. When we look at the impact of unemployed social networks on the unemployment rate, which depends on the job-worker-matching probability, we find that the unemployment rate becomes lower when unemployed workers have connectivity between them. Also, a higher wage rate or higher probability of hearing about a job from other sources reduces the unemployment rate. A higher wage rate reduces the unemployment rate because workers are less selective and accept jobs more frequently. A higher probability of hearing about a job from other sources reduces the unemployment rate because the number of job opportunities becomes larger.

For the second analysis, we investigate the social planner's preference, given his objective being to maximize the social welfare. When the workers become more selective, both unemployed and employed workers' welfare improve.[5] However, when workers become more selective, they are less likely to accept job offers. This leads to a higher unemployment rate, making more workers become unemployed and driving down the total welfare. Therefore, a lower reservation disutility also creates some losses. We find that the social planner prefers that workers become more selective than in the equilibrium. This is due to the externality that when workers become more selective, they not only improve their own welfare but also have a greater chance of providing job information to others and making other workers better off. The workers do not take into account this externality, thus are less selective than the social optimum.

Next, we introduce a difference in the size of the unemployed social networks. In this economy, some unemployed workers have large networks and some have small ones. In each network, people not only have friends with large networks but also those with small networks. We find that workers with large networks are more selective than those with small networks, and in terms of job-worker-matching probability, the workers with large networks have a higher job-worker-matching probability than those with small networks do. This is because workers with large networks are more likely to hear about job information from unemployed contacts. Then, we investigate the impact of increasing size difference and increasing proportion of unemployed workers with large networks. We first show that increasing size difference will enlarge the difference in welfare between two types of unemployed workers and reduce the unemployment rate. Second, we show that when the proportion of unemployed workers who have large networks increases in each network, all unemployed workers are hurt because of the dilution effect, which is generated by increasing indirect neighbors who compete for each potential job information, and the unemployment rate may follow a non-monotonic pattern.

Lastly, we extend our analysis one step further to a general equilibrium framework. The wage is endogenously determined and could be adjusted to compensate a worker's disutility for a particular job. We find that the degree of compensation negatively depends on the worker's bargaining power. This is because the worker's disutility is compensated by the firm. When the firm's bargaining power becomes lower, it receives lower surplus and consequently compensates less on the worker's disutility. We show that when worker's bargaining power becomes higher, which implies lower degree of compensation on worker's disutility, the reservation of disutility may follow a non-monotonic pattern and job-worker-matching probability becomes lower.

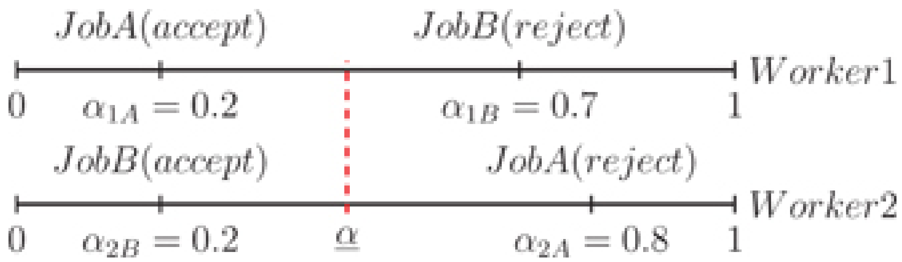
There are many recent theoretical analysis investigating the role of social networks in job search. The leading works by Calvó-Armengol and Jackson (2004) and Calvó-Armengol and Jackson (2007) have shown very rich theoretical perspectives on interactions between social networks and labor market dynamics. They indicate that employed contacts raise employment probability and wages, while network size differences induce inequality. Referring to the investigation on the impact of network structure, Calvó-Armengol and Zenou (2005) derive an aggregate matching function stemming from an explicit network structure and show a non-monotonic relationship between network size and the unemployment rate. Ioannides and Soetevent (2006) show that when the network becomes denser, the mean unemployment rate falls and the mean wage rate increases. There are also many other theoretical studies that explore the importance of social networks for labor market outcomes, for example, Cahuc and Fontaine (2009), Fontaine (2007), and Topa (2001) . These literatures assume that only employed workers can transmit job information to their unemployed friends through personal contacts, and that the ties between unemployed workers are actually considered to be useless. However, in our paper, the case that the unemployed contacts are directly helpful can happen when workers are too selective regarding the job.[6] The extent of selectivity is endogenously determined and affects the intensity of job transmission or the effectiveness of network. In contrast to the studies mentioned above which focus on the impact of social contacts on the labor market, we analyze how the labor market performance affects the worker's intensity of job transmission (through affecting the extent of worker's selectivity); this, in turn, will affect the labor market outcome. Therefore, the effectiveness of unemployed contacts varies when the factors associated with labor market performance change. Galeotti and Merlino (2014) also endogenize the intensity of social networks but still assume that only employed workers can transmit job information. They find that the unemployed workers rarely use social contacts when the probability of becoming employed is too high or too low.[7] The change in the probability of becoming employed affects the effectiveness of using social contacts and thus affects the intensity of social networks. However, in our paper, wherein we mainly analyze the unemployed contacts, when unemployed workers are more probable to become employed, for example, when they have higher probability of hearing about a job from other sources (or when the vacancy cost is lower in the general equilibrium case), they can become more selective and transmit job information more frequently to other unemployed friends.

The rest of the paper is organized as follows. In Section 2, we construct the basic set-up and describe a simple model in which job information can be transmitted among unemployed workers. We solve the model under the condition of identical network size. In Section 3, we try to analyse the social planner's objective and compare the equilibrium with the social optimum. In Section 4, we introduce the difference in the size of social networks and try to establish the impact of the increasing size difference and the increasing proportion of workers having large networks. In Section 5, we extend the model to a general equilibrium framework with endogenous wage and link the degree of compensation and the selectivity on the job. Section 6 concludes.

2 Social Network with Identical Size

In our model, we assume that when a worker is employed, he can earn wage, but must simultaneously bear disutility or cost, which is dependent on his degree of job dissatisfaction. The more the worker dislikes his job, the greater is the disutility. Here, we use $\alpha \in [0, 1]$ to represent this disutility.

The value of α is observed before an individual decides whether or not to accept the job, and the cost will start when the job and unemployed worker are matched.[8] α is job-worker specific. For each job, different workers have different disutilities, and for different jobs, workers rank them differently according to their own disutilities. For example, worker 1 prefers working as an officer to working as a cleaner as the disutility of working as a cleaner for worker 1 is greater than that of working as an officer. However, worker 2 prefers working as a cleaner to working as an officer as the disutility of working as a cleaner for worker 2 is lower than that of working as an officer. Given that the workers are rational, they do not accept the jobs which generate too large a disutility; each only accepts the job he *does not* dislike that much. That is, working should be at least as good as being unemployed and the net surplus of working should not be lower than 0. In order to indicate how workers make the decision to accept a job in our model, we define $\underline{\alpha} \in [0, 1]$ as the reservation disutility. If the worker's disutility of working is above this reservation, the worker will reject the job. Lower reservation $\underline{\alpha}$ means that the workers are more selective and more likely to refuse a job.[9] If an unemployed worker $i = 1, 2$ meets with a job $j = A, B$ and has the working disutility α_{ij}, which is lower than the reservation $\underline{\alpha}$, he will accept the job. On the contrary, if α_{ij} is higher than the reservation $\underline{\alpha}$, he will reject it. For example, by looking at the schematic diagram below, we observe that worker 1 only accepts job A and worker 2 only accepts job B.



When each unemployed worker has social contacts with other unemployed workers, for example, an unemployed worker can know other unemployed workers in employment agencies, training program provided by job centers, etc. The jobs that are rejected will not be wasted; the unemployed workers will pass them along to their unemployed friends through social networks. For example, by looking at the schematic diagram above again, if worker 1 receives job B, he will reject it, but he can pass the information to worker 2. Each worker can hear about job information from two sources: unemployed friends through unemployed social networks or other sources. Other sources can include the potential employers and employed social networks. To focus on the role and the job transmission mechanism of social networks formed by unemployed workers, we assume that the probability of hearing about a job from other sources is the same across workers and equals v in each period. When we mention social networks in the following analysis, it refers to the unemployed social networks.

2.1 The Determination of Job-Worker-Matching Probability with Job Transmission

The disutility is job-worker specific. To simplify the computation, we also assume that each worker's disutility $\alpha \sim F(\alpha)$ is continuously distributed on jobs. Workers place different values of disutility on different jobs, and workers are different in the sense that workers have different preferences regarding each job. The unemployed workers only perform jobs with relatively lower costs such that $\alpha < \underline{\alpha}$. For any given job, the probability that a randomly selected unemployed worker wants to accept and perform that job is $F(\underline{\alpha})$. Symmetrically, that probability also equals the probability that a given unemployed worker wants to accept a randomly selected job.

We assume that each unemployed worker knows s unemployed friends and hears about a job with probability h in each period. Consequently, the amount of job information that can be transmitted in each unemployed worker's network is $s[1-F(\underline{\alpha})]h$. Moreover, each unemployed worker competes each unemployed friend's available information with $s-1$ other unemployed workers. Therefore, the probability of hearing about a job from his unemployed friends through social networks in each period is $\frac{s[1-F(\underline{\alpha})]h}{s}$.[10] Each unemployed worker hears about a job either from unemployed contacts with probability $\frac{s[1-F(\underline{\alpha})]h}{s}$, or from other sources with probability v. Like many other literature does, we assume that these two events are mutually exclusive.[11] Therefore, the probability of hearing about a job information in the equilibrium is given by

$$h = v + (1-v)[1-F(\underline{\alpha})]h\frac{s}{s} \tag{1}$$

h appears on both sides of the equation but with different meanings[12]. On the left hand side, h represents the probability of an unemployed worker hearing about a job, and on the right hand side, h represents the probability that each of his unemployed friends hears about a job information. They are equal because of symmetry. In each period, some unemployed friends become employed and are leaving the unemployed network. Thus they become other sources of job information. For example, once an unemployed friend becomes employed, the contact with him becomes employed contact. Or once an unemployed friend decides to run a business by himself, he becomes an employer. At the same time, some employed friends are losing their jobs and the contacts with them become unemployed contacts. For simplicity, we assume that the network size is unchanging and is constant. Additionally, from eq. (1), it appears that the size s has no impact on the probability of hearing about job information for each unemployed worker. That is because s has two effects on h. Extensively, as s is larger, each unemployed worker has more contacts, and therefore more potential chances to hear about a job. This has a positive effect on h. But intensively, a larger s means that each of the members in the unemployed worker's network also has more contacts, so increasing the number of indirect neighbors will drive down the probability of hearing about a job information from his friend. This has a negative effect on h. And when the network sizes are the same, these two effects balance each other.[13]To simplify our analysis, we assume that the

α is uniformly and continuously distributed over $[0, 1]$. Then, we have

$$h = \frac{v}{1 - (1 - v)(1 - \underline{\alpha})} \tag{2}$$

This is our equilibrium job transmission condition. Clearly, when unemployed workers are not extremely unselective, $\underline{\alpha} \neq 1$, the probability of hearing about a job h is higher than that without unemployed contacts v, $h > v$. Therefore, forming social networks between unemployed friends can raise the probability of hearing about a job information.

As for the derivations of the probability of hearing about a job information, h, and the job-worker-matching probability, $h\underline{\alpha}$, with respect to the reservation disutility, $\underline{\alpha}$, we have

$$\frac{\partial h}{\partial \underline{\alpha}} < 0, \frac{\partial h\underline{\alpha}}{\partial \underline{\alpha}} > 0$$

[14] Therefore, during the job transmission, when unemployed workers are more selective (lower $\underline{\alpha}$), each worker has a higher probability of transmitting job to unemployed friends and this makes the probability that each worker hears about a job become higher too. However, the job-worker-matching probability becomes lower due to the concavity of $h\underline{\alpha}$. The increase in h due to the increasing selectivity is not large enough to make it more likely that job and worker are matched.

Lemma 1. The job transmission condition implies that:

i. The probability of hearing about a job, h, decreases with the reservation disutility, $\underline{\alpha}$;

ii. The job-worker-matching probability, $h\underline{\alpha}$, increases with the reservation disutility, $\underline{\alpha}$.

2.2 The Determination of the Reservation Disutility in the Labor Market

Each worker has a disutility α when he is matched with a job. δ is the probability that a job is destroyed in each period. To avoid the on-the-job search problem, we assume α is constant across time and the job turn-over's cost is high enough. The welfare of an employed worker in the steady state is

$$rV_E(\alpha) = w - \alpha + \delta[V_U - V_E(\alpha)] \tag{3}$$

This formula tells us that the welfare of an employed worker is equal to his wage minus his disutility, $w - \alpha$, and job destruction rate, multiplied by his net return from the change of state $V_U - V_E(\alpha)$. Similarly, we can write the welfare of the unemployed worker in the steady state as[15]

$$rV_U = h \int_0^{\underline{\alpha}} (V_E(\alpha) - V_U) d\alpha \tag{4}$$

The present welfare of an unemployed worker equals the sum of present profit which is 0 and discounted expected future welfare which equals the probability that each unemployed worker hears about a job times the expected net return from the change of state.

The formulas above show us the general form of worker's welfare. When the disutility of an unemployed worker α is equal to the reservation disulity level $\underline{\alpha}$, the welfare of being employed is the same as for being unemployed

$$V_E(\underline{\alpha}) = V_U \tag{5}$$

Using eqs (3), (4) and (5), we obtain the following three equations

$$rV_U = w - \underline{\alpha} \tag{6}$$

$$(r + \delta)V_E = w - \alpha + \frac{\delta}{r}(w - \underline{\alpha}) \tag{7}$$

$$(r + h\underline{\alpha})V_U = h \int_0^{\underline{\alpha}} V_E(\alpha) d\alpha \tag{8}$$

From eqs (6) and (7), we can see that both the welfare of each employed worker V_E and the welfare of each unemployed worker V_U decrease with $\underline{\alpha}$, thus the reservation value of disutility $\underline{\alpha}$ plays a negative role on the welfare of workers. Intuitively, when workers are more selective, they are more likely to reject job offers and even reject some jobs that they would had accepted before. Therefore, what they have then are better jobs, and this makes them be better off. Plugging eqs (6) and (7) into eq. (8) gives us the equilibrium condition in the labor market

$$h\underline{\alpha}^2 + 2(r+\delta)\underline{\alpha} = 2(r+\delta)w \tag{9}$$

With this equation, we can conclude as follows.

Lemma 2. The labor market equilibrium condition implies that with higher job-worker-matching probability (higher $h\underline{\alpha}$), workers become more selective (lower $\underline{\alpha}$).

When the job-worker-matching probability $h\underline{\alpha}$ is higher, unemployed workers become employed more often and have higher expected welfare, thus they become more selective.

2.3 Equilibrium

The equilibrium job transmission condition (2) and the labor market equilibrium condition (9) form our two equilibrium conditions. Combining the two equations gives the conditions below which allow to derive respectively the equilibrium $\underline{\alpha}$ and $h\underline{\alpha}$

$$\frac{v\underline{\alpha}^2}{1-(1-v)(1-\underline{\alpha})} + 2(r+\delta)\underline{\alpha} = 2(r+\delta)w \tag{10}$$

$$\frac{v(h\underline{\alpha})^2}{v-(1-v)h\underline{\alpha}} + 2(r+\delta)\frac{vh\underline{\alpha}}{v-(1-v)h\underline{\alpha}} = 2(r+\delta)w \tag{11}$$

We make comparative statics in order to see how the probability of hearing about a job information from other sources and the wage rate affect the reservation disutility and job-worker-matching probability. The computations are put in the Appendix. With respect to the probability of hearing about a job information from other sources, we have

$$\frac{\partial\underline{\alpha}}{\partial v} < 0, \frac{\partial h\underline{\alpha}}{\partial v} > 0$$

With respect to the wage rate w, we have

$$\frac{\partial\underline{\alpha}}{\partial w} > 0, \frac{\partial h\underline{\alpha}}{\partial w} > 0$$

Proposition 1.

i. As the probability of hearing about a job from other sources v increases, the reservation disutility $\underline{\alpha}$ decreases and job-worker-matching probability $h\underline{\alpha}$ increases;

ii. As the wage w increases, the reservation disutility $\underline{\alpha}$ increases and job-worker-matching probability $h\underline{\alpha}$ increases.

We graphically illustrate this result in Figure 1 (see Appendix). In a $(\underline{\alpha}, h\underline{\alpha})$ plane, the horizontal-axis represents the reservation disutility $\underline{\alpha}$, and the vertical-axis represents the job-worker-matching probability $h\underline{\alpha}$. The curve JTC describes a positive relationship between $\underline{\alpha}$ and $h\underline{\alpha}$ during the job transmission. When workers become more selective, they have a lower probability of accepting job, equivalently the job-worker-matching probability is lower. And the RD curve describes a negative relationship between $\underline{\alpha}$ and $h\underline{\alpha}$ when the reservation disutility is determined in the labor market. With a higher job-worker-matching probability, workers are more likely to be employed and thus become more selective and reservation disutility decreases.

When the probability of hearing about a job from other sources v increases, for each level of reservation disutility $\underline{\alpha}$, we have higher job-worker-matching probability. The JTC curve shifts upward. Therefore, we have higher $h\underline{\alpha}$ and lower $\underline{\alpha}$ in the new equilibrium. Intuitively, as the number of other opportunities becomes larger, each unemployed worker has better outside option due to the increasing job-worker-matching probability and becomes more selective. In this case, each unemployed worker is less likely to accept jobs and more likely to transmit job information to others.

When the wage w becomes higher, working brings workers a higher reward and raises their expected return. With higher compensation for the job, for each given job-worker-matching probability $h\underline{\alpha}$, workers become less selective, $\underline{\alpha}$ increases. The RD curve shifts upward. Therefore, we have higher $h\underline{\alpha}$ and higher $\underline{\alpha}$ in the new equilibrium. Intuitively, as the wage becomes higher, it compensates unemployed workers more, each worker thus becomes less selective and is more likely to accept jobs.

2.4 Unemployment Rate in the Steady State

u is the unemployment rate and $1-u$ is the employment rate in each period. The law of motion of unemployment can be written as $\dot{u} = -uh\underline{\alpha} + \delta(1-u)$, thus we can have the steady state unemployment rate as

$$u = \frac{\delta}{\delta + h\underline{\alpha}} \tag{12}$$

The unemployment rate decreases with the job-worker-matching probability. Since we have analyzed the impacts of probability of hearing about a job from other sources v and wage rate w on the job-worker-matching probability $h\underline{\alpha}$, we can make following conclusion.

Corollary 1.

i. As the probability of hearing about a job from other sources v increases, the unemployment rate u decreases;

ii. As the wage w increases, the unemployment rate u decreases.

When there are more other opportunities, job-worker-matching probability becomes higher, and this drives down the unemployment rate. In addition, higher wages make workers become less selective and accept jobs more frequently. This also drives down the unemployment rate.

2.5 Network Effect

As we have shown above, $h > v$, with unemployed social networks, unemployed workers can hear about a job with higher probability. In addition, we have a negative relationship between the reservation disutility $\underline{\alpha}$ and the probability of hearing about a job h in the equilibrium, $\frac{\partial \underline{\alpha}}{\partial h} < 0$.[16] As a consequence, comparing to the situation where there are not unemployed networks, unemployed workers are more selective when they have unemployed social contacts. According to eqs (6) and (7), we conclude that with unemployed social networks, both the unemployed and employed workers' welfare are raised.

Additionally, with regard to the welfare difference between the employed and unemployed workers $V_E - V_U$. We find that with the unemployed social networks, this difference will be shrunk because the unemployed workers benefit directly from forming social networks and the employed workers benefit indirectly.[17]

Corollary 2.

i. The unemployed worker's welfare is raised with unemployedsocial networks;

ii. The employed worker's welfare is also raised, but to a less extent.

3 Social Welfare

The social welfare equals the sum of the welfare of all agents in the economy. The objective of the social planner here is to maximize the total social welfare

$$\underset{\underline{\alpha}_s, u_s}{Max} \int_t^{\infty} e^{-r(s-t)} [(1-u(s)) \int_0^{\underline{\alpha}_s} (w - \alpha_s) f(\alpha_s) d\alpha] ds$$

The law of motion of unemployment is

$$\dot{u}_s = \delta(1-u_s) - u_s \frac{v\underline{\alpha}_s}{1-(1-v)(1-\underline{\alpha}_s)} \tag{13}$$

Normally, through maximization programs, we can obtain the social optimal reservation disutility $\underline{\alpha}^{SO}$. By comparing $\underline{\alpha}^{SO}$ with the $\underline{\alpha}^{E}$ which is reservation disutility in the equilibrium, we can see the social planner's preference. With the law of motion of unemployment and the objective function, we can solve the optimal $\underline{\alpha}^{SO}$ in the steady state. The state variable is unemployment rate u, and the control variable is reservation disutility $\underline{\alpha}$. We prove in the appendix that social optimal reservation disutility is lower than that in the equilibrium, $\underline{\alpha}^{SO} < \underline{\alpha}^{E}$.[18]

Proof. See Appendix. □

Proposition 2. Social planner prefers the unemployed workers to be more selective than that in the decentralized equilibrium.

When workers become more selective, $\underline{\alpha}$ decreases. On one hand, this will raise the workers' welfare. This is because when they become more selective, what they accept are better jobs and they suffer less from working. On another hand, lower $\underline{\alpha}$ increases the unemployment rate, driving down the total welfare of workers. For example, when $\underline{\alpha}$ is 0, workers are extremely selective and all workers are unemployed, and the total welfare of workers is 0. Therefore, a tradeoff arises by reducing $\underline{\alpha}$.

The social planner wants to choose a lower reservation disutility $\underline{\alpha}^{SO}$ than the equilibrium value of $\underline{\alpha}^{E}$. This is due to the externality. When unemployed workers become more selective, they not only improve their own welfare, they also have a greater chance of providing job information to others and making other unemployed workers and employed workers (indirectly) become better off. Since the workers do not take the latter effect into account, the equilibrium is not efficient.

4 Heterogeneous Size of Social Network

In the previous section, we discussed unemployed social networks in the labor market where unemployed workers do not differ in their network sizes. Now we assume that there exists heterogeneities in the network structure. Some unemployed workers have large networks and some have small ones. In each network, there is a fraction θ of unemployed workers who have large networks with size s^L, and $1-\theta$ who have small networks with size s^S. We assume that there is no homophily and links are randomly drawn.[19] The probability of hearing about a job information for an unemployed worker with a large network and a small network are given as follows

$$h^L = v + (1-v)[h^L \frac{\theta s^L(1-\underline{\alpha}^L)}{s^L} + h^S \frac{(1-\theta)s^L(1-\underline{\alpha}^S)}{s^S}]$$

$$h^S = v + (1-v)[h^S \frac{(1-\theta)s^S(1-\underline{\alpha}^S)}{s^S} + h^L \frac{\theta s^S(1-\underline{\alpha}^L)}{s^L}]$$

h^L is the probability of hearing about a job for those unemployed workers with large networks. The first term inside bracket $h^L \frac{\theta s^L(1-\underline{\alpha}^L)}{s^L}$ is the probability of hearing about a job from his unemployed friends who also have large networks. The second term $h^S \frac{(1-\theta)s^L(1-\underline{\alpha}^S)}{s^S}$ is the probability of hearing about a job from his unemployed friends with small networks. Similarly, h^S is the probability of hearing about a job for unemployed workers with small network. The first term inside bracket $h^S \frac{(1-\theta)s^S(1-\underline{\alpha}^S)}{s^S}$ is the probability of hearing about a job from his unemployed friends who also have small networks, and the second term $h^L \frac{\theta s^S(1-\underline{\alpha}^L)}{s^L}$ is the probability of hearing about a job from his unemployed friends who have large networks.

We denote $\frac{s^L}{s^S} = \eta > 1$ as the degree of size difference. By rearranging the two equations above, we have the probability of hearing about a job for each type of unemployed worker

$$h^L = \frac{v + (1-v)v(1-\underline{\alpha}^S)(1-\theta)(\eta-1)}{1-(1-v)(1-\underline{\alpha}^L)\theta - (1-v)(1-\underline{\alpha}^S)(1-\theta)} \tag{14}$$

$$h^S = \frac{v + (1-v)v(1-\underline{\alpha}^L)\theta(\frac{1}{\eta} - 1)}{1 - (1-v)(1-\underline{\alpha}^L)\theta - (1-v)(1-\underline{\alpha}^S)(1-\theta)} \quad (15)$$

We can see that the probability of hearing about a job for an unemployed worker with a large network h^L depends not only on his own reservation disutility $\underline{\alpha}^L$, but also on the reservation disutility of unemployed worker with a small network $\underline{\alpha}^S$. Similarly, the probability of hearing about a job for an unemployed worker with a small network h^S depends on both $\underline{\alpha}^S$ and $\underline{\alpha}^L$. As for the unemployment rate, in the steady state, we have that the inflow of unemployment equals the outflow, $(1-u)\delta = \theta u h^L \underline{\alpha}^L + (1-\theta)u h^S \underline{\alpha}^S$. So in the equilibrium, the unemployment rate is

$$u = \frac{\delta}{\delta + [\theta h^L \underline{\alpha}^L + (1-\theta)h^S \underline{\alpha}^S]}$$

4.1 Effects of Size Difference η

Here we have four equations that determine four unknowns h^L, $\underline{\alpha}^L$, h^S and $\underline{\alpha}^S$, they are eqs (14), (15) and following two conditions which determine the reservation disutilities, eqs (16) and (17)

$$h^L(\underline{\alpha}^L)^2 + 2(r+\delta)\underline{\alpha}^L = 2(r+\delta)w \quad (16)$$

$$h^S(\underline{\alpha}^S)^2 + 2(r+\delta)\underline{\alpha}^S = 2(r+\delta)w \quad (17)$$

We can observe from eqs (14) and (15) that $h^L > h^S$ because the size difference is greater than 1, $\eta > 1$. Using eqs (16) and (17), from which we know that the probability of hearing about a job h decreases with the reservation disutility $\underline{\alpha}$, we can obtain indirectly that in the equilibrium, $\underline{\alpha}^L < \underline{\alpha}^S$ and $h^L\underline{\alpha}^L > h^S\underline{\alpha}^S$.

Proposition 3. When there is size difference between the networks, the unemployed workers with large networks are more selective and have higher job-worker-matching probability than those with small networks.

According to eqs (14) and (15), we can see that when the network size difference η increases, for each $\underline{\alpha}^L$, $h^L\underline{\alpha}^L$ becomes greater. And for each $\underline{\alpha}^S$, $h^S\underline{\alpha}^S$ becomes smaller. These generate new equilibria where the unemployed workers with large networks become more selective and have higher job-worker-matching probability while the unemployed workers with small networks become less selective and have lower job-worker-matching probability.

We next undertake numerical simulations to illustrate the effects of increasing size difference on the job-worker-matching probability of each type of unemployed worker, unemployment rate and the difference of reservation disutility between two types of unemployed workers. Our parameter values are set as follows. Job destruction rate δ is set to 0.01. Discount rate r is set to 0.005. Wage rate w is set to 1. The probability of hearing about a job from other sources v is set to 0.5. On the proportion of unemployed workers with large networks θ, it is set to 0.5. The simulation results are illustrate in Figure 2 (See Appendix). We can see that the increasing network's size difference η will simply reinforce the advantage of having higher job-worker-matching probability for the unemployed workers who have large networks. The unemployed workers who have large networks have higher job-worker-matching probability and those with small networks have lower job-worker-matching probability. And the unemployed workers who have large networks become more selective but those who have small networks become less selective, so the difference between the two reservations increases. Furthermore, the unemployed workers with large networks are relatively more responsive to changes in network size difference because they are more dependent on the network for job information. Therefore, when the size difference η increases, the change in job-worker-matching probability for unemployed workers with large networks would be higher than that for those with small networks. Consequently, the negative impact on the unemployment dominates the positive impact, and the unemployment rate becomes lower.

4.2 Effects of Proportion of Unemployed Workers with Large Network θ

Another parameter which captures the degree of heterogeneity in network structure between unemployed workers is the proportion of unemployed workers with large networks, θ. A higher θ means that there are more workers having large social networks. It can be seen as a factor that reflects the density of social connections.

When the proportion of workers with large network θ increases, it is hard to observe directly its impacts on the probability of hearing about a job and other targets. Therefore, we illustrate the results by undertaking numerical simulations and the results are put in Figure 3 (See Appendix). Our parameter values chosen are same as the previous simulation exercises. Here the size difference η is set to 2. As θ increases, we can see how the job-worker-matching probability of each type of unemployed worker, unemployment rate and difference of the reservation disutility between two types of workers change. We find that both $h^L\underline{\alpha}^L$ and $h^S\underline{\alpha}^S$ decrease with θ. As each unemployed worker has a larger proportion of friends with large networks in his network, the job opportunities available from his friends decrease because job information held by his unemployed friends now is shared by a larger number of unemployed workers. Therefore, unemployed workers suffer from the information sharing constraints due to the increasing number of indirect neighbors. This negative dilution effect makes all unemployed workers become worse off and have lower job-worker-matching probability. As for the difference of reservation disutility $\underline{\alpha}^S - \underline{\alpha}^L$, when θ increases, the difference becomes smaller. Therefore, we can conclude that the welfare difference between two types of workers decreases with θ. Unemployed workers with large networks are more dependent on the network for job information, and they suffer more from dilution effect. According to the expression of unemployment rate, the term $\theta(h^L\underline{\alpha}^L - h^S\underline{\alpha}^S) + h^S\underline{\alpha}^S$ determines the trend of unemployment rate. The derivative of this term with respect to θ is $h^L\underline{\alpha}^L - h^S\underline{\alpha}^S + \theta\frac{\partial h^L\underline{\alpha}^L}{\partial\theta} + (1-\theta)\frac{\partial h^S\underline{\alpha}^S}{\partial\theta}$. The first part $h^L\underline{\alpha}^L - h^S\underline{\alpha}^S$ is the composition effect, and it is positive. When θ increases, more workers have large networks, and this improves the average job-worker-matching probability, reducing the unemployment since unemployed worker with large network matches with job with higher probability. The second part $\theta\frac{\partial h^L\underline{\alpha}^L}{\partial\theta} + (1-\theta)\frac{\partial h^S\underline{\alpha}^S}{\partial\theta}$ is the dilution effect, and it is negative. When θ becomes higher, all workers have lower job-worker-matching probability, and this decreases the average job-worker-matching probability, increasing the unemployment. When θ is small, the composition effect is large and dominates the dilution effect, the unemployment rate decreases. As θ becomes larger, however, composition effect becomes smaller as the difference of reservation disutility between workers becomes smaller, which implies the smaller difference of job-worker-matching probability, and the dilution effect can be large enough to dominate the composition effect, thus raising unemployment eventually.

5 Discussion: A General Equilibrium Model with Job Selectivity

In the Section 2, we showed how the reservation disutility of workers and job-worker-matching probability are affected by the factors related to the labor market performance. It allows us to analyze the effect of both the probability of hearing about a job from other sources and the wage rate. We observe that the reservation disutility $\underline{\alpha}$ thus depends negatively on the probability of hearing about a job from other sources and positively on the wage rate. However, if firms do not commit to wages or the disutility is observed before meeting any workers, for example, those dirty and dangerous jobs, firms can adjust the wage after a meeting, and then a flexible wage could be adjusted to compensate a worker's distaste for a particular job. In this discussion, we extend our analysis one step further to a general equilibrium framework by endogenizing wages. The objective is to see how the disutility of working is compensated and how the degree of compensation affects the reservation disutility as well as the extent of job transmission. We endogenize wages by assuming wage is negotiated through Nash bargaining between workers and firms, and worker's bargaining power is β. For simplicity, we assume that the worker can hear about a job from either unemployed contacts or labor market directly. We add a job creation condition and solve the equilibrium in the Appendix. The three equilibrium conditions are given as follows

$$\beta h\underline{\alpha}^2 + 2(r+\delta)\underline{\alpha} = 2(r+\delta) \tag{18}$$

$$\frac{cv(r+\delta)}{u} = \frac{1-\beta}{2}h\underline{\alpha}^2 \tag{19}$$

$$h\underline{\alpha} = \frac{v\underline{\alpha}}{1-(1-v)(1-\underline{\alpha})} \tag{20}$$

Further, the unemployment rate in the steady state is $u = \frac{\delta}{\delta + h\underline{\alpha}}$. Now, we have three endogenized variables: reservation disutility $\underline{\alpha}$, job-worker-matching probability $h\underline{\alpha}$ and vacancy rate v. The wage is negotiated through Nash bargaining, and we can obtain the equilibrium wage as

$$w(\alpha) = 1 + (1-\beta)\alpha - (1-\beta)\underline{\alpha} \tag{21}$$

We can observe from the wage equation that the equilibrium wage increases with the worker's disutility α. When the disutility on the job is higher, the worker is compensated more. $1-\beta$ captures the degree of compensation, and it depends on the firm's bargaining power.[20] When the firm has higher bargaining power, it compensates a higher proportion of worker's disutility on the job.

When worker's bargaining power β increases or the degree of compensation $1-\beta$ decreases, on one hand, firm compensates less on the worker's disutility, making workers become more selective, on another hand, this leads firms to post less vacancies, making workers become less selective. We can consider what happens for two extreme values of the β. When the worker's bargaining power $\beta = 0$, worker's disutility is fully compensated by the wage. With equilibrium conditions, we have that workers are extremely unselective, thus $\underline{\alpha} = 1$. And when the worker's bargaining power $\beta = 1$, the disutility is not compensated at all. The firm gets 0 surplus and therefore does not post any vacancies. Also, workers are extremely unselective, $\underline{\alpha} = 1$. In these two extreme cases, unemployed workers do not transmit job information to others. Mathematically, the differentiation of reservation disutility $\underline{\alpha}$ with respect to the worker's bargaining β can be obtained from the equation below[21]

$$[1+\frac{2(r+\delta)}{\beta}\frac{2c(r+\delta)}{\delta(1-\beta)}(\frac{1-\underline{\alpha}}{\underline{\alpha}^2}+\frac{1}{\underline{\alpha}})+\frac{2(r+\delta)}{\beta}(\frac{1-\underline{\alpha}}{\underline{\alpha}^2}+\frac{1}{\underline{\alpha}}-1)]\frac{\partial\underline{\alpha}}{\partial\beta}= \quad (22)$$

$$\frac{2c(r+\delta)}{\delta}(1-\beta)^{-2}[\delta+2(r+\delta)\underline{\alpha}^{-1}(1-\underline{\alpha})\beta^{-2}(\beta-1)]-2(r+\delta)(1-\underline{\alpha})(\frac{1}{\underline{\alpha}}-1)\beta^{-2} \quad (22)$$

Clearly, the term in the bracket of the left-hand side is positive; thus, the sign of $\frac{\partial\underline{\alpha}}{\partial\beta}$ is same as that of the term on the right-hand side. When β is small enough (for example when β is close to 0), the term on the right-hand side is negative. Thus $\frac{\partial\underline{\alpha}}{\partial\beta} < 0$. On the contrary, when β is large enough, for example, when β is close to 1, the term on the right-hand side is positive. Thus, $\frac{\partial\underline{\alpha}}{\partial\beta} > 0$. Therefore, the reservation disutility $\underline{\alpha}$ may follow a non-monotonic pattern with respect to the worker's bargaining power β. Also, workers may be more or less likely to transmit job information to friends when worker's bargaining power increases. Intuitively, the higher the worker's bargaining power is, the lower is the surplus of firms. Therefore, job creation falls, leading the worker to become less selective regarding the job. But against this, the higher the worker's bargaining power is, the lower is the compensation on the worker's disutility, leading the worker to become more selective regarding the job. When the worker's bargaining power is small, the marginal effect of increasing the worker's bargaining power on the reservation disutility through decreasing compensation is large, and the marginal effect of increasing worker's bargaining power on reservation disutility through decreasing job creation is relatively small. Thus the negative effect on the reservation disutility dominates the positive effect. On the contrary, when the worker's bargaining power is large, the positive effect on the reservation disutility dominates the negative effect. As higher worker's bargaining power implies lower degree of compensation on disutility, we can conclude that the reservation disutility may follow a non-monotonic pattern with respect to the degree of compensation. When workers are compensated with higher degree on their disutility of working, they may become more or less likely to transmit job information to other unemployed friends.

Similarly, we can rearrange the three equilibrium conditions and obtain the impact of the worker's bargaining power β on job-worker-matching probability $h\underline{\alpha}$ through the equation below

$$[2c(r+\delta)\frac{\beta}{1-\beta}(\delta+2h\underline{\alpha})+2\beta\delta h\underline{\alpha}+\frac{4c(r+\delta)^2}{1-\beta}]\frac{\partial h\underline{\alpha}}{\partial\beta}= \quad (23)$$

$$-2c(r+\delta)(\delta+h\underline{\alpha})h\underline{\alpha}\frac{1}{(1-\beta)^2}-\delta(h\underline{\alpha})^2-4c(r+\delta)^2(\delta+h\underline{\alpha})\frac{1}{(1-\beta)^2} \quad (23)$$

Clearly, when the worker's bargaining power β increases, job-worker-matching probability $h\underline{\alpha}$ decreases. This is because when the worker's bargaining power increases, the firm has a lower proportion of surplus, and thus posts fewer vacancies. This pushes down the job-worker-matching probability. We then make our conclusion below.

Proposition 4. When the worker's bargaining power β increases, which implies lower degree of compensation on worker's disutility,

i. The reservation disutility $\underline{\alpha}$ may follow a non-monotonic pattern;

ii. The job-worker-matching probability $h\underline{\alpha}$ becomes lower.

Normally, the disutility cannot be fully compensated as bargaining power of worker is not 0. Therefore, in a general equilibrium model, unemployed workers are also selective regarding jobs and reject the unwanted ones. In this sense, our previous partial equilibrium analysis does not lose its generality. Additionally, in a general equilibrium model, change in the worker's bargaining power, which leads to change in the compensation degree, affects the reservation disutility of workers and job-worker-matching probability through affecting the compensation on the disutility of job and vacancy rate. What we can observe is the joint effect of the two channels. In our previous partial equilibrium analysis, however, we can see the effects separately.[22]

6 Conclusion

The main goal of this paper is to learn how social networks formed by unemployed workers play a role in the job search process. We develop a simple model with an endogenous reservation of workers' job disutility; some unemployed workers reject the jobs because the disutility of working is higher than their reservation disutility. We find that the reservation disutility depends on a set of parameters like the wage and the probability of hearing about job information from other sources. When the wage increases or the probability of hearing about job information from other sources decreases, workers become less selective, hence the reservation disutility of working increases. In addition, the change in the reservation disutility indirectly impacts the frequency of job transmission and unemployment rate.

First, when the unemployed social networks are equal in size, the unemployed and employed workers' welfare are higher than that in an economy without unemployed social networks. This is because workers have better outside options given that they have more opportunities of hearing about job. And the unemployment rate will be lower. Moreover, when the wage increases, workers become less selective and have higher job-worker-matching probability, this will drive down the unemployment. When the probability of hearing about a job from other sources becomes higher, however, workers become more selective and have higher job-worker-matching probability as well, this will also drive down the unemployment rate.

Second, we prove that the equilibrium is not efficient. This is due to the externality. The social planner prefers that workers be more selective than in the equilibrium because when worker becomes more selective, not only are the workers themselves better off, but it also makes it more likely that other unemployed workers who can hear about job information more frequently become better off.

Next, we introduce the network's size difference, large vs. small. We find that increasing the size difference between networks is beneficial to unemployed workers who have large networks but harmful to those who have small ones; the unemployment rate decreases along with the size difference. Additionally, we find that all unemployed workers will lose as the proportion of unemployed workers with a large network in each network increases. This is due to the dilution effect. The unemployment rate may follow a non-monotonic pattern when the proportion of workers with large networks increases.

Finally, we extend our analysis to a general equilibrium framework by endogenizing the wage. The wage could be adjusted to compensate a worker's disutility for a particular job. We show that the degree of compensation on worker's disutility negatively depends on the worker's bargaining power. When worker's bargaining power becomes higher, the reservation disutility may follow a non-monotonic pattern and job-worker-matching probability becomes lower.

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Notes

[1]According to the results of the International Social Survey Programme: Social Relations and Support Systems/Social Networks II – ISSP 2001, 41.7% of the individuals who participated in the survey found their jobs through social networks.

[2]See Table 1 in Appendix.

[3]ISSP 2001 does not provide information on the employment status of workers at the moment when they helped others to find jobs. Either they were employed when they passed along job information to others, or they were unemployed. The former case does not really account for the role of unemployed contacts. Thus, we only focus on the latter case in this paper.

[4]The objective of the stochastic job matching model is to investigate which job matches are accepted and which are rejected.

[5]When workers are more selective, they are more likely to reject job offers and even reject some jobs that they would had accepted before. Therefore, what they have are better jobs, and this makes them be better off.

[6]Bramoullé and Saint-Paul (2010) also show that connectivity between unemployed workers raises the job matching rate because unemployed workers constitute a form of *latent* social capital which can be helpful when they find a job; thus, the prospects of finding job are improved. In other words, the unemployed contacts can be indirectly helpful because they can become employed contacts.

[7]In both cases, the benefits from investing in connections are low.

[8]We assume that each unemployed worker can know the disutility of the job he hears about. For example, when a worker hears about a transportation-related job but does not like travelling, doing this job is costly for him because the disutility is large.

[9]Because the disutility is job-worker specific, the lower the reservation disutility, the higher the probability of rejecting a job.

[10]We have s in the denominator because each of unemployed friend also has s unemployed friends.

[11]We verify that when individuals can use both sources of information simultaneously, the results are the same. Therefore, we stick to the standard assumption like others.

[12]In our model, each unemployed worker can hear about a job from unemployed friends with probability $h(1-F(\underline{\alpha}))\frac{s}{s}$. If we use Calvó-Armengol and Zenou (2005) 's way of writing the probability of hearing about a job from unemployed friends, each unemployed worker's probability of hearing about a job from unemployed friends should be $1-[1-h(1-F(\underline{\alpha}))\frac{1}{s}]^s$. Mathematically, $h(1-F(\underline{\alpha}))\frac{s}{s}$ is approximately equal to $1-[1-h(1-F(\underline{\alpha}))\frac{1}{s}]^s$ as the term $h(1-F(\underline{\alpha}))\frac{1}{s}$ is a quite small number. We choose our way of writing probability because it can simplify the computation dramatically and make everything capable of being resolved analytically without changing the main results.

[13]The number of unemployed contacts can be written as a function of unemployment rate, when unemployment rate is higher, the number of unemployed contacts is larger. But this complexity does not affect the equilibrium because two effects of size cancel each other.

[14]We have that $\frac{\partial h}{\partial \underline{\alpha}} = \frac{-v(1-v)}{[1-(1-v)(1-\underline{\alpha})]^2} < 0$ and $\frac{\partial h\underline{\alpha}}{\partial \underline{\alpha}} = \frac{v^2}{[1-(1-v)(1-\underline{\alpha})]^2} > 0$.

[15]For simplicity, we assume no unemployment benefit.

[16]We derive this relationship from eq. (11).

[17]Employed workers can benefit from unemployed contacts when they lose their jobs.

[18]It is complicated to obtain the social optimal reservation disutility $\underline{\alpha}^{SO}$ directly. To deal with this problem, we try to plug equilibrium reservation $\underline{\alpha}^E$ into the first order condition of Hamiltonian. Notice that the equilibrium reservation $\underline{\alpha}^E$ is determined by the eq. (10). If $\frac{\partial \mathcal{H}}{\partial \underline{\alpha}^E} = 0$, then we can conclude that the equilibrium is social optimum, if $\frac{\partial \mathcal{H}}{\partial \underline{\alpha}^E} > 0$, then social planner prefers higher reservation $\underline{\alpha}^O$ than equilibrium, if $\frac{\partial \mathcal{H}}{\partial \underline{\alpha}^E} < 0$, then social planner prefers lower reservation $\underline{\alpha}^O$ than equilibrium.

[19]To simplify our analysis, we don't put the analysis of the case where unemployed workers with large networks form social connections more often with unemployed workers who also have large networks here. Our extra work actually shows that the main results and intuitions we obtain in this section are not far from the case with homophily problem. But incorporating this would complicate the model a lot and dilute our focus.

[20]Firm has bargaining power $1-\beta$ and has a fraction of $1-\beta$ of surplus. Thus, firm only compensates part of worker's disutility on the job.

[21]The computation is put in the Appendix.

[22]Other comparative statics with respect to the labor market institutions can be easily undertaken as well, for example, the impact of vacancy cost on the reservation disutility is positive.

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Appendix

A Comparative Statics of $\underline{\alpha}$ and $h\underline{\alpha}$

The derivations of $\underline{\alpha}$ and $h\underline{\alpha}$ with respect to the probability of hearing about a job from other sources v are

$$\frac{\partial\underline{\alpha}}{\partial v} = \frac{-\underline{\alpha}^3}{v\underline{\alpha}^2 + 2v^2\underline{\alpha} - v^2\underline{\alpha}^2 + 2(r+\delta)(\underline{\alpha} + v - v\underline{\alpha})^2} < 0$$

$$\frac{\partial h\underline{\alpha}}{\partial v} = \frac{2(r+\delta)wh\underline{\alpha}}{2v^2h\underline{\alpha} + 2(r+\delta)v^2 + 2(r+\delta)wv(1-v)} > 0$$

The derivations of $\underline{\alpha}$ and $h\underline{\alpha}$ with respect to the wage rate w are

$$\frac{\partial\underline{\alpha}}{\partial w} = \frac{2(r+\delta)(\underline{\alpha} + v - v\underline{\alpha})^2}{v(1-v)\underline{\alpha}^2 + 2v^2\underline{\alpha} + 2(r+\delta)(\underline{\alpha} + v - v\underline{\alpha})^2} > 0$$

$$\frac{\partial h\underline{\alpha}}{\partial w} = \frac{2(r+\delta)[v - (1-v)h\underline{\alpha}]}{2vh\underline{\alpha} + 2(r+\delta)v + 2(r+\delta)(1-v)w} > 0$$

B Social Planner's Objective

B.1 Optimal $\underline{\alpha}$

Social planner's objective is to maximize the social welfare and it is given by

$$\underset{\underline{\alpha}_s, u_s}{Max} \int_t^{\infty} e^{-r(s-t)}[(1-u(s))\int_0^{\underline{\alpha}_s}(w-\alpha_s)f(\alpha_s)d\alpha]ds, \tag{24}$$

subject to the law of motion of unemployment

$$\dot{u}_s = \delta(1-u_s) - u_s\frac{v\underline{\alpha}_s}{1-(1-v)(1-\underline{\alpha}_s)} \tag{25}$$

The control variable here is the $\underline{\alpha}$ and the state variable is u. We can now write down the Hamiltonian

$$\mathcal{H} = (1-u)(w\underline{\alpha} - \frac{1}{2}\underline{\alpha}^2)\frac{1}{\underline{\alpha}} + \varphi[\delta(1-u) - u\frac{v\underline{\alpha}}{[1-(1-v)(1-\underline{\alpha})]}] \tag{26}$$

We only focus on the steady state. Next, we can write down the first order conditions as follows

$$\frac{\partial\mathcal{H}}{\partial\underline{\alpha}} = 0 \Longleftrightarrow -\frac{1}{2}(1-u) - \varphi u\frac{v^2}{[1-(1-v)(1-\underline{\alpha})]^2} = 0 \tag{27}$$

$$\frac{\partial\mathcal{H}}{\partial u} = 0 \Longleftrightarrow -(w - \frac{1}{2}\underline{\alpha}) + \varphi[-\delta - \frac{v\underline{\alpha}}{[1-(1-v)(1-\underline{\alpha})]}] = \varphi r \tag{28}$$

Then we can obtain the φ

$$\varphi = \frac{-(w - \frac{1}{2}\underline{\alpha})}{r + \delta + \frac{v\underline{\alpha}}{1-(1-v)(1-\underline{\alpha})}} \tag{29}$$

Substituting into $\frac{\partial\mathcal{H}}{\partial\underline{\alpha}} = 0$, and we get

$$\frac{\partial\mathcal{H}}{\partial\underline{\alpha}} = -\frac{1}{2}(1-u) + u\frac{v^2}{[1-(1-v)(1-\underline{\alpha})]^2}\frac{(w - \frac{1}{2}\underline{\alpha})}{r + \delta + \frac{v\underline{\alpha}}{1-(1-v)(1-\underline{\alpha})}} = 0 \tag{30}$$

This condition defines the socially optimal condition through which we can obtain the optimal $\underline{\alpha}$. And the equilibrium $\underline{\alpha}$ is determined by the equation

$$\frac{v(\underline{\alpha}^E)^2}{1-(1-v)(1-\underline{\alpha}^E)} + 2(r+\delta)\underline{\alpha}^E = 2(r+\delta)w \tag{31}$$

The second order condition of Hamilton with respect to $\underline{\alpha}$ is

$$\frac{\partial^2\mathcal{H}}{\partial\underline{\alpha}^2} = \frac{1}{2}\frac{\partial u}{\partial\underline{\alpha}} + \frac{\partial u}{\partial\underline{\alpha}}\frac{v^2}{[1-(1-v)(1-\underline{\alpha})]^2}\frac{(w - \frac{1}{2}\underline{\alpha})}{r + \delta + \frac{v\underline{\alpha}}{1-(1-v)(1-\underline{\alpha})}} \tag{32}$$

$$+uv^2\frac{\partial\frac{1}{[1-(1-v)(1-\underline{\alpha})]^2}\frac{(w-\frac{1}{2}\underline{\alpha})}{r+\delta+\frac{v\underline{\alpha}}{1-(1-v)(1-\underline{\alpha})}}}{\partial\underline{\alpha}} \tag{32}$$

What is more, the unemployment rate in the steady state is

$$u = \frac{\delta[1-(1-v)(1-\underline{\alpha})]}{\delta[1-(1-v)(1-\underline{\alpha})] + v\underline{\alpha}} \tag{33}$$

The derivation with respect to $\underline{\alpha}$ is

$$\frac{\partial u}{\partial\underline{\alpha}} = \frac{-\delta v^2}{\{\delta[1-(1-v)(1-\underline{\alpha})] + v\underline{\alpha}\}^2} \tag{34}$$

This term is negative. Clearly, $\frac{1}{[1-(1-v)(1-\underline{\alpha})]^2}\frac{(w-\frac{1}{2}\underline{\alpha})}{r+\delta+\frac{v\underline{\alpha}}{1-(1-v)(1-\underline{\alpha})}}$ decreases with $\underline{\alpha}$. Therefore, the objective function is concave. We plug equilibrium $\underline{\alpha}^E$ into the first order condition $\frac{\partial\mathcal{H}}{\partial\underline{\alpha}}$. If $\frac{\partial\mathcal{H}}{\partial\underline{\alpha}} = 0$, then we can conclude that the equilibrium is social optimum, if $\frac{\partial\mathcal{H}}{\partial\underline{\alpha}} > 0$, then social planner prefers higher $\underline{\alpha}$ than equilibrium, if $\frac{\partial\mathcal{H}}{\partial\underline{\alpha}} < 0$, then social planner prefers lower $\underline{\alpha}$ than equilibrium. Then the first order condition becomes

$$\frac{\partial \mathcal{H}}{\partial \underline{\alpha}}(\underline{\alpha} = \underline{\alpha}^E) \tag{35}$$

$$= \frac{1}{2[\delta(1-(1-v)(1-\underline{\alpha}^E)) + v\underline{\alpha}^E]}[-v\underline{\alpha}^E + \underbrace{\frac{2\delta v^2(w - \frac{1}{2}\underline{\alpha}^E)}{(r+\delta)[1-(1-v)(1-\underline{\alpha}^E)] + v\underline{\alpha}^E}}_{\Phi}] \tag{35}$$

$$= \frac{1}{2[\delta(1-(1-v)(1-\underline{\alpha}^E)) + v\underline{\alpha}^E]}[-v\underline{\alpha}^E + \underbrace{\frac{\delta v^2\underline{\alpha}^E}{(r+\delta)[1-(1-v)(1-\underline{\alpha}^E)]}}_{\Psi}] \tag{35}$$

$$= \frac{v\underline{\alpha}^E}{2[\delta(1-(1-v)(1-\underline{\alpha}^E)) + v\underline{\alpha}^E]}[\frac{-rv - (r+\delta)(1-v)\underline{\alpha}^E}{(r+\delta)(1-(1-v)(1-\underline{\alpha}^E))}] < 0 \tag{35}$$

Φ and Ψ is equivalent because

$$\frac{v(\underline{\alpha}^E)^2}{1-(1-v)(1-\underline{\alpha}^E)} + 2(r+\delta)\underline{\alpha}^E = 2(r+\delta)w \tag{36}$$

$$\Longleftrightarrow \frac{v(\underline{\alpha}^E)^2}{1-(1-v)(1-\underline{\alpha}^E)} + (r+\delta)\underline{\alpha}^E = 2(r+\delta)(w - \frac{1}{2}\underline{\alpha}^E) \tag{36}$$

$$\Longleftrightarrow (r+\delta)[1-(1-v)(1-\underline{\alpha}^E)] + v\underline{\alpha}^E = \frac{2(r+\delta)(w-\frac{1}{2}\underline{\alpha}^E)[1-(1-v)(1-\underline{\alpha}^E)]}{\underline{\alpha}^E} \tag{36}$$

$$\Longleftrightarrow \frac{2(w-\frac{1}{2}\underline{\alpha}^E)}{(r+\delta)(1-(1-v)(1-\underline{\alpha}^E)) + v\underline{\alpha}^E} = \frac{\underline{\alpha}^E}{(r+\delta)(1-(1-v)(1-\underline{\alpha}^E))} \tag{36}$$

Therefore we can conclude that social planner prefers that workers are more selective than that in the equilibrium.

C General Equilibrium Model with Endogenized Wage

C.1 Workers

The welfare of an employed worker in the steady state is

$$rV_E(\alpha) = w(\alpha) - \alpha + \delta[V_U - V_E(\alpha)] \tag{37}$$

And the welfare of the unemployed worker in the steady state is

$$rV_U = h\int_0^{\underline{\alpha}}[V_E(\alpha) - V_U]d\alpha \tag{38}$$

As before, when the disutility of an unemployed worker α is equal to the reservation disutility level $\underline{\alpha}$, the welfare of being employed is the same as for being unemployed

$$V_E(\underline{\alpha}) = V_U \tag{39}$$

Using these three equations, we can have

$$rV_U = w(\underline{\alpha}) - \underline{\alpha} \tag{40}$$

$$(r+\delta)V_E(\alpha) = w(\alpha) - \alpha + \frac{\delta}{r}[w(\underline{\alpha}) - \underline{\alpha}] \tag{41}$$

$$(r+\delta)[V_E(\alpha) - V_U] = w(\alpha) - \alpha - [w(\underline{\alpha}) - \underline{\alpha}] \tag{42}$$

C.2 Job Creation

The welfare of an occupied job $J(\alpha)$ in the steady state is

$$rJ(\alpha) = 1 - w(\alpha) + \delta[V - J(\alpha)] \tag{43}$$

The productivity is normalized to 1. The welfare of a vacant job V in the steady state is

$$rV = -c + h\underline{\alpha}\frac{u}{v}E[J(\alpha)] \tag{44}$$

$h\underline{\alpha}$ is the job-worker-matching probability and thus $h\underline{\alpha}\frac{u}{v}$ is the probability that a vacant job is filled. $E[J(\alpha)]$ is the conditional expectation of the job's net worth. Free entry condition $V = 0$ implies that

$$\frac{cv}{h\underline{\alpha}u} = E[J(\alpha)] \tag{45}$$

C.3 Wage Determination

Wage is negotiated through Nash bargaining. Worker gets a share β of surplus and firm gets a share $1-\beta$. Using eqs (42) and (43), we have

$$\frac{1}{1-\beta}w(\alpha) - \alpha - w(\underline{\alpha}) + \underline{\alpha} = \frac{\beta}{1-\beta} \tag{46}$$

When disutility equals the reservation value $\alpha = \underline{\alpha}$, we have

$$w(\underline{\alpha}) = 1$$

Therefore, the eq. (46) becomes

$$w(\alpha) = 1 + (1-\beta)(\alpha - \underline{\alpha}) \tag{47}$$

Plugging this wage equation back to eq. (42), and combining eqs (38) and (40) allow us to have

$$(r + h\underline{\alpha})\frac{(1-\underline{\alpha})}{r} = \frac{1}{r}h\underline{\alpha} - [\frac{1}{r} - \frac{\beta}{2(r+\delta)}]h\underline{\alpha}^2 \tag{48}$$

This can be simplified into

$$\beta h\underline{\alpha}^2 + 2(r+\delta)\underline{\alpha} = 2(r+\delta) \tag{49}$$

Combining eqs (43) , (44) and (47) gives

$$\frac{cv(r+\delta)}{u} = \frac{1-\beta}{2}h\underline{\alpha}^2 \tag{50}$$

Since the unemployment rate in the steady state is

$$u = \frac{\delta}{\delta + h\underline{\alpha}} \tag{51}$$

The condition (50) becomes

$$2cv(r+\delta)(\delta + h\underline{\alpha}) = (1-\beta)\delta h\underline{\alpha}^2 \tag{52}$$

And we also have job transmission condition

$$h\underline{\alpha} = \frac{v\underline{\alpha}}{1-(1-v)(1-\underline{\alpha})} \tag{53}$$

Therefore, eqs (49), (52) and (53) form our equilibrium conditions, and $h\underline{\alpha}$, $\underline{\alpha}$ and v are endogenized variables.

D Computation of $\underline{\alpha}$ and $h\underline{\alpha}$

According to the three equilibrium conditions, we can write vacancy rate v as a function of $\underline{\alpha}$ and $h\underline{\alpha}$

$$v = \frac{h\underline{\alpha}\underline{\alpha}}{\underline{\alpha} - h\underline{\alpha} + h\underline{\alpha}^2} \tag{54}$$

Plugging it back into job creation condition gives

$$\frac{c(r+\delta)}{\underline{\alpha} - h\underline{\alpha} + h\underline{\alpha}^2} = \frac{1-\beta}{2}\frac{\delta}{\delta + h\underline{\alpha}} \tag{55}$$

Together with eq. (49), we can obtain the equilibrium reservation disutility $\underline{\alpha}$ as

$$\underline{\alpha} = \frac{2c(r+\delta)}{\delta(1-\beta)}[\delta + \frac{2(r+\delta)(1-\underline{\alpha})}{\beta\underline{\alpha}}] + \frac{2(r+\delta)(1-\underline{\alpha})}{\beta}(\frac{1}{\underline{\alpha}} - 1) \tag{56}$$

The differentiation of $\underline{\alpha}$ with respect to β can be obtained from the eq. (57)

$$[1 + \frac{2(r+\delta)}{\beta}\frac{2c(r+\delta)}{\delta(1-\beta)}(\frac{1-\underline{\alpha}}{\underline{\alpha}^2} + \frac{1}{\underline{\alpha}}) + \frac{2(r+\delta)}{\beta}(\frac{1-\underline{\alpha}}{\underline{\alpha}^2} + \frac{1}{\underline{\alpha}} - 1)]\frac{\partial\underline{\alpha}}{\partial\beta} = \tag{57}$$

$$\frac{2c(r+\delta)}{\delta}(1-\beta)^{-2}[\delta + 2(r+\delta)\underline{\alpha}^{-1}(1-\underline{\alpha})\beta^{-2}(\beta-1)] - 2(r+\delta)(1-\underline{\alpha})(\frac{1}{\underline{\alpha}} - 1)\beta^{-2} \tag{57}$$

Similarly, we can obtain the equilibrium job-worker-matching probability $h\underline{\alpha}$ through the eq. (58)

$$2(r+\delta)(1-\beta)\delta = 2c(r+\delta)[2(r+\delta) + \beta h\underline{\alpha}](\delta + h\underline{\alpha}) + \beta(1-\beta)\delta(h\underline{\alpha})^2 \tag{58}$$

The differentiation of $h\underline{\alpha}$ with respect to β can be obtained from the eq. (59)

$$[2c(r+\delta)\frac{\beta}{1-\beta}(\delta + 2h\underline{\alpha}) + 2\beta\delta h\underline{\alpha} + \frac{4c(r+\delta)^2}{1-\beta}]\frac{\partial h\underline{\alpha}}{\partial\beta} = \tag{59}$$

$$-2c(r+\delta)(\delta + h\underline{\alpha})h\underline{\alpha}\frac{1}{(1-\beta)^2} - \delta(h\underline{\alpha})^2 - 4c(r+\delta)^2(\delta + h\underline{\alpha})\frac{1}{(1-\beta)^2} \tag{59}$$

Table 1: How often do workers help others find jobs.

How often	Unemployed workers	Employed workers	Percent of unemployed	Cum unemployed	Percent of employed	Cum employed
> 1 once a week	67	346	0.025	0.025	0.019	0.019
1 once a week	56	328	0.021	0.046	0.018	0.037
1 once a month	103	794	0.039	0.085	0.043	0.08
2 or 3 in the past year	242	3104	0.092	0.177	0.168	0.248
1 in the past year	318	4074	0.12	0.297	0.221	0.468
not at all in the past year	1857	9810				
Source: ISSP (2001)						

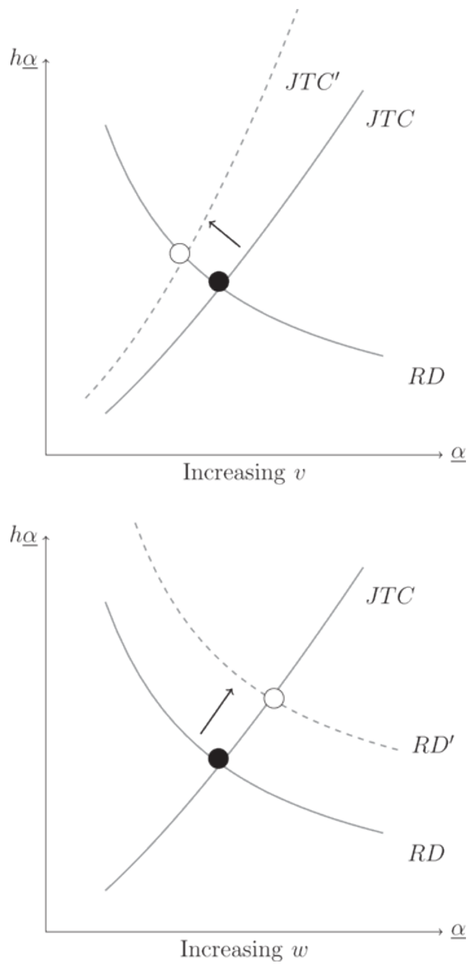

Figure 1: Equilibrium determination.

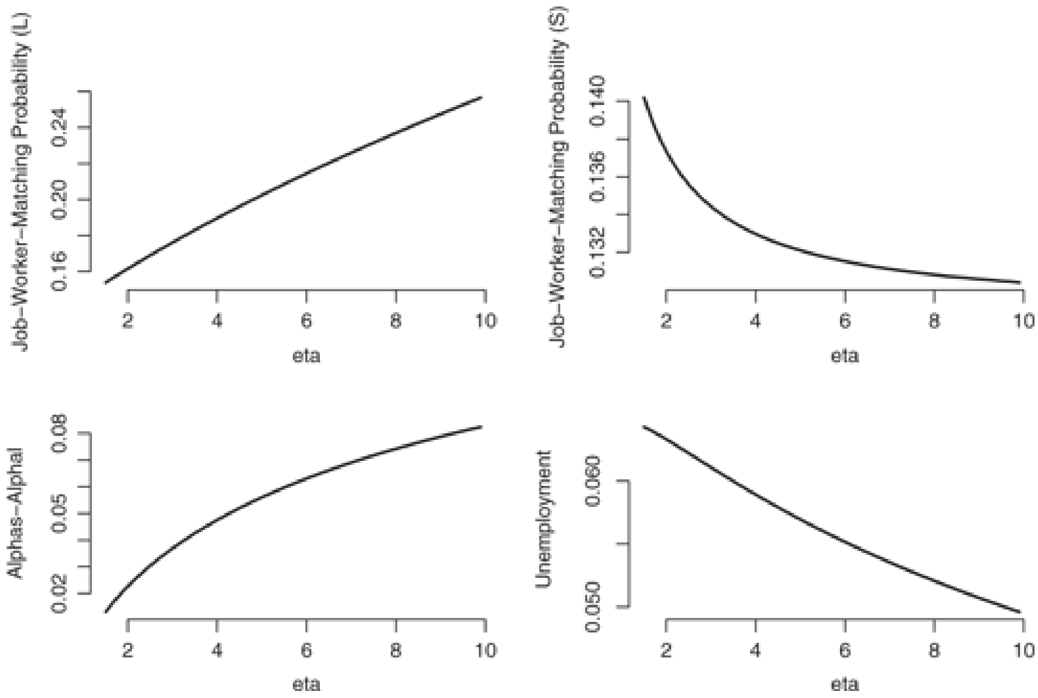

Figure 2: Impact of size difference.

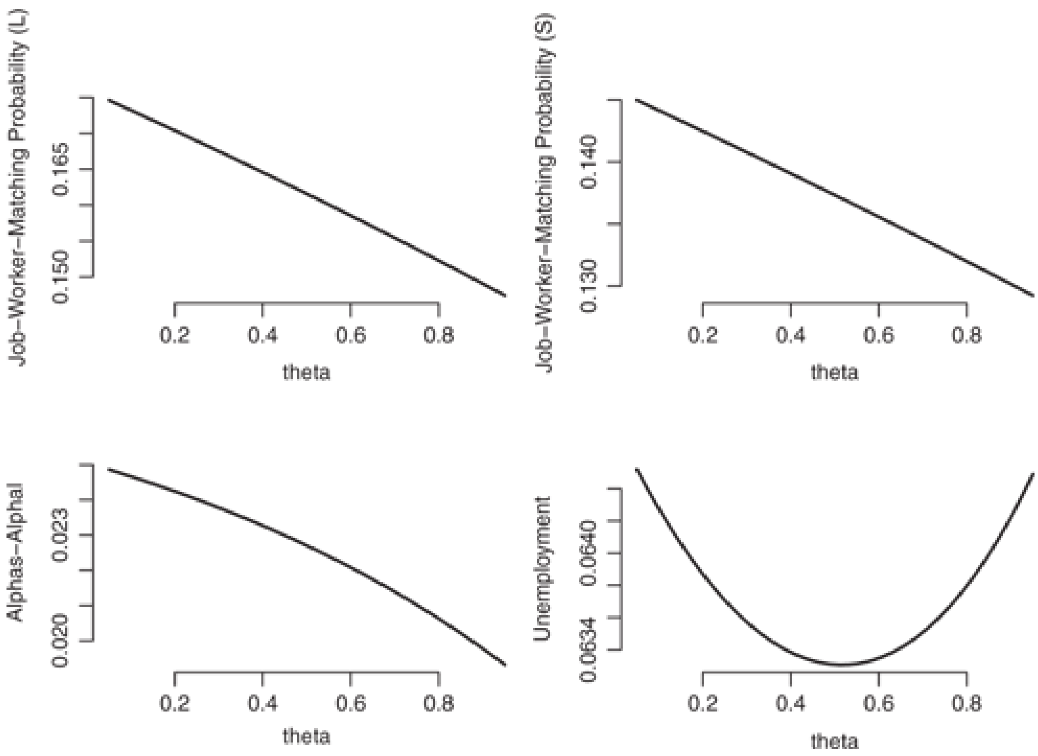

Figure 3: Effect of composition difference.