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# A Matching Model on the Use of Immigrant Social Networks and Referral Hiring

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## ABSTRACT

Using a simple search model, with urn-ball derived matching function, this paper investigates the effect of firm owner's and coworkers' nativity on hiring patterns and wages. In the model, social networks reduce search frictions and wages are derived endogenously as a function of the efficiency of the social ties of current employees. As a result, individuals with more efficient connections tend to receive higher wages and lower unemployment rate. However, because this efficiency depends on matching with same-type owners and coworkers, there is also a differential effect among workers' wages in the same firm. This analysis highlights the potential importance of social connections and social capital for understanding employment opportunities and wage differentials between these groups.

**Keywords:** Immigration; Search Models; Social Networks; Wage Differential; Hiring Process

## 1. Introduction

Previous work has studied the effects of networks in the labor market to explain labor market inequalities as a function of differential social capital (social resources, network structures, network resources). Minority individuals are generally connected to other minority-group workers who can only provide them with limited opportunities to change their employment outcomes. In this context, personal networks are then considered an additional determinant of inequality [1]. For instance, Hispanics and blacks are disadvantaged because they are likely to match with same-kind job contacts, and end up working in lower wage workplaces where other Hispanics and blacks work (see [2]).

This paper intends to model the interconnection between owner's and coworkers' nativity and workers' hiring patterns and wages. We use a simple search model where social networks reduce search frictions to develop the theoretical implications of social ties between owners and workers for individual labor outcomes. In the model, wages are derived endogenously as a function of the efficiency of the social ties of current employees. Firms can fill their vacancies either by posting their offers or by using their current workers' connections. However, employers may use this mechanism differently for different worker types, depending on their ability to take advantage of their workers' connections. Given their cultural, linguistic, and social backgrounds, immigrant employers have an advantage, compared to natives, in exploiting their immigrant workers' social connections. As a result, individuals with better connections—a combination of owner type and coworkers type—tend to have higher wages. Two forces drive that result. First, current workers provide a costless recruitment mechanism to the firm. Second, workers will produce more new hires in the future and for those unemployed, a better social connection would result in more job offers.

The rest of the paper is arranged as follows: Section 2 provides a background on the discussion on the use of networks in the labor market, particularly by minority groups; Section 3 provides reasoning behind the assumptions in the model; Section 4 presents the model; and Section 5 offers concluding remarks.

## 2. Background

### 2.1. On the Effect of Firm Owners and Coworkers

Both employers and employees may make use of their contacts to find each other. On the job seeker side, for instance, three direct beneficial effects can be related to the use of contacts. First, contacts can provide job opportunities that may not be widely known by the public. Also, contacts can increase the chances of getting a particular job by being a referred candidate. Third, contacts may offer additional information about the job environment (*i.e.* internal structure and boss-employee relation)[1].

[1]See [3,4], among others.

 

The potential benefits of the use of this mechanism by employers are also documented. The personnel literature has discussed the employers hiring procedures, with special attention to certain informal methods of recruitment, such as those which rely on current employees for dissemination of information (see [5,6]). Also the role of employee referrals in the understanding of ethnic divisions of labor and allocation of jobs has been considered (see [2]).

Current workers may increase the number of applicants by spreading the words about a new opening. This process is generally costless for the firm. Furthermore, in the labor market generally employers have imperfect information about the candidate unobserved ability. To correct for this, firms could use employee referrals as a useful screening device. Personal contacts might transmit information about productivity of applicants that otherwise would be difficult to obtain from a simple evaluation of the candidate Current workers give information for future candidates, because workers tend to refer individuals with similar characteristics to themselves ([6] called "*inbreeding bias*"), or tend to refer high-qualified candidates given that their reputation would depend on this new candidates performances. Therefore, current workers' information may reduce uncertainty about future workers' productivity.

Additionally, employers can obtain more information about candidate qualities such as work ethic and leadership, providing a higher chance of a "better match". Finally, employers can also benefit from the potential cooperation among coworkers in the workplace. On-the-job training can be provided by older employees at zero cost for the firm, generating a faster assimilation for new comers.

On wage effects, previous research has suggested that much of the unexplained variation in wages among employees is linked to characteristics of their firms, such as size and industry[2]. Not only individual characteristics explain wage differentials between immigrants and natives, but potentially so do other characteristics, such as the birthplace or ethnicity of employers and coworkers.

### 2.2. Social Networks, Ethnic/Racial Groups and Immigrant Segregation

Empirical literature has also discussed the racial and ethnic differences in informal job matching (see [2,5]). These differences arise because informal channels permit race and other characteristics in the network to play a more prominent role in the hiring process than it does when formal mechanisms are used. As noted by [2], one of the puzzles during 1980s and 1990s was the worsening of less educated blacks in the labor markets while the same markets were absorbing thousands of new immigrant workers. Surprisingly, these new workers had, on average, similar characteristics to blacks: low formal education and high geographic segregation. So the question of job distribution became to be a first order issue, especially in the topics of immigration and immigrant assimilation. According to [10], the answer for this puzzle has been focused in the use of social networks by different groups for finding employment.

Meanwhile the role of prospective employers in the use of these mechanisms has been ignored. The differential use of job referral by the employers is also relevant when we examine who is hired and how the benefits are distributed in the firm. For instance, immigrants will be hired most likely by immigrant firms with high share of immigrant workers than by native firms with high share of immigrant workers. This tendency promotes the creation of what [1] called *immigrant economies*.

## 3. Modeling the Importance of Social Networks and Labor Outcomes

[5] is the first theoretical discussion of firms' hiring procedures. However, no implications for wages were analyzed. The hypothesis is that networks may reduce costs and the uncertainty about workers' productivity. Since screening workers, negotiating wages, supervising, and enforcing contracts are all part of the administrative costs of a firm, firm owners may improve efficiency by using network connections available to workers with similar social backgrounds. We can think then that information networks may work better within groups (ethnic/race of employers and employees) than between them.

A second group of studies consider job information networks as exogenous and investigate the impact of networks on wages (see [6]). Networks solve the informational problem that employers face when they cannot observe the underlying ability of potential workers. In these models, the equilibrium wage distribution increases with the probability that an offer comes from a contact. These works further evaluate the link between wages and the strength of social ties (strong versus weak). Their models assume that firms post wages above or below the market wage based on the distribution of skill across individuals, and then workers decide whether to accept the offer or do otherwise. Because there is not a reservation wage developed in the model, individuals who reject offers or do not receive any offer must find employment in the anonymous market, so there is not employment differential across worker types.

More recent studies have explicitly modeled the structure of networks to analyze the effect of network dynamics on wages and unemployment (see [11,12]). In these models, the topology of the social ties is defined and built with detail and networks also work as instruments

[2]See [7-9].

 

to dissipate information imperfections. Workers face a cost of obtaining information on vacancies, or need to join networks that provide them with the best information. However, these models only focus on the supply side of the market; the role of firms or any type of negotiation are ignored. They treat labor markets as a black box. Therefore, the origin of the vacancy and the participation of firms in the job search are ignored.

## 4. A Simple Search Model

We consider a model similar to [5] where firms choose hiring procedures and workers search for jobs, and, then, include the importance of social contacts by assuming that firms take into account their current workers' social connections in their decision process. We include different types of firms and multiple networks. Firms can choose to fill their vacancies either by posting offers or by using their current workers' connections—a costless process—considering the capacity of their employees to find candidates for the position.

There are two types of firms ($o$) denoted as native-owned ($n$) and immigrant-owned ($f$), and two types of workers ($i$) denote as native ($n$) and immigrant ($f$). The number of each type of worker is exogenously given by $L_i$, and the number of type $i$ workers among the unemployed is $u_i$.

Workers and firms are risk neutral, live infinitely and have a common discount rate $r$. There is free-entry, and $\delta_o$ represents the number of type $o$ firms in steady state. Only unmatched workers engage in search. Unemployed workers receive a value of leisure $b$, and workers are separated from jobs at the exogenous rate $s$. Jobs are vacant or occupied.

### 4.1. The Matching Function

Like [13], the matching function is derived from an urn-ball process[3]. This process provides a microfoundation for the matching process and considers the coordination failure that arises from congestion externalities[4].

Then, as in [6] we include workers in the search process and the idea of job referral as a screening device. So, the efficiency of the social networks is also a function of the capacity of current workers to replicate themselves through the new candidate ("inbreeding bias"), together with employers' capacity of obtaining the best information from the worker about the new comer.

Each existing worker generates applicants for the employer at an exogenous rate $\rho_{io}$, which depends on worker ($i$) and employer ($o$) types. This factor is common to all firms with type $o$ and worker $i$. Here, $\rho_{io}$ plays the role of the network efficiency variable considered in [13]. Network efficiency depends on the number of workers of type $i$ in the firm and their social ties with same-type unemployed workers in steady state, and of the employer $o$'s ability to use his employees' (type $i$) connections.

Unemployed workers receive offers from two sources: from posted vacancies and from similar-type current workers in the firm. $1/u$ is the chance that any unemployed worker receives an offer from a posted vacancy and $1/u_i$ is a type-$i$ unemployed worker's probability of receiving an offer from social ties to a particular existing worker at the firm. Given the randomness of vacancies offered to unemployed workers, the probability that no firms' offers reach an unemployed worker of type $i$ is given by

$$\prod_{o\in n,f}^{o}\left(1-1/u\right)^{v_o}\left(1-1/u_i\right)^{\rho_{io}L_{io}}.$$

We assume that the levels of vacancies and unemployment are very high, which result in a constant ratio (market tightness). Therefore, the urn-ball matching function exhibits constant returns to scale.

With this in mind, we can then derive the probability that an unemployed worker from group $i$ receives at least one offer.

$$C_i = 1-\prod_{o\in n,f}^{o}\left(1-1/u\right)^{v_o}\left(1-1/u_i\right)^{\rho_{io}L_{io}} \qquad (1)$$

where $C_i$ represents the probability that an unemployed worker receives at least one job offer. This distribution can be approximated by a Poisson distribution.

$$C_i \approx 1-\exp\left(-\theta_i\right) \qquad (2)$$

where

$$\theta_i = \frac{\sum_o p_i v_o + \sum_o \rho_{io}L_{io}}{u_i} \qquad (3)$$

and

$$p_i = \frac{u_i}{u} \qquad (4)$$

The probability that an offer is matched to an unemployed worker of type $i$ is given by the matching function

[3]In the typical urn-ball process, there are U unemployed workers and V vacancies. Each unemployed worker submits an application. These applications are randomly distributed across the V vacancies with the restriction that any particular worker send at most one application to any particular vacancy. Each vacancy then chooses one application at random and offers that applicant a job. A worker may get more than one offer. In that case, the worker accepts one of the offers at random. Urn-ball process introduces a new coordination problem, because there could be multiple applications of job seekers but only one firm will hire the individual.

[4]This failure arises when workers apply to some vacancies without knowing where other workers applied, so that as a result there are multiple applications to some vacancies and zero to others. Therefore, the group of vacancies without applicants remains unfilled. For more detail refer to [14]. Here the case is reversed. Unemployed workers are considered the urns and job offers the balls. These workers received multiple offers depending on the conditions in the model.

 

$$m(\theta_i) = u_i C_i \frac{1}{\sum_o p_i v_o + \sum_o \rho_{io} L_{io}} \quad (5)$$

This function exhibits constant returns to scale. An increase of $\rho_{io}$ will translate into an increase in the number of offers to a particular worker in group *i*. We can rewrite Equation (5) as

$$m(\theta_i) = \frac{1}{\theta_i}\left(1-\exp(-\theta_i)\right) \quad (6)$$

where $m(\theta_i)$ is the expected number of workers hired of type *i*. It can be shown that $\partial m(\theta_i)/\partial \theta_i < 0$.

$$\frac{\partial m(\theta_i)}{\partial \theta_i} = \frac{\theta_i \exp(-\theta_i) - \left(1-\exp(\theta_i)\right)}{\theta_i^2} \quad (7)$$

which is negative as long as

$$1-\exp(-\theta) > \theta\exp(-\theta_i).$$

when $x=0$, then $xexp(-x)-\left(1-exp(-x)\right)=0$. The derivative of this function is negative with respect to *x* for $x>0$ (*i.e.* the tighter the market, the harder for firms to find a worker).

Additionally, $\theta_i m(\theta_i)$ represents the exit rate from unemployment for an individual *i*. The total number of matches is the sum of the contact rates within each social group.

$$M = \sum_o \sum_i \left(p_i v_o + \rho_{io} L_{io}\right) m(\theta_i) \quad (8)$$

### 4.2. Workers: Unemployed and Employed

On the workers' side, we denote $U_i$ as the present discounted utility of an unemployed worker and $W_{io}$ as the present discounted value of an employed worker holding a job, with $w_{io}$ being the wage rate for worker type *i* in firm type *o*.

$$rU_i = b + \theta_i m(\theta_i)\left(E\left[W_{io} - U_i\right]\right) \quad (9)$$

$$rW_{io} = w_{io} + s\left(U_i - W_{io}\right) \quad (10)$$

Workers receive offers from formal and informal channels, but only accept one offer. Therefore, an increment in the probability of finding a candidate through current workers increases the number of offers received by unemployed workers through informal channels.

### 4.3. Firms: Vacancy and Filled-Job Value

To simplify the model, an employee of a given group transfers job offers only to unemployed workers belonging to the same group. If he doesn't find an unemployed worker from his group, the job offer is lost. All types of employed workers produce $y$.

In addition to relying on coworker referrals, firms can advertise a job vacancy at a cost *c*. These posted offers are sent randomly to *u* unemployed workers. $\theta_i$ represents market tightness for workers of group *i*. $v_o$ is the number of vacancies posted by firm of type *o*.

Firms choose $v_o$ taking into account that employees also produce applicants. Therefore, employers face the following profit maximization problem:

$$V_o(L_{io}) = \underset{v_o \geq 0}{Max}\left[ y\left(\sum L_{io}\right) - \sum w_{io} L_{io} - c v_o + rV(L_{io})\right]$$

$$\text{s.t} \quad \dot{L}_o = \sum_i \left(\rho_{io} L_{io} + v_o\right) m(\theta_i) - sL_o$$

$$\dot{L}_o = \sum_i \dot{L}_{io} \quad (11)$$

The firm is interested in $L_{io}$ given $\rho_{io}$. $V(L_{io})$ is the firm expected profit.

Solving the Bellman Equation and using Kuhn-Tucker conditions we obtain:

$$\frac{c}{m(\theta_i)} = \frac{y - w_{io}(.)}{r + s - \rho_{io} m(\theta_i)} \rightarrow v_o > 0 \quad (12)$$

$$\frac{c}{m(\theta_i)} > \frac{y - w_{io}(.)}{r + s - \rho_{io} m(\theta_i)} \rightarrow v_o = 0 \quad (13)$$

Firms will post a vacancy if and only if the cost of posting the vacancy is equal to the value of filling the vacancy. If $v_o$ different to zero, in each period a firm *o* would choose the number of advertised vacancies, so it controls the increment of its total number of employees. In this way, the firm indirectly influences the number of applicants the social network will produce. Therefore, social connections may be used by the firms to find new workers in a costless way and as a mechanism for screening workers.

Wages are a result of bargaining between workers and employers. With this we endogenize labor market outcomes (wages and vacancies) but assume an exogenous job information network[5].

Wages are subject to a bargaining process. The surplus of each match is shared according to the Nash solution of the bargaining problem, with $\beta \in [0,1]$ representing the bargaining weight of firms.

$$\beta J_{io} = (1-\beta)\left(W_{io} - U_i\right) \quad (14)$$

where $J_o$ is the expected value of a filled job with a worker type *i* for a firm *o*. An individual will accept an offer if it is above the bargained wage. Using Equations (9)-(11) and Equation (14) we derive the wage implied by Nash bargaining.

[5]Other models fully describe the topology of the networks. However, in the framework of this paper, trying to endogenize networks would make it impossible to find a closed form solution. The simplicity of the model presented here allows us to draw strong implications without losing the relevant characteristics of the process.

 

$$w_{io} = b + \beta \frac{r + s + [\Omega]}{r + s + \beta[\Omega] - (1-\beta)\rho_{io}\dfrac{[\Omega]}{\theta_i}}(y - b) \quad (15)$$

where $[\Omega] = \theta_i m(\theta_i)$.

The arrival rate of job offers from a firm *o* to an unemployed worker of type *i* is directly proportional to the number of people in the network (group *i*) who are employed in firm *o*. An interpretation for $\rho_{io}$ is that it represents the capacity of workers and employers to take advantage of the groups' social connections. We could think $\rho_{io}$ consists of two exogenous components

$$\rho_{io} = f(\rho_i, \rho_o). \quad (16)$$

where $\rho_i$ is the set of connections that current workers of type *i* have, and $\rho_o$ represents the employer's ability to take advantage of his current employees' social ties.

Proposition 1: In partial equilibrium, taking $\theta_i$ as given, and for a given *y*, *c*, *b*, and *s*, wages are an increasing function of the efficiency of the social network $\rho_{io}$. A higher network efficiency induces a higher job matching rate for the firm with no additional cost.

Proof: Using Equation (15) we compute the derivative of wages with respect to social network efficiency:

$$\frac{\partial w_{io}}{\partial \rho_{io}} = \frac{\beta(1-\beta)m(\theta_i)(y-b)}{\left[r + s + \beta\theta_i m(\theta_i) - (1-\beta)\rho_{io}m(\theta_i)\right]^2} > 0 \quad (17)$$

The increase on the efficiency of networks for a worker type *i* in a firm *o* generates a higher number of expected matches for workers of type *i*, given them a better bargaining position in the firm. Therefore, we would expect the probability of hiring an immigrant worker to be higher the larger the amount of immigrant workers already employed by a firm. We could call this the "coworker effect". Additionally, when group *i* has more efficient social ties, and the owner is also more efficient in taking advantage of these social ties to find new workers, the use of current employees' connections to find candidates becomes less costly. Workers of type *i* would provide more candidates to the firm, therefore, the probability of this group being hired by the firm will be higher than otherwise, and the wage of those particular candidates would be higher compared to those with less efficient social networks in the firm.

There are two forces generated by any increment in $\rho_{io}$. On one side, it increases the job offers using informal channels, more candidates are searched by owners using current workers. On the other side, it decreases the number of vacancies advertised because firms find more costly to post a vacancy compared to using informal channels. This substitution effect guarantees the uniqueness of the equilibrium.

Because of lack of familiarity with their employees' cultural background, language, and social patterns, owners may not necessarily be able to exploit their employers' social ties. Within a firm, workers of different groups are paid differently because their social ties differ in their level of efficiency. That is, foreign-born and native workers receive different wages when working for an immigrant firm because links between immigrant employers and immigrant workers result in more worker referrals. Additionally, workers with higher offer arrival rates earn more in equilibrium. For instance, if we assume a distribution of network efficiency as follows: $\rho_{nn} > \rho_{ff} > \rho_{fn} > \rho_{nf}$, there would be a distribution of wages in which natives are paid higher wages when working for native firms, but are paid lower when they work for immigrant-owned businesses. Similarly, immigrants are paid better when working for immigrant employers, but still obtaining lower wages overall in the market.

Proposition 2: In equilibrium, labor market tightness adjusts so that the expected cost of an advertised vacancy equals the expected profit of a filled position.

Proof: Using results from the firm's problem, Equation (11), with $v_o > 0$, and wage bargaining results from Equation (15), we obtain:

$$\frac{c}{m(\theta_i)} = \frac{(1-\beta)y - b}{r + s + \beta\theta_i m(\theta_i) - (1-\beta)\rho_{io}m(\theta_i)} \quad (18)$$

The solution is defined only when the right hand side of Equation (18) is positive, that is, when the marginal value of a filled position is positive. This holds provided that

$$r + s + \beta\theta_i m(\theta_i) - (1-\beta)\rho_{io}m(\theta_i) > 0.$$

Assuming $\overline{\theta_i}$, such that :

$$r + s + \beta\overline{\theta_i} m(\overline{\theta_i}) - (1-\beta)\rho_{io}m(\overline{\theta_i}) = 0,$$

then for values of $\theta_i \in \left[\overline{\theta_i}, +\infty\right]$, the expression is increasing in $\theta_i$, so that the marginal value of a filled vacancy is decreasing with respect to $\theta_i$, while the cost of a filling vacancy increases with higher values of $\theta_i$.

Unemployment rate in equilibrium is obtained by equating the flow out of employment to the flow into the unemployment for each type *i* and is a function of the market tightness and the exit rate.

$$u_i = \frac{s}{s + \theta_i m(\theta_i)} \quad (19)$$

Recall that $\theta_i m(\theta_i)$ is the unemployment exit rate. Using Equation (19), as $\rho_{io}$ increases, the equilibrium exit rate $\theta_i m(\theta_i)$ increases, reducing $u_i$.

## 5. Concluding Remarks

Using a simple matching framework, this paper explores the potential mechanisms explaining the interconnection

 

between owner's and coworkers' nativity and workers' hiring patterns and wage.

The model has implications on the effect of social interactions on market wages. Among subgroups with the same *y*, *h*, *s*, firm-group combinations with higher $\rho_{io}$ will have higher wages and a lower unemployment rate.

There would be a distribution of wages in which workers are paid higher when working for same-type owners. Within a firm, workers of different groups are paid differently because their social ties differ in their level of efficiency. That is, foreign-born and native workers receive different wages when working for an immigrant firm because links between immigrant employers and immigrant workers result in more worker referrals. Additionally, workers with higher offer arrival rates earn more in equilibrium.

Even an immigrant firm with a low level of skilled workers could be able to generate a more efficient connection with its current workers if it can exploit the rate of worker replication. The better the employer can get information from its current employees, in this case the better immigrant firms obtain information from its current immigrant employees, the lower the uncertainty on the expected productivity, the lower the informational cost, and the lower the recruitment cost. The informal mechanism would be relatively more efficient than the use of formal recruitment processes.

In this framework, there are two effects generated by any increment of social connection's efficiency. On one side, it increases the job offers using informal channels; more candidates are found using current workers. On the other side, it decreases the number of vacancies advertised because firms find more costly to post a vacancy compared to use informal channels.

In the model, wages are derived endogenously as a function of the efficiency of the social ties of current employees. There are two types of owners and workers: native and immigrant. Owners can choose to fill their vacancies either by posting offers or by using their current workers' connections. As a result, individuals with better connections have higher wages. Individual with more ties would find more candidates for the firm, but he would have more opportunities when he becomes unemployed.

This analysis highlights the potential importance of social connections and social capital for understanding the disparity of employment opportunities and wage differentials between native and foreign born workers.

Notice that we assume exogenous network efficiency. Trying to endogenize and define the topology of networks could make more challenging the solution of the model.

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