How to Screen Miners' Skills:

Recruiting in the Coal Mining in Early Twentieth Century Japan

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Abstract

In the early 20th century Japan, coal mining firms took an intermediary organization of labor, "dormitory system." Given traditional technology that required high manual skills unknown to managements, firms relied on the intermediary organization both for screening and monitoring workers. This study focuses on referrers of miners, who took an essential role of signaling in the coal mining industry.

Key words: organization of labor, asymmetric information, adverse selection, moral hazard, internal double marginalization, social networks, informal job networks, referral hiring, employee referrals, intermediary management, coal mining, Japan.
JEL: L22, L71, J20.

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Introduction

This study focuses on the interaction between technological progress and the transformation of the organization of labor. While it was once believed that the importance of skill would decrease with technological progress, in reality, new technology requires workers to have new skills and to be organized in new ways. For instance, in industries that predate modern times, mechanization caused the organization of labor to change gradually from indirect to direct employment. The mining industry is a typical case. Before the introduction of modern machines, Japanese coal mining firms employed workers indirectly through an intermediate organization called the "dormitory system." Miners lived at a dormitory that the firm built near the coal mine—it was a row house, there were dormitory heads in each dormitory, and workers were managed by their dormitory heads rather than directly by the firm, as later miners would be. In Japan, neither the modern spinning industry nor the modern silk reeling industry underwent transitions similar to that of the mining industry. These industries, modeled after those in Western countries, were factory industries from inception. In contrast, the mining industry existed before the early modern period and experienced rapid growth in modern times, and thus, almost all mining firms experienced the transition from the indirect employment system to the direct employment system. This study examines what caused the traditional organization of labor to be transformed and how it was transformed and in the coal mining industry in Chikuho region, Kyushu, Japan. The mining industry is an instructive example of this transition, and the Chikuho coal mining industry is an ideal example because it existed in the early modern period and grew in modern times.

In the Chikuho coal mining industry, the transition from the indirect employment system to the direct employment system was completed in the 1930s. The beginning and the end of this transition was studied by Sumiya (1968) and Ogino (1993), but they did not study the process of this transition as the industry changed over thirty years. In this study, we look at the interaction between technological progress—for example, the introduction of mining machines and changes in mining techniques—and the changes in the industry's information structure. We then consider the interaction between the changes in the information structure and the changes in the employment system. In other words, we study the interdependence between the organization of labor and technology through changes in the information structure.

When mining depended on manual skills, which we refer to as traditional skills, technical knowledge was accumulated in individual miners. Coal mining firms did not have this knowledge and could not observe miners' skills and behavior; therefore, they left almost everything about mining to the dormitory heads and to the miners. The technology required made asymmetric information a prominent feature of the coal mining industry. The dormitory heads and miners had an informational advantage over mining firms; they had more knowledge about the technology they used and about mining activities. Asymmetric

information generates two types of problems: adverse selection and moral hazard. Adverse selection occurs before a contract is concluded, that is, before and during the hiring process in this context. Adverse selection could occur before hiring because mining firms could not verify applicants' skills and abilities, which applicants had an incentive to misreport. Moral hazard problems occur after a contract is concluded; in this case, the problem was in monitoring the miners. Moral hazard could occur because mining firms did not understand what miners did inside the coal mine. The firms did not know the potential output of a given number of workers in a given coal mine until the Mining Act promulgated, nor did they know whether miners were working properly, and hence, the firms could not properly incentivize miners. The transition from indirect employment to direct employment could not be achieved overnight; it could only be achieved through the gradual development of solutions to these two types of problems. Section II of this paper gives our perspective on this gradual change.

The transition in the organization of labor, which was dependent on technology and the information structure, can be understood only by following each step in its gradual change. This study shows how the interdependence between the technological features of coal mining and the information structure and that between the information structure and the organization of labor changed in the process of transition.

Section III describes the experience of a coal mine, Aso Fujidana Second Coal Mine owned by Aso Coal Mining Co., from 1902 to 1907, focusing on the changes in the interdependence between mining technology, the information structure, and the organization of labor. Aso Fujidana Second Coal Mine was under the dormitory system, an indirect employment system, but began the transition to adopting a new kind of organization, a direct employment system. The new kind of organization was of two types, both of which are discussed later in this paper. At that time, the Second Fujidana Coal Mine used a "room and pillar mining method," which required traditional mining skills, and the miners were managed by the dormitory heads. However, Aso Coal Mining Co. partially adopted the direct employment system when it operated the mine for the relatively short period between 1902 and 1907. When Aso Coal Mining Co. purchased the mine in 1902, the change in ownership meant it was less bound by tradition. Thus, Aso Coal Mining Co. was in a position to implement innovative reform. Using this transitional employment system as a case study, we consider the change in the employment system of the Chikuho coal mining industry. We study the historical documents left by the Aso family, focusing on "The applications of miners"[1] for the Second Fujidana Coal Mine, "The address list of the miners," and "The book of attendance management."

The Mining Act, promulgated in 1890 and enforced in 1892, obligated every mine in Japan to make a list of their miners. Having information on individual miners was necessary for the transformation to direct employment. This Act created the basic

[1] All firsthand documents we deal with are from *Aso ke Monjo (Documents of Aso)*.

conditions for the entire mining industry's transformation to the direct employment system. Under the requirements of the Act, Aso Co. was compelled to make the address lists and the withdrawal record and, therefore, tried to acquire more information on individual miners. In Section II, we consider the different features of employment contracts depending on job types in the mine.

In Section III, we analyze the databases containing the complete application information of the Second Fujidana Coal Mine. The data include each applicant's hometown, age, and details on family members who applied jointly; furthermore, their referrers always signed at the end of the application. When applicants were directly employed by the firm, the Aso employee wrote "Personnel division" on the applications and signed their name. We cross-reference referrers' names in "The book of attendance management" to find whether they were employees, dormitory heads, or other kinds of referrer. Further, we consider the implications of the subsystems within dormitories through studying "The book of attendance management." Using this information, we attempt to understand the structure of the transitional labor market and employment system.

I. Technology and organization in coal mines

1) The technological feature and information structure in coal mines

A typical coal mine might contain 20 to 30 miners, formed into groups of 5 to 10 miners. Each group was led by a dormitory head. Mining firms did not recognize individual employees' names or how many people worked in their mines; the turnover of miners was high, it was difficult to know how many there were on a given day or even in a given month. Thus, firms left the tasks of monitoring, paying, recruiting, and otherwise managing miners to the dormitory heads. Although machines were introduced in the 1880s to drain spring water and to convey coal out of the mine, mining firms left almost all tasks to the dormitory system. Therefore, miners, and of course dormitory heads, still had an informational advantage over firms. In addition to this, miners worked underground, where it was dark and narrow. The processes of mining coal and placing and removing pillars inside a coal mine were conducted by experienced miners with traditional manual skills. Under these conditions, it is easy to imagine that firms did not know how workers mined coal. Thus, the information asymmetry between firms and workers was serious. This could introduce moral hazard and adverse selection. Thus, firms had no option but to leave almost all mining operations to the dormitory heads. It cost firms an additional information rent, but it was a reasonable second-best option.

As information asymmetry about mining techniques and miners' performance decreased, firms no longer needed to leave miners' management to dormitory heads and they could change from an indirect organization of labor to a direct one. Changing the informational structure affected organizations' efficiency. That is, firms could make the transition from indirect employment to direct employment as information asymmetry

decreased. This could occur only gradually in coal mines. The working process was traditionally divided between coal mining, conveyance, placing pillars, and coal cleaning, among others. The necessary skills and techniques were different for each process. The introduction of modern machines was crucial for decreasing information asymmetry. First, a drain pump, and later, a conveyance machine were introduced. These introductions allowed firms to be significantly better informed about miners' work. These technological advances did away with the need to have dormitory heads monitor the operators of drain pumps and conveyance elevators. Pump operators and elevator operators were directly employed by firms in an earlier period than were other employees. From this point, more coals became to convey, and firms came to be able to sell more coal than before to introduce those machines.

Given the market price of coal and individual rational constraint imposed by the labor market, firms decided wages as the piece rate per a unit of coal to maximize profit. The dormitory heads responded to this piece rate, which was their marginal revenue. They settled the coal output such that the marginal revenue equaled to their marginal cost. Since firms delegated coal mining to the heads, each dormitory was a kind of an upstream company and double marginalization occurred. Thus, the coal output did not necessarily equal to the one which would have maximized profit of the whole coal mine.

Firms came to be able to convey much more coals from inside their mines to the outside when conveyance elevators were introduced in the 1890s. The optimal amount to maximize joint profit of upstream mining process and downstream conveyance process accordingly increased. However, the upstream mining process was operated still under the traditional technology and the dormitory system. Each dormitory managed the mining process and was still an independent profit center. Thus, the amount of coal output decided by the dormitory heads failed to achieve the optimal output that could have maximized joint profit. In other words, the potential increase in joint profit, which could have been generated if firms had integrated the dormitories, grew, at some point, beyond the cost for vertically integrating the dormitories. Then, firms decided to reform the dormitory system in order to settle on the amount of coal output at optimal level. Hence, firms strengthened their control at the mining processes. Firms' personnel took over some tasks that had been in charge of the dormitory heads.

Mining firms began introducing machines in coal mining processes about 20 years after introducing them for drainage and conveyance. This allowed firms to have technological information about coal mining, the key process in the industry. Firms then monitored miners and paid their wages directly rather than leaving it to the dormitory heads. This introduction of machines was accompanied by a change in the mining method from room and pillar mining to longwall mining. This modernization of mining methods and introduction of mining machines made firms better informed about mining techniques and allowed them to observe miners' work more closely. In the coal mining industry, operations were different for each process. Each process was highly independent and required a

different set of traditional skills before the introduction of machines. Firms did not have information about these processes, and therefore, they depended on dormitory heads to recruit and monitor miners. When a machine was introduced to a process, it allowed firms to be better informed about relevant skills and the task of monitoring the process was transferred from dormitory heads to firms. The introduction of machines to each process was technologically independent, and naturally, machines were introduced to each process individually. Therefore, changes to the information structure and the organization of labor occurred individually in each process. Hence, the change in the organization of labor for the whole mine was completed gradually. When machines were introduced into the process of coal mining, which still depended on manual skill until the 1930s, firms could control all processes based on modern engineering and could increase productivity by synchronizing all processes. When all processes became complementary to each other and all processes had firm-dominant information structures, the entire mining operation came to be controlled by the firm.

2) Moral hazard and adverse selection in the coal mining industry

Suppliers can have more information about the quality of their services than consumers do before entering into a contract. Information asymmetry (hidden knowledge) before the conclusion of a contract might lead to adverse selection. Even after the conclusion of a contract, consumers might not be able to observe whether suppliers provide good services. Such information asymmetry (hidden action) after the conclusion of a contract can lead to moral hazard.

In the coal mining industry, firms could not observe whether miners' efforts increased coal output after employment agreements. There was asymmetric information about miners' actions. Hence, firms might pay a lazy miner the same wage as they would a hard-working miner, thus incentivizing laziness. That is moral hazard. To decrease this asymmetry and to indirectly observe miners' effort, firms set dormitory heads to monitor miners, to manage their attendance, and to distribute wages to each miner in the dormitory instead of firms.

Moral hazard might occur between firms and dormitory heads as well. Firms could not observe whether heads instructed and managed their dormitories' miners correctly. Firms did not know whether dormitory heads misreported their expenses, including miners' wages. Heads might evaluate miners unfairly to defraud miners of their wage. To control this type of moral hazard, firms needed to give incentive wages to heads to encourage appropriate management and provision of information. In other words, when firms rewarded heads for proper management, heads would keep managing miners appropriately to preserve their extra money. The information rent earned by dormitory heads included incentive wages to control moral hazard of them.

By the time each process was modernized in the coal mining industry, firms continued to employ dormitory heads in some way. Losses incurred by firms due to

asymmetric information were composed of losses from miners' moral hazard and information rents paid to heads to contain their moral hazard. Before modernization, hiring dormitory heads was an efficient second-best despite the information rents required. If firms fired the heads to avoid paying information rents, they would incur bigger losses owing to asymmetric information. Because management traditionally did not enter their mines and did not have technical information about miners' manual skills, the information rent paid to dormitory heads was smaller than the cost of direct management of all miners. This aspect explains why firms used the indirect organization of labor, where monitoring was delegated to dormitory heads.

Firms had difficulties screening applicants because they did not observe mining processes and lacked expertise on traditional manual skills. Before the conclusion of an employment contract, miners had information about their own skills that firms did not. Applicants could misrepresent their skills before signing an employment contract. This is adverse selection. To mitigate this, firms left recruitment to dormitory heads.

3) The gradual transition of the information structure and the organization of labor

In the Chikuho coal mining industry, a drain pump was first introduced, and later, a conveyance machine was introduced. By the late 1890s, most major coal mines had introduced these machines. The introduction of a conveyance machine drastically increased conveyance capacity out of the mine. However, the process of coal mining still depended on manual skill.[2] Drain pump operators and conveyance elevator operators were employed directly by firms, not through dormitory heads.[3]

The coal mining method was changed from room and pillar mining to longwall mining after World War I. In 1932, almost all major coal mines adopted the new method.[4] Longwall mining was intended to consolidate faces and to increase mining efficiency over that of the room and pillar mining, whereby a coal seam bed was separated into several faces that were mined independently. As the consolidation of faces enables machine usage in mining, firms introduced coal mining machines.[5] Coal mining machines included a rock drill, a coal cutter, a coal pick, and a face conveyance.[6]

Preceding studies on the coal mining industry did not explicitly analyze the interdependence between the technological features of coal mining and the information structure, and between the information structure and the organization of labor. Sumiya (1963) noticed that people who worked at the processes of drainage and conveyance, which were mechanized, were directly employed.[7] Tanaka (1984) and Ogino (1993) pointed out

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[2] See Sumiya (1968), pp.308-312 and Hatakeyama (2008), pp.200-254, for the examples of the Mitsubishi-Namazuda coal mine.
[3] See Sumiya (1968), p.314.
[4] See Ogino (1993), p.141 and p.293.
[5] See Ogino (1993), p.262.
[6] See Ogino (1993), pp.293-294.
[7] See Sumiya (1968), pp.313-314.

that the completion of mechanization and the abolishment of the dormitory head system occurred around the same period (in the 1930s).[8] Their works indicate some kind of perspective on the interdependences mentioned above. We might say they shared a similar viewpoint on this matter.

In spite of these preceding studies, the most important question has not yet been analyzed. The organization of labor started to transform from indirect employment to direct employment when mechanization was introduced, and the transition to direct employment was completed when the mechanization was completed. The beginning and the end of the transition can be analyzed from static viewpoints, as the preceding studies did. However, the preceding studies gave only a vague view of the changes in technology and the organization of labor from the 1900s to the 1920s, the period in which mining machines and the new mining method gradually came to be widely used. For instance, Ogino (1993) mentioned that the organization of labor at Aso Fujidana Second Coal Mine was partially reformed in the 1900s and attempts were made to directly employing miners, even though the mine used the old mining method.[9] Our study is related to this pioneering study, although Ogino (1993) did not inquire further into the details or discuss the implication of the changes in technology and organization of labor.

The missing link in those preceding studies mainly comes from that few surviving historical materials for studying the transition were available and those that exist are hard to read. This study examines those historical documents, namely, miners' applications at Aso Fujidana Second Coal Mine, and analyzes the transition.

Another reason is that the preceding studies regarded the transition of organization as a change in the distribution of value added between management and the dormitory heads and between the heads and the miners, rather than viewing it as improving organizational efficiency. They did not consider that efficiency might depend on the sum of surpluses belonging to the management, dormitory heads, and miners. That is why the preceding studies did not analyze the interdependence between technology and information structure and between information structure and organization of labor. In this study, we first analyze the organization of labor from the perspective of how efficiency was improved, and that guides us toward the mechanism of the change in the organization of labor and the factors of the changes. We do not necessarily ignore the distribution of value added. For instance, pursuing improved efficiency, coal mining firms introduced machines and provided training programs, invested in human capital, and then offered improved benefit programs in the 1930s. These changes improved efficiency. In this process, miners might have received greater rents. We focus on the efficient organization of labor, which was determined by the interdependence between technology and the information structure, and between the information structure and the organization of labor.

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[8] See Tanaka (1984), pp.397-441 and Ogino (1993), pp.407-410.
[9] See Ogino (1993), pp.69-77.

Let us separate the organization of labor's transition processes into four stages. First, when the problems of moral hazard and adverse selection were serious, management fully delegated to dormitory heads. Second, there was a transitional phase, during which asymmetric information was serious and still firms began to strengthen their control at mining processes because of the increase of distortion from the double marginalization along with the technological progress in the downstream conveyance process. Third, after introducing mining machines, the moral hazard problem was curbed. Finally, both moral hazard and adverse selection were curbed and management adopted the organization of labor wherein individual workers were directly screened and monitored by the firm.

(i) The dormitory system

When the problems of moral hazard and adverse selection were serious, coal mining firms did not have any choice but to turn to the dormitory system to recruit, monitor, and manage miners. Dozens of miners lived at one dormitory and its head guided the miners' work and life. A dormitory consisted of a head and several groups, each of which worked together as a unit. A group had a leader and he coordinated his group. Thus, the dormitory system was composed of two layers. (See Figure 1.)

A dormitory head was responsible for recruiting miners, monitoring their daily work, paying their wages, and looking after their daily life on behalf of the firm.[10] A head received his miners' wages in a lump sum by piece rate bases and gave each miner his individual wages based on his output. The difference between the amount heads received and the amount they handed to miners as wages was an information rent paid to heads for curbing moral hazard and adverse selection problems. Furthermore, firms had to pay information rents to the leader of each group under the dual layer system. Nevertheless, that was less costly than directly managing all miners and, thus, was an efficient second-best given the information structure, the technological condition, and the organization of labor at that time. Given serious asymmetric information between firms and the dormitory heads, this was the reasonable second-best organization.

(ii) Partially direct recruitment

In the 1890s, conveyance elevators were introduced, and then firms came to be able to convey much more coals from inside their mines to the outside. The optimal amount of coal output to maximize joint profit of mining processes and conveyance processes increased. Since the amount of output was decided by the dormitory heads, it failed to achieve the optimal output that could have maximized joint profit. Thus, firms began to reform the dormitory system in order to decide the amount of coal output. They strengthened their control at the upstream mining processes. Personnel division of firms

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

came to take over tasks that had been in charge of the dormitory heads. In addition, they directly employed the leaders of small units in the lower layer of dormitories, and hence, these units were not managed by the dormitory heads anymore. What firms tried to do was to weaken the control of dormitory heads, and firms newly installed "directly controlled dormitory," which was not a profit center anymore but just a cost center. (See Figure 2.)

Since the leaders had knowledge about the processes of mining, firms came to be able to have the leaders recruit new employees. This curbed adverse selection. In addition to this, the leaders trained their subordinates. This enabled firms to employ farmers and new inexperienced entrants to the coal mining industry. When firms employed farmers, they did not need to examine their skill as miners. Adverse selection could be curbed further. Nevertheless, firms still could not directly monitor individual miners because they were not able to observe the working processes in detail.

In this way, mining firms came to be able to deal with the adverse selection problem though asymmetric information was still serious. As a result, firms came to save the double information rent incurred under the dual layer system by easing the adverse selection problem. Firms intended to put traditional manual skills under their internal control by skipping dormitory heads and directly hiring the leaders of small units. It was the first step toward direct control.

(iii) The system of facilitators

The change in this stage was triggered by firms' introduction of mining machines from the 1920s onward. The machines were owned by firms, which had learned how to operate the machines and how to correctly estimate the amount of coal mined during a given period of time. That is, firms, not the dormitory heads or the leaders of small units, gained an informational advantage about a mining process. Firms could infer whether miners worked appropriately from their output. Since the information asymmetry after the employment agreement decreased, the moral hazard problem could be tackled. The ability to better estimate coal output meant that firms could accurately expect output per labor input. This meant that firms could appropriately decide wage rates to incentivize miners. That is, firms no longer needed to leave everything about miners' wages to the heads. Therefore, they did not need to pay information rents to the heads for monitoring workers. Thus, many coal mining firms transformed their labor organization to a direct one such as the system of facilitators in the late 1920s. Firms hired facilitators to recruit miners and monitor their daily work and living but the facilitators neither decided nor distributed miners' wages.[11] Firms began to decide the wage system because technology had eased the moral hazard problem; they no longer gave miners' wages to the dormitory heads. Meanwhile, the adverse selection problem remained a serious problem until intellectual skill[12] became necessary

[11] See Osaka Administrative Office of Employment Agency (1926), p.21.

[12] Ujihara (1966), pp.398-399 and Koike (2005), pp.11-26. Ujihara (1966) argued that firms replaced the manual and artisanal skills that individual skilled workers accumulated with

and an internal labor market was formed.

(iv) Directly managed organization of labor

The introduction of mining machines increased the importance of the intellectual skills accumulated by training in each firm; these skills were based on cognitive skills. Firms learned to tell their employee whether new entrants could acquire intellectual skills and then, they could recruited new entrants. That is, adverse selection was eased. Thus, both information problems were eased and firms no longer needed to leave tasks to dormitory heads. They had to train their miners with new types of skills to use the new mining machines. Thus, firms did not have to hire experienced miners anymore, and therefore, they abolished the indirectly managed organization of labor, the dormitory system, and fully entered into employment contracts with individual miners without intermediate agents. Firms' personnel came to handle the tasks that the dormitory heads had done previously.

The existence of the second phase especially does not go beyond the bound of assumptions; the existence of the first, third and fourth phases were written on documents. Moreover, this study might be the first to make these explanations of mechanism about the reason why each organization of labor was selected at each time. However, we can give hypothetical but reasonable explanations through these assumptions above and we can get an overall picture of the transition.

II. The beginning of change in the organization of labor

The whole transition described above was a long process from the 1890s to the 1930s, which contained many entangled elements. In order to decompose these elements and to clarify the transition process, let us take a case coal mine. The coal mine was named Aso Fujidana Second Coal Mine which was operated in the second phase. This is an empirical study focusing on how the coal mine faced adverse selection issues, especially we concentrate how the coal mine implemented screening applicants.

1) The organizational reform at Aso Fujidana Second Coal Mine

The miners at Aso Fujidana Second Coal Mine mined with picks and used the room and pillar mining method. Since the coal mining machines were not introduced there, the management of miners was mainly delegated to dormitory heads. However, this coal mine tried to directly manage the miners in practices called "Direct recruitment" and "Directly controlled dormitory." This dormitory heads (heads of directly controlled dormitories) were under the firm's stronger control than heads of ordinary dormitories.

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the skills that accumulated by training in the firms. He named the latter "intellectual skill." The "intellectual skill" Koike (2005) regarded is a subset of what Ujihara (1966) mentioned. Here after "intellectual skill" is regarded as the one Ujihara (1966) mentioned.

Ogino (1993) mentioned the existence of a directly controlled dormitory at Aso Fujidana Second Coal Mine in the 1900s,[13] but did not examine what it was and why it worked.

2) Historical documents

We study 774 applications submitted by miners to Aso Fujidana Second Coal Mine from 1902 to 1907, mainly from 1905 to 1907. These applications contained applicants' information at that time, such as their address, positions, previous jobs, full names (with a seal or thumb print), birth date, referrers' name (with their seals) and the date of application. We also use "The address list of the miners" and "The book of attendance management." Each application was produced when the applicant applied. These applications were written by several employees of the mine's human resource division; there were several sets of handwriting. The address list of the miners was produced after their application. "The book of attendance management" recorded miners' daily entrance to the mine.

As the 1890 Mining Act obligated every mine in Japan to record their miners' names, ages, addresses, previous jobs, and their hiring and firing dates, Aso created those lists as well. In the 1890s, 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 tried to make such lists, the associated dormitory head would likely move to another coal mine with his miners to avoid the loss of information rent. However, when all coal mines were required by the Act to make the lists simultaneously, dormitory heads would not have an 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.

3) The details of the employment agreement

Article 4 of the employment agreement read, "I swear to conduct all tasks in accordance with your company's personnel or the dormitory head who I belong to." This means that its management was still mixed, with a direct line through the company personnel and an indirect line through the dormitory head. Further, Article 5 read, "I swear I should not let someone, even my relatives or friends, stay at my dormitory room without the permission of your company's personnel." This indicates that the management still could not control all that happened not only in the mine but also in the residences, otherwise agreements such as that in Article 5 would have been redundant.

There were a few types of application. Almost all applications just had room for writing applicants' information and their signature (as described above), and the articles of the employment agreement were printed on the applications. However, five out of the 774

[13] See Ogino (1993), pp.91-92.

applications were different from these. These were for applicants to the Machinery Division. These bore the seal of the manager of the coal mine, two other personnel, the referrer, and the Machinery Division. The normal application had only the referrer's seal. Furthermore, these applications to the Machinery Division also had the referrer's address, though the normal application had only the referrer's name. This indicates that Aso regarded the Machinery Division as a key part of the coal mine and needed four official seals of approval for the recruitment of people to the Machinery Division. There are also "The report of expulsion" and "The report of firing" of the Machinery Division, and these reports bore the seal of the manager of this coal mine, one personnel and the Machinery Division. For ordinary miners, reports were different and simple. The firm just picked the expelled miners' individual data from "The address list of miners," crossed off their names, and bound them. There were no seals of the personnel. As Sumiya (1968) mentioned, those who worked on a machine were employed directly and the management was stringent.[14]

III. Selection of employees and investment in human capital at Aso Fujidana Second Coal Mine

1) Description of the applications

In this section, we provide an overview of 774 miners' applications. Of the total applicants, 589 were males (that is, 76.1%). Of these males, 192 applied with a family member. The number of females who applied by themselves was 14.

Table 7-3 contains applicants' hometown. Only three people were from the village where this coal mine was located. The applicants' hometowns were mainly in Fukuoka prefecture, where this coal mine was located, and were spread over Western Japan. (See Figure 3.) Other coal mines in the Kyushu area had the same tendency, as applicants came from Western Japan.[15] This indicates that the labor market in the coal mining industry was being integrated.

Let us focus on the features of referrers. We found there were 85 referrers, coming in four types. Applicants were referred by Aso, by a dormitory head, by the head of a directly controlled dormitory, or by a freelance referrer. Some of the freelance referrers applied to the coal mine first as miners, and then a few months later, they became referrers. From the applications, we infer that there were about eight dormitories at all times. There were 13 dormitory heads, and 3 were the heads of directly controlled dormitories.

Table 2 states the list of names of the referrers who recruited four or more males who applied by themselves. Table 3 gives the list of names of the referrers who recruited three or more families. Table 2 shows that a relatively large number of applicants were previously employed as skilled miners such as a coal miner or a pillar worker. Table 3

[14] See Sumiya (1968), p.314.
[15] See Tanaka (1984), pp.272-274 and Ogino (1993), p.105.

reveals that few applicants held previous jobs as skilled miners. This means that some referrers were specialized in recruiting skilled miners, and others were specialized in recruiting people with family, who were not always skilled miners.

Table 4 states the list of referrers who recruited two or more people whose previous jobs were as farmers. These people were new entrants into the coal mining industry. Two dormitory heads, J. K. and C. Y., and two heads of directly controlled dormitories, H. U. and R. S., referred more than one-third of miners who used to work as farmers. Staff of the Personnel Division served as referrers also actively recruited new entrants such as farmers. That is to say, both the management and the dormitory heads actively recruited new entrants such as farmers, trained them into skilled miners, and thus invested in human capital. According to "The book of attendance management" at this coal mine, these heads, K. K., J. K., and C. Y., had over 100 miners in their dormitories and recruited many people. Let us refer to the dormitories that had more than 100 miners as "large-scale dormitories" and the rest of dormitories as "small-scale dormitories." The heads of "large-scale dormitories" tended to recruit applicants whose previous jobs were as farmers and the heads of "small-scale dormitories" tended to recruit skilled miners. Thus new entrants were trained at "large-scale dormitories," while skilled miners were organized into "small-scale dormitories."

2) Statistical analysis of the applications

In this part, we analyze a database of applications. First, we analyze the features of the applicants. Table 5 shows the results of a probit regression analysis. SL, the dependent dummy variable, takes the value 1 if a miner puts his/her seal on an application and 0 otherwise. The independent dummy variables are MNG (the previous job was as a coal miner), APL (previously a pillar miner), ELV (previously an elevator operator), MGL (previously a miner, but of a different type), AGR (previously a farmer), MIS (previously, neither a farmer nor a miner), and MALE (indicates gender). AGE is an independent variable.

We can strongly say that applicants who used to be "other miners" (MGL) carried their own seals. They were, for example, day workers or carpenters in a coal mine. People who carried their own seals seem to have been literate. In their childhood, elementary schooling was becoming common, and thus, their birth year would affect their literacy. Furthermore, 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. In the results of model 5-2, we can see that both coefficients on independent variables, AGE and MALE, are not significant. Since MGL is significant in this model as well, we infer that the tendency of carrying one's own seal depended on the job type.

Next, Table 6 shows the tendency of entering into an employment agreement with family. We already know that Article 5 of the employment agreement stipulated that employees were prohibited from housing someone in their rooms without the firm's

permission, and had to write down the names of family members on the application. Models 6-1, 6-2 and 6-4 show that female workers were likely to apply with their husbands and fathers, since MALE's coefficients are negative. Models 6-1, 6-2, 6-3, and 6-4 strongly indicate that applicants whose previous job was as pillar workers (APL) tended not to apply with their family members. Moreover, models 6-3 and 6-4 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 (those were 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. It is no surprise, then, that the results of table 6 show that the workers in charge of those dangerous tasks tended to apply by themselves, and people with families, on the other hand, wanted to be coal miners instead of being pillar workers. Models 6-1 and 6-2 show that AGR's coefficients and marginal effects are negative and significant. This means that applicants whose previous jobs were as farmers applied without their family members. Model 6-2 contains AGE as an independent variable but model 6-1 dose not. Even so, the magnitude of AGR's marginal effects on both models does not have big differences. Thus, we cannot say that people who used to be a farmer were not married because they were young. These models indicate that people who used to be a farmer did not have industry specific skills for coal mining yet and they could not earn enough money for building their family. For this reason, they tended to apply by themselves.

Let us move on to the types of referrers. We look what kinds of referrers tended to refer what kinds of applicants. Tables 7, 8, 9, and 10 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 referrers. First, what kinds of referrers recruited applicants who were new entrants to the coal mining industry? Table 7 shows that the firm tended to directly employ the new entrants and both heads of ordinary dormitory and directly controlled dormitory tended to refer them. Model 7-2 shows that it applies to just the applicants whose previous job as a famer. Table 7 also shows that ordinary referrers did not tend to refer them since the marginal effects of FRM, HNN and FN are all significant and positive.

How about the applicants who used to work in the mining industry? Table 8 shows what kinds of referrers tended to refer them. The marginal effects of HNN and FN are significant and negative. The marginal effect of FRM is not significant but negative. It implies that the ordinary referrers were likely to refer the applicants who used to work in the mining industry. Let us see more details. Table 9 shows that what kinds of referrers tended to refer the applicants whose previous job as a coal miner. Model 9-1 shows that only HNN's marginal effect is significant and negative. Model 9-2 shows that OGT's marginal effect is strongly significant and positive. Thus, the ordinary referrers were very likely to refer workers who used to work as a coal miner.

Next, table 10 shows that what kinds of referrers tended to refer the applicants

whose previous job as an elevator operator and "other miner." It tells us that the dormitory heads did not tend to refer them. The applicants whose previous job as an elevator operator were required the new skills of new introductory machines, that is conveyance elevators. The machines were newly introduced by firms and they had the knowledge about the needed skills. Thus, it was reasonable that the dormitory heads did not tend to refer the applicants who used to be an elevator operator because the dormitory heads did not have the knowledge. "Other miners" were likely to be literate as we saw the result in table 5. Literacy skills were the new kinds of skills at that time. The dormitory heads did not tend to refer them but the firm would be likely to refer such a worker with the new skills, for the coefficient and marginal effect of FRM is not significant but positive in table 10. About the applicants whose previous job as a pillar worker, we cannot get any statistically significant results given the small sample size.

We summarize these results above as follows. First, when recruiting new entrants, Aso staff tended to directly employ them and the heads of directly controlled and ordinary dormitories tended to become their referrers. Second, people who used to be elevator operators and "other miners" who seemed to have been literate; in short, people with new skills tended to be directly employed by the firm. People who used to be coal miners and thus were accumulated the needed manual skills were employed through ordinary referrers. The ordinary referrers had extensive mining experience. Some of them were presently miners, some were freelance referrers and others were hired by Aso as a referrer. Thus, we infer that coal miners referred each other. They moved from one mine to another and were employed across miners' job networks.

To confirm the existence of miners' job networks, we conduct another regression analysis; the dependent variables are the number of applicants that each referrer recruited from 1902 to 1907 (NOG) and the independent dummy variables are the types of applicants. The results are shown in table 11. The coefficients on MGT and MNG were negative and significant, and the coefficient on AGR was positive and significant. This result strongly indicates that the new entrants, such as people who used to be farmers, tended to enter Aso through the heads of large dormitories; "large" means the number of NOG is large. On the other hand, the skilled miners tended to enter Aso through the referrers who did not recruit many applicants. These kinds of referrers were "ordinary referrers" such as miners who also currently worked at this mine and freelance referrers. However, the staff of the Personnel Division served as referrers also tended to recruit small numbers of applicants. Thus, this analysis is consistent with the inferences made above; miners who had high manual skills were employed across the miners' horizontal network, and people with new skills were employed through Aso staff.

From the late 19th century to the early 20th century in Japan, skilled miners in the metal mine industry independently recruited applicants across a horizontal and

cross-company network called Tomoko.[16] From our analysis, we find that coal miners who had manual mining skill were employed across the same kind of network. On the other hand, firms started to directly employ people who had new skills. This was the state of the labor market in the Chikuho coal mining industry at the beginning of the 20th century.

3) The multiple paths of skill acquisition in the transitional period

How did Aso pay their miners? They kept "The report of mining cost," and it said that they paid the dormitory heads a lump sum every day and the heads paid the individual coal miners. The firm paid the heads of directly controlled dormitories in the same way. In the case of elevator operators, they did not pay the dormitory heads but the leader of an elevator operators' group in a lump sum (Figures 1 and 2). Since the management collected a receipt for receiving the wages from each employee, they could see how much each employee got paid ex-post, but they did not know individual employees' output and wage when paid, including those of employees who belonged to the directly controlled dormitories. Now, what was the difference between the management of directly controlled and ordinary dormitories? One difference was the way pillar workers were managed, though not coal miners. The heads of ordinary dormitories were paid in advance for the costs of tunneling and setting/removing/maintaining pillars. We can infer that Aso started to directly pay individual pillar workers as a trial at that time; thus, Aso partially started to directly employ pillar workers. While the heads of ordinary dormitories subcontracted those tasks to pillar workers, the heads of directly controlled dormitories did not play such a role.

Let us consider the path of skill acquisition given our results on the recruiting path discussed above. Table 7 and 9 indicate that a traditional path might exist whereby applicants left their farm village, entered a large dormitory, gained experience at a coal mine, became skilled miners, and moved to another coal mine across the horizontal miners' network.

On the other hand, table 7 and 10, which provides the features of Aso's staff at its human resources division, indicates that Aso's trial of direct employment was accompanied by a new path of skill acquisition. The new path was that staff of Aso's human resources division recruited new entrants and then arranged them into dormitories. The pillar workers were moving away from being Aso's sub-subcontractors and came to be directly managed by Aso. However, individual coal miners were not directly managed and the heads of directly controlled dormitories were still delegated the task of managing coal miners. The recruiting and monitoring of elevator operators and pillar workers were separated from dormitory heads but it did not necessarily mean that individual workers of the group were directly monitored by Aso. Aso monitored only group leaders of these sections. Thus, Aso did not intend to immediately dissolve the intermediate organization of labor, but to incorporate their monitoring function, preserving their autonomy to some extent.

[16] See Murakoshi (1989), pp.301-306 and pp.331-341 and Doi (2010), pp.7-10.

Training inexperienced people had to be done by skilled miners. Aso Fujidana Second coal mine still used the room and pillar mining method and did not introduce mining machines in the 1900s. Thus, the needed skills were traditional and manual ones. Trainers had to be experts in those skills. That meant that management intended to directly employ the leader of miners' groups in order to incorporate their experienced manual skills into its human capital.

As a robustness check of this hypothesis, we run another analysis by the least-squares method; the dependent dummy variables is GRT, which takes a value 1 if a referrer can be identified as an applicant from 1902 to 1907 and 0 otherwise, and independent dummy variables are applicants' types, such as MNG and MGT. The result is in table 12. Given the small sample size, we only run least-squares estimation, but it will give us a casual observation of their tendency. As expected, during the sample period, applicants who were farmers at the time of application were not recognized as skilled miners and, thus, did not qualify as referrers. This is why they did not show up as referrers by the end of the sample period. On the other hand, tended to qualify as referrers; MNG who tended to be recruited by ordinary referrers (table 9), and ELV who had new skills, such as operating an elevator, and tended to be recruited by Aso staff (table 10). Therefore, the miners' job networks was duly used actively by skilled coal miners and elevator operators formed their network and could be incorporated by the firm. Let us introduce two narrative stories corresponding to this inference.

Both cases are from the applications. Two applicants set up a group and applied together. One applicant, T.H., was from a village near this coal mine. He was 28 years old and applied on February 7, 1907 along with five relatives from the same village with the same last name as his and four other people. He was a referrer of 10 people, including himself, and two months after his application, he became a referrer to three people who used to be elevator operators. He was the only person whose referrer was himself. This was a rare case and means that he was not subordinated to any kind of subcontracting organization such as that of the dormitory heads. Thus, he might be directly employed. He was a necessary human resource for the firm as a leader of a miners' group who carefully screened his skilled fellow workers.

Another applicant, F.I., was 28 years old and from a village where a big coal mine was located. He applied on July 3, 1905 with five other people from the same village. Their referrer was K.Ha., and he was an ordinary referrer. F.I.'s last name was written in the margin on the applications of five people who applied with F.I. It indicates that F.I. was the leader of these five people.

Although there were only two unique cases from the applications, such cases do not seem to be rare. We find one miner's name written above sets of several miners' names in the margins of "The book of attendance management." They can naturally be thought to be leaders of miners' groups. Interestingly, those leaders' names written on the margin are more frequently found in "The book of attendance management of directly controlled miners"

than in “The book of ordinary dormitories.” It means that details of group leaders were better recognized by the firm for directly controlled dormitories than for ordinary dormitories. The management of miners who belonged to directly controlled dormitories was delegated to those heads as mentioned above. It follows that the miners belonging to directly controlled dormitories were monitored more closely than ones belonging to ordinary dormitories. We infer that in directly controlled dormitories, miners with high manual skill who could be regarded as group leaders were directly employed, and the firm made them monitor their subordinates.

It can be easily imagined that the rents paid to heads of both ordinary and directly controlled dormitories decreased through the process of transformation of the two-layered structure consisting of dormitories and inside groups. However, the firm did not immediately start to directly manage individual miners. The firm tried to weaken one power of the two-layered structure, that is, the dormitory heads. They started to directly employ group leaders in order to incorporate their administrative ability and miner-development capability.

Concluding Remarks

In section II and III, we found that there were two ways of recruiting path. That is, workers entered the coal mine through referrers who belonged to some kind of intermediary organizations and through the staff of the Personnel Division. The former, not through the staff, had several types; dormitory heads, the heads of directly controlled dormitories and ordinary referrers. The ordinary referrers were highly likely to be skilled miners. They acquired traditional manual skills and then, qualified as a referrer. They gathered information about skilled miners by using miners’ job networks in order to recruit them. Both direct employment side and indirect employment side recruited new entrants such as people whose previous job was as a farmer. Then, both of them trained the new entrants.

In the case of direct employment, the management seemed to directly employ a person who was a leader of miners’ group in order to train new entrants. This first step of transition proceeded with easing adverse selection. Both direct employment and indirect employment necessarily coexist in the transitional phase.

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Figure 1. Dormitory system

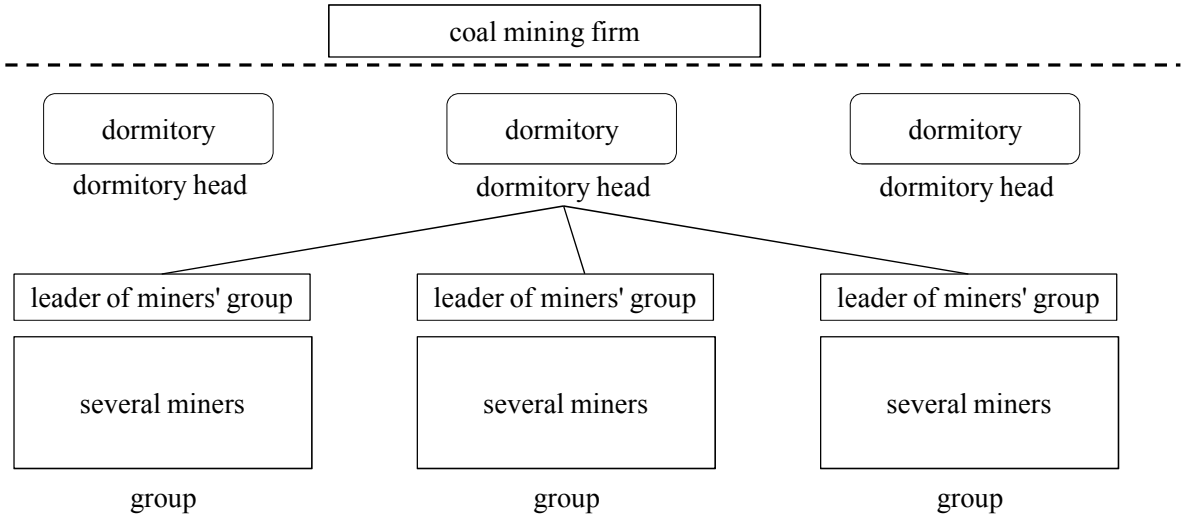


Figure 2. Partially direct recruitment

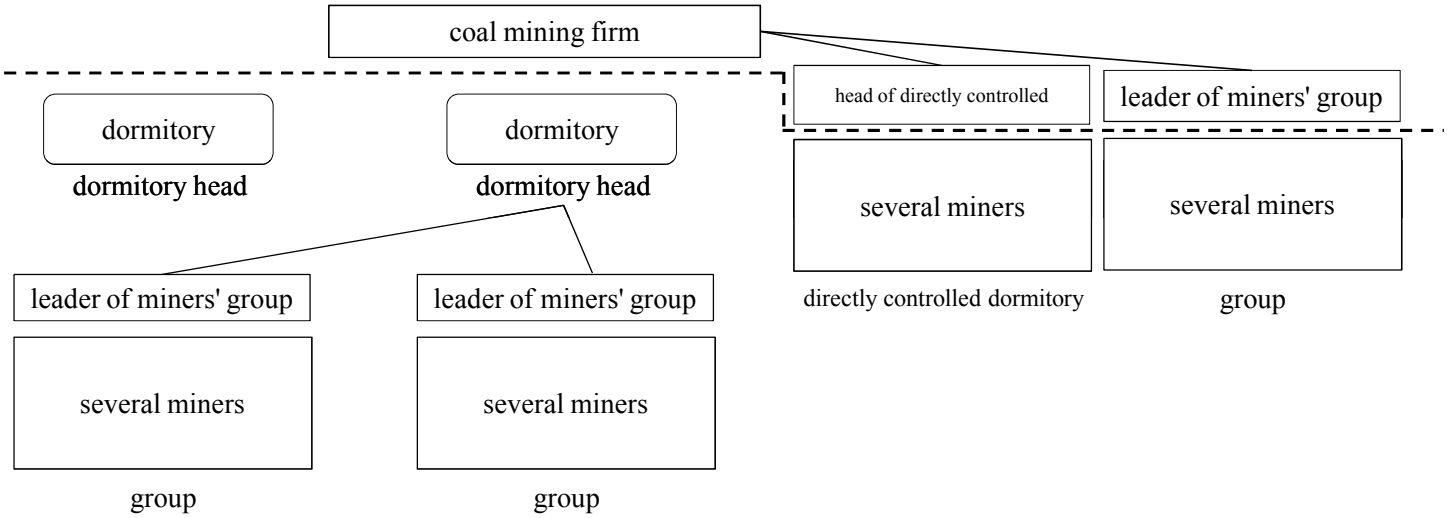
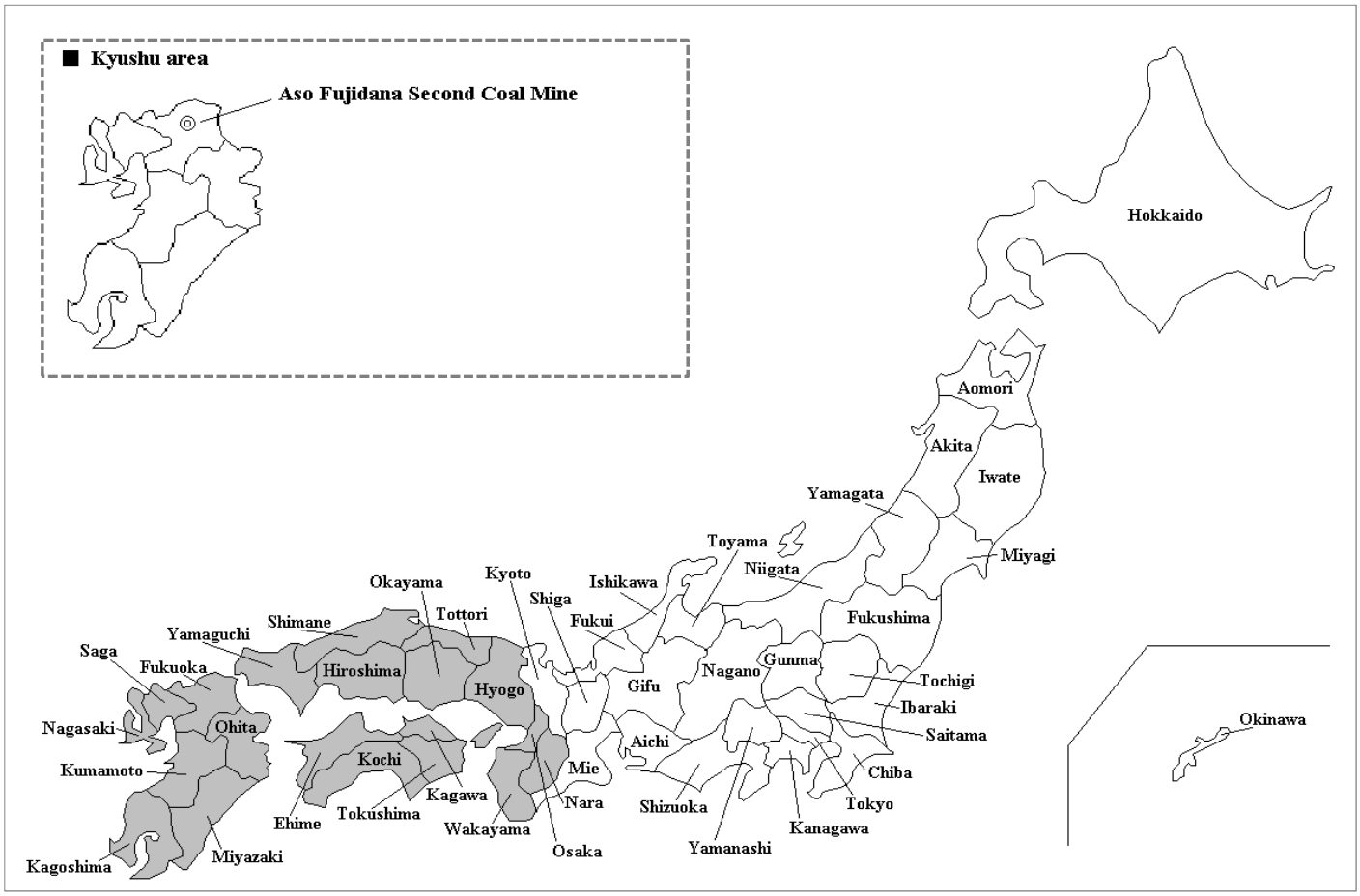


Figure 3.



Notes: The applicants were from shaded prefectures.

Table 1 The number of applicants by previous jobs and prefectures from which they came

Area	prefecture	Sum	coal miner	pillar worker	elevator operator	other miner	farmer	others	NA
Kyushu	Fukuoka	272	28	13	5	10	43	3	170
	Saga	37	4	0	1	1	1	1	29
	Ohita	83	1	4	0	2	9	0	67
	Kumamoto	57	5	1	1	6	4	0	40
	Nagasaki	16	3	2	0	0	0	2	9
	Miyazaki	7	0	2	0	0	0	0	5
	Kagoshima	6	1	0	0	0	0	0	5
Chugoku	Hiroshima	90	5	7	1	3	17	0	57
	Shimane	32	0	2	0	0	5	0	25
	Yamaguchi	31	0	1	0	0	3	0	27
	Okayama	13	0	1	0	0	4	0	8
	Tottori	6	0	0	0	0	0	0	6
Shikoku	Ehime	72	8	11	0	3	11	0	39
	Kagawa	22	2	0	0	0	7	0	13
	Tokushima	8	0	1	0	0	3	0	4
	Kochi	6	1	1	0	0	0	0	4
Kinki	Hyogo	7	1	1	0	0	0	0	5
	Osaka	4	0	1	0	0	0	0	3
	Wakayama	3	0	3	0	0	0	0	0
	Nara	2	2	0	0	0	0	0	0
	Sum	774	61	51	7	24	107	8	516

From “The applications of miners”

Table 2 The referrers who recruited four or more males applying by themselves

Referrers' initials	Total number of referrals	Referrals' previous job	Applied themselves or with family
K. Ai.	11		in a couple : 3, with his son : 1, male who applied themselves : 3
A. T. (Head of ordinary dormitory)	12	coal miner : 2, pillar worker : 1	All referrals were males and applied themselves.
K. As.	9	pillar worker : all (9)	All referrals were males and applied themselves.
K. Ik.	4		All referrals were males and applied themselves.
J. I.	3		All referrals were males and applied themselves.
U. I. (Head of ordinary dormitory)	11		in a couple : 1, male who applied themselves : 9
K. Id.	4	coal miner : 2	All referrals were males and applied themselves.
S. U.	4	coal miner : 1, pillar worker : 3	All referrals were males and applied themselves.
T. S. (Head of ordinary dormitory)	11	farmer : 10	in a couple : 3, male who applied themselves : 8
R. S. (Head of directly controlled	12	coal miner : 1, pillar worker : 9	female who applied themselves : 2, male who applied themselves : 10
S. T.	4	farmer : 3	All referrals were males and applied themselves.
I. T.	26	coal miner : 2 (They were a couple.)	in a couple : 5, family of three : 2, with his son : 1
B. N.	10	elevator operator : 4 (all out of all applivants.)	All referrals were males and applied themselves.
T. N. (Qualified as a referrer later)	7	coal miner : 1	in a couple : 1
F. N.	4		All referrals were males and applied themselves.
K. Ha.	33	coal miner : 4, other miner : 1	in a couple : 4, family of three : 1
S. H. (Head of ordinary dormitory)	34	coal miner : 13, pillar worker : 12	in a couple : 7, two sisters : 1, male who applied themselves : 17
H. H.	4	pillar worker who was recruited by Personnel Division : 1	All referrals were males and applied themselves.
K. Hirak.	8		in a couple : 1, family of three : 1
T. M. (Qualified as a referrer later)	4	coal miner : 2, pillar worker : 1	All referrals were males and applied themselves.
Y. M.	33	coal miner : 2, smithy : 1	in a couple : 8, family of three : 1, male who applied themselves : 13
O. Y. (Head of ordinary dormitory)	36	coal miner : 5, pillar worker : 5	in a couple : 5, family of three : 1, male who applied themselves : 22
K. Y. (Head of ordinary dormitory)	24	farmer : 2, other miner : 1	in a couple : 7, family of three : 1, male who applied themselves : 6
C. Y. (Head of ordinary dormitory)	42	pillar worker : 1, other miner : 1, farmer : 14, ambulant vendor : 1	in a couple : 7, family of three : 2, male who applied themselves : 18, with his son: 2

From “The applications of miners”

Table 3 The referrers who recruited three or more families

Referrers' initials	Total number of referrals	Referrals' previous job	Applied themselves or with family
H. U. (Head of directly controlled	32	farmer : 12, other miner : 2, fisher : 1	in a couple : 4, two brothers : 1
K. U. (Qualified as a referrer later)	18	coal miner : 5, pillar worker : 1	in a couple : 3, family of three : 1, two sisters : 1
K. K. (Head of ordinary dormitory)	64	farmer : 12, other miner : 4	in a couple : 11, family of three : 1
J. K. (Head of ordinary dormitory)	74	farmer : 28, fisher : 1	in a couple : 13, family of three : 4
M. S.	28	coal miner : 2, pillar worker : 2, other miner : 2	in a couple : 2, family of three : 2, family of four : 1, family of six : 1
NA	19	female day worker : 2	in a couple : 6
S. N. (Personnel Division)	27	coal miner : 2, pillar worker : 3, other miner : 3, farmer : 6, sailor : 1	in a couple : 1, two brothers : 1, family of five : 1
I. N. (Personnel Division)	11	farmer : 4 (All of them applied themselves.)	in a couple : 4
I. T.	26	coal miner : 2 (They were a	in a couple : 5, family of three : 2, with his son : 1
K. Ha.	33	coal miner : 4, other miner : 1	in a couple : 4, family of three : 1
S. H. (Head of ordinary dormitory)	34	coal miner : 13, pillar worker : 12	in a couple : 7, two sisters : 1
K. Hirad.	13	coal miner : 2	in a couple : 3, family of three : 1
Y. M.	33	coal miner : 2, smithy : 1	in a couple : 8, family of three : 1
O. Y. (Head of ordinary dormitory)	36	coal miner : 5, pillar worker : 5	in a couple : 5, family of three : 1
K. Y. (Head of ordinary dormitory)	24	farmer : 2, other miner : 1	in a couple : 7, family of three : 1
C. Y. (Head of ordinary dormitory)	42	pillar worker : 1, other miner : 1, farmer : 14, ambulant vendor : 1	in a couple : 7, family of three : 2, with his son: 2

From “The applications of miners”

Table 4 The referrers who recruited two or more persons who used to be a farmer

Referrers' initials	Total number of referrals	Referrals' previous job	Applied themselves or with family
J. K. (Head of ordinary dormitory)	74	farmer : 28, fisher : 1	in a couple : 13, family of three : 4
H. U. (Head of directly controlled	32	farmer : 12, other miner : 2, fisher : 1	in a couple : 4, two brothers : 1
K. K. (Head of ordinary dormitory)	64	farmer : 12, other miner : 4	in a couple : 11, family of three : 1
S. N. (Personnel Division)	27	coal miner : 2, pillar worker : 3, other miner : 3, farmer : 6, sailor : 1	in a couple : 1, two brothers : 1, family of five : 1
I. N. (Personnel Division)	11	farmer : 4 (All of them applied themselves.)	in a couple : 4
I. U. (Personnel Division)	2	farmer : 2	All referrals were males and applied themselves.
R. S. (Head of directly controlled dormitory)	12	farmer : 9, coal miner : 1 (His family name was Shinohara)	female who applied themselves : 2, the rest of referrals were all males who applied themselves.
S. T.	4	farmer : 3	All referrals were males and applied themselves.
Just written as "Direct recruitment"	6	farmer : 2	in a couple : 1
B. N.	10	elevator operator : 4 (all out of all applicants.)	All referrals were males and applied themselves.
K. Y. (Head of ordinary dormitory)	24	farmer : 2, other miner : 1	in a couple : 7, family of three : 1, male who applied themselves : 6
C. Y. (Head of ordinary dormitory)	42	pillar worker : 1, other miner : 1, farmer : 14, ambulant vendor : 1	in a couple : 7, family of three : 2, with his son: 2

From “The applications of miners”

Table 5 Types of miners : previous jobs and their seals

	5-1			5-2		
Estimation method	binary probit			binary probit		
Dependent Variable	SL			SL		
Independent variable	Coefficient	Marginal Effects	z-Statistic	Coefficient	Marginal Effects	z-Statistic
C	-1.2915		-17.1259***	-1.3042		-5.6866***
MNG	-0.5642	-0.0909	-1.7697*	-0.5280	-0.0819	-1.64780*
APL	-0.7539	-0.1217	-1.8080*	-0.6876	-0.1067	-1.6321
ELV	0.1411	0.0213	0.2463	0.6289	0.0910	2.1762**
MGL	0.5852	0.0862	2.0539**	0.1968	0.0285	0.3416
MIS	1.2915	0.1944	1.4520	1.3316	0.1935	1.4856
AGR	-0.2241	-0.0354	-1.1100	-0.1585	-0.0239	-0.7637
AGE				0.0018		0.2536
MALE				-0.0909	-0.0146	-0.5624
Included observations		774			709	
McFadden R^2		0.0346			0.0369	
Log likelihood		-224.5804			-200.2526	
LR statistic		16.1069***			15.3530***	

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

Table 6 Types of miners : previous jobs and applying with families

	6-1			6-2			6-3			6-4		
Estimation method	binary probit			binary probit			binary probit			binary 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	1.4274		10.5005***	1.2663		6.3931***	-0.5322		-4.2477***	0.8705		3.7112***
MNG	-0.0056	-0.0023	-0.0304	0.0270	0.0108	0.1454	0.6318	0.2492	3.13104***	0.4244	0.1690	1.9244*
APL	-0.7653	-0.3052	-3.3933***	-1.0221	-0.4075	-3.9659***	-0.4489	-0.1786	-1.8093*	-0.6249	-0.2493	-2.2050
ELV	-0.2317	-0.0924	-0.4576	0.0012	0.0005	0.0027	0.2136	0.0848	0.4559	0.3977	0.1586	0.8433
MGL	-1.3144	-0.5243	-2.1631***	-0.2059	-0.0821	-0.7799	0.1737	0.0689	0.6084	0.1911	0.0762	0.6610
AGR	-0.3766	-0.1502	-2.5756**	-0.3746	-0.1494	-2.4907**						
MIS							0.5322	0.2112	0.5946	0.6718	0.2679	0.7411
UNK							0.6003	0.2113	4.3840***	0.4032	0.1539	2.6985***
AGE				0.0051		0.9430				0.0050		0.9157
MALE	-1.7617	-0.2971	-12.2597***	-1.7214	-0.3019	-11.4248**				-1.7183	-0.3023	-11.3936***
Included observations		774			709			774			709	
McFadden R^2		0.2193			0.2175			0.0409			0.2187	
Log likelihood		-417.3487			-383.0256			-512.7448			-382.2937	
LR statistic		234.5239***			212.8660***			43.7317***			214.1297***	

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

Table 7 Types of referrers who recruited new entrants

	7-1			7-2		
Estimation method	binary probit			binary probit		
Dependent Variable	AGR+MIS			AGR		
Independent variable	Coefficient	Marginal Effects	z-Statistic	Coefficient	Marginal Effects	z-Statistic
C	-2.0596		-13.3526***	-2.0596		-13.3526***
FRM	1.5477	0.2262	6.2471***	1.5477	0.2233	6.2471***
HNN	1.2461	0.0895	7.2029***	1.2245	0.0880	7.0687***
FN	1.9504	0.2754	8.0925***	1.9504	0.2718	8.0925***
Included observations		774			774	
McFadden R^2		0.1733			0.1724	
Log likelihood		-261.5638			-258.8517	
LR statistic		109.6814***			107.8717***	

Notes : *** denote significance at the 1 percent levels.
See Appedix Table 1 for definitions of variables.

Table 8 Types of referrers who recruited the experienced workers

Estimation method	binary probit		
Dependent Variable	MGT		
Independent variable	Coefficient	Marginal Effects	z-Statistic
C	-0.7542		-10.2099***
FRM	-0.0268	-0.0069	-0.1220
HNN	-0.3369	-0.0975	-2.9594***
FN	-0.7581	-0.2021	-2.5635**
Included observations		774	
McFadden R^2		0.0365	
Log likelihood		-131.4179	
LR statistic		0.0188***	

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

Table 9 Types of referrers who recruited former coal miners

	9-1			9-2		
Estimation method	binary probit			binary probit		
Dependent Variable	MNG			MNG		
Independent variable	Coefficient	Marginal Effects	z-Statistic	Coefficient	Marginal Effects	z-Statistic
C	-1.2273		-13.8915***	-1.5780		-15.9664***
FRM	-0.4844	-0.0735	-1.4336			
HNN	-0.3178	-0.0555	-2.2578**			
FN	-0.4844	-0.0735	-1.4336			
OGT				0.3508	0.0403	2.6459***
Included observations		774			774	
McFadden R^2		0.0173			0.0163	
Log likelihood		-214.6222			-214.8431	
LR statistic		7.5457*			7.1039***	

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

Table 10 Types of referrers who had new skills

Estimation method	binary probit		
Dependent Variable	ELV+MGL		
Independent variable	Coefficient	Marginal Effects	z-Statistic
C	-1.5863		-14.6957***
FRM	0.3528	0.0280	1.3125
HNN	-0.4392	-0.0494	-2.3148**
FN	-0.4328	-0.0373	-1.0120
Included observations		774	
McFadden R^2		0.0365	
Log likelihood		-131.4179	
LR statistic		0.0188***	

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

Table 11 Types of miners and the number of referrals by each referrers

	11-1		11-2		11-3		11-4	
Estimation method	least squares		least squares		least squares		least squares	
Dependent Variable	NOG		NOG		NOG		NOG	
Independent variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
C	28.6399	29.8868***	28.3721	10.4700***	28.9068	30.0276***	28.5260	10.5361***
MGT	-7.6399	-3.6552***	-5.2495	-2.498291**				
MNG					-9.1448	-3.1665***	-7.5223	-2.6233***
APL					-9.4986	-2.9371***	-6.3976	-1.9569*
ELV					-14.9068	-1.9356*	-12.0995	-1.6013
MGL					-2.2111	-0.4798	0.5397	0.1186
MIS	28.8601	1.8804*	31.0111	2.0637**	28.5933	1.8673*	30.7176	2.0480**
AGR	11.5916	5.0526***	13.2434	5.6985***	11.3247	4.9418***	12.9957	5.5908***
AGE			0.0691	0.8374			0.0748	0.9076
MALE			-4.3365	-2.2215**			-4.4004	-2.2331**
Included observations	757		695		757		695	
Adjusted R^2	0.0599		0.0660		0.0643		0.0696	
F-statistic	17.0615***		10.8083***		9.6557***		7.4920***	

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

Table 12 Types of miners and the number of referrals by each referrers

	12-1		12-2		12-3		12-4	
Estimation method	least squares		least squares		least squares		least squares	
Dependent Variable	GRT		GRT		GRT		GRT	
Independent variable	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
C	0.5133	24.9284***	0.5942	9.9851***	0.5087	24.6467***	0.5891	9.9368
MGT	0.0592	1.3097	0.0107	0.2326				
MNG					0.1104	1.7596*	0.0681	1.0745
APL					0.0219	0.3123	-0.0379	-0.5241
ELV					0.4913	2.9331***	0.4460	2.6675***
MGL					-0.0287	-0.2978	-0.0707	-0.7330
MIS	-0.5133	-1.5342	-0.5405	-1.6210	-0.5087	-1.5271	-0.5360	-1.6145
AGR	-0.4485	-8.9896***	-0.4896	-9.5148***	-0.4439	-8.926***	-0.4850	-9.4479***
AGE			-0.0020	-1.0903			-0.0020	-1.0877
MALE			0.0168	0.3945			0.0169	0.3950
Included observations	774		709		774		709	
Adjusted R^2	0.1033		0.1175		0.1112		0.1253	
F-statistic	30.6841***		19.8545***		17.1139***		13.6797***	

Notes : *** and * respectively denote significance at the 1 and 10 percent levels.
See Appedix 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 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.	
MGT	dummy variable	= 1 if the previous job was as all jobs related mining industry, 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.	
GRT	dummy variable	= 1 if qualified as a referrer after employed as a miner, 0 otherwise.	
AGE		the applicants' age	
NOG		the number of referrals	
FRM	dummy variable	= 1 if referrer was staff of Personnel Division of Aso coal mining Co. , 0 otherwise.	
HNN	dummy variable	= 1 if referrer was a head of ordinary dormitory (or we call him just "a dormitory head"), 0 otherwise.	
FN	dummy variable	= 1 if referrer was a head of directly controlled dormitory, 0 otherwise.	
OGT	dummy variable	= 1 if referrer was an ordinary referrer, 0 otherwise.	not head of any dormitory nor direct management recruitment. 1-(FRM+HNN+FN).
SL	dummy variable	= if applicants put own seal on their applications, 0 otherwise.	