

Cyclical Behavior of Unemployment and Job Vacancies in Japan

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Abstract

This paper studies whether the Mortensen and Pissarides (MP) search and matching model can explain the observed labor market fluctuations in Japan. Although the MP model correctly predicts the observed regularities in the cyclical fluctuations of unemployment and job vacancies, it cannot generate the observed unemployment and vacancy fluctuations in response to productivity shock of reasonable size. I incorporate separation shocks and training costs into the MP model, finding that their inclusions do not significantly improve the ability of the model to explain the cyclical volatility of unemployment and vacancies observed in the Japanese labor market. This paper also provides the business-cycle properties of the Japanese labor market.

Keywords: Search; Matching; Business Cycles; Japanese Labor Market

JEL classification: E24; E32; J64

1 Introduction

The Mortensen and Pissarides search and matching model (henceforth MP model) has become a standard framework for analyzing aggregate labor markets. However, the MP model has recently criticized for its inability to explain key business cycle properties of the U.S. labor market (Costain and Reiter, 2008; Hall, 2005; Shimer, 2005). Shimer (2005) demonstrates that the MP model cannot generate the observed unemployment and vacancy fluctuations in response to productivity shocks of reasonable size. In the literature, many solutions have been proposed to solve this problem.¹ However, there have been only a few studies to examine whether this failure of the MP model can be observed in other countries as well (Burgess and Turon, 2005; Zhang, 2008). Especially, there has been no study on the Japanese labor market case.

This paper studies how well the MP model can explain the observed business cycle fluctuations in the Japanese labor market. Although the model correctly predicts the observed regularities in the cyclical fluctuations in labor market variables qualitatively, the model cannot explain key cyclical properties of the Japanese labor market quantitatively. The calibrated model explains less than 1/4 of the observed fluctuations in the vacancy-unemployment ratio.²

The business-cycle properties of the Japanese labor market are presented. Over the business cycle, both unemployment and job vacancies are volatile and persistent, and these two variables are negatively correlated. While unemployment is counter-cyclical, job vacancies are pro-cyclical. To understand the detail of the unemployment dynamics, I examine the cyclical properties of job finding and separation rates. I measure the job finding rate and the separation rate by using monthly data from the Labour Force Survey. In the Labour Force Survey, the half of the sample is surveyed over two consecutive months. By matching workers across the two months, I can measure month-over-month transitions by individual workers between employed, unemployed, and non-in-labor-force. Both job finding and separation rates display considerable variations over the business cycle. The job finding rate is pro-cyclical and the separation rate is counter-cyclical. Qualitatively, all these observations are correctly predicted by the MP model. However, as in the US, the calibrated model cannot generate the observed unemployment and vacancy fluctuations in response to productivity shock of reasonable size.

The data also shows that both job finding and separation rates are important in accounting for cyclical unemployment variability in Japan. This result is similar to what Fujita and Ramey (2009) and Pissarides (2008) find in the US. However, the relative importance of job separation differs between two countries. While the job finding rate is a relatively important determinant of the unemployment fluctuation in the US,

¹Some examples are wage rigidity (Hall, 2005; Shimer, 2005), different calibration strategies (Hagedorn and Manovskii, 2008), on-the-job search (Krause and Lubik, 2007; Nagypál, 2007; Tasci, 2006) and informational rents (Kennan, 2009).

²Shimer (2005) demonstrates that the MP model explains less than 10% of the volatility in US unemployment and vacancies when fluctuations are driven by productivity shocks.

the separation rate is relatively important in Japan. Specifically, in Japan, the separation rate accounts for 55 percent of the observed fluctuation in unemployment, while the job finding rate accounts for 40 percent of those fluctuations. To capture this fact, I incorporate separation shocks into the model. However, the incorporation of separation shocks does not significantly improve the ability of the MP model to generate the observed fluctuations in labor market variables.

A number of studies show that firm-specific training costs affects labor market dynamics in Japan. Genda et al. (2001) argue that a firm-specific training cost plays an important role to explain the low gross job flows in Japan. Miyamoto and Shirai (2006) demonstrate that by incorporating firm-specific skill training, the MP model can explain the often mentioned peculiarity of the Japanese labor market; low rates of unemployment, job creation, and job destruction. Furthermore, recently several studies demonstrate that the incorporation of training costs (matching costs) can significantly improve the ability of the MP model to explain the cyclical volatility of unemployment and vacancies in the U.S. (Pissarides, 2008; Silva and Toledo, 2009a, 2009b). Therefore, I study the role of training costs and demonstrate that the incorporation of training costs does not significantly improve the performance of the model.

The reminder of the paper is organized as follows. Section 2 presents salient features of the Japanese aggregate labor market over the business cycle. Section 3 describes the theoretical model. I develop a search and matching model with training costs. In Section 4, I calibrate the model parameters and present the quantitative results. In Section 5, I study the role of training costs. Conclusions and suggestions for future research are presented in Section 6.

2 Japanese labor market facts

In this section, I present some of the salient features of the Japanese aggregate labor market over the business-cycle. I focus on labor productivity and four labor market variables: unemployment, vacancies, the job-finding rate, and the separation rate.

The first variable of interest is unemployment, which is measured as the number of workers who are looking for a job and ready to work immediately if a job is available, yet not working. I obtain the data from the Labour Force Survey (LFS) conducted by the Statistics Bureau and the Director-General for Policy Planning.³ My focus is cyclical fluctuations in unemployment and hence low-frequency movements in the data are filtered out by using a Hodrick-Prescott (HP) filter with smoothing parameter of 10^5 , as in Shimer (2005). In Figure 1, I present the quarterly time series of unemployment and its trend. Until the

³The Labour Force Survey is conducted in the last week of each month. The survey defines completely unemployed workers as persons who satisfy the following conditions: (i) with no job and did not work at all during the reference week (other than employed person); (ii) ready to work if work is available; and (iii) did any job seeking activity or preparing to start business during the reference week (including waiting the outcome of the job seeking activity done in the past).

early 1990's unemployment had been low but it climbed gradually and exhibited strong fluctuations. The difference between log unemployment and its trend has a standard deviation of 0.144. Thus, unemployment is often as much as 29 percent above or below its trend. The cyclical component of unemployment also exhibits a large persistence with quarterly autocorrelation of 0.96.

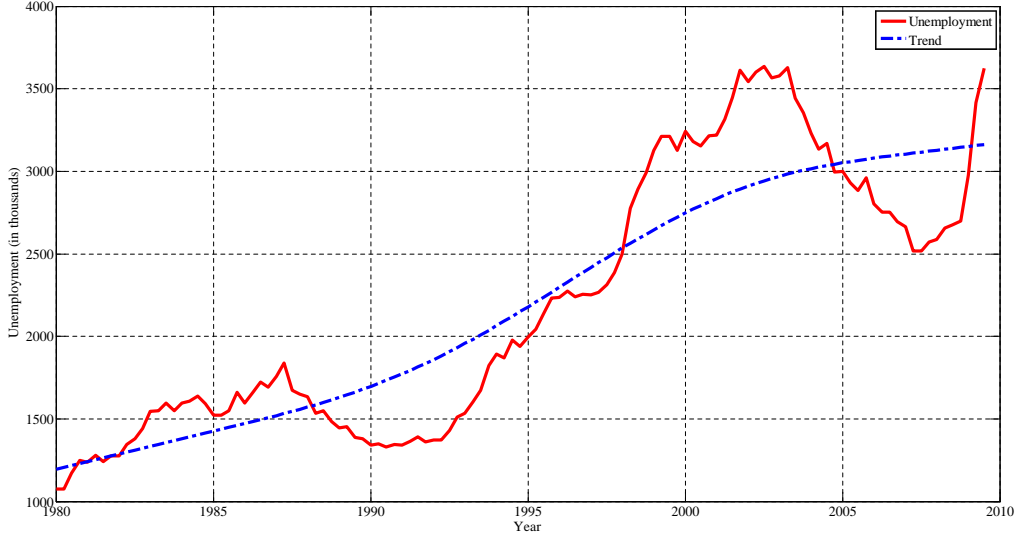


Figure 1: Quarterly Unemployment (in Thousands) and Trend, 1980Q1-2009Q3

Notes: Unemployment is a quarterly average of the monthly series constructed from the LFS. The series are seasonal adjusted by using the Census's X-12-ARIMA algorithm. The trend is an HP filter of the quarterly data with smoothing parameter 10^5 .

The flip side of unemployment is job vacancies. Vacancies are defined as the difference between the number of job openings (*yuko-kyujin-suu*) and the number of job placements (*shushoku-ken-suu*), and calculated using data from Employment Security Service Statistics (*Shokugyo Antei Gyomu Tokei*). Figure 2 shows the vacancies and its trend. Similar to unemployment, job vacancies exhibit remarkable variation. The cyclical component of job vacancies has a standard deviation of 0.142, and it also exhibits a large persistence with quarterly autocorrelation of 0.912.

In Figure 3, I present the cyclical components of unemployment and job vacancies simultaneously. The correlation between these two series during the sample period is -0.591. Since unemployment is countercyclical, while job vacancies are procyclical, the vacancy-unemployment ratio is strongly procyclical. The standard deviation of the cyclical component of the vacancy-unemployment ratio is 0.289.

I measure job finding and separation rates by using monthly data from the LFS over the period

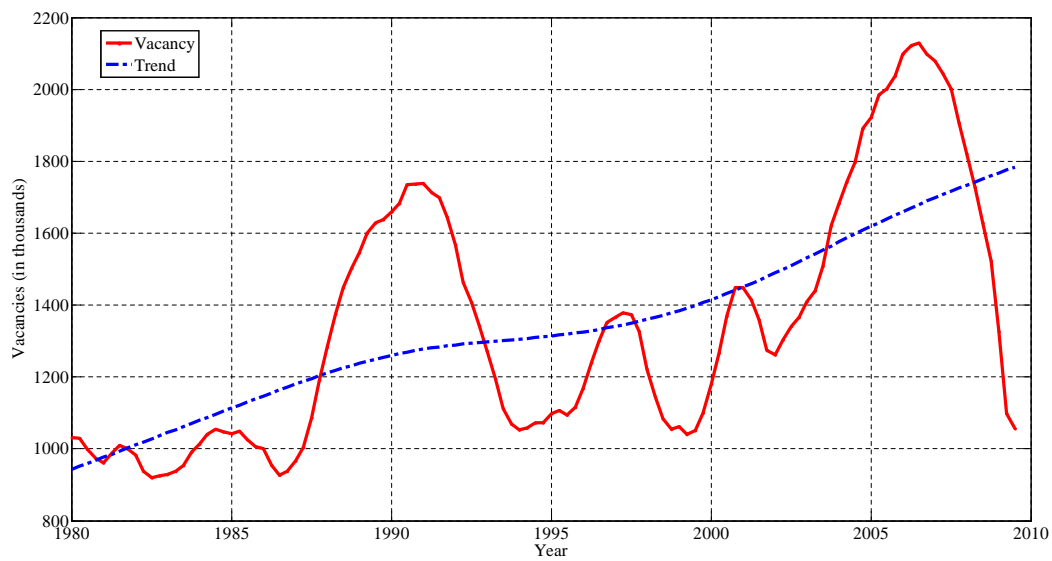


Figure 2: Quartely Vacancies (in Thousands) and Trend, 1980Q1-2009Q3

Note: Job vacancies are defined as the difference between the number of job openings and the number of job placements, and constructed from Employment Security Service Statistics. The series are seasonal adjusted by using the Census's X-12-ARIMA algorithm. The trend is an HP filter of the quarterly data with smoothing parameter 10^5 .

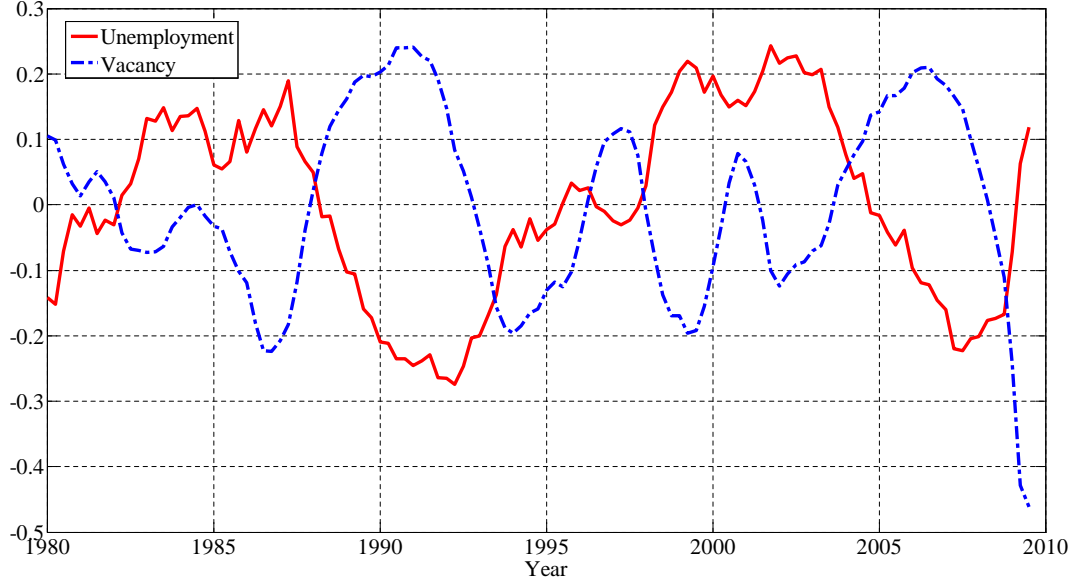


Figure 3: Comparison of Cyclical Components of Unemployment and Job Vacancy, 1980-2009

1980-2009.⁴ In the LFS, the half of the sample is surveyed over two consecutive months. By matching workers across the two months, I can measure month-over-month transitions by individual workers between employed, unemployed, and non-in-labor-force. It is well known that the flow data from LFS contains various forms of bias. Due to these biases, the flow data is not consistent with the stock data. Therefore, I correct this error by using the adjustment method of Ministry of Labour (1985).⁵

Let eu and ue denote the gross flows from employment to unemployment and from unemployment to employment, respectively, and let e and u indicate the measured stocks of employed and unemployed workers, respectively. Then, the average monthly job finding rate f and separation rate s are determined by

$$f_t = \frac{ue_t}{u_{t-1}} \text{ and } s_t = \frac{eu_t}{e_{t-1}}.$$

I time-aggregate the underlying monthly data to get quarterly averages, removing substantial low-frequency fluctuations that likely reflect measurement error in the LFS. I then detrend the quarterly data using an HP filter with smoothing parameter 10^5 .

Figure 4 shows the quarterly average of the monthly job-finding rate and its trend. The average of the

⁴By using Labour Force Survey, Kuroda (2003), Ohta and Teruyama (2003a, 2003b), Ohta (2005), Sakura (2006), Ohta et.al. (2008) also construct the worker flows. Abe and Ohta (2001) construct the worker flows from the Special Survey of the Labor Force, and study the industry-level causes of fluctuations in Japanese unemployment in 1990s.

⁵Kuroda (2003) and Sakura (2006) also correct the error by using the adjustment method of Ministry of Labour (1985).

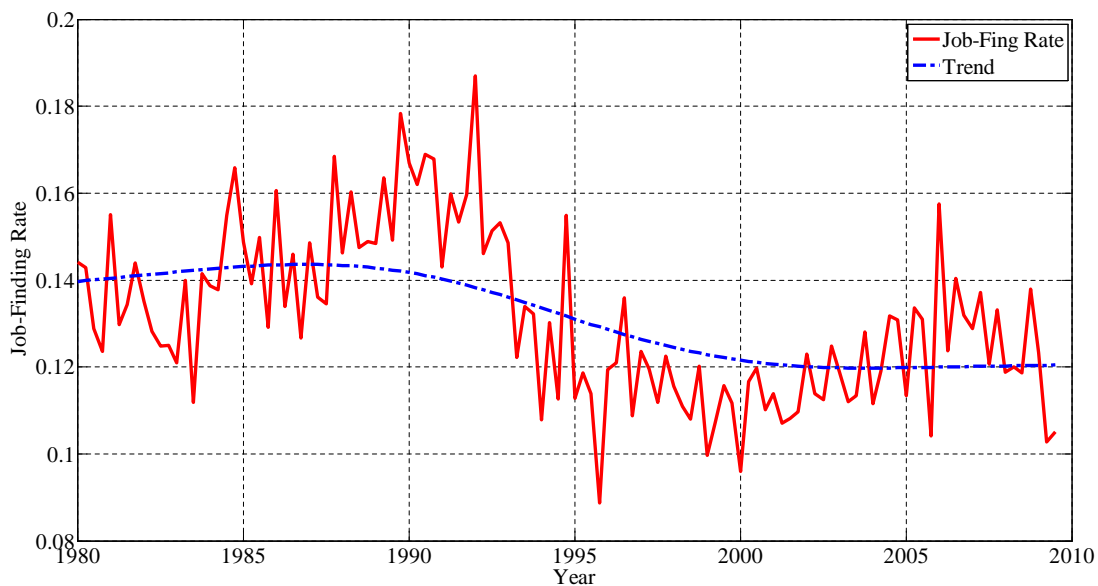


Figure 4: Monthly Job-Finding Rate for Unemployed Workers, 1980-2009

Note: The job finding rate is computed using the gross worker flows constructed from the Labour Force Survey. It is expressed as a quarterly average of monthly data. The series are seasonal adjusted by using the Census's X-12-ARIMA algorithm. The trend is an HP filter of the quarterly data with smoothing parameter 10^5 . Sample covers 1980Q1-2009Q3.

job-finding rate during the sample period is 13.1 percent. The difference between the log of the job-finding rate and its trend has a standard deviation of 0.113. Thus, the job-finding rate displayed considerable variations. The correlation between the cyclical components of the vacancy-unemployment ratio and that of the job-finding rate is 0.641. This high correlation is consistent with a fairly stable matching function, as assumed by the standard search and matching model.

Figure 5 shows the quarterly average of the monthly separation rate and its trend. The separation rate is small, averaging 0.4 percent during the sample period. This implies that jobs last on average for 18 years. The trend of the separation rate moved upward in 1990's and was roughly stable afterwards. The difference between the log of the separation rate and its trend has a standard deviation of 0.144, and is countercyclical.

Now I quantify the contributions of job-finding and separation rates to overall variability over the business-cycle following Shimer (2007) and Fujita and Ramey (2009). To analyze how hazard rates affect unemployment variability, Shimer (2007) and Fujita and Ramey (2009) approximate the unemployment rate using the theoretical steady-state value associated with the contemporaneous job-finding and separa-

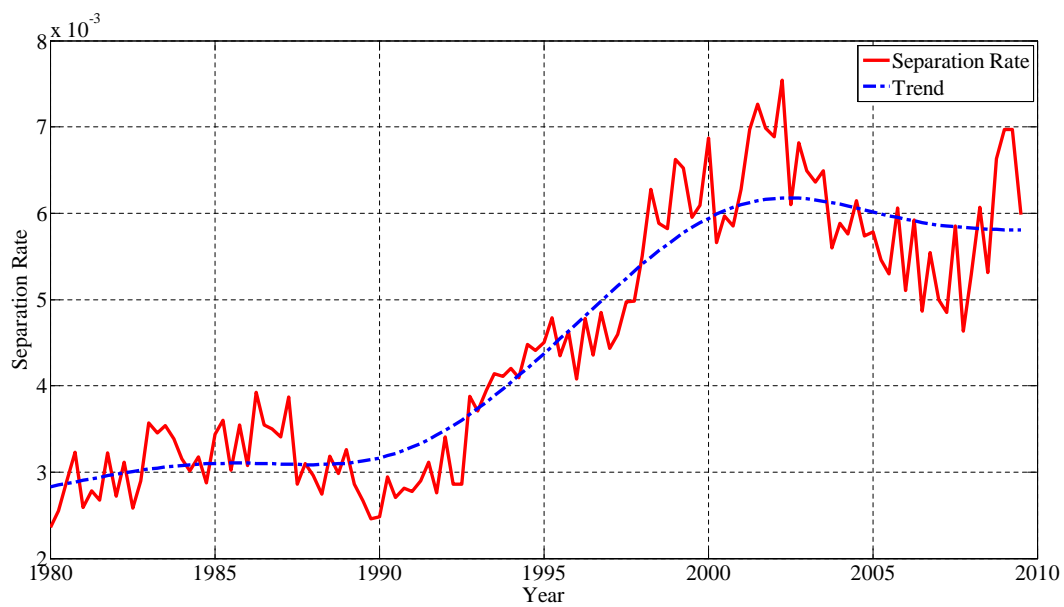


Figure 5: Monthly Separation Rate for Employed Workers, 1980-2009

Note: The separation rate is computed using the gross worker flows constructed from the Labour Force Survey. It is expressed as a quarterly average of monthly data. The series are seasonal adjusted by using the Census's X-12-ARIMA algorithm. The trend is an HP filter of the quarterly data with smoothing parameter 10^5 . Sample covers 1980Q1-2009Q3.

tion rates. Thus,

$$u_t \simeq \frac{s_t}{s_t + f_t} \equiv \tilde{u}_t.$$

Let \bar{f} and \bar{s} denote the average value of f_t and s_t during the sample period. Then, I compute the hypothetical unemployment rates

$$u_t^f \equiv \frac{\bar{s}}{\bar{s} + f_t} \text{ and } u_t^s \equiv \frac{s_t}{s_t + \bar{f}}$$

as measures of the contributions of fluctuations in the job finding and separation rates to overall fluctuations in the unemployment rates.

Figure 6 compares the cyclical components of u^f and u^s with the cyclical component of \tilde{u}_t . Figure 6 shows that both the job finding rate and the separation rate tend to move with the unemployment rate. In particular, the job finding rate accounts for 40 percent of the observed fluctuations in unemployment, while the separation rate accounts for 55 percent of those fluctuations.⁶

The last variable examined is labor productivity that is measured as real output per employed workers. The output measure is based on the National Income and Product Accounts, while employment is constructed by Statistics Bureau and Statistics Center. Figure 7 shows labor productivity, normalized to 100 for 2000, and its trend. Labor productivity moved upward in 1980s and early 1990s and downwards afterwards. The performance of the Japanese economy was very good in the 1980s. Labor productivity increases during the “bubble” periods of the late 1980s and early 1990s. However, labor productivity declined after 1991. While the trend component of labor productivity was 216 in 1990, it was 102 in 2000. Thus, the trend component of labor productivity decreased by more than 50% during the 1990s.

Figure 8 plots the cyclical components of the vacancy-unemployment ratio and labor productivity. The correlation between these two series is 0.81. The important message from this figure is that the vacancy-unemployment ratio fluctuates much more than labor productivity. The overall fluctuations in the vacancy-unemployment ratio are over ten times larger than those of labor productivity during the sample period.

Table 1 summarizes the key statistical moments describing the Japanese labor market. Unemployment and job vacancies are about 6 times more volatile than labor productivity. The vacancy-unemployment ratio is more than 10 times more volatile. Moreover, the vacancy-unemployment ratio is strongly pro-cyclical. The job finding rate is about 5 times more volatile than labor productivity and is pro-cyclical. The separation rate is about 6 times more volatile than productivity and is counter-cyclical. It is also strongly autocorrelated.

⁶I obtain these numbers by regressing u^f or u^s on \tilde{u} . Since this is not an exact decomposition, these two numbers add up less than 1. See Shimer (2007) and Fujita and Ramey (2009) for a similar exercise.

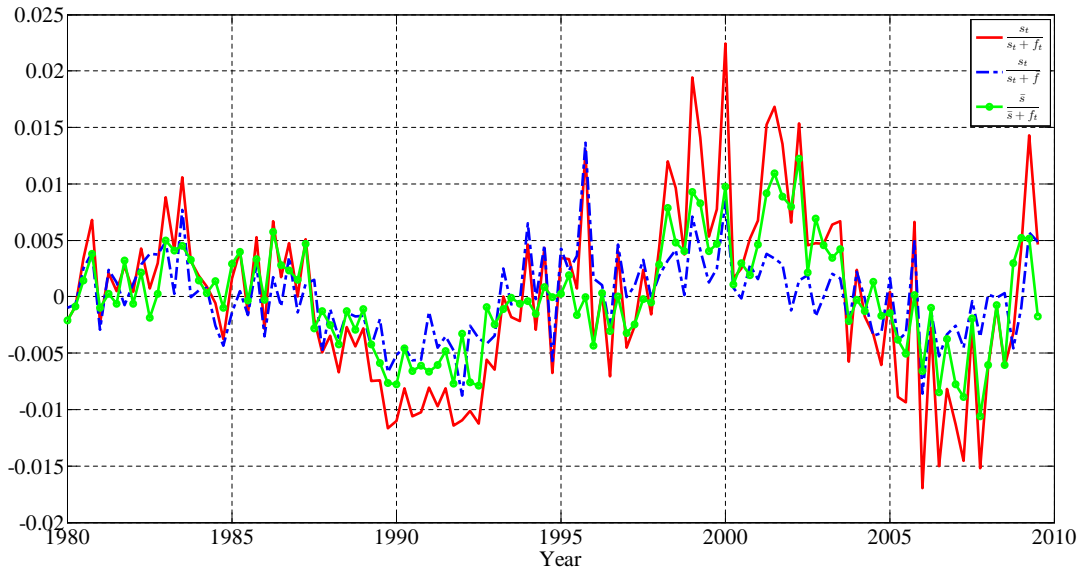


Figure 6: Contribution of unemployment rate variability

Note: The solid line indicates the hypothetical unemployment rate \tilde{u} . The dashed line indicates the hypothetical unemployment rate if there were only fluctuations in the job finding rate u^f . The line with circle indicates the hypothetical unemployment rate with only fluctuations in the separation rate u^s . See text for definitions of \tilde{u} , u^f , and u^s .

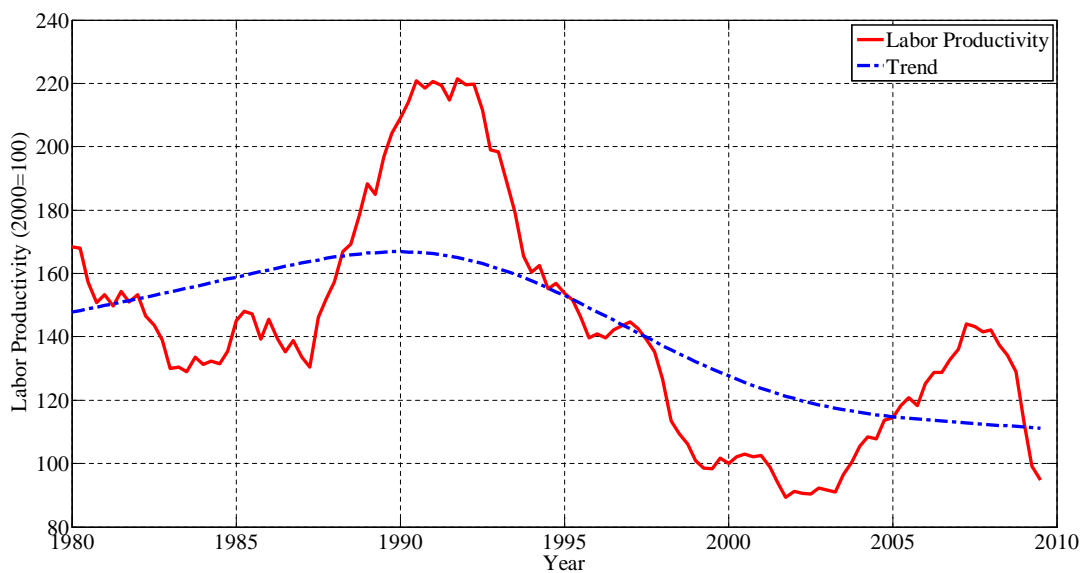


Figure 7: Quarterly average labor productivity and trend, 1980Q1-2009Q3

Note: Labor productivity is measured as real output per employed workers, and is normalized to 100 for 2000. The series are seasonal adjusted by using the Census's X-12-ARIMA algorithm. The trend is an HP filter of the quarterly data with smoothing parameter 10^5 .

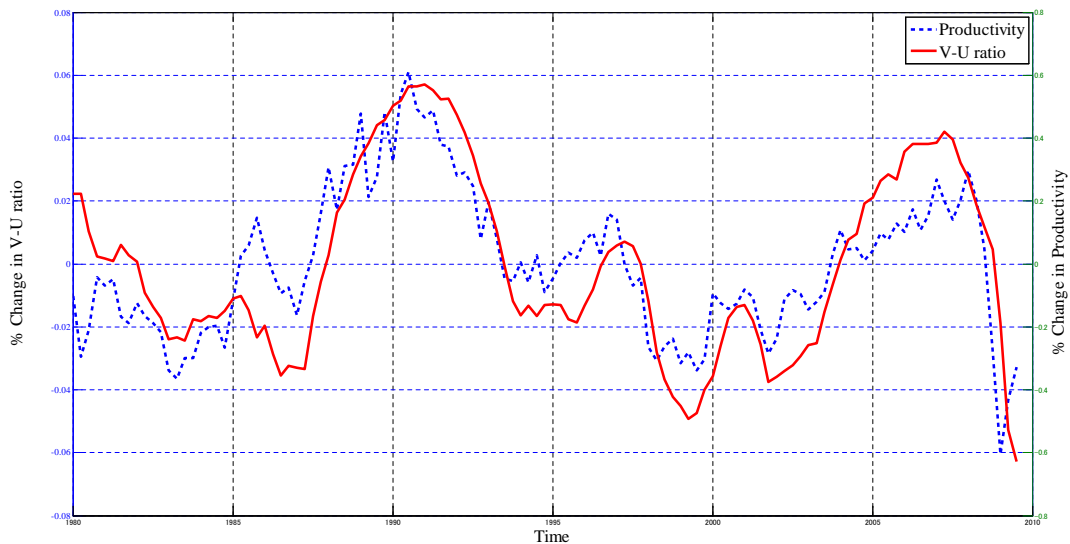


Figure 8: Cyclical components of the vacancy-unemployment ratio and labor productivity

Note: Both the vacancy-unemployment ratio and labor productivity are expressed in logs as deviations from HP filter with smoothing parameter 10^5 .

3 The model

Shimer (2005) demonstrates that the standard search and matching model cannot explain the cyclical volatility of unemployment and vacancies in the US. Now I examine whether this failure of the model can be observed in Japan as well. Shimer (2005) and Mortensen and Nagypál (2007) demonstrate that steady-state responses of the matching model are essentially equivalent to the dynamic response of the full stochastic version of it.⁷ Therefore, here I consider the non-stochastic version of the search and matching model of Pissarides (2000) with training costs.

Consider an economy consisting of a continuum of workers normalized to one and a large number of identical risk-neutral firms. Time is continuous. All agents are infinitely lived and maximize the present discounted value of their income with discount rate r .

⁷In the model, the vacancy-unemployment ratio is a forward looking jump variable that responds immediately to an aggregate productivity shock. Thus, the dynamic response of this endogenous variable is very similar to the comparative static results as long as the productivity process is highly persistent. Since the job finding rate is determined by the vacancy-unemployment ratio, the job finding rate is also jump variable. The unemployment rate is the only endogenous variable that does not instantaneously adjust. However, due to the instantaneous adjustments of job finding, the transition dynamics of unemployment are very fast.

Table 1: Summary statistics, quarterly Japanese data, 1980-2009

	u	v	v/u	f	s	p
Standard deviation	0.144	0.142	0.289	0.113	0.144	0.023
Autocorrelation	0.961	0.912	0.947	0.330	0.675	0.892
Correlation matrix	u	1	-0.592	-0.886	-0.537	0.797
	v	-	1	0.881	0.536	-0.639
	v/u	-	-	1	0.641	-0.822
	f	-	-	-	1	-0.621
	s	-	-	-	-	1
	p	-	-	-	-	-

Unemployment u is constructed from the Labour Force Survey (LFS). The job vacancies v are defined as the difference between the number of job openings and the number of job placements, and constructed from Employment Security Service Statistics. The job-finding rate f and the separation rate s are constructed from the LFS. See the text for data construction details. u , v , f , and s are quarterly averages of monthly series. Labor productivity p is measured as real output per employed workers. I seasonally adjust all series using the Census's X-12-ARIMA algorithm. All variables are reported in logs as deviations from an HP trend with smoothing parameter 10^5 . Sample covers 1980Q1-2009Q3.

A firm has only one job that can be either filled or vacant. One job is filled by one worker.⁸ A firm can produce output p if its job is filled. If it is vacant, the firm produces no output and searches for a worker. A worker can be either employed or unemployed. If a worker is employed, he produces output and earns an endogenous wage but cannot search for other jobs. If he is not employed, he gets flow utility z from non-market activity and searches for a job. When a firm with a vacant job and an unemployed worker meet and start producing, it is said that job creation takes place. On the other hand, job separation takes place when a filled job separates and stops producing. When job separation takes place, the firm can either reopen a job as a new vacancy or withdraw from the labor market, while the worker becomes unemployed. In order to hire a worker, a firm posts a vacancy at flow cost γ . Free entry drives the expected present value of an open vacancy to zero.

⁸In the standard search and matching model, each firm hires one worker and can post at most one vacancy (Mortensen and Pissarides, 1994; Pissarides, 2000). Pissarides (2000, Ch.3) considers a model of large firms in which each firm can employ many workers. He shows that a model with large firms has the same implication as the standard model, under the assumption that wage is determined through bargaining at the individual level.

When a firm with a vacancy meets an unemployed worker and an employment contract is signed, the firm pays a training cost C . This training cost is incurred only once at the time of job creation. A job remains “new” until a shock with arrival rate λ hits the match and changes its status to a continuing job. The wages are determined through the Nash bargaining between a firm and a worker over the share of expected future joint income, where the worker has bargaining power $\beta \in (0, 1)$. It is assumed that at the initial wage determination stage, the training cost is considered as a loss in joint income.⁹ Because of this, there is a difference between the initial wage bargain and subsequent renegotiation. Thus, new and continuing jobs have different wages w^n and w , respectively.

The number of successful job matches per unit time is given by the matching function $M(u, v)$, where u is the number of unemployed workers and v is the number of vacancies. The matching function $M(u, v)$ is continuous, twice differentiable, increasing in its arguments, and exhibits constant returns to scale. Define $\theta \equiv v/u$, which captures the tightness of the labor market. The rate at which a firm with a vacancy is matched with a worker per unit of time is $M(u, v)/v = M(1/\theta, 1) \equiv q(\theta)$. Similarly, the rate at which an unemployed worker is matched per unit of time is $M(u, v)/u = \theta q(\theta) \equiv f(\theta)$. Because the matching function has constant-returns, $q(\theta)$ is decreasing and $f(\theta)$ is increasing in θ . In the steady-state, the inverse of the transition rates, $1/q(\theta)$ and $1/f(\theta)$, are the expected duration of a vacancy and an unemployment, respectively. I also make the standard Inada-type assumptions on $M(u, v)$, which ensure that $\lim_{\theta \rightarrow \infty} q(\theta) = 0$, $\lim_{\theta \rightarrow 0} q(\theta) = \infty$, $\lim_{\theta \rightarrow \infty} f(\theta) = 0$, and $\lim_{\theta \rightarrow 0} f(\theta) = \infty$.

Let the value of a vacant job be V , the value of a new job be J^n , and the value of a continuing job be J . Then, they are characterized by the following Bellman equation:

$$rV = -\gamma + q(\theta)(J^n - V - C), \quad (1)$$

$$rJ^n = p - w^n + s(V - J^n) + \lambda(J - J^n), \quad (2)$$

and

$$rJ = p - w + s(V - J). \quad (3)$$

I now turn to the side of a worker. When an unemployed worker finds a job, he/she first belongs to a new job. Thus, the value of an unemployed worker U satisfies

$$rU = z + f(\theta)(W^n - U), \quad (4)$$

where W^n is the value of an employed worker in a new job.

The value of an employed worker in a new job W^n and the value of an employed worker in a continuing job W are given by

$$rW^n = w^n + s(U - W^n) + \lambda(W - W^n), \quad (5)$$

⁹This wage determination mechanism is adopted in most of search and matching models. See Pissarides (2000, Ch.9) and Mortensen and Pissarides (1999).

and

$$rW = w + s[U - W]. \quad (6)$$

In equilibrium, all profit opportunities from new jobs are exploited, so that the following free entry condition holds:

$$V = 0. \quad (7)$$

The starting wage and the continuation wage is determined by the following equations

$$w^n = \arg \max (W^n - U)^\beta (J^n - V - C)^{1-\beta},$$

and

$$w = \arg \max (W - U)^\beta (J - V)^{1-\beta}.$$

The solutions to these optimization problem, w^n and w , must satisfy the following first-order conditions,

$$(1 - \beta)(W^n - U) = \beta(J^n - V - C), \quad (8)$$

and

$$(1 - \beta)(W - U) = \beta(J - V), \quad (9)$$

respectively.

By using all the value functions (1)-(6), the free entry condition (7), and wage sharing rules (8) and (9), I obtain the following equilibrium wages:

$$w^n = (1 - \beta)z + \beta[p + \theta\gamma - (r + s + \lambda)C], \quad (10)$$

and

$$w = (1 - \beta)z + \beta(p + \theta\gamma). \quad (11)$$

Substituting (11) into (3) and using (7), I obtain the value of a continuing job,

$$J = \frac{(1 - \beta)(p - z) - \beta\theta\gamma}{r + s}. \quad (12)$$

Similarly, substituting (10) into (2) and using (7) and (12), I obtain the value of a new job,

$$J^n = \frac{(1 - \beta)(p - z) - \beta\theta\gamma}{r + s} + \beta C. \quad (13)$$

Making use of (1), (7), and (13), I obtain the equilibrium job creation condition

$$\frac{\gamma}{q(\theta)} = \frac{(1 - \beta)(p - z) - \beta\theta\gamma}{r + s} - (1 - \beta)C. \quad (14)$$

A steady-state equilibrium in this economy is a triplet of labor market tightness and wage rates (θ^*, w^{n*}, w^*) that solves equations (10), (11), and (14) for the steady-state productivity level p^* .

The evolution of unemployment over time is given by

$$\dot{u} = s(1 - u) - f(\theta)u.$$

In the steady-state, the unemployment rate is determined by

$$u = \frac{s}{s + f(\theta)}. \quad (15)$$

3.1 Steady-state elasticities

The central question in this paper is whether the search and matching model can explain the observed cyclical amplitude of unemployment and vacancy fluctuations in Japan. To explore this issue, I compute elasticities of labor market variables with respect to labor productivity p .

From the job creation condition, I obtain the elasticity of the vacancy-unemployment ratio with respect to labor productivity,

$$\varepsilon_{\theta, p} \equiv \frac{\partial \ln \theta}{\partial \ln p} = \frac{p}{p - z - (r + s)C} \frac{r + s + \beta f(\theta)}{(r + s)(1 - \eta(\theta)) + \beta f(\theta)},$$

where $\eta(\theta) \equiv \theta [f(\theta)]' / f(\theta)$ is the elasticity of the matching function with respect to vacancies.

From (15), I obtain the elasticity of the unemployment rate with respect to labor productivity

$$\varepsilon_{u, p} \equiv \frac{\partial \ln u}{\partial \ln p} = -\frac{\eta(\theta)f(\theta)}{s + f(\theta)} \frac{\partial \ln \theta}{\partial \ln p}.$$

Finally, the elasticity of vacancies with respect to labor productivity is

$$\varepsilon_{v, p} \equiv \frac{\partial \ln v}{\partial \ln p} = \frac{\partial \ln \theta}{\partial \ln p} + \frac{\partial \ln u}{\partial \ln p}.$$

4 Quantitative analysis

4.1 Basic calibration

In this section, I calibrate a simplified version of the previous model, where the training costs are set to be zero, to match Japanese labor market facts. The purpose is, in the same setup as Shimer (2005), to gauge to what extent the standard search and matching model explains the observed volatilities in unemployment and vacancies in Japan. The following 8 parameters have to be determined: the discount rate r , the level of labor productivity p , the value of leisure z , the worker's bargaining power β , two matching function parameters m_0 and α , the separation rate s , and the vacancy cost γ .

I choose the model period to be one-month and set the discount rate $r = 0.003$ because the average annual interest rate during the sample is 3.6%. The labor productivity parameter p is normalized to be one.

I assume that the matching function is Cobb-Douglas,

$$M(u, v) = m_0 u^{1-\alpha} v^\alpha,$$

where m_0 is the matching constant and α is the matching elasticity with respect to vacancies. Then, the job finding rate is $f(\theta) = m_0 \theta^\alpha$ and the vacancy filling rate is $q(\theta) = m_0 \theta^{\alpha-1}$. The elasticity of the matching function α is estimated by using the method of Mortensen and Nagypál (2007), explained in the Appendix. The estimated value is 0.653 which lies in the plausible range of 0.5 to 0.7 reported by Petrongolo and Pissarides (2001). I use the Hosios (1990) condition to pin down the worker's bargaining power, so $\beta = 1 - \alpha$.

The vacancy-unemployment ratio, the job-finding rate, and the separation rate are those constructed in Section 2. I target a mean value of the vacancy-unemployment ratio of $\theta = 0.676$. In order to pin down the scale parameter m_0 , I combine the monthly job-finding rate $f = 0.131$ with the vacancy-unemployment ratio. I set the monthly exogenous separation rate at $s = 0.004$.

I now determine the value of non-market activity z . In calibration of search and matching models, the choice of the parameter value z is controversial.¹⁰ Martin (1998) computes the average replacement rates, the ratio of unemployment benefits to average wages, in the OECD countries. Martin (1998) reports that the replacement rate in Japan is about 0.6, so I set $z = 0.6$. Finally, following Shimer (2005), the vacancy cost γ is obtained from the steady-state solutions of the model. The parameter values are summarized in Table 2.

4.2 Results

Table 3 reports the elasticities of relevant labor market variables with respect to labor productivity. The vacancy-unemployment ratio, the job finding rate, and vacancies are procyclical, while the unemployment rate is counter-cyclical. Thus, the prediction of the model is consistent with basic Japanese labor market facts.

Column (1) of Table 3 summarizes the main results from my model. To evaluate the performance of the model, I use two data moments: unconditional and conditional moments. The unconditional data moments are the ratios of standard deviations σ_x/σ_p , where σ_x is the standard deviation of the $\ln x$.

¹⁰Shimer (2005) sets z/p equal to 0.4 in order to capture unemployment benefits. Hagedorn and Manovskii (2008) argue that Shimer's choice of the value of opportunity cost of employment is too low because it does not allow for the value of leisure, home production, as well as unemployment benefits. They calibrate the opportunity cost of employment and the worker's bargaining power to match the observed cyclical response of wages and average profit rate. Their results are $z = 0.955$ and $\beta = 0.052$. Mortensen and Nagypál (2007) criticize Hagedorn and Manovskii (2008) for using these parameters because these parameters yield workers a gain of 2.8% in flow utility by going from unemployment to employment. Hall and Milgrom (2008) use utility parameter values based on the empirical literature on household consumption and labor supply and reports the effective replacement rate of 0.71.

Table 2: Calibrated parameter values

Parameter	description	value	source / target
r	discount rate	0.003	data
s	exogenous rate of job separation	0.004	data
z	value of non-market activity	0.6	Martin (1998)
m_0	scale parameter of Matching function	0.169	vacancy filling rate
α	elasticity of matching function	0.653	Mortensen and Nagypál (2007)
β	worker's bargaining power	0.347	$\beta = 1 - \alpha$ (efficiency)
γ	cost of posting a vacancy	1.02	see text
p	labor productivity	1.0	normalized

They are calculated from the cyclical components of labor market variables constructed in Section 2. The conditional moments are obtained by $\rho_{xp}\sigma_x/\sigma_p$, where ρ_{xp} is the correlation between $\ln x$ and $\ln p$. As Mortensen and Nagypál (2007) argue, this conditional criterion allows for the evaluation of the performance of the MP model in predicting the response to productivity shocks without making the strong assumption that other shocks are not affecting labor market fluctuations.¹¹

In any case, as Table 3 reports, the elasticities are far from those observed in the Japanese labor market, both conditional and unconditional. In the literature, the elasticity of the vacancy-unemployment ratio with respect to labor productivity is used to evaluate the performance of the model over the business cycle. In the unconditional data moment, the target value for this elasticity is 12.6. In the model, the elasticity is 2.74, which explains 22% of observed volatility of the vacancy-unemployment ratio. Even using the conditional criterion, the model can explain only 27% of it. Thus, we conclude that the standard MP model fails to explain key business cycle properties of the Japanese labor market.

Table 3: A comparison of the model with the Japanese data

Elasticity	Data		Benchmark	Benchmark
	Unconditional on p	Conditional on p	(1)	+ separation shock (2)
$\varepsilon_{\theta, p}$	12.6	10.2	2.74	3.12
$\varepsilon_{u, p}$	-6.26	-4.26	-1.73	-6.41
$\varepsilon_{v, p}$	6.17	4.28	1.00	-3.29
$\varepsilon_{f, p}$	4.91	2.53	1.79	2.04

¹¹Mortensen and Nagypál (2007) argue that the empirical equivalent to the change in x relative to changes in y in the matching model in which adjustment of all endogenous variables takes place instantaneously or very fast, $\varepsilon_{x, y}$, is the OLS regression coefficient $\rho_{xy}\sigma_x/\sigma_y$.

As seen in Section 2, job separation is also the important determinant of the fluctuations in unemployment. To capture this fact, I incorporate separation shocks into the model. In data, the correlation between the logs of the separation rate s and labor productivity p is -0.730 . Given the standard deviations of $\ln s$ and $\ln p$ are 0.144 and 0.023 respectively, the implied estimate of the response elasticity of the separation rate to labor productivity is

$$\frac{\partial \ln s}{\partial \ln p} = \rho_{sp} \frac{\sigma_s}{\sigma_p} = -0.730 \cdot \frac{0.144}{0.023} = -4.570.$$

When training costs $C = 0$, by taking logs and differentiating of (14), I obtain

$$\frac{\partial \ln \theta}{\partial \ln p} = \left(\frac{p}{p-z} - \frac{s}{r+s+\beta\theta q(\theta)} \frac{\partial \ln s}{\partial \ln p} \right) \frac{r+s+\beta f(\theta)}{(r+s)(1-\eta(\theta))+\beta f(\theta)}.$$

I can also obtain the elasticities of the unemployment and the elasticity of vacancies rate with respect to labor productivity

$$\frac{\partial \ln u}{\partial \ln p} = -\frac{\eta(\theta)f(\theta)}{s+f(\theta)} \frac{\partial \ln \theta}{\partial \ln p} + \frac{f}{s+f(\theta)} \frac{\partial \ln s}{\partial \ln p},$$

and

$$\frac{\partial \ln v}{\partial \ln p} = \frac{\partial \ln \theta}{\partial \ln p} + \frac{\partial \ln u}{\partial \ln p},$$

respectively.

Column (2) of Table 3 reports elasticities of labor market variables with respect to labor productivity when exogenous separation shocks are added. The elasticity of the vacancy-unemployment ratio with respect to labor productivity slightly rises to 3.12. However, the model with separation shocks predicts a counter-cyclical of vacancies. This can be understood by looking at the job creation condition (14). A lower separation rate raises the vacancy-unemployment ratio, since it encourages firms to post vacancies by increasing the value of job creation. The rise in θ rotates the job creation line anti-clockwise. On the other hand, a lower separation rate shifts the Beveridge curve toward the origin. Equilibrium moves from point E to point E' as seen in Figure 9. while unemployment decreases unambiguously, the effect on vacancies is ambiguous. With a Cobb-Douglas matching function, the shift of the Beveridge curve may be large enough to make both unemployment and vacancies decrease, explaining why the model with separation shocks predict counter-cyclical vacancies.

5 The role of training costs

In this section, I study the role of training costs in the amplification mechanism of the matching model. Several studies demonstrate that the incorporation of fixed training costs (matching costs) can improve the ability of the MP model to explain the cyclical volatility of unemployment and vacancies observed in the U.S. labor market (Mortensen and Nagypál, 2007; Pissarides, 2008; Silva and Toledo, 2009a, 2009b).

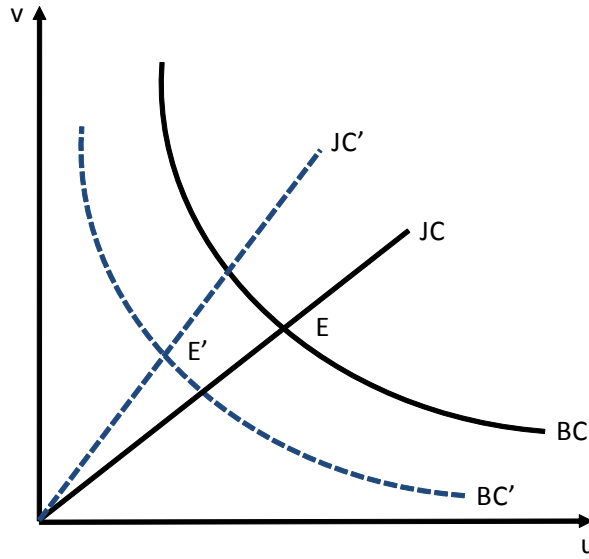


Figure 9: The effect of a decrease in the separation rate.

Furthermore, a number of studies pointed out that Japanese firms train their employees to equip with firm-specific skills intensively.¹² Therefore, incorporating training costs seems to be a natural way to analyze the Japanese labor market.

Since there is no empirical counterpart of training costs, I use the same targets and parameter values as in previous section, and calibrate the model without training costs, $C = 0$. Then, I study whether the extended MP model with training costs can explain the observed fluctuations in unemployment and vacancies by changing the value of C . When I change C , I adjust the cost of posting a vacancy γ in order to maintain the same steady-state value for the labor market tightness. Following Silva and Toledo (2009b), λ is set to be $1/3$. Thus, it takes an average duration of one quarter before new hired jobs are converted to continuing jobs.

Table 4 reports the elasticity of the vacancy-unemployment ratio with respect to labor productivity for different values of C . One can see that the change in elasticity is very small when training costs changes. Without separation shocks, the elasticity of the vacancy-unemployment ratio increases by 5 percent when training costs C increase from 0 to 3. With separation shocks, the elasticity increases by 9 percent. The incorporation of training costs does not significantly improve the ability of the MP model to explain the observed unemployment and vacancy fluctuations in Japan.

¹²See Shimada (1981), Mincer and Higuchi (1988), and Hashimoto and Raisian (1985, 1992) and Koike (1984, 1988).

Table 4: Model results at different training costs

λ	C	γ	w_n	Without Separation Shocks			With Separation Shocks		
				ε_θ	ε_u	ε_v	ε_θ	ε_u	ε_v
0.33	0	1.02	0.96	2.74	-1.74	1.00	3.12	-6.41	-3.29
0.33	0.5	1.01	0.90	2.76	-1.75	1.01	3.17	-6.44	-3.27
0.33	1	1.00	0.84	2.78	-1.77	1.02	3.22	-6.46	-3.25
0.33	2	0.98	0.72	2.83	-1.79	1.04	3.32	-6.54	-3.21
0.33	3	0.96	0.60	2.89	-1.83	1.06	3.43	-6.61	-3.18

6 Conclusions

This paper studies whether the Mortensen-Pissarides search and matching can explain the business cycle fluctuations observed in the Japanese labor market. Qualitatively, the model succeeds to predict the observed cyclical pattern in labor market variables. However, the model cannot explain the observed fluctuations in unemployment and job vacancies in response to productivity shocks of plausible magnitude. The calibrated model explains less than 1/4 of the observed fluctuations in the vacancy-unemployment ratio.

Since the data shows that job separation is an important determinant of the fluctuations in unemployment, I incorporate the variation in the separation rate and study the amplification mechanism of it. The incorporation of separation shocks does not significantly improve the ability of the MP model to explain the fluctuations in unemployment and vacancies. Rather, the model with separation shocks predicts a counterfactual counter-cyclical of vacancies. I also study the role of training costs and demonstrate that the incorporation of training cost does not improve the ability of the MP model to generate the observed unemployment and vacancy variations in response of productivity shocks of plausible magnitude.

A number of important issues remain for future research. One issue to be considered is the alternative calibration strategy of the MP model. Hagedorn and Manovskii (2008) proposed the calibration strategy which uses the data on the cost of posting a vacancy and the cyclical of wage to identify the value of the non-market activity and the worker's bargaining power. They demonstrate that their calibrated model is consistent with the key business cycle facts observed in the US. To examine what extent the MP model under an alternative calibration strategy explains the observed cyclical properties of the Japanese labor market is an important issue. The MP model not only falls short of replicating labor market fluctuations but also exhibits no propagation of productivity shocks. For the U.S. labor market, Fujita (2003) and Fujita and Ramey (2007) address this issue. Studying whether the MP model exhibits propagation of productivity shocks observed in the Japanese labor market is also an important issue.

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7 Appendix

7.1 The elasticity of the matching function

I estimate the elasticity of the matching function α by using the method of Mortensen and Nagypál (2007). The steady-state unemployment rate is determined by equating the flow into unemployment with the flow out of it. Thus, I have

$$M(u, v) = s(1 - u)$$

By using a Cobb-Douglas specification of the matching function and taking logarithms on both sides of the above equation, I obtain

$$\ln m_0 + \alpha \ln v + (1 - \alpha) \ln u = \ln s + \ln(1 - u).$$

Then, the regression coefficient implied by (15) is

$$\frac{\partial \ln v}{\partial \ln u} = -\frac{1}{\alpha} \left(\frac{u}{1 - u} + 1 - \alpha \right).$$

The data moments documented in Table 1 implies

$$\frac{\partial \ln v}{\partial \ln u} = \rho_{vu} \frac{\sigma_v}{\sigma_u} = -0.592 \cdot \frac{0.142}{0.144} = -0.584$$

Since the average monthly unemployment rates over the period of 1980-2009 is 3.38 percent, I obtain the estimated value of $\alpha = 0.653$.