Explaining the Cyclical Behavior of the Korean Labor Market

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Abstract

The Korean labor market is characterized recently by (1) more volatile employment and OLF than unemployment and (2)employment which is much more correlated with OLF than with unemployment. Based on these facts, the role of the unemployment rate as a business cycle indicator would seem to have been weakened, and a significant amount of the fluctuations in employment is explainable primarily by the fluctuations in the rate of nonparticipation. In this paper, I evaluate existing models and modify them. The distinction between unemploymunt and OLF becomes clear, and the model developed in this paper generates the OE transition without an assumption that nonparticipants are inactive searchers. Moreover, some parameters which determine the model dynamics are assumed to be time-varying. The modified model accounts quite well for the Korean labor market of the last two decades. Among other time-varying parameters, stochastic nonparticipant's probability of entering the labor force, which moves in coordination with the state of the labor market, explains the Korean labor market. A quantitative analysis of the reduced-form dynamics shows clearly that a change in the participation rate is capable of generating the cyclical movements of employment, unemployment and OLF that we observe in the 2000-2007 data.

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I. Introduction

According to the Economically Active Population Survey (EAPS), reported monthly by the National Statistical Office of Korea, the volatility of the unemployment rate (and the unemployment-to-population ratio) has decreased considerably in recent years, while that of the nonparticipation rate has not decreased much. The volatilities of the unemployment and nonparticipation rates were .43 and .39 percent, respectively, over the last two decades, but .12 percent and .25 percent for the last seven years.[1] The correlation between employment-to-population and unemployment-to-population ratios has also decreased dramatically, from -.86 to -.65 in terms of absolute values, while the correlation between the employment-to-population ratio and the nonparticipation rate has increased from -.82 to -.93. The employment-to-population ratio is now much more correlated with the nonparticipation rate than with the unemployment-to-population ratio. This evidence gives rise to the argument that the role of the unemployment rate as an indicator for the business cycle has been weakened, and that a portion of fluctuations in employment can be accounted for by fluctuations in nonparticipation.

The existing studies related to this paper include Tripier (2004), Kim (2004) and Pries and Rogerson (2008) among others. Tripier (2004) investigate the real business cycle (RBD) model with both labor market frictions and nonparticipation, and find that the RBC model with these features does not produce a Beveridge relationship between vacancies and unemployment. Kim (2004) and Pries and Rogerson (2004) (hereafter KPR) build up a matching model with nonparticipation, which is defined as inactive search.

In this paper, I modify the standard Mortensen-Pissardies (1994) matching model in several ways: First, those who do not engage in job search are classified as out of the labor force, which is consistent with the EAPS data. Second, the employed consist of both those who have been working and those who search and find employment. Then the transition from OLF to employment occurs between two consecutive periods, and it is not necessary to assume that nonparticipants are inactive searchers. Third, although the transition rate from unemployment to employment is much higher than the transition rate from OLF

1) All time series data are Hodrick-Prescott filtered with smoothing parameter 14,400. The volatility of the unemployment-to-population ratio was .43 percent over the last two decades, but just .12 for the last seven years. Throughout I use interchangeably employment and the employment-to-population ratio, unemployment and the unemployment-to-population ratio, and OLF and the nonparticipation rate. Where necessary, I distinguish among them.

to employment, the conditional job-finding probability that a nonparticipant reentering the labor market faces is much higher than an unemployed worker faces. This leads those out of the labor force to participate in the labor market because nonparticipants have a higher job-finding probability reservation than the unemployed. Finally, some parameters which determine the model dynamics are assumed to be time-varying: nonparticipant's probability of entering the labor force, the unemployed workers' probability of remaining in the labor force, and the employed workers' probability of leaving the labor force. The parameters are assumed to move stochastically with aggregate productivity.

The findings can be summarized as follows. The model with constant parameters accounts for the Korean labor market over the last two decades, which is mainly characterized by a high and volatile unemployment rate due to the 1998-1999 recession. The unemployment rate is the most volatile and the nonparticipation rate the least volatile among the labor market variables. The employment-to-population ratio is more negatively correlated with the unemployment-to-population ratio than with the nonparticipation rate. In particular, the model predicts the Beveridge relationship. Once the probability of a nonparticipant entering the labor force (which is stochastic and weakly and positively correlated with the probability of moving from unemployment to employment) is introduced, the model matches the labor market of the last seven years. A quantitative analysis of the reduced-form dynamics shows clearly that a small change in the participation rate is capable of generating fluctuations of employment, unemployment and OLF that we observe in the 2000-2007 data.

This paper is one of the many studies about the cyclical behaviors of the Korean labor market. To my knowledge, however, this paper is the first attempt to explain the joint behavior of the Korean labor market using the matching model. Chang et al. (2004) and Kim (2006), among others, focus on long-run behaviors of the Korean labor market, and theirs are distinguished from this study.

The paper is organized as follows. Section 2 presents some stylized facts about the labor market in Korea and reports the changes in volatilities of the labor market variables and the correlations among them. Section 3 modifies the standard matching model, and suggests a possible extension. Section 4 quantifies the modified matching model, and Section 5 presents the conclusions.

II. Korean Labor Market Stylized Facts

In this section, I discuss the time series behavior of labor market variables in Korea. In particular, I employ the Economically Active Population Survey (EAPS, Korean National Statistical Office) from January 1986 to December 2006. When asking respondents their major activities during the reference week, the survey provides for several possible responses. In 2000, for example, 'Working', 'Absent from work (including temporary leave)', 'Looking for work', 'Child care', 'Keeping house', 'Student', 'Senior', 'Disabled', and 'Other' were listed. In 2006, the possible responses were increased to 17, to capture the youth labor force status.

Based upon the major activities indicated for the reference week, I classify respondents as follows: those working or absent from work as employed, those looking for work as *unemployed*, and all others as OLF. Even if persons are categorized as OLF, some are working for money and some have non-zero job-search duration. Those who work for money more than 15 hours during the reference week are classified as *employed*. Those who have non-zero job-search duration, I classify as *unemployed* only if they are available for work.

To understand the dynamic behavior of the labor market, I need to analyze not only the transitions between employment and unemployment but also movements in and out of the labor force. Measures of worker transitions take advantage of the rotating-panel aspect of the EAPS, which are available only since 1986 to me. Furthermore, there are several months for which it is impossible to match workers across months. I used household ID, person ID, sex, and date of birth in my matching algorithm. The months for which I could not construct matches are the January of every year, July 1988, and February 1993. I use matched worker data to construct the probability that a worker who is in labor force state X in month $\tau-1$ is in state Y in month τ, i.e. the XY transition rate or equivalently h_{XY}.

1. Employment, Unemployment and Nonparticipation

Figure 1(a) presents the monthly employment-to-population ratio (or simply employment) and its estimated trend (a Hodrick-Prescott filter with smoothing parameter 14,400). In the average month from 1986 to 2006, 58.4 percent of the population were working or on temporary leave (see Table 1(a)). This time series exhibits some variation, starting from 52.8 percent in January 1986, reaching 60.9 percent in February 1997, falling to 54.5 percent in November 1998, but reaching 59.9 percent in December 2002 and in February 2004.

Figure 1(b) presents the monthly unemployment-to-population ratio (or simply unemployment) and its estimated trend, and Figure 1(c) presents monthly unemployment and the unemployment rate. In an average month, the unemployment rate is 3.5 percent and unemployment 2.1 percent. Between the late 1980s and the early 1990s, the unemployment rate trended downward. In June 1993, it increased to 3.1 percent, but fell continuously after that to stand below 2 percent in February 1996. In September 1998, at the worst point due to Korean Crisis, the unemployment rate reached 9.2 percent. Since then, it has fallen back to average levels. By September 2002, it had dropped to 3.1 percent, and from January 2003 through the end of 2006 it hovered at near 3.7 percent.

Figure 1(d) presents the monthly nonparticipation rate and its estimated trend. In the average month from 1986 to 2006, 39.5 percent of the population did not form part of the labor force (see Table 1(a)). In January 1986, the nonparticipation rate was as high as 44.6 percent. Since then, it has been on a consistent decline and in February 1997 fell to the lowest level in the sample period, 37.5 percent. During the Korean Crisis, however, the nonparticipation rate reached 40.2 percent (February 1999). From 2003 through the end of 2006, it moved at around 38.6 percent.

Table 1 Summary Statistics of Economically Active Population Survey (EAPS)

(a) Mean and Standard Deviation

	Mean (%)				Standard Deviation (%)			
	E	U	O	$\tilde{U}$	E	U	O	$\tilde{U}$
1986–2006	58.42	2.09	39.49	3.46	1.62	0.90	1.36	1.49
2000–2006	59.02	2.32	38.66	3.79	0.51	0.24	0.33	0.40

(b) Standard Deviations and Contemporaneous Correlations of Detrended Data

	Standard Deviation (%)				Correlation Coefficient		
	$Std(e)$	$Std(u)$	$Std(o)$	$Std(\tilde{u})$	$Corr(e,u)$	$Corr(e,o)$	$Corr(u,o)$
1986–2006	1.21	14.26	.96	14.52	−.82	−.83	.40
2000–2006	.61	7.06	.64	7.17	−.74	−.80	.24

*All data are seasonally adjusted (Census X-12) and HP-filtered with smoothing parameter 14,400. E, U, O, and $\tilde{U}$ denote the employment-population ratio, the unemployment-population ratio, nonparticipation rate, and unemployment rate, respectively. e, u, o, $\tilde{u}$ and υ denote the associated log-detrended series. Finally, $Std(x)$ and $Corr(x,y)$ denote the standard deviation of variable x and the correlation coefficient between x and y, respectively.

To investigate high frequency fluctuations, I take the differences between the monthly time series data and their low frequency trends, Hodrick-Prescott (HP) filters with smoothing parameter 14,400. Table 1(b) shows the cyclical features of the data. The difference between the employment-to-population ratio and its trend has standard deviations of 1.21 percent for the entire period (1986-2006) and .61 percent for the subperiod (2000-2006). For the entire period, employment volatility was twice what it was for the subperiod.

The difference between the unemployment-to-population ratio and its trend has a standard deviation of 14.26 percent for the entire period and 7.06 percent for the subperiod. For the unemployment rate, the figures are 14.52 and 7.17 percent, respectively. The unemployment-to-population ratio and the unemployment rate are both more than three times as volatile than for the subperiod.

The difference between the nonparticipation rate and its trend has a standard deviation of .96 percent for the entire period and .64 percent for the subperiod. Unlike the case with the employment-to-population ratio and the unemployment-to-population ratio, the difference in nonparticipation rate volatilities between the entire period and the subperiod is not so great. For the subperiod, in particular, the nonparticipation rate is even more volatile than the unemployment rate.

Looking at the persistence of the detrended variables, all three series display strong positive autocorrelations. The monthly autocorrelations for the employment-to-population ratio, the unemployment-to-population ratio, and the nonparticipation rate are .88, .94, and .68 for the entire period, respectively. For 2000-2006, the autocorrelations for the employment-to-population ratio and the unemployment-to-population ratio decrease from .88 to .86 and from .94 to .87, respectively. Interestingly, the monthly autocorrelation for the nonparticipation rate increases from .68 to .76.

As far as contemporaneous correlations are concerned, Table 1(b) shows the entire period and the subperiod presenting quite different pictures. The correlation between the employment-to-population ratio and the unemployment-to-population ratio is -.82 for the entire period, while it is -.74 for the subperiod. On the other hand, the correlation between the employment-to-population ratio and the nonparticipation rate is -.83 for the entire period and -.80 for the subperiod. For the subperiod, the employment-to-population ratio has a much larger negative correlation with the nonparticipation rate than with the unemployment-to-population ratio.

2. Transition Probabilities

Figure 2(a) through Figure 2(c) present time-series for the transition probabilities, and Table 2(a) and Table 2(b) present the average transition probabilities for the entire period and the subperiod, respectively.

The first thing that strikes one in the figures is that the probability of transition from E to U (hereafter the EU transition rate) and the OU transition rate maintain the lowest levels over twenty years, while the UE transition rate sustains the highest level. The EU transition rate, which had trended downward until 1996, went up to 1.9 percent in September 1998 due to the mass layoffs at that time when the unemployment rate was at its highest level of 9.1 percent. The EU transition rate has recently been about .8 percent, a bit higher than before the Korean crisis. The OU transition rate shows a low frequency pattern similar to that of the EU transition rate. During 1997-1998, the OU transition rate also increased considerably, from .4 percent on July 1997 to 2.5 percent in September 1998. The sharp increases are explained by those who were out of the labor force entering the labor market to search for jobs. In the average month from 1986 to 2006, on the other hand, the UE transition rate was 26.2 percent. That is, about one-quarter of the unemployed found employment within a month. This time series exhibits considerable variation, starting from 23.8 percent in January 1986, reaching 40.5 percent in July 1990, falling to 16.9 percent in December 1997, and from January 2000 through the end of 2006 moving at around 25 percent with a standard deviation of 1.8 percent. The UO transition rate trended upward in the late 1980s, but downward in the early 1990s. In the mid-1990s it reached its lowest level at about 4 percent but it has increased consistently over the last decade since then. Recently, more than 10 percent of the unemployed typically give up looking for employment and leave the labor force.

Figure 2 **Transition Probabilities**

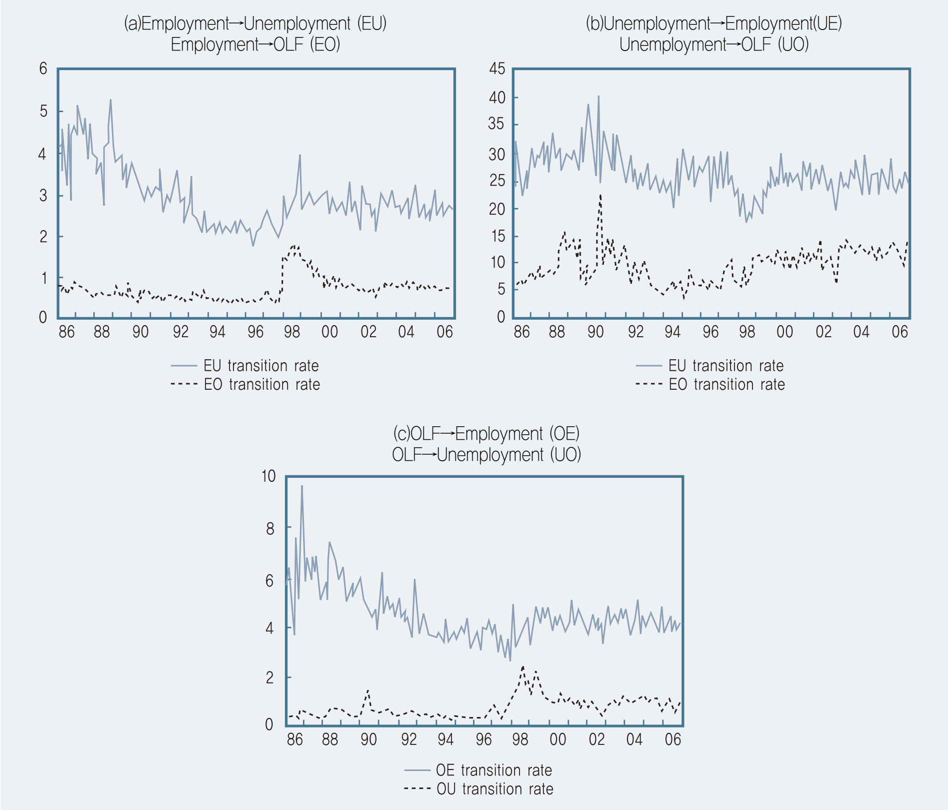


Table 2 **Transition Probabilities of the EAPS**

(a) January 1986 ~ December 2006

%	Employed (*t*+1)	Unemployed(*t*+1)	OLF(*t*+1)
Employed (*t*)	96.37 (0.78)	0.70 (0.28)	2.93 (0.69)
Unemployed(*t*)	26.20 (3.36)	64.27 (4.56)	9.53 (2.94)
OLF(*t*)	4.53 (1.00)	0.75 (0.37)	94.72 (1.02)

(b) January 2000 ~ December 2006

%	Employed (*t*+1)	Unemployed(*t*+1)	OLF(*t*+1)
Employed (*t*)	96.51 (0.29)	0.77 (0.10)	2.73 (0.22)
Unemployed(*t*)	25.37 (1.83)	63.09 (2.53)	11.54 (1.57)
OLF(*t*)	4.20 (0.35)	0.94 (0.15)	94.85 (0.42)

* All data are seasonally adjusted with X-12. Standard deviations are given in parentheses.

3. Cyclicality of Labor Market Variables

To investigate the cyclicality of the labor market variables, I look at the contemporaneous correlations between output and the labor market variables. I construct quarterly data by monthly averages because GDP data is not available at monthly frequencies. Tables 3(a) and 3(b) report the contemporaneous correlations between the labor market variables and per capita GDP at quarterly frequencies. Since a quarterly population measure is not available, I use the population 15 years old or over. For most of the stock and flow variables, the correlation with output has decreased significantly since 2000.

Table 3 Correlations with per capita GDP

(a) Correlations between per capita GDP and Labor Market Stock Variables

per capita GDP	Employed Persons		Unemployed Persons		Nonparticipants	
	with trend	without trend	with trend	without trend	with trend	without trend
1986-2006	.88	.89	-.90	-.90	-.74	-.69
2000-2006	.56	.56	-.52	-.51	-.38	-.39

(b) Correlations between per capita GDP and Labor Market Flow Variables

per capita GDP	Transition Probabilities					
	E→U	E→O	U→E	U→O	O→E	O→U
1986-2006	-.86	-.33	.53	-.16	-.09	-.76
2000-2006	-.30	.05	.09	-.17	.10	-.35

(c) Correlations between Transition Probabilities

Probability U→E	Transition Probabilities				
	E→U	E→O	U→O	O→E	O→U
1986-2006	-.44	.08	.24	.32	-.28
2000-2006	.21	.52	.36	.69	.42

* Per capita GDP is real GDP divided by the population aged 15 or over. All data are converted to quarterly frequencies, seasonally adjusted, and HP-filtered with smoothing parameter 1,600.

The most important parameter in the labor market is the UE transition rate, which can be interpreted as the job-finding probability. GDP can also reflect the labor market, but it is an aggregate variable which contains much information about the whole economy. For that reason, the labor market related information available on the UE transition rate is much better than the information available on GDP. The UE transition rate is informative not only to concerning unemployed persons, but also to employed persons and nonparticipants. Employed persons wishing to move to other jobs carefully look at the transition rate. Based upon it, they make their decisions. Nonparticipants also care about the transition rate, because it gives them useful information about the best time to enter the labor market and search for jobs.

Table 3(c) shows correlations between the UE transition rate and other transition rates. A high UE probability implies that it is easy for people to find jobs. Recently, the correlation between UE and EO transition rates has increased from .08 to .52, while the correlation between UE and UO transition rates has similarly risen from .24 to .36. This may be taken to imply that employed and unemployed persons are more likely to leave the labor market (increases in the EO and UO transition rates) when the possibility of finding a job is high. Note that nonparticipants are more likely to enter the market (increases in the OE and OU transition rates) when the UE transition rate is high. The correlation between the UE and the OE transition rates has increased from .32 to .69, while the correlation between the UE and the OU transition rates has similarly risen from -.28 to .42.

III. The Model

The model economy is a variant of the Mortensen and Pissarides (1994) matching model which consists of workers and firms (or entrepreneurs). Both workers and firms are homogeneous. Unlike in the standard Mortensen-Pissarides matching model, workers can be employed, unemployed, or out of the labor force.[2)]

1. Environments

There is a continuum of infinitely-lived and risk-neutral workers with total mass equal to one. Each worker has preferences defined by

$$\sum_{t=0}^{\infty} \beta^t c_t \tag{1}$$

2) For more details about the model, see Moon (2008).

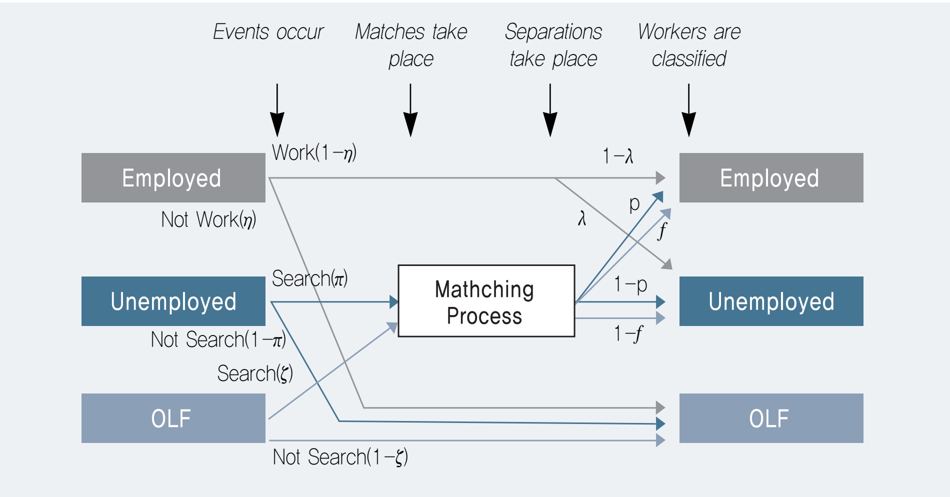
where $0 < \beta < 1$ is a discount factor and c_t is consumption which takes the following values depending upon the worker's labor market status: w_t if the worker is working, b if the worker is searching for a job, and 0 if the worker is out of the labor force.

At the beginning of each period, there are three types of workers (based on the classifications made one period before): employed, unemployed, and out of the labor force (I discuss the classification of workers below). Employed workers work on their current jobs with probability $1-\eta$ or do not work with probability η. If an employed worker does not work, then (s)he is classified as *OLF*. Conditional on working, workers separate with probability λ at the end of that period. Those who separate are classified as *unemployed*, and those who do not separate are classified as *employed*.

Unemployed workers look for work with probability π or do not look for work with probability $1-\pi$. If unemployed workers do not search, then they are classified as *OLF*. Conditional on searching, workers find jobs with probability p. Those who find employment are classified as employed, and those who do not find employment are classified as *unemployed*.

Nonparticipants are to look for work with probability ξ or do not with probability $1-\xi$. If a nonparticipant does not search, then (s)he is classified as *OLF*. Conditional on entering the labor force, nonparticipants find employment with probability f. Those who find employment are classified as *employed*, and those who do not are classified as *unemployed*. Figure 3 summarizes the worker flows.

Figure 3 **Flow Chart**



There are also infinitely many risk-neutral firms in this economy. Each firm has preferences defined by

$$\sum_{t=0}^{\infty} \beta^t c_t \tag{2}$$

where $0 < \beta < 1$ is a discount factor and c_t consumption. In a certain period, firms can be active or vacant. An active firm is one that is matched with a worker and is currently producing output z, where z is an aggregate productivity level which is assumed to follow an AR(1) process in logs:

$$\ln z' = \rho \ln z + \varepsilon' \tag{3}$$

where ε follows a normal distribution with mean zero and variance σ_{ε}^2. The steady state productivity level is normalized to 1. All active firms confront exogenous separation with probability λ. A vacant firm is one that is posting a vacant position and looking for workers. All vacant firms find workers with probability q. I assume that firms pay k units of the consumption good to post a vacancy.

Table 2 reports the probabilities of transition between different labor force states for the Korean labor market. The UE transition rate is about 26.2 percent and the OE transition rate about 4.5 percent. Based on this fact, Kim (2004) and Pries and Rogerson (2008) assume that the probability that an unemployed worker finds a job is much higher than the probability that a nonparticipant finds one.

The job search decision is made by both those out of the labor force and the unemployed. In the data, the reason we observe a direct transition from OLF to employment is that the survey does not ask respondents who were out of the labor force the previous month and found a job this month what they did between two consecutive months. This is what is termed a survey design issue. We know that those who move directly from OLF to employment made at least minimal search effort.[3)]

3) In Section II, I classify as unemployed all of those who report their unemployment duration is greater than 0, and are available for work. Among those out of the labor force, some report that they have ever looked during work the last survey year. They are not, however, considered as job-seekers because they are not actively searching for work when they are interviewed. Even though some of those out of the labor force say that they would work if they had a job, this cannot be considered as search behavior.

This study focuses on the job search which should be made by those who move from OLF to employment. The probability that nonparticipants become employed is not their job-finding probability, but the conditional probability that they find a job when they are searching. Similarly, the probability that the unemployed become employed is not their job-finding probability, but the conditional probability that the unemployed find a job when they are searching.[4)]

Before making a job-search decision, a nonparticipant decides first whether to participate in the labor force.

$$\Pr(UE \mid Labor\ Force) = \frac{UE}{UE+UU} = \frac{26.2\%}{26.2\%+64.3\%} = 29\%$$

$$\Pr(OE \mid Labor\ Force) = \frac{OE}{OE+OU} = \frac{4.5\%}{4.5\%+.8\%} = 85.8\% \tag{4}$$

Nonparticipants' job-finding probability is defined as a conditional probability: conditional on participation in the labor force and searching for work, a nonparticipant finds a job with a certain specified probability. The unemployed workers' conditional job-finding probability is then about 29 percent and the nonparticipants' about 85.8 percent. If a nonparticipant is to search, then (s)he will have a three times higher job-finding probability that an unemployed worker will. Let denote the relative search efficiency:

$$x = \frac{\Pr(OE|Labor\ Force)}{\Pr(UE|Labor\ Force)} \tag{5}$$

4) In this paper, the search decision has two steps: First, each individual receives a piece of information about the labor market without any cost or any effort. For example, one can look over the job classifieds when reading newspapers, or one can hear from friends and relatives about vacancy openings. Second, based on such costless information, each individual takes costly action by searching for work: ,i.e, filling out applications, writing resumes, and going to job interviews. In the context of information networks, the sources of job information can be categorized as formal and informal . (See Rees (1966)) Formal sources include state and private information agencies, and newspaper advertisements, while informal sources include friends, relatives, and other acquaintances. The importance of information obtained through personal relationships is stressed by Montgomery (1992), who reports that approximately 50 percent of all workers currently employed found their jobs through informal sources.

A constant-returns-to-scale matching function is assumed:

$$m(s,\upsilon) = \omega\upsilon^{1-\gamma}s^{\gamma} \tag{6}$$

where s is the efficiency unit of the searchers, υ the number of vacancies, γ the elasticity of the matching function, and ω a matching function parameter. Using the relative search efficiency x , the number of searchers is $s = \pi U + x\xi O$, where U and O is the beginning-of-period unemployed workers and nonparticipants, respectively. The probability p that a worker in the labor market finds a job and the probability f that a worker entering the labor market finds a job are given by

$$p = \frac{m}{s} = \omega\theta^{1-\gamma} \tag{7}$$

$$f = x\frac{m}{s} = x\omega\theta^{1-\gamma} \tag{8}$$

$$q = \frac{m}{\upsilon} = \omega\theta^{-\gamma} \tag{9}$$

where is $\theta = \upsilon/s$ is the vacancy-searcher ratio. The worker-finding probability is where time subscript is omitted, but , p,f and q are time-varying.

2. Equilibrium

The individual worker's problem can be formulated recursively. Let $V^{w}(z,\varphi)$ denote the value function of a worker who works, $V_{p}^{s}(z,\varphi)$ the value function of a worker who was classified as unemployed in the previous period and who searches in the current period, $V_{f}^{s}(z,\varphi)$ the value function of a worker who was classified as OLF in the previous period and who searches in the current period, and $V^{n}(z,\varphi)$ the value function of a worker who does not search in the current period, where z denotes aggregate productivity and φ is the distribution of workers.

The value function of a worker who is to work is given by

$$\begin{aligned} V^{w}(z,\varphi) = w(z,\varphi) + \beta(1-\lambda)E_{z}[\eta V^{n}(\acute{z},\acute{\varphi}) + (1-\eta)V^{w}(\acute{z},\acute{\varphi})] \\ + \beta\lambda E_{z}[\pi V_{p}^{s}(\acute{z},\acute{\varphi}) + (1-\pi)V^{n}(\acute{z},\acute{\varphi})] \end{aligned} \tag{10}$$

where $w(z,\varphi)$ is a Nash bargaining wage and λ the exogenous separation rate. A worker earns wages $w(z,\varphi)$ in the current period. In the subsequent period, if the match survives with probability 1-λ, then the worker will continue or terminate the match, depending on probability η. However, if the match is dissolved exogenously with probability λ, then the worker will search with probability π.

The value function of a worker who was classified as unemployed in the previous period and searches in the current period is given by

$$V_p^s(z,\varphi) = b + \beta p(z,\varphi) E_z[\eta V^n(\acute{z},\acute{\varphi}) + (1-\eta) V^w(\acute{z},\acute{\varphi})] \\ + \beta(1-p(z,\varphi)) E_z[\pi V_p^s(\acute{z},\acute{\varphi}) + (1-\pi) V^n(\acute{z},\acute{\varphi})] \tag{11}$$

where the job-finding probability is $p(z,\varphi) = \omega\theta(z,\varphi)^{1-\gamma}$. A worker who is looking for work receives unemployment insurance benefits, b, in the current period, and in the subsequent period finds a job with probability $p(z,\varphi)$. If a worker finds a job, then (s)he will be to work on that job or not depending on probability η. Otherwise, (s)he will search again or not, with probability π.

The value function of a worker who was classified as OLF in the previous period and searches in the current period is given by

$$V_f^s(z,\varphi) = \beta f(z,\varphi) E_z[\eta V^n(\acute{z},\acute{\varphi}) + (1-\eta) V^w(\acute{z},\acute{\varphi})] \\ + \beta(1-f(z,\varphi)) E_z[\pi V_p^s(\acute{z},\acute{\varphi}) + (1-\pi) V^n(\acute{z},\acute{\varphi})] \tag{12}$$

where the job-finding probability is $f = x\omega\theta(z,\varphi)^{1-\gamma}$. Note that a worker who was out of the labor force in the last period and is looking for work does not receive unemployment insurance benefits in the current period.

Finally, the value function of a worker who does not search is given by

$$V^n(z,\varphi) = \beta E_z[\xi V_f^s(\acute{z},\acute{\varphi}) + (1-\xi) V^n(\acute{z},\acute{\varphi})] \tag{13}$$

A worker who does not search in current period searches or does not search in the subsequent period with probability ξ.

The firm's problem is also formulated recursively. Let $J(z,\varphi)$ denote the value function of a firm matched with a worker and V the value of posting a vacancy. The value function of the matched firm is given by

$$J(z,\varphi) = z - w(z,\varphi) + \beta(1-\lambda)\{E_z[(1-\eta)\, J(\acute{z},\acute{\varphi}) + \eta V]\} + \beta\lambda V \qquad (14)$$

where z is output, $w(z,\varphi)$ a Nash bargaining wage, and the remaining term the discounted expected values of the match weighted by the probability that the match survives, $(1-\lambda)$.

The value of a firm with a vacant position is given by

$$V = -k + \beta q(z,\varphi) E_z[(1-\eta)\, J(\acute{z},\acute{\varphi}) + \eta V] + \beta(1-q(z,\varphi))V \qquad (15)$$

where k is job-posting cost. The free-entry condition, $V = 0$, which states that vacancies earn zero profits determines the equilibrium number of job vacancies

Let $S(z,\varphi)$ denote the match surplus between a worker and a firm. The match surplus is defined to be the difference in the sum of the payoffs of the worker and the firm:

$$S(z,\varphi) = V^w(z,\varphi) - V^n(z,\varphi) + J(z,\varphi) \qquad (16)$$

where the threat point of the worker is the value from being out of the labor force. A worker who breaks up the match is then out of the labor force, but never becomes a job-seeker because (s)he cannot find a better wage through a search in this framework.

The wage is derived by assuming that fixed fractions of the surplus accrue to the worker and the firm. The total match surplus is shared in accordance with the following Nash product:

$$w(z,\varphi) = \text{argmax}\ [V^w(z,\varphi) - V^n(z,\varphi)]^{\alpha} J(z,\varphi)^{1-\alpha} \qquad (17)$$

where γ is the worker's bargaining power, which is set to equal the elasticity of the matching function with respect to search, so that the Hosios (1990) condition is satisfied. Following Hall (2005), I assume that wages are rigid over the business cycle so that they are given by $w(z,\varphi) = w(z^*,\varphi^*)$ for all z and φ, where z^* is the steady state productivity level, φ^* the steady state distribution of workers, and $w(z^*,\varphi^*)$ the Nash bargaining wage at (z^*,φ^*).

Finally, the evolution of the aggregate state is described by the function $T(z,\varphi)$, where for each (z,φ) this function specifies a distribution over the next period's values of the state variables.

The recursive equilibrium is a list of functions $V^w(z,\varphi)$, $V_p^s(z,\varphi)$, $V_f^s(z,\varphi)$, $V^n(z,\varphi)$, $J(z,\varphi)$, $p(z,\varphi)$, $f(z,\varphi)$, $q(z,\varphi)$, and $w(z,\varphi)$ such that:

1. Taking the functions $p(z,\varphi)$, $f(z,\varphi)$, $q(z,\varphi)$ and $w(z,\varphi)$ as given, $V^w(z,\varphi)$, $V_p^s(z,\varphi)$, $V_f^s(z,\varphi)$, $V^n(z,\varphi)$, and $J(z,\varphi)$ solve the Bellman equations (10)-(14)
2. The free-entry condition holds so that $V = 0$.
3. Wages are determined by Nash bargaining (17).
4. For each (z,φ), decisions generate a distribution over the next period's state that is equal to the distribution given by $T(z,\varphi)$.

3. Reduced-Form Labor Market Dynamics

Following Cole and Rogerson (1999), I also characterize the implications of the model for the time series. The model implies the following times series of employment, unemployment and OLF:

$$E_{t+1} = (1-\eta)(1-\lambda)E_t + \pi p_t U_t + \xi f_t O_t \tag{18}$$

$$U_{t+1} = (1-\eta)\lambda E_t + \pi(1-p_t)U_t + \xi(1-f_t)O_t \tag{19}$$

$$O_{t+1} = \eta E_t + (1-\pi)U_t + (1-\xi)O_t \tag{20}$$

Note that OLF is independent of the job-finding probabilities, p_t and f_t.

Moon (2008) shows that in the Kim (2004) and Pries and Rogerson (2008), OLF is a function of the job-finding probabilities, and their model predict linear relationships between employment, unemployment and OLF, which imply the perfect correlations. My model, however, does not give any linear relationship between the variables, and no perfect correlations are derived.

Another advantage of my model is that the UE and OE transition rates, πp and ξf, are directly identified from the data, because they represent conditional probabilities which are consistent with intuition. For example, the OE transition rate, ξf, consists of two parts: the first part the probability of entering the labor force and the second the job-finding probability conditional on being in the labor force. Although we observe that the UE transition rate is quite high and the OE transition rate quite low, this does not necessarily imply that p is greater than f. Suppose that p is less than f. If the probability of remaining unemployed, π is much higher than the probability of entering the labor force, ξ then a higher UE transition rate is observed in the data.

4. Extension of the Basic Model

So far, we have considered the model in which only the job-finding probabilities are time-varying, but other variables such as the separation rate (λ), the rates of leaving the labor force ($1-\pi$ and η), and the labor force participation rate (ξ) are constant over time. Leaving other things the same, I assume that the parameters are time-varying over time.

First, the labor market participation decision, ξ, can vary over time. Table 4 shows the correlations between the UE transition rate and the rate of transition from OLF to the labor force, which are .38 for 1986-2006 and .62 for 2000-2006 at monthly frequencies. As the job-finding probability gets higher, those out of the labor force are more likely to participate in the labor market by looking for work. Thus, I assume that the parameter governing labor force participation follows an AR(1) process:

$$\xi' = \rho_\xi \xi + (1-\rho_\xi)\bar{\xi} + \nu' \tag{21}$$

where $\bar{\xi}$ is the average participation rate, ρ_ξ is the persistence parameter, and ν follows a normal distribution with mean 0 and variance σ_ν^2. ν can be correlated with the shock to the aggregate productivity, ε.

Second, the probability that an unemployed worker does not leave the labor force, π can be time-varying.

$$\pi' = \rho_\pi \pi + (1-\rho_\pi)\,\bar{\pi} + \zeta' \tag{22}$$

where $\bar{\pi}$ is the average probability of participating in the labor market, ρ_π is the persistence parameter, and ζ follows a normal distribution with mean 0 and variance σ_ζ^2. ζ can be correlated with the shock to the aggregate productivity, ε .

Table 4 **Correlations with the Detrended UE Transition Probability**

Probability U→E	Transition Probabilities		
	(1) O → E or U	(2) U → E or U	(3) E → O
1986-2006	.38	.09	.13
2000-2006	.62	-.17	.31

* Monthly data are employed. All data are seasonally adjusted and HP-filtered with smoothing parameter 14400.

The probability $1-\pi$ captures the discouraged worker effect. If the labor market is hit by a goods shock, the unemployed are less likely to leave because they expect higher value from being in the labor force through increases in the job-finding probability and labor income. That is, π is increasing when the possibility of finding a job is high. In the data given in Table 4, however, the correlations between the UE transition rate and the rate of transition from unemployment to the labor force are .09 for 1986-2006 and -.17 for 2000-2006, at monthly frequencies and we do not observe a significant discouraged worker effect.[5)]

Finally, the parameter η which determines the BO transition rate can be time-varying.

$$\eta' = \rho_\eta \eta + (1-\rho_\eta)\bar{\eta} + \tau' \tag{23}$$

where $\bar{\eta}$ is the average probability of being OLF, ρ_η the persistence parameter, and τ follows a normal distribution with mean 0 and variance σ_τ^2. τ can be correlated with the shock to the aggregate productivity, ε.

In the data (Table 4), the correlations between the UE and EO transition rates are .13 for 1986-2006 and .31 for 2000-2006, at monthly frequencies. That is, the EO transition rate is likely to increase when the possibility of finding a job is high.

5) There should be discouraged worker effects for a certain group of people. Since we focus on aggregate variables, these effects are offset by other people.

5. The Reduced-Form Dynamics from the KPR Model

In this subsection, I introduce the reduced form labor market dynamics derived by Kim (2004) and Pries and Rogerson (2008), in which the unemployed are defined as those who search actively and nonparticipants as those who search inactively.[6)]

Time $t+1$ matched workers who have employment opportunities, denoted by M_{t+1} and unmatched workers who have no employment opportunities, N_{t+1}, are given as follows:

$$M_{t+1} = (1-\lambda)E_t + p_t U_t + f_t O_t \tag{24}$$

$$N_{t+1} = \lambda E_t + (1-p_t)U_t + (1-f_t)O_t \tag{25}$$

where E_t, U_t, and O_t denote employed workers (the employment-to-population ratio or employment), unemployed workers (unemployment-to-population ratio or unemployment), and nonparticipants (the nonparticipation rate or OLF), respectively. Thus, time $t+1$ employment, unemployment and OLF can be expressed in terms of matched workers and unmatched workers:

$$E_{t+1} = (1-\eta)M_{t+1} \tag{26}$$

$$U_{t+1} = \mu(\eta M_{t+1} + N_{t+1}) \tag{27}$$

$$O_{t+1} = (1-\mu)(\eta M_{t+1} + N_{t+1}) \tag{28}$$

As discussed in Moon (2008), the above reduced-form dynamics have the following shortcomings. First, the unemployment-to-population ratio, U, is expressed as a fraction of those who do not work:

$$U_t = \mu(1-E_t) \tag{29}$$

The correlation between employment and unemployment is then -1, and the

6) For more details, see Moon (2008).

standard deviation of unemployment expressed as the ratio to the standard deviation of employment is equal to μ.

Second, the relationship between OLF and unemployment is given by

$$O_t = \frac{1-\mu}{\mu} U_t \tag{30}$$

The correlation between unemployment and OLF is then 1, and the standard deviation of OLF to the standard deviation of unemployment is equal to $(1-\mu)/\mu$.

IV. Quantitative Analysis

1. Parameterization

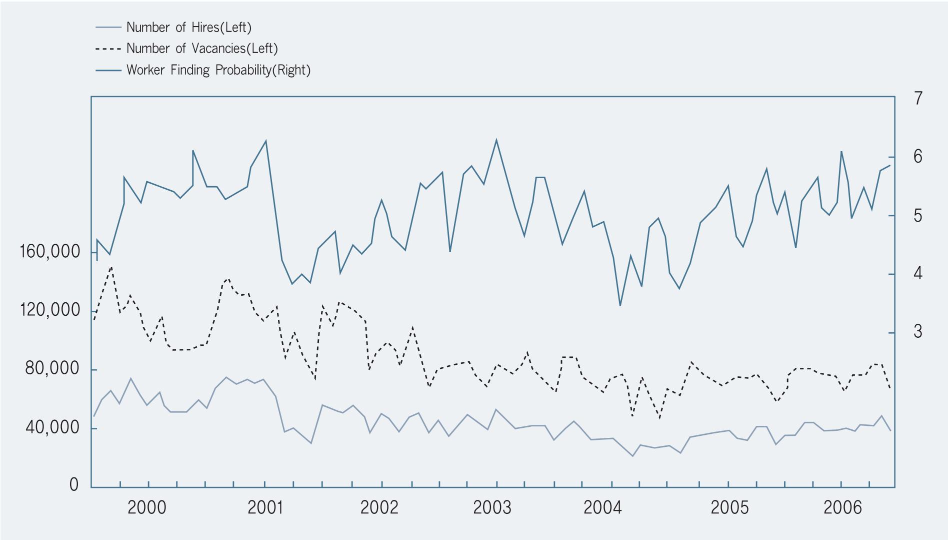
The model operates at a monthly frequency, and therefore the discount factor is set to $\beta = 0.9963$, equivalent to an annual interest rate of 4.5 percent. Workers' bargaining power and the matching function elasticity with respect to search are set to $\gamma = 0.5$. The level of unemployment benefits (or the replacement ratio) is set to .26, which is 40% of the steady state Nash bargaining wage. The probability that an unemployed worker stays in the labor force is computed from the UO transition rate, $\pi = 1 - h_{UO} = 90.47\%$. The steady state probability that an unemployed worker finds a job is $p^* = h_{UE}/(h_{UE} + h_{UU})$. The probability that a nonparticipant enters the labor force is $\xi = h_{OE} + h_{OU} = 5.28\%$. The steady state probability that a nonparticipant finds a job is $f^* = h_{OE}/(h_{OE} + h_{OU})$. The probabilities of a worker leaving the labor force and of being laid off are calculated from the steady-state condition of the reduced-form labor market dynamics:

$$\eta = \frac{\xi O^* - (1-\pi) U^*}{E^*} \tag{31}$$

$$\lambda = \frac{(1-\pi+\pi p^*) U^* - \xi (1-f^*) O^*}{(1-\eta) E^*} \tag{32}$$

where E^*, U^*, and O^* are the steady state employment-to-population ratio, unemployment-to-population ratio and nonparticipation rate, respectively. The relative search efficiency is given by $x = f^{*}/p^{*}$. The worker-finding probability comes from the Monthly Report of Public Employment Service Worknet data (see Figure 4). I use only observations during seven years(2000-2006), as there were numerous measurement errors prior to 2000. The probability, q^{*}, is estimated by dividing the total number of new hires by the total number of new vacancies, which yields (5).

Figure 4 Vacancies, Hires and Worker-Finding Probability



* Source: Public Employment Service Worknet Monthly Report (2000-2006), Korea Employment Information Service.
** The average monthly worker-finding probability is .5, and its standard deviation is .06.

Accordingly, the steady state vacancy-to-searcher ratio and matching function parameter are pinned down. That is, $\theta^{*} = p^{*}/q^{*}$ and $\omega = p^{*}\theta^{*-\gamma}$. Finally, the persistence parameters of the productivity shock and the other shocks are set to 0.95. The standard deviation of the innovation to the productivity shock, σ_{ε}, is set to .4 percent. The other standard deviations of the innovations to ξ, π, and η, (σ_{ν}, σ_{ζ}, and σ_{τ}) are set to .05 percent.6 percent, and .03 percent, respectively because the model-generated statistics match the actual volatility of OLF. The correlations between a shock to productivity, ε, and other shocks such as ν, ζ, and τ are assumed to have values between 0 and 1. All parameters are summarized in Table 5.

The computation procedure is as follows: Given the parameters in Table 5, I first solve the steady state of the model and then find the Nash bargaining wage, which is .66. Assuming that Nash bargaining wages are rigid at the steady-state Nash bargaining wage, I solve the Bellman equations from equation (10) to (15) by using the method of value function iterations, from which I find the vacancy-search ratio, θ, as a function of aggregate productivity. Given θ, I simulate the reduced-form dynamics given in equations (18)-(20) and generate time-series data.

Table 5 **Parameters**

(a) Basic Parameters

Variables	Description	Values	
		1986-2006	2000-2006
β	discount factor	.9963	
γ ,α	worker's bargaining power and matching function elasticity	.5	
b	unemployment insurance benefits	.26	
ω	matching function parameter	.3805	
p^*	job-finding probability	.2896	.3787
χ	relative search efficiency	2.9639	2.8468
q^*	worker-finding probability	.5	
θ^*	vacancy-searcher ratio	.5793	.5736
π	probability that unemployed workers stay in the labor force	.9047	.8846
ξ	probability that nonparticipants enter the labor market	.0528	.0515
η	probability that workers leave the labor force	.0323	.0292
λ	probability of being laid off	.0080	.0086
ρ, ρ_ζ, ρ_π, ρ_η	persistence parameters of shocks	.95	
σ_ε	standard deviation of productivity shock	.4%	
E	employment-population ratio	.5842	.5902
U	unemployment-population ratio	.0209	.0232

(b) Additional Model Parameters

Variables	Description	Values
σ_ν	standard deviation of shock to the probability that nonparticipants enter the labor market	.014%
σ_ξ	standard deviation of shock to the probability that unemployed workers stay in the labor force	.22%
σ_τ	standard deviation of shock to the probability that workers leave the labor force	.01%

2. Results

The time period of the model is 200 months, and the associated statistics are obtained by 100 simulations. The model-generated data are detrended by an HP filter with smoothing parameter 14,400. Standard errors are given in parentheses. First, I report the results from the model developed in Kim (2004) and Pries and Rogerson (2008), in which unemployment is an active search and OLF is an inactive search. Now I turn to my model.

A. KPR Model

Table 6 presents the simulation results, the relative volatilities of unemployment and OLF expressed as the ratios to the standard deviation of employment. The relative volatility of unemployment is 1.4 which is equal to the relative volatility of OLF. If one takes logarithm in equation (30),

$$\ln O_t = \frac{1-\mu}{\mu} + \ln U_t$$

The KPR model, therefore, face a limit in accounting for the highly volatile unemployment.

Table 6 **Results of the KPR Model**

(a) Standard Deviations of Detrended Variables

	Std (e), %	$\frac{Std(u)}{Std(e)}$	$\frac{Std(o)}{Std(e)}$	$\frac{Std(u)}{Std(e)}$	$\frac{Std(\upsilon)}{Std(e)}$
Data: 1986-2006	1.21	11.81	0.79	12.02	
Data: 2000-2006	0.61	11.59	1.06	11.77	
KPR Model (1986-2006)	0.18 (0.04)	1.41	1.41	2.32	10.64

(b) Correlations Between Detrended Variables

	Corr(e,u)	Corr(e,o)	Corr(u,o)	Corr(u,υ)
Data: 1986-2006	-.82	-.83	.40	
Data: 2000-2006	-.74	-.80	.24	
KPR Model (1986-2006)	-.99	-.99	1.00	-.22

* See footnote for <Table 1>
** Parameters are set to the entire period 1986~2006. See Moon(2008)
*** Standard deviations of 100 simulations are given in parentheses.

B. Benchmark Model

I start by showing the relationship between the aggregate productivity and the vacancy-searcher ratio given in Figure 5.

Figure 5 **Productivity Shock and Vacancy-Searcher Ratio**

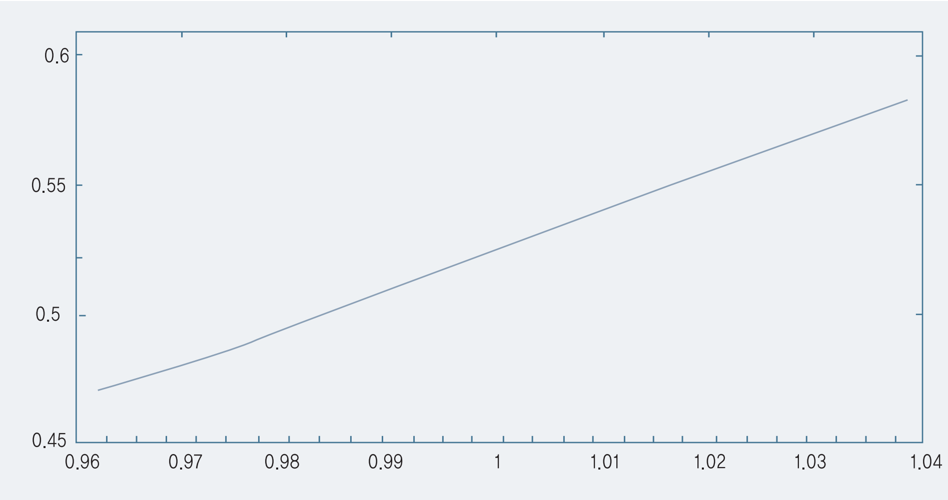


Table 7 demonstrates that the benchmark model accounts for the Korean labor market better than the KPR model does. In fact, the model does not amplify productivity shocks as much as the KPR model does. The benchmark model, nevertheless, improves the volatilities and correlations of the labor market variables.[7)]

In particular the model amplifies the volatility of unemployment, but this is not consistent with the data of 1986-2006. It is worth noting, however, that as Shimer (2005) points out, the lack of an amplification mechanism in the search and matching model makes it hard to accounts for a highly volatile unemployment rate, but the benchmark model does a good job.

Compared to the volatility of the employment, the relative volatility of unemployment is 24, which is the most volatile in the labor market variables.

7) The aim of this paper is not to match the volatility of employment, but to evaluate how the matching model accounts for the Korean labor market and how to improve the existing model. Since nobody knows the standard deviations of productivity shocks to the labor market, the parameter value is set such that the volatility of the model-generated employment is close to the actual volatility of employment. See Cooley and Quadrini (1999), for example.

The relative volatilities of the unemployment-to-population ratio and the nonparticipation rate are 240% and 40%, respectively.

Table 7 **Results of the Benchmark Model**

(a) Standard Deviations of Detrended Variables

	$Std(e)$, %	$\frac{Std(u)}{Std(e)}$	$\frac{Std(o)}{Std(e)}$	$\frac{Std(u)}{Std(e)}$	$\frac{Std(\upsilon)}{Std(e)}$
Data: 1986-2006	1.21	11.81	0.79	12.02	
Data: 2000-2006	0.61	11.59	1.06	11.77	
Benchmark Model (1986-2006)	0.09	23.66	0.43	23.77	15.73

(b) Correlations Between Detrended Variables

	$Corr(e,u)$	$Corr(e,o)$	$Corr(u,o)$	$Corr(u,\upsilon)$
Data: 1986-2006	-.82	-.83	.40	
Data: 2000-2006	-.74	-.80	.24	
Benchmark Model (1986-2006)	-.96 (.004)	-.62 (.058)	.40 (.063)	-.47 (.077)

* See footnote for <Table 1>
** Parameters are set to the entire period 1986~2006. See Moon(2008)
*** Standard deviations of 100 simulations are given in parentheses.

The benchmark model accounts for the contemporaneous correlations and the Beveridge relationship, with a negative correlation between unemployment and vacancies of −.47.[8] As Tripier (2004) points out, the RBC models cannot generate a Beveridge relationship.[9] In what follows, I present the simulation results from the extended model.

B. Benchmark Model

I now discuss the results from the extended model. Table 8 presents the results when the stochastic participation rate is introduced. The results listed in the

8) The relationship between unemployment and vacancy is given by equation (15). Given the efficiency unit of searchers, we can compute the vacancy rate such that equation (15) holds for a realized productivity shock. If those who move directly from OLF to employment are taken into account, it is natural to look at the efficiency unit of searchers, which is not observed in the data. For that reason, I look at the unemployment-to-population ratio.
9) This result is not sensitive to functional forms of the preferences. Veracierto (2008) also reaches a similar conclusion, using Lucas and Prescott's island model.

second rows, for "Model $\sigma_\nu = 0$", correspond to the results of the benchmark model with a constant participation rate, Table 8. The parameter values are set to the statistics of sample 2000−2006.

The stochastic participation rate moves according to equation (21). Once the stochastic participation rate is brought into the benchmark model, the volatility of the nonparticipation rate increases whereas those of the unemployment-to-population ratio and the unemployment rate decrease. A small deviation of the participation rate, with 0.014%, increases the nonparticipation rate considerably from 0.58 to 1.11, and decreases the unemployment rate as well as the unemployment-to-population ratio dramatically, from 20.2 and 10.3 to 16.6 and 16.7, respectively. This is because the job-finding probability for a nonparticipant who is to enter the labor force is much higher than that which an unemployed worker confronts. The correlations between the employment-to-population ratio and the unemployment-to-population ratio, and between the

Table 8 **Results of the Extended Model**

(a) Standard Deviations of Detrended Variables

	$Std(e)$,%	$\frac{Std(u)}{Std(e)}$	$\frac{Std(o)}{Std(e)}$	$\frac{Std(u)}{Std(e)}$	$\frac{Std(\upsilon)}{Std(e)}$
Data: 2000−2006	.61	11.59	1.06	11.77	
Model $\sigma_\nu = 0$	.09 (.015)	20.16	.58	20.31	16.24
Model σ_ν =.014%, $\rho(\varepsilon,\nu)$ = 0	.10 (.019)	16.61	1.11	16.65	13.71
Model σ_ν =.014%, $\rho(\varepsilon,\nu)$ = 1/4	.12 (.021)	14.72	1.08	14.87	13.10
Model σ_ν =.014%, $\rho(\varepsilon,\nu)$ = 2/4	.13 (.023)	13.23	1.05	13.47	12.64
Model σ_ν =.014%, $\rho(\varepsilon,\nu)$ = 3/4	.13 (.024)	11.99	1.04	12.33	12.28
Model σ_ν =.014%, $\rho(\varepsilon,\nu)$ = 1	.14 (.027)	10.86	1.02	11.28	11.92

(b) Correlations Between Detrended Variables

	$Corr(e,u)$	$Corr(e,o)$	$Corr(u,o)$	$Corr(u,\upsilon)$
Data: 2000−2006	−.74	−.80	.24	
Model $\sigma_\nu = 0$	−.94	−.67	.38	−.49
Model σ_ν =.014%, $\rho(\varepsilon,\nu)$ = 0	−.68	−.74	.04	−.46
Model σ_ν =.014%, $\rho(\varepsilon,\nu)$ = 1/4	−.72	−.81	.20	−.47
Model σ_ν =.014%, $\rho(\varepsilon,\nu)$ = 2/4	−.76	−.86	.34	−.49
Model σ_ν =.014%, $\rho(\varepsilon,\nu)$ = 3/4	−.80	−.91	.49	−.50
Model σ_ν =.014%, $\rho(\varepsilon,\nu)$ = 1	−.86	−.94	.64	−.51

* σ_ν is the standard deviation of shock (ν) to the participation rate (ξ) and $\rho(\varepsilon,\nu)$ is the correlation coefficient between the productivity shock (ε) and the shock to the participation rate (ν)

** Standard deviations of 100 simulations are given in parentheses.

unemployment-to-population ratio and the nonparticipation rate decrease considerably in terms of absolute values, from −.94 and .38 to −.68 and .04, respectively, but the correlation between the employment-to-population ratio and the unemployment-to-population ratio goes up in terms of absolute values, from −.67 to −.74.

As the correlation between a shock to productivity and a shock to the participation rate increases, however, all correlations also increase in terms of absolute values. If the correlation between the shock to productivity and the shock to participation is between one-quarter and .5, the model matches the data of 2000−2006. The panel (c) of Table 3 confirms this finding: During 2000−2006, the correlations of the UE transition rate with both the OE and the OU transition rates increase. In particular, the correlation between the UE and the OE transition rates increases from .32 to .69, and the correlation between the UE

Table 9 **Sensitive Analysis for π**

(a) Standard Deviations of Detrended Variables

	$Std(e)$,%	$\frac{Std(u)}{Std(e)}$	$\frac{Std(o)}{Std(e)}$	$\frac{Std(u)}{Std(e)}$	$\frac{Std(\upsilon)}{Std(e)}$
Data: 2000−2006	.61	11.59	1.06	11.77	
Model $\sigma_\zeta = 0$,	.09 (.015)	20.16	.58	20.31	16.24
Model $\sigma_\zeta = .22\%$, $\rho(\varepsilon,\zeta) = 0$	.09 (.016)	19.56	1.08	19.51	15.07
Model $\sigma_\zeta = .22\%$, $\rho(\varepsilon,\zeta) = 1/4$	.10 (.017)	16.78	1.08	16.83	14.31
Model $\sigma_\zeta = .22\%$, $\rho(\varepsilon,\zeta) = 2/4$	.11 (.019)	14.30	1.08	14.46	13.70
Model $\sigma_\zeta = .22\%$, $\rho(\varepsilon,\zeta) = 3/4$	.11 (.020)	11.98	1.08	12.27	13.19
Model $\sigma_\zeta = .22\%$, $\rho(\varepsilon,\zeta) = 1$	.12 (.023)	9.62	1.08	10.08	12.69

(b) Correlations Between Detrended Variables

	$Corr(e,u)$	$Corr(e,o)$	$Corr(u,o)$	$Corr(u,\upsilon)$
Data: 2000−2006	−.74	−.80	.24	
Model $\sigma_\zeta = 0$,	−.94	−.67	.38	−.49
Model $\sigma_\zeta = .22\%$, $\rho(\varepsilon,\zeta) = 0$	−.70	−.62	−.10	−.42
Model $\sigma_\zeta = .22\%$, $\rho(\varepsilon,\zeta) = 1/4$	−.70	−.74	.06	−.44
Model $\sigma_\zeta = .22\%$, $\rho(\varepsilon,\zeta) = 2/4$	−.71	−.83	.22	−.47
Model $\sigma_\zeta = .22\%$, $\rho(\varepsilon,\zeta) = 3/4$	−.76	−.90	.40	−.51
Model $\sigma_\zeta = .22\%$, $\rho(\varepsilon,\zeta) = 1$	−.85	−.96	.66	−.57

*σ_ζ is the standard deviation of shock to the probability that an unemployed worker does not leave the labor force and $\rho(\varepsilon,\zeta)$ is the correlation coefficient between the productivity shock (ε) and shock ζ.
** Standard deviations of 100 simulations are given in parentheses.

and the OU transition rates increases from −.28 to .42.[10)]

For sensitivity analysis, I assume that the probability that an unemployed worker does not give up searching and the probability that employed workers leave the labor market follows equation (22) and (23), respectively. In the data, the probability that an unemployed worker does not leave the labor market, π, is weakly negatively correlated or not correlated with the UE transition rate, which

Table 10 **Sensitive Analysis for η**

(a) Standard Deviations of Detrended Variables

	Std(e), %	$\frac{Std(\tilde{u})}{Std(\tilde{e})}$	$\frac{Std(\tilde{o})}{Std(\tilde{e})}$	$\frac{Std(\tilde{u})}{Std(\tilde{e})}$	$\frac{Std(\upsilon)}{Std(e)}$
Data: 2000-2006	.61	11.59	1.06	11.77	
Model $\sigma_\tau = 0$,	.09 (.015)	20.16	.58	20.31	16.24
Model $\sigma_\tau = .01\%$, $\rho(\varepsilon,\tau) = -2/4$	.14 (.026)	12.15	1.05	12.46	9.85
Model $\sigma_\tau = .01\%$, $\rho(\varepsilon,\tau) = -1/4$	.13 (.024)	13.15	1.07	13.39	10.67
Model $\sigma_\tau = .01\%$, $\rho(\varepsilon,\tau) = 0$	.12 (.021)	14.52	1.10	14.66	11.78
Model $\sigma_\tau = .01\%$, $\rho(\varepsilon,\tau) = 1/4$	.10 (.019)	16.48	1.13	16.51	13.37
Model $\sigma_\tau = .01\%$, $\rho(\varepsilon,\tau) = 2/4$	.09 (.016)	19.63	1.20	19.50	15.93
Model $\sigma_\tau = .01\%$, $\rho(\varepsilon,\tau) = 3/4$	.07 (.012)	25.86	1.36	25.47	21.01
Model $\sigma_\tau = .01\%$, $\rho(\varepsilon,\tau) = 1$	.03 (.005)	52.05	2.31	50.77	42.37

(b) Correlations Between Detrended Variables

	Corr(e,u)	Corr(e,o)	Corr(u,o)	Corr(u, υ)
Data: 2000-2006	−.74	−.80	.24	
Model $\sigma_\tau = 0$,	−.94	−.67	.38	−.49
Model $\sigma_\tau = .03\%$, $\rho(\varepsilon,\tau) = -2/4$	−.78	−.90	.44	−.47
Model $\sigma_\tau = .03\%$, $\rho(\varepsilon,\tau) = -1/4$	−.74	−.87	.32	−.48
Model $\sigma_\tau = .03\%$, $\rho(\varepsilon,\tau) = 0$	−.70	−.82	.18	−.49
Model $\sigma_\tau = .03\%$, $\rho(\varepsilon,\tau) = 1/4$	−.66	−.75	.02	−.50
Model $\sigma_\tau = .03\%$, $\rho(\varepsilon,\tau) = 2/4$	−.62	−.63	−.18	−.51
Model $\sigma_\tau = .03\%$, $\rho(\varepsilon,\tau) = 3/4$	−.60	−.39	−.46	−.52
Model $\sigma_\tau = .03\%$, $\rho(\varepsilon,\tau) = 1$	−.71	.31	−.89	−.53

* σ_τ is the standard deviation of shock to the probability that an employed worker leaves the labor force and $\rho(\varepsilon,\tau)$ is the correlation coefficient between productivity shock ε and shock τ.
** Standard deviations of 100 simulations are given in parentheses.

10) The model should be examined using more precise measures which better capture its productivity. It is almost impossible, however, to obtain such measures. Other measures of productivity do not even reflect the labor market very well.

implies that the probability of leaving the labor force does not decrease even when the possibility of finding a job gets higher. On the other hand, the probability that an employed worker leaves the labor force, η, is weakly positively correlated with the UE transition rate, which implies that the probability of leaving the labor force is increasing when the possibility of finding a job gets higher.

I search for some relationship of the shocks to π and η with the productivity shock ε on which the extended model accounts for the data. Table 9 and Table 10 shows that the model accounts for the data if (1) the probability that an unemployed worker does not leave the labor force, π, is highly positively correlated with the labor market productivity shock, and (2) the probability that an employed worker leaves the labor force, η, is weakly negatively correlated with a labor market productivity shock. The sensitivity analysis confirms that parameters other than the participation rate do not play an important role in explaining the cyclical behaviors of the labor market variables.

VI. Conclusion

The Korean labor market has been characterized recently by (1) more volatile employment and OLF than unemployment and (2) employment which is much more closely correlated with OLF than with unemployment. Based on these stylized facts, the role of the unemployment rate as a business cycle indicator would seem to have weakened, and a significant amounts of employment fluctuations to be explainable primarily by the fluctuations in nonparticipation.

In this paper, I evaluate existing models and modify the standard matching model. The distinction between search and OLF becomes clear, and the model generates the OE transition without the assumption that nonparticipants are inactive searchers. Moreover, some parameters which determine the model dynamics are assumed to be time-varying.

The modified model accounts quite well for the Korean labor market of the last two decades. Among other time-varying parameters, the stochastic nonparticipant's probability of entering the labor force, which co-moves with the state of the labor market, explains the recent Korean labor market. A quantitative analysis of the reduced-form dynamics shows clearly that a small change in the participation rate is capable of generating the cyclical movements of employment, unemployment and OLF that we observe in the 2000-2007 data.

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