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Abstract: This paper estimates matching functions to measure search frictions in the Japanese labor market and presents determinants of search duration to explain the effect of unemployment benefits on a job seeker's behavior. We employ administrative micro data that track the job search process of individuals who left or lost their job in August 2005 and subsequently registered at their local public employment service. Our finding is that the matching function would exhibit decreasing returns-to-scale for job seekers and vacancies, rather than constant return-to-scale. We also find that generous unemployment benefits lengthen (shorten) the duration of job search for job seekers who voluntarily (involuntarily) leave employment.
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1. Introduction

The matching function defines the flow of new hires as a function of the stocks of individual job seekers and job vacancies in firms. This particular function is very useful for embodying unemployment in models with search frictions because of the omission of the microfoundations for the underlying frictions when constructing these models. As a result, there are many empirical studies that estimate the matching function to measure the extent of search frictions in the labor market—see Petrongolo and Pissarides (2001) for a comprehensive survey.

These studies typically employ aggregate data at a yearly, quarterly, or monthly frequency. Needless to say, they help us better understand the job search process between job seekers and firms with job vacancies, but the use of aggregated data sometimes causes serious aggregation bias to arise.[1] To correct for it, micro data that track the search process for each individual are more appropriate. However, to the best of our knowledge, there are few studies that estimate matching functions using micro data, with the exception of Nickell (1979), Atkinson *et al*. (1984), and Petrongolo (2001).

Of these, Petrongolo (2001) is the first study known to investigate returns-to-scale in

[1] As an alternative, Coles and Smith (1996) and Anderson and Burgess (2000) employ state-level data. Here, the variance in state-specific factors reduces omitted variable bias. This provides more precise estimates of the elasticity of matching formations to the stocks of job seekers and vacancies.

the matching formation using individual data.[2] Accordingly, in the spirit of Petrongolo (2001), this paper estimates the matching function to gauge the extent of frictions in the Japanese labor market using micro data collected from job seekers with the assistance of the Japanese public employment service office. In our approach, we use two different segmentations to define the size of the local market faced by each individual job seeker, namely, the prefectural area where the job seeker lives and the smaller area administered by a local public employment service office in which the job seeker registers for employment.

In our study, we employ two large sets of administrative micro data from the Japanese Ministry of Health, Labour, and Welfare, *Report on Unemployment Insurance* and *Report on Employment Services*. Both sets of data include all individuals throughout Japan who left or lost their job in August 2005. The former data set includes the job seeker's job history, including previous wage and the precise date when the individual resigned or lost his/her job, while the latter data set includes the job seeker's individual characteristics and details about the job search process. Fortunately, individuals bear the same identification number in each data set, and this allows us to merge the two sets of data. We then obtain history-based information on when individuals quit or lost their old job, when they registered with the local employment service office and started to look for a new job, and when they found a job and exited

[2] Nickell (1979) and Atkinson *et al*. (1984) add labor market tightness as an explanatory variable to estimate the exit rate from unemployment. However, they do not address returns-to-scale in the matching formation.

from unemployment.

These administrative micro data sets have three main merits. The first is that, as mentioned above, we do not need to consider the aggregation bias that arises when data at the yearly, quarterly, or monthly frequency are used. The second is that because the data were collected for administrative purposes, respondents are not able to self-select; that is, the selection bias problem does not arise. The final merit is that unlike interview surveys, where it is usually impossible to cover large geographical areas comprehensively, the data include job seekers from all of the employment service offices located throughout Japan. Accordingly, there is no geographical bias.

This paper also estimates the duration analysis to address the effect of the generosity of unemployment benefits on a job seeker's search behavior. As shown in the implications of a well-known job search model (Lippman and McCall, 1976), generous unemployment benefits increase the job seeker's reservation wage, thus leading to an increase in the duration of unemployment. In the Japanese welfare system, the generosity of unemployment benefits varies according to age, the insured period, and whether applicants quit their employment position voluntarily or lost their job involuntarily. These differences identify the extent to which the generosity of unemployment benefits prevents job seekers from exiting from unemployment.

The main contribution of this paper is that we employ large and specialized micro data sets for the first time in Japan when evaluating the individual job search process. This allows us to measure more precisely the extent to which search frictions prevent a job seeker and a job vacancy from forming a match. It also allows us to assess the effect of the generosity of unemployment benefits on a job seeker's search behavior,

controlling for the problems of aggregation, selection, and geographical bias.

The main findings are as follows. First, regardless of whether we define the local labor market where a job seeker is active as the prefectural area where they live, or the more narrowly defined area administered by a local public employment service office where they register for employment, the matching function would exhibit decreasing returns-to-scale with respect to both job seekers and job vacancies, rather than constant return-to-scale. A possible intuition underlying this result is that a larger market apparently lowers average productivity at least partly because of the increasing formation of job mismatch. Lower productivity then shifts downward the wage offer distribution, thereby discouraging job seekers from forming a match with an encountered firm. There is also a countereffect in that lower productivity decreases the job seeker's reservation wage, and this tends to increase the probability of exit from unemployment.

Our estimates imply that the former effect dominates the latter, resulting in decreasing returns-to-scale in the matching function. This result is consistent with Kano and Ohta (2005) and Sasaki (2007), though both of these studies estimated the matching function using aggregate data. One implication is that our estimate does not ensure that a unique unemployment rate exists along the steady-state growth path (Mortensen and Pissarides, 1998; Pissarides, 2000). According to a parametric estimate of the duration analysis using a Weibull distribution, the hazard rate is then negatively dependent, implying that the longer-term unemployed are less likely to exit from unemployment, in part because of skill depreciation.

We also find, as one would expect, that more generous unemployment benefits extend

the search duration for job seekers who quit their job voluntarily. However, we also find that job seekers who lost their job involuntarily are more likely to return to work, even though they are eligible to receive more generous unemployment benefits. This may be because those who lose their job against their will may have a stronger preference for work, and therefore, they are eager to exit from unemployment as soon as possible, despite the generous provision of unemployment benefits.

The remainder of the paper is organized as follows. Section 2 presents the econometric specifications. Section 3 describes the two data sets obtained from the Japanese Ministry of Health, Labour, and Welfare and defines search duration and the covariates. Section 4 reports the estimated results, and Section 5 provides some concluding remarks.

2. Econometric specifications

In this section, and following Petrongolo (2001), we construct the estimating equation of an individual-level matching function when microdata are used. Many earlier studies estimate the matching function to measure the extent of search frictions in the labor market.[3] Importantly, these studies generally employ aggregate data on job seekers, job vacancies, and matched jobs (Petrongolo and Pissarides, 2001). Because the micro data capturing the individual matching process are available, we can estimate the

[3] There is an additional literature that addresses the issue of non-random matching. For example, Coles and Smith (1998) and Coles and Petrongolo (2008) estimate a stock-flow matching model and show that this performs better than the random matching function.

returns-to-scale in the matching formation and the effects of unemployment benefits and their provision period on the exit rate from unemployment.

A standard matching function is:

$$M_j = \bar{A}_j U_j^{\beta} V_j^{\gamma},$$

where M_j is a measure of job matches formed during a given length of time in area *j*, U_j is a measure of unemployed in area *j*, and V_j is a measure of job vacancies in area *j*. The parameters β and γ indicate the elasticity of M_j with respect to U_j and V_j, respectively. $\bar{A}_j$ is a measure of the extent of area-specific search technology and/or the average search effort put into job search by the unemployed living in area *j*. We assume this function is increasing in both arguments. Note that employed job seekers are not included in U_j; that is, a group of job seekers consists only of unemployed workers, as explained later in detail. Similarly, V_j excludes nonregistered vacancies, and M_j represents the number of matches only between U_j and V_j. Therefore, we do not need to address the problem of endogeneity that results from job competition between unemployed and employed job searchers and vacancy competition between registered and nonregistered firms.[4]

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[4] Broersma and van Ours (1999) and Mumford and Smith (1999) argue the need to correct for the bias caused by unobserved employed job searchers. Anderson and Burgess (2000) address endogenous on-the-job search as a source of estimation bias (or job competition). Fahr and Sunde (2005) deal with the endogeneity problem caused by alternative vacancy postings (or vacancy competition). Finally, Sunde (2007) uses a different approach to identify the bias caused by both job and vacancy competition.

The average exit rate of an unemployed worker living in area *j* is then:

$$\bar{\lambda}(U_j, V_j) = \bar{A}_j U_j^{-(1-\beta)} V_j^{\gamma} = \exp\left[\ln\bar{A}_j - (1-\beta)\ln U_j + \gamma \ln V_j\right].$$

Note that this function is nonnegative. The exit rate of an unemployed individual *i* is then given by:

$$\lambda\left(U_j, V_j, X_i, Z_j\right) = A\left(X_i, Z_j\right) U_j^{-(1-\beta)} V_j^{\gamma} = \exp\left[\ln A\left(X_i, Z_j\right) - (1-\beta)\ln U_j + \gamma \ln V_j\right],$$

where X_i is a vector of individual characteristics, and Z_j is a vector of area-specific characteristics.

We employ a parametric estimation method with a Weibull distribution and a semiparametric estimation method with a proportional hazard model (Cox, 1972) to estimate the search duration. The hazard rate is thus:

$$h\left(t_i; U_j, V_j, X_i, Z_j\right) = \lambda\left(U_j, V_j, X_i, Z_j\right)\phi(t_i),$$

where $\phi(t_i) > 0$ represents the baseline hazard function common to all individuals. An individual hazard therefore differs proportionally by λ. In the parametric estimate with a Weibull distribution, $\phi(t_i) = \alpha t_i^{\alpha-1}$ where α is a parameter indicating the extent of duration dependence.[5] The estimated equation follows a log-linear specification:

$$\ln h\left(t_i; U_j, V_j, X_i, Z_j\right) = \ln A\left(X_i, Z_j\right) - (1-\beta)\ln U_j + \gamma \ln V_j + \ln\phi(t_i).$$

Many earlier empirical studies have been preoccupied with the nature of equilibrium. One issue that needs to be considered in the estimation of a matching function is to test whether the matching function exhibits constant returns-to-scale with respect to U_j and V_j, implying that the rate at which a job seeker encounters a vacancy is determined by

[5] If $\alpha > 1$ ($\alpha < 1$), the hazard rate is positively (negatively) dependent.

labor market tightness, V_j/U_j, but not by the market size. If $\beta + \gamma = 1$ (that is, the coefficients of $\ln U_j$ and $\ln V_j$ are equal in the absolute term), we support the hypothesis of constant returns-to-scale. This ensures that the unemployment rate is uniquely determined when flows into and out of the unemployment pool are equal. However, if $\beta + \gamma > 1$, the matching function exhibits increasing returns-to-scale, thus implying that an increase in search effort on one side of the stocks encourages the other side of the stocks to devote more search effort, as well as to decrease the search cost incurred by the other side. This situation leads to multiple-ranked equilibria (Diamond, 1982).

The estimates also provide the extent of externalities that determine the degree of efficiency in the decentralized labor market. For instance, the absolute value of the coefficient on $\ln U_j$, $(1 - \beta)$, indicates the extent of congestion externality in the sense that the entry of one more unemployed person makes it more competitive for any incumbent unemployed to look for a job. Conversely, the coefficient on $\ln V_j$ (γ) indicates the extent of search externality with the entry of one more job vacancy, making it less competitive for the unemployed to find a job.[6]

Although the measures of the unemployed and job vacancies vary over time through their continuous inflow and outflow during a spell of unemployment, we treat them as time-invariant covariates in our estimation. That is, the local labor market conditions

[6] The estimate of β measures the search externality with the entry of an unemployed person making it less competitive for firms to find an unemployed person, while $(1 - \gamma)$ indicates the extent of the congestion externality in that the entry of a job vacancy lowers the probability of other incumbent firms finding an unemployed person.

prevailing at the time an individual starts to search for a job serve as the covariates. To counter the argument that local labor market conditions at the time an individual starts to look for a job are not relevant to the decision of exiting from unemployment after a spell of searching for a job, we specify local labor market conditions just one month before each individual exits as the time-invariant covariates. For individuals whose spell of unemployment is incomplete, we use local labor market conditions at the end of the observed interval.

3. Data

We employ two administrative micro data sets constructed by the Employment Security Bureau, Japanese Ministry of Health, Labour, and Welfare. The first is the *Report on Unemployment Insurance*. This data set contains the job history of an insured person, including the wage previously earned and the actual date when the person resigned from his/her employment or lost it between August 1 and August 31, 2005. This data set does not include those ineligible for unemployment insurance, including the self-employed, housewives, and part-time workers (those working fewer than 20 hours per week). The data set also does not include disadvantaged persons and those with a disability.[7] The second data set is the *Report on Employment Services*, which captures the job search process conducted by the individuals who quit or lost their job between August 1 and August 31, 2005. This data set tracks and monitors the process of job search from the

[7] Disadvantaged persons are: (1) persons aged more than 65 years, (2) seasonal workers, (3) daily workers, and (4) job seekers who have been unemployed for more than a year.

date when a job seeker registered at his/her local employment service office to the date when he/she found a job, or the last date in the observed interval (July 13, 2006).

Both data sets include a common identification (ID) number for each job seeker, and this allows us to merge the data sets using the ID number. This data processing operation leaves us with only job seekers who are eligible to receive unemployment benefits during their job search and have registered at the public employment service office and frequently visit to receive benefits.[8] Note that those who join the unemployment insurance program cannot actually receive benefits without first registering with the public employment service office. Because the date an individual quit or lost his/her last job does not exactly correspond with the date he/she registered as a job seeker at the local employment office, as a robustness check, we use not only the date when individuals registered with the employment office but also the date when they quit or lost their previous employment as the starting date for job search. Therefore, two separate sets of search duration data are available in our estimates. In addition, because the *Report on Employment Services* tracks and monitors job search on a weekly basis, the frequency of the search duration data is weekly.

Our concern now moves to the covariates. We begin with the local labor market conditions. Two methods are employed to measure the tightness of the local labor

[8] Some of the literature focuses on identifying the effect of search methods on the search duration. See, for example, Blau and Robin (1990) in the US, Gregg and Wadsworth (1996) in the UK, and Addison and Portugal (2002) in Portugal. The public employment service is popular for job seekers and productive in forming matches in the UK (Jobcentre), but not in the US and Portugal. In this paper, we do not explore which particular search methods are more productive.

market. The first is simply to use monthly measures of job seekers and job vacancies in a prefecture where an individual resides. The merit of using prefectural data is that we can obtain prefectural labor market conditions at the time of just one month before each individual exits and at the end of the observed interval, as well as when the individual starts to search for a new job. This is because the release of the prefectural-level data on job seekers and job vacancies is monthly, allowing us to observe the effect on the exit rate of the most recent labor market conditions. However, one problem is that the prefectural labor market is so geographically large that it does not necessarily match up with the exact area where an individual is actively searching for a job.

To compensate for this shortcoming, we instead use measures of job seekers and job vacancies registered at the local public employment service office where an individual registered to receive unemployment benefits. This precisely pins down the labor market where individuals are actually looking for a job. It is of course possible that an individual actively searches for a job in, for example, an urban area, despite his/her registration being with the local employment service office nearest to their suburban residence. The main problem of using this method is, additionally, that the aggregate data on job seekers and job vacancies registered at each employment service office are available only at a yearly frequency. We use the 2005 data on job seekers and job vacancies. The data on job seekers and job vacancies in the local labor market (both at the prefectural level and in the area administered by the local employment service office) are obtained from the Japanese Ministry of Health, Labour, and Welfare.

Unemployment benefits and individual characteristics are crucial covariates determining the search duration. This is because we consider these as proxies indicating

the extent of job search effort, the level of human capital and the level of the reservation wage. As background, we outline the Japanese unemployment insurance system before we explain how we include unemployment benefits in the vector of covariates. In sum, the unemployed in Japan receive 50–80% of their wage prior to becoming unemployed for 90 to 360 days. The amount of benefits and the provision period then depend on the person's age, the length of the insured period, and whether they resigned from their previous employment voluntarily or lost their job involuntarily.

All other things being equal, an employed person receives more generous benefits if they are older, if they have become involuntarily unemployed, and/or when insured for a longer period. When an unemployed person exits from unemployment at an early stage (before the last day for the provision of benefits), the benefits remaining are partially paid if certain conditions are met. After the provision of unemployment benefits ends, alternative allowances are not available for any unemployed still looking for a job.[9]

It is expected that the generosity of unemployment benefits affects the level of search effort; that is, when benefits are more generous, the unemployed put less effort into searching for a job. We employ several dummy variables indicating the types of unemployment benefits: 90, 120, 150 days of benefits with voluntary job turnover, and 90, 120, 180, 240, and more than 240 days of benefits with involuntary job turnover. Finally, some individual characteristics are included in the vector of covariates, including age, sex, marital status, education, prior job tenure, and the prior wage. These

[9] In contrast, in Europe, public assistance continues for the unemployed still looking for a job, even after the provision of unemployment benefits ends.

covariates determine an individual's level of human capital and the reservation wage. The Appendix provides some descriptive statistics.

4. Results

4.1 Labor market conditions

Table 1 reports estimated results of the matching function where prefectural data on job seekers and job vacancies as of August 2005 define the local labor market conditions. In the first two columns of Table 1, we define the starting date of job search by when an individual registered at the local public employment service office, and in the second two columns by when they quit or lost their previous job. Columns [1] and [3] provide the semiparametric estimates using Cox's proportional hazard model, while columns [2] and [4] present the parametric estimates using a Weibull distribution.

Regardless of the starting date of job search, the estimated coefficient on job seekers is negative while that on job vacancies is positive according to the semiparametric estimations (columns [1] and [3]). This is consistent with our expectations. However, while the job seekers' coefficient is significant at the 1% level, the coefficient on job vacancies is statistically insignificant. In addition, the former is larger in absolute magnitude than the latter, and the sum of these coefficients is less than zero. We therefore reject the hypothesis that the sum of the coefficients is zero, suggesting that the matching function does not exhibit constant returns-to-scale, rather decreasing returns-to-scale. This result is inconsistent with the existence of a unique unemployment rate along the steady-state growth path (Mortensen and Pissarides, 1998; Pissarides, 2000).

However, this result is consistent with the estimated matching functions in Kano and Ohta (2005) and Sasaki (2007) when using aggregate data by prefecture.[10] Nevertheless, Sasaki (2008) still shows that the matching function exhibits constant returns-to-scale after correcting for the temporal aggregation bias that arises when discrete-time data are used to estimate a continuous-time matching formation.[11,12] Ueno *et al*. (2004) also estimate the job matching function by including the individual characteristics of job seekers, and they conclude that the matching function exhibits constant returns-to-scale.[13] Lastly, Petrongolo and Pissarides (2001) survey the international literature and summarize on this basis that the job matching function across countries and over time generally exhibits constant returns-to-scale.[14]

In columns [1] and [3], the elasticity of job matches with respect to job seekers lies within the range 0.765–0.778, while the elasticity with respect to job vacancies is relatively smaller in magnitude, from 0.070 to 0.084. This implies that an additional job

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[10] Kano and Ohta (2005) find that $\beta + \gamma = 0862$ and Sasaki (2007) that $\beta + \gamma = 0.830$. This is apparently despite some differences in sampling, where Kano and Ohta (2005) include regional data from 1973 to 1999 and Sasaki (2007) uses quarterly regional data from 1998 q1 to 2007 q1.

[11] Sasaki (2008) suggests that the matching function formation should be nonrandom (stock–flow matching); however, the estimation advantage appears trivial.

[12] Burdett *et al*. (1994) and Coles and Petrongolo (2008) both show how to correct for the temporal aggregation bias.

[13] This study covers data from 1991 to 2001.

[14] Yet other studies find that the matching function exhibits increasing returns-to-scale (Blanchard and Diamond, 1989; Yashiv, 2000).

vacancy has only a minor effect on the probability of forming a job match.

Similar results are obtained in the parametric estimations with a Weibull distribution, as shown in columns [2] and [4] in Table 1. This part of the analysis shows that the hazard rate of a job seeker is negatively dependent, implying that the exit rate of a job seeker from unemployment becomes lower as the search duration becomes longer. In turn, this suggests that job seekers are more likely to become long-term unemployed, at least partly because the job seekers' human capital depreciates as the duration of unemployment becomes longer.

Table 2 provides the estimated results of the matching function using the data on prefectural labor conditions either one month before the job seeker exited from unemployment or at the end of the observed interval (July 13, 2006). As shown in columns [1] and [3] of the semiparametric estimations, job vacancies have a positive impact on search duration at the 5% level of significance, while job seekers maintain a negative effect at the 1% level of significance. As in Table 1, the sum of the coefficients on $\ln U_j$ and $\ln V_j$ is negative, thus indicating that the matching function exhibits decreasing but not constant returns-to-scale.

However, unlike the estimates in Table 1, the magnitudes of these coefficients are larger in the sense that the elasticity of job match to job seekers is smaller (0.399–0.510), while the elasticity with respect to vacancies is larger (0.287–0.381). Given the difference in data sampling between these two sets of estimates, this implies that search and congestion externalities are larger when we specify data one month before a job match or at the end of the interval, and but in August 2005. The reason why the externalities are small using the data as of August 2005 is as follows. An increase in job

vacancies in August 2005 increases the likelihood that a job seeker exits from unemployment, but may also discourage the job seeker from job search hastily because he/she believes many vacancies remain available. We expect the latter effect to relatively dominate when job search activity begins in August 2005, while the former effect relatively dominates one month before the formation of a job match.

We can interpret an increase in the coefficient on $\ln U_j$ in a similar manner. Because job seekers are not very serious in searching for a job as of August 2005 when search activity actually begins, the entry of an additional job seeker does not generate a serious congestion externality for other job seekers. However, because job seekers become gradually more serious in searching for a job as they keep searching, the entry of an additional job seeker generates a large congestion externality for incumbent job seekers. The inclusion of independent variables indicating a job seeker's individual characteristics should help control for the extent of individual search effort to some degree, but it apparently does not do this perfectly.

Regardless of the starting date of job search, the same results are obtained in the parametric estimations with a Weibull distribution, as shown in columns [2] and [4] of Table 2. As in Table 1, the hazard rate of a job seeker is negatively dependent, thereby indicating that in the Japanese labor market, the longer-term unemployed have greater difficulty in exiting from unemployment.

Table 3 presents the estimated matching function where job seekers and job vacancies registered at each employment service office in 2005 are used as the local labor market conditions. As a result, the labor market where a job seeker is actively searching is defined by the area administered by the local employment service office at which they

registered for employment. Note that we specify yearly data for 2005. Despite these differences in sampling, the estimated results are close to those in Table 2 in the sense that the coefficient on job vacancies remains positive at the 5% level of significance, while the coefficient on job seekers remains negative at the 1% level of significance. Moreover, the sum of these coefficients is also negative, again indicating that the matching function exhibits decreasing returns-to-scale.

The results are also similar to those in Table 1 in the sense that the search and congestion externalities are both relatively small when we specify yearly data for 2005 from the local labor market as administered by the local employment service office. Because the data on local labor market conditions are weighted averages from January to December 2005, the discouraged job seeker effect—in the sense that an additional vacancy discourages a job seeker from beginning job search hastily and that an additional job seeker does not yet generate a serious congestion externality to other job seekers—is relatively strong, and this reduces the magnitude of these externalities.

According to the parametric estimates with a Weibull distribution (columns [2] and [4] in Table 3), the hazard rate remains negatively dependent, when the starting date of job search is defined as when an individual registered with the public employment service office (column [2]). However, it becomes positively dependent when we specify the date at which an individual quit or lost his/her job as the starting date of job search (column [4]).

Overall, Tables 1–3 provide robust results indicating that the matching function exhibits decreasing returns-to-scale, thereby implying that doubling the number of job seekers and job vacancies delivers fewer than twice as many job matches. One of the

possible reasons for this is *negative* scale effects at the level of the local labor market. For instance, Petrongolo and Pissarides (2006) hypothesize that a larger market size increases productivity on average to support increasing returns-to-scale at the structural level. Our view is contrast with Petrongolo and Pissarides (2006) in that a larger market size somehow *decreases* productivity on average, possibly because the limited number of staff at employment service offices cannot efficiently coordinate productive job matching formations between too many unemployed and job vacancies. Alternatively, it could be because the transfer of job information in a larger market to both the unemployed and firms is not as efficient, resulting in unproductive job matches (or mismatches). A decrease in productivity then shifts downward the wage offer distribution, thereby discouraging job seekers from forming a match with an encountered firm. A countereffect is that lower productivity decreases the reservation wage of job seekers, encouraging them to exit from unemployment. Based on our estimates, we thus conclude that the former effect dominates the latter, thereby leading to decreasing returns-to-scale.

4.2 Unemployment benefits

This subsection focuses on the effects of unemployment benefits on a job seeker's search behavior. Tables 1–3 provide the estimated results, assuming that the reference dummy is "the provision of benefits for 90 days because of voluntary turnover". While some of the results obtained are qualitatively alike in these tables, the effects differ to some extent by the level of significance. One noteworthy finding is that according to the parametric and semiparametric estimates of the duration analysis in columns [1]–[4], job seekers who resign (are removed) from their previous employment voluntarily

(involuntarily) are less (more) likely to exit from unemployment. In particular, those who lose their previous job involuntarily and are eligible to receive benefits for 120 days are the quickest to exit from unemployment. In addition, even though job seekers are eligible to receive benefits for more than 90 days, those job seekers who quit their job against their own will are generally eager to get back to work as soon as possible.

Focusing attention on job seekers who quit their previous job voluntarily, we can see that generous benefits encourage them to spend more time looking for a job, and this extends the duration of unemployment. This is consistent with the predictions of the benchmark search model. We can interpret this result as meaning that unemployment benefits lower matching effectiveness in the sense that it takes more time to form a match between a job seeker and a job vacancy.

However, we should also note that matching effectiveness is not only measured by the time it takes to form a match (the search duration) but also by the wage rate earned after matching with a new firm and the length of tenure experienced at the new firm. To account for this, we predict that greater benefits increase an individual's reservation wage, leading to both a longer duration of unemployment and a higher wage if eventually hired at a new firm. There are, of course, trade-offs in terms of matching effectiveness between the duration of unemployment and the expected wage at the new firm (or matching quality). In terms of work in this area, Kohara *et al*. (2010) explores the effect of the unemployment insurance system on matching effectiveness as measured by the length of tenure at a newly matched firm, using the same micro data as the present analysis.

4.3 Other covariates

Finally, we report on the extent to which individual characteristics affect the exit rate from unemployment (the duration of job search). The covariates include proxies indicating the level of human capital, the reservation wage, and the search effort. Once again, many of the results are common in Tables 1–3. To start with, compared with married women, single women and single and married men are more likely to exit from unemployment. This supports the notion that the reservation wage of married women is relatively high because these women receive income earned exogenously by their husbands and because the customary division of labor in Japan (husbands concentrating on market work while wives specializing in household duties) may remain prevalent.

We also find that the more educated find a new job at earlier stages of the job search process. One intuition behind this result is that because the more educated incur a greater burden of the opportunity cost of being unemployed, they put more effort into searching for a job. In addition, a higher wage in the previous job also induces job seekers to exit from the unemployment pool more quickly. We interpret this as meaning much the same, namely, that the more educated who are expected to receive a higher wage in their previous job incur a higher opportunity cost of being unemployed.

Finally, job seekers who are older or have enjoyed longer tenure in their previous job are less likely to exit from unemployment. This could be because they are skillful enough to set their reservation wage sufficiently high. Alternatively, it could be because as they have worked longer, they have saved sufficient funds, which allows them to delay the process of finding a new job.

5. Concluding remarks

Using administrative job search micro data from the Japanese Ministry of Health, Labour, and Welfare, this paper estimates matching functions to measure the extent of search frictions in the Japanese labor market and presents a duration analysis to elucidate the effect of unemployment benefits on a job seeker's behavior. It is important to note that the administrative data are extremely valuable in that they track the job search process of job seekers who resigned from their employment or lost it in August 2005 and subsequently registered at one of the local public employment service offices located throughout Japan. Because these are administrative micro data sets, neither aggregate, sample selection nor geographical bias potentially arises. This is the first research attempt known to use this particular data set for the purpose outlined in this paper.

We found that the matching function does not exhibit constant but rather decreasing returns-to-scale with respect to the numbers of job seekers and job vacancies. This result is consistent with Kano and Ohta (2005) and Sasaki (2008) who estimate matching functions in Japan using aggregate data. According to the duration analysis using a Weibull distribution, we also find that the hazard rate of a job seeker is negatively dependent, implying that the longer-term unemployed have more difficulty in exiting from unemployment, partly because of the depreciation of human capital during the period unemployed.

Another finding is that more generous unemployment benefits extend the search duration of job seekers who quit their previous job voluntarily. In contrast, job seekers who lost their job involuntarily are more likely to return to work, thereby shortening the duration of unemployment. This is perhaps because the involuntarily unemployed may

exhibit a greater preference for work and therefore put more effort into searching for a new job, even though they are technically eligible to receive more generous unemployment benefits.

A number of policy implications concerning matching effectiveness arise from our analysis. To start with, because the matching function exhibits decreasing returns-to-scale, fewer than twice the number of job matches result from double the numbers of job seekers and job vacancies. This implies that mismatch between job seekers and job vacancies lowers matching effectiveness. To reduce the incidence of job mismatch, advertisements for job vacancies could be more frequent and more accurate. Job training with the unemployed could also focus on instilling the skills firms are seeking. Alternatively, as far as the available budget permits, an increase in the number of staff in public employment service offices could encourage more productive (not mismatched) coordination between job seekers and job vacancies. Finally, the negative dependency of the hazard rate shows that it takes more time for an individual who has been unemployed longer to leave the unemployment pool. This suggests the need to implement a policy that targets the long-term unemployed to make them sufficiently skillful to get a job as soon as possible.

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Table 1
Estimations of the matching function using the prefectural data

Search duration	[1] Cox	[2] Weibull	[3] Cox	[4] Weibull
ln(vacancies)	0.070	0.079	0.084	0.085
	(0.069)	(0.071)	(0.061)	(0.062)
ln(job seekers)	-0.222 ***	-0.234 ***	-0.235 ***	-0.238 ***
	(0.080)	(0.083)	(0.072)	(0.073)
ln(age)	-0.521 ***	-0.540 ***	-0.377 ***	-0.387 ***
	(0.022)	(0.023)	(0.022)	(0.022)
Single man	0.519 ***	0.523 ***	0.556 ***	0.565 ***
	(0.032)	(0.032)	(0.030)	(0.031)
Single woman	0.465 ***	0.469 ***	0.516 ***	0.527 ***
	(0.023)	(0.024)	(0.023)	(0.024)
Married man	0.859 ***	0.870 ***	0.873 ***	0.885 ***
	(0.034)	(0.034)	(0.033)	(0.033)
ln(education yrs)	0.386 ***	0.399 ***	0.417 ***	0.434 ***
	(0.038)	(0.039)	(0.035)	(0.036)
ln(prev. tenure)	-0.118 ***	-0.121 ***	-0.160 ***	-0.160 ***
	(0.008)	(0.008)	(0.007)	(0.007)
ln(prev. wage)	0.068 ***	0.068 ***	0.060 ***	0.063 ***
	(0.016)	(0.017)	(0.016)	(0.016)
UI benefits				
120 days with	-0.034 **	-0.035 **	-0.025 *	-0.025 *
voluntary quit	(0.014)	(0.015)	(0.014)	(0.015)
150 days with	-0.168 ***	-0.176 ***	-0.151 ***	-0.151 ***
voluntary quit	(0.029)	(0.029)	(0.028)	(0.029)
90 days with	0.025	0.021	0.001	0.004
involuntary quit	(0.021)	(0.022)	(0.021)	(0.022)
120 days with	0.188 ***	0.193 ***	0.230 ***	0.237 ***
involuntary quit	(0.049)	(0.051)	(0.049)	(0.051)
180 days with	0.112 ***	0.110 ***	0.095 ***	0.100 ***
involuntary quit	(0.025)	(0.026)	(0.025)	(0.025)
240 days with	0.067 **	0.063 *	0.103 ***	0.107 ***
involuntary quit	(0.034)	(0.035)	(0.032)	(0.033)
More than 240 days with	0.057 **	0.050 *	0.105 ***	0.106 ***
involuntary quit	(0.028)	(0.029)	(0.028)	(0.028)
Constant		-2.868 ***		-3.488 ***
		(0.281)		(0.254)
Dependency		0.935		0.959
Log-likelihood	-674075	-151058	-810689	-174887
Wald Chi2	4334.69	4512.32	5923.91	5806.78
F-value				
N	119115	119115	135347	135347

*** 1% ** 5% * 10% significant

[1][2]: The search duration is from the date when a job seeker registered at the employment service office to when he/she found a job, or July 13, 2006. [3][4]: The search duration is from the date when a job seeker left or lost his/her previous job to when he/she found a job, or July 13, 2006. The numbers of job seekers and job vacancies are measured when a job seeker starts to look for a job (August, 2005).

Table 2
Estimations of the matching function using the prefectural data

Search duration	[1] Cox	[2] Weibull	[3] Cox	[4] Weibull
ln(vacancies)	0.381 **	0.399 **	0.287 **	0.301 **
	(0.154)	(0.158)	(0.131)	(0.136)
ln(job seekers)	-0.601 ***	-0.624 ***	-0.490 ***	-0.510 ***
	(0.198)	(0.204)	(0.168)	(0.174)
ln(age)	-0.522 ***	-0.542 ***	-0.381 ***	-0.392 ***
	(0.022)	(0.023)	(0.021)	(0.022)
Single man	0.528 ***	0.533 ***	0.560 ***	0.570 ***
	(0.031)	(0.032)	(0.030)	(0.030)
Single woman	0.468 ***	0.472 ***	0.518 ***	0.529 ***
	(0.024)	(0.024)	(0.023)	(0.024)
Married man	0.869 ***	0.880 ***	0.878 ***	0.891 ***
	(0.034)	(0.034)	(0.033)	(0.033)
ln(education yrs)	0.358 ***	0.371 ***	0.399 ***	0.415 ***
	(0.041)	(0.042)	(0.037)	(0.038)
ln(prev. tenure)	-0.127 ***	-0.131 ***	-0.163 ***	-0.163 ***
	(0.009)	(0.009)	(0.007)	(0.007)
ln(prev. wage)	0.041 **	0.041 **	0.044 **	0.045 **
	(0.018)	(0.018)	(0.018)	(0.018)
UI benefits				
120 days with	-0.028 **	-0.029 **	-0.024 *	-0.024
voluntary quit	(0.014)	(0.014)	(0.014)	(0.014)
150 days with	-0.169 ***	-0.177 ***	-0.153 ***	-0.153 ***
voluntary quit	(0.028)	(0.028)	(0.028)	(0.028)
90 days with	0.038 *	0.035	0.013	0.016
involuntary quit	(0.021)	(0.022)	(0.022)	(0.022)
120 days with	0.203 ***	0.208 ***	0.239 ***	0.247 ***
involuntary quit	(0.049)	(0.051)	(0.049)	(0.050)
180 days with	0.127 ***	0.125 ***	0.107 ***	0.112 ***
involuntary quit	(0.027)	(0.028)	(0.026)	(0.026)
240 days with	0.087 ***	0.084 **	0.116 ***	0.120 ***
involuntary quit	(0.033)	(0.034)	(0.032)	(0.033)
More than 240 days with	0.079 ***	0.072 **	0.118 ***	0.120 ***
involuntary quit	(0.029)	(0.030)	(0.029)	(0.029)
Constant	(0.028)	-1.829 ***		-2.730 ***
		(0.572)		(0.488)
Dependency		0.940		0.963
Log-likelihood	-673427	-150362	-810193	-174351
Wald Chi2	4599.96	4774.58	5182.39	5130.28
F-value				
N	119115	119115	135347	135347

*** 1% ** 5% * 10% significant

[1][2]: The search duration is from the date when a job seeker registered at the employment service office to when he/she found a job, or July 13, 2006. [3][4]: The search duration is from the date when a job seeker left or lost his/her previous job to the when he/she found a job, or July 13, 2006. The numbers of job seekers and job vacancies are measured just one month before the job seeker found a job, or at the end of the interval (July 13, 2006).

Table 3

Estimations of the matching function using the data of employment service office

Search duration	[1] Cox	[2] Weibull	[3] Cox	[4] Weibull
ln(vacancies)	0.061 **	0.064 ***	0.064 ***	0.064 **
	(0.024)	(0.025)	(0.025)	(0.025)
ln(job seekers)	-0.192 ***	-0.197 ***	-0.199 ***	-0.204 ***
	(0.028)	(0.029)	(0.028)	(0.029)
ln(age)	-0.518 ***	-0.538 ***	-0.456 ***	-0.472 ***
	(0.018)	(0.018)	(0.017)	(0.018)
Single man	0.524 ***	0.528 ***	0.598 ***	0.613 ***
	(0.018)	(0.018)	(0.018)	(0.018)
Single woman	0.469 ***	0.473 ***	0.550 ***	0.567 ***
	(0.014)	(0.014)	(0.014)	(0.014)
Married man	0.871 ***	0.882 ***	0.948 ***	0.971 ***
	(0.018)	(0.019)	(0.018)	(0.019)
ln(education yrs)	0.406 ***	0.420 ***	0.429 ***	0.453 ***
	(0.031)	(0.032)	(0.031)	(0.032)
ln(prev. tenure)	-0.122 ***	-0.125 ***	-0.115 ***	-0.117 ***
	(0.006)	(0.006)	(0.006)	(0.006)
ln(prev. wage)	0.049 ***	0.049 ***	0.039 ***	0.040 ***
	(0.013)	(0.014)	(0.013)	(0.014)
UI benefits				
120 days with	-0.034 **	-0.035 **	-0.022	-0.020
voluntary quit	(0.017)	(0.017)	(0.017)	(0.017)
150 days with	-0.169 ***	-0.177 ***	-0.144 ***	-0.144 ***
voluntary quit	(0.022)	(0.022)	(0.022)	(0.023)
90 days with	0.022	0.018 **	0.078 ***	0.080 ***
involuntary quit	(0.019)	(0.020)	(0.020)	(0.021)
120 days with	0.191 ***	0.195 ***	0.246 ***	0.258 ***
involuntary quit	(0.049)	(0.051)	(0.050)	(0.052)
180 days with	0.096 ***	0.093 ***	0.148 ***	0.153 ***
involuntary quit	(0.027)	(0.028)	(0.028)	(0.028)
240 days with	0.077 **	0.072 **	0.127 ***	0.134 ***
involuntary quit	(0.031)	(0.032)	(0.032)	(0.033)
More than 240 days with	0.056 *	0.048	0.103 ***	0.106 ***
involuntary quit	(0.031)	(0.032)	(0.033)	(0.033)
Constant		-3.351 ***		-4.801 ***
		(0.157)		(0.159)
Dependency		0.936		1.106
Log-likelihood	-636154	-143350	-638947	-134598
Wald Chi2	6637.32	6722.15	6590.83	6563.28
F-value				
N	113219	113219	113363	113363

*** 1% ** 5% * 10% significant

[1][2]: The search duration is from the date when a job seeker registered at the employment service office to when he/she found a job, or July 13, 2006. [3][4]: The search duration is from the date when a job seeker left or lost his/her previous job to when she found a job, or July 13, 2006. The numbers of job seekers and job vacancies registered at each employment service office are measured in 2005.

Appendix Table 1
Descriptive statistics (prefectural data, the date when starting to look for a job)

	N	Average	Std. Dev.	Min	Max
Search duration	150391	197.488	110.479	0	365
Proportion of those who find a job within the interval	150391	0.510	0.500	0	1
Individual characteristics					
Age	150391	39.128	12.914	16	65
Single man	150391	0.228	0.419	0	1
Single woman	150391	0.280	0.449	0	1
Married man	150391	0.229	0.420	0	1
Married woman	150391	0.263	0.440	0	1
Education years	121641	12.288	1.891	9	18
Tenure of the previous jobs (days)	150391	2426.850	3009.704	7	18043
Previous wage (monthly thousands)	147351	187.724	112.608	1	9190
UI benefits					
90 days with voluntary quit	150391	0.618	0.486	0	1
120 days with voluntary quit	150391	0.108	0.310	0	1
150 days with voluntary quit	150391	0.148	0.355	0	1
90 days with involuntary quit	150391	0.041	0.198	0	1
120 days with involuntary quit	150391	0.005	0.069	0	1
180 days with involuntary quit	150391	0.030	0.172	0	1
240 days with involuntary quit	150391	0.024	0.153	0	1
More than 240 days with involuntary quit	150391	0.026	0.159	0	1
Local labor market					
Prefectural data					
When starting for a job					
Job vacancies	150391	90351.02	85327.71	8492	343101
Job seekers	150391	83438.51	59384.25	10986	237491
One month before when finding a job					
Job vacancies	150391	92170.14	86291.82	8497	343101
Job seekers	150391	83429.04	59118.20	10986	222826

The search duration is from the date when a job seeker registered at the employment service office to when he/she found a job, or the end of the interval (July 13, 2006). The numbers of job seekers and job vacancies are measured from the prefectural data. We here limit the data on job seekers who found a job within one year.

Appendix Table 2
Descriptive statistics (prefectural data, the date when leaving or losing the previous job)

	N	Average	Std. Dev.	Min	Max
Search duration	170516	218.961	116.2091	1	346
Proportion of those who find a job within the interval	170516	0.532	0.499	0	1
Individual characteristics					
Age	170516	38.841	12.835	16	64
Single man	170516	0.230	0.421	0	1
Single woman	170516	0.284	0.451	0	1
Married man	170516	0.229	0.420	0	1
Married woman	170516	0.257	0.437	0	1
Education years	137993	12.298	1.885	9	18
Tenure of the previous jobs (days)	170489	2209.864	2946.843	1	18043
Previous wage (monthly thousands)	167358	188.011	110.782	1	9190
UI benefits					
90 days with voluntary quit	170516	0.663	0.473	0	1
120 days with voluntary quit	170516	0.095	0.294	0	1
150 days with voluntary quit	170516	0.130	0.337	0	1
90 days with involuntary quit	170516	0.036	0.187	0	1
120 days with involuntary quit	170516	0.004	0.065	0	1
180 days with involuntary quit	170516	0.027	0.161	0	1
240 days with involuntary quit	170516	0.021	0.144	0	1
More than 240 days with involuntary quit	170516	0.023	0.149	0	1
Local labor market					
Prefectural data					
When leaving or losing the prior job					
Job vacancies	170516	86926.74	81836.80	8790	307820
Job seekers	170516	84236.61	60045.03	13091	219737
One month before when finding a job					
Job vacancies	170516	91478.67	85849.61	8497	343101
Job seekers	170516	83235.24	58931.52	10986	222826

The search duration is from the date when a job seeker left or lost the previous job to when he/she found a job, or the end of the interval (July 13, 2006). The numbers of job seekers and job vacancies are measured from the prefectural data. We here limit the data on job seekers who found a job within one year.

Appendix Table 3
Descriptive statistics (data from employment service office, the date when starting to look for a job)

	N	Average	Std. Dev.	Min	Max
Search duration	143494	197.807	110.385	0	365
Proportion of those who find a job within the interval	143494	0.509	0.500	0	1
Individual characteristics					
Age	143494	39.086	12.900	16	65
Single man	143494	0.228	0.419	0	1
Single woman	143494	0.281	0.450	0	1
Married man	143494	0.228	0.419	0	1
Married woman	143494	0.263	0.440	0	1
Education years	115625	12.298	1.894	9	18
Tenure of the previous jobs (days)	143494	2419.786	3008.113	7	18043
Previous wage (monthly thousands)	140586	188.227	113.376	1	9190
UI benefits					
90 days with voluntary quit	143494	0.620	0.485	0	1
120 days with voluntary quit	143494	0.108	0.310	0	1
150 days with voluntary quit	143494	0.148	0.355	0	1
90 days with involuntary quit	143494	0.041	0.198	0	1
120 days with involuntary quit	143494	0.005	0.068	0	1
180 days with involuntary quit	143494	0.030	0.171	0	1
240 days with involuntary quit	143494	0.024	0.152	0	1
More than 240 days with involuntary quit	143494	0.025	0.157	0	1
Local labor market					
Data from employment service offices					
When starting for a job					
Job vacancies (2005 average)	143494	110671.30	108264.00	3159	782957
Job seekers (2005 average)	143494	107607.50	72852.77	4677	314853

The search duration is from the date when a job seeker registered at the employment service office to when he/she found a job, or the end of the interval (July 13, 2006). The numbers of job seekers and job vacancies are measured from each employment service office. We here limit the data on[job seekers who found a job within one year.

Appendix Table 4
Descriptive statistics (data from employment service office, the date when leaving or losing the previous job)

	N	Average	Std. Dev.	Min	Max
Search duration	143677	228.490	110.728	1	346
Proportion of those who find a job within the interval	143677	0.508	0.500	0	1
Individual characteristics					
Age	143677	38.968	12.901	16	64
Single man	143677	0.228	0.419	0	1
Single woman	143677	0.282	0.450	0	1
Married man	143677	0.228	0.419	0	1
Married woman	143677	0.263	0.440	0	1
Education years	115769	12.298	1.894	9	18
Tenure of the previous jobs (days)	143677	2419.031	3007.740	7	18043
Previous wage (monthly thousands)	140767	188.223	113.351	1	9190
UI benefits					
90 days with voluntary quit	143677	0.620	0.485	0	1
120 days with voluntary quit	143677	0.108	0.310	0	1
150 days with voluntary quit	143677	0.147	0.355	0	1
90 days with involuntary quit	143677	0.041	0.198	0	1
120 days with involuntary quit	143677	0.005	0.068	0	1
180 days with involuntary quit	143677	0.030	0.171	0	1
240 days with involuntary quit	143677	0.024	0.152	0	1
More than 240 days with involuntary quit	143677	0.025	0.157	0	1
Local labor market Data from employment service offices When leaving or losing the prior job					
Job vacancies (2005 average)	143677	110493.80	108110.00	3225	782957
jJb seekers (2005 average)	143677	107879.60	73059.33	4677	314853

The search duration is from the date when a job seeker left or lost the previous job to when he/she found a job, or the end of the interval (July 13, 2006). The numbers of job seekers and job vacancies are measured from each employment service. We here limit the data on job seekers who found a job within one year.office.