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The Wage and Employment Adjustment Process in the Japanese Labor Market: A VECM Approach*

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Abstract

This paper investigates the wage and employment adjustment processes following shocks in the Japanese labor market from 1985-2002. Most of the literature on employment adjustment does not consider the wage adjustment that accompanies employment adjustment in the labor market. We analyze wage and employment adjustment using a vector of error correction model. We find that employment adjustment has become more important since the collapse of the bubble economy because of the downward rigidity of wages. This wage rigidity prolongs the employment adjustment period following shocks.

JEL Classifications: J21, J31

Keywords: labor market, adjustment process, VECM, wage rigidity

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1. Introduction

This paper investigates the wage and employment adjustment processes following shocks in the Japanese labor market from 1985–2002 using a vector of error correction model (VECM). We examine how wage and employment adjust when there is excess employment in the labor market and how quickly excess employment can adjust.

Our empirical methods are characterized by the following two points. First, our empirical model describes the market wage adjustment that could accompany employment adjustment. Second, our estimation does not need to specify a labor supply function and an unemployment determination rule even though we consider the wage adjustment in the labor market.

The speed of employment adjustment is defined as fast when employment quickly reaches the optimal labor demand. We are interested in the employment adjustment speed because when unemployment correlates more closely with economic fluctuations, the adjustment speed is faster. That is, a fast adjustment speed implies high unemployment in a recession.

Various studies investigate the adjustment speed of employment. The most popular approach is based on the partial adjustment model, which describes the firm's dynamic employment policy and which is found, for example, in Nickell (1986) and Hamermesh (1993). In this approach, the labor demand function of competitive firms is estimated given the market wage, and the wage is treated as an exogenous variable even though in practice employment could be adjusted through interactions with the wage in the labor market. If a wage adjustment accompanies the employment adjustment, the mismatch between labor demand and supply is adjusted so that a fast employment adjustment speed does not imply a high unemployment rate. Furthermore, we could underestimate the employment adjustment speed.

Ohtake (1988) and Campa and Goldberg (2001) analyze interactions between wage and employment adjustments in the labor market. These papers do not consider the unit root and cointegration, so excess employment is not estimated with an appropriate method. Furthermore, they assume many restrictions on the labor demand and supply functions and on the unemployment determination rule without testing those specifications. In this paper, we present a simple estimation method of interacted wage and employment adjustments using cointegrated relations among the variables without specifying the labor supply function and the unemployment determination rule.

This paper is organized as follows. The next section presents the empirical model, which describes the wage, employment, and unemployment rate adjustment processes with a VECM using the labor demand function derived from the firm's profit maximization behavior. Section 3 provides the estimation results of the VECM and the simulation analysis of the response of each variable to excess employment. Finally, we summarize and discuss our empirical results.

2. Empirical model

This paper employs a VECM to examine wage and employment adjustment in the Japanese labor market. In our VECM, wage and employment converge on the labor demand function, which is the cointegrating relation and which is impacted by deviations from the labor demand function.

Ohtake (1988) analyzes the model by specifying the equations of labor demand and supply. Campa and Goldberg (2001) specify the equation for existing unemployment. Our paper considers a model where the wage and employment are determined by the balance between labor demand and supply. We specify only the labor demand equation in the long run but not the labor supply equation or a mechanism of existing unemployment.

Now, we derive the labor demand function from the firm's profit maximization behavior. The production function is specified by the Cobb-Douglas functional form $Y_t = A_t(L_t)^{\gamma}$, where Y_t is output, A_t is a trend term, and γ is a parameter. The first-order condition for maximizing the firms' profit is as follows:

$$\frac{\gamma P_t Y_t}{L_t} = w_t, \tag{1}$$

where P_t denotes the price level. By taking natural logarithms, equation (2) can be written as the following labor demand equation:

$$l_t = p_t + y_t - w_t + \log\gamma, \tag{2}$$

where a lowercase letter represents the natural logarithm. If the cointegrated relation is described as in equation (2), there is an adjustment mechanism for excess employment that is represented by deviations from equation (2). Because excess employment should be adjusted in the labor market, either the wage or employment must adjust for the excess employment. Thus, the unemployment rate

could also be influenced.

Supposing that the cointegrating relationship between wage and employment is described by equation (3), we construct the VECM for the vector of variables $X_t = [l_t, w_t, u_t]^t$ as follows:

$$\Delta X_t = \alpha EC_{t-1} + \sum_{i=1}^{12} \Gamma_i \Delta X_{t-i} + \upsilon_t, \tag{3}$$

where the error correction term is $EC_{t-1} = l_{t-1} - p_{t-1} + y_{t-1} - w_{t-1}$. A positive EC term represents overemployment in the long run. $\alpha = [\alpha_1, \alpha_2, \alpha_3]^t$ contains the adjustment coefficients of the error correction term, and υ_t is a disturbance vector. A description of the constant and trend terms is omitted. We set the lag length to 12 because we use monthly data.

Our empirical model does not consider the labor supply and determination of unemployment even though the employment adjustment is not independent of a worker's labor supply behavior or imperfections in the labor market. In order to identify the labor supply, we must specify an unemployment determination rule, but doing so is prone to misspecification because of several imperfections in the labor market. The VECM estimator is consistent even when the labor supply and the unemployment determination rule are omitted when deviations from equation (2) do not correlate with deviations from other cointegrating relations omitted from our empirical model.[1]

3. The data and empirical results

This paper estimates the VECM of equation (3) to analyze the adjustment processes of wage and employment in the labor market. We use seasonally adjusted monthly data in the sample period from Jan. 1985 to Dec. 2002. The index of total cash earnings, which is reported in the Monthly Labour Survey by the Ministry of Health, Labour, and Welfare, is used as the nominal wage. The total cash

[1] When deviations from omitted cointegrating relations are denoted by EC^o_{t-1}, model (3) can be written as

$$\Delta X_t = \alpha EC_{t-1} + \beta EC^o_{t-1} + u_t = \alpha EC_{t-1} + v_t$$

where $v_t \equiv \beta EC^o_{t-1} + u_t$. When $E[EC_{t-1} v_t] = 0$ is satisfied, the estimator is consistent. Because we cannot find a necessary relation between EC and EC^o, we assume $E[EC_{t-1} v_t] = 0$ in the paper.

earnings data include biannual bonuses that workers receive regularly. Freeman and Weitzman (1987) point out the importance of wage flexibility in Japan attained by the bonuses. The bonuses vary across individual firms and are sensitive to industry profits, which can increase wage flexibility. In our analysis, we include biannual bonuses in the wage.

The employment level is obtained from employment indexes of regular workers at establishments with 30 or more employees reported in the Monthly Labour Survey. The unemployment rate is obtained from the Labour Force Survey. Output is given by the Japan Indices of Industrial Production (IIP) published by the Ministry of Economy, Trade, and Industry. The price index is the output price index for the manufacturing industry sector, published by the Bank of Japan.

Since the bubble of real estate prices collapsed in the early 1990s, the Japanese economy has been stagnant. After the bubble burst, wages in many firms stopped growing even though price inflation turned into mild deflation. Many firms decreased their labor force, and the unemployment rate has been increasing. In the analysis, we consider the year 1991 as the turning point of structural change and divide the sample into the periods Jan. 1985-Dec. 1990 and Jan. 1991-Dec. 2002.

We investigate the order of integration in employment, output, wage, price, and the unemployment rate. Tables 1-1 and 1-2 present the results of the ADF test. All series in each period may have a unit root.

If the firms determine their employment level to maximize their long-run profit, wage, employment, and price should be consistent with equation (2). Because each variable has a unit root, we can check whether the firms' employment policies are described by equation (2) by testing for the cointegrating relation between the I (1) variables, as in equation (2). An ADF unit root test of the residual computed by equation (2) can be used as the cointegration test because there are no other estimators besides the constant term. The results shown in Table 2 indicate that the existence of a cointegrating relation, as in equation (2), is supported in each of the sample periods. Therefore, we find that the firms' employment policies are consistent with equation (2), which describes the firms' profit maximization behaviors.

Because the cointegration rank and vector in our VECM are known, each equation in (3) can be estimated using OLS. Table 3 reports the results of a short run causality test excluding the adjustment effects for overemployment. In both periods, there is causality only from employment to the unemployment rate. This implies that the wage and employment do not affect each other except

for the effect of overemployment. Table 4 gives the estimation results of the adjustment coefficients, which represent the inference of each endogenous variable from the EC term. The results present the effects of each variable on overemployment. In the period 1985-1990, deviations from the long run relation are adjusted by changes in employment and wages. In the period 1991-2002, on the other hand, deviations from the long run relation are adjusted by changes in employment and the unemployment rate without a change in wages. In this period, the price mechanism could not adjust disequilibrium of labor demand and supply in the labor market, so the unemployment rate was affected by the adjustment of overemployment.

Next, we investigate the adjustment process of each variable for deviations from the long run equilibrium. Figures 1-1, 1-2, and 1-3 show the simulation results for each variable's response to 0.01 deviations from long-run labor demand in each period[2]. The result shows how the variables adjust to the long run equilibrium by interacting with each other when the employment level becomes excessive.

For deviations from the long-run equilibrium, employment, and the wage decrease, we find that in 1985-1990 the wage response is larger and employment response is smaller than in 1991-2002. This change in the response of the wage is consistent with the estimation results on the inference for the EC term in Table 4. That is, α_1 is statistically significant in 1985-1990 but not significant in 1991-2002. Furthermore, the unemployment rate responds strongly in 1991-2002 but weakly in 1985-1990. Those results imply that labor market adjustments had an effect entirely in the 1990s.

Fig. 1-4 shows the adjustment process of the EC. In 1985-1990, the adjustment of the EC is 50% completed in 20 months, and in 1991-2002, the adjustment is 50% completed in 89 months. Furthermore, in 1985-1990, the adjustment of the EC is 90% completed in 59 months, and in 1991-2002, the adjustment is 90% completed in 301 months. We find that adjustments for deviations from the long run require much more time in 1991-2002 than in 1985-1990.

[2] In the simulation results, we compute the response of each variable under the assumption that $\beta = 0.75$. The parameter β represents the labor share of output, and we know β is in the range of 0.6-0.8. Our essential results are robust to other parameter values in that range.

4. Conclusion

In this paper, we analyze wage and employment adjustments using a VECM, and we obtain the following results. First, the nominal wage was more flexible in 1985-1990 than in 1991-2002. This result implies downward rigidity of the nominal wage. The labor demand and supply were stringent in 1985-1990 because the Japanese economy sustained high rates of GDP growth before the collapse of the bubble economy. Almost of the labor market adjustment in the period 1985-1990 was growth of the nominal wage for excess labor demand.

On the other hand, the growth rate of GDP in Japan prominently decreased in the mid-1990s, and many firms had excess employment. In the period 1991-2001, the market mechanism in the labor market required a decreasing nominal wage to correct an imbalance of labor demand and supply. However, it is harder to adjust the nominal wage downward because of pressure from labor unions and needing to sustain incentives for employees to work. Therefore, the nominal wage in the labor market was rigid from 1991-2002. Disequilibrium of the labor market was adjusted by employment; the wage could not decrease during the period, so the unemployment rate increased.

Second, wage and employment adjustments for deviations from the long-run equilibrium required much more time in 1991-2002 than in 1985-1990. In particular, the difference in the time required to complete 50% of the adjustment is about 4.5 times. Adjustments in 1985-1990 were 50% completed in 20 months, and adjustments in 1991-2002 were 50% completed in 89 months. One of the reasons for this difference in the adjustment time is that the disequilibrium of labor demand and supply was adjusted by only employment in 1991-2002, whereas disequilibrium of labor demand and supply was adjusted by both the wage and employment in 1985-1990. It is clear that disequilibrium in labor market was more rapidly adjusted by both wage and employment than by wage only.

Another reason for slower employment adjustment in 1991-2002 is that firms' employment adjustments in 1985-1990 frequently increased employment, whereas such adjustments in 1991-2002 were frequently decreasing. The adjustment costs for employment are asymmetric, and increases in employment are relatively more expensive than decreases, as, for example, in Azetsu and Fukushige (2009).

This paper developed a VECM approach for analyzing the wage and employment adjustment

processes to shocks in the labor market. There are some further extensions to our research. First, we could add new variables to our model. For example, we should add working hours, which are an important employment adjustment method for firms. Second, we can review the characteristics of adjustment processes in the labor markets in other countries using our approach. Third, we could focus on a segmented labor market. For example, our approach can review the characteristics of the wage and employment adjustment processes for regular employees and non-regular employees. All of these could be areas for further research.

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Table1-1: 1985-1990: ADF Test Statistics

	Const.	Const. & Trend	Non
L	0.51	-1.34	1.44
Y	0.12	-1.81	2.15
W	2.58	-0.57	3.79
P	-1.67	0.54	-0.53
u	-0.06	-1.44	-1.29
ΔL	-2.26	-2.61	-1.74
ΔY	-3.23*	-3.30	-2.36*
ΔW	-4.59**	-5.50**	-0.77
ΔP	-2.73	-4.31**	-2.70**
Δu	-9.18**	-9.29**	-9.05**

** (*) indicates significance at 1% (5%).

Table 1-2: 1991-2002: ADF Test Statistics

	Const.	Const. & Trend	Non
L	3.24	-1.55	-2.819**
Y	-4.09**	-4.06**	-0.65
W	-1.94	-0.58	2.51
P	-0.72	-2.02	-3.83**
u	-0.08	-2.72	3.33
ΔL	-3.18*	-6.51**	-1.51
ΔY	-4.29**	-4.27**	-4.25**
ΔW	-9.54**	-9.802**	-11.53**
ΔP	-10.7**	-10.67**	-9.83**
Δu	-14.13**	-14.09**	-13.16**

** (*) indicates significance at 1% (5%).

Table 2: Cointegration Test

1985-1990	-2.96**
1991-2002	-3.47**

** (*) indicates significance at 1% (5%).

Table 3: Short Run Causality Test

	1985-1990	1991-2002
ΔL←ΔW	1.33	8.89
ΔL←Δu	10.73	1.21
ΔW←ΔL	4.57	6.67
ΔW←Δu	2.11	7.16
Δu←ΔL	15.44**	21.16**
Δu←ΔW	9.86	12.57

** (*) indicates significance at 1% (5%).

Table 4: Inference for EC term

	1985-1990	1991-2002
$\alpha_1: EC \rightarrow \Delta l$	-0.0258*	-0.0151**
$\alpha_2: EC \rightarrow \Delta$w	-0.1400*	-0.0065
$\alpha_3: EC \rightarrow \Delta$u	0.0046	0.0089**

** (*) indicates significance at 1% (5%).

Fig. 1-1: Impulse response to l

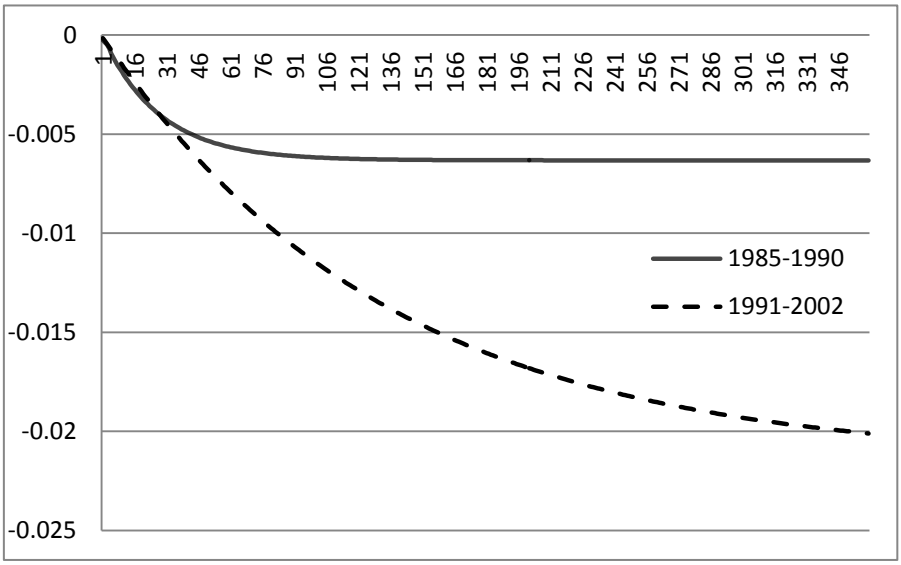

Fig. 1-2: Impulse response to *w*

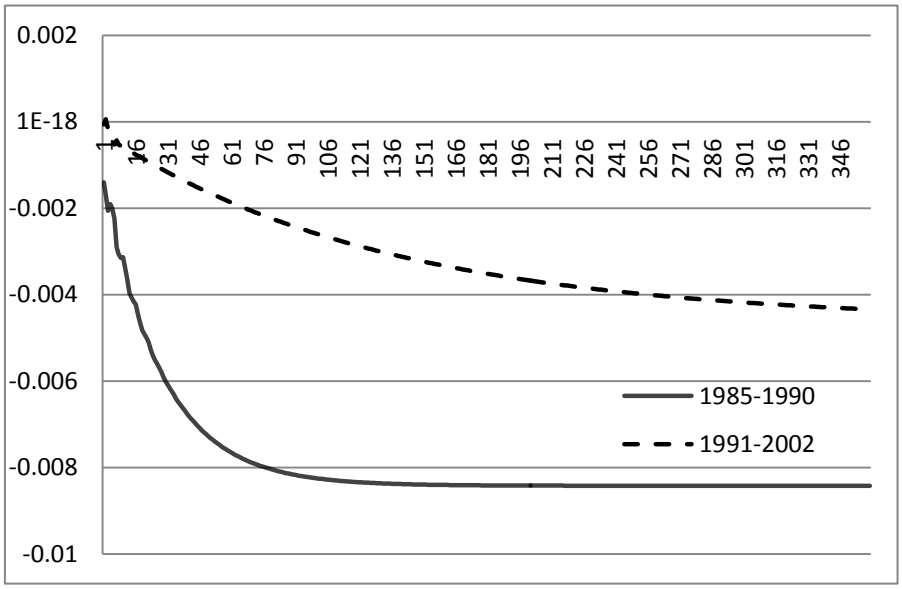

Fig. 1-3: Impulse response to u

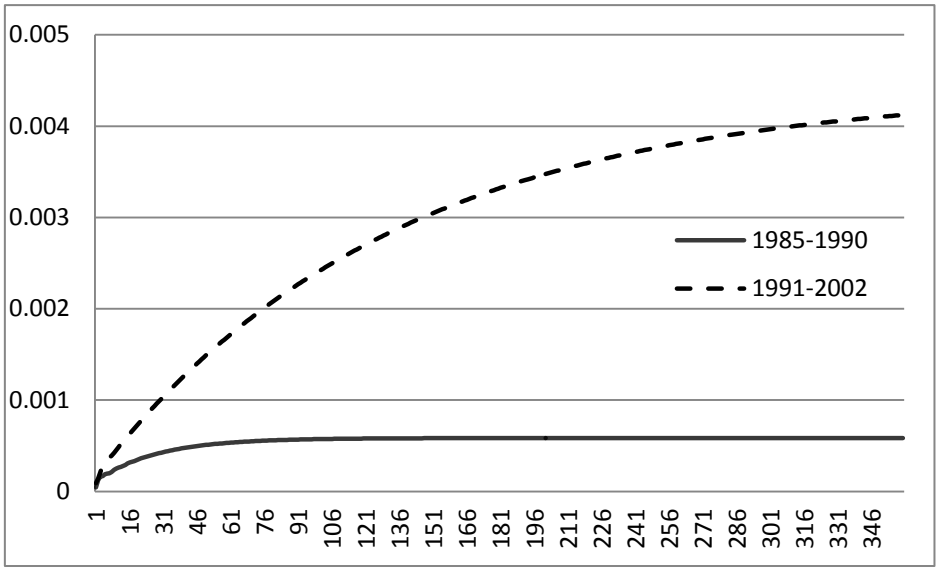

Fig. 1-4: Impulse response to EC