

# Measuring Matching Efficiency Using the Public Employment Service Agency in Japan

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This paper decomposes the probability of a match being formed between a job seeker and a firm into two components. In the first matching process, a job seeker applies for a job and manages to obtain an interview with a firm advertising a job vacancy at the employment service office, and in the second process, upon contact, the job seeker and the firm agree to form a match. This allows us to explore in which process matching efficiency has improved over the sample period.

## I. Introduction

This paper estimates the probability of a job seeker exiting from unemployment, using prefectural-level panel data from Japan. Our estimate decomposes the exit probability into two components; the first is the probability that a job seeker contacts a firm advertising a job vacancy at the employment service office, with the help of an employment counselor, and the second is the conditional probability that, upon contact, the job seeker and the firm agree to sign an employment contract. This enables us to explore in which process matching efficiency has improved. Because our dataset includes the number of referral flows, indicating the number of contacts between job seekers and job vacancies, we can contribute to decomposing the exit probability of a job seeker.

The unemployment rate was not a serious issue in Japan until the early 1990s, particularly compared with unemployment in the United States and European countries. The Japanese unemployment rate was between 2% and 3% in the 1980s, but it rapidly increased to over 5% in the 1990s and, as of June 2003, it had reached 5.3%. The unemployment rate currently remains at around 5%.<sup>1</sup>

What was the cause of this rapid increase in the unemployment rate that occurred in the 1990s? There are three possible elements to be considered. The first is a steady decrease in the level of effort that job seekers put into searching for a job. To obtain an interview with a firm, a job seeker has to visit the local employment service office, search for an appropriate job using a job vacancy database and request an employment counselor to issue a referral letter and to arrange an interview with the firm. Therefore, the extent of the search effort by a job seeker can be measured by how many referral letters the job seeker asks his or her employment counselor to issue during a given length of time.<sup>2</sup>

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<sup>1</sup> The data on the unemployment rate are obtained from the Labour Force Survey conducted by the Japanese Ministry of Health, Labour and Welfare.

<sup>2</sup> A job seeker can apply for a firm without a referral letter issued by the employment service office. However, because the referral letter gives the job seeker a stamp of approval, it is more advanta-

According to the 2002 Actual Condition Survey of Job Seekers (released in December, 2005), 60.2% of job seekers who registered at an employment service office in December 2002 had applied for at least one job vacancy using the public employment service up to June 2005.<sup>3</sup> Note that job seekers who do not visit an employment service office are not necessarily lazy about searching; when job seekers recognize that there are no appropriate job vacancies compatible with their skill, they do not visit the employment service office, which usually posts medium-skilled and low-skilled job vacancies, and may instead search for an appropriate job through the channel of private employment services.

The second element to be considered in understanding the rapid increase in unemployment is coordination failure among job seekers. When job seekers decide which job to apply for, usually they do not take account of which job other job seekers will apply for; in other words, the job seekers do not coordinate with each other about which job each applies for. As a result, it is possible to observe that, on the one hand, there are excess applicants for one job vacancy, but, on the other hand, that no one applies for a different job vacancy. If job seekers coordinated their efforts in relation to the allocation of job seekers to job vacancies in order to avoid multiple applications for one job vacancy, the number of job placements would increase, thereby leading to a decrease in the unemployment rate.

The final element in understanding the increase in unemployment is the decision process regarding acceptance of a job vacancy upon contact with the firm. Even though at least one job seeker applies for a job vacancy within a firm, the job vacancy will not be occupied if either the job seeker or the firm does not agree to sign the employment contract. Both the job seeker and the firm with a vacancy mutually agree to consummate a job match if and only if the pair's idiosyncratic productivity equals or exceeds the reservation productivity level. However, if the pair's idiosyncratic productivity is lower than the reservation productivity level, the firm does not send an acceptance letter to the applicant, and, simultaneously, the job seeker is better off not forming a match with this firm, instead looking for another job.<sup>4</sup> If the firm does not agree to form a match with any of the job seekers who applied for the job vacancy, then the job remains vacant. A firm has additional conditions of employment that are not included in the posted job-placement ads, which a job seeker applying for a job vacancy realizes only when he or she is interviewed by the firm. Therefore, there is a possibility that some job applicants will end up rejecting an offer from a firm despite the fact that they applied for the position.

This paper focuses on the first element, i.e., a decrease in search efforts, and also

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geous for the job seeker to have the referral letter.

<sup>3</sup> This survey is called *Kyushokusha Sogo Jittai Chosa* and is conducted by the Japanese Ministry of Health, Labour and Welfare.

<sup>4</sup> We assume here that the total surplus that a matched job creates is transferable; both a job seeker and a firm with a job vacancy mutually agree to match if the total surplus is positive; otherwise, neither of them agrees to match. If the total surplus is nontransferable, it is possible to observe one side agreeing to a match despite the fact that the other side does not.

considers, separately and then jointly, the second and third elements, the coordination failure among job seekers and the decision process regarding acceptance of a job vacancy following contact with a firm. The first element relates to the intensity of the search process, in which a job seeker visits the employment service office, searches for an appropriate job using the job vacancy database and manages to obtain an interview. The second and third elements relate to the process of matching formation in which, upon contact, the job seeker and the firm with the job vacancy agree to sign an employment contract.

In this study, we employ aggregate data on labor market conditions from the *Report on Employment Services* produced by the Employment Security Bureau, Japanese Ministry of Health, Labour and Welfare. This dataset contains prefectural-level, quarterly data on the numbers of job seekers, job vacancies, job placements and referral flows, covering the period from the first quarter of 1998 to the first quarter of 2007. Because the Japanese economy was recovering during the sample period, we can observe how the economic recovery affects the matching efficiency of each search process.

The main findings are as follows. We begin with the first search process (search intensity). When we regress the ratio of job vacancies to referral flows (the labor market tightness) on the ratio of job vacancies to job seekers (the application ratio), its coefficient is positively significant and ranges between 0.944 and 0.980. This result implies that, holding the number of job vacancies constant, a 1% increase in the number of job seekers raises the number of contacts between job seekers and job vacancies by approximately 1%.

For the second search process (matching formation), when we regress the ratio of job placements to job vacancies (the adequacy ratio) on the ratio of job vacancies to referral flows (the labor market tightness), its coefficient is negatively significant and ranges between  $-0.782$  and  $-0.818$ . There are two intuitions underlying this result. The first is that because an increase in job vacancies per referral flows implies a decrease in the number of applicants per job vacancy, the job vacancy is less likely to be occupied. Second, as it is more competitive for firms to hire, the firms raise the offered wage to attract more job seekers and, in response, job seekers demand a higher wage in order to accept an offer. In order to maintain profitability in the face of the increase in the hiring cost, firms raise the reservation productivity level required to form a match with a job seeker. Therefore, the probability that both the firm and the job seeker agree to sign the employment contract is lower, implying a decrease in the ratio of job placements to job vacancies.

The coefficients on the year dummies capture variations in the matching efficiency over the sample years. The estimate of the first search process shows that the number of referral flows increased during the sample period. This result implies an improvement of matching efficiency in the contact process. As the economy was recovering, firms advertised better job terms to attract more job seekers. In response, job seekers more frequently visited employment service offices and asked employment counselors to issue referral letters. Alternatively, it could be interpreted that the productivity of employment counselors at the reception desks of the employment service offices improved over the years.

The estimate of the second search process shows that the coefficients on year dummies are significantly negative and, therefore, that the ratio of job placements to job vacancies declined over the years. This implies that the efficiency of the matching formation process worsened over time. As the economy was recovering, job seekers searched for jobs using different methods (e.g., newspaper and/or magazine classifieds, word of mouth from acquaintances, private employment services), as well as using the public employment service. Because job seekers had more job opportunities offered to them as a result of using different service mediums, on average, the job seekers were more likely to reject a job offer from a firm referred to them by the public employment service office. An increase in the use of different search methods worsened the matching efficiency of the public employment service office.

The remainder of the paper is organized as follows. Section II develops a simple urn-ball matching model with search and matching between a job seeker and a job vacancy, and presents the implications from the model. Section III presents the econometric specifications and describes the prefectural-level data. Section IV reports the estimated results, and Section V provides some concluding remarks.

## II. Matching Process

This section describes the formation of a match between a job seeker and a job vacancy in which the public employment service office is used as a mediator. To do this, we extend the basic urn-ball matching model (Butters 1977 and Hall 1979). The essence of the model is as follows. Each job seeker chooses one job vacancy randomly and applies for it without any coordination with other job seekers. A firm with a job vacancy randomly chooses one of the applicants if at least one job seeker applies for its job vacancy. If an applicant is not chosen, he or she remains unemployed. If no one applies for the job vacancy, it automatically remains vacant. Coordination failure among job seekers is the source of search frictions.

This study is different from past studies in that we decompose the search process into two processes: first, the process whereby a job seeker makes a search effort and manages to contact a firm; and second, the process whereby the job seeker and the encountered firm agree to consummate a match. We begin with the first process. In the placement role played by the employment service office, a job seeker leaves his or her residence and travels to the local employment service office, searches for an appropriate job vacancy posted there and asks a counselor at the reception desk to arrange an interview with the firm and to issue a referral letter. Therefore, job seekers have to make significant search efforts to obtain an interview. For this reason, job seekers who receive referral letters are considered to be seriously looking for a job, and the number of referral letters is used to measure the efficient number of job seekers.

The number of referral flows is given by:

$$E = kU,$$

where  $E$  represents the number of referral flows and  $U$  indicates the number of job seekers who register at the employment service office. Therefore,  $k$  implies an average number of referral letters per job seeker. Alternatively,  $k$  indicates the extent to which job seekers put search efforts into obtaining an interview with a firm. If  $k \geq 1$ , a job seeker applies for more than one job vacancy on average. Dividing the number of job vacancies ( $V$ ) by the above equation gives:

$$\phi = \frac{1}{k} \theta,$$

where  $\phi (\equiv V/E)$  represents the ratio of job vacancies to job seekers who seriously look for a job. This ratio is referred to as “labor market tightness.” The symbol  $\theta$  indicates the ratio of job vacancies to all job seekers, regardless of whether they have referral letters. This is referred to as the “application ratio.”

In the context of the urn-ball matching model, each serious job seeker chooses one job vacancy randomly, not taking into account which jobs other job seekers apply for. Thus, the probability of a firm having a job seeker respond to its vacancy is  $1/V$ .<sup>5</sup>

Our focus now shifts to the second process of matching formation. Our paper differs from the previous literature in regard to the matching technology, as we do not assume that all contacts result in matching formations. We employ a stochastic matching model, following Pissarides (2000), in which it is assumed that job matches are *ex post* heterogeneous with respect to the productivity of a matched pair, although all job seekers and vacancies are *ex ante* identical. Therefore, the conditional probability of forming a match upon contact needs to be modeled as well. We assume that each matched pair produces  $\alpha$  units of output.  $\alpha$  is specific to the job match and is known by the job seeker and the firm with a job vacancy prior to the decision to form a match upon contact. The job-match-specific productivity is idiosyncratic and is considered to be a random variable drawn from a continuously differentiable and time-invariant distribution of  $G(\alpha)$ .

Because all job seekers and firms with job vacancies are assumed to be *ex ante* identical, they all realize which job match is formed in equilibrium. In other words, there is a common reservation productivity for job matching among job seekers and job vacancies in equilibrium. If the job-match productivity equals or exceeds the reservation productivity, a matching formation is consummated, but otherwise, it is not. Let  $\alpha^*$  denote the reservation productivity. Then, the fraction of successful job matches as a proportion of contacts is  $[1-G(\alpha^*)]$ .

Pissarides (2000) shows the uniqueness of the equilibrium in the stochastic matching model in which free entry and the steady-state conditions are allowed. One of the characte-

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<sup>5</sup> In the urn-ball matching model, we assume that all job vacancies are homogenous with respect to job characteristics. However, this does not seem to be the case in reality. Ueno, Kambayashi, and Muraoka (2004) show that a job seeker’s choice of a job vacancy is not random, according to the Survey on Employment Trends conducted by the Japanese Ministry of Health, Labour and Welfare.

istics is that the reservation productivity depends positively on unemployment benefits ( $z$ ) and labor market tightness ( $\phi$ ). An increase in unemployment benefits raises the reservation productivity, thereby leading to a lower probability of matching formation upon contact. As unemployment benefits increase, job seekers increase their reservation wage and demand an increase in the offered wage. In response, firms increase the wage offered to attract more job seekers. Thus, the firms raise the reservation productivity of the job to compensate for the increased hiring cost incurred by the increase in the wage.

An increase in labor market tightness also raises the reservation productivity. As the labor market becomes tighter, the job seeker's bargaining strength becomes stronger, thereby resulting in an increase in the wage. Firms then raise the reservation productivity to maintain profitability in response to the increase in hiring cost. In contrast with the above argument, it is argued that labor market tightness has a negative effect on the reservation productivity if the number of job vacancies is fixed in the short run. The tighter labor market means firms must compete more to attract job seekers and the firms consequently become less selective in hiring a job seeker from among the applicants who apply for the job vacancy. That is, it results in lower or less selective hiring criteria. From an alternative perspective, because the number of job vacancies is limited, a job seeker's bargaining strength is not as strong as when free entry is allowed, and he or she becomes less selective in accepting a wage offer. A decrease in the reservation productivity results in an increase in the matching formation. Overall, therefore, the impact of labor market tightness on the reservation productivity is theoretically ambiguous.

The probability that a firm faces an applicant and then the job-match productivity equals or exceeds the reservation productivity is  $[1-G(\alpha^*)]/V$ . We assume that job seekers who seriously look for a job ( $E$ ) are binomially distributed according to Bin ( $E$ ,  $[1-G(\alpha^*)]/V$ ). Therefore, the probability that a firm has at least one applicant whose job-specific productivity equals or exceeds the reservation productivity is:

$$1 - \left(1 - \frac{1 - G(\alpha^*)}{V}\right)^E.$$

The firm chooses the applicant whose job-specific productivity is the highest. The number of matches is:

$$X = \left[1 - \left(1 - \frac{1 - G(\alpha^*)}{V}\right)^E\right] V.$$

If  $E$  and  $V$  are sufficiently large, holding  $\phi$  ( $\equiv V/E$ ) constant, the binomial distribution approximates the Poisson distribution. The number of matches is rewritten as:

$$X = \left[1 - \exp\left(-\frac{1 - G(\alpha^*)}{\phi}\right)\right] V.$$

Because doubling the number of job seekers and job vacancies delivers twice as many job matches, this matching process exhibits constant returns to scale with respect to job seekers and job vacancies.

The ratio of job placements to job vacancies (the adequacy ratio) is then given by:

$$q^V \equiv X/V = \left[ 1 - \exp \left( -\frac{1 - G(\alpha^*)}{\phi} \right) \right].$$

As  $\phi$  rises, the adequacy ratio declines because the probability that a job seeker applies for a firm with a job vacancy is lower. Pissarides (2000) refers to this as the job-offer effect. There are two other effects that  $\phi$  has on the adequacy ratio, which occur through the reservation productivity channel. The first captures the long-run effect of  $\phi$ . As the labor market becomes tighter, firms raise the wage to attract more selective job seekers. In response, firms raise the reservation productivity to compensate for the increase in their hiring cost. In this case, a job seeker and a firm are less likely to reach an employment agreement, which in turn lowers the adequacy ratio. The second effect is a short-run effect. Firms are encouraged to lower the reservation productivity level to ensure their own vacancies are occupied as soon as possible, which then raises the adequacy ratio. Together, these two opposite effects of  $\phi$  that occur through the channel of the reservation productivity are referred to as the reservation-wage effect. The overall effect, combined with the job-offer and reservation-wage effects, is ambiguous, and hence our empirical task is to determine the overall effect.

### III. Data and Specifications

In this section, we construct the estimating equations for the ratio of job vacancies to referral flows (labor market tightness) and the ratio of job placements to job vacancies (the adequacy ratio), using the prefectural-level panel data. This study employs quarterly data on labor market conditions from the *Report on Employment Services* produced by the Employment Security Bureau, Japanese Ministry of Health, Labour and Welfare. The heterogeneity across prefectures should be controlled in estimating the equations.

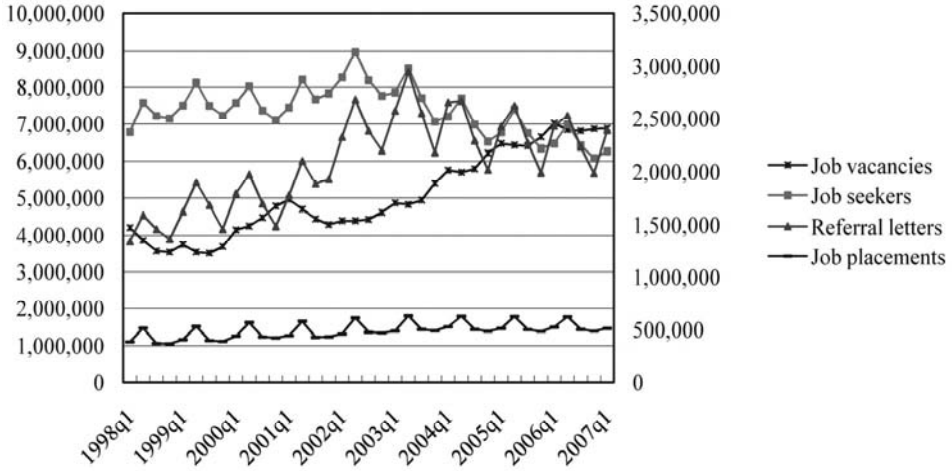
Labor market tightness and the adequacy ratio are estimated using the recursive simultaneous equations indicated below:

$$\ln \phi_{it} = \eta_i + \gamma \ln \theta_{it-1} + \mu D_t + v_{it},$$

and

$$\ln q_{it}^V = \delta_i + \beta \ln \phi_{it} + \lambda D_t + \varepsilon_{it}.$$

In the first equation, the dependent variable indicates the logarithmic value of the ratio of job vacancies at  $t-1$  to referral flows at  $t$  (the labor market tightness), whereas the independent variables indicate the logarithmic value of the ratio of job vacancies at  $t-1$  to job seekers at  $t-1$ , regardless of whether the job seekers are eager to search for a job (the application ratio). The year dummies capture the variation in the matching efficiency over the sample years. We use the one-year lagged variable of the ratio of job vacancies to job seekers to control for the simultaneous bias.  $\eta_i$  represents the individual effect controlling for the heterogeneity across prefectures. If this individual effect is time-invariant and



*Note:* The left vertical axis measures numbers of job vacancies and job seekers, while the right vertical axis measures numbers of referral letters and job placements.

Figure 1. Trends for Job Seekers, Job Vacancies, Referral Letters

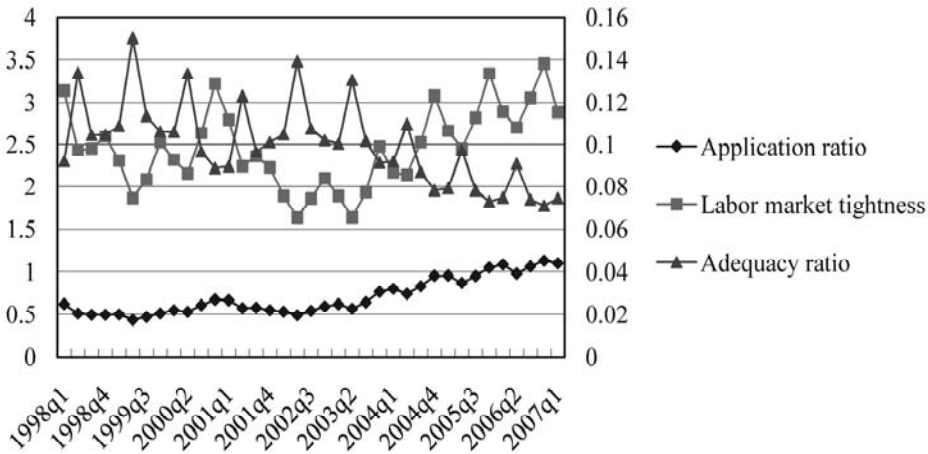
prefecture-specific, the individual effect is treated as the fixed effect. On the other hand, if the individual effect is the random variable, we employ the random-effect estimation. Whether the individual effect is fixed or random is tested according to the Hausman test. The symbol  $v_{it}$  represents the error term.

Looking at the second equation, the dependent variable is the logarithmic value of the ratio of job placements at  $t-1$  to job vacancies at  $t$  (the adequacy ratio), whereas a vector of dependent variables consists of the ratio of job vacancies at  $t-1$  to referral flows at  $t$  and year dummies. As in the previous section, unemployment benefits should be included in the vector of dependent variables, but we cannot obtain the appropriate variable indicating the extent of unemployment benefits.  $\delta_{it}$  is the variable controlling for heterogeneity across prefectures, and  $\varepsilon_{it}$  is the error term. If the error terms  $v_{it}$  and  $\varepsilon_{it}$  are correlated,  $\varepsilon_{it}$  and  $\ln\phi_{it}$  are correlated as well, in which case the OLS estimation provides a biased estimate for  $\ln\phi_{it}$ . Therefore, it is necessary to correct for this bias.

This dataset covers from the first quarter of 1998 to the first quarter of 2007. This sample period is interesting because it covers the dynamic variations of the Japanese economy from the recession to economic recovery. The dataset combines matching formations in both full-time and part-time occupations, and new college graduates are not included in the dataset.

Some graphical views are presented before the estimated results are reported. Figure 1 shows the time trends for the aggregate numbers of job seekers, job vacancies, referral flows and job placements over the sample period. In the first quarter of 1998, the number of job seekers greatly exceeded that of job vacancies, although the gap has become smaller





*Note:* The left vertical axis measures the application ratio and the extent of labor market tightness, while the right vertical axis measures the adequacy ratio.

Figure 2. Trends for Application Ratio, Labor Market Tightness, Adequacy Ratio

since then, and the relation was finally reversed in the fourth quarter of 2005, meaning that the application ratio became greater than one. The economic recovery and an increase in labor demand due to the retirement of the baby-boomer generation were the main factors responsible for the improvement in the employment situation. In a tight labor market, the number of referral flows also increased; there were 1.37 million referral flows in the first quarter of 1998, increasing to 2.39 million in the first quarter of 2007. As the labor market became tighter, job seekers became more eager to search for a better job and received more referral letters. The number of job placements also increased over the sample period, but not as rapidly as the number of referral flows. One possible reason is that because the labor market was tighter, job seekers were more selective in their choice of an appropriate job, which delayed exit from the unemployment pool.

As shown in Figure 2, the ratio of job vacancies to job seekers (the application ratio) gradually increased over the sample period, reaching 1.09 in the first quarter of 2007. This implies an improvement in the employment situation. The ratio of job vacancies to referral flows (labor market tightness) fluctuated over the sample period. Roughly speaking, labor market tightness experienced a downward trend until 2002, but then this trend reversed. The ratio of job placements to job vacancies (the adequacy ratio) subsequently remained at low levels and experienced a gradual downward trend. This implies that the number of job vacancies increased more than did the number of job placements.

Figure 3 shows the trend in the ratio of referral flows to job seekers. This ratio represents the proportion of job seekers who seriously looked for a job, and also proxies the average level of search effort by a job seeker. As of the first quarter of 1998, a job seeker

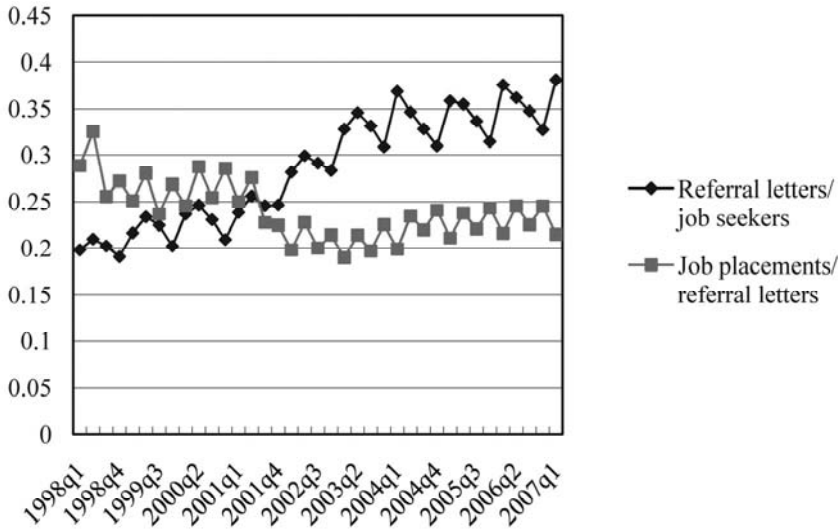


Figure 3. Trends for Referral Letters/Job Seekers and Job Placements/Referral Letters

received an average of 0.2 referral letters, but the average number of referral letters per job seeker increased to 0.4 in the fourth quarter of 2007. The figure also reports that job seekers were encouraged to apply for more firms over the sample period. In addition, Figure 3 indicates the ratio of job placements to referral flows (the acceptance ratio), which experienced a gradual downward trend. This implies that the number of job placements did not increase as much as the number of referral flows, probably because job seekers became choosier in their job search.

#### IV. Results

We begin with estimations of a matching function as a benchmark for matching formation between job seekers and job vacancies. In a similar way to the existing studies, we regress the number of job placements on the numbers of job seekers and job vacancies (see Petrongolo and Pissarides [2001]). The first column of Table 1 shows the estimated result when contemporary values are used for both independent and dependent variables. Therefore, a simultaneous bias arises in the estimation. In contrast, the second column shows the result when the one-year lagged values are used for job seekers and job vacancies. This corrects for the endogenous problem caused by the simultaneous bias. Finally, the third column shows that the number of job seekers (job vacancies) is calculated by the sum of the number of job seekers (job vacancies) still remaining from the previous year, plus the new inflow of job seekers (job vacancies), following Berman (1997). Both fixed- and random-effect estimates are displayed, although the Hausman test indicates that the random-effect model is preferable.

Table 1. Estimations of a Matching Function

Dependent variable ln(job replacements)	[1]		[2]		[3]	
	fixed	random	fixed	random	fixed	random
ln(job seekers)	0.612 *** (0.050)	0.617 *** (0.031)	0.545 *** (0.056)	0.618 *** (0.032)	0.614 *** (0.056)	0.631 *** (0.032)
ln(job vacancies)	0.218 *** (0.025)	0.214 *** (0.021)	0.163 *** (0.025)	0.178 *** (0.022)	0.188 *** (0.027)	0.187 *** (0.022)
year dummies	+	+	+	+	+	+
constant	-0.459 (0.789)	-0.462 (0.417)	1.156 (0.866)	0.018 (0.417)	-0.052 (0.879)	-0.267 (0.419)
sample	423	423	376	376	376	376
groups	47	4.7	47	47	47	47
R2-within	0.872	0.872	0.831	0.830	0.841	0.841
R2-between	0.913	0.913	0.917	0.918	0.917	0.917
R2-overall	0.911	0.911	0.915	0.915	0.915	0.915
F-value	248.77		175.02		188.05	
Wald Chi2		2966.82		2066.29		2193.78
Hausman		1.33		3.31		1.25

Notes: 1. The contemporary values are used for job seekers and job vacancies.

2. The one-year lagged values are used for job seekers and job vacancies.

3. The independent variable of job seekers (job vacancies) is defined by the sum of job seekers (job vacancies) still remaining from the previous year plus the new inflow of job seekers (job vacancies).

4. \*\*\* 1%, \*\* 5%, \* 10% significant.

As we would expect, the coefficients on both job seekers and job vacancies are positive in terms of the matching formation with a 1% level of significance. Because the results do not vary much by column, we interpret this to mean that simultaneous bias is not a serious issue. The coefficient on job seekers is approximately three times as large as that on job vacancies. This implies that the elastic value of matching is larger with respect to job seekers than with respect to job vacancies.<sup>6</sup> The sum of these coefficients is less than one, ranging from 0.796 to 0.831, which implies that the matching formation exhibits decreasing returns to scale with respect to job seekers and job vacancies. This result is consistent with that of Kano and Ohta (2005).<sup>7</sup> On the other hand, Kambayashi and Ueno (2006) and Ueno, Kambayashi, and Muraoka (2004) conclude that the matching formation exhibits constant returns to scale.<sup>8</sup> Sasaki (2007) corrects for the temporal aggregation bias and then estimates the matching function using both monthly and quarterly data from April 1982 to December 2006. He also shows that the matching function exhibits constant returns to scale.

Table 2 displays the results of alternative estimations when the adequacy ratio is

<sup>6</sup> The coefficients on job seekers and job vacancies indicate the extent of labor market externalities.

<sup>7</sup> Kano and Ohta (2005) use the prefectural and yearly panel data from 1973 to 1999.

<sup>8</sup> They use the prefectural and yearly panel data from 1991 to 2001.

Table 2. Estimations of the Adequacy Ratio

Dependent variable ln(adequacy ratio)	[1]		[2]		[3]	
	fixed	random	fixed	random	fixed	random
ln(application ratio)	-0.740 *** (0.019)	-0.742 *** (0.019)	-0.773 *** (0.021)	-0.774 *** (0.021)	-0.765 *** (0.021)	-0.767 *** (0.021)
year dummies	+	+	+	+	+	+
constant	-2.643 *** (0.013)	-2.645 *** (0.035)	-2.602 *** (0.013)	-2.603 *** (0.035)	-2.605 *** (0.014)	-2.606 *** (0.035)
sample	423	423	376	376	376	376
groups	47	47	47	47	47	47
R2-within	0.893	0.893	0.903	0.903	0.894	0.894
R2-between	0.521	0.521	0.512	0.512	0.519	0.519
R2-overall	0.578	0.578	0.575	0.575	0.57	0.57
F-value	340.72		371.91		339.05	
Wald Chi2		3118.40		3029.36		2765.47
Hausman		0.56		0.13		0.33

Notes: 1. The contemporary values are used for job seekers and job vacancies.

2. The one-year lagged values are used for job seekers and job vacancies.

3. The independent variable of job seekers (job vacancies) is defined by the sum of job seekers (job vacancies) still remaining from the previous year plus the new inflow of job seekers (job vacancies).

4. \*\*\* 1%, \*\* 5%, \* 10% significant.

regressed on the application ratio. Both fixed- and random-effect estimates are displayed, although the random-effect model is preferable according to the Hausman test. The coefficient on the application ratio is negative at the 1% level of significance. A 1% rise in the application ratio leads to a decline in the adequacy ratio of 0.7%.

Tables 1 and 2 show that the year dummies are significantly positive, which implies that the matching efficiency has improved between 1998 and 2007, partially because of the economic recovery.

Table 3 shows the estimated results of the recursive simultaneous equations. The upper half of Table 3 presents the estimated results when labor market tightness is regressed on the application ratio, whereas the lower half displays the results when the adequacy ratio is regressed on labor market tightness. We begin with the second process of matching formation to estimate the adequacy ratio (the lower half of Table 3). The coefficient on labor market tightness is negative at the 1% level of significance. This result ensures that the job-offer effect and the long-term reservation-wage effect are dominant over the short-term reservation-wage effect. A rise in the ratio of job vacancies to referral flows implies that the number of applicants per job vacancy decreases, resulting in the lower adequacy ratio. Because it is a much more competitive strategy for firms to hire a worker, the firms have to raise the wage to attract more applicants. In turn, this raises the hiring cost, which leads firms to become more selective in regard to the matching quality. Therefore, it leads to

Table 3. Recursive Simultaneous Estimations (Labor Market Tightness and Adequacy Ratio)

Dependent variable ln(labor market tightness)	[1]		[2]		[3]	
	fixed	random	fixed	random	fixed	random
ln(application ratio)	0.945 *** (0.026)	0.946 *** (0.025)	0.944 *** (0.031)	0.947 *** (0.029)	0.980 *** (0.031)	0.981 *** (0.030)
year dummies	-	-	-	-	-	-
constant	1.561 *** (0.018)	1.562 *** (0.046)	1.422 *** (0.020)	1.423 *** (0.029)	1.451 *** (0.020)	1.452 *** (0.047)
F-value	339.33		264.28		271.81	
Wald Chi2	3409		2403		2472	
Dependent variable ln(adequacy ratio)	[1]		[2]		[3]	
	fixed	random	fixed	random	fixed	random
ln(labor market tightness)	-0.783 *** (0.017)	-0.784 *** (0.017)	-0.818 *** (0.020)	-0.818 *** (0.020)	-0.781 *** (0.019)	-0.782 *** (0.019)
year dummies	-	-	-	-	-	-
constant	-1.421 *** (0.019)	-1.420 *** (0.033)	-1.438 *** (0.019)	-1.439 *** (0.033)	-1.472 *** (0.018)	-1.470 *** (0.033)
sample	423	423	376	376	376	376
groups	47	47	47	47	47	47
R2-within	0.924	0.926	0.920	0.923	0.916	0.919
R2-between	0.637	0.637	0.633	0.634	0.635	0.635
R2-overall	0.681	0.681	0.681	0.681	0.673	0.673
Wald Chi2	1.29+e6	4376.93	1.00+e6	3679.22	1.17+e6	3488.59
Hausman	0.25		0.02		0.13	

- Notes: 1. The contemporary values are used for job seekers, referral letters and job vacancies.  
2. The one-year lagged values are used for job seekers, referral letters and job vacancies.  
3. The independent variable of job seekers (job vacancies) is defined by the sum of job seekers (job vacancies) still remaining from the previous year plus the new inflow of job seekers (job vacancies).  
4. \*\*\* 1%, \*\* 5%, \* 10% significant.

an increase in the reservation productivity and, thereby, a decline in the adequacy ratio.

For comparison purposes, we estimate a single regression of the adequacy ratio on labor market tightness, shown in Table 4. The coefficient on labor market tightness remains negative at the 1% level of significance. This reconfirms that the job-offer effect and the long-term reservation-wage effect are large enough to dominate the short-term reservation-wage effect.

A comparison of the lower half of Table 3 with Table 2 shows that the coefficient on the application ratio is almost the same as that on labor market tightness. This implies that all job seekers who register at the employment service office actively look for a job and apply for a posted job vacancy. A 1% increase in job seekers implies a 1% increase in

Table 4. Estimations of the Adequacy Ratio

Dependent variable ln(adequacy ratio)	[1]		[2]		[3]	
	fixed	random	fixed	random	fixed	random
ln(labor market tightness)	-0.719 *** (0.015)	-0.722 *** (0.015)	-0.726 *** (0.017)	-0.729 *** (0.017)	-0.701 *** (0.016)	-0.705 *** (0.016)
year dummies	-	-	-	-	-	-
constant	-1.487 *** (0.016)	-1.484 *** (0.032)	-1.520 *** (0.016)	-1.517 *** (0.032)	-1.542 *** (0.015)	-1.539 *** (0.032)
sample	423	423	376	376	376	376
groups	47	47	47	47	47	47
R2-within	0.928	0.928	0.927	0.927	0.922	0.922
R2-between	0.637	0.637	0.633	0.634	0.635	0.635
R2-overall	0.680	0.680	0.680	0.680	0.672	0.672
F-value	523.77		506.33		475.53	
Wald Chi2		4783.59		4128.74		3872.47
Hausman		1.77		0.89		1.91

Notes: 1. The contemporary values are used for referral letters and job vacancies.

2. The one-year lagged values are used for referral letters and job vacancies.

3. The independent variable of job seekers (job vacancies) is defined by the sum of job seekers (job vacancies) still remaining from the previous year plus the new inflow of job seekers (job vacancies).

4. \*\*\* 1%, \*\* 5%, \* 10% significant.

applicants who actually apply for a job.

To confirm this finding, we move to examining the first process of search intensity to indicate that job seekers who register at the employment service office actually receive a referral letter and contact a firm. Examining the upper half of Table 3, where labor market tightness is regressed on the application ratio, the coefficient on the application ratio is positive at the 1% level of significance, and is approximately one; that is, a 1% increase in job seekers leads to a 1% increase in applicants. This is consistent with the finding that there is little difference in size between the coefficients on the application ratio and on labor market tightness between Table 2 and the lower half of Table 3.

Table 5 shows the estimated results when the number of referral flows is regressed on the numbers of job seekers and vacancies. The coefficient on job seekers is positive at the 1% level of significance and is approximately one (0.949–1.084). The size of this coefficient is larger than that calculated by Ueno, Kambayashi, and Muraoka (2004). We again confirm that a 1% increase in job seekers leads to a 1% increase in applicants who actually look for a job. In contrast, the coefficient on job vacancies is not necessarily significant, and its size is very small. It is concluded that the effect of job vacancies on the number of referral flows is trivial. The number of referral flows depends on the number of job seekers, but not on the number of job vacancies.

In Tables 3–5, we investigate in which search process the matching efficiency has

Table 5. Estimations of Referral Letters

Dependent variable ln(referral letters)	[1]		[2]		[3]	
	fixed	random	fixed	random	fixed	random
ln(job seekers)	1.072 *** (0.068)	0.953 *** (0.030)	0.949 *** (0.085)	0.941 *** (0.033)	1.084 *** (0.082)	0.977 *** (0.034)
ln(job vacancies)	0.097 *** (0.033)	0.048 * (0.025)	0.057 (0.038)	0.036 (0.029)	0.053 (0.039)	0.009 (0.029)
year dummies	+	+	+	+	+	+
constant	-3.741 *** (1.071)	-1.577 *** (0.318)	-1.497 (1.299)	-1.137 *** (0.320)	-3.2150 ** (1.290)	-1.2870 *** (0.320)
sample	423	423	376	376	376	376
groups	47	47	47	47	47	47
R2-within	0.916	0.915	0.864	0.864	0.878	0.877
R2-between	0.970	0.971	0.970	0.971	0.971	0.971
R2-overall	0.965	0.967	0.965	0.965	0.965	0.966
F-value	398.88		225.88		254.97	
Wald Chi2		5440.44		3526.96		3781.18
Hausman		5.07		1.37		2.81

Notes: 1. The contemporary values are used for job seekers and job vacancies.

2. The one-year lagged values are used for job seekers and job vacancies.

3. The independent variable of job seekers (job vacancies) is defined by the sum of job seekers (job vacancies) still remaining from the previous year plus the new inflow of job seekers (job vacancies).

4. \*\*\* 1%, \*\* 5%, \* 10% significant.

improved. First, we focus on the first search process of search intensity, which captures whether a job seeker receives a referral letter at the employment service office and manages to obtain an interview. As shown in the upper half of Table 3, the year dummies are significantly negative for labor market tightness (the ratio of job vacancies to the number of referral letters), whereas Table 5 shows that the year dummies are significantly positive in relation to the referral flow. These results indicate that the number of referral letters received by a job seeker has increased over the sample period, given the numbers of job seekers and job vacancies. Both tables confirm that the matching efficiency has improved in relation to the first search process between 1998 and 2007. As the Japanese economy was recovering, firms posted better job terms in the job-placement ads to attract qualified job seekers. Job seekers then more frequently visited the employment service office and asked employment counselors to issue referral letters. From a different point of view, we can interpret the result to indicate that the productivity of the employment counselors at the employment service offices improved over the years in question.

We turn our attention to the second process of matching formation in which a match between an interviewed applicant and an interviewing employer is formed. The lower half of Table 3 and Table 4 show that the year dummies are significantly negative for the adequacy ratio, which indicates that the adequacy ratio has deteriorated over the sample period,

given the labor market tightness. Because job seekers had more job opportunities offered to them from media other than the public employment service office, job seekers were more likely to reject a job offer from a firm contacting them through the public employment service office. The availability of different search methods lowered the matching efficiency of the public employment service office.

The matching efficiency has improved for the first search process but deteriorated for the second search process. Overall, however, as shown in Tables 1 and 2, the matching efficiency has improved.

## V. Concluding Remarks

This paper estimates the probability of a matching formation occurring between a job seeker and a firm, using prefectural-level panel data from Japan. The exit probability is decomposed into two components, based on matching processes: the first matching process occurs when a job seeker contacts a firm advertising a job vacancy at the employment service office and manages to obtain an interview with the firm; in the second process, upon contact, the job seeker and the firm agree to form a match. This allows us to explore in which search process matching efficiency has improved. Our dataset includes the number of referral flows, indicating the number of contacts between job seekers and job vacancies, which makes it possible to decompose the exit probability of a job seeker.

The main findings are summarized as follows. In the first process of search intensity, a 1% increase in the number of job seekers raises the number of contacts between job seekers and job vacancies by approximately 1%. In the second process of matching formation, the ratio of job vacancies to referral flows has a significantly negative effect on the ratio of job placements to job vacancies (the adequacy ratio). There are two intuitions supporting this result. First, a decrease in the number of applicants per job vacancy makes a job vacancy less likely to be occupied. Second, as it is more competitive for firms to hire, the firms raise the offered wage to attract more job seekers and, in response, job seekers demand a higher wage to accept an offer. To compensate for an increase in their hiring cost, the firms then raise the reservation productivity level required to form a match. Therefore, the probability that a match between the firm and the job seeker is formed becomes lower.

The matching efficiency has improved in the first process of search intensity but deteriorated in the second process of matching formation. Overall, the matching efficiency has improved over the sample period (1998–2007), partly as a result of the economic recovery that occurred over the sample period.



## References

- Berman, Eli. 1997. Help wanted, job needed: Estimates of a matching function from employment service data. *Journal of Labor Economics* 15, no.1:S251–S292.
- Butters, Gerard R. 1977. Equilibrium distributions of sales and advertising prices. *Review of Economic Studies* 44, no.3:465–91.
- Hall, Robert E. 1979. A theory of the natural unemployment rate and the duration of employment. *Journal of Monetary Economics* 5, no.2:153–69.
- Kambayashi, Ryo, and Yuko Ueno. 2006. Vacancy market structure and matching efficiency. Discussion Paper no. 160, Economic and Social Research Institute (ESRI), Tokyo.
- Kano, Shigeki, and Makoto Ohta. 2005. Estimating a matching function and regional matching efficiencies: Japanese panel data for 1973–1999. *Japan and the World Economy* 17, no.1:25–41.
- Petrongolo, Barbara, and Christopher A. Pissarides. 2001. Looking into the black box: A survey of the matching function. *Journal of Economic Literature* 39, no.2:390–431.
- Pissarides, Christopher A. 2000. *Equilibrium unemployment theory*. 2nd ed. Cambridge, MA: MIT Press.
- Sasaki, Masaru. 2007. Is the matching formation random or a stock—Flow in the Japanese labor market? Mimeo.
- Ueno, Yuko, Ryo Kambayashi, and Keiko Murata. 2004. Matchingu no gijutsuteki koritsusei to nyushoku keiro sentaku kodo (Is job search conducted randomly in Japanese labor market?—Efficiency of matching technology and route selection by searchers in market). Discussion Paper no.106, Economic and Social Research Institute (ESRI), Tokyo.