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The impact mechanism of social networks on Chinese rural–urban migrant workers' behaviour and wages

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Abstract
Chinese domestic rural–urban migrant workers have played a substantial role in economic development since the late 1970s. This article makes an attempt to establish a two-period hiring model interpreting the impact mechanism of social networks on migrant workers' wages. The findings indicate that the extension of social networks of both firms and workers facilitates a decrease in the information gap between them and improves extra common benefits to both.

JEL Codes: J31, J61

Keywords
Guanxi, impact mechanism, rural–urban migrant worker, social network, wages

Introduction

In the more than three decades since the late 1970s, ever-increasing numbers of Chinese farmers have migrated from rural to urban locations to seek jobs. According to National Bureau of Statistics of the People's Republic of China (NBSC, 2013), the number of migrant workers had reached 262 million by the end

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of 2012. The increasingly significant phenomenon of labour flow has attracted specialists' attention, especially to the wage determinant of rural–urban migration, which has now become one of the most important issues relating to China's non-agricultural industry growth (Wang and Jing, 2012). Compared with local workers, rural migrant workers usually lack adequate information about job vacancies and positions. The channels for workers' job search are usually categorised into two dimensions. One is through labour markets, or the formal channel, by which migrant workers search for jobs in formal labour markets. The other is the informal channel, based on social networks, by which migrant workers rely on information from their friends and relatives to gain opportunities to work in urban areas. Chinese rural–urban migrants tend to use social network resources to achieve their employment goals.

Basic evidence from China

The Longitudinal Survey on Rural Urban Migration in China (RUMiC)[1] emphasises social networks such as relatives and friends as an important method for rural–urban migrants to seek jobs. Table 1 reports an interesting finding from the RUMiC: approximately 60% of employed rural migrants found their jobs in urban centres through referrals of their relatives and friends, and only 12.5% obtained their jobs by direct application. This shows that social networks play an important role in migrants' job seeking.

Another survey[2] conducted in the Pearl River Delta of China in 2008 also attests to the importance of social networks in migrants' job seeking. Table 2 summarises the roles of relatives and friends in job seeking by rural–urban migrants in the survey. It indicates that 86.3% of the interviewed migrants obtained employment information from relatives or friends, 85.4% gained their jobs with the recommendation of relatives and friends, 88.0% were accompanied by relatives and friends for job interviews and 70.2% directly arranged employment with the help of their relatives and friends. In one of our previous surveys, we also found that the social network was one of the main channels through which rural–urban migrant workers were successfully employed.[3]

Table 1. Job-seeking methods used by rural–urban migrants.

Job-seeking methods	Number	Percentage
Relatives/friends	3966	60.0
Advertisement	417	6.3
Applied directly	827	12.5
Employment agency	373	5.6
Employer recruitment	442	6.7
Self-employment	347	5.2
Others	244	3.7
Sample size	6616	100.0

Source: The Longitudinal Survey on Rural Urban Migration in China (RUMiC) in 2008.[1]

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Table 2. Basic statistics for migrants' current jobs.

Job-seeking methods by relatives and friends	Number	Percentage	Total sample size
Providing information	1770	86.3	2051
Recommendation	1751	85.4	2051
Accompanying for job interview	1805	88.0	2051
Arranging jobs directly	1440	70.2	2051

Source: Survey of migrants' behaviour at the Pearl River Delta of China, 2008. This survey was organised by a research team from Sun Yet-Sen University, China.[2,3]

Chinese migrant workers nowadays depend strongly on social ties embedded in labour markets for their employment in urban areas. Using data from a detailed household survey in Northeast China, Zhang and Li (2003) show that social networks (*guanxi*) have a significant impact on an individual's probability of securing a nonfarm job. Furthermore, other studies show that a social network arising from an individual's friends or relatives who have worked in urban areas is more likely to reduce the individual's job-searching cost and to improve his or her wage (Bridges and Villemez, 1986; Caliendo et al., 2010; Coleman, 1988; Durlauf and Fafchanps, 2004; Granovetter, 1985). In one of our recent studies, we show empirically that social capital has a significant and positive effect on rural migrants' income (Wang and Zhou, 2013).[4]

Why the majority of migrant workers rely on social networks for seeking jobs and how social networks influence those migrants' strategic behaviour and their wages, are pressing issues. Some previous studies suggest that social networks significantly contribute to the income of rural migrant workers in China and other developing economies (Amuedo-Dorantes and Mundra, 2007; Giles et al., 2006; Knight and Yueh, 2008; Zhang and Li, 2003), while others make counter conclusions from the US or European evidence (Mouw, 2002, 2003). In addition, Pellizzari (2010) finds large cross-country and cross-industry variation in income premiums associated with the role of informal social networks. The aforementioned studies help us to understand the relationship between social networks and labourers' wages, but do not provide a detailed mechanism to explain why and how social networks impact on Chinese migrant workers' wages. Furthermore, little of the literature concentrates on the benefit-shifting of both migrants and firms due to the extension of social networks over time. This article attempts to undertake a detailed analysis of decision-making as social networks are extended for both firms and workers, when there exists within these networks a mechanism for narrowing the information gap regarding work compensation.

This article focuses on how social networks influence the strategic behaviours of individuals and the wage of migrant workers. It is structured as follows. This first section provides the background and basic evidence from China, and the section 'Literature review' provides a review of the theoretical literature. In the section titled 'The model', a theoretically novel framework is proposed, and section 'The determination of the wage' provides a solution of the model. 'The effects of the social

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networks on the offer wage' then draws out the theoretical relationship between social networks and wages, with the section 'Conclusion and remarks' providing a conclusion.

Literature review

As mentioned above, the empirical literature has reached diverse conclusions relating to the issue of social networks and migrant workers' wage. In resolving this debate, the first priority is to investigate the mechanism in operation. That is, why and how do social networks benefit jobseekers as well as employers?

Montgomery (1991) develops a simple two-period model categorising workers into two groups with high and low ability. Assuming that high-ability workers have a higher probability of holding a tie to high-ability workers of the next period, Montgomery derives that an employing firm will seek to hire second-period workers by using referrals from their high-ability workers in the first period, instead of hiring from the open labour market. This is consistent with the finding by Rees (1966): hiring by networks is an efficient channel for firms to gain more information about worker quality than hiring directly from labour markets.

Classification of social networks is another important issue. Existing literature generally categorises social networks into two types: those based on strong ties and those characterised by weak ties. The first type refers to close relationships such as with relatives and good friends, while the latter refers to a more distant relationship such as that with colleagues or common acquaintances. Granovetter (1973, 1975) argues that weak ties can convey more useful job information to jobseekers than strong ties. Lin (2008) believes that weak ties facilitate sending more new job information to jobseekers, since strong ties such as those among relatives and good friends may involve no more than a sharing of information that is the same as, or similar to that already known to the jobseekers. Based on search theory, Montgomery (1992) advances a framework that involves the ideas of both Granovetter and Lin. In this model, a higher offer rate embodies Granovetter's view and a better wage distribution reflects Lin's idea. Montgomery's model implies that jobseekers' minimum acceptable wage is likely to increase with the rate of weak ties in the total networks. However, this model also shows that only in very special cases will the expected wage gained through weak ties be higher than the expected wage gained through strong ties. Montgomery's study nevertheless indicates that the structure of networks (the rate of weak ties in the total networks) should be valued.

A related issue of interest in the literature is the impact of social networks on inequality of employment opportunities and wages. Montgomery (1994) advances a simplified Markov model that involves weak ties, strong ties and formal channels in job seeking. In equilibrium, the existence of weak ties may reduce inequality of employment opportunities. Moreover, under some conditions, more weak ties are likely to increase the employment rate. Calvó-Armengol and Jackson (2003, 2004) develop a general Markov model that does not depend on any specific network

(though the network should be unchanging). They prove that the employment situation of heterogeneous individuals in different periods is positively related in the steady state. Allowing for search costs and the possibility of dropping out of the labour market, they also suggest that, even though the structure of two network groups may be identical, the group that starts with the better wage or employment situation will end up with a better wage or employment situation in the steady state. Loury (2006) indicates that a better match and limited-choice mechanism can account for differences in the wage effects of different types of job contacts. The above findings suggest that the existence of social networks contributes to the probability of inequality, which is opposite to Montgomery's (1994) conclusion.

Typically, three main methods are used to model the mechanism of networks' impact on wages. The first method (e.g. Montgomery, 1992) is based on the recursive equation of search theory. That is, the discounted utility of accepting the offer at this stage equals the subsequent discounted utility of finding a job in the next stage. Here, the social network is assumed to change the offer rate and wage directly. This kind of analysis focuses on how jobseekers make the offer-acceptance decision and determine the reserve wage, and so it cannot derive the impact of networks on the actual wage.

The second method (Calvó-Armengol and Jackson, 2003; Montgomery, 1994) analyses the transition probability based on the Markov model. It is suitable for all kinds of network structures, as different kinds of network can be interpreted by different transition probability matrices. However, since the probability is exogenously set, the method cannot illustrate how the transition probability matrix forms, nor can it interpret how the wage changes as the network structure shifts. Moreover, it merely analyses employers' behaviour. But firms' behaviour is actually impacted by social networks.

The third method describes both the workers' and firms' behaviour directly. Because different networks and different model settings may directly differ in workers' and firms' behaviour, this type of model depends on the model setting per se and is not universal. The Montgomery (1991) two-period model is such a typical example. Nevertheless, in these models, the wage is determined by the endogenous behaviour of workers and firms. If uncertainty exists, the distribution of wage levels would be a deductive result rather than an assumption, which should be considered cautiously.

In this article, we develop a model that fits the third type, which is based on Montgomery's (1991) framework. This study makes a positive contribution to the previous literature in the following respects: First, it extends Montgomery's model by generalising the assumption that a high-ability worker is more likely to hold a tie to a high-ability worker in the next period. In our model, types of firms and workers are continuous random variables distributed on [0, 1]. The match of types between firms and workers is pursued; thus, the types are no longer limited to the diverse quality of workers. These different types in our model can be further interpreted as indication of diverse sectors of industry. Second, we derive the equilibrium wage and make a further comparative static analysis of the positive effect of social networks on the wage instead of conducting a partial analysis as in

Montgomery's (1991) model. Finally, in contrast with Montgomery (1991)'s model, ours assumes that each firm provides an offer to the one worker who is the closest match to the firm's type from among the workers with network links to the firm's first-period workers, and each worker chooses to accept the highest offer wage. The mechanism in our model, whereby the employer hires through referrals in informal channels, is more consistent with reality.

The model

Rural–urban jobseekers often find jobs through acquaintances such as friends and relatives who provide job information and referrals. Meanwhile, firms usually rely on employee referrals to screen new migrant worker job applicants for ability and skills. The information gap between employers and migrant workers would otherwise often lead to an imperfect labour market, especially in developing countries such as China (Knight et al., 2011; Lee and Meng, 2010; Meng, 2001). Social networks such as employee referrals may play an important role in delivering information and facilitating the proper matching between jobseekers and firms. Our model below investigates why social networks help narrow the information gap and affect the going wage.

Assumptions

Labour market. To be consistent with Montgomery's (1991) assumptions, we assume that there is a two-period economy, where there are N firms and N workers in each period. Firms exist in two periods, while workers participate for only one period, that is, the first-period workers will all retire from the labour market at the end of the first period. In the second period, N new workers will enter the labour market. For simplicity, we assume that each firm can only hire one worker in each period. Denote the type of firm θ as a random variable representing the variety of industries. Correspondingly, assume the type of migrant worker is also a random variable θ matching the firm to which the worker is most suited. As there are N firms and N workers in each period, labour demand always equals labour supply, namely, the economy is always in equilibrium.

Information. Each firm knows exactly its own type θ, but does not know other firms' types. The distribution of firm types is common knowledge, for simplicity, denoted as $\theta \sim U[0, 1]$. Before recruiting, firms do not know migrant workers' types but only their distribution $\theta \sim U[0, 1]$. However, after recruitment, firms become cognisant of their employees' types. A worker only knows his or her own type and the type of the matching employer, and the distribution of other workers and firm types is common knowledge.

Two-period model. In Period 1, firms are established. Denote the type of a representative firm i by $\theta_i, \quad i = 1, 2, \ldots, N$. The firm hires a worker from the labour market

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stochastically. After hiring, the firm knows exactly its employee's type θ_{1i}, but does not know the types of employees in other firms, only their distribution: $\theta \sim U[0, 1]$.

In Period 2, workers in the first period retire and firms recruit new workers from the labour market directly or through referrals provided by their first-period employees. If a firm hires workers through the labour market, the only information about new workers available to the firm is that the type of new workers (denoted by θ_{2Mi}) is distributed uniformly on $[\theta_i, \theta_{1i}]$ or $[\theta_{1i}, \theta_i]$. Alternatively, the firm often hires second-period workers on the basis of first-period employees' referrals (i.e. via a social network), whereby the worker recommends a worker of the type most suited to the type of firm. Assume that the density of social networks of each first-period employee is m, that is, each employee in the first period knows m candidate workers in the second period. The type of each candidate is uniformly distributed on $[\theta_i, \theta_{1i}]$ or $[\theta_{1i}, \theta_i]$. The firm will determine the offer wage to maximise its expected profit and then make the offer to the new worker. The firm can only send one offer. The workers who have received more than one offer will accept the highest offer and refuse others. Firms that have been refused and workers who receive no offer will continue to search in the labour market and pay the market wage.

Firm. Assume that in both of the two periods, there is only one product and all firms produce the same product, and a representative firm i's production function is

$$q_i = 1 - |\theta_i - \theta_k|$$

where q_i is the output, θ_i and θ_k are the firm's and its employees' types, respectively, and $|\theta_i - \theta_k|$ is the distance between the firm's and the employees' types, which is a measure of their matching cost. This specification of the production function makes it easy to show that the distance between the two types – of the firm and the worker – constitutes the cost to the firm, in reduced output, that results from a poor match. It is this matching cost that the firm seeks to reduce, by hiring through employee referrals (or social networks).

The profit of firm i is $y_i = 1 - |\theta_i - \theta_k| - w$, where w is the wage. Denote the market wages in the first and second periods as w_{1M} and w_{2M}, respectively, which are both assumed to be exogenous variables.

The firm's behaviour

In Period 1, firm i hires a worker from the labour market stochastically with its profit function being $y_{1i} = 1 - |\theta_i - \theta_{1i}| - w_{1M}$. In Period 2, it determines whether to hire through the labour market or through a social network. In the former case, the type of workers is

$$\theta_{2Mi} \sim \begin{cases} U[\theta_i, \theta_{1i}], & \text{if } \theta_i < \theta_{1i} \\ U[\theta_{1i}, \theta_i], & \text{if } \theta_i > \theta_{1i} \end{cases}$$

and the firm's profit function is $y_{2i} = 1 - |\theta_i - \theta_{2M}| - w_{2M}$. In the latter case, firms have to determine the offer wage.

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Denote the type of the m candidates at the end of Period 1 as θ_{2i}^k $(k = 1, 2, \ldots, m)$ with

$$\theta_{2i}^k \sim \begin{cases} U[\theta_i, \theta_{1i}], & \text{if } \theta_i < \theta_{1i} \\ U[\theta_{1i}, \theta_i], & \text{if } \theta_i > \theta_{1i} \end{cases}$$

The cumulative distribution function is denoted by $H_{1i}(\cdot)$. As illustrated above, each new candidate is recommended by a first-period employee according to his or her type and the firm's type. As the firm does not know the specific type θ_{2i}^k exactly, this hiring through referrals can be seen as if the firm randomly samples m times from the distribution $U[\theta_i, \theta_{1i}]$ or $U[\theta_{1i}, \theta_i]$, and chooses the closest candidate type denoted by θ_{2Ri}. If the firm's offer is accepted, its expected profit in Period 2 will be $y_{2i} = 1 - |\theta_i - \theta_{2Ri}| - w_{2Ri}$; otherwise, it has to hire through labour market and the expected profit is $y_{2i} = 1 - |\theta_i - \theta_{2Mi}| - w_{2M}$.

The workers' behaviour

As a first-period employee recommends the most suitable new workers to the firm and helps it maximise its profit, the employee's network can be seen as that of the firm. Assume that the density of social networks of each second-period worker is n, that is, each second-period worker knows n first-period workers. The second-period worker does not know exactly the type of the first-period workers in his or her networks, but knows that it is uniformly distributed on [0, 1]. The second-period worker with more than one offer will accept the highest wage offer, while the person with no offer will have to search for a job in the labour market and accept the market wage w_{2M}.

The determination of the wage

We now derive the firm's optimal offer wage which is related to social networks m and n. Firm i provides its offer wage w_{2M} to maximise its expected profit:

$$\max_{w_{2Ri}} E(y_2|\theta_i, \theta_{1i}) \equiv \pi_i(w_{2Ri})[E(q_{2Ri}|\theta_i, \theta_{1i}) - w_{2Ri}] + [1 - \pi_i(w_{2Ri})][E(q_{2Mi}|\theta_i, \theta_{1i}) - w_{2M}]$$

where $\pi_i(w_{2Ri})$ is the probability that a worker will accept the firm's offer w_{2Ri}, and $q_{2Ri} = 1 - |\theta_i - \theta_{2Ri}|$ and $q_{2Mi} = 1 - |\theta_i - \theta_{2Mi}|$ are the firm's second-period output when hiring workers through social networks and through the labour market, respectively. Denote $A_i \equiv q_{2Ri} - q_{2Mi}$. This is the extra output due to the reduction of the matching cost from hiring through networks instead of through the market. It can also be seen as the extra common benefit, since the firm has to share A_i with the worker who accepts the wage offer. Denote $EA_i \equiv E(q_{2Ri} - q_{2Mi}|\theta_i, \theta_{1i})$. From Appendix 2, $EAi = (m - 1)/2(m + 1)|\theta_i - \theta_{1i}|$. The firm's optimal offer wage w_{2Ri}^* satisfies the following first-order condition

$$\pi_i(w_{2Ri}^*) = \pi_i'(w_{2Ri}^*)[EA_i - (w_{2Ri}^* - w_{2M})] \quad (1)$$

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Hence w^*_{2Ri} is a function of EA_i, denoted as

$$w^*_{2Ri} = w_i(EA_i) \tag{2}$$

where $w_i(\cdot)$ is the optimal response function of firm i conditional on θ_i and θ_{1i}, the distribution of θ_{2Mi} and θ_{2Ri}, and the specific form of $\pi_i(\cdot)$. This shows that firm i will set the optimal wage offer w^*_{2Ri} according to the realisation of EA_i. The uncertainty of w^*_{2Ri} is due to the randomness of EA_i. Appendix 2 derives the distribution of EA_i, which is related to the social network m.

The probability $\pi_i(w^*_{2Ri})$ reflects the response of the worker who has received firm i's offer w^*_{2Ri}. Whether the worker of type θ_{2Ri} accepts firm i's wage offer w^*_{2Ri} depends on whether he or she has received a higher wage from other firms. Suppose the worker of type θ_{2Ri} also receives firm j's offer w^*_{2Rj}. Then

$$\begin{aligned}\pi_i\left(w^*_{2Ri}\right) &= P\left\{\theta_{2Ri} \text{ accepts } w^*_{2Ri}\right\} \prod_{j=1, j\neq i}^{N} P\left\{\theta_{2Ri} \text{ receives no offer with wage } w^*_{2Rj} > w^*_{2Ri}\right\} \\ &= \prod_{j=1, j\neq i}^{N} \left(1 - P\left\{\theta_{2Ri} \text{ receives } w^*_{2Rj} > w^*_{2Ri}\right\}\right)\end{aligned}$$

where $P\{\theta_{2Ri} \text{ receives } w^*_{2Rj} > w^*_{2Ri}\}$ can be written as

$$\begin{aligned}&P\left\{\theta_{2Ri} \text{ ties to } \theta_{1j}\right\} \cdot P\left\{\theta_{1j} \text{ make offer to } \theta_{2Ri} | \theta_{2Ri} \text{ ties to } \theta_{1j}\right\} \cdot \\ &P\left\{w^*_{2Rj} > w^*_{2Ri} | \theta_{2Ri} \text{ ties to } \theta_{1j},\ \theta_{1j} \text{ make offer to } \theta_{2Ri}\right\}\end{aligned} \tag{3}$$

To relate the response of the worker to the density of social networks n and m, we study each term in equation (3). Under the assumption of equal probability, $P\{\theta_{2Ri} \text{ ties to } \theta_{1j}\} = n/N$. Since both firm j and the worker know nothing about the type of firm i except the distribution of the type, the second term $\tau \equiv P\{\theta_{1j} \text{ send offer to } \theta_{2Ri} | \theta_{2Ri} \text{ ties to } \theta_{1j}\}$ is irrelevant to θ_{1i} and θ_i. Also, since the firm's decision to make an offer only depends on the distance between its type and the worker's type, τ is irrelevant to n. Moreover, τ is a function of the social network density m. We can assume that $\partial\tau/\partial m < 0$ since the probability of θ_{2Ri} receiving an offer from another firm will decrease with the size of the social network of first-period workers. The last term in equation (3) is $1 - K_i(w^*_{2Ri})$, where $K_i(w) = P(w^*_{2Rj} < w, \quad j \neq i)$ is the distribution function of firm j's offer wage w^*_{2Rj} to the worker θ_{2Ri}. Furthermore, as n, N, τ and $K(\cdot)$ are all the same for all firms, we can write $\pi(w^*_{2Ri}) = \pi_i(w^*_{2Ri})$. Hence

$$\pi\left(w^*_{2Ri}\right) = \prod_{\substack{j=1 \\ j\neq i}}^{N-1} \left(1 - \frac{n}{N} \cdot \tau \cdot \left[1 - K_i\left(w^*_{2Ri}\right)\right]\right) = \left(1 - \frac{n}{N} \cdot \tau \cdot \left[1 - K\left(w^*_{2Ri}\right)\right]\right)^{N-1} \tag{4}$$

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The specific form of $K(w)$ is determined by the distribution of EA_j (from the viewpoint of firm i). It follows from the monotonicity of $w(EA_i)$ and the distribution of EA_i that

$$K\left(w_{2Ri}^{*}\right) = P\left\{w_{2Rj}^{*} \le w_{2Ri}^{*}\right\} = P\left\{w(EA_j) \le w(EA_i)\right\} = P\left\{EA_j \le EA_i\right\} = A(EA_i) \quad (5)$$

Since $0 \le EA_i \le ((m-1)/2(m+1))$ and $EA_i = w^{-1}(w_{2Ri}^{*})$, substituting equation (5) into equation (4), we have

$$\pi\left(w_{2Ri}^{*}\right) = \left[1 - \frac{n\tau}{N}\left(1 - \frac{2(m+1)}{m-1}w^{-1}\left(w_{2Ri}^{*}\right)\right)^{2}\right]^{N-1} \quad (6)$$

Denote $\delta \equiv N/n\tau$ and $c \equiv 2(m+1)/m - 1$. Differentiating (6) with respect to w_{2Ri}^{*} and solving the differential equation (1) with the initial condition: $w_{2Ri}^{*} = w_{2M}$ as $EA_i = 0$, we have

$$w_{2Ri}^{*} = w_{2M} + EA_i - S \quad (7)$$

where $S \equiv \int_0^{EA_i} ((\delta - (1-cx)^2)/(\delta - (1-cEA_i)^2))^{N-1} dx$, $0 \le S \le EA_i$, $\delta = N/n\tau$ and $c = (2(m+1))/(m-1)$.

This is the expression of the optimal response $w_{2Ri}^{*} = w(EA_i)$. It can also be written as

$$w_{2Ri}^{*} = w_{2M} + \frac{m-1}{2(m+1)}|\theta_i - \theta_{1i}| - \frac{m-1}{2(m+1)}\int_0^{|\theta_i - \theta_{1i}|}\left(\frac{N - n\tau(1-x)^2}{N - n\tau(1-|\theta_i - \theta_{1i}|)^2}\right)^{N-1} dx \quad (8)$$

Note that $w_{2M} \le w_{2Ri}^{*} \le EA_i + w_{2M}$. This implies that the optimal offer wage should be greater than the market wage; otherwise, workers will refuse the offer. Also, w_{2Ri}^{*} should not be higher than the sum of the market wage and extra common benefit; otherwise, firms will not hire through referrals.[5]

The optimal wage offer, as shown in equation (8), is composed of three parts. The first part is the market wage, w_{2M}, which is the benchmark for pricing labour in any wage offer. The second part is EA_i, the difference in expected production from these two hiring channels. It is due to the existence of the extra common benefit that the firm is inclined to hire through networks. The third part is a positive number S deducted from the wage offer. S and $EA_i - S$ constitute the extra common benefit and belong to the firm and the worker, respectively.

By the definition of S, the division S from extra common benefit is determined by the total number of firms and workers N, the social networks of first-period workers m, the social networks of second-period workers n, the probability of the worker receiving another offer τ and the extra common interest EA_i (also influenced by m). These factors are all taken into account by the firm in determining its wage offer. Meanwhile, the division of the extra common interest is determined.

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In fact, the division results from the interaction of the 'power' of firms and workers. First, the social network of first-period workers m is the 'power' of firms, and hence can increase EA_i, S and w^*_{2Ri}. Second, n is the 'power' of second-period workers, which can increase the probability of the workers receiving wage offers higher than w^*_{2Ri} and refusing the firm's offer. As the firm being refused cannot earn the extra common benefit, it seeks to increase the offer wage to ensure that the probability of being accepted is not too low. Third, τ, the probability of receiving an offer from other firms, to some extent can represent the intensity of competition among firms. The more intense the competition, the more 'power' second-period workers have. This will certainly increase the offer wage and decrease the extra common benefit S to the firm. All these results imply that the social network is one of the significant determinants of the offer wage.

The effects of social networks on the offer wage

The influence of social network of the first-period worker on the offer wage

As stated above, first-period workers help their employers find the most suitable second-period employees. Accordingly, the social network of first-period workers can be seen as that of the firms in which first-period workers worked. It follows from equations (7) and (8) that $0 \leq S \leq EA_i$ and $\partial w^*_{2Ri}/\partial m > 0$. That is, the social network of firms plays a positive role in enhancing the offer wage for second-period workers. By $\partial w^*_{2Ri}/\partial m = \partial EA_i/\partial m - \partial S/\partial m > 0$, we know that the firm can benefit by the extra common interest when it hires through networks so that the matching cost decreases. However, the second-period workers have the right to reject the offer. So, the firm is inclined to share some benefit (by means of a setting higher wage) with its target employee to increase the probability for its wage offer to be accepted. It is this mechanism that makes both the firm and second-period workers benefit more when the firm hires through networks. Furthermore, $\partial^2 S/\partial m^2 < 0$ and $\partial^2 w^*_{2Ri}/\partial m^2 < 0$. This implies that the positive effect of the social network on wage is marginally diminishing.

Moreover, it follows from

$$\frac{EA_i - S}{EA_i} = 1 - \frac{1}{|\theta_i - \theta_{1i}|} \int_0^{|\theta_i - \theta_{1i}|} \left(\frac{N - n\tau(1-x)^2}{N - n\tau(1 - |\theta_i - \theta_{1i}|)^2} \right)^{N-1} dx$$

that the proportion of the extra common benefit which the firm and second-period workers share does not change with m. Thus, the social networks of firms influence the wage only by increasing the extra common benefit. The benefit will not change the sharing structure on either side.

The influence of the social network of the second-period worker on the offer wage

Among the three components of the optimal wage in equation (7), it is only S that can be influenced by n. Denote $g(n,\tau) \equiv (N - n\tau(1-x)^2)/N - n\tau(1 - |\theta_i - \theta_{1i}|)^2$,

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where $0 \leq x \leq |\theta_i - \theta_{1i}|$. It is easy to see that $(\partial g(n,\tau))/\partial n < 0$ and $(\partial^2 g(n,\tau))/\partial n^2 > 0$. Hence $\partial S/\partial n < 0$ and $\partial w^*_{2Ri}/\partial n > 0$. This suggests that the offer wage will increase with the extent of the social network of second-period workers. As the total extra common benefit EA_i is irrelevant to n, the profit of firms will decrease with n in this case. So n influences the wage by changing the share S of the extra common benefit in a manner different from the role of m. Here n is the 'power' of second-period workers, while m is the 'power' of first-period workers or that of firms. Firms have to increase their wage to reduce the probability of their offers being refused when n increases.

Furthermore, by $\partial^2 g(n,\tau)/\partial n^2 > 0$, we have $\partial^2 S/\partial n^2 > 0$ and $\partial^2 w^*_{2Ri}/\partial n^2 < 0$. This fact implies a diminishing marginal effect of social network n on wage w^*_{2Ri}. Although the wage increases with the extent of the social network n, its marginal effect will decrease with n. The social network, as a form of capital, can bring the workers benefits; however, as they gain additional acquaintances or friends (i.e. more social capital), the effect of social capital in lifting the wage will decrease. This may be due to the fact that the job vacancy information from this extra social network has already included the information from the original or old networks so that the new social network is not as informative as the old one prior to the further social network increase.

Although the effects of these two types of social networks on the wage are quite similar (i.e. positive but marginally decreasing), their mechanisms are completely different. The network of a firm, m, influences the wage by changing both the extra common benefit and the allocation of that benefit such that $\partial EA_i/\partial m > 0$ and $\partial S/\partial m > 0$, while the network of the second-period workers, n, affects the wage only by changing the distribution of benefit such that $\partial S/\partial n < 0$ since $\partial EA_i/\partial n = 0$. For the second-order effects of the allocation of benefit, the signs are reversed: $\partial^2 S/\partial m^2 < 0$ and $\partial^2 S/\partial n^2 > 0$.

Conclusion and remarks

This article has investigated in detail the mechanism of the relationship between social networks and wage levels. Based on Montgomery's (1991) assumption, we have presented a two-period model to illustrate how the optimal offer wage is determined and how the components of the wage are influenced by two types of social networks. From the analysis of the mechanism, we obtain the following main results.

Conclusion 1

Both the firm's social network and the second-period employees' social network can cut down the matching cost of the firm and the workers, and benefit both parties in the labour market. Hence, firms are inclined to hire through referrals.

In China, many local firms hire workers by using referrals to decrease the matching cost. For example, according to *Yangcheng Evening News* (2011), a firm in Dongguan in Guangdong Province encouraged its former employees to recommend their fellow-villagers to work in the firm. For each successful referral, the former

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employee would be rewarded with 400 yuan if the new worker was female and 200 yuan if the new worker was male. However, when the firm established open and formal recruitment fairs at bus stations, few suitable workers could be successfully recruited, and the benefit to the firm was negatively affected. Hiring through referrals benefited both the firm and the employees. The Dongguan case is typical of the functioning of the Chinese labour market recruiting migrant workers.

Conclusion 2

Given the type of firm and its first-period employees, owing to social networks, the firm's optimal offer wage to a second-period worker is expressed as $w^*_{2Ri} = w_{2M} + EA_i - S$ with $w_{2M} \leq w^*_{2Ri} \leq EA_i + w_{2M}$, where w^*_{2Ri} is the optimal offer wage, w_{2M} is the market wage, EA_i is the extra common benefit, and S is the share of the benefit belonging to the firm.

This conclusion argues that the difference between the firm's offer wage and the market wage is greater than zero but less than the extra common benefit. It is known that more social capital can improve the wage above the market wage (see Knight and Yueh, 2008; Lu and Song, 2006; Montgomery, 1994, among others); however, the section 'Conclusion 2' focuses more on the effect of social capital: the wage offer can at most exceed the market wage over the extra common benefit, thanks to social capital. The amount by which the offer wage exceeds the market wage will depend on how much of the share of the benefit is acquired by the firm. This is where our conclusion is different from those in the literature.

Conclusion 3

The optimal offer wage tends to increase with the social networks of both firms and workers. However, the two types of social networks show diminishing marginal effects on the wage.

As pointed out in the Dongguan case above, the offer wage of the firm to the new workers also increases with the density of the social network of the former employees (i.e. that of the firm) since the former employees may present more information about the quality characteristics of the new workers to the firm and urge the firm to offer a higher wage to their village-followers or friends. In fact, Zhang and Li (2003) use data from a detailed household survey in Northeast China to show that *guanxi* (a kind of social capital in China) has a significant impact on an individual's probability of securing a nonfarm job (Bian, 1994).

The social network of the employees in a firm can also increase the wage of these employees themselves. For example, in Wang and Zhou (2013), we conclude empirically that in an enterprise the friendly relationship between migrants and local workers can help increase the probability of the migrants' earning a high and upper-middle wage. The latter part of 'Conclusion and remarks' is also interesting since it implies that the positive effect of the social network on wage decreases with the volume of social capital. At some degree of social networking, the wage will arrive at a maximum. Using social capital alone to improve the wage is insufficient;

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other factors such as human capital and social professionals may play more important roles in upgrading the wage.

Conclusion 4

The social network of firms influences the wage by influencing the extra common benefit, while the network of the workers affects the wage only through the distribution of the benefit. That is, the two types of social networks both play a positive role in affecting the wage, but in quite different ways.

The economic performance of migrant workers strongly depends on social networks since human capital and social professionals are, in fact, in relatively low supply. However, social organisations such as Chinese labour unions have little power in struggling for labourers' benefit, though they have made much progress in pursuing power since the late 1970s. To some extent, our theoretic results indicate that, to improve their whole economic status, migrant workers need to work to ensure a harmonious labour relationship with and within employing enterprises. Harmonious social networks or hiring by referrals are also important for firms to recruit workers who are a better match and decrease the matching cost. Therefore, developing urban social organisations for the two-way exchange of employment information and establishing an effective interactive platform for both employers and migrant workers are helpful for both. Our study implies that appropriate affirmative action can be taken to improve social networks among migrant workers and firms in China in order to enhance the benefits to both sides.

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Notes

1. The Longitudinal Survey on Rural Urban Migration in China (RUMiC) consists of three parts: the Urban Household Survey, the Rural Household Survey and the Migrant Household Survey (http://idsc.iza.org/?page=122#RUMiC). It was initiated by a group of researchers at the Australian National University, the University of Queensland and the Beijing Normal University and was supported by the Institute for the Study of Labor (IZA), which provides the Scientific Use Files. The financial support for RUMiC was obtained from the Australian Research Council, the Australian Agency for International Development (AusAID), the Ford Foundation, IZA and the Chinese Foundation of Social Sciences.
2. The population of rural–urban migrant workers in the Pearl River Delta accounts for the majority among all metropolitan circles. This survey is organised by a team in Sun Yet-Sen University (http://engcss.sysu.edu.cn/).

3. In a survey of Pearl River Delta in 2010, we randomly interviewed 1339 rural migrant workers in Guangzhou, Zhuhai, Shenzhen and Dongguan, 51% of whom found their job through referrals of relatives and friends, 20% by themselves, 18% in labour markets and only 2% through government assistance.
4. Lin (2001) argues that 'social capital may be defined operationally as resources embedded in social networks and accessed and used by actors for actions' (pp. 24–25). Putnam (2000) defines social capital as 'connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them' (p. 19). The above two definitions suggest that social capital is one element coming from a specific social network.
5. In this case, the profit from hiring through networks is less than that from hiring through the labour market.

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Appendix 1

The distribution of θ_{2Ri} and the conditional expectation of $\theta 2_{Ri}$ and θ_{2Mi}

The type of the worker hired by firm i from networks is θ_{2Ri}. At the beginning of Period 2, θ_{1i}, θ_i are both known and θ_{2Ri} is the closest type, of m candidates, to the type of firm i. The types of candidates θ^j_{2i} are uniformly distributed on $[\theta_i, \theta_{1i}]$ or $[\theta_{1i}, \theta_i]$, and they are independent for $j = 1, 2, \ldots, m$.

When $\theta_{1i} > \theta_i$, $\theta_{2Ri} = \min\{\theta^1_{2i}, \cdots, \theta^m_{2i}\}$. So the distribution function of θ_{2Ri} is

$$\begin{aligned} Z(z|\theta_i, \theta_{1i}) &\equiv P\{\theta_{2Ri} \le z\} \\ &= P\{\min\{\theta^1_{2i}, \ldots, \theta^m_{2i}\} \le z\} = 1 - P\{\min\{\theta^1_{2i}, \ldots, \theta^m_{2i}\} > z\} \\ &= 1 - P\{\theta^1_{2i} > z\} \cdots P\{\theta^m_{2i} > z\} = 1 - P\{\theta^j_{2i} > z\}^m \\ &= 1 - \left[1 - P\{\theta^j_{2i} \le z\}\right]^m = 1 - [1 - H_{1i}(z)]^m \end{aligned}$$

Since $\theta^j_{2i} \sim U[\theta_i, \theta_{1i}]$ with distribution function

$$H_{1i}(z) = \begin{cases} 0, & < \theta_i \\ \frac{z-\theta_i}{\theta_{1i}-\theta_i}, & \theta_i \le z < \theta_{1i} \\ 1, & z \ge \theta_{1i} \end{cases}$$

we can derive that

$$Z(z|\theta_i, \theta_{1i}) = \begin{cases} 0, & z < \theta_i \\ 1 - \left(1 - \frac{z-\theta_i}{\theta_{1i}-\theta_i}\right)^m, & \theta_i \le z < \theta_{1i} \\ 1, & z \ge \theta_{1i} \end{cases} \quad (9)$$

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Similarly, when $\theta_{1i} < \theta_i$, we have $\theta_{2Ri} = \max\{\theta_{2i}^1, \cdots, \theta_{2i}^m\}$ and

$$Z(z|\,\theta_i, \theta_{1i}) = \begin{cases} 0, & z < \theta_{1i} \\ \left(\dfrac{z-\theta_{1i}}{\theta_i - \theta_{1i}}\right)^m, & \theta_{1i} \le z < \theta_i \\ 1, & z \ge \theta_i. \end{cases} \tag{10}$$

Furthermore, by equations (9) and (10), the conditional expectation of θ_{2Ri} is

$$E(\theta_{2Ri}|\theta_i, \theta_{1i}) = \theta_i + \frac{\theta_{1i} - \theta_i}{m+1} \tag{11}$$

no matter whether $\theta_{1i} > \theta_i$ or $\theta_{1i} < \theta_i$.

If firm i hires a second-period worker from the labour market, the type of the worker is distributed as

$$\theta_{2Mi} \sim \begin{cases} U[\theta_i, \theta_{1i}], & \text{if } \theta_i < \theta_{1i} \\ U[\theta_{1i}, \theta_i], & \text{if } \theta_i > \theta_{1i} \end{cases}$$

Its conditional expectation is

$$E(\theta_{2Mi}|\theta_i, \theta_{1i}) = \theta_i + \frac{\theta_{1i} - \theta_i}{2} \tag{12}$$

Equations (11) and (12) show that the conditional expectation of θ_{2Ri} is closer to θ_i than that of θ_{2Mi} if $m > 1$. This implies that hiring through social networks is indeed better than hiring through the labour market.

Appendix 2

The extra common benefit EA_i and its distribution

According to the definition, Ai is the extra output from hiring through networks, which comes from the reduction of the matching cost in this kind of hiring. We call A_i the extra common benefit because firm i has to share A_i with the worker who accepts its offer.

At end of the first period, θ_i and θ_{1i} is known and $\theta_{2Mi} \sim U[\theta_i, \theta_{1i}]$, $\theta_{2Ri} \sim Z(z|\theta_i, \theta_{1i})$ (see Appendix 1 for the distribution of θ_{2Ri}). When $\theta_{1i} \ge \theta_i$

$$E|\theta_i - \theta_{2Mi}| = E(\theta_{2Mi} - \theta_i) = \int_{\theta_i}^{\theta_{1i}} \frac{z-\theta_i}{\theta_{1i}-\theta_i} dz = \frac{\theta_{1i} - \theta_i}{2}$$

when $\theta_{1i} < \theta_i$, $E|\theta_i - \theta_{2Mi}| = \int_{\theta 1i}^{\theta i} (\theta_i - z)/(\theta_i - \theta_{1i}) dz = (\theta_i - \theta_{1i})/2$. Hence, $E|\theta_i - \theta_{2Mi}| = |\theta_i - \theta_{1i}|/2$. Similarly, we have $E|\theta_i - \theta_{2Ri}| = |\theta_i - \theta_{1i}|/m + 1$. Thus,

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$$EA_i = E|\theta_i - \theta_{2Mi}| - E|\theta_i - \theta_{2Ri}| = \frac{|\theta_i - \theta_{1i}|}{2} - \frac{|\theta i - \theta_{1i}|}{m+1} = \frac{m-1}{2(m+1)}|\theta_i - \theta_{1i}|$$

where $0 \le EA_i \le (m-1)/(2(m+1))$. The property $EA_i \ge 0$ implies that all the firms independently send an offer to a candidate, and that only the firms refused by candidates would hire through the labour market.

When $\theta_{1i} > \theta i$, $EA_i = ((m-1)/2(m+1))(\theta_{1i} - \theta_i)$, when $\theta_{1i} < \theta_i$, $EA_i = ((m-1)/2(m+1))(\theta_{1i} - \theta_i)$. Hence, $EA_i = (m-1)/(2(m+1))|\theta_i - \theta_{1i}|$. Note that $0 \le EA_i \le (m-1)/(2(m+1))$. When $a \ge (m-1)/(2(m+1))$, $A(a) = 1$; when $a < 0$, $A(a) = 0$; and when $0 \le a < (m-1)/((2(m+1))$, we have

$$\begin{aligned} A(a) &= P\{EA_i \le a\} = P\left\{\frac{m-1}{2(m+1)}|\theta_i - \theta_{1i}| \le a\right\} \\ &= 1 - 2\times\frac{1}{2}\left[1 - \frac{2(m+1)}{m-1}a\right]^2 = \frac{4(m+1)}{m-1}a - \frac{4(m+1)^2}{(m-1)^2}a^2 \end{aligned}$$

Hence the distribution of EA_i is

$$A(a) = \begin{cases} 0, & a < 0 \\ \dfrac{4(m+1)}{m-1}a - \dfrac{4(m+1)^2}{(m-1)^2}a^2, & 0 \le a < \dfrac{m-1}{2(m+1)} \\ 1, & a \ge \dfrac{m-1}{2(m+1)} \end{cases}$$

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