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Abstract

There are a number of indications that Japanese job security laws have been relaxed since the end of the 1990s. The purpose of this paper is to establish causality between job security laws and firing costs in the Japanese labor market. The analysis first investigates when and how firing costs changed, and then compares the timing of these changes in firing costs with those of job security laws. The results indicate that gradual changes in firing costs began in about 1992, lagging one or two years behind the bursting of the bubble economy, while job security laws started to change towards the end of the 1990s.

Keywords: Adjustment costs for labor; Gradual switching model; Job security laws

JEL Classification: J23; J32

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1 Introduction

When firms adjust their labor forces, they face adjustment costs (e.g., hiring and firing costs), such that they need to dynamically determine their labor demand.[1] It is then important to understand the structure of adjustment costs because these costs are critical in determining the pattern of labor demand in response to environmental shocks. While hiring costs comprise expenditure on advertising and the time spent on interviewing, testing and so on, it is argued that firing costs depend more on institutional aspects, for example, job security laws. This implies that a relaxation in job security laws leads to lower firing costs. However, there are few studies that empirically verify this effect. The purpose of this paper is then to investigate causality between job security laws and firing costs.

Although the statute of employment security in Japan stipulates that employers can freely discharge their employees, case law established after the 1973 oil shock severely limits mass dismissal.[2] Several cases established four basic requirements that employers must meet before proceeding to dismiss workers: (a) the necessity of redundancy (i.e., the firm faces serious administrative difficulties), (b) efforts at avoiding redundancy (e.g., reducing working hours, hiring freezing, and conversion of the work-place), (c) the

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[1]See, for example, Nickell (1986).

[2]According to the Employment Protection Legislation Indicators in OECD (1999), Japan has some of the severest job security laws.

reasonableness of selection criteria, and(d) the reasonableness of the procedure itself. Legal protection, of course, is not sufficient to provide protection in itself, especially in the case of Japan where legal actions may take many years to run through the courts and can be quite costly for the litigants. In particular, workers in small, nonunionized firms are unlikely to believe that they have much protection from the law. Nevertheless, there is a social convention in Japan that a reduction in the number of workers should only be used as a last resort.

Job security system as case laws is not clear in the aspect of the rule of judgment but it is suitable for the changes in economic environments. In actuality, several recent studies point out the possibility of changing job security laws in Japan. Ohtake (2002), for example, quantitatively analyzes the cases for redundancy, and argues that the job security laws changed from the latter half of the 1990s. However, Inoue (2000) argues that there were some cases that relaxed the criteria of unjust dismissal in 1999 and 2000. Thus, we can consider cases since the end of 1990 as being indicators of the relation of Japanese job security laws.

Although many studies on firms' employment adjustment typically assume that adjustment costs are symmetric, we assume an asymmetric form to distinguish between hiring and firing costs, and focus on the changes in firing costs. Jaramillo et al. (1993) and Phann and Palm (1993) propose use of the Euler equation for a dynamic labor demand model that allows for asymmetry between hiring and firing. In a more recent study, Azetsu and Fukushige (2005) develop a dynamic labor demand model with asymmetric adjustment costs for the number of workers and working hours. [3] In this paper, we investigate the structural change of adjustment costs using the model developed by Azetsu and Fukushige (2005). If structural changes in adjustment costs occur, change may be gradual rather than more drastic. We therefore allow the structure of adjustment costs to change gradually over time with the gradual switching model proposed by Ohtani and Katayama (1985) and Ohtani et al. (1990). This model can detect when the change in firing costs starts and allows the causality between firing costs and job security laws to be established.

The structure of the paper is as follows. In the next section, we develop the dynamic model of labor demand that is the basis of our empirical work. In section 3, we describe the data used, the empirical specification and the results. In section 4 we discuss the implications of the result and conclude the paper.

[3] Goux et al. (2001) assume that the labor force is the sum of permanent and fixed-term workers, which implies that the marginal productivities of the two types are equivalent. Therefore, the estimable Euler equation can be derived without specifying the production function. Azetsu and Fukushige (2005) derive the Euler equation without specifying the production function. This differs from Goux et al. (2001) where the labor force is the product of working hours per worker and the number of workers.

2 The Model

Our analysis follows the model developed by Azetsu and Fukushige (2005), which derives and estimates the Euler equation for working hours and the number of workers without specifying the production function. This is of some benefit because it is usually difficult to estimate production functions, especially the aggregate level (e.g., specification problems with functional form and technical progress, measurement problems with physical capital).

We start by assuming the form of technology. Let H_t and N_t denote, respectively, working hours per worker and the number of workers that a representative firm hires. Thus, H_tN_t is the firm's effective labor force. We assume that the firm has a production function $f(H_tN_t, \epsilon_t)$, with $\partial f(H_tN_t, \epsilon_t)/\partial(H_tN_t) > 0$ and $\partial^2 f(H_tN_t, \epsilon_t)/\partial(H_tN_t)^2 < 0$. The term ϵ_t represents a productivity shock observed at the beginning of period t. Also, we assume that the adjustment costs for the number of workers and working hours are quadratic and asymmetric. The nondifferentiability of adjustment costs causes a discontinuity in the firm's decision rule. For example, Hamermesh (1989) argues that labor demand has lumpy or linear adjustment costs at the individual plant level, but continuous costs at the aggregate level. Since we use macro data in this analysis, the discontinuity in labor demand can be ignored.[4]

[4]Hildreth and Ohtake (1998) examines the discreteness of labor demand using data provided by Japanese companies.

The risk-neutral representative firm adjusts working hours and the number of workers, after the realized current shock is observed, in order to maximize the present discounted value of expected profits, V, over an infinite horizon. The firm's optimization problem is as follows:

$$V(H_{t-1}, N_{t-1}) = \max_{i_t, r_t, a_t, s_t} F(H_t N_t, \epsilon_t) - w_t H_t N_t - \frac{c_I}{2} i_t^2 - \frac{c_D}{2} d_t^2 - \frac{c_A}{2} a_t^2 - \frac{c_S}{2} s_t^2 + \delta E_t[V(H_t, N_t)], \quad (1)$$

subject to

$$H_t - H_{t-1} = i_t - d_t, \quad (2)$$

$$N_t - N_{t-1} = a_t - s_t, \quad (3)$$

$$H_t,\ N_t,\ i_t,\ r_t,\ a_t,\ s_t\ \geq 0, \quad (4)$$

where E_t denotes expectations at the end of period t. a_t, s_t, i_t, and d_t, respectively, represent hiring workers, firing workers, increasing working hours, and reducing working hours. The parameter δ is a discount factor and w_t is the wage per working hour.

Solving this problem yields the following Euler equations for working hours and the number of workers, respectively:

$$M_t N_t - (c_I i_t - c_D d_t) + \delta E_t[c_I i_{t+1} - c_D d_{t+1}] = 0, \quad (5)$$

$$M_t H_t - (c_A a_t - c_S s_t) + \delta E_t[c_A a_{t+1} - c_S s_{t+1}] = 0, \quad (6)$$

where $M_t \equiv F'(t) - w_t$. When both c_I and c_D (c_A and c_S) are positive, the firm will not choose both i_t and d_t (a_t and s_t) to be positive.

Each condition (5) and (6) means that the optimal decision is such that the current marginal return to adjustment of working hours (of the number of workers) is equal to the discounted expected marginal cost for the adjustment itself.

The Euler equations (5) and (6) can be combined to yield:

$$E_t\left[(\hat{a}_t - \hat{s}_t) - \alpha(\hat{a}_t + \hat{s}_t) - \beta\hat{i}_t + \gamma\hat{d}_t\right] = 0, \tag{7}$$

where $\hat{a}_t \equiv (a_t - \delta a_{t+1})/H_t$, $\hat{s}_t \equiv (s_t - \delta s_{t+1})/H_t$, $\hat{i}_t \equiv (i_t - \delta i_{t+1})/N_t$, $\hat{d}_t \equiv (d_t - \delta d_{t+1})/N_t$. The $\alpha \equiv (c_S - c_A)/2c_N$, where $c_N = (c_S + c_A)/2$, measures the asymmetry between the costs of hiring and firing workers. Both c_A and c_S are positive, if and only if $-1 < \alpha < 1$ is satisfied. If α is positive (negative), then the adjustment costs for firing workers are relatively larger (smaller) than that for hiring. $\alpha = 0$ implies that the adjustment costs for workers are symmetric. The parameters, $\beta \equiv c_I/c_N$ and $\gamma \equiv c_D/c_N$, measure the relative costs of adjusting working hours to costs for adjusting the number of workers. The model cannot be rejected if the estimated parameters satisfied the sign conditions; $-1 < \alpha < 1$, $\beta,\ \gamma > 0$.

3 Data and Econometric Estimation

We use seasonally unadjusted monthly data for the Japanese labor market from 1986 to 2004, as reported in the Monthly Labour Survey by the Ministry of Health, Labour and Welfare. We use indices of working hours, H_t, and the number of workers, N_t, both normalized to 100 in 2000. The terms i_t and d_t represent the net flow of working hours, H_t. The variables a_t and

s_t are represented by the numbers of acquisitions and separations. In general, the words “dismissal” or “firing” are defined as one-sided cancellation employment contracts by the firm. We use “dismissal” or “firing” when the firm reduces the number of workers. Although early retirement is argued to be voluntary, it is often the case that the company puts heavy pressure on unwanted employees to leave the firm. In this sense, we can regard much voluntary early requirement as “dismissal” or “firing”.

In order to estimate the model, the realized values of period $t+1$ are substituted for unobserved expectations of i_{t+1}, d_{t+1}, a_{t+1}, s_{t+1}, and the disturbances u_{1t} and u_{2t} are added to (5) and (6), respectively. We obtain the following:

$$M_t N_t - (c_I i_t - c_D d_t) + \delta(c_I i_{t+1} - c_D d_{t+1}) = u_{1t}, \tag{8}$$

$$M_t H_t - (c_A a_t - c_S s_t) + \delta(c_A a_{t+1} - c_S s_{t+1}) = u_{2t}. \tag{9}$$

This specification leads (7) to the following equation:

$$(\hat{a}_t - \hat{s}_t) - \alpha(\hat{a}_t + \hat{s}_t) - \beta\hat{i}_t + \gamma\hat{d}_t = v_t, \tag{10}$$

where $v_t = u_{1t}/N_t - u_{2t}/H_t$. Since we use aggregate data, the disturbances u_{1t} and u_{2t} may be serially correlated, and furthermore, u_{1t}/N_t and u_{2t}/H_t, divided by N_t and H_t, may be heteroskedastic. Accordingly, the composite disturbance v_t can exhibit both serial correlation and heteroskedasticity. We now assume the composite disturbance $v_t = \mu_t + \bar{\mu}$, where μ_t is an MA(n) process with heteroskedasticity disturbances and $\bar{\mu}$ is constant. [5] We assume the order of the MA process to be $n = 23$.

We allow the parameters, which represent the structure of the adjustment costs, to gradually change over time as unexpected change, such that the parameters are specified as follows:

$$\alpha_t = \alpha_0 + \lambda_t \alpha_1, \ \beta_t = \beta_0 + \lambda_t \beta_1, \ \gamma_t = \gamma_0 + \lambda_t \gamma_1, \ \bar{\mu}_t = \bar{\mu}_0 + \lambda_t \bar{\mu}_1,$$

where λ_t is a transition function that accounts for a change from α_0, β_0, γ_0 to $\alpha_0 + \alpha_1$, $\beta_0 + \beta_1$, $\gamma_0 + \gamma_1$, over time. The transition function is formed as follows:

$$\begin{aligned} \lambda_t &= 0 && \text{for } t\text{=}1,\ 2,\ .\ .\ .\ ,\ t_s - 1 \\ &= (t - t_s)/(t_e - t_s) && \text{for } t\text{=}t_s,\ .\ .\ .\ ,\ t_e - 1 \\ &= 1 && \text{for } t\text{=}t_e,\ .\ .\ .\ ,\ T, \end{aligned}$$

where t_s, t_e represent a start-point and end-point of the gradual shift to be estimated.

In order to allow for endogeneity of the regressors, we estimate the equation (10) using the Generalized Method of Moments (GMM) technique developed by Hansen (1982), and employ Newey and West's (1987) weight

[5] Since the composite disturbance exhibits serial correlation and heteroskedasticity, $E[v_t]$ may not be zero, even though $E[u_{1t}]$ and $E[u_{2t}]$ are zero.

matrix. The following variable terms serve as instrumental variables:

$$1,\ \lambda_t,\ \hat{a}_{t-lag} - \hat{s}_{t-lag},\ \hat{a}_{t-lag} + \hat{s}_{t-lag},\ \hat{i}_{t-lag},\ \hat{d}_{t-lag},$$

$$\lambda_{t-lag}(\hat{a}_{t-lag} - \hat{s}_{t-lag}),\ \lambda_{t-lag}(\hat{a}_{t-lag} + \hat{s}_{t-lag}),\ \lambda_{t-lag}\hat{i}_{t-lag},\ \lambda_{t-lag}\hat{d}_{t-lag}.$$

Lag indicates the number of lags used for a variable, based on monthly data. For example, if $lag = 1$, the variable x_{t-1} is used, whereas x_{t-1} and x_{t-2} are used if $lag = 1, 2$. To allow for the autocorrelation of disturbances in the form of the 23rd-order moving average, the instruments must be lagged at least 24 periods.

Table 1 shows the GMM estimation result for equation (10). A chi-square test (sometimes called the J-test) is used to test the overidentifying restrictions of the model. In the estimation process, the start-point and end-point of the gradual switching, t_s, t_e, are simultaneously selected as maximizing the Wald statistics, which test the null hypothesis that no parameters have changed. As shown in Table 1, γ_1 and $\bar{\mu}_1$ are not significant, which implies that there is no structural change in γ and $\bar{\mu}$. Table 2 shows the result for the same equation excluding the parameters γ_1 and $\bar{\mu}_1$. By comparing the results in both Table 1 and Table 2, we confirm the robustness of the parameters excluding γ_1 and $\bar{\mu}_1$. Hereafter, we focus on the results presented in Table 2.

To start with, we check whether the model of labor demand in section 2 can be rejected. For each parameter, the following condition must be satisfied:

$$\text{asymmetry of adjustment costs for workers} \quad -1 < \alpha < 1,$$

$$\text{relative adjustment costs for working hours} \quad \beta > 0,\ \gamma > 0.$$

The estimated parameters satisfy the sign conditions in every case. To be more specific, before the structural change the estimated α range was from 0.481 to 0.491, and after the structural change from 0.235 to 0.274. All of these are significantly positive and less than 1. The estimated β before the change range was between 0.016 and 0.017; following, between 0.028 and 0.030. The estimated γ is 0.009. All of these parameters are significantly positive and satisfy the sign conditions.

Next, we analyze the results for the estimated structure of adjustment costs and the timing of structural change. The significance of α_1 and β_1 suggests that structural change in the adjustment costs for labor has occurred. The start-point of the structural change selected is from Sep. 1991 to Apr. 1992. The end-point of the change is selected from Sep. 2001 to Jan. 2002.[6] These results suggest that adjustment costs started to change within one or two years of the bubble burst, and continued to change for nearly 10 years.

The estimated α is about 0.5 before the structural change, and falls to 0.25 after the change. All of these are significantly positive. This implies

[6] When we use the instrument lag = 24,25,26 the selected end-point of the structural change is May 1998. Since this result differs from those with instrument lag = 24,25 and lag = 24,25,26,27, we ignore the results.

that the costs of adjusting the number of workers are asymmetric, with firing costs exceeding hiring costs. The relative costs of increasing working hours to adjusting the number of workers, β, is estimated to be about 0.015: it is much less costly to adjust working hours than the number of workers. After the change, β rises to 0.03. This means that the relative costs of increasing working hours increase significantly. On the other hand, the relative costs of decreasing working hours, γ, is not significantly zero, but is very small. Structural change in γ is not detected.

4 Discussion and Concluding Remarks

The results of this analysis indicate that structural change gradually took place between 1992 and 2001. We also obtained the estimated parameters before and after the structural change. The measure of asymmetry between the costs for hiring and firing fell, that is, firing costs became large relative to hiring costs. The relative costs of increased working hours and decreasing rose and were unchanged, respectively. For the purposes of this paper, we investigated change in firing costs, not the change in asymmetry between the costs for hiring and firing. Figure 1 shows the change of the parameter c_S, c_N with setting $c_A = 1$. We can see that firing costs c_S have decreased, with hiring costs normally taken to be expenditure on advertising and time spent on interviewing, testing, training new workers, etc. Of course, in a recession, the labor market is more relaxed such that the firms' costs of searching for new workers could become relatively cheaper when compared to, say, a boom. However, screening costs could also rise because firms select new workers more carefully. It is then natural to believe that hiring costs do not change, regardless of business performance. Figure 2 shows the change of the parameters c_I and c_D. The costs of increasing working hours c_I rose, and the costs for decreasing working hours c_D fell.

In this paper we used aggregate data, which does not separate regular from part-time workers. The amount of employed part-time workers increased on average by 4.63% per year from 1994 to 2001, while the number of regular workers decreased by 0.39%. In general, the cost of adjusting part-time workers is smaller than the cost for regular workers. It is therefore possible that a recent increase in the ratio of part-time workers to total workers affects the structure of adjustment costs. Figure 3 shows the ratio of part-time workers to total workers, reported in the Monthly Labour Survey by the Ministry of Health, Labour and Welfare. This only started to rise around 1998, while structural change started around 1991. Therefore, the increase in the ratio of part-time workers to total workers has not been the only cause of structural change.

Now, we reach a stage where it is possible to argue that firing costs have gradually fallen since the bubble burst.[7] Why then did firing costs start

[7] The costs for increasing working hours have increased and those for decreasing working hours have fallen. In fact, a reduction in working hours has been encouraged since a revised government ordinance from January 1994. In 1986, legal working hours went to 40 hours

to fall from about 1992? As already noted in section 1, there were several cases that caused the criterion of unjust redundancy to be relaxed towards the end of the 1990s. This implies that firing costs had fallen gradually, without relaxing job security laws. With the exception of job security laws, bargaining power and the social consensus for firms' reduction of workers establish firing costs. Since almost all workers employed by small, nonunionized firms cannot pay the court costs, they are not directly protected by job security laws. But they are, however, protected by the social regulation governing the reduction of workers. When firms reduce the number of their workers, they stand to lose their reputations and to be strongly opposed by trade unions. If the firms obtain a social consensus for the reduction of workers, the costs for reducing workers could be lower. After the bubble burst in 1991, social sympathy for the firms' reduction of workers occurred because of worsening economic performance. We can then understand that relaxation of the social regulation governing firms' reduction of workers led to lower firing costs. Thus, our results are consistent with those of Suruga (1997), who found, using firm micro-level data, a positive correlation between firing and a firm's administrative trouble. Suruga (1997) also argues that a firm could seek and obtain sympathy for the firm's reduction of workers, and avoid conflict with workers and trade unions, if the firm has serious

a week from 48 hours a week, taking effect after 1994. This could lead to rising costs for increasing working hours and falling costs for decreasing working hours.

administrative problems.

Following the Second World War, there were many dismissal conflicts between employees and employers. Workers furiously resisted collective dismissals, so firing costs gradually increased. Severe job security laws were enacted in 1980s and 1990s after the first oil shock in 1973. After the bubble burst in the beginning of the 1990s, Japan suffered from a prolonged period of economic stagnation. During this period, firms could gain the acceptance of workers for reducing the number of workers, such that firing costs began to gradually decrease. Job security laws also started to relax, but lagging the reduction in firing costs.

This analysis shows that firing costs had started to fall one or two years after the bubble burst, and continued to fall for nearly 10 years, while job security laws started to change at the end of the 1990s. We conclude that firing costs in the Japanese labor market can change to suit the economic environment, because change in the social consensus as regards firms that reduce the number of workers corresponds to the economic environment. We also find that job security laws follow change in the social consensus when such change is quite large.

Appendix

In this Appendix, we solve the optimization problem of the text, and derive the estimation equation (7). First, we define W as follows:

$$W \quad = \quad F(H_t N_t, \epsilon_t) - w_t H_t N_t - \frac{c_I}{2} i_t^2 - \frac{c_D}{2} d_t^2 - \frac{c_A}{2} a_t^2 - \frac{c_S}{2} s_t^2 + \delta E_t[V(H_t, N_t)].$$

The problem of the text is maximizing W for i_t, d_t, a_t, s_t under the constraints; transition equations (2) and (3), and the Nonnegativity restrictions (4). That is:

$$V(H_{t-1}, N_{t-1}) = \max_{i_t, d_t, a_t, s_t} W, \tag{11}$$

$$\text{subject to} \qquad H_t - H_{t-1} = i_t - d_t, \tag{12}$$

$$N_t - N_{t-1} = a_t - s_t, \tag{13}$$

$$H_t,\ N_t,\ i_t,\ d_t,\ a_t,\ s_t\ \geq 0, \tag{14}$$

Differentiating W with respect to each variable, taking account of (12) and (13), we have:

$$\frac{\partial W}{\partial i_t} \quad = \quad M_t N_t - c_I i_t + \delta E_t \left[\frac{\partial V(H_t, N_t)}{\partial H_t} \right], \tag{15}$$

$$\frac{\partial W}{\partial d_t} \quad = \quad -M_t N_t - c_D d_t - \delta E_t \left[\frac{\partial V(H_t, N_t)}{\partial H_t} \right], \tag{16}$$

$$\frac{\partial W}{\partial a_t} \quad = \quad M_t H_t - c_A a_t + \delta E_t \left[\frac{\partial V(H_t, N_t)}{\partial N_t} \right], \tag{17}$$

$$\frac{\partial W}{\partial s_t} \quad = \quad -M_t H_t - c_S s_t - \delta E_t \left[\frac{\partial V(H_t, N_t)}{\partial N_t} \right], \tag{18}$$

where $M_t \equiv \partial F(H_t N_t, \epsilon_t)/\partial(H_t N_t) - w_t$. The Kuhn–Tucker conditions are $\partial W/\partial i \leq 0$, $\partial W/\partial d \leq 0$, $\partial W/\partial a \leq 0$, $\partial W/\partial s \leq 0$, with the complementary-slackness proviso that $i(\partial W/\partial i) = 0$, $d(\partial W/\partial d) = 0$, $a(\partial W/\partial a) = 0$,

$s(\partial W/\partial s) = 0$, respectively. When all adjustment cost parameters c_I, c_R, c_A, c_S are strictly positive, the firm never chooses both i_t and d_t positive, and neither a_t nor s_t. But, if one of c_I and c_D (c_A and c_S) is negative, the firm may choose both i_t and d_t (a_t and s_t) positive.

By differentiating both sides of (11) with respect to H_{t-1} and N_{t-1}, we have the following:

$$\frac{\partial V(H_{t-1}, N_{t-1})}{\partial H_{t-1}} = M_t N_t + \delta E_t \left[\frac{\partial V(H_t, N_t)}{\partial H_t} \right], \tag{19}$$

$$\frac{\partial V(H_{t-1}, N_{t-1})}{\partial N_{t-1}} = M_t H_t + \delta E_t \left[\frac{\partial V(H_t, N_t)}{\partial N_t} \right]. \tag{20}$$

Using the above Kuhn–Tucker conditions and (19), (20), we can derive the following Euler equations for working hours and for the number of workers:

$$E_t[M_t N_t - \{c_I i_t - c_D d_t\} + \delta\{c_I i_{t+1} - c_D d_{t+1}\}] = 0, \tag{21}$$

$$E_t[M_t H_t - \{c_A a_t - c_S s_t\} + \delta\{c_A a_{t+1} - c_S s_{t+1}\}] = 0. \tag{22}$$

Dividing (21) and (22) by N_t, H_t respectively, the above Euler equations are:

$$E_t[M_t - c_I \hat{i}_t + c_D \hat{d}_t] = 0, \tag{23}$$

$$E_t[M_t - c_A \hat{a}_t + c_S \hat{s}_t] = 0, \tag{24}$$

where $\hat{a}_t \equiv (a_t - \delta a_{t+1})/H_t$, $\hat{s}_t \equiv (s_t - \delta s_{t+1})/H_t$, $\hat{i}_t \equiv (i_t - \delta i_{t+1})/N_t$, $\hat{d}_t \equiv (d_t - \delta d_{t+1})/N_t$.

Combining the two equations (23) and (24)as follows:

$$E_t\left[(\hat{a}_t - \hat{s}_t) - \frac{c_S - c_A}{2c_N}(\hat{a}_t + \hat{s}_t) - \frac{c_I}{c_N}\hat{i}_t + \frac{c_D}{c_N}\hat{d}_t\right] = 0, \tag{25}$$

where $c_N = (c_S + c_A)/2$.

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Table 1: Estimation of equation (10)

	$\delta = 0.990$			$\delta = 0.999$		
	lag=24,25	lag=24,25,26	lag=24,25,26,27	lag=24,25	lag=24,25,26,	lag=24,25,26,27
t_s	1991:10	1992:4	1991:9	1991:11	1992:4	1991:9
t_e	2001:7	1998:4	2002:1	2001:7	1998:4	2002:1
α_0	0.484*	0.492*	0.484*	0.483*	0.492*	0.484*
	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)
α_1	-0.242*	-0.218*	-0.250*	-0.242*	-0.218*	-0.250*
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.007)
β_0	0.017*	0.016*	0.017*	0.017*	0.016*	0.017*
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)
β_1	0.008	0.011*	0.011*	0.008	0.011*	0.011*
	(0.007)	(0.004)	(0.003)	(0.007)	(0.004)	(0.003)
γ_0	0.008*	0.008*	0.009*	0.008*	0.008*	0.008*
	(0.003)	(0.002)	(0.001)	(0.003)	(0.002)	(0.001)
γ_1	0.005	0.002	0.002	0.005	0.002	0.002
	(0.006)	(0.005)	(0.003)	(0.006)	(0.005)	(0.003)
$\bar{\mu}_0$	1.34E-04*	1.32E-04*	1.29E-04*	0.09E-04	6.90E-04	0.03E-04
	(0.37E-04)	(0.36E-04)	(0.34E-04)	(0.37E-04)	(0.36E-04)	(0.34E-04)
$\bar{\mu}_1$	0.38E-04	0.31E-04	0.44E-04	0.62E-04	0.52E-04	0.69E-04
	(0.71E-04)	(0.61E-04)	(0.64E-04)	(0.69E-04)	(0.61E-04)	(0.64E-04)
W	828.256	1100.057	1505.241	822.163	1099.479	1496.368
J	9.098	9.293	9.598	9.098	9.292	9.599
$p-value$	0.334	0.862	0.990	0.334	0.862	0.990

Note: *lag* indicates the number of lags used for the instrumental variable, based on the forcing variable.

* indicates that the coefficient is significant at the 5% level.

Lag indicates the number of lags used for the instrumental variable, using the forcing variable.

Numbers in parentheses are the standard errors of the parameters.

W denotes the Wald statistics which test the null hypothesis, H_0:$\alpha_1 = 0$, $\beta_1 = 0$, $\gamma_1 = 0$, $\bar{\mu}_1 = 0$.

J is the J-test statistic and p-value is the probability value associated with the J-test.

Table 2: Estimation of equation (10), excluding γ_1, $\bar{\mu}_1$

	$\delta = 0.990$			$\delta = 0.999$		
Inst	lag=24,25	lag=24,25,26	lag=24,25,26,27	lag=24,25	lag=24,25,26,	lag=24,25,26,27
t_s	1991:10	1992:4	1991:10	1991:10	1992:4	1991:10
t_e	2001:9	1998:5	2002:1	2001:9	1998:5	2002:1
α_0	0.483*	0.491*	0.483*	0.481*	0.491*	0.485*
	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)
α_1	-0.242*	-0.217*	-0.248*	-0.231*	-0.217*	-0.236*
	(0.008)	(0.007)	(0.007)	(0.009)	(0.007)	(0.007)
β_0	0.016*	0.016*	0.017*	0.016*	0.016*	0.017*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
β_1	0.013*	0.012*	0.013*	0.013*	0.012*	0.012*
	(0.005)	(0.003)	(0.003)	(0.005)	(0.003)	(0.002)
γ_0	0.009*	0.009*	0.009*	0.009*	0.009*	0.009*
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
$\bar{\mu}_0$	1.47E-04*	1.48E-04*	0.31E-04	0.33E-04	0.32E-04	0.31E-04
	(0.25E-04)	(0.25E-04)	(0.23E-04)	(0.25E-04)	(0.25E-04)	(0.23E-04)
W	832.673	1109.951	1497.011	823.635	1104.939	1482.813
J	9.216	9.356	9.620	9.213	9.355	9.620
$p - value$	0.512	0.928	0.996	0.512	0.928	0.996

Note: lag indicates the number of lags used for the instrumental variable, based on the forcing variable.

The * indicates that the coefficient is significant at the 5% level.

Lag indicates the number of lags used for the instrumental variable, using the forcing variable.

Numbers in parentheses are the standard errors of the parameters.

W denotes the Wald statistics which test the null hypothesis H_0:$\alpha_1 = 0$, $\beta_1 = 0$.

J is the J-test statistic and p-value is the probability value associated with the J-test.

Fig. 1. The transition of C_A, C_S, C_N

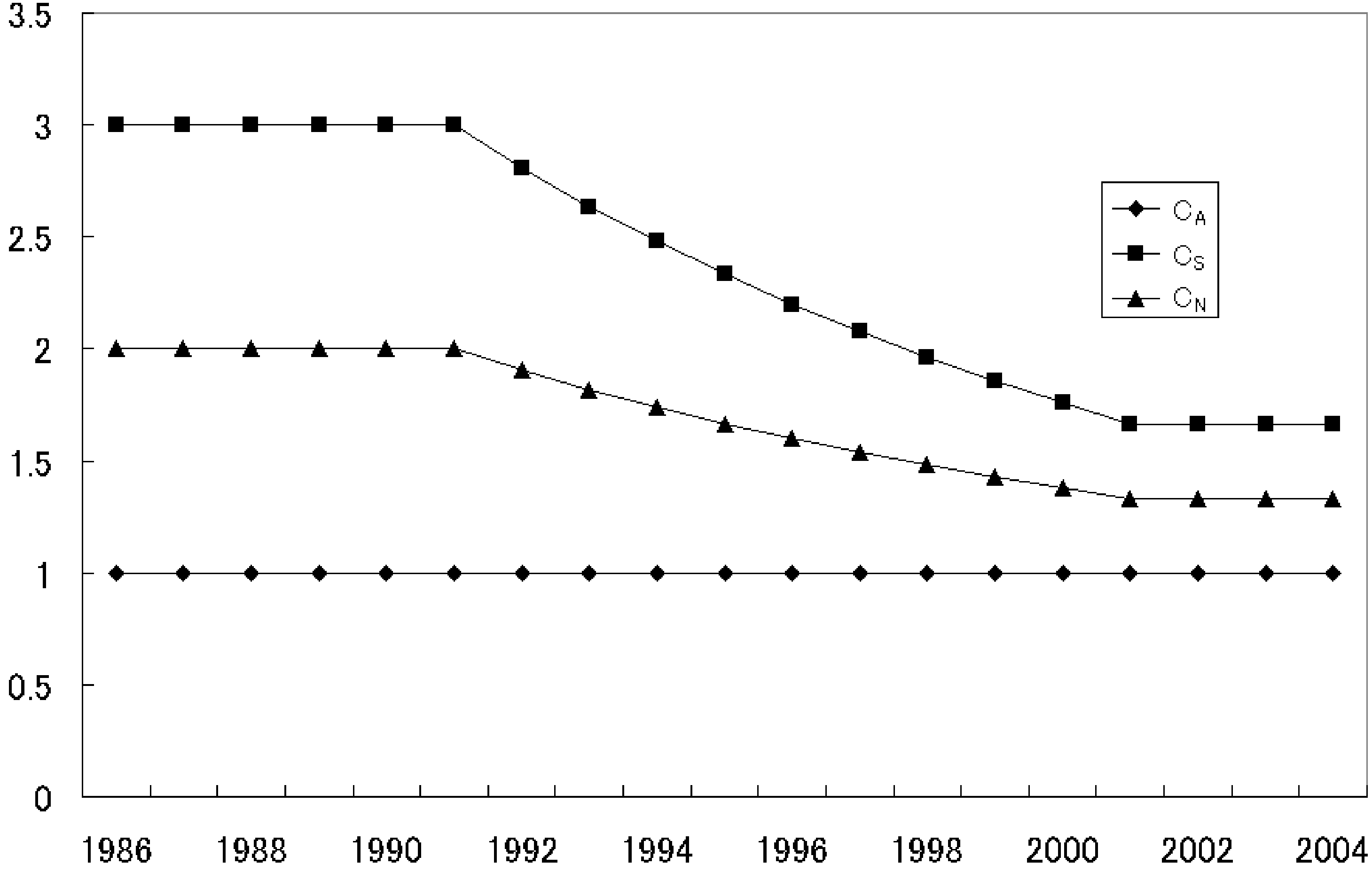

Fig. 2. The transition of C_I, C_D

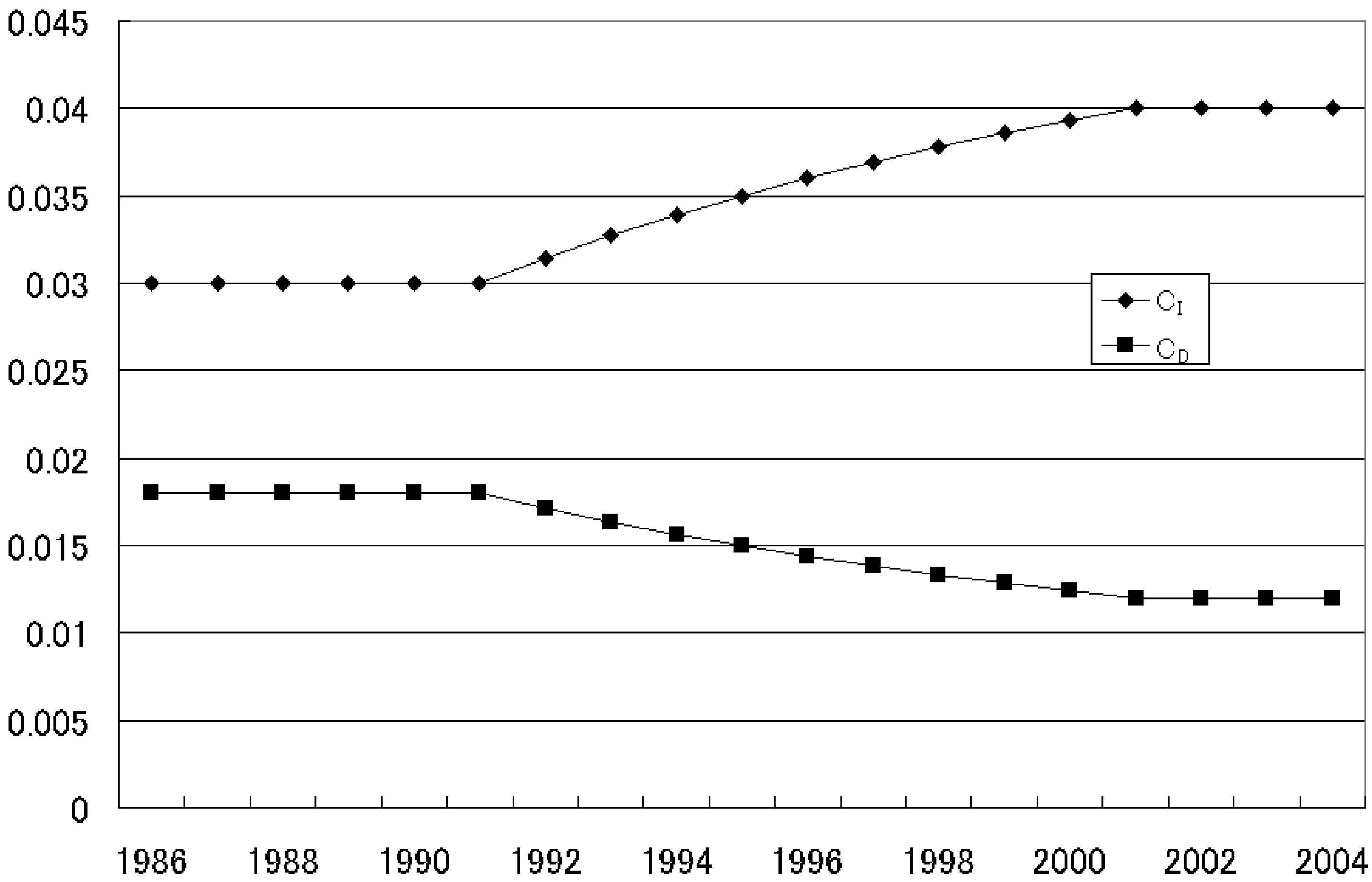

Fig. 3. The ratio of part-time workers to total workers