Screening and Monitoring Miners:
Recruitment and Personnel Management in Japanese Coal Mining

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Abstract

In the Japanese coal mining industry, firms originally used the dormitory system, an indirect organization of labor. Firms delegated all kinds of tasks of managing miners to dormitory heads. However, between the 1890s and 1930s, the introduction of machinery coincided with a gradual transformation to a direct organization of labor. We study a coal mine during the organization transitional period. Using job applications and attendance records, we observe miners' recruitment paths and working statuses, and the organization structures to which they belonged. In other words, these records enable us to determine the links between the labor market and the organization of labor for individual workers. Thus, we consider how coal mining firms managed and monitored workers when traditional manual skills were still dominant, prior to the introduction of mining machinery. Our regression analysis shows that skilled miners tended to belong to conventional dormitories. However, the heads of these dormitories tended not to monitor these miners very well. In contrast, miners in a dormitory which was under stronger controlled than conventional one were monitored well. In addition, we find that firms began managing smaller units under dormitory heads.

Key words: organization of labor, screening, monitoring, moral hazard, referral hiring, employee referrals, intermediary management, coal mining, Japan.
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Introduction

The intermediate organization of labor in the Japanese coal mining industry has attracted much interest. Before the introduction of machinery, Japanese coal mining firms used an intermediate organization of labor, called the "dormitory system." These firms built dormitories for the miners near the coal mines. Each dormitory had a leader, called a dormitory head. Firms delegated managing, monitoring, training, recruiting, and taking care of miners to these dormitory heads. However, as mining machinery was introduced, the dormitory system gradually transformed to a direct employment system. Many researchers have focused on the process of the transition from the indirect employment system to the direct employment system. For example, Sumiya (1968) studied the beginning of the transition in the 1890s, while (Ogino (1993) studied the end of the transition in the 1930s. However, these researchers have not determined what caused these changes to the organization of labor between the 1890s and the 1930s.

Sakai (2014) studied the Aso Fujidana Second Coal Mine, which was owned by the Aso Mining Company from 1902 to 1907. This coal mine operated under the dormitory system, but partially adopted the direct employment system. That is, the firm employed a few miners directly and used "directly controlled dormitories." Sakai (2014) mainly investigated "Miner Job Application" left by the Aso family. Each job application contained an applicant's information, such as his/her name (with his/her personal seal or thumbprint), registered address, social status (commoner or ex-samurai), previous job, birth date, his/her referral agent's name (with referral agent's personal seal or thumbprint), and the date of application. The study by Sakai (2014) produced three main findings. First, skilled miners tended to be referred by dormitory heads and skilled miner referral agents. Dormitory heads and skilled miner referral agents accumulated field experience and had traditional manual skills, which were required before the introduction of mining machinery. Therefore, they were able to refer skilled miners. Second, new entrants to coal mining tended to be referred by dormitory heads, and not by skilled miner referral agents. This indicates that dormitory heads were able to train new entrants, but that skilled miner referral agents were not. Third, miners who were able to operate the newly introduced machines, conveyance elevators, tended to be referred by the firm. Since the firm introduced the new machinery, it knew how to operate these machines and, thus, was able

to screen miners with these skills and employ them directly.

In this study, we investigate "Miner Attendance Records" from the Aso Fujidana Second Coal Mine on July 1905. These records contain miners' daily work attendance at the mine. Existence of the documents, "Miner Attendance Records" itself implies that the firm started strengthening its control rather than leaving the management of miners to the dormitory heads. These records provide us with information on the number of miners, the number of dormitories, the number of dormitory heads, and the types of dormitories. The records show that 555 miners worked at the coal mine during the month. Then, the "Miner Job Applications" provide information on 774 job applicants for the coal mine from the database built by Sakai (2014). Here, we check the information from the "Miner Attendance Records" against the information from the "Miner Job Applications." The "Miner Job Applications" tell us information at a time when miners were hired, for example their previous job types, and their referral agent types. Miners were referred by dormitory heads, directly controlled dormitory heads or skilled miner referral agents, or they were employed directly by the firm. The "Miner Job Applications" contain information about the miners when they applied for work at the firm, including how referral agents screened the applicants. On the other hand, the "Miner attendance records" tell us information at a time when applied once miners were working, including how dormitory heads monitored the miners in their dormitory. Collating the two sets of records lets us link information before and after the conclusion of an employment contract. Thus, we can observe each miner's recruitment path, working status, and the organization structure to which he/she belonged. In addition, 202 miners have records in the "Miner Attendance Records" and in the "Miner Job Applications." The records for these miners enable us to determine the links between the labor market and the organization of labor for individual workers, as well as which referral agents brought reliable miners to the firm.

This study represents the first empirical research using first-hand documents of employment contracts and attendance records. Our main findings are as follows. First one is about the screening function. We call those who appear only as referral agents in both documents "independent referral agents," in other words, freelance referral agents. These referral agents tended to screen miners who worked longer period. On the other hand, "employee referral agents," who appear as both a referral agent and a miner, and

dormitory heads tended not to screen miners with longer periods of employment. Second, with regard to the monitoring function, ordinary dormitory heads tended not to monitor their own members well. However, miners in the directly controlled dormitory tended to be monitored well. Third, with regard to recruitment paths, dormitory heads tended to refer miners in ordinary dormitories. Employee referral agents and independent referral agents tended to refer miners in the directly controlled dormitory. In particular, independent referral agents tended to refer miners in the pillar worker dormitory. Fourth, with regard to organization structures, we find that ordinary dormitories tended to get skilled miners, while directly controlled dormitories did not.

The rest of the paper is organized as follows. In section 1, we describe the transitional organization in the Japanese coal mining industry. Section 2 describes the "Miner Attendance Records," and section 3 presents the estimation results. Finally, section 4 concludes the paper.

1. Transitional organization in the coal mining Japan

1) The dormitory system and transition to the direct employment system

Dormitory heads received miners' wages in a lump sum on a piece-rate basis and then paid each miner based on individual output. The difference between the amount a dormitory head received and the amount they paid to miners is an information rent paid to heads for problems that arouse from asymmetric information. Furthermore, firms had to pay information rent to the leader of each group under the dual-layer system. Nevertheless, this was less costly than managing all miners directly. Therefore, the dormitory system was a reasonable second-best option, given the technological conditions and the asymmetric information structure between firms and dormitory heads.[1]

However, the dormitory system gradually transformed to become a direct employment system. At first, conveyance elevators were introduced to the conveyance process in the 1890s. Sumiya (1968) argued that workers who operated conveyance elevators were employed directly. During the subsequent 30 years, coal mining firms began partially adopting direct management, called a "direct controlled dormitory," and

[1] See Sakai (2013), pp.227–228, and Sakai (2014), p.9.

tried to employ miners directly. However, firms still managed miners based on the dormitory system. Then, 40 years after the introduction of the conveyance elevator, mining machinery was introduced in the coal mining process, and the dormitory system was abolished.

2) Referral hiring in the Japanese coal mining

Sakai (2014) studied "Miner Job Applications" from the Aso Fujidana Second Coal Mine and found that almost all job applicants (93.5%) were employed through referral agents. These referral agents were paid a referral fee when they referred applicants.[2] These job applications were addressed to the Aso Fujidana Second Coal Mine.

Firms have less information about workers' types than workers. Thus, there is asymmetric information about job applicants' types, and employers cannot obtain complete information on whether job applicants have the required skills. Furthermore, job applicants are motivated to overstate their own skill level. This asymmetry in information may result in adverse selection problems. Using referral agents, employers are able to obtain more information about job applicants, which mitigates these problems because referral agents screen the job candidates. For example, when employers recruit new employees, they require specific skills to be present. When the referral agents possess these skills, employers can obtain more correct information about applicants than when employing workers directly.

Based on the "Miner Job Applications," Sakai (2014) found three types of referral agents, namely dormitory heads, directly controlled dormitory heads, and skilled miner referral agents. Few applicants were employed directly. During the organization transition period, coal mining firms used these referral agents and they began hiring directly. Sakai (2014) found that skilled miners tended to be referred by dormitory heads and skilled miner referral agents. Since dormitory heads and skilled miner referral agents accumulated field experience and have traditional manual skills, they were able to refer skilled miners. Sakai (2014) also found that new entrants to coal mining tended to be referred by dormitory heads rather than by skilled miner referral agents. This is probably

[2] See Tanaka (1984), pp.280–281.

because dormitory heads were able to train new entrants, but skilled miner referral agents were not. Furthermore, miners with machine operating skills tended to be referred by the firm. The new machinery, namely conveyance elevators, were introduced by the firm. Therefore, the firm knew how to operate these machines and, thus, was able to screen and employ miners with these skills directly.

3) Our perspective

Sakai (2014) used job applications to examine the recruitment and screening of workers. Sakai (2014) found that coal mining firms recruited miners when traditional manual skills were dominant, given the choice of labor institutions in the labor market. In this study, we consider how miners were managed and how coal mining firms monitored miners when traditional manual skills were still dominant, prior to the introduction of mining machinery. It seems that firms did not have much choice other than to delegate the management of miners with traditional manual skills to conventional management by dormitory heads, since these skills were required. However, firms could manage some workers by incorporating smaller units under dormitory heads as they began hiring directly. Firms could choose among several types of labor organization because they used several types of referral agents.

2. Descriptive analysis of "Miner Attendance Records"

1) Description of "Miner Attendance Records"

The "Miner Attendance Records" recorded miners' daily work attendance at the coal mine. These records were produced every month by the personnel staff of the firm, while the coal mine operated, and consists of about 30 pages. Each page includes a box for the dormitory's name and 22 columns, one for each miner. Each column has 31 rows, each of which contains a seal indicating a miner's attendance. Since miners in this worked a two-shift system, there were "1" or "2" seals, depending on whether a miner worked one or two shifts. We deduce that they worked 10-hour shifts, based on published historical documents.[3] In addition, there were two other types of seal. Miners sometimes

[3] See Chikuho Sekitan Kougyo Kumiai (Chikuho Coal Mining Industry Association), *Chikuho Sekitan Kougyo Kumiai Geppo (Monthly Report of Chikuho Coal Mining Industry Association).* Volumes 43

entered the mine to work as a pillar worker. In this case, the box for that day contained a kanji seal. The attendance records apply to workers who worked inside the mine, not outside (e.g., cleaners), and particularly to coal miners who worked at the coal face. Thus, firms created an extra seal to indicate those doing pillar worker jobs. The second additional seal is also a kanji seal, and indicates when a worker is sick. This would be used when a miner got sick or was injured and, thus, was absent from work. In addition to the seals, we also found handwritten records when a worker entered the mine, was sick, or quit the mine. Other handwriting in the page margins indicated the same information, and in some cases, the names of other miners.

We examine the "Miner Attendance Records" for July 1905 for the Aso Fujidana Second Coal Mine. Here, we capture the information from this record book and calculate miners' attendance rates. We found 555 miners' records of attendance, of which 400 were male (72.1%) and 296 worked with a family member. Only 18 females worked without a family member.

The average attendance rate in July 1905 was 22.5%. That is, miners worked approximately 7.0 shifts of 31 days, on average. The highest attendance rate in this month was 80.6%, recorded for just one person, who worked 25 shifts in 31 days. We consider the real attendance rate as the number of individual attendance days divided by individual length of employment. Some miners began working at the mine before the month under review, while others began working or quit during the month. If miners started working prior to this month, we cannot know the date they actually started. Thus, we consider their start date to be July 1, 1905. Furthermore, even if miners continued working in the following month, we assume that they quit on July 31, 1905. Thus, we obtain an average length of employment of 24.7 days. The real average rate of attendance was 27.8%. This means that miners worked nine shifts a month on average. (See Table 1.)

We find 15 dormitories, including one "directly controlled dormitory" and one "pillar worker dormitory." The remaining 13 dormitories were named according to the last name of the relevant dormitory head. Table 2 shows the number of members in each dormitory.

(January 1908) and 48 (June 1908) contain articles on the circumstances within the coal mines. Volume 43 states that workers in the Kaneda coal mine worked for10 hours, on average. Volume 48 states that workers in the Hokoku coal mine also worked for10 hours.

2) Collation of "Miner Attendance Records" with "Miner Job Applications"

By checking the information from the 555 attendance records against the database of 774 job applications built by Sakai (2014), we find 202 miners in both historical documents. Moreover, 22 referral agents appear in both sets of records. These agents worked as referral agents and as miners. Table 3 shows the number and the component ratio of referral agent-miner workers in each dormitory. The pillar worker dormitory had the highest component ratio of such workers. Pillar workers required high levels of traditional manual skills, which could only be acquired from field experience, and they knew how to prop pillars and mine coal and do other things in the coal mine. Thus, we infer that the referral agent ratio was high in the pillar worker dormitory. Then, the directly controlled dormitory had a slightly higher ratio than the others did. This indicates that firms tried to put skilled miners in the directly controlled dormitory. It seems the firm tried to incorporate traditional manual skills, which were dominant in the 1900s before the advent of mining machinery, into its human capital.

3) Specific cases from "Miner Attendance Records"

Here, we introduce two specific cases from the "Miner Attendance Records." The first describes the A dormitory. The head of A dormitory was K.U., and the actual name of the dormitory is derived from his last name. Since his name was written in the box, he worked as A dormitory's head and as a miner. He was also employed directly, along with C.W., on June 14, 1905. In other words, they were not referred by referral agents. These two applied this coal mine together, and appeared in the same job application. The space reserved for a referral agent's name was filled with "Personnel section" and contained an Aso employee's seal. More interestingly, K.U. referred 18 job applicants from the day after he applied through July 13, 1905. This indicates that he was a skilled miner.

The A dormitory consisted of 20 miners, including these two miners. C.W. appeared in the first column of the "Miner Attendance Records" for the dormitory. The other 18 members were applicants referred by K.U., as mentioned above. In the space above 13 of these 18 miners, we find C.W.'s last name. This indicates that the A dormitory

was composed of K.U.'s group, consisting of five people, and C.W.'s group, consisting of 13 people. The C.W. group had five people whose had previously worked as a coal miner and one person whose previous job was a pillar worker. On the other hand, the K.U. group did not have anyone who mentioned a previous job in their job applications. Thus, we infer that the members of the K.U. group were less skilled than those in the C.W. group. K.U. might have trained his group members to be coal miners while working in the coal mine. C.W. may have led the more skilled miners in doing difficult tasks with higher risks. K.U. and C.W divided their responsibilities in the dormitory.

What is special about the A dormitory is that these two miners were directly employed, and they recruited miners and organized their own dormitory. In other words, the firm employed them directly, and let them work as referral agents to mitigate adverse selection problems. The firm also let them organize their dormitory to mitigate any moral hazard problems. The firm would have expected K.U. and C.W. to recruit workers as a complete working group. This case shows how the firm employed miners directly to work as conventional dormitory heads, as well as to organize the dormitory.

Secondly, we introduce the B dormitory case. From the "Miner Job Applications," we find that one head of the B dormitory was K.H., and that he referred 33 applicants. From the "Miner attendance records," we also find S.Y. and T.Y. They applied on May 19, 1905, and were referred by K.H. Their attendance boxes were filled with words "Going home for rice planting," in handwriting. In addition, another miner, K.Y., belonged to the B dormitory and worked with his wife. His attendance boxes were also filled with "Going home for rice planting," in handwriting. Furthermore, a slip of paper with the words "Going home for rice planting" was placed between the B dormitory pages. K.Y. was a referral agent for 24 applicants from October 1906 through May 1907, and we find him to be a dormitory head, based on the "Miner Attendance Records" on March 1907. He referred 24 applicants in total, including two applicants whose previous jobs were as a farmer, and one applicant whose previous job stated he was a "miner." K.Y. was from a farming village, and he returned home temporarily in July 1905, during the busy farming season, and referred two applicants from a farming village. These facts imply that K.Y. had networks from which to recruit idle labor resources from farming villages. Thus, we infer that the B dormitory focused on recruiting such idle resources from

farming villages.

3. Empirical analysis of "Miner Attendance Records"

In this section, we analyze the “Miner Attendance Records” database and check these data against the “Miner Job Applications.” The two main types of regression analysis are 1) an analysis based on all 555 miners who in the “Miner Attendance Records,” and 2) an analysis based on 202 miners who appeared in both sets of records. When we refer to information provided by miners when they entered this coal mine, we use the latter analysis.

1) Variables for measuring the monitoring function and the screening function

The dependent variables are as follows: 1) real attendance rate; 2) length of employment; 3) dummy variables indicating miners’ types (e.g., their previous or current job); and 4) dummy variables indicating the dormitory to which miners belonged.

First, the real attendance rate captures how often miners worked. This included how the miners’ organization and their group leaders (a dormitory head or a group leader) disciplined them, and how well their group leaders monitored the miners. Using real attendance rate as a dependent variable, we infer the monitoring function of the organization to which miners belonged. The better the organization monitored, the higher was the real attendance rate of miners.

Second, the length of employment captures how likely workers were to settle into the coal mine. Using length of employment as a dependent variable, we infer the screening function of miners’ referral agents. The better their referral agents succeeded in screening longer periods of employment types, the longer miners were employed.

Third, there are two types of dummy variables indicating miners’ types. The first type are dummy variables indicating miners’ previous job types, which were found in the “Miner Job Applications.” By checking “Miner Attendance Records” database against that of the “Miner Job Applications,” we observe individual miners’ previous job types, their recruitment path, and the organizations to which he/she belonged. In other words, we observe which previous job type miners tended to be referred from, by which referral agents, and who was managed by the different dormitory types. This enables us to observe

miners' trends in the labor market in the Japanese coal mining industry, and in the organizations to which miners belonged. The second type are dummy variables indicating whether the space above a miner's name box contained another miner's name. When this occurred, we infer that the firm knew who the miner's group leader was.

Finally, there are three types of dummy variables indicating the dormitory to which miners belonged: the direct controlled dormitory, the pillar worker dormitory, and ordinary dormitories.

The independent variables are as follows: 1) dummy variables indicating the dormitory to which miners belonged (i.e., direct controlled dormitory, pillar worker dormitory, or ordinary dormitory); 2) dummy variables indicating the current job, namely current coal miner or current pillar worker; 3) dummy variables indicating male or female; 4) dummy variables indicating whether miners worked with a family member; 5) dummy variables indicating the referral agents miners were referred by (i.e., ordinary dormitory heads, employee referral agents (who worked as a miner and a referral agent), independent referral agents (not work as a miner)); 6) dummy variables indicating miners whose name was written in the space above another miner's name box; and 7) dummy variables indicating miners whose space above their own name box included another miner's name (see appendix table 1).

2) Effects of referral agents and dormitories

First, we analyze the relations between miners' attendance and dormitories. Table 4 shows the result of our analysis using the least-squares method of 555 miner attendance records. The dependent variable is real attendance rate (AAD). The coefficient of the independent dummy variable, DCD, takes the value 1 if a miner belonged to the direct controlled dormitory, and 0 otherwise. The coefficient is significant and positive. This indicates that miners who belonged to the directly controlled dormitory tended to have a high real attendance rate compared to ordinary dormitories and the pillar worker dormitory. Thus, the directly controlled dormitory succeeded in monitoring their miners. In addition, model 4-2 shows that the coefficient of the independent dummy variables DCD and ODM are significant and positive. Then, model 4-3 shows that the coefficient of DCD is significant and positive and that of APD is significant and negative. These

results indicate that the pillar worker dormitory were not as successful in monitoring their miners.

Next, we consider a screening function, depending on miners' recruitment paths. Table 5 shows which referral agents screened longer periods of employment for the miner types. Here, we use the 202 miners who appeared in both sets of records. The dependent variable is length of employment (TDT). We include an independent variable CUAP (worked as a pillar worker) to control their length of employment tendency. Pillar workers prop up a mine roof with wooden or coal pillars to prevent the roof from collapsing at the face, and remove these pillars once mining is complete. Unlike pillar workers, coal miners move from between coal mines to seek a better coal face. Pillar workers did not have such a motivation. Therefore, pillar workers may work for longer periods than coal miners, and may settle at a coal mine. The coefficient of the independent dummy variable CUAP is strongly significant and positive in models 5-1 and 5-2. This indicates that current pillar workers tended to work for longer periods. Model 5-1 has an independent dummy variable, IDR, which takes the value 1 if a miner was referred by an "independent referral agent," and 0 otherwise. Independent referral agents are not found as miners in the attendance records and as applicants in the job applications. They only appear as referral agents in the job applications. We consider that they did not work for this coal mine as both a miner and a referral agent, but instead worked as freelance referral agents. Model 5-1 shows that the coefficient of IDR is significant and positive. This means that miners who were referred by independent referral agents tended to work for longer periods than miners who were referred by dormitory heads and "employee referral agents."

Table 6 shows that the proportion of skilled miners in each dormitory. We define skilled miners as miners whose previous job was a coal miner or a pillar worker. This table tells us the relations between previous job types and dormitories and shows ordinary dormitories had the highest proportion of skilled miners. Ordinary dormitories tended to get skilled miners but the directly controlled dormitory tended not to. Sakai (2013) showed that dormitory heads and skilled miner referral agents tended to refer skilled miners. These two results indicate that the conventional dormitory heads referred workers who worked with them and they assigned them to their own dormitories.

Table 7 shows the referral agents who referred the miners in each dormitory.

Employee referral agents and independent referral agents did not tend to refer miners who belonged to ordinary dormitories, since the coefficients and marginal effects of the independent variables EMR and IDR are strongly significant and negative in model 7-1. This means that dormitory heads tended to refer miners in ordinary dormitories. Model 7-2 shows that employee referral agents and independent referral agents tended to refer miners in the directly controlled dormitory. Model 7-2 shows that the directly controlled dormitory had relatively less skilled miners. This supports model 6-2, which showed that the directly controlled dormitory did not tend to get skilled miners. Employee referral agents and independent referral agents possessed the required skills and were able to screen skilled miners. Therefore, what was the purpose of referring less skilled miners for the directly controlled dormitory? We conclude that they might have referred less skilled, but promising candidates. Model 7-3 shows that employee referral agents and independent referral agents tended to refer miners in the pillar worker dormitory, since the coefficients and marginal effects of the independent variables EMR and IDR are significant and positive. Furthermore, the marginal effects on IDR are greater than those on EMR. Thus, independent referral agents more often referred miners in the pillar worker dormitory than did employee referral agents. This implies that independent referral agents were able to screen applicants' suitability as a pillar worker, and were able to access pillar workers' job information networks.

3) Effects of the firm's dealing with recognizing smaller units under dormitory heads

In this section, we study the information in the space above miners' name boxes. We find another miner's name in this space in 120 cases. Here, we define NOME as a dummy variable that takes the value 1 if another miner's name appears above a miner's name, and 0 otherwise. In addition, we define NOM as a dummy variable that takes the value 1 for a miner if his/her name is written in the space above another miner's name box, and 0 otherwise.

Why did the firm write someone else's name in the space above a name box? Was this a referral agent's name, or perhaps a group leader's name? In all, 94 miners of the 120 NOME group were also found in the job applications. Of these, 68 NOME referral agents were not NOM. That is, 72% of NOME's NOM were not NOME's referral agents.

The firm already knew who miners' referral agents were from their job applications. Thus, it is highly likely that NOM were leaders of each NOME's group. NOM might manage, monitor, and discipline their own NOME (i.e., their group member). The firm recorded these names because it recognized smaller units under dormitory heads. (See Table 8)

Table 9 shows the result of our analysis using the least-squares method and indicates the NOME working states. In model 9-1, the dependent variable is real attendance rate (AAD). Here, NOME tended to have relatively high real attendance rates, since the coefficient of NOME is significant and positive. In model 9-2, the dependent variable is length of employment (TDT). This shows that NOME did not tend to settle at this coal mine, since the coefficient of NOME is significant and negative. NOME were monitored by their leader, NOM, and NOM's monitoring was recognized by the firm. Thus, NOM succeeded in monitoring their group members, NOME. The firm's recognition of smaller units under the dormitory system might have led to NOME's good real attendance rates. However, NOME's referral agents seem not to have focused on screening for longer periods of employment miner types.

Implications

The directly controlled dormitory tended to succeed in monitoring miners, and miners in this dormitory had relatively high real attendance rates. While the directly controlled dormitory had relatively less skilled miners, they focused on attendance more than obtaining highly skilled miners.

Independent referral agents tended to screen longer periods of employment miner types. They also tended to refer miners to the pillar worker dormitory.

Information in the space above name boxes provides us with details about smaller units inside dormitories. The names of the leaders of these smaller units were written above their unit members' name boxes. Since the firm produced the "Miner Attendance Records," it recognized the existence of smaller units and, thus, incorporated these units. Then, the firm began hiring directly, and managing miners.

Skilled miners tended to belong to ordinary dormitories. Sakai (2013) found that dormitory heads and skilled miner referral agents tended to refer skilled miners. Therefore,

considering these results together, skilled miners were referred by a dormitory head and were assigned to the dormitory whose head referred them. In other words, dormitory heads referred skilled miners who would then be members of their dormitory.

In this study, we define the real attendance rate as indicating the monitoring function, and the length of employment type as indicating the screening function. Attendance rate could be regarded as workers' types and, thus, could be a screening function. We could also regard length of employment as an indication of whether miners settled at the coal mine. However, we did not get significant results from the following regression analyses: 1) dependent variable is real attendance rate and independent variables are types of referral agents; and 2) dependent variable is length of employment and independent variables are organization types. This indicates that regarding real attendance rate as a monitoring function and the length of employment type as a screening function is plausible. Adding attendance records from another period to the database may change these results. We leave this for future research.

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Table 1. Descriptive statistics from "Miner Attendance Records," July 1905

(days, %)

	(1) Attendance days	(2) Attendance rate (=(1) / 31)	(3) Length of employment	(4) Real attendance rate (=(1) / (3))
Mean	6.97	22.48	24.66	27.75
Median	5.00	16.13	31.00	25.81
Maximum	25.00	80.65	31.00	100.00
Minimum	0.00	0.00	1.00	0.00
Std. Dev.	6.33	20.41	9.57	21.65
Observations	555	555	555	555

Table 2. The number of each dormitory's member in order of appearance

	Total	At the end of July
Directly controlled dormitor	145	119
A dormitory	20	7
B dormitory	65	50
C dormitory	7	6
D dormitory	13	5
E dormitory	40	35
F dormitory	30	23
G dormitory	34	17
H dormitory	13	9
I dormitory	36	12
J dormitory	7	4
Pillar worker dormitory	63	59
K dormitory	46	43
L dormitory	27	15
M dormitory	9	7
Sum	555	411

From "Miner Attendance Records," July 1905.

Notes : All dormitory names except direct controlled dormitory and pillar worker dormitory are named their own dormitory

Table 3. The number of referral agents at each dormitory and its percentage of total

Directly controlled dormitory	8	5.5%
A dormitory	1	5.0%
B dormitory	2	3.1%
E dormitory	1	2.5%
F dormitory	1	3.3%
I dormitory	1	2.8%
Pillar worker dormitory	6	9.5%
K dormitory	1	2.2%
L dormitory	1	3.7%
Sum	22	4.0%

From "Miner Attendance Records," July 1905 and "Miner Job Applications," 1902-1907.

Table 4

	4-1		4-2		4-3	
Estimation method	least squares		least squares		least squares	
Dependent Variable	AAD		AAD		AAD	
Independent variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
C	0.1801	7.2978 ***	0.2162	7.7007 ***	0.1908	7.6159 ***
MALE	0.0617	2.7769 ***	0.0626	2.7817 ***	0.0625	2.8224 ***
FML	0.0574	2.8314 ***	0.0683	3.3641 ***	0.0546	2.7023 ***
DCD	0.0855	4.1263 ***	0.1408	4.3725 ***	0.0762	3.6165 ***
ODM			0.0646	2.2374 **		
APD					-0.0646	-2.2374 **
Included observations	555		555		555	
Adjusted R^2	0.0496		0.0565		0.0565	
Log likelihood	77.9651		80.4793		80.4793	
F-statistic	10.6465***		9.2944***		9.2944***	

From "Miner Attendance Records," July 1905.

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

Table 5

	5-1		5-2		5-3	
Estimation method	least squares		least squares		least squares	
Dependent Variable	TDT		TDT		TDT	
Independent variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
C	20.0035	13.3903 ***	17.7671	15.8547 ***	18.1807	15.4424 ***
FML	2.7907	2.0685 **	2.3759	1.7965 *	2.3730	1.7254 ***
CUAP	4.3452	3.0714 ***	4.0699	2.8846 ***	4.1971	2.9401 ***
RDH	-2.6985	-1.7567 *				
IDR			3.6864	1.9243 *		
EMR					0.2469	0.1028
Included observations	202		202		202	
Adjusted R^2	0.0475		0.0504		0.0327	
Log likelihood	-731.1382		-730.8289		-732.6948	
F-statistic	4.3383***		4.5540***		3.2625**	

From "Miner Attendance Records," July 1905 and "Miner Job Applications," 1902-1907.

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

Table 6

	All (A)	Found from "Miner Job Applications" (B)	Skilled miners (C)	(C)÷(A)	(C)÷(B)	Previous job	
						Coal miner	Pillar worker
DCD	145	34	3	(2.1%)	(8.8%)	3	0
ODM	347	159	34	(9.8%)	(21.4%)	20	14
APD	63	9	1	(1.6%)	(11.1%)	0	1

From "Miner Attendance Records," July 1905 and "Miner Job Applications," 1902-1907.

Table 7

Estimation method	7-1 binary probit			7-2 binary probit			7-3 binary probit		
Dependent Variable	ODM			DCD			APD		
Independent variable	Coefficient	Marginal Effects	z-Statistic	Coefficient	Marginal Effects	z-Statistic	Coefficient	Marginal Effects	z-Statistic
C	1.6418		9.8167 ***	-1.8599		-9.5074 ***	-2.0777		-8.8729 ***
EMR	-2.8286	-0.8415	-6.5783 ***	2.5815	0.7843	6.6610 ***	0.8909	0.1206	1.9360 *
IDR	-2.3781	-0.7549	-7.4555 ***	2.1533	0.6450	6.7887 ***	1.0576	0.1497	2.7882 ***
Included observations		202			202			202	
McFadden R^2		0.5036			0.4668			0.1248	
Log likelihood		-51.9139			-48.8162			-32.2024	
LR statistic		105.3377***			85.4633***			9.1870**	

From "Miner Attendance Records," July 1905 and "Miner Job Applications," 1902-1907.

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

表 8

All miners			
555	NOME		
	120	Found in "Miner Job Applications"	
		94	Their NOM was not their referral agents
			68 (72.3%)

From "Miner Attendance Records," July 1905 and "Miner Job Applications," 1902-1907.

Table 9

	9-1		9-2	
Estimation method	least squares		least squares	
Dependent Variable	AAD		TDT	
Independent variable	Coefficient	t-Statistic	Coefficient	t-Statistic
C	0.1837	7.3108 ***	24.8619	22.9989 ***
MALE	0.0608	2.7077 ***	0.8154	0.8432
FML	0.0737	3.6469 ***	1.1965	1.3763
NOME	0.0495	2.2398 **	-6.5809	-6.9221 ***
Included observations	555		555	
Adjusted R^2	0.0291		0.0796	
Log likelihood	72.0349		-2015.8218	
F-statistic	6.5380***		16.9755***	

From "Miner Attendance Records," July 1905.

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		a constant term
AAD		real attendance rate= attendance days ÷ length of employment
TDT		length of employment
MALE	dummy variable	= 1 if male, 0 otherwise.
FML	dummy variable	= 1 if worked with their spouse or families, 0 otherwise.
DCD	dummy variable	= 1 if belonged to direct controlled dormitory, 0 otherwise.
APD	dummy variable	= 1 if belonged to pillar worker dormitory, 0 otherwise.
ODM	dummy variable	= 1 if belonged to ordinary dormitory, 0 otherwise. (neither in direct controlled dormitory nor in pillar worker dormitory)
CUAP	dummy variable	= 1 if worked as a pillar worker, 0 otherwise.
NOM	dummy variable	= 1 if his/her own name written in the space above another miner's name box, 0 otherwise.
NOME	dummy variable	= 1 if the space above his/her own name box had another miner's name, 0 otherwise.
RDH	dummy variable	= 1 if a miner was referred by a dormitory head when he/she applied, 0 otherwise.
EMR	dummy variable	= 1 if a miner was referred by a "employee referral agent" (who worked for the coal mine) when he/she applied, 0 otherwise.
IDR	dummy variable	= 1 if a miner was referred by an "independent referral agent" (who did not work for the coal mine) when he/she applied, 0 otherwise.