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Job Value: New Measure of Career Success Potential from a Job*

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【Keywords】 Internal labor market; Career paths; Promotion; Fast track; Job Assignment

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【Abstract】 This paper develops a new method for assigning a value to each job that evaluates the likelihood and speed of promotion from that job to top executive and applies it to personnel data for Japanese bureaucrats. We find that outwardly similar jobs within the same hierarchical rank involve very different opportunities for promotion to top executive. We also reveal frequent real demotions and the early selection of elite bureaucrats unable to be detected through use of hierarchical rank. These findings suggest that assignment to a specific job can be a credible signal for promotion to top management.

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1 Introduction

Internal labor markets have been widely investigated since Doeringer and Piore (1971), and their characteristics shown to be quite different from those of external labor markets. The main reason is that in internal labor markets, employees within an organization are effectively shielded from competition in a series of spot markets, as found in external labor markets. Instead, employees face career paths in the organization that are stable over time. Because it is likely that these career paths are designed to play several functions, including skill accumulation, as a screening device and as an incentive mechanism, the accumulated evidence on internal labor markets attracts theorists by providing several empirical regularities that must be explained by economic theory (e.g., Gibbons and Waldman (1999a) (1999b)).

One obstacle to a solid quantitative examination of career paths is that most important job characteristics are qualitative along several dimensions, including function, location, and business unit. Furthermore, there are uncodified characteristics of jobs, such as skill requirements. Although the existing literature uses either an organization chart or transition matrices between major job titles to identify the level in a hierarchical organization (e.g., Baker, Gibbs, and Holmstrom (1994), Lin (2005)), significant heterogeneity in job characteristics is likely to remain at the same hierarchical level. Such heterogeneity could be critically important in the analysis of promotions.

This would be particularly true for the analysis of promotions in the public sector. As argued by Tirole (1994), because government pursues multiple goals, many of which are challenging to measure, it is difficult to provide high powered incentives through a formal salary. Therefore, career concerns could be one of the most important motivations for hard work. Alternatively, because the number of highly ranked positions in a hierarchical organization is limited, it is more likely that the public sector strategically employs more lateral transfers at the same hierarchical level to motivate workers than does the private sector.

This paper develops a new method to assign each job a value that can evaluate both the likelihood and speed of promotion for that job to top executive and applies it to the

personnel data of an elite group of white-collar government officials working in the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT). While our method could apply to the career paths of any hierarchical organization, the personnel data available for Japanese government officials is ideal for demonstrating its power. This is because while the promotion system of public officials in Japan appears to follow a rigid rule based solely on the length of tenure, several case studies have revealed that public officials are also subject to secret long-term competition for executive positions in ministries (e.g., Kishi (2015)). We argue that our method can reveal this hidden feature of career paths for Japanese elite officials, which cannot be uncovered by either an official organization chart or the standard method developed by Baker, Gibbs, and Holmstrom (1994).

As in the seminal work by Baker, Gibbs, and Holmstrom (1994), we employ the transition across jobs as the basic information used to evaluate each job. However, unlike Baker, Gibbs, and Holmstrom (1994), which uses information on moves between major job titles to define levels, where the major titles are selected from their data set, we estimate the transition probabilities between all the individual jobs available in our data set. We can differentiate these not only by job title, but also by functional department and business unit. Using these transition probabilities, we define the value of each job using the discounted expected probability of becoming a top executive. As a result, this evaluates not only the likelihood of being promoted to a top executive position, but also the speed of promotion. Using the job value, we can then extract the heterogeneity of individual jobs within the same formal rank typically omitted in previous studies.

We find that there are significant differences in job values within the same hierarchical rank. We also show that within the same high hierarchical rank, there are both successful jobs, whose discounted expected probabilities of being promoted to top executive are nearly one, and so-called dead-end jobs, whose discounted expected probabilities are nearly zero. This suggests that the heterogeneity of jobs within the same hierarchical rank is important for the analysis of promotions in the Japanese public sector. We also find frequent real

demotions (or job relegations) in the sense of downgrading to a job with a lower job value. However, this is not in the sense of downgrading to a lower hierarchical rank. This suggests that officials are likely to face intense but hidden competition for top executive positions through job assignment.

We can also detect the presence of implicit fast tracks for elite officials, a matter undetected by hierarchical rank. Our data show that most officials are promoted to department heads, a designated position, and that it is rare to observe more than two hierarchical rank differences for elite officials of the same tenure until they reach 30 years of tenure. Because the majority of officials retire by 35 years of tenure, they are seemingly treated equally for most of their careers.[1] However, we also find that the variation in job values within the same tenure gradually rises as the tenure of officials increases, even during the early stages of their careers. This suggests that the public sector may select officials during a much earlier stage of their careers than we would usually consider.

To confirm the presence of secret fast tracks, we also conduct regression analysis. While we cannot find any indication of fast tracks using hierarchical rank, we obtain robust evidence that the job value of the first job assigned upon promotion to a lower hierarchical rank is significantly positively associated with promotion in a later period. This confirms previous hypotheses that the public sector selects its employees by assigning specific jobs to promising candidates for top management early in their careers.

Finally, we also obtain robust evidence that the value of the first job assigned upon promotion to a lower hierarchical rank is significantly negatively associated with exit in later years. As discussed later, many officials retire as soon as they are assigned to being a head of department because the Japanese bureaucratic system is designed to increase the outside options of officials when they are promoted to a designated position. This negative association suggests that an official assigned to a job with a low job value could be a signal to them of having little promise for future promotion to top executive, and hence they choose

[1]Several Japanese labor economists (e.g., Koike (2002)) point out the late selection as a common feature of internal labor markets in Japanese firms.

to leave the organization when they reach the designated position.

To explain these new findings, we follow Prendergast (1992, 1993) and develop a simple model. Prendergast (1992, 1993) shows that promotion can be designed to encourage firm-specific human capital when the firm cannot write a wage contract that depends on neither human capital nor performance. We modify the assumptions in Prendergast (1992) to meet the institutional features of Japanese government employment and include job values in the model. We show that our refined model can account for four new features: (1) there are dead-end and successful jobs of the same hierarchical rank, (2) while demotions in the sense of downgrading to a lower hierarchical rank are rare, there are frequent real demotions in the sense of downgrading to a job with a lower job value, (3) while there is no indication of fast tracks using hierarchical rank, we find government assigns jobs with high job values to promising candidates for top management toward the middle of their careers, and (4) many officials assigned to jobs with low job values toward the middle of their careers leave as soon as they are assigned to a designated position.

A key idea is that assignment to specific jobs that have high job values can be a credible signal for promotion to top management. When organization-specific human capital is important for top managers, it is cost effective that only candidates for top manager invest in human capital. To encourage these candidates to invest in human capital, the government has an incentive to reveal their evaluation to officials. We show that assigning candidate executives to specific jobs can send a reliable signal for promotion to top management positions, even if there are no formal differences between these and other jobs.

There have already been several attempts to analyze personnel data and provide the stylized features of the internal labor markets in firms (e.g., Rosenbaum (1984), Baker, Gibbs, and Holmstrom (1994), Treble, Gameren, Bridges, and Barmby (2001), Lin (2005), Kauhanen and Napari (2012), and Gittings (2012)) and within the public sector (e.g., Inoki (1995, 2002), Inatsugu (1996), and Gibbs (2001)). Most recently, several studies have begun to pay attention to movement within hierarchical rank (Koike (2002), Dohmen, Kriechel, and

Pfann (2004), Ariga (2006), Clemens (2012), Frederiksen and Kato (2017), Belzil, Bognanno, and Poinas (2018), Jin and Waldman (2020) and Takii, Sasaki, and Wan (2020)).[2] However, no studies have attempted to measure the heterogeneity of jobs in the same hierarchy, with the exception of Clemens (2012).[3]

Clemens (2012) distinguishes between jobs of the same hierarchical rank using the probability of direct promotion from that job to the next hierarchical rank. In contrast, our job value distinguishes between jobs using the likelihood and speed of promotion to top management. Thus, the job value assigns a numerical value that is comparable, not only within but also across hierarchical ranks in terms of promotion to the top, allowing for a more comprehensive examination of the information concerning the prospects for promotion to the top that accompanies job assignments. Owing to this, our analysis shows that the differences in the job value of assigned positions increase with tenure or length of employment. It also shows that not only does job value at lower hierarchical ranks increase the probability of promotion to the next hierarchical rank, but also that it increases the likelihood of promotion to a higher hierarchical rank and decreases future exit. These facts help us to understand the hidden mechanisms underpinning the career paths of the Japanese bureaucracy that seem to work in countries outside Japan.

Indeed, the idea that assignment to a particular job within the same hierarchical rank can be a reliable signal of promotion to top management is novel and may be applicable to other organizations. The role of job assignment as a signal has been noted in several papers (e.g., Waldman (1984)). In particular, Prendergast (1992) points out that wages and promotions can be used as signaling devices to motivate workers when it is difficult to write performance-based contracts. However, many organizations, such as those in the public sector, have little

[2]A number of other studies also provide theories on the role of job rotation (e.g., Cosgel and Miceli (1999), Ickes, and Samuelson (1987), Ortega (2001), Eguchi (2004, 2005), and Eriksson and Ortega (2006)).

[3]Other studies using personnel data in Japanese firms or public sector organizations consider the heterogeneity of the jobs observed. Like our approach, these point out that the differentials in job assignment between promising and other employees can be observed before a difference in the speed of promotion arises ((Matsushige (2000), Umezaki (1999), Uehara (2007) and Ichise (2013)). However, because they do not include systematic measurement to quantify the prospects for promotion to top executive for each job, they can only identify jobs with a distinguishing trait through casual observation.

discretion over the payment of wages and only a limited number of highly ranked positions to offer. In this case, it is practically impossible to use wages and promotions as signaling devices. By using the measure of job value, this paper shows theoretically and empirically that even in a constrained economic environment like the public sector, organizations can strategically assign jobs at the same hierarchical rank and inform workers in advance of their promotion prospects.

The remainder of the paper is organized as follows. The next section explains the institutional background of the personnel system for Japanese public officials and the third section presents our data set. The fourth section provides evidence using hierarchical rank and the fifth section investigates career paths using a job value. The sixth section conducts regression analyses using hierarchical ranks and job values and shows that we can detect a fast track only when we use a job value. The seventh section shows that similar regression analyses also detect that exit is negatively associated with the job values of jobs to which officials are assigned in early career. The eighth section constructs a model to explain new facts obtained by the job values. The final section concludes.

2 Institutional Background

There are two main groups of white-collar government officials in Japan: an elite group destined to be future senior civil servants of ministries and a non-elite group that only has a restricted possibility of promotion. Traditionally, the Japanese government sets different ports of entry depending on the group (Inatsugu (1996)). The elite group of Japanese public officials enters the ministries by overcoming two hurdles. First, they must pass an employment examination carried out by the National Personnel Authority that places a heavy weight on academic skills. Second, the promising candidates passing the entrance examination will be selected through multiple rounds of interviews by the ministry they wish to join. The personnel department in each ministry has authority to decide employment using

the candidate list of successful examinees in the employment examination. Finally, about a third of candidates are screened for the elite group of officials. The MLIT recruits around 20 white-collar elite officials every year.

These candidates typically enter the ministries with no full-time job experience immediately after graduating from university. Given the nature of the employment examination, the officials of the elite group are also relatively homogeneous in terms of academic skill. Graduates of the University of Tokyo have long occupied a prestigious position among the elite group of officials in the Japanese central government as well as in the judiciary, as pointed out by Kawaguchi and Ma (2008).

The officials of the elite group are subject to competition for executive positions in the ministry. Similar to most Japanese private large firms, the personnel department in each ministry controls the job transfers of all officials employed by that ministry until their retirement. Japanese cabinet ordinance prescribes the standard job titles and their official level, with the hierarchy in the internal organization of a ministry consisting of the eight official ranks listed in Table 6 in Appendix A. Because of competition, none or at most one candidate within an entry cohort can become the Vice-Minister of any given ministry. The ordinance also provides a formal statement on the required abilities and skills for each official rank, although it would be difficult to grasp precisely the required skills from the statement. The salary structure is prescribed by other laws and rules so that the range of wages has a solid link with the official job levels.

The competition for executive positions is not visible, but there is anecdotal evidence supporting its existence. Based on an institutional analysis of Japanese public administration, Omori (2006) argues that there is a secret order of jobs within the same job title. For instance, it is said that managers of personnel, budget and account, and general affairs divisions in the Minister's Secretariat at a hierarchical rank of five in Table 6 have better prospects of being promoted to the top executive than other division managers. Kishi (2015) also points out the role of the heterogeneity of jobs in terms of future career prospects, which

is based on many interviews with active and retired officials, primarily from the Ministry of Finance. These face three gateways to the top executive in their careers: mid-30s, mid-40s, and mid-50s. At each gateway, successful jobs are assigned to the most promising officials. How well qualified an official is for a top executive position then depends on their reputation with both the insiders and outsiders of the ministry. Our analysis provides a method that quantifies the importance of this existing anecdotal evidence.

The salary schedule applied to officials with titles of the same official level of section manager or lower consists of two parts: "kyu" depending on the official job level, and "gou" depending mainly on tenure within an official job level. Hence, we can predict most of the salary of officials if we know their official rank and tenure.

There is one notable feature of the salary schedule of Japanese public officials. This is that officials with titles of the same level of department head or higher, called "officials of designated service (*shitei-shoku*)," receive discontinuously higher salaries as a reward for their promotion from the level of section manager because the salary schedule applied to them has changed according to the remuneration act.[4] Of course, their salary grows as they go further up the job ladder. The higher salaries for designated officials also result in much higher retirement allowances, which ultimately depend on the salary paid for the last job of their career.

In addition, officials who have retired as designated officials have further advantages. First, they tend to be assigned to high socioeconomic positions such as executive officers in public or private firms and receive greater remuneration following retirement. Second, retirement from the ministry at a higher executive position leads to higher status. This practice, called *amakudari* in Japanese, provides for deferred compensation to public officials (Inoki (1995)).

[4] *The Annual Report on Salaries of National Public Officials 2011* published by the National Personnel Authority states that university-graduate officials at section manager level to whom the highest salary grade is applied receive an average of 559,810 yen per month, whereas the lowest monthly salary for designated officials is 724,000 yen.

3 Data

The data set used in this paper is the personnel records for an elite group of white-collar officials working in MLIT. This ministry was established in 2001 through the merger of four government offices: the Ministry of Construction (MOC), the Ministry of Transport (MOT), the National Land Agency, and the Hokkaido Development Agency.

We mainly construct the data set using 13 editions of the *Kokudo Kotsu Sho Meikan* (*Directory of MLIT officials*) from 2003 to 2015 published by *Jihyo Sha*. Each edition includes all middle managers (*Kacho* class) and higher-ranked officials in the internal bureaus of both the ministry and the extra-ministerial agencies as of October 31 each year.[5] Each observation contains an official's name, date of birth, education, job title, the departments and sections of the current job, the year and month of taking up the current job, and the official's past job history.

It is a common personnel practice in the Japanese bureaucracy to exchange officials between the central government and other organizations. Those transferred to external organizations usually return to the central government after a few years. The directories also include all the top management and the head of department in some external organizations such as local branch offices, research institutes, and educational facilities established in affiliation with the ministry. However, data are not available for retired officials and those transferred to the other external organizations, including other ministries, embassies, local governments, and public or private firms.

To fill part of these missing data, we also use *iJAMP* as supplemental material, which is an internet service on public administrative information provided by *Jiji Press*. This data source enables us to obtain information on careers for almost all middle- and high-rank managers in the internal bureaus of most Japanese ministries.

[5]Specifically, the extra-ministerial agencies are four organizations attached to the MLIT. These are the Japan Coast Guard, the Japan Meteorological Agency, the Japan Tourism Agency, and the Japan Transport Safety Board, along with two agencies formerly attached to the Prime Minister's Office, being the National Land Agency and the Hokkaido Development Agency.

Finally, we include the omitted jobs for some officials by referring to the files of personnel changes for all officials in MLIT since April 1, 2004, which are publicly available on the MLIT website. These files also allow us to specify the retirement date for retired officials, whereas the other two aforementioned data sources do not identify whether officials not included in the data sources have retired or were transferred to an external organization.

Through the data enrichment process mentioned above, we construct half-yearly panel data of complete job histories of MLIT officials. Once an official is assigned to a middle- or high-rank management position in an internal bureau or an affiliate of MLIT between 2003 and 2015, we thereafter have a complete job history. Hence, we can investigate the career paths for middle- or high-rank managers without too much concern about any sample selection bias. In total, there are 659 officials, of whom 284 entered MOC and 375 entered MOT during the period 1969–2000.[6]

To obtain information on early careers before managers enter a middle management position, however, we need to rely on their recall of events. This presents two potential problems. First, some managers do not report all of their early jobs. Hence, the job history records of low-rank positions for some of these managers are not perfect. When we encounter data that do not exhibit any job changes over the long term, we can only assume that these managers have remained in the same job. Second, if some officials retire from the ministry before becoming middle managers, then they are also omitted from our data set.

To maximize the amount of information we can extract from the data and to minimize any potential sample selection bias, we utilize two different samples from our data set. First, to obtain an overall picture of career paths that includes the early career, we combine our complete panel data with the early career recall data and construct data profiles for the entire personnel history following entry. Hereafter, we refer to this as the sample of job histories with recall data. To minimize any potential sample selection biases, we sometimes

[6]See Appendix B for the representativeness of our data set. The gender of the officials in our data set is unknown. Of course, it is possible to presume the gender using their names, but this cannot be done with any degree of certainty. However, as far as we can tell, it is safe to say that there are almost no women.

utilize a subsample of these data. We report which (sub)sample is used in each figure or table. Second, when we pay greater attention to the career paths of middle- or high-rank management positions, we use the panel data of officials between 2003 and 2015 because we can observe their full job histories. Hereafter, we refer to this as the sample of complete job histories for middle- or higher-ranked managers.

4 Hierarchical Rank

We can potentially identify the rank of each job using the name of the title of each official. As noted in Section 2, the standard names of job titles and their official ranks are prescribed by Japanese cabinet ordinance, which also provides a formal statement on the required abilities and skills for each official rank. The salary structure has a solid link with official job ranks. It is almost certain that the official ranks of job titles play an important role in characterizing the hierarchy of bureaucracy.

One of the difficulties in identifying the ranks of all jobs is that our data set contains many job titles other than the prescribed standard titles; therefore, it is not clear what their official ranks are. To assign a rank to all jobs, we apply the method developed in Baker, Gibbs, and Holmstrom (1994) to the sample of job histories with recall data. We refer to the assigned ranks as hierarchical ranks.

To start, we construct a transition matrix to represent the moves between jobs with the selected major titles in the internal bureaus of the MLIT and classify each one into one of seven hierarchical ranks (Ranks 2–8). We additionally assign Rank 1 to the first job of each official by taking advantage of the fact that there is a single port of entry for new graduates into the ministry. Next, we assign appropriate hierarchical ranks to the jobs with titles other than the major ones based on the transition patterns between titles. Because it is common to exchange officials between internal bureaus and other organizations, we require additional procedures not prescribed by Baker, Gibbs, and Holmstrom (1994). We provide more details

Table 1: Transition matrix for hierarchical ranks

Current	Next rank							
rank	3	4	5	6	7	8	Exit	Total
3	81.5	14.1	3.3	-	-	-	1.1	100
4	0.3	88.6	11.0	0.0	-	-	0.1	100
5	0.1	0.7	93.1	5.4	0.1	-	0.7	100
6	0.1	-	1.0	84.3	6.3	0.1	8.2	100
7	-	-	-	2.1	80.7	6.2	11.0	100
8	-	-	-	-	1.4	75.2	23.4	100
Total	0.9	24.9	48.5	16.4	5.3	1.4	2.6	100

This table provides the transition matrix for the hierarchical ranks using the complete job histories for middle- or higher-ranked managers. A hyphen denotes a zero-transition probability. Moves within a box are stays, moves to the right promotions, and moves to the left demotions.

on this procedure in Appendix C. We manage to classify all job titles in our data set into eight hierarchical ranks, which turn out to be consistent with the official ranks prescribed by the ordinance as shown in Table 6.

4.1 Promotion and Demotion

Table 1 provides the transition matrix between the hierarchical ranks using the sample of complete job histories for middle- or high-rank managers.[7] In this table, moves to the right of a boxed cell are promotions, and moves to the left are demotions. As shown, promotions of more than one rank and demotions are quite rare, with the probability of moving one rank below being quite low, and the probability of moving more than two ranks above also being low. These observations are consistent with the stylized facts presented in the literature, including Baker, Gibbs, and Holmstrom (1994).

[7]We report the same transition matrix using the sample of job histories with recall data in Appendix D.

Table 2: Distribution of hierarchical ranks by tenure

Hierarchical	Tenure																																
rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
8																																		0.9	2.5
7																														0.5	0.6	7.1	25.0	40.5	47
6																											0.5	1.1	13.2	51.1	70.0	75.5	64.8	47.7	40.7
5																		1.1	3.7	16.8	33.7	55.8	70.7	78.0	89.5	96.9	97.9	96.3	85.7	47.3	29.4	16.8	9.4	9.0	9.9
4								0.5	2.4	1.7	1.1	1.1	1.7	9.3	19.6	44.6	71.1	86.2	92.6	82.1	65.8	42.6	28.3	22.0	10.5	3.1	1.6	2.6	1.1	1.1		0.6	0.8	0.9	
3			1.0	1.0	1.0	2.6	22.0	38.7	75.6	87.9	94.9	97.2	96.7	90.2	79.9	54.8	28.9	12.8	3.7	1.1	0.5	1.6	1.0											0.9	
2		0.5	16.2	33.0	40.8	44.5	42.9	40.8	22.0	10.4	4.0	1.7	1.7	0.5	0.5	0.5																			
1	100	99.5	82.7	66.0	58.1	52.9	35.1	19.9																											

This table details the percentage of officials at each hierarchical rank for given years of tenure using the sample of job histories with recall data for those entering the ministry between 1974 and 1980. The sample accounts for 87.2 percent of all officials from the same cohort and all have more than 35 years of tenure.

Table 2 details how many officials belong in each hierarchical rank at any given years of tenure. To examine the selection process from entry for 35 years, we use the sample of job histories with recall data for those entering the ministry between 1974 and 1980. Note that these account for 87.2 percent of all officials in the same cohort and that all officials in this sample have more than 35 years of tenure. Hence, this sample minimizes any possible sample selection bias in early careers.

As shown, holding tenure constant, there is no significant difference in the speed of promotion until officials spend about 30 years of their careers in the ministry. Even if we can observe some differences in the speed of promotion, they seem not to last long. For example, most of the surviving officials are in Rank 3 at 12 years of tenure. Some differentials seem to appear at 15 years of tenure, but disappear at 18 years of tenure.

4.2 Retirement

The different patterns of selection procedure gradually appear after 30 years of tenure. For example, 70 percent of the surviving officials are in Rank 6 at 31 years of tenure. The various ranks of officials are evident at 33 years of tenure and this difference does not contract thereafter. This suggests that the selection procedure for the Japanese bureaucracy is quite slow. Several Japanese labor economists, such as Koike (2002), have pointed out that the late selection is a prominent feature of the internal labor market in Japanese firms. Our result provides similar evidence for the Japanese public sector.[8]

We can finalize the competition for promotion when an official retires. Many officials seem to retire as soon as the selection appears to occur. We now more closely look at the retirement of officials. Table 3 presents the timing of retirement for 255 officials retiring over the period 2004–2015. Panel (A) in this table shows the number of officials who have retired at each hierarchical rank of their last jobs by tenure at retirement. As shown, most officials

[8]Ichise (2013) shows that there is "quite late selection" in the National Police Agency, another Japanese government organization. In other words, the difference in the speed of promotion does not last until the unpromising officials retire.

Table 3: Exit behavior of officials

(A) The timing of retirement

		Tenure at retirement										
		29-	30	31	32	33	34	35	36	37	38+	Total
Last hierarchical rank	4-	1	0	0	0	0	1	1	0	0	0	3
	5	7	1	9	5	0	2	5	1	0	1	31
	6	0	7	23	24	11	28	20	12	6	0	131
	7	0	0	2	2	14	15	7	10	4	3	57
	8	0	0	0	0	0	1	3	6	9	14	33
	Total	8	8	34	31	25	47	36	29	19	18	255

(B) Retirement at Rank 6

		Tenure at retirement								
		30	31	32	33	34	35	36	37	Total
Tenure at promotion to Rank 6	25	0	1	0	0	0	0	0	0	1
	27	0	2	1	0	0	0	0	0	3
	28	0	3	8	1	3	1	0	0	16
	29	7	4	7	2	5	3	6	0	34
	30	0	13	3	3	4	5	2	3	33
	31	0	0	5	3	4	6	3	2	23
	32	0	0	0	2	7	2	1	1	13
	33	0	0	0	0	5	0	0	0	5
	34	0	0	0	0	0	2	0	0	2
	35	0	0	0	0	0	1	0	0	1
	Total	7	23	24	11	28	20	12	6	131

Panel (A) details the number of officials that have retired at each hierarchical rank of their last job by tenure at retirement. Panel (B) shows the timing of retirement only for those that have retired at Rank 6 in relation to tenure at promotion to the rank. Both tables use the sample of complete job histories for middle- or higher-ranked managers.

have retired at Rank 6 or higher before the mandatory retirement age.

In actuality, there is an institutional arrangement in the Japanese bureaucracy designed to motivate officials to retire following promotion to Rank 6. As noted in Section 2, officials of designated service belonging to Ranks 6–8 receive discontinuously higher salaries as a reward for their promotion from Rank 5 according to the remuneration act, which result in much higher retirement allowances. Besides, officials who have retired at Rank 6 or higher tend to be assigned to higher *amakudari* positions as executive officers in public or private firms and receive greater remuneration following retirement. Thus, being a designated official is economically important in that it has a considerable influence on lifetime wages. Under this system, officials are likely to have a great incentive to remain in service until promotion to Rank 6.

Interestingly, most officials retire as soon as they are promoted to Rank 6. Panel (B) in Table 3 details the years of tenure at retirement only for the 131 officials who have retired at Rank 6 in relation to tenure at their promotion to that rank. We find that 26.7 percent of these retired one year after their promotion to Rank 6 and that 71.7 percent retired within four years after their promotion. This exit behavior suggests that they are making the best possible use of *amakudari* because the outside options of officials significantly improve when they are promoted to Rank 6. We can also conjecture that because officials who do not retire tend to be promoted to Rank 7, they are already aware of their opportunities of being promoted to Rank 7 when promoted to Rank 6.

5 Job Value

The promotion and retirement pattern observed in the previous section suggests that all officials are equally treated during most of their careers before they become officials of designated service (Rank 6). Once promoted to Rank 6, most officials soon retire. For their part, the remaining officials are promoted to top executives. Therefore, officials seem to recognize

their own likelihood of being promoted to top executive before being promoted to Rank 6. A relevant question is then when and how they learn about their future promotion likelihood. We would like to argue that the career path itself reveals how they are evaluated by their supervisors.

For this purpose, we develop a method to value each individual job by not only the prospects but also the speed of promotion to top executive. If an official is promoted to top executive with a high probability shortly after being assigned to a certain job, we assign the job a high value. In our method, we utilize richer information on jobs than in the method of identifying the hierarchical ranks employed in the previous section because individual jobs are distinguished by organizations and functional departments as well as job titles.

5.1 Definition

More specifically, let $V_j^* \equiv (1-\delta)\, V_j$ be the value of job j, where V_j satisfies

$$V_j = w_j + \delta \sum_{k=1}^{n} P(k|j) V_k, \text{ for all } j, \tag{1}$$

and w_j is the instantaneous value of job j; δ is a discount factor; n is the number of available jobs including retirement; and $P(k|j)$ is the probability that an official currently belonging to job j would be transferred to job k in the next period, which can be calculated from the half-yearly panel data from personnel records.[9] Using the matrix notation such as

$$\mathbf{V} = \begin{bmatrix} V_1 \\ \vdots \\ V_n \end{bmatrix}, \mathbf{w} = \begin{bmatrix} w_1 \\ \vdots \\ w_n \end{bmatrix}, \mathbf{P} = \begin{bmatrix} P(1|1) & \cdots & P(n|1) \\ \vdots & \ddots & \vdots \\ P(1|n) & \cdots & P(n|n) \end{bmatrix},$$

[9] If there exists a job s first appearing in the last period of the data set, it is impossible to compute the values of the job s and the previous jobs that are transferred to job s because there is no information on job transitions to other jobs from job s. We assume that $P(s|s) = 1$ and $P(k|s) = 0$ for any $k \neq s$ for such job s. In this way, the value of job s is set to be 0.

(1) can be expressed as

$$\mathbf{V} = \mathbf{w} + \delta \mathbf{P}\mathbf{V}.$$

Hence, we can compute the job value by

$$\mathbf{V}^* = (1-\delta)\,(\mathbf{I} - \delta \mathbf{P})^{-1}\mathbf{w}, \tag{2}$$

where $\mathbf{V}^* = (1-\delta)\,\mathbf{V}$ and $\mathbf{I}$ is an identity matrix.

We assume that $w_j = 1$ if job j indicates a top management position or retirement after top executive, and $w_j = 0$ otherwise. We set the probability when retiring as $P(r|r) = 1$ and $P(k|r) = 0$ for any $k \neq r$, where r denotes retirement. Under these assumptions, $V_j^* = 1$ when j indicates either a top executive or retirement after top executive, and $V_j^* = 0$ when j denotes retirement after jobs other than top executive. Hence, the value of a job is close to one when the official in the job has a high probability of shortly being promoted to top management, while the value is close to zero either when the job has a high probability of retirement without being promoted to top management or when it is expected to take a long time to become a top executive from this job. Thus, our measure provides a simple prediction of career success, which reflects both the likelihood and speed of promotion from each job to top executive.

To estimate the job value, we must specify which jobs are the top management positions. We identify these based on the formal rules and directives by the National Personnel Authority about salary grades for officials of designated service.[10] Top executives are defined as jobs in the internal bureaus of ministries accompanied by Grade 5 salary or more.[11] The set of top executives defined in this way is a subset of jobs at hierarchical ranks 7 and 8,

[10]The rule of the National Personnel Authority No. 9–42 provides an ambiguous expression of the links between individual jobs and salary grades for designated officials. The particular rules are prescribed by the directives of the National Personnel Authority, which are not publicly available. However, specific links were revealed by the formal answers submitted to an ordinary session of the Diet (the Japanese parliament) to questions from a member of the House of Councilors in May 2011.

[11]There are eight salary grades for officials of designated service according to rule No. 9–42 by the National Personnel Authority.

87 percent of which are top management positions as defined here. We assume that once an official reaches a top management position, they remain assigned to a top management position. Because we are interested in promotion to the top management position, once an official is promoted to the top executive, we omit that data thereafter.

5.2 Successful and Dead-end Jobs

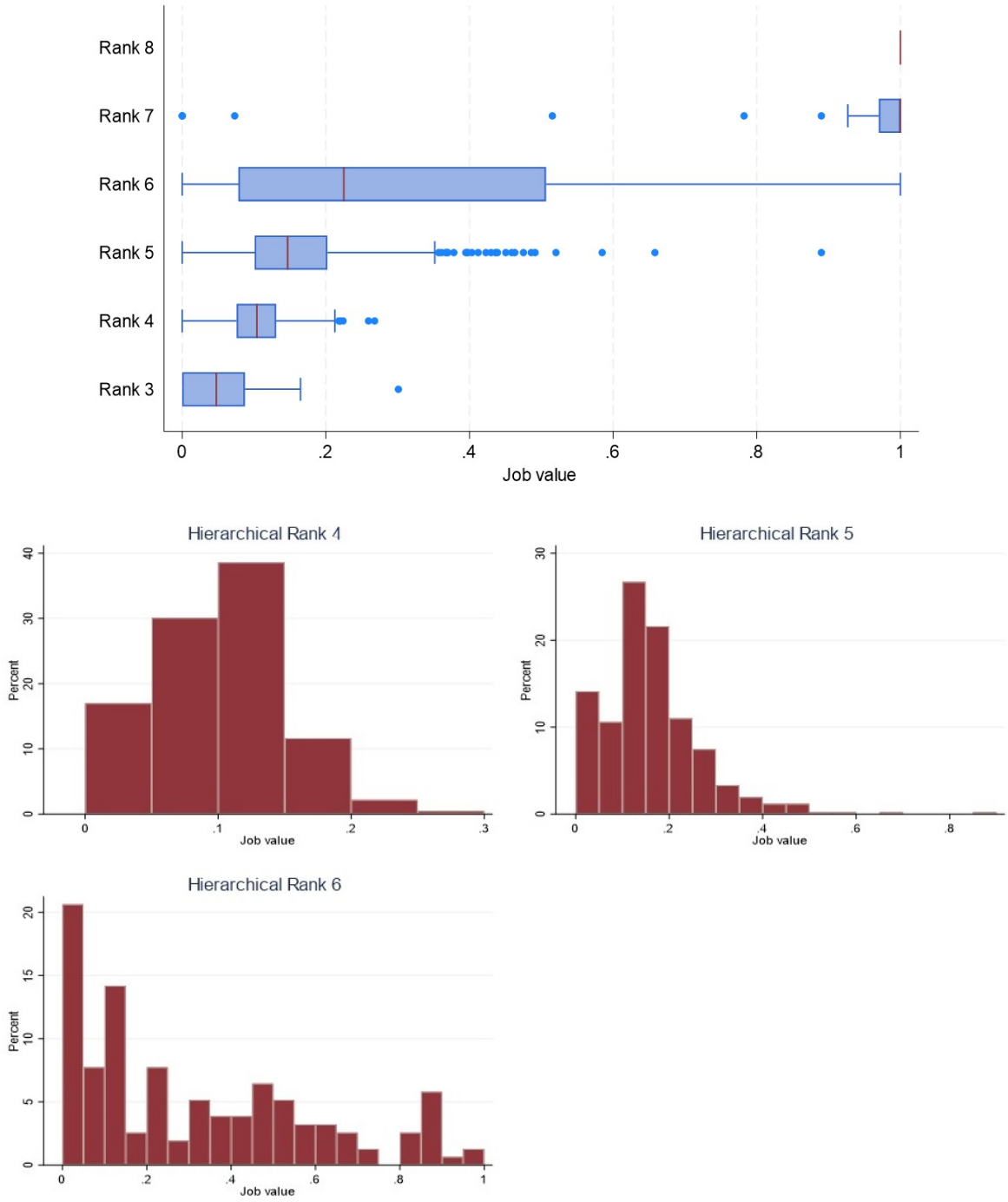
Assuming that $\delta = 0.97$, which is frequently used by many macroeconomists as being most appropriate, we compute the job values for all individual jobs. The distribution of the job values using the sample of complete job histories for middle- or high-rank managers is presented in Figure 1.[12] The box plot shows that while jobs at a high hierarchical rank have on average high job values, there are still large variations in job values within the same hierarchical rank. Within the jobs at Rank 5 or 6, in particular, there are both *successful jobs*, whose job values are nearly one, and *dead-end jobs*, whose job values are nearly zero. When an official is assigned to a successful job, that official would be in a position near the top executive.

The lower images in Figure 1 show that the variations in job values gradually increase with the hierarchical rank, which may suggest that officials are gradually screened within the organization. Within Rank 4, the share of the jobs whose job values are higher than 0.15 is very low, but a small number of jobs whose job values are higher than 0.3 are observed within Rank 5. The jobs at Rank 6 can be divided into three groups: a very few successful jobs, some middle-valued jobs, and many dead-end jobs. This confirms our previous conjecture that assigned jobs make many officials realize their likelihood of being promoted to top executive when promoted to Rank 6.

To investigate how the heterogeneity of job values develops through officials' tenure, we match the calculated job values to individual panel data and plot the relationship between the value of the job each official belongs to and the tenure of the officials. Figure 2 depicts

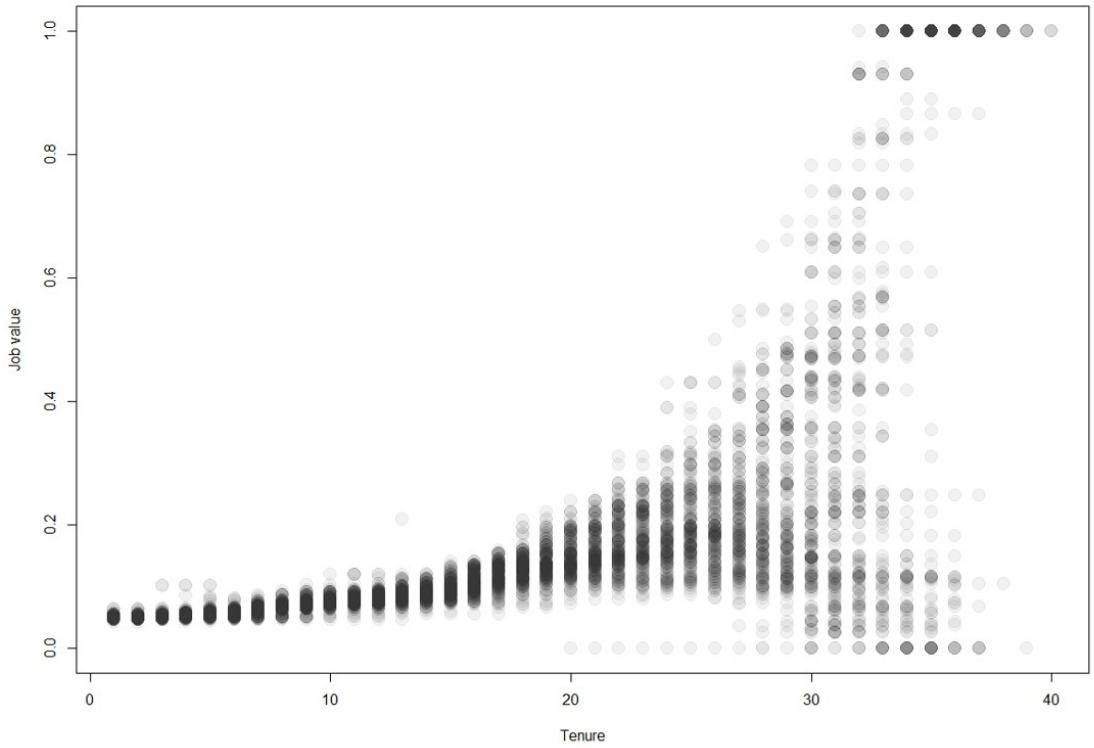
[12] We report the same box plot using the sample of job histories with recall data in Appendix D.

Figure 1: Distribution of job values within the same hierarchical rank



The box plot and histograms detail the distribution of job values calculated using the sample of complete job histories for middle- or higher-ranked managers by hierarchical rank.

Figure 2: Distribution of job values by tenure



This figure details the distribution of job values. Darker colored points identify that more officials belong to that job value. The job values use the sample of job histories with recall data for those entering the ministry between 1974 and 1980. The sample accounts for 87.2 percent of all officials from the same cohort and all have more than 35 years of tenure.

the result using the sample of job histories with recall data for those entering the ministry between 1974 and 1980. A darker point in the figure indicates that more officials belong to that job value. As expected, this shows that the variance of job values gradually increases as tenure becomes longer. The increase in the variance appears even before 20 years of tenure, but certainly accelerates after 20 years. Hence, it is likely that the competition for promotion becomes more intense after 20 years of tenure. The majority of officials seem to be screened out before 20–25 years of tenure. Finally, after 36 years of tenure, there is a clear separation between officials in jobs that almost guarantee their being promoted to top executive and officials in the jobs that have no chance of being promoted to the top executive.

While Figure 2 provides important information on how job variability changes as tenure increases, caution should be exercised in its interpretation. The values of early jobs must be low and have small variations, as by definition they are heavily influenced by the discount factor δ. To remove this, we construct a measure of relative job value by dividing an official's job value at some year of tenure by the mean of the job value over officials with the same length of tenure.

Table 4 details the distribution of relative job value by tenure using the sample of job histories with recall data for those entering the service of the ministry between 1974 and 1980. In contrast to the distribution of the hierarchical ranks by tenure in Table 2, we can observe a gradual increase in the variation of relative job values. The proportion of relative values between 0.75 and 1.25 is down to 80 percent up until 16 years of tenure, and further declines to 70 percent at 20 years of tenure, 50 percent at 26 years of tenure and 17 percent at 30 years of tenure. While it is true that the variation in relative job values rapidly increases after 20 years of tenure, the increase up until 20 years of tenure cannot be ignored. This leads us to surmise that the ministry might also differentiate among officials, even early in their careers. While we previously found that the ministry seems not to formally differentiate between officials until 30 years of tenure, the results in this table suggest the possibility of the tacit selection of promising officials through job assignment.

We also examine the persistence of the values of jobs in which officials belong. For this purpose, we construct a transition matrix among quintiles of job values calculated using the sample of complete job histories for middle- or high-rank managers. Table 5 provides the result. As shown, most of the bottom quintile remain in the bottom quintile and most of the top quintile either remain in the top quintile or are promoted to the top executive in the next 6 months. This confirms a strong persistency for the job values in which officials belong for low- and high-value jobs. That is, there are sets of almost always dead-end jobs and almost always successful jobs in the Japanese bureaucracy.

Table 4: Distribution of relative job values by tenure

Relative job value RV	Tenure																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Top executive																																0.6	14.8	34.2	46.9
$RV \geq 2.25$													0.5											1.6	1.6	0.5	1.0	1.6	1.1	3.8	2.8	6.5			
$2 \leq RV < 2.25$																						1.1			1.0	1.0	2.1	1.6	1.6	2.2	5.0	2.6	4.7		
$1.75 \leq RV < 2$			1.5	1.5	1.5													0.5	0.5	0.5		1.6	1.0	3.1	1.6	2.6	4.2	5.8	9.5	3.8	5.6	8.4	6.3	4.5	
$1.5 \leq RV < 1.75$				0.8	0.7					0.6	2.2	1.1			0.5			2.7	5.8	5.8	10.0	12.1	8.9	7.9	8.9	7.9	5.8	10.5	5.3	14.0	10.6	5.2	3.1	5.4	1.2
$1.25 \leq RV < 1.5$	0.8	0.8			3.0	2.9	2.0	4.1	4.0	1.7	1.7	1.7	4.9	7.6	11.4	17.6	15.4	16.5	16.4	21.1	21.1	21.6	24.6	19.9	15.2	14.1	7.9	6.8	13.2	7.5	8.9	9.7	3.9	1.8	2.5
$1 \leq RV < 1.25$	38.8	35.7	29.8	28.8	38.1	40.4	46.7	36.8	44.1	48.6	53.9	55.6	57.9	56.0	38.4	42.8	50.5	48.9	47.6	40.5	34.2	28.4	24.1	24.1	23.6	17.3	19.9	12.6	10.1	5.9	8.3	7.7	13.3	0.9	1.2
$0.75 \leq RV < 1$	60.5	63.6	68.7	68.9	56.7	56.6	50.0	55.0	46.9	46.3	40.0	38.9	34.4	34.8	48.6	35.3	28.7	26.6	25.4	27.9	30.0	27.4	29.3	29.3	31.9	32.5	25.7	20.5	11.6	10.8	8.3	6.5	7.0	5.4	2.5
$0.5 \leq RV < 0.75$							1.3	4.1	5.1	2.8	2.2	2.8	2.2	1.6	1.1	4.3	4.8	4.8	4.2	3.7	4.2	7.4	11.0	13.6	14.7	19.9	26.7	24.2	24.9	24.2	11.1	14.2	4.7		2.5
$0.25 \leq RV < 0.5$																	0.5						0.5		1.0	3.7	5.8	14.7	20.1	17.2	22.8	20.6	14.1	9.0	4.9
$0 \leq RV < 0.25$																				0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.6	2.6	10.8	16.7	18.1	28.1	38.7	38.3

This table details the percentage of employees belonging to each range of relative job values for the given years of tenure. The relative job value is constructed by dividing an official's job value for some year of tenure by the mean of the job value over officials with the same length of tenure. The values are calculated using the sample of job histories with recall data for those entering the ministry between 1974 and 1980. The sample accounts for 87.2 percent of all officials from the same cohort and all have more than 35 years of tenure.

Table 5: Transition matrix between job values

Current quintile	Next quintile							
	[0, 0.2)	[0.2, 0.4)	[0.4, 0.6)	[0.6, 0.8)	[0.8, 1)	Top	Exit	Total
[0, 0.2)	93.5	4.0	0.3	0.0	0.0	0.1	2.1	100
[0.2, 0.4)	8.4	82.8	5.5	1.1	0.5	0.5	1.3	100
[0.4, 0.6)	4.7	5.3	75.9	4.3	4.1	4.1	1.5	100
[0.6, 0.8)	3.1	1.2	5.0	72.7	7.5	10.6	-	100
[0.8, 1)	-	-	1.2	0.6	72.3	25.4	0.6	100
Top executive	0.7	-	-	-	0.6	83.6	15.1	100
Total	65.0	18.1	5.4	1.6	1.7	5.6	2.6	100

This table details the transition matrix among quintiles of job values using the sample of complete job histories for middle- or higher-ranked managers. A hyphen denotes a zero-transition probability.

This table also demonstrates that we observe frequent large promotions and real demotions for the set of jobs with job values between 0.2 and 0.8. This means that the government aggressively selects officials from those in jobs with values between 0.2 and 0.8. In particular, frequent real demotions may attract special attention. Those assigned to jobs with values between 0.6 and 0.8 can expect promotion with a probability of about 18 percent in the next 6 months. However, they can also be demoted to low-value jobs with a probability of about 10 percent in the next 6 months. It is thus likely that officials in jobs with values between 0.2 and 0.8 face intense competition.

5.3 Measurement Errors in Job Values

The number of individual jobs, which are characterized by the organization, department, function and business unit, and job title to which they belong, is quite large. Therefore, the number of observations available for estimating an individual's probability of changing jobs may be reduced, and the job values calculated using the job transition probabilities could contain measurement errors because of the small sample size.

To assess the significance of measurement error, we calculate job values using the sample drawn by bootstrap sampling. We first resample the officials with replacement, and then

replicate their job histories with recall data for the frequencies for which they are selected. Using the replicated data, we calculate the job values of all individual jobs experienced by the selected officials. We conduct 100 bootstrap replications.[13]

Panel (A) of Figure 3 depicts the distribution of the coefficient of variation of each of the job values calculated using bootstrap sampling for each hierarchical rank. The results show that the coefficient of variation for most job values is less than 0.5. This means that the standard deviations of most job values are less than half of the means of the job values, which we consider quite small. This figure also shows that the coefficients of variation gradually increase with hierarchical rank, suggesting that the lower the hierarchical rank, the more reliable the job value. This also suggests that although job values in lower hierarchical ranks is likely to be cumulatively influenced by measurement error in the transition matrices, because the discount factor has larger impacts on the construction of job values in the lower rank, reliability is greater.

As Figure 1 illustrates that the heterogeneity of job values is apparent in the hierarchical ranks of 4 to 6, we check how much measurement error influences the heterogeneity in these ranks. We use the sample of jobs with hierarchical ranks 4–6 and divide the mean bootstrap value of the job values into categories in 0.2 increments. Panel (B) of Figure 3 plots the distribution of the coefficients of variation of the job value for each category.

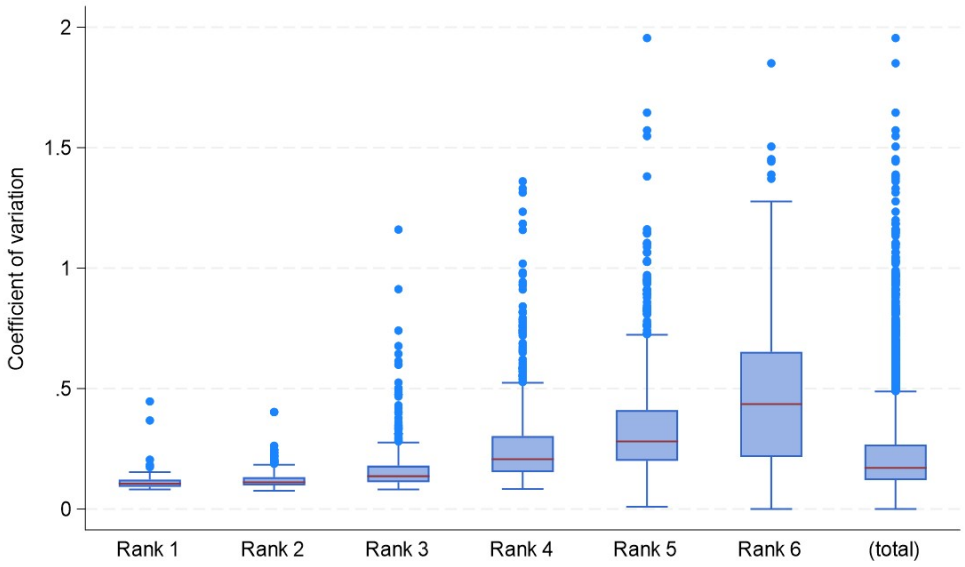
As illustrated, the scatter is very small for jobs with a mean value of 0.8 or more. This suggests that it is almost certain that successful jobs are present. It is less obvious that dead-end jobs exist because the coefficients of variation for jobs of less than 0.2 are much larger. Hence, we estimated 95 percent confidence intervals for the mean job value for jobs with mean job values less than 0.2. The results show that the upper bound of the confidence interval is less than 0.215 for 99 percent of these jobs. This suggests that while there is some impact of measurement error, it is difficult to reject the existence of dead-end jobs.

In sum, while there are some job values that we may need to concern ourselves with,

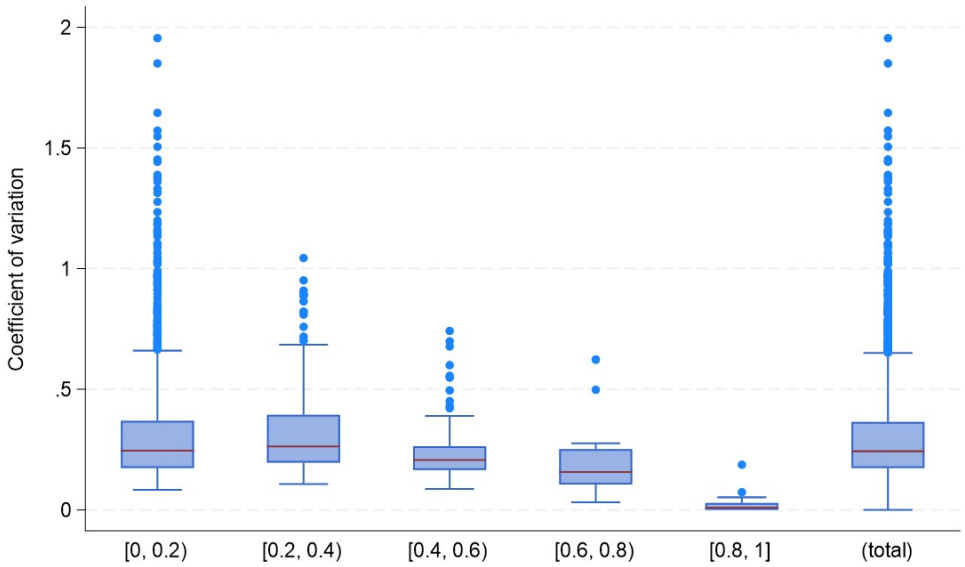
[13]We confirm that the bootstrap does not cause any systematic bias in job values. See Appendix E for details.

Figure 3: Coefficients of variation for job values using bootstrap sampling

(A) By hierarchical rank



(B) By mean value



This figure plots the distribution of the coefficients of variation for each job value calculated using bootstrap sampling for each hierarchical rank in Panel (A) and for each 0.2 increment of mean value of jobs with hierarchical ranks 4–6 in Panel (B).

about the possible influence of measurement error, most job values are reliable. We conduct the regression analysis including a caution regarding a potential measurement problem in the following section.

6 Existence of Fast Tracks

In Section 4, we revealed that the speed of promotion to a higher hierarchical rank is roughly the same for all officials. However, we also obtained suggestive evidence that the government may select promising officials much earlier during their careers. The following more closely investigates the presence of fast tracks by conducting regression analysis.

For this purpose, we estimate the probability of promotion to a higher rank using the following probit model:

$$Y_{it}^* = \beta_0 + \beta_{1s} V_i(s) + \beta_2 TP_{it} + \beta_3 D_{it} + \beta_4 (TP_{it} \times D_{it}) + \beta_{\mathbf{x}} \mathbf{X}_{it} + \beta_t + \varepsilon_{it}, \tag{3}$$

$$Y_{it} = \begin{cases} 1 \text{ if } Y_{it}^* > \bar{a}, \\ 0 \text{ if } Y_{it}^* \leq \bar{a}, \end{cases}$$

where Y^* is a latent variable; $V(s)$ is the job value of the job to which officials are assigned when first promoted to hierarchical rank $s \in \{3, 4, 5\}$; TP is tenure in the previous hierarchical rank; D is a dummy variable indicating that an official is assigned to the current hierarchical rank by demotion from the previous rank; $\mathbf{X}_{it}$ is a vector of other control variables; β_t is a dummy for period t; and ε is a normally distributed error term. Y_{it} is an outcome variable that takes a value of one if an official i in period t is promoted to a higher hierarchical rank in the next period $t+1$ or zero otherwise. The parameter $\bar{a}$ is the threshold for the outcome. As control variables $\mathbf{X}_{it}$, we use tenure in the current hierarchical rank, total tenure in the ministry, the squared terms of these two tenure variables, and dummy variables indicating the current hierarchical rank, education, and the ministry an official joined.

The education variable is a dummy variable that takes a value of one if an official graduated in law at the University of Tokyo and zero otherwise. As noted in Section 2, public officials graduating in law at the University of Tokyo have long occupied a prestigious position among the elite group of officials in the Japanese central government. About 80 percent of the officials in our data set graduated from the University of Tokyo, 80 percent of whom are law graduates.

We are mainly interested in the value of the coefficient β_{1s}, which provides information on the degree of association between the job value of the job to which officials are assigned when first promoted to hierarchical rank s and the future probability of promotion to a higher hierarchical rank. The definition of early selection, which we consider an indicator of a fast track, does not require causality. Therefore, if the β_{1s} estimate is positive, it can be interpreted as a sign of fast tracks without concern about causal interpretation.

For comparison, we are also interested in the estimate of the coefficient β_2, which is the association between the duration in the previous hierarchical rank and the future probability of promotion to a higher hierarchical rank. This parameter corresponds to the definition of fast tracks by Baker, Gibbs, and Holmstrom (1994) and Ariga et al. (1999). If the use of hierarchical rank detects fast tracks, then the estimate of β_2 should be negative. We show that while the use of hierarchical rank cannot detect fast tracks, that of job value can.

For this estimation, we utilize the sample of complete job histories for middle- or high-rank managers between 2003 and 2015. Like the calculation of job values, once an official is promoted to top executive, we omit any following data because no more variation in the hierarchical rank can be observed.

As discussed in Section 5.3, the job values could contain measurement error due to small sample size. Given that the regression analysis specifies $V(s)$ as an explanatory variable, we may need to take this into account. Because we are not interested in causal interpretation, bias due to measurement error is not a main concern (if anything, the true association would be stronger than the association without measurement error; hence, our estimates would

only be conservative). However, the reliability of our estimate is likely to be influenced by the degree of measurement error. To deal with this problem, we also estimate the standard deviations of the parameters using the same sample extracted by bootstrapping in Section 5.3. Following Chapter 10 in Hansen (2022), we obtain bootstrap percentile-t confidence intervals using the distribution of the bootstrap t-ratio.

We conduct regression analyses and obtain the sample means and sample standard deviations of β_{1s} and β_2 using the same sample extracted by bootstrapping in Section 5.3. Then we construct bootstrap percentile-t confidence intervals. Figure 4 reports the results.

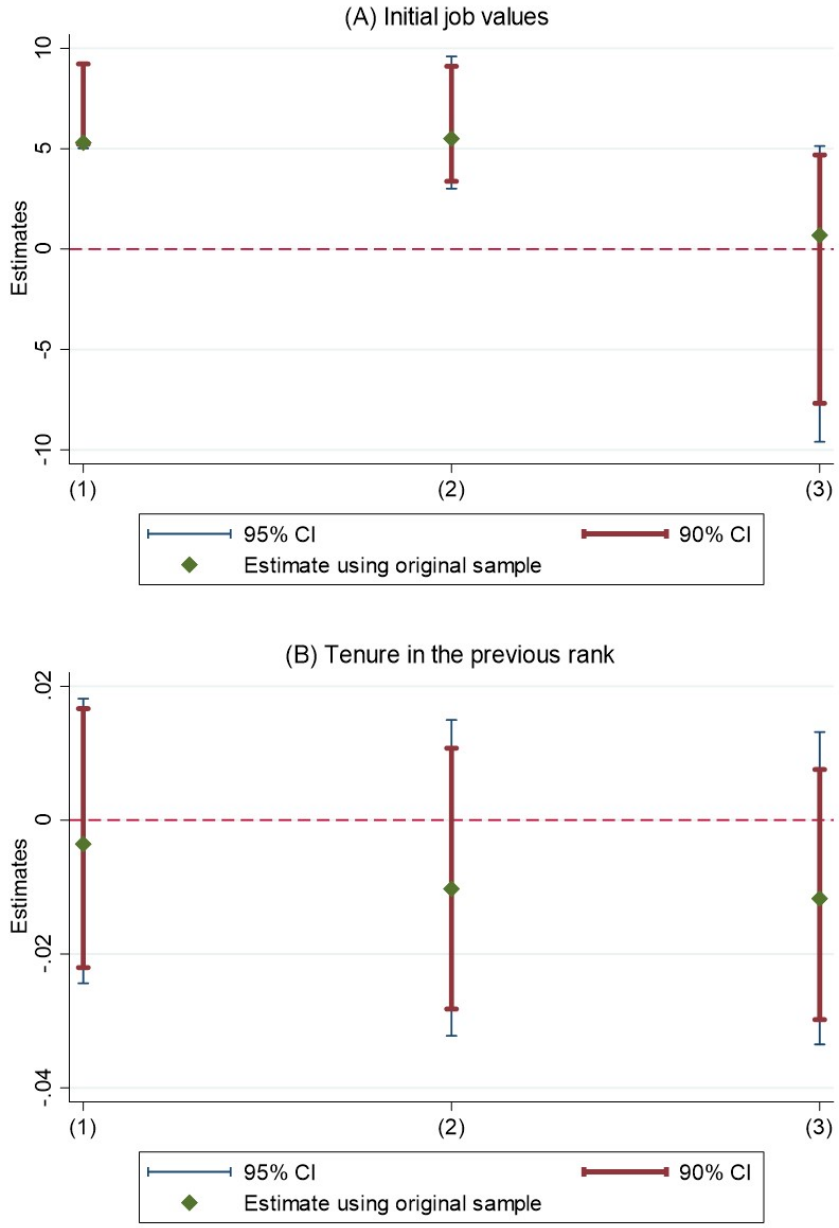
Graphs (1) to (3) are for different model specifications. Graphs (1), (2), and (3) are the results of the models that include an initial job value at Ranks 5, 4, and 3 as an explanatory variable, respectively.

Panel (A) in Figure 4 reports the bootstrap percentile-t confidence intervals of coefficients β_{1s}. The diamond-shaped dot within the interval is the coefficient estimated using the original sample with complete job histories for middle- or high-rank managers between 2003 and 2015. This shows that initial job values at Ranks 4 and 5 are significantly and positively associated with the probability of promotion, while the association of the initial job value at Rank 3 on the probability of promotion is not statistically significant.

This fast track cannot be detected by hierarchical rank. Panel (B) shows that we cannot reject the hypothesis that the coefficients of tenure in the previous rank, β_2, is zero for all specifications and all samples. That is, we cannot detect any indication of fast tracks from the use of hierarchical rank.

In sum, we find the indication of fast tracks using job values, which cannot be detected by hierarchical rank.

Figure 4: The bootstrap percentile-t confidence intervals of the estimated coefficients for the promotion probability model



The figures show the bootstrap percentile-t confidence intervals of the coefficients of key variables for the promotion probability models. Panel (A) reports the confidence intervals of the coefficients for initial job values of hierarchical Ranks 3–5, and Panel (B) for tenure in the previous rank.

7 Exit Rates

In this section, we analyze the association between job value and retirement using the same specification as our analysis of promotion probability in the previous section. The outcome variable Y is changed to a variable that takes a value of one if the worker retires in the next period and zero otherwise. If the estimated coefficient β_{1s} is negative, then assignment to a job with a low job value when promoted to hierarchical rank s predicts the greater likelihood of being followed by resignation. As in the previous section, we estimate the models using the same sample extracted by bootstrapping in Section 5.3 and obtain the bootstrap percentile-t confidence interval.

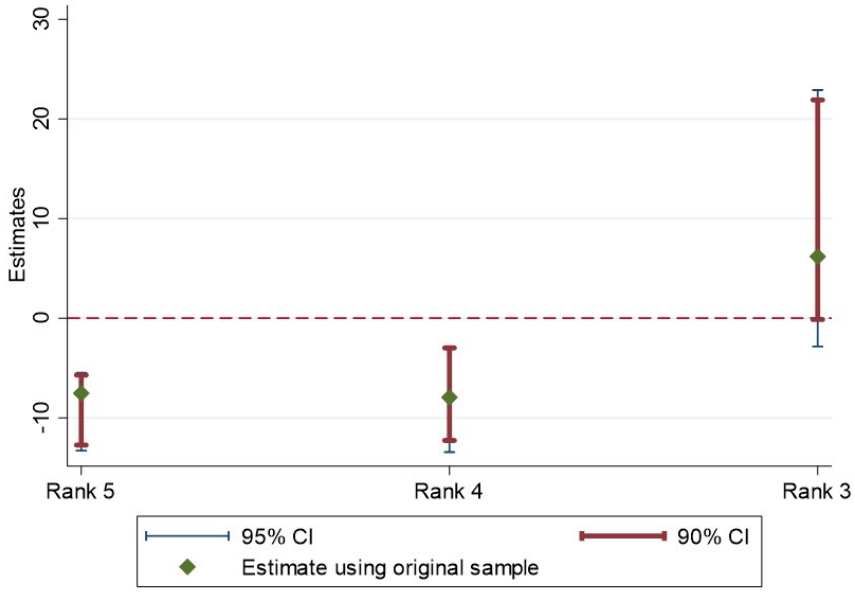
Figure 5 depicts the confidence intervals for the coefficients of the job values of jobs when first promoted to hierarchical Ranks 3–5.[14] In contrast to the analysis of promotion probabilities, initial job values at Ranks 4 and 5 are significantly and negatively associated with the probability of retirement. This suggests that an official assigned to a job with a low job value could be given a signal that they show little promise for future promotion to being a top executive, and hence, they may choose to leave the organization.

8 Theory

In this section we modify the model in Prendergast (1992) to meet the institutional features of Japanese government employment and include job values. We show that our refined model can account for four new features: (1) there are dead-end and successful jobs of the same hierarchical rank, (2) while demotions in the sense of downgrading to a lower hierarchical rank are rare, there are frequent real demotions in the sense of downgrading to a job with a lower job value, (3) while there is no indication of fast tracks using hierarchical rank, we find government assigns jobs with high job values to promising candidates for top management

[14] In the estimation with the bootstrap samples, the model does not converge in a very few cases. The results are presented after excluding these cases, but this does not have a significant impact on the overall results.

Figure 5: The bootstrap percentile-t confidence intervals of the estimated coefficients for the exit rate model



The figure plots the bootstrap percentile-t confidence intervals of the coefficients of initial job values of hierarchical Ranks 3–5 for the exit rate models.

toward the middle of their careers, and (4) many officials assigned to jobs with low job values toward the middle of their careers leave as soon as they are assigned to a designated position.

8.1 Model

We assume that the career of officials can be divided into three periods and that there is one measure of officials in each generation. For a simple analysis, we assume that discount factor is one and agents are risk neutral. The first period is an exploration period where the government randomly assigns a job to officials and explores the ability of these officials. At the end of the first period, the government realizes the ability of the officials, but officials do not. We consider that officials experience jobs with hierarchical ranks of 1 to 3 in the first period. The second period is a training period in that the government strategically assigns a job to the officials and officials strategically decide if they invest in organization-specific human capital. We assume that the second period occurs with hierarchical ranks of 4 and

5. The third and final period is where some officials are assigned to top management jobs and others decide whether they should exit. We consider the third period starts when they become designated officials, which is more than or equal to Rank 6.

Assume that there are two types of job, difficult and easy. We consider jobs more than or equal to hierarchical Rank 7 as difficult jobs and below Rank 7 as easy jobs. Hence, all jobs in the first and second periods are easy jobs. The quality of services for each job, $y \in \mathbf{R}$, is determined by the production function, $f_x(a,h)$:

$$y = f_x(a,h),$$

which depends on the type of jobs, $x \in \{D,E\}$, where D is a difficult job and E is an easy job, the level of ability, a, where a is uniformly distributed in $[0,1]$, and the organization-specific human capital of officials operates the job, $h \in \{0,q\}$, which is $h = q > 0$ if the officials train and $h = 0$ if not.

For our simple analysis, we assume that the accumulation of organization-specific skill improves the productivity of difficult jobs, but does not improve those of easy jobs:

$$f_D(a,q) > f_D(a,0), \ \frac{\partial f_D(a,h)}{\partial a} > 0, \ \forall a,h. \tag{4}$$

$$y^*(a) = f_E(a,0) = f_E(a,q), \forall a, \tag{5}$$

Equations (4) and (5) imply that organization-specific human capital is useful for difficult jobs but not for easy jobs. Equation (5) is more than necessary, but it simplifies our analysis.

We also assume that the values of the officials' outside option varies by period:

$$f_D(a,q) \geq R_3 + c, \ \forall a$$

$$R_3 > z(a) \geq \max\{R_2 - R_3, R_1 - R_2\}, \ \forall a$$

where $z(a) \in \{f_D(a,0), y^*(a)\}$, R_t is the value of the officials' outside option at period t,

and $c > 0$ is the cost of accumulating skills. These ranges of outside options guarantee the existence of an equilibrium that is consistent with the evidence. Several remarks are in order concerning this assumption. First, the condition implies that $f_D(a,q) - f_D(a,0) > c$ for all a. This means that if the government assigns an official to a difficult job, it is efficient for the official to invest in organization-specific skills. Second, the assumption of $R_3 > z(a)$, where $z(a) \in \{f_D(a,0), y^*(a)\}$, indicates that from a societal perspective it is desirable for all officials that had an easy job in their third period or were given a difficult job without organizational human capital in their third period to exit the government. As discussed in Section 2, when officials become designated officials, their retirement allowances substantially increase and Japanese "*amakudari*" practice provides attractive exit options from Japanese government jobs. The assumption of $R_3 > z(a)$ is designed to capture this institutional regulation.

As in Prendergast (1992, 1993), we assume that human capital h, ability a, and output y are not verifiable, but period and hierarchical rank (and, therefore, the type of job) are verifiable. Therefore, the wage contract of officials is a function of job type and period. This is consistent with the salary system of Japanese officials, which is a function of hierarchical rank and tenure.

Let $w^j_{t,x} \geq 0$ denote the wage of job type x in period t when government chooses job assignment strategy j. Because all jobs in periods 1 and 2 are easy jobs, $w^j_{t,D}$ does not exist and $w^j_{t,E} = w^j_t$ for all j when $t = \{1,2\}$. Because of the assumption of $R_3 > z(a) \in \{f_D(a,0), y^*(a)\}$, and $f_D(a,q) \geq R_3 + c$, it is optimal for government to retain officials that invest in human capital and are assigned to a difficult job, but to encourage any other officials to exit. Hence, the individual rationality constraint at period 3 should be $w^j_{3,E} < R_3$, and $w^j_{3,D} \geq R_3$ for all j.

We assume that the measure of jobs in the first and second periods is 1, but the measure of difficult jobs is $\#D \in (0,1)$. Hence, only some officials can be assigned to difficult jobs. Because $\frac{\partial f_x(a,h)}{\partial a} > 0$ for all a and h, government has an incentive to assign officials

with $a \geq a_*$, where $\#D = 1 - a_*$, to difficult jobs if all of these officials have invested in organization-specific human capital in advance. Although the government knows the ability of officials at the beginning of the second period, the government cannot commit itself to assign able officials to difficult jobs until they invest in human capital.

We assume that in the second period, the government can choose two different job assignment strategies $j \in \{s, n\}$, where s is a selective job assignment strategy and n is a nonselective job assignment strategy. The selective job assignment strategy assigns a particular job to officials with $a \geq a_*$, while the nonselective job assignment strategy randomly assigns jobs to officials. We show that government optimally chooses the selective assignment strategy, and the empirical predictions of the equilibrium given this strategy are consistent with four empirical features revealed in our analysis using job values.

We first explain the equilibrium under the selective job assignment strategy. To make clear the relationship between our findings and theoretical prediction, we assume that the government assigns officials with ability a to jobs with job values a in the hierarchical rank of 4 and 5 in the second period. Because all jobs in the hierarchical rank of 4 and 5 are easy jobs, the quality of jobs and wage payments in the second period are identical. However, this job assignment strategy provides a credible signal about how government assesses the competence of its officials. Because the officials know that the government has an incentive to assign officials with ability $a \geq a_*$, where $\#D = 1 - a_*$, to difficult jobs in the third period as long as they invest in organization-specific human capital, officials assigned to jobs with job values of $a \geq a_*$ believe that they will be assigned to difficult jobs in the third period if they invest in human capital.

To provide these officials with an incentive to invest in human capital, the wage payment must satisfy the following incentive compatibility constraint.

$$w^s_{3,D} - R_3 \geq c \tag{6}$$

Note that when equation (6) is satisfied, $w^s_{3,D} \geq R_3$ is always satisfied.

Because the job assignment strategy in the second period also reveals that officials assigned to jobs with job value $a < a_*$ will not be assigned to difficult jobs in the third period, they do not have any incentive to invest in organization-specific human capital. Because they expect that they will retire at the beginning of the third period, the following participation constraint must be satisfied in the second period.

$$R_3 + w^s_2 \geq R_2 \tag{7}$$

Note that in using the two equations (6) and (7), the participation condition of officials with ability $a \geq a_*$, $w_{3,D} - c + w^s_2 \geq R_2$ is always satisfied.

In the first period, the government does not know the ability of the officials, and therefore must randomly assign jobs to them. Because officials also do not know their ability, they consider that they will be assigned to successful jobs with probability $1 - a_*$ and assigned to dead-end jobs with probability a_* in the second period. Hence, the participation constraint in the first period is

$$R_1 \leq (1 - a_*) V_{2,D} + a_* V_{2,E} + w^s_1, \tag{8}$$

where $V_{2,D} = w^s_{3,D} - c + w^s_2$, and $V_{2,E} = R_3 + w^s_2$.

Government is assumed to solve the following cost minimization problem

$$C^s = \min_{w_{3,D}, w_2, w_1} \#D w^s_{3,D} + w^s_2 + w^s_1$$

subject to equations (6), (7), (8) and $\#D = 1 - a_*$, where C^j are the optimal labor costs when the government chooses job assignment strategy $j \in \{s, n\}$. It is easy to see that all constraints bind, and we obtain

$$w^s_1 = R_1 - R_2, w^s_2 = R_2 - R_3, w^s_{3,D} = R_3 + c$$

and

$$C^s = R_1 - (1 - \#D)\, R_3 + \#Dc. \tag{9}$$

The empirical predictions of this equilibrium are consistent with four features obtained by our measure of job values. The model predicts that there will be (1) dead-end and successful jobs of the same hierarchical rank in the second period, (2) a decrease in job values from the first period to the second period, but no decrease in hierarchical rank,(3) no indication of a fast track from the observation of hierarchical rank, but there is a fast track in that officials assigned to a job with job value $a \geq a_*$ at the beginning of the second period are guaranteed to be assigned to difficult jobs, and (4) officials assigned to a job with job value $a \leq a_*$ at the beginning of the second period exit at the beginning of the third period.

To show that the selective job assignment strategy is optimal, we need to examine the costs when the government chooses a nonselective job assignment strategy. In this case, equations (6), (7), (8) can be replaced by the following

$$c \leq (1 - a_*) \left(w^n_{3,D} - R_3 \right) \tag{10}$$

$$R_2 \leq (1 - a_*)\, w^n_{3,D} + a_* R_3 + w^n_2 - c \tag{11}$$

$$R_1 \leq (1 - a_*)\, w^n_{3,D} + a_* R_3 + w^n_2 - c + w^n_1 \tag{12}$$

Equation (10) is an incentive compatibility condition that encourages investment in human capital. Equations (11) and (12) are participation conditions in the second and first periods, respectively. The main difference between Equations (6), (7), and (8) and Equations (10), (11), and (12) is the differences in the expectations of officials on the timing of investing in human capital. Because officials do not know their ability, and therefore the possibility of promotion to difficult jobs when they invest in human capital under the nonselective job assignment strategy, all officials are encouraged to incur investment cost, c, even though this investment cost might be wasted.

As a result, the solutions to the cost minimization problem of the government change to

$$w_1^n = R_1 - R_2, w_2^n = R_2 - R_3, w_{3,D}^n = R_3 + \frac{c}{\#D}.$$

Note that the only difference between the solutions for the selective and nonselective allocation strategies is $w_{3,D}^n > w_{3,D}^s$. Because all officials are unsure if they will be assigned to difficult jobs, the benefits of investing in human capital are reduced by the probability of the assignment to difficult jobs, $(1 - a_*)$ in Equation (10). As a result, the government is obliged to increase $w_{3,D}^n$ to encourage officials to invest in human capital. The optimal labor cost under the nonselective strategy is

$$C^n = R_1 - (1 - \#D) R_3 + c. \tag{13}$$

Comparing Equations (9) and (13), we obtain

$$C^n - C^s = (1 - \#D) c > 0.$$

Hence, the optimal solution must be a selective job assignment strategy.

Proposition 1 *If noncontractible organization-specific human capital is important at the top of an organization, there exists an equilibrium in which the government can place highly capable employees in high value jobs at the beginning of the second period, and the empirical predictions of the equilibrium are then consistent with the four empirical features found by our empirical study using job values.*

The intuition behind the proposition is as follows. Because organization-specific human capital is important for top but not middle managers, it is cost effective that only candidates for top manager positions invest in human capital. To encourage only these candidates to invest, the government has an incentive to reveal their evaluation to officials. For this

purpose, the job assignment strategy to the same hierarchical rank can be designed to provide a credible signal.

8.2 Discussions

The model indicates that assignment to a particular job of the same hierarchical rank can be considered a signaling device against the possibility of promotion. However, if the government has an incentive to reveal its assessment of an official's competence, we could realistically believe there are many other ways to send a similar signal. Why then should job assignments be used as a signaling device?

We consider two possibilities. First, as assignment to a job is public information, the signal provided is more transparent and reliable. If it were not public information, the government might have an incentive to promise promotions to all officials. Thus, officials may be less likely to trust private information obtained from the government. Therefore, by using the job assignment strategy as a signaling device, officials no longer need to worry about the possibility that the government might lie, thereby promoting investment in organization-specific human capital.

Second, although we constructed a simple model in which job assignment has no role other than that of a signaling device, actual job assignments may play other important roles. For example, if one workplace is a better place to learn organization-specific human capital than another, then better workers will be assigned to such workplaces. Such a possibility can easily be incorporated into the model.

Suppose that the level of organizational human capital depends on the job assignment in the second period.

$$q = \phi(a, v), \ \frac{\partial \phi}{\partial a \partial v} \geq 0,$$

where a is the staff member's ability and v is the job value of the job assigned in the second period. Using Becker's (1973) theory, we show that the optimal assignment is positive

assortative under these conditions. Without loss of generality, assume that v is also uniformly distributed in $[0, 1]$. Positive assortative matching means that $a = v$ when $a \geq a_*$. In this case, the selective job assignment strategy is not only cost effective, but also improves the quality of services provided by the government. Thus, the new role of job assignment is simply an enhancement of the benefits of the selective job assignment strategy.

9 Conclusion

This paper develops a method to assign each job a value that evaluates the likelihood and speed of promotion from each job to top executive and applies this method to investigate the career paths of officials in the Japanese public sector. We find that outwardly similar jobs within the same hierarchical rank yield major differences in the probability of being promoted to top executive. We also detect frequent real demotions and the presence of implicit fast tracks for elite officials, matters unable to be detected through use of hierarchical rank. We also provide a model that can account for this new evidence. Our model shows that if noncontractible organization-specific human capital is important at the top of an organization, assignment to a specific job of the same hierarchical rank can be a credible signal for promotion to top management.

Because it seems a reasonable conjecture that organizations utilize movements within hierarchical rank for several purposes, it could be possible that the great heterogeneity of jobs within the same hierarchical rank can be found in other institutions. Because the method provided in this paper is applicable to any organization with a clear career goal of promotion, it would be useful for systematically revealing this hitherto hidden feature of career movement. For this reason, we trust it can help provide further important evidence about internal labor markets.

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Table 6: Standard job titles and their official ranks

Hierarchical rank	Standard title
8	Vice-Minister
7	Director-General
6	Director
5	Section Manager
4	Office Manager
3	Assistant Section Manager
2	Chief Official
1	Official

This table summarizes the standard job titles and their official ranks in Japanese ministries prescribed by the "Cabinet Ordinance on Standard Job Titles."

A Standard Job Titles and Official Ranks

Table 6 lists the standard job titles and their official level prescribed by Japanese cabinet.

B Number of Officials by Entry Year

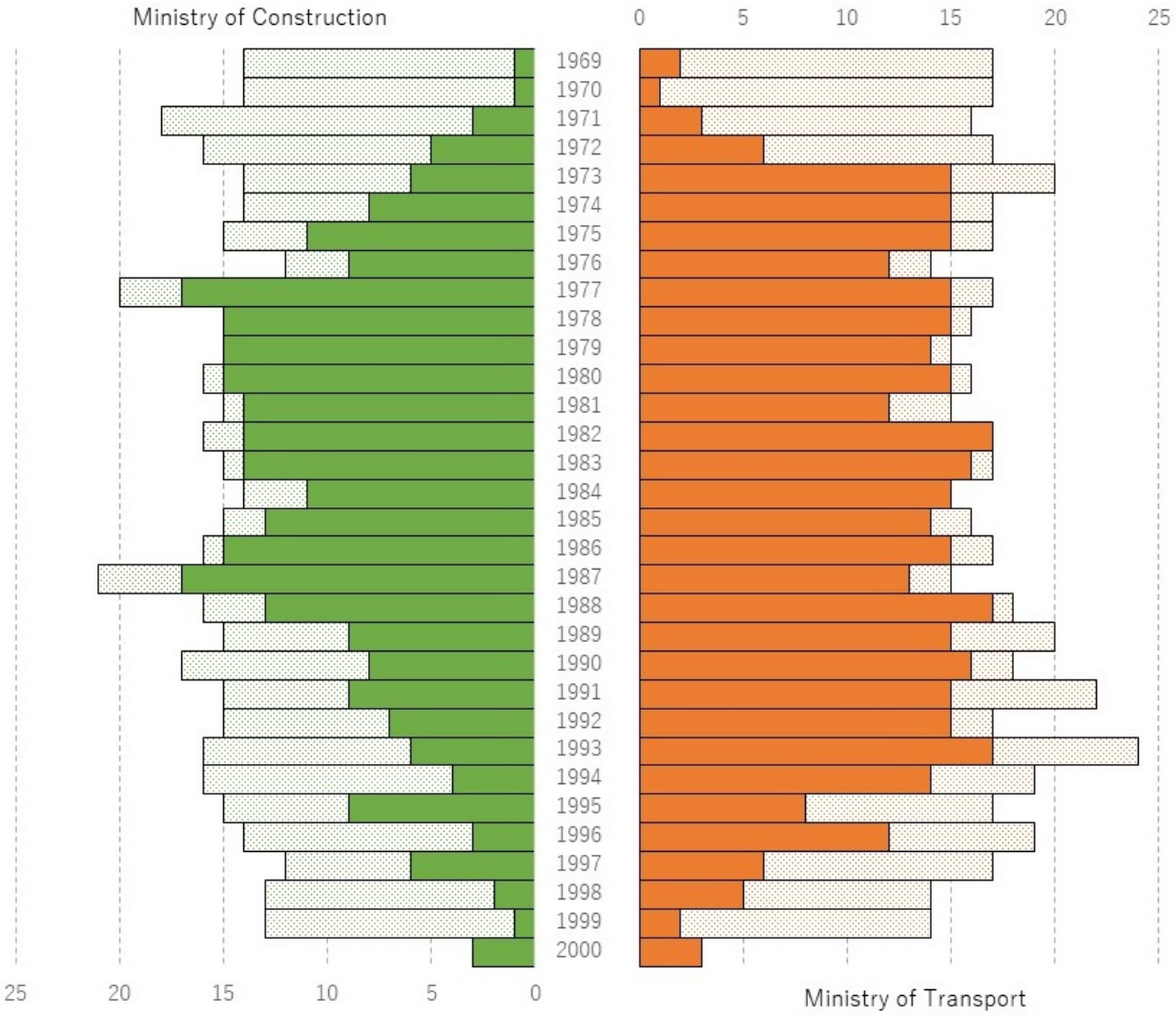
Figure 6 illustrates the representativeness of our data set. The dark shaded bar in Figure 6 represents the number of the officials included in the data set for each entry year. The light shaded area represents the officials we could not capture because they either retired or were not yet promoted to middle manager. As shown, while our data set covers more than 70 percent of all officials who entered the two ministries in each entry year during the period 1974–1988, it does not for other entry years.

C Assignment of Hierarchical Ranks

This section discusses the detailed procedures for the assignment of hierarchical ranks. Firstly, we select the 19 major titles from the 178 different titles in the internal bureaus of the MLIT and the four ministries antecedent to the MLIT.[15] The major titles are the 18

[15]We first focus on the job titles in the internal bureaus of MLIT. This is because there are a great variety of external organizations in the data set and because the rank of one title in an internal bureau is likely to

Figure 6: Number of officials by entry year



This figure shows by entry year the numbers of officials captured. The darker (lighter) shaded areas are officials included (not included) in the data set. On the left side of the figure are those that entered the MOC and on the right side those that entered the MOT.
Source: National Personnel Authority annual reports.

titles that account for at least 0.5 percent of the observations with job titles, as well as the top title to which one of the 18 titles are moved. These major titles cover 87.4 percent of the total observations with internal job titles.

Using the sample of job histories with recall data, we construct the transition matrix to present moves between jobs with the major titles in the internal bureaus. Table 7 shows the matrix. Because the names of the lowest-rank titles are blank in our data set, the titles that should be categorized at Rank 1 do not appear in the transition matrix. The earliest jobs are, however, moved only to Title A within the major titles, and no one enters this title from the other titles. Thus, it is natural to categorize Title A as Rank 2. The moves from Title A are then to Titles B, C, and D in the internal bureaus, save transfers at the same title (A) and transfers to external organizations, so these three titles are categorized as Rank 3. Iterating this process, the major titles can be classified into the seven ranks. And we assign Rank 1 to the first job for each official by taking advantage of the fact that there is a single port of entry for new graduates in the ministry.

Next, we assign appropriate hierarchical ranks to the jobs with titles other than the major ones based on the transition patterns between titles. As discussed, it is common to exchange officials between the central government and other organizations. Hence, we need to assign a hierarchical rank to a job in other organizations. One difficulty is that the same title appears not only in the internal bureaus of the MLIT but also in the external organizations. As it is likely that the same title in different external organizations has a different role, we allow that a job title in one external organization can be at a different hierarchical rank from the same title in another external organization. We assign a unique title if an official's title is blank or an official is studying abroad. In the end, we have 1,236 different titles except for the major ones to assign hierarchical ranks.

be different from that of the same title in an external organization.

Table 7: Transition matrix between major job titles

Rank	Title	2	3			4							5		6			7	8		Other	External	Exit	Total
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S				
2	A	78.3	1.2	1.7	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5	17.7	–	100
3	B	–	80.0	–	0.7	0.5	1.1	1.7	0.2	0.0	0.6	0.1	–	–	–	–	–	–	–	–	3.8	11.4	–	100
	C	–	5.1	70.2	10.4	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.3	11.7	–	100
	D	–	1.6	0.5	81.1	0.5	0.1	–	0.1	0.1	0.6	0.6	–	–	–	–	–	–	–	–	1.4	13.7	–	100
4	E	–	0.2	–	0.3	71.4	–	–	0.2	–	1.1	0.4	5.2	0.5	–	–	–	–	–	–	2.6	18.1	–	100
	F	–	0.5	–	–	1.9	64.9	–	–	0.5	6.6	–	–	–	–	–	–	–	–	–	12.8	12.8	–	100
	G	–	–	–	–	–	2.0	59.2	–	–	25.9	5.4	–	–	–	–	–	–	–	–	2.7	4.8	–	100
	H	–	2.4	–	–	1.2	–	–	65.9	–	–	–	1.2	–	–	–	–	–	–	–	8.5	20.7	–	100
	I	–	–	–	–	9.2	–	–	–	63.2	2.6	1.3	–	1.3	–	–	–	–	–	–	–	22.4	–	100
	J	–	–	–	–	8.5	0.1	–	0.1	0.8	71.8	1.4	1.4	0.3	–	–	–	–	–	–	3.7	11.9	–	100
	K	–	0.8	–	2.5	5.0	–	–	–	1.7	14.2	56.7	5.0	1.7	–	–	–	–	–	–	4.2	8.3	–	100
5	L	–	–	–	–	0.4	–	–	–	–	–	0.0	79.8	2.0	2.1	0.8	0.5	–	–	–	1.7	12.8	–	100
	M	–	–	–	–	–	–	–	–	–	–	0.3	24.9	61.3	1.0	–	–	–	–	–	2.6	9.5	0.3	100
6	N	–	–	–	–	–	–	–	–	–	–	–	–	–	67.7	2.7	6.3	2.5	–	–	3.5	13.9	3.5	100
	O	–	–	–	–	–	–	–	–	–	–	–	–	–	2.3	67.4	11.6	3.1	–	–	3.9	10.1	1.6	100
	P	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5	0.5	64.4	6.7	–	–	11.9	14.4	1.6	100
7	Q	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	72.7	5.0	–	8.0	6.7	7.6	100
8	R	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	69.2	11.5	–	5.1	14.1	100
	S	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50.0	–	–	50.0	100
	Other	3.1	1.1	0.2	0.5	1.1	0.2	0.1	0.0	0.1	1.0	0.1	0.7	0.1	0.1	0.0	0.0	0.5	0.2	–	81.9	8.8	0.4	100
	External	0.3	1.7	0.4	1.4	1.3	0.2	0.1	0.1	0.1	0.5	0.0	2.1	0.3	0.3	0.1	0.1	0.1	0.0	–	2.0	88.0	0.9	100
	Total	3.1	6.0	1.0	5.2	4.0	0.6	0.4	0.2	0.2	2.4	0.3	7.5	0.8	1.0	0.3	0.5	0.6	0.2	0.1	15.2	49.8	0.7	100

This table details the transition matrix among the major titles selected from the different titles in the internal bureaus of the ministry using the sample of job histories with recall data. "Other" are titles other than the major titles in the internal bureaus, and "External" are all titles in external organizations. A hyphen denotes a zero-transition probability. Moves within a box are stays, moves to the right (except Other and External) promotions, and moves to the left demotions.

There is a caveat. Because we have many minor titles not only in the internal bureaus but also in an external organization, we must extrapolate the hierarchical ranks of some minor titles using a procedure not prescribed in Baker, Gibbs, and Holmstrom (1994). Suppose that an official is appointed to a position X that has an unknown rank x. Suppose that s/he has spent t_1 years to be appointed to the position since s/he had been appointed to a different position that has Rank n. Suppose also that s/he is appointed to a new position that has Rank m in t_2 years later. The estimated rank x of the position X is the weighted average of the two known ranks:

$$x = \frac{t_2 n + t_1 m}{t_1 + t_2}.$$

This measure reflects the relative distance between the two positions with known ranks: if $t_1 < t_2$, then the rank of the position X should be relatively closer to Rank n. Because we can observe several officials who were appointed to some position X, we assign the closest integer to the average of x over all officials belonging to position X as the hierarchical rank of this position.

There are some officials belonging to position X but we are unable to calculate their weighted average because we are unable to locate the two positions with known rank needed for this calculation. To assign the hierarchical rank to these positions, we conduct the following iteration. We first estimate the hierarchical rank of minor titles that we can calculate using the weighted average for all officials belonging to only major titles. Because this increases the number of positions that can be utilized to calculate the weighted average for some officials, we iterate this procedure until there is no job that we can assign a rank using this procedure. In the second round, we conduct the same procedure for the minor titles that we can calculate a weighted average for the 90 percent of officials. We repeat this iteration by changing the criterion from 90 percent to 80, 70, and then 66 percent. This iteration allows us to assign a rank to 86.4 percent of titles.

Even when iterating this procedure, we cannot estimate the ranks of some titles if they move to retirement or if there is no title to which they are moved in the next period. For

each official we set x =rank of the job in the previous period+0.5 in the former case and x =rank of the job in the previous period in the latter case. Then we assign the closest integer to the average of x across officials to the rest of the titles.

As a result of the process stated in this subsection, all job titles are successfully categorized into eight hierarchical ranks, which are consistent with the official ranks of standard job titles prescribed by the cabinet ordinance. We consider that jobs at Ranks 7 and 8 in the internal bureaus of all ministries can be regarded as top executives. This is because Director-General, Title Q in Table 7, at Rank 7 has the ultimate authority and responsibility for each policy field under the jurisdiction of each bureau that is the primary department of the central offices in the ministry.

D Comparison Between Samples

In Section 4.1, we discuss the patterns of promotion and demotion based on the transition matrix between the hierarchical ranks using the sample of complete job histories for middle- or high-rank managers. In Section 5.2, we discuss the distribution and transition of job values using the same sample. In this section, we reveal the robustness of the result even when using the sample of job histories with recall data.

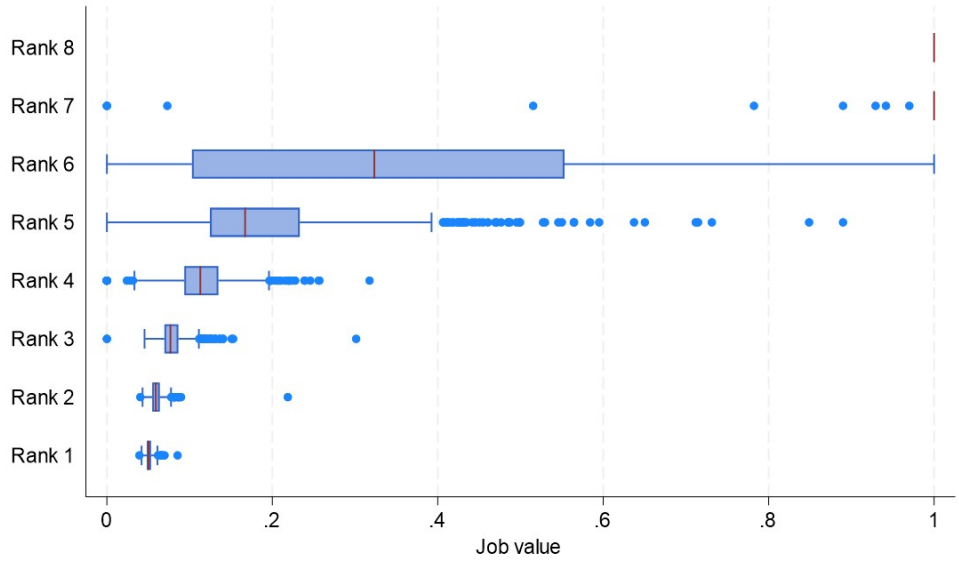
Table 8 details the transition matrix between the hierarchical ranks using the sample of job histories with recall data. Figure 7 shows the distribution of job values calculated using the same sample. The results are almost the same at Rank 4 or higher as those using the sample of complete job histories. But we need to be careful about the values for the jobs at Rank 3 or lower because the job history in the early career stage is partly omitted.

Table 8: Transition matrix between hierarchical ranks

Current	Next rank									
rank	1	2	3	4	5	6	7	8	Exit	Total
1	91.1	7.3	1.5	0.0	-	-	-	-	-	100
2	-	86.5	13.3	0.2	-	-	-	-	-	100
3	-	0.2	93.0	6.8	0.1	-	-	-	0.0	100
4	-	-	0.7	91.5	7.7	0.1	-	-	0.0	100
5	-	-	0.1	1.0	94.0	4.5	0.1	-	0.5	100
6	-	-	0.1	-	1.0	85.2	6.5	0.1	7.1	100
7	-	-	-	-	-	2.0	81.5	6.4	10.2	100
8	-	-	-	-	-	-	1.4	75.7	22.9	100
Total	15.1	9.3	25.6	21.7	20.4	5.2	1.6	0.4	0.7	100

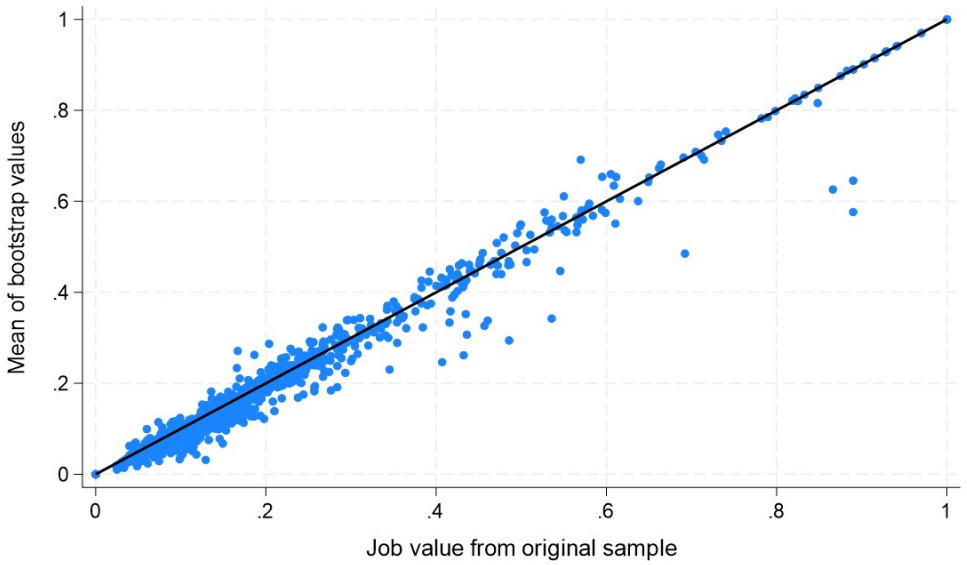
This table details the transition matrix among the hierarchical ranks using the sample of job histories with recall data. A hyphen denotes a zero-transition probability. Moves within a box are stays, moves to the right promotions, and moves to the left demotions.

Figure 7: Distribution of job values within the same hierarchical rank



The box plot provides the distribution of job values calculated using the sample of job histories with recall data by hierarchical rank.

Figure 8: Average job values using bootstrap sampling



For each individual job, this figure plots the job value computed using the original sample on the horizontal axis and the average of job values computed using bootstrap sampling on the vertical axis. The solid line is the 45-degree line.

E Measurement Errors in Job Values

Figure 8 plots each job value computed using the original sample and the average of job values computed using bootstrap sampling. For most jobs, each plot is located on the 45-degree line, and thus confirms that bootstrapping does not cause systematic bias in the job values.