Referral Hiring of Miners

Case from the Coal Industry in Early Twentieth Century Japan*

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Abstract

Referral hiring has been a practical solution to the problem of adverse selection in the labor market and, as a result, increasingly attracts interest from economic researchers. This study argues that firms use referral hiring when workers' skills are too specialized for employees in the human resources division to decide on a right candidate. In the 1900s, coal mining firms used referral hiring to screen workers. We focus on the recruitment of miners and study the experience of a coal mine in the 1900s, analyzing employment contracts. Our theoretical predictions argue that workers with traditional manual skills were hired with using referral hiring and unskilled workers and workers with modernized skills were hired directly by firms, not using referral hiring. Our empirical analysis is consistent with the predictions.

Key words: referral hiring, job referral, asymmetric information, adverse selection, social networks, informal job networks, intermediary management, organization of labor, coal mining, Japan.
JEL: J20, L22, L71.

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Introduction

From the late 19th century to the early 20th century, coal mining firms used the intermediary organization of labor called the "dormitory system."[1] Here, firms built dormitories around their coal mines in which miners resided. Each dormitory had a leader, called a dormitory head, to whom firms delegated the tasks of managing miners, including monitoring, paying, and recruiting miners.[2]

In this study, we focus on the recruitment of miners. In the early days of the coal mining industry, firms subcontracted the recruitment of workers entirely to dormitory heads, and were not involved in drawing up employment contracts with individual miners. However, The Mining Act of 1892 compelled all coal mining firms in Japan to make a list of their workers. Technically, this meant firms had employment contracts with individual miners. However, in practice, the firms still did not recruit miners. Instead, they delegated the recruitment function to referral agents, to whom they paid a fee for the service.[3] Dormitory heads and skilled miners played important roles as referral agents. Here, we define referral agents as people who search for job applicants, screen their skills, and refer and introduce them to a company.

This recruitment policy involving screening by referral agents was not unique to the coal mining industry in the 1900s. The system is known as referral hiring, and has been the focus of much research in labor economics literature.[4] Referral hiring is also called a job referral, and is one way of solving certain hiring problems. For example, it can reduce employers' ex ante uncertainty about worker productivity.[5] These studies also examine the effects of job hunting through workers' friends and relatives, as well as using employee referrals when matching, searching, and screening. The findings indicate that social networks matter in labor markets.[6]

Nakajima, Tamura and Hanaki (2010) and Pinkston (2012) argue that employers acquire more information about workers when using referral hiring. Nakajima, Tamura and Hanaki (2010) showed that "networked" inventors tend to be more productive and have longer tenure than non-

[1] See Ogino (1993), p. 41.

[2] See Osaka Chihou Shokugyo Shokai Jimukyoku (Osaka Administrative Office of Employment Agency) (1926), p. 21.

[3] See Tanaka (1984), pp. 280–281.

[4] Tassier and Menczer (2008) defined referral hiring as hiring through the use of social or familial contact.

[5] See Simon and Warner (1992).

[6] Montgomery (1991) argued by his theoretical analysis that hiring through social networks is effective. On the other hand, Ioannides and Loury (2004) reported that more educated job-seekers were less likely to use informal job networks.

networked inventors. They define networked inventors as people who work with collaborator(s) with whom they were worked in the past research activities. Furthermore, they argue that such informal job networks act as a screening mechanism to select inventors' research ability.[7]

In the early 20th century, white-collar management rarely went to the coal mines to supervise workers. Mining coal and maintaining mineshafts required a high level of manual skill. Workers acquired these skills by accumulating field experience on coal beds. This made it difficult for management to screen appropriate candidates when hiring new workers. Thus, they delegated the screening of candidates to the dormitory heads and skilled miners, who acted as referral agents, and then employed workers based on their recommendations.

The skills required by miners a century ago may seem different to those required by the inventors in a high-tech industry in the 21st century, as described in Nakajima, Tamura and Hanaki (2010). However, they have important characteristics in common, namely that workers' types are private information and both sets of skills are too complicated for employees in the human resources division to be able to decide on the appropriateness of a candidate. Miners require high levels of traditional skills, while the latter require high levels of advanced skills. Thus, the asymmetric information between management and workers meant that referral hiring was a more effective method of hiring productive workers.

Workers often have more information about their own skills and abilities than firms do. In addition, job applicants have an incentive to exaggerate their skills. Thus, asymmetric information about applicants' types between firms and job applicants may result in adverse selection problems.

Employers use referral hiring to mitigate these problems, because they can obtain more information about job applicants in this way. Referral hiring uses referral agents, who screen job applicants. In general, referral agents are more adept than managers at assessing applicants' skills.

The remainder of this paper is organized as follows. In section 1, we describe the theoretical model on screening effects. We use "Miner Job Applications" to test the model, so, Section 2 describes the documentations, and section 3 presents the empirical results. Finally, section 4 concludes the paper.

[7] See Nakajima, Tamura and Hanaki (2010), p.732.

1 Screening effects by referral hiring: A theoretical prediction

1.1 The model

We assume that there are two types of workers in the coal mining industry: high productivity workers and low productivity workers. Let p denote the proportion of the firm hiring the high type $(0 \leq p \leq 1)$. Then $1-p$ is the proportion of a firm hiring the low type. And we assume that the former type produces coal output q_H, while the latter produces output q_L $(0 < q_L < q_H)$, at the end of a period. Wages in the coal mining industry consists of a hourly wage as a base salary and a performance-based wage. Let α denote a base salary and β denote an incentive corresponding to their output. The two types are paid $\alpha + \beta q_i (i = H, L)$, respectively. We assume that all coal output is sold at the same price, then the sales amount of the high type is Q_H and of the low type is Q_L. For simplicity, we further assume that there are no costs other than wages and screening costs. Then, when recruiting workers without screening, the expected profit is expressed as follows:

$$\pi = p\{Q_H - (\alpha + \beta q_H)\} + (1-p)\{Q_L - (\alpha + \beta q_L)\}$$

We define that screening is performed by referral agents. These agents are either dormitory heads or skilled miners in the coal mining industry and are paid a fee by the firm to screen workers. We suppose that the firm does not incur screening costs when it employs workers directly. In other words, screening is performed by referral agents, and the screening cost refers only to the fee paid to the referral agent. For simplification, without loss of generality, we standardize the screening cost to zero when the firm hires a worker directly. Assume that the firm pays s as fees to referral agents for screening workers. Then, let c denote the firm's own selection skills and assume c is given by technological conditions $(0 < s, c)$. We assume that the proportion of hiring the high type p depends on s and c, then we define p as a function of s and c, $f(s, c)$. Thus, when recruiting workers with screening, the expected profit with screening is as follows,

$$\pi = f(s,c)\{Q_H - (\alpha + \beta q_H)\} + (1 - f(s,c))\{Q_L - (\alpha + \beta q_L)\} - (s + c) \qquad (1)$$

We define $f(s,c)$ as follows,

$$\begin{cases} f(s,c) = p \quad (\text{if } s,c = 0\ ), \\ \frac{\partial f}{\partial s}, \frac{\partial f}{\partial c} > 0 \\ \frac{\partial^2 f}{\partial^2 s}, \frac{\partial^2 f}{\partial^2 c} < 0 \\ \lim_{s\to\infty} f(s,c) = 1, \lim_{c\to\infty} f(s,c) = 1 \\ \frac{\partial^2 f}{\partial s \partial c} < 0 \end{cases}$$

The first-order condition in order to maximize equation (1) is

$$\frac{\partial \pi}{\partial s} = \frac{\partial f}{\partial s}\left[\{Q_H - (\alpha + \beta q_H)\} - \{Q_L - (\alpha + \beta q_L)\}\right] - 1 = 0 \tag{2}$$

1.2 Analysis

We express equation (2) $\frac{\partial f}{\partial s}A - 1 = 0$ where $\{Q_H - (\alpha + \beta q_H)\} - \{Q_L - (\alpha + \beta q_L)\} = A$. By the implicit function theorem, we have,

$$\frac{ds^*}{dA} = -\frac{\frac{\partial f}{\partial s}}{\frac{\partial^2 f}{\partial^2 s}A} > 0 \tag{3}$$

$$\frac{ds^*}{dc} = -\frac{\frac{\partial^2 f}{\partial s \partial c}}{\frac{\partial^2 f}{\partial^2 s}} < 0 \tag{4}$$

The definition of $f(s,c)$ and $\{Q_H - (\alpha + \beta q_H)\} - \{Q_L - (\alpha + \beta q_L)\} = A > 0$ imply that equation (3) is positive. Therefore, the greater the difference between the profits generated by the high type and by the low type is, the greater s^* which maximizes π is. This indicates that the firm's expected profit can increase by delegating screening when there is a large difference in workers' productivity. Furthermore, the definitions of $f(s,c)$ and $A > 0$ imply that equation (4) is negative. Therefore, as the firm's own selection skills improve, s^*, which maximizes profit, decreases. We define the firm's better selection skills as the case when the firm has more information about recruiting workers than referral agents do. In other words, the optimal screening costs s^* decreases when the firm has an informational advantage over workers. Thus, we can derive the following two predictions.

- **Prediction 1.** The greater the difference between the profits generated by the high type and by the low type is, the greater the optimal screening costs s^* are.

- **Prediction 2.** The better a firm's selection skills are, the lower the optimal screening costs s^* are.

We consider each prediction in the next section.

1.3 Screening three type workers in the coal mining industry

First, we consider **Prediction 1**. When is the difference between the profit from the high type and that from the low big? In the coal mining industry, arguably, it was when recruiting workers who had the required traditional manual skills. This is because such workers had to mine coal while considering all necessary factors, such as the characteristics of the coal bed and the mine-shaft. Therefore, years of experience were required, although this was not the only criterion. High type of traditional manual skilled miners required both experience and competence. Therefore when recruiting traditional manual skilled miners, the difference in productivity between the two type of workers (A) was large. This implies that the optimal s^* by equation (3) was also large. This indicates that the firm was more likely to use referral agents when hiring traditional manual skilled workers.

Conversely, when is the difference in productivity small? In the coal mining industry, it occured when recruiting workers who were new entrants to the market, such as applicants who used to be farmers. In this case, A was negligible, then the optimal s^* was small by equation (3). This indicates that the firm was more likely to employ new entrants directly without using referral agents.

Second, we consider **Prediction 2**. When are firms' selection skills c high? It occured when the firm hires workers who had the required modernized skills (e.g., workers who can operate newly introduced machines). If the firm introduces the new machines itself, then it is likely that it has knowledge about the machines. Then, the firm is more likely to have an informational advantage over workers, in contrast to when it hires manual skilled workers. In such a case, where c is large, the optimal s^* is small by equation (4). Thus, the optimal intensity of using referral hiring is low and the firm is more likely to employ workers directly without using referral agents.[8]

Conversely, when are firms' selection skills c low? This occured when recruiting traditional manual skilled workers in the coal mining industry. Here, the firm did not have the information

[8]By the late 1890s, conveyance elevators were introduced. Sumiya (1968) noticed that people who worked at the conveyance process were directly employed by a firm, not through dormitory heads. See Sumiya (1968), pp.308–314.

necessary to screen workers, which means, the firm's selection skills c were small. By equation (4), the optimal s^* was large when c was small. Thus, the optimal intensity of using referral hiring was high and the firm was more likely to use referral agents to hire traditional manual skilled workers.

The optimal intensity of using referral hiring depends on the difference in productivity A and the firm's level of informational advantage, c. In the coal mining industry in the 1900s, A and c depended on workers' types; a worker with traditional manual skills (i.e., A was large and c was small), a new entrant (i.e., A was small) and a worker with modernized skills (i.e., c was large).

In Section 3, we analyse these two predictions empirically using job applications from a coal mine. First, we describe the job applications documents in Section 2.

2 "Miner Job Applications"

2.1 Firsthand histrical documents

We examine historical miner application documents, "Miner Job Applications"[9] left by the Aso family, for the Aso Fujidana Second Coal Mine. These were employment contracts, which the Aso Company required job applicants to submit.[10]

The Aso Fujidana Second Coal Mine was operated from 1902 to 1907 by the Aso Co. It was under the dormitory system but began the transition to adopting direct employment system. There were two types of direct employment system. One was "directly controlled dormitory." The directly controlled dormitories were under the firm's stronger control than ordinary dormitories. Note that we refer to the traditional dormitory as an ordinary dormitory to avoid confusion with the directly controlled dormitory. And the other was "direct recruitment" which meant hiring not through any referral agent, i.e. directly employed. The coal mine was in the organization's transitional phase.[11]

There was more than one type of job application form. The simplest and most common form had the terms and conditions printed on the right-hand side, and columns to fill in three applicants' details on the left. An employee in the personnel division (rather than the applicant) recorded an

[9] All firsthand documents are from 'Aso ke Monjo (Documents of Aso)' held by Kyushu Daigaku Fuzoku Toshokan Fusetsu Kiroku Siryokan (Kyushu University Manuscript Library, Histrical Record Section).

[10] Since no applications appear to have been rejected, we assume all applicants were more likely to be hired.

[11] See Ichihara (1997), pp.78–83 and Ogino (1993), pp.53–57 and pp.135–136. They argued many coal mines in Japan were in the organization's transitional phase in the 1900s.

applicant's registered address, social status, previous job, full name (with his/her seal or thumb print), birth date, his/her referral agent's name (with his/her seal), and the date of application. We find several handwriting styles in the job applications. The job applications were not always fully completed, but did always include address and name information.

The Mining Act, promulgated in 1890 and enforced in 1892, compelled all mines in Japan to list their miners' names, ages, addresses, previous jobs, and their hiring and firing dates. Aso Coal Mining Co. made job applicants submit a job application and it also created "Miner Adress Lists." Around the 1900s, almost all coal mines still used the dormitory system. When firms tried to acquire miners' information, dormitory heads could lose their exclusive information rents. If only one coal mine had made such a list, the dormitory head would likely move to a different coal mine with his miners to avoid the loss of information rent. However, when all coal mines were required by the Act to make such lists, dormitory heads had no incentive to move elsewhere. The recognition of individual miners was the first step of the transformation to a directly managed organization of labor. Thus, the 1890 Mining Act sparked the initial phase of the transformation to a direct employment system in the coal mining industry.

2.2 Description of "Miner Job Applications"

We study all the surviving job applications for the Aso Fujidana Second Coal Mine from 1902 to 1907, although mainly from 1905 to 1907. In all, there were 774 job applicants, of which 589 were males (76.1%). Of the males, 192 applied with a family member (32.6%). There were 14 females who applied by themselves (7.6%).

Table 1 describes the prefectures from which applicants originated (i.e., their home towns). Only three people were from the village where the coal mine was located. However, most applicants' registered address were the Fukuoka prefecture, where the coal mine was located, and were spread over western Japan. (See Figure 1.) Many coal mines in the Kyushu area showed a similar trend, with applicants originating from western Japan.[12] This indicates that the labor market in the coal mining industry was being integrated.

We found 79 referral agents, broken into three groups: a dormitory head, a directly controlled dormitory head and a skilled miner referral agent. The last of the three is a freelance referral agent. All received a referral fee after referring a job applicant. We have 22 ordinary dormitory heads,

[12] See Tanaka (1984), pp.272–274 and Ogino (1993), p.105

three directly controlled dormitory heads, and 54 skilled miner referral agents. Of all applicants, 6% were directly employed and the column of referral agent's name were filled with the name of employee in the personnel division. The rest of applicants were referred by referral agents.

Table 2 shows the referral agents who recruited four or more males who applied by themselves. Table 3 shows the referral agents who recruited four or more applicants who applied with their family members. The referral agents who are in both tables has high total number of referrals and they are dormitory heads. Such a head of large-scale dormitory seemed to recruit single men and people with a family. On the other hand, Table 2 has referral agents who are not in Table 3. It seems that such a referral agent almost exclusively recruited men who applied by themselves. There were dormitory heads who recruited both males who applied by themselves and people with a family and referral agents who specialized in males who applied by themselves.

2.3 Database construction

We gather all information from "Miner Job Applications" into a database, including applicants' previous jobs, whether they were applied with their families or not, their age, the type of their referral agent, and whether they put their own seal on their job applications. We use this database to test the predictions described in Section 1. See Appendix table 1 for more details.

3 Empirical analysis of "Miner Job Applications"

In this section , we analyze the database from "Miner Job Applications" to confirm the theoretical predictions in Section 1.

3.1 The applicants

First, we analyze the characteristics of the applicants by means of a probit regression analysis. Table 5 describes the applicants who put their own seal on their job applications. This group appears to have been literate. However, in the 1900s, literacy rates were low in Japan, particularly among miners. Thus, it is worth establishing what kinds of applicants would be literate.

The dependent dummy variable, SL, takes the value 1 if an applicant put his/her seal on the application, and 0 otherwise. The independent dummy variables are MNG (the previous job was as a coal miner), APL (previously a pillar worker), ELV (previously a conveyance elevator crew),

MGL (previously a miner, but not a coal miner or pillar worker), AGR (previously a farmer), MIS (not previously a farmer or one of the aforementioned miners), and MALE (indicates gender). The variable AGE is an independent variable.

Table 4 shows that applicants who used to be "other miners" (MGL) tended to carry their own seals. Their previous jobs were day workers or carpenters in a coal mine. Other miners were likely to be literate. In their childhood, elementary schooling was becoming common, and thus, their birth year would affect their literacy level. In addition, males might have had more opportunities to study reading and writing than females. Therefore, we conduct another probit regression analysis to control for these factors (see specification 4-2). Here, neither of the coefficients of the independent variables, AGE and MALE, are statistically significant. However, since MGL is significant and positive in this model and in specification 4-1, we infer that the tendency to carry one's own seal depended on the job type.

Next, table 5 shows the tendency to apply to the coal mine with family members. Specifications 5-2 and 5-4 show that female workers were likely to apply with their husbands and fathers, because the coefficients of MALE are negative. Specfications 5-1, 5-2, and 5-4 strongly indicate that applicants who previously worked as pillar workers (APL) tended not to apply with their family members. Moreover, specifications 5-3 and 5-4 show that applicants who used to be coal miners most likely applied with their family members. Pillar workers propped up a mine roof with pillars (wooden pillars or coal of pillars) to prevent the roof from collapsing at a face and removed these pillars once done. This was dangerous work and required artisanal skills. Thus, it is no surprise that the results of Table 5 show that the workers in charge of these dangerous tasks tended to apply by themselves, while those with families preferred to be coal miners.

Specifications 5-1 and 5-2 show that the coefficients of AGR and the marginal effects are negative and significant. This means that applicants who were previously farmers applied without family members. Specification 5-2 contains AGE as an independent variable, but specification 5-1 does not. Even so, the magnitude of the marginal effects of AGR in both models are not that different. Thus, we cannot say that people who used to be farmers were not married, because they were young. These models indicate that people who used to be farmers did not yet have industry-specific skills for coal mining and were not yet earning enough to build a family. For this reason, they tended to apply by themselves.

3.2 Referral hiring for new entrants and traditional manual skilled workers

In this and next section, we consider what kinds of referral agents tended to refer the various types of applicants. Tables 6, 8 and 9 show the results of a probit regression analysis. The dependent dummy variables are the types of applicants and the independent dummy variables are the types of referral agents.

First, we consider what kinds of referral agents recruited applicants who were new entrants to the coal mining industry. The result is presented in Table 6. The dependent variable in specification 6-1 is AGR and in 6-2 is AGR and MIS (not previously a farmer or a worker in mine). Table 6 shows that the firm tended to hire new entrants directly and that the heads of ordinary dormitories and directly controlled dormitories tended to refer them since the coefficients of FRM (directly hired by the firm), HNN (referred by an ordinary dormitory head) and FN (referred by a directly controlled dormitory) are significant and positive. Both specifications in Table 6 show that skilled miner referral agents did not tend to refer new entrants.

This result is consistent with **Prediction 1**. Table 6 shows that the firm tended to directly hire new entrants. As discussed in Section 1, if we can assume that the difference in profits between the new entrants were negligible, then, the optimal intensity of using referral hiring for new entrants is predicted to be accordingly low.

On the other hand, Table 6 also shows that the heads of ordinary dormitories and directly controlled dormitories tended to refer the new entrants. As we discussed above, the optimal intensity of **not** using referral hiring for new entrants into the coal mining industy was high, however, it did not mean that referral hiring was never used for new entrants. It means that the intensity of using referral hiring for new entrants was lower than for traditional manual skilled miners.

Here, let us see a list of referral agents who recruited two or more new entrants (Table 7). It shows that the heads of ordinary dormitories and directly controlled dormitories referred many new entrants to coal mining industry while the firm directly hired new entrants. As in **Prediction 1**, the firm actually hired new entrants directly, and also the firm used referral hiring to recruit new entrants.

Moreover, we assumed that referral agents were homogeneous in our model in Section1. In fact, there were difference between ordinary dormitry heads, directly controlled dormitory heads and skilled miner referral agents. These heads were relatively older than skilled miner referral

agents and these heads could have much more experience of coal mining. Thus, job information networks which the heads had built could be bigger than those built by skilled miner referral agents. Table 6 shows that the heads of ordinary dormitory and directly controlled dormitory tended to refer new entrants but skilled miner referral agents did not. It indicates that the size of their job information networks was different. The heads accumulated experience in coal mines and became dormitory heads. They could built the job information networks which could refer promising beginners. This could be why heads of ordinary dormitory and directly controlled dormitory tended to refer new entrants but skilled miner referral agents did not.

Table 8 shows which referral agents tended to refer applicants who were previously coal miners or pillar workers. The coefficients of HNN and SMRA are statistically significant and positive. Thus, dormitory heads and skilled miner referral agents tended to refer these workers. These agents had accumulated traditional manual skills, enabling them to screen coal miner and pillar worker applicants.

This result is consistent with **Prediction 1** and **2**. When recruiting traditional manual skilled miners like coal miners and pillar workers, the difference in the profits between high type and low type (A) could be large. Furthermore, the firm did not have information necessary to screen them, that is, c was low. Both factors led to high optimal intensity of using referral hiring. Therefore, the firm tended to hire them using referral agents as shown in Table 8.

3.3 Referral hiring for workers with modernized skills

Table 9 shows those referral agents who tended to refer applicants whose previous job was as a conveyance elevator operator (ELV) or were categorized as "other miners" (MGL). Applicants who were previously elevator operators were required to operate new machinery, namely conveyance elevators. The group of "other miners" were likely to be literate, as shown in Table 5. Literacy skills were new at that time. In this sense, the dependent variables in Table 9 are applicants with new skills. And Table 9 shows that the firm tended to employ these workers directly and skilled miner referral agents tended to refer them since the coefficients of FRM (directly hired by the firm), SMRA (referred by a skilled miner referral agent) are significant and positive.

This mixed result is not inconsistent with the prediction in Section 1. When the firm hired workers who had new skills, the firm's selection skills (c) could be high, because the new conveyance elevators were introduced by the firms, who therefore had the requisite knowledge and

skills to screen applicants themselves. Thus, the optimal intensity of using referral hiring was low. Then, applicants with new skills were likely to be employed directly by the firm as shown in Table 9. This result is consistent with **Prediction 2**.

On the other hand, Table 9 also shows that skilled miner referral agents tended to refer the new skilled workers. There were differences between the profit (A) from them as well as from applicatns with traditional skills. When the firm hired workers with new skills, the firm's selection skills (c) could be large but still we have positive A. Therefore, referral hiring was used for recruiting the new skilled workers.

Moreover, as is the case in new entrants, we assumed that referral agents were homogeneous in our model in Section1. In fact, not dormitory heads but skilled miner referral agents referred applicants with new skills. It indicates that dormitory heads could not be involved in recruiting them. Dormitory heads started working for the coal mining industry earlier than skilled miner referral agents did. The heads accumulated much more experience than skilled miner referral agents and they built their job information networks, thus they could refer traditional skilled miners and promising new entrants. However, they did not have a chance to operate newly introduced conveyance elevators, then they had a disadvantage for recruiting new skilled workers. Skilled miner referral agents were relatively young. They had operated conveyance elevators, accumulated the operating skills and then became referral agents. Thus, skilled miner referral agents tended to refer applicants with new skills but dormitory heads did not.

Conclusion

In this study, we capture the specificity of the coal mining labor market in the organization's transitional phase. The empirical analysis seems to support the prediction of the theoretical model. Here, we theoretically and empirically showed that new entrants to the coal mining industry and workers with modernized skills tended to be directly employed by the firm, and workers with traditional manual skills tended to be hired with using referral hiring. In addition to this, our empirical results showed that new entrants tended to be referred by the heads of ordinary dormitories and directly controlled dormitories, and workers with modernized skills tended to be referred by skilled miner referral agents. While these findings are beyond our theoretical predictions, we argued possible explanations.

If our predictions are correct, a more mechanized process (increases in c) implies that less intense use of referral hiring. Mechanization in the coal mining industry was completed in the 1930s. How the labor market changed during that period, particularly with regard to the use of referral hiring, remains as our future work.

References

Chikuho Tanzan Rodo Jijo (The working situation of coal mine in the Chikuho district). 1926. (In Japanese).

Ichihara, Hiroshi. 1997. *Tanko No Rodo Shakaishi: Nihon no Dentoteki Rodo, Shakai Chitsujo To Kanri (A Social History of Coal Mining Labor: Traditional Labor, Social Order, and Management in Japan).* Tokyo:Taga Shuppan. (In Japanese).

Ioannides, Yannis, and Linda D. Loury. 2004. "Job Information Networks, Neighborhood Effects, and Inequality." *Journal of Economic Literature*, 42(4): 1056–1093.

Montgomery, James D. 1991. "Social Networks and Labor-Market Outcomes: Toward an Economic Analysis." *American Economic Review*, 81(5): 1408–1418.

Nakajima, Ryo, Ryuichi Tamura, and Nobuyuki Hanaki. 2010. "The effect of collaboration network on inventors' job match, productivity and tenure." *Labor Economics*, 17(4): 723–734.

Ogino, Yoshihiro. 1993. *Chikuho Tanko Roushi Kankeishi (History of Industrial Relations of the Coal Mining in the Chikuho District).* Fukuoka:Kyushu Daigaku Shuppan Kai. (In Japanese).

Pinkston, Joshua C. 2012. "How Much Do Employers Learn from Referrals?" *Industrial Relations*, 51(2): 317–341.

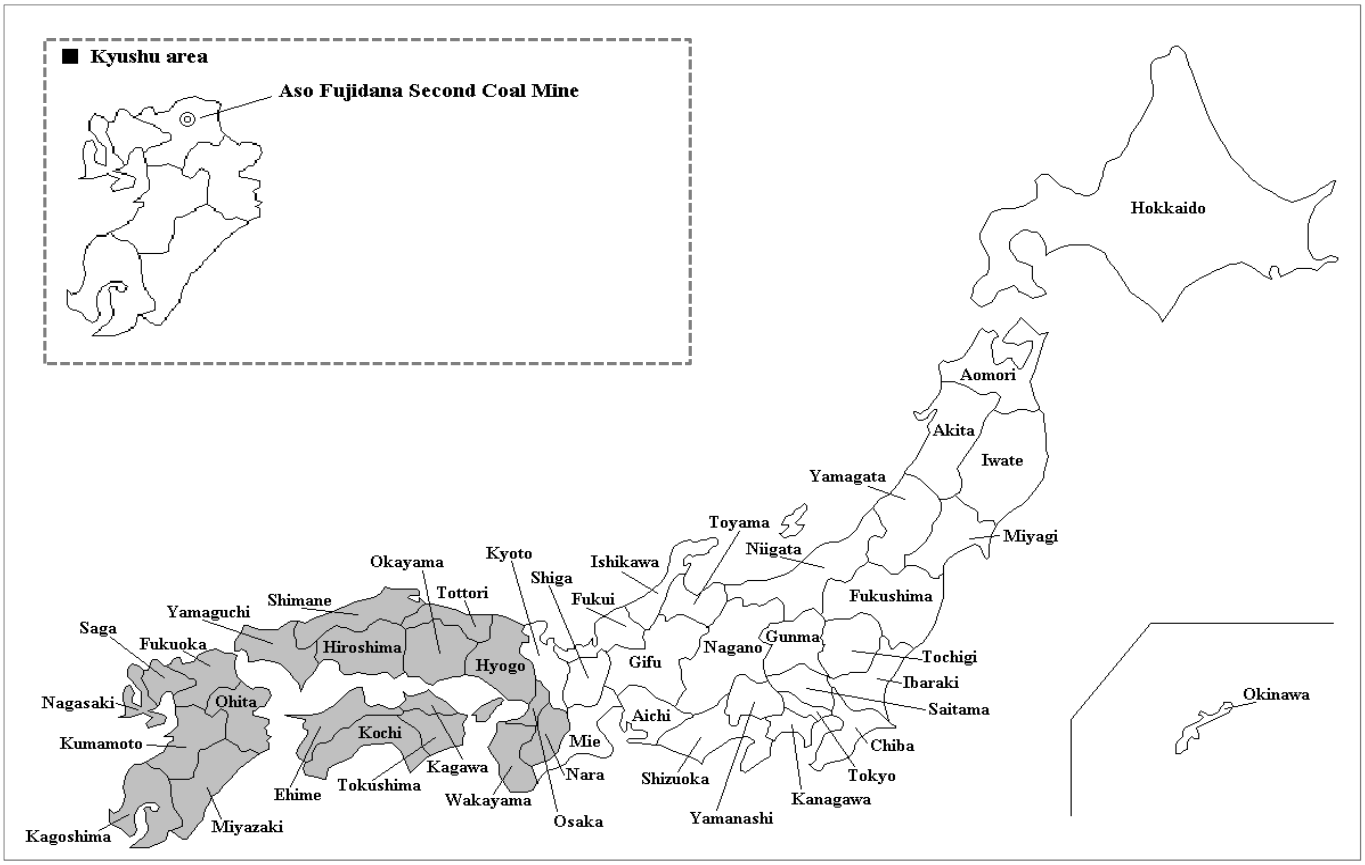
Simon, J. Curtis, and John T. Warner. 1992. "Matchmaker, matchmaker: the effect of old boy networks on job match quality, earnings, and tenure." *Journal of Labor Economics*, 10(3): 306–330.

Sumiya, Mikio. 1968. *Nihon Sekitan Sangyo Bunseki (Analysis on the Japanese Coal Mining Industry).* Tokyo:Iwanami Shoten. (In Japanese).

Tanaka, Naoki. 1984. *Kindai Nihon Tankou Rodo-shi Kenkyu (Research on Labor History at coal mines in modern Japan).* Chiba:Sofukan. (In Japanese).

Tassier, Troy, and Filippo Menczer. 2008. “Social network structure, segregation, and equality in a labor market with referral hiring.” *Journal of Economic Behavior and Organization,* 66(3-4): 514–528.

Figure 1.



Notes: The applicants were from shaded prefectures.

Table 1 Registered address and previous job type

District	Prefecture	Sum	(%)	Previous job						
				Coal miner	Pillar worker	Elevator operator	Other miner	Farmer	Others	NA
Sum		774	100.0	61	51	7	24	107	8	516
Kyushu		478	61.8	42	22	7	19	57	6	325
	Fukuoka	272	35.1	28	13	5	10	43	3	170
	Saga	37	4.8	4	0	1	1	1	1	29
	Oita	83	10.7	1	4	0	2	9	0	67
	Kumamoto	57	7.4	5	1	1	6	4	0	40
	Nagasaki	16	2.1	3	2	0	0	0	2	9
	Miyazaki	7	0.9	0	2	0	0	0	0	5
	Kagoshima	6	0.8	1	0	0	0	0	0	5
Chugoku		172	22.2	5	11	1	3	29	0	123
	Hiroshima	90	11.6	5	7	1	3	17	0	57
	Shimane	32	4.1	0	2	0	0	5	0	25
	Yamaguchi	31	4.0	0	1	0	0	3	0	27
	Okayama	13	1.7	0	1	0	0	4	0	8
	Tottori	6	0.8	0	0	0	0	0	0	6
Shikoku		108	14.0	11	13	0	3	21	0	60
	Ehime	72	9.3	8	11	0	3	11	0	39
	Kagawa	22	2.8	2	0	0	0	7	0	13
	Tokushima	8	1.0	0	1	0	0	3	0	4
	Kochi	6	0.8	1	1	0	0	0	0	4
Kinki		16	2.1	3	5	0	0	0	0	8
	Hyogo	7	0.9	1	1	0	0	0	0	5
	Osaka	4	0.5	0	1	0	0	0	0	3
	Wakayama	3	0.4	0	3	0	0	0	0	0
	Nara	2	0.3	2	0	0	0	0	0	0

From “Miner Job Applications”

Table 2 Referral agents who recruited four or more males applying by themselves

Referral agent		Males applying by	Total number of referrals	Previous job				
Initial	Type			Coal miner	Pillar worker	Elevator operator	Other miner	Farmer
K. K.	dormitory head	35	64	0	0	0	4	12
J. K.	dormitory head	35	74	0	1	0	0	28
O. Y.	dormitory head	22	36	5	5	0	0	0
H. U.	directly controlled dormitory head	21	32	1	0	0	1	12
Se. N.	employee in Personnel division	18	27	2	3	0	5	6
C. Y.	dormitory head	18	42	0	1	0	1	14
S. H.	dormitory head	17	34	13	12	0	0	0
Ki. H.	dormitory head	16	33	4	0	0	2	0
Y. M.	dormitory head	13	33	2	0	0	0	0
T. A.	dormitory head	12	12	2	1	0	0	0
R. S.	directly controlled dormitory head	10	12	1	0	0	0	8
B. N.	skilled miner referral agent	10	10	0	0	4	0	3
U. I.	dormitory head	9	11	0	0	0	1	0
Ku. A.	dormitory head	9	9	0	9	0	0	0
T. H.	skilled miner referral agent	9	13	0	0	3	0	0
M. S.	dormitory head	8	28	2	2	0	1	0
Is. T.	dormitory head	7	26	2	0	0	0	0
K. U.	dormitory head	7	18	5	1	0	0	0
K. Y.	dormitory head	6	24	0	0	0	1	2
T. S.	directly controlled dormitory head	5	11	0	0	0	0	10
S. K.	skilled miner referral agent	5	11	0	4	0	0	1
T. N.	skilled miner referral agent	5	7	1	0	0	0	0
J. T.	skilled miner referral agent	4	4	0	0	0	0	3
F. N.	employee in Personnel division	4	4	0	0	0	0	0
S. Hi.	skilled miner referral agent	4	4	0	1	0	0	0
Ki. I.	skilled miner referral agent	4	4	0	0	0	0	0
K. I.	skilled miner referral agent	4	4	2	0	0	0	0
S. U.	skilled miner referral agent	4	4	1	3	0	0	0
T. M.	skilled miner referral agent	4	4	2	1	0	0	0

From “Miner Job Applications”

Table 3 Referral agents who recruited four or more applicants applying with their family members

Referral agent		Applicants with family members	Total number of referrals	Previous job				
Initial	Type			Coal miner	Pillar worker	Elevator operator	Other miner	Farmer
J. K.	dormitory head	36	74	0	1	0	0	28
K. K.	dormitory head	27	64	0	0	0	4	12
C. Y.	dormitory head	24	42	0	1	0	1	14
M. S.	dormitory head	20	28	2	2	0	1	0
Y. M.	dormitory head	19	33	2	0	0	0	0
Is. T.	dormitory head	18	26	2	0	0	0	0
Ki. H.	dormitory head	17	33	4	0	0	2	0
K. Y.	dormitory head	17	24	0	0	0	1	2
S. H.	dormitory head	16	34	13	12	0	0	0
O. Y.	dormitory head	13	36	5	5	0	0	0
K. U.	dormitory head	11	18	5	1	0	0	0
H. U.	directly controlled dormitory head	10	32	1	0	0	1	12
K. Hi.	dormitory head	10	13	2	0	0	0	0
Se. N.	employee in Personnel division	9	27	2	3	0	5	6
K. A.	skilled miner referral agent	8	11	0	0	0	0	0
I. N.	employee in Personnel division	8	11	0	0	0	0	4
T. S.	directly controlled dormitory head	6	11	0	0	0	0	10
S. K.	skilled miner referral agent	6	11	0	4	0	0	1
Ka. H.	skilled miner referral agent	5	8	0	0	0	0	0
S. W.	dormitory head	5	8	0	0	0	0	0
Y. Ta.	skilled miner referral agent	4	5	4	0	0	0	0
T. H.	skilled miner referral agent	4	13	0	0	3	0	0
Se. H.	skilled miner referral agent	4	4	0	0	0	0	0
Ka. N.	dormitory head	4	4	0	0	0	0	0

From “Miner Job Applications”

Table 4 Which type of applicants put their own seal on the job applications

Estimation method	4-1 probit			4-2 probit		
Dependent Variable	SL			SL		
Independent variable	Coefficient	Marginal Effects	z-Statistic	Coefficient	Marginal Effects	z-Statistic
C	-1.2344		-16.7877 ***	-1.1846		-5.1054 ***
MNG	-0.1576	-0.0312	-0.6475	-0.1113	-0.0188	-0.4526
APL	-0.8275	-0.1722	-1.9971 **	-0.7512	-0.1338	-1.7937 *
ELV	0.1668	0.0325	0.2824	0.2351	0.0392	0.3962
MGL	0.6859	0.1305	2.4483 **	0.7788	0.1260	2.7051 ***
MIS	0.5599	0.1086	1.1489	0.6292	0.1042	1.2804
AGR	-0.2068	-0.0367	-1.0632	-0.1312	-0.0224	-0.6552
AGE				-0.0002	0.0000	-0.0308
MALE				-0.1119	-0.0208	-0.7275
Included observations		774			710	
McFadden R^2		0.0294			0.0331	
Log likelihood		-249.7227			-223.1759	
LR statistic		15.1126**			15.2660*	

From "Miner Job Applications"

Notes: ***, ** and * respectively denote significance at the 1, 5, and 10 percent levels. See Appendix Table 1 for definitions of variables.

Table 5 Which type of applicants applied with their family member

Estimation method	5-1 probit			5-2 probit			5-3 probit			5-4 probit		
Dependent Variable	FML			FML			FML			FML		
Independent variable	Coefficient	Marginal Effects	z-Statistic	Coefficient	Marginal Effects	z-Statistic	Coefficient	Marginal Effects	z-Statistic	Coefficient	Marginal Effects	z-Statistic
C	1.4210		10.4750 ***	1.3324		6.3473 ***	-0.5004		-3.9448 ***	0.9611		3.9433 ***
MNG	0.1170	0.0466	0.6241	0.1137	0.0453	0.5972	0.6447	0.2488	3.1444 ***	0.4737	0.1840	2.1007 **
APL	-0.7571	-0.2784	-3.3515 ***	-0.8852	-0.3178	-3.6883 ***	-0.3554	-0.1369	-1.4953	-0.5251	-0.2014	-1.9551 **
ELV	-0.2233	-0.0882	-0.4408	-0.2367	-0.0935	-0.4665	-0.0656	-0.0260	-0.1266	0.1232	0.0490	0.2364
MGL	-0.1459	-0.0579	-0.5490	-0.1328	-0.0528	-0.4898	0.1817	0.0724	0.6270	0.2273	0.0901	0.7659
AGR	-0.3684	-0.1445	-2.5096 **	-0.3605	-0.1416	-2.3883 **						
MIS			-12.2634				-0.1741	-0.0683	-0.3495	-0.0051	-0.0020	-0.0102
UNK							0.5684	0.2200	4.1089 ***	0.3676	0.1454	2.4314 **
AGE				0.0038		0.6475				0.0040		0.6835
MALE	-1.7637	-0.5774	-12.2634 ***	-1.7634	-0.5757	-11.5259 ***				-1.7578	-0.5745	-11.4748 ***
Included observations		774			710			774			710	
McFadden R^2		0.2189			0.2191			0.0377			0.2197	
Log likelihood		-417.8035			-383.0458			-514.6953			-382.7441	
LR statistic		234.1526***			214.9298***			40.3689***			215.5332***	

From "Miner Job Applications"

Notes: ***, ** and * respectively denote significance at the 1, 5, and 10 percent levels. See Appendix Table 1 for definitions of variables.

Table 6 Recruitment of new entrants to coal mining industry

Estimation method	6-1 binary probit			6-2 binary probit		
Dependent Variable	AGR			AGR+MIS		
Independent variable	Coefficient	Marginal Effects	z-Statistic	Coefficient	Marginal Effects	z-Statistic
C	-1.7713		-10.3812 ***	-1.7091		-10.4712 ***
FRM	1.1885	0.3637	4.6726 ***	1.1847	0.2227	4.7817 ***
HNN	0.5722	0.1022	3.0730 ***	0.5512	0.0718	3.0821 ***
FN	1.8855	0.6180	7.8421 ***	1.9157	0.3341	8.1207 ***
Included observations	774			774		
McFadden R^2	0.1288			0.1317		
Log likelihood	-270.9026			-282.4351		
LR statistic	80.1207***			85.6551***		

From “Miner Job Applications”

Notes : *** denote significance at the 1 percent levels.

See Appendix Table 1 for definitions of variables.

Table 7 Referral agents who recruited two or more new entrans

Referral agent		New entrants		Total number of referrals	Previous job			
Initial	Type	Farmer	Others		Coal miner	Pillar worker	Elevator operator	Other miner
J. K.	dormitory head	28	1	74	0	1	0	0
C. Y.	dormitory head	14	2	42	0	1	0	1
H. U.	directly controlled dormitory head	12	1	32	1	0	0	1
K. K.	dormitory head	12	0	64	0	0	0	4
T. S.	directly controlled dormitory head	10	0	11	0	0	0	0
R. S.	directly controlled dormitory head	8	1	12	1	0	0	0
Se. N.	employee in Personnel division	6	1	27	2	3	0	5
I. N.	employee in Personnel division	4	0	11	0	0	0	0
J. T.	skilled miner referral agent	3	0	4	0	0	0	0
B. N.	skilled miner referral agent	3	0	10	0	0	4	0
Direct recruitment		2	0	6	0	0	0	0
I. U.	employee in Personnel division	2	0	2	0	0	0	0
K. Y.	dormitory head	2	0	24	0	0	0	1

From “Miner Job Applications”

Notes : "Direct recruitment" means that the firm directly hired applicants. There were no name in the referral agent's name column in the applications but just "Direct recruitment" written in it.

Table 8

Estimation method	binary probit		
Dependent Variable	MNG + APL		
Independent variable	Coefficient	Marginal Effects	z-Statistic
C	-1.7945		-5.6684 ***
FRM	0.5130	0.1409	1.2878
HNN	0.7322	0.1409	2.2578 **
SMRA	0.9213	0.2553	2.7576 ***
Included observations	774		
McFadden R^2	0.0171		
Log likelihood	-314.4947		
LR statistic	10.9685**		

From "Miner Job Applications"

Notes : *** and ** respectively denote significance at the 1 and 5 percent levels.

See Appendix Table 1 for definitions of variables.

Table 9

Estimation method	binary probit		
Dependent Variable	ELV + MGL		
Independent variable	Coefficient	Marginal Effects	z-Statistic
C	-2.0420		-15.7278 ***
FRM	0.7604	0.0997	2.7712 ***
FN	-0.0508	-0.0036	-0.1200
SMRA	0.6500	0.0661	3.4850 ***
Included observations	774		
McFadden R^2	0.0633		
Log likelihood	-121.8742		
LR statistic	16.4832***		

From "Miner Job Applications"

Notes : *** and ** respectively denote significance at the 1 and 5 percent levels.

See Appendix Table 1 for definitions of variables.

Appendix Table 1 Definition of variables

C	dummy variable	a constant term	
MNG	dummy variable	= 1 if the previous job was as a coal miner, 0 otherwise.	worked at a coal face and mined coal.
APL	dummy variable	= 1 if the previous job was as a pillar worker, 0 otherwise.	propped pillars to hold a ceiling at a face.
ELV	dummy variable	= 1 if the previous job was as a elevator operator or a smithy, 0 otherwise.	
MGL	dummy variable	= 1 if the previous job was as a miner excluding those above, 0 otherwise.	
AGR	dummy variable	= 1 if the previous job was as a farmer, 0 otherwise.	
MIS	dummy variable	= 1 if the previous job was as other jobs than mining industry or farmer, 0 otherwise.	not mining industry nor agriculture
UNK	dummy variable	= 1 if the field which should have written the previous job was left blank, 0 otherwise.	
FML	dummy variable	= 1 if applying with their spouse or families, 0 otherwise.	
MALE	dummy variable	= 1 if an applicants was male, 0 otherwise.	
AGE		an applicant's age	
FRM	dummy variable	= 1 if an applicant was directly employed, 0 otherwise.	
HNN	dummy variable	= 1 if an applicant was referred by ordinary dormitory head (or we call him just "a dormitory head"), 0 otherwise.	
FN	dummy variable	= 1 if an applicant was referred by a head of directly controlled dormitory, 0 otherwise.	
SMRA	dummy variable	= 1 if an applicant was referred by a skilled miner referral agent, 0 otherwise.	not head of any dormitory nor direct management recruitment. 1-(FRM+HNN+FN).
SL	dummy variable	= if an applicant put own seal on his/her job application, 0 otherwise.	