Industrial Differences in Labor Inputs and Wage Adjustments: Evidences from Japanese Industries

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Abstract

This study empirically examines the relative responses of labor inputs and wage adjustment across Japanese industry. Using industry level data of one digit, we investigate two related issues. One is whether wages play role in adjustments between quantity variable such as labor inputs and price variable, herein wage, in response to changes in demand. Evidence shows that the response of each industry may be more sensitive or elastic than adjustment behavior revealed by aggregate response. Furthermore, responses of wages in elasticity play also important role in coping with uncertainty with other labor inputs variables. The other is whether the adjustment pattern varies across industries to demand shock. Evidence indicates that there exists distribution effects in adjustments across industries. In comparison between manufacturing sectors and non-manufacturing sectors by constructing an index, the *normalized relative industrial elasticity of response* index (NRIER index), evidence empirically confirm differences in two sectors, showing divergent patterns of response among adjustment variables. In addition to empirical findings, one contribution of our study would be the proposal of measurement such as both RIER and NRIER indices for identifying the industrial distribution effects of labor inputs and wage flexibility across industries.

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Keywords: Labor adjustment, Wage flexibility, Employment, Work-hours, Economic fluctuation, Japanese industry, Industrial distribution, NRER index.

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Ⅰ. Introduction

The adjustment of markets to change in economic conditions is the central issue in economics and for policy makers as well. Labor market flexibility is defined to describe the degree of responsiveness of labor markets to changing demand and supply conditions. Thus knowing the empirical degree of overall labor market flexibility in an economy is important to understand which adjustment factor influences much to the performance of an economy through absorbing temporary or permanent shocks to labor demand arising at the national, regional or industrial level.

However, the measures of labor flexibility or adjustment, used to describe the responsiveness of an economy's labor market to changes in underlying conditions, have various and vague definitions in terms of both employment flexibility/adaptability and wage flexibility. This means that we need to distinguish adjustments between quantity (labor inputs such as employment and work-hours) and price (wage).

For an economy with high wage flexibility exhibiting rigidity in terms of employment adjustment, there would be a trade-off between the two so that it is worth considering the combination of the wage flexibility and employment adaptability. In this sense, an economy in the face of disturbances can better accommodate some degree of labor hoarding and the relatively stable employment under the flexible wage adjustment. It stands widely out that wages in Japan are flexible[1]. It is thus interesting to empirically examine the relative roles of adjustment between labor inputs and wage in response to demand change in Japan.

The purpose of this study is to identify industrial differences of adjustments by empirically examining the relative responses of labor inputs and wage adjustment across Japanese industry over three decades after WW Ⅱ. In order to get better understanding of labor adjustments, we examine the industry level data and then to look at whether the adjustment pattern varies across industries and compare with behavior of aggregate behavior of the corresponding adjustment to demand shock. To achieve this purpose, we consider several separate but related specific questions in this paper. When we distinguish change in demand into two sorts: unexpected and expected changes, the related question would be: How are the responses to short-run shock in product demand, measured by the unanticipated demand change? How are the responses to the anticipated or long-run demand changes? Do effects on adjustment depend on whether changes in product demand are anticipated or unanticipated? The basic question to address in the industry study among others is how does adjustment patterns differ across industries in Japan?

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1) There are several possible explanations that have accounted for the flexibility of wage in Japan. [Gordon (1982)]

Ⅱ. Motivations

Economic fluctuation is measured by changes in the real GDP to reflect the aggregate performance of an economy. However, there seem to be divergences in disaggregate data in various aspects. For example, behavior of industry at a disaggregate level show various differences across industries. The motivation of our study is to address important questions on economic adjustment under uncertainty: Given this difference in changes in output, do patterns of labor and wage adjustment vary across industry? What are the relative roles among employment, work-hours and wage when firms in an industry face demand shock as well as expected changes in demand?

The major economic rationale for labor inputs and wage adjustments stem from the phenomenon of excess labor or labor hoarding and the sequential wage flexibility, which derives from the theory of firm or industry specific human capital. Industry or firm-specific investments give rise to a stream of rent shared by the firms and its workforce. Given the fact that returns are uncertain and that relevant information may well be asymmetric, it is argued that it may be the mutual interest to maintain a long-term employment relationship as long as joint rents remain positive or even if they turn negative in the short run. [Topel (1982) and Hashimoto (1993)]

For unexpected short-term fluctuation, say, downturns in economic activity, firms must weigh of the cost of holding employment that is surplus to current requirements against those of lay-offs, and subsequently potentially need to replace, specific human capital investment. As a rationale for different responses, human capital argument indicates differences in firm or industry-specific human capital investment across countries and across industries or firms[2]. Given this, the sensitivity of labor inputs or the degree of labor adjustments to changes in demand should differ systematically cross countries and across industries.

However, the stream of the existing research only focues on the quantity side of adjustment, given assumption of price or wage rigidity. Given this quantity-side argument of relatively high degree of hoarding or the long-term employment, we argue in this paper that under the certain circumstances, it is needed to consider the firms or industry in which not only quantity-side variables but also wage (price)-side variables are adjusted, in a relatively flexible way, to cope with change in demand. The motivation for our empirical analysis is the fact that there has been price-side adjustment, herein adjustment of wage, through which Japanese firms use internal buffers against aggregate demand changes; in particular, the behavior of wages seem to be relatively flexible than other ones of labor input variables. Given flexible agreements over optimal rent shares in Japan, the buffer to fluctuations in product demand is said to be prices (wages) rather than quantities. The mechanism of wage adjustment consists of frequent recontracting or regular arrangement (usual bi-annual) over

2) Evidences, based on the estimated wage-tenure profiles, support strongly the proposition that firm-specific human capital investments are significantly higher Japan than in the United Sates. [Hashimoto (1979)]

regular wages and bonus.

In addition to this internal adjustment mechanism of wage, the other is changes in labor utilization rates. This includes the use of hours as another buffer against demand fluctuation. Firms can respond to downward business cycle by reallocating employment or by recourse to work-sharing rather than layoffs. This issue is related with the excess labor and the work-hours and the limit of overtime hour of work. It is important to understand the adjustment mechanism in that it allows us to examine both stock and utilization dimensions of the labor input.

To investigate patterns of labor adjustment across Japanese industries, we use the interdependent factor demand model since we need to consider not only labor inputs (employment and work-hours) but also wages. The model we employ in this study has advantages over the models of Topel(1982) and Hashimoto (1993)[3] in that wage adjustment are considered which allow us to empirically compare the relative role among adjustment variables in coping with demand uncertainty in industrial sectors. The empirical model for this study complements the previous studies in several aspects. First, our empirical study covers a wider range of the industries besides the manufacturing sector while Topel(1982) and Hashimoto (1992) only cover manufacturing industry rather than industries covering the economy as a whole, excluding non-manufacturing industries. Second, our study extends the period of the previous studies which did not include the bubble and post-bubble period when both employment and wage seem to play roles in some ways.

Ⅲ. Model of Industrial Adjustments

In this section, we will describe the models that will be used for estimation. As an empirical counterpart of the adjustments and trade-off among employment, hours, and wage, the model consists of a set of linear interactive decision rules that summarize choices corresponding to three endogenous variables: employment, hours of works, and wages. The desired levels of these endogenous variables depend on their initial values and the future values of the demand variable. Assume that each industry responds only on its own changes in demand. The basic idea of the assumption is similar to the island assumption of Lucas type economy. It implies that there is no common shock among industry. The log-linear model of labor inputs and wage adjustments for industry, i, is as follows:

$$L_{it}=a_{10}+a_{11}L_{i,t-1}+a_{12}H_{i,t-1}+a_{13}W_{i,t-1}+\sum_{k}a_{1k}X_{ki,t-1}+\sum_{0}^{T}B_{1j}\hat{q}_{i,t+j}+r_1q_{it}^{u}+\mathrm{Trend} \quad (1)$$

3) The theoretical basis of optimization procedure for the model are discussed in Topel (1982) for the early discussion and Galeotti, Maccini and Schiantarelli (2005) and Wen (2005) for the recent rigorous discussion besides labor adjustment costs.

$$H_{it}=a_{20}+a_{21}L_{i,t-1}+a_{22}H_{i,t-1}+a_{23}W_{i,t-1}+\sum_{k}a_{2k}X_{ki,t-1}+\sum_{0}^{T}B_{2j}\hat{q}_{i,t+j}+r_2q_{it}^{u}+\mathrm{Trend} \quad (2)$$

$$W_{it}=a_{30}+a_{31}L_{i,t-1}+a_{32}H_{i,t-1}+a_{33}W_{i,t-1}+\sum_{k}a_{3k}X_{ki,t-1}+\sum_{0}^{T}B_{3j}\hat{q}_{i,t+j}+r_3q_{it}^{u}+\mathrm{Trend} \quad (3)$$

where L_{it}, H_{it}, W_{it} are employment, hours of works and wages (earnings per worker) of industry i. X_{kit} are inventories of other factors or intermediate stocks and materials of each industry. The economy is assumed to be demand driven of each industry. As empirical decision rules, firms in the industry are assumed to choose the magnitudes of the endogenous variables by taking account the fluctuation in the forecasted future demand as well as unforeseen deviations in the current demand for its product. The model uses industrial output as a forcing variable among others, which is distinguished between the influences of the expected and unexpected demand, changes of demand, or output in each industry. The expected demand is measured by expected values of industrial output $\hat{q}$s and the unexpected demand is measured by the unforeseen deviations in industrial output from the forecasted value: q_{it}^{u}s ($\equiv q_t-\hat{q}_t$), q_t is the actual industrial output. The unexpected changes in product demand represent demand shocks of each industry in the model. The T is a planning horizon that remains to be specified. All the variables in the model except time-trend are measured in natural logarithms. The estimated coefficients of a, B, r could be interpreted as elasticity of responses with respect to right-hand side variables. a is 3 by 3 matrix of coefficients of employment, work-hours and wage variables with one lag. The variables in the model are also treated as the deviations from the long-run trend by including trend variables in the model.

To complete the model and to construct the forecasted values of future industrial outputs, the method by which expected industrial outputs evolve must be specified. We construct series of expected demand based on monthly data by assuming that industrial outputs follow a seasonally differenced ARIMA process[4]. Those constructed series are used as explanatory and exogenous variables in estimating equations. Expected demand values are calculated based on the assumption that they depend only on the past values of industrial outputs and not on the past of other endogenous variables, though these may depend on current information.

Our primary interests are in the *industry-level* relationship among the parameters of the decision rules in distribution of these parameters *across industries* in addition to empirical

4) For monthly data we used, we assume that industrial outputs follow a seasonally differenced ARIMA process of the form as same as Topel (1982), Hashimoto (1993) and Orazem and Park (2003). The parameters in the specification are assumed to be fixed and employers know them. The best ones were chosen to generate the forecasted value of industrial outputs. Regarding the model specification for estimating the expected demand, we followed the principal criteria for the residual to be white noise to some extent, which can be judged by various statistics. For that, the planning horizon, T, was set alternatively at 4, 6, 9 and 12 months and mostly used 12 months horaizon. Hashimoto (1993) used 9 month time horizon, while Topel (1982,) imposed additional structure and varied the time horaizons within manufacturing sector.

analysis of aggregate level as a benchmark reference for the comparison. In particular, immediate focuses are the distribution of elasticity across industries in terms of relative sensitivity of non-manufacturing industries relative to manufacturing industry associated with the *short-run* product demand variables.

Labor inputs (n_{it}) for industry that represent the quantity-side of adjustment in the model are defined as the product of employment (l_{it}) and hours-worked (h_{it}): $n=l*h$. The log-linear version of labor inputs equation can be rewritten as

$$N_{it}=\eta_{i0}+\eta_{i1}L_{lt}+\eta_{i2}H_{it} \tag{4}$$

where $N_t=\ln n_t$, $L_t=\ln l_t$, $H_t=\ln h_t$, η_0 are factors representing other industry-specific variables and η_1, η_2 are parameters corresponding elasticity of employment and work-hours respectively. When comparing quantity and wage adjustments in the empirical analysis, it is useful to decompose elasticity of labor inputs into two components: employment and work-hours, given the residual term, η_{i0}.

In estimating the model of labor inputs and wage adjustment, the focus are in the relationship between quantities (employment, hours-worked) and prices (wages) variables. Further, our concern is the comparison of the relative sensitivity between labor inputs effect and wage effect. The decision rules in terms of elasticity responses to demand changes could be estimated be in order to identify the relative degree of adjustments between quantity variables (employment, work-hours) and price variable (here wages).

In order to empirically identify differences of cross-industry responses among employment, work-hours and wages, we construct the measurement that define the *relative industrial elasticity of response index* (hereafter RIER index) as the deviation of each industry's elasticity from the economy's elasticity that is measured by the average of all industries. When we define $\hat{\xi}_f$ as the aggregate responses measured by the average of elasticity over all industries considered, then we can construct the industry i's *RIER index* for adjustment variables, f = employment, work-hours and wages as following:

$$RIER_{if} = \xi_{if} - \hat{\xi}_f, \text{ where } \quad \hat{\xi}_f = \sum_{i=1}^{I} \xi_{fi} \tag{5}$$

The value of RIER index represents the relative size of elasticity of each adjustment variable compared to the aggregate elasticity of responses, so that it allows us to empirically measure how adjustment variable responds to change in demand relative to the whole economy. The gap may represent the distribution of responses in each adjustment variable across industries. The absolute size of RIER indicates the degree of divergence or convergence across industries in terms of labor input and wage adjustment.

The other concern of empirical study is to see whether pattern of adjustment varies across industries. In order to identify differences of responses between manufacturing sector and non-manufacturing sectors, we use the *normalized relative industrial elasticity of response* index (hereafter NRIER index) which measure how adjustment variables respond to change in

demand when we treat manufacturing sector to respond as one unit. NRIER index in the log-linear model can be written as

$$NRIER_{if} = \xi_{if} - \xi_{mf},$$
$$i = \text{non-manufactruing industrires},\ m = \text{manufactruing industrires},$$
$$f = \text{employment, work-hours and wage} \qquad (6)$$

where ξ_{if} is each industry i's elasticity of adjustment variables, f, in response to change in demand. If the value of the NRIER index in an industry is greater than one, the industry reveals the larger sensitivity in the corresponding variable to cope with change in demand in the industry.

Given the long-term employment system, the sensitivity of employment effect is expected be relatively smaller than one of wage effect. When we consider wage flexibility as one of main forces in labor adjustments[5], the parameter of wage or earnings represents the degree of wage adjustment to cope with demand uncertainty that is measured by industrial outputs in this study. The flexible wage adjustment to demand change implies the preferred hoarding of employment, resulting in the long-term employment system. In particular, the immediate foci are the coefficients of wage and employment associated with expected current industrial outputs, those for expected future industrial outputs, and those for unexpected current demand shocks. In order to have better understandings of adjustment mechanism, it is useful to measure the degree of wage flexibility relative to other labor inputs adjustment variables such as employment and hours. The elasticity coefficient of the wage effect reflects the degree of wage flexibility in the economy[6].

Ⅳ. The Evidence: Data and Findings

4.1. Data

The data used for the empirical analysis of industrial adjustment in this study are from the listed sources, covering of the period January 1969~December 2000. The series used to

5) It has long been widely held that wages in Japan are flexible. [Gordon (1982), Brunello and Wadhwani (1989), Orazem and Park (2003), Park (2006)]

6) The view of wage determination based on the existence of significant profit-sharing the values of wage coefficient measure the effects of profit-sharing. According to this view, there is the portion of wages or total earnings that is accounted for by profit-sharing component. One of famous examples is a bonus system that Japanese firms operate. When firms link bonus to performances and it is generally accepted that bonuses are fairly responsive to profits, the system can be said to respond like a profit-sharing economy. [Weitzman (1987)]. There is an interesting alternative view regarding flexibility of wages in Japan. Using both Japanese aggregate and firm micro data of large firms, Ohashi (1989) tested both effort compensation hypothesis and profit-sharing hypothesis and claimed that bonus can be better explained by overtime hours than by profits. Ohashi (1989) argues that flexible hours, through overtime hours, are a key to obtaining stable employment in Japan so that a mechanism for compensating flexible hours and increased intensity must be devised.

Table 1. Aggregate Growth Rate and Contribution of Industry in Japan: 1971−2001

Contributions / Periods	Aggregate GDP Growth Rate	Contributions of Industries to Aggregate Economic Growth									
		Agriculture	Mining	Construction	Manufacturing	Whole, Retail	Energy	Transportation/telecom	Finance/ insurance	Real estate	Service
1971−2001	3.66	0.0004	−0.0001	0.21	0.92	0.62	0.11	0.21	0.34	0.51	0.74
(S.D.)	(2.77)	(0.20)	(0.04)	(0.80)	(1.45)	(0.52)	(0.13)	(0.32)	(0.40)	(0.56)	(1.17)
1971−1981	4.21	−0.002	0.00	0.33	1.34	0.93	0.13	0.17	0.33	0.57	0.51
(S.D.)	(2.18)	(0.29)	(0.04)	(0.59)	(1.30)	(0.49)	(0.14)	(0.24)	(0.50)	(0.25)	(1.29)
1982−1991	5.00	0.07	0.01	0.56	1.22	0.54	0.13	0.38	0.40	0.69	1.17
(S.D.)	(3.23)	(0.12)	(0.04)	(1.13)	(1.83)	(0.28)	(0.16)	(0.34)	(0.30)	(0.91)	(1.51)
1992−2001	1.35	−0.07	−0.01	−0.26	0.16	0.36	0.07	0.08	0.28	0.25	0.54
(S.D.)	(1.29)	(0.12)	(0.02)	(0.22)	(0.89)	(0.60)	(0.08)	(0.35)	(0.41)	(0.12)	(0.37)

Source: Authors' calculation based on "*Annual report on National Accounts of 2003*" Economic Planning Agency, Japan.
Note: Contribution = [(Current year - previous year)/ GDP of previous year]*100.

estimate the model for industry level are monthly and seasonally unadjusted for Japanese data. The series on employment, hours and wages are from the same sources as previous studies from which we use the aggregate level data in Orazem and Park (2003).

For disaggregate data based on industry classification, the whole economy is classified by economic activity at constant prices. We use the Japanese Industry Classification Standard by which the whole economy consists of nine industries classified by economic activity at constant prices. Ten industries with this subdivision are 1. agriculture, forestry and fishing; 2. mining; 3. manufacturing; 4. construction; 5. electricity, gas and water supply; 6. wholesale and retail supply; 7. finance and insurance; 8. real estate; 9. transport and communication; 10. service activities. Note that series for 'service industry' in Japan are available only after 1970, industry total does not include service industry until 1969. Data for intermediate stocks and materials are from indices of industrial production, indices of all industry activity, ministry of economy, trade and industry.

The series on employment is from *Labor Force Survey*, Ministry of Public Management, Home as Affairs, Posts and telecommunication. The series on wages (total earnings) and hours of work are from *Monthly labor Survey* and *Wage Census* (*Basic Survey on Wage Structure*), Ministry of Health, Labor and Welfare. The series on price is from *Consumer price Index*, Ministry of Public Management, Home Affairs, Post and Telecommunications.

For measuring demand changes in industrial levels, we use data for both shipments series and GDP series. Series on shipments are from *Annual Report of Business Cycle Indicators*, Japan Economic Planning Agency and *Annual Report of Manufacturing Index*, Ministry of Economic and Industry & Commerce. The series on shipments is the data of shipment index, covering the period of January 1969 to December 2001. The changes in demand of each industry are measured by the changes in GDP of each industry that are used to construct the expected values of demand. Series on output change of each are from "Gross Domestic Product by kind of Economic Activity", in *Annual report on National Accounts*, Office of Cabinet

(Economic Planning Agency)[7]. Time Series on output are from SNA Time series for Japanese real GDP for the period of the post WWII: Annual real GDP 1955～2001, where series 1955～1979 is from former SNA68 series and series 1980～2001 is from New SNA95 (H7) series.

4.2. Empirical Results

We examine the behavior of Japanese industries in conjunction with labor inputs and wage adjustments when there is fluctuation in output and demand in product market, in order to grasp the better picture for sensitivity of adjustment variables to exogenous changes. On the contrast to the conventional wisdom, evidence from Japanese industry reveals that adjustments of wage across industries also play an important role in response to changes in demand. In this sense, one of our concerns here is to see whether there are divergences in adjustment behaviors across industries that may be offset each other enough to generate the smoother responses in aggregate level than ones that happens in real world of Japanese economy.

Our finding from an industry perspective using disaggregate level data from Japanese industry is that responses of labor inputs and wage adjustments to demand change vary across industries in Japan. In order to clarify the transmission mechanism of industry distribution with respect to demand responses, rigorous empirical investigation in both theory and empirics based on panel data regarding Japanese industry is needed. For example, industries with higher investment in industry-specific human-capital may differ from industries with lower investment. Employment in the industry with higher investment in industry-specific human capital might be relatively less responsive than hours of work and inventories, and wages or earnings are more responsive, to one with lower investment when facing to changes in product demand.

In order to identify differences in adjustment pattern or divergences across industries and further to examine the degree of relative responses in adjustments in labor market across industries, we estimated the model which allows wage flexibility in labor adjustments, represented by the system of equations, (1)～(3)[8-9]. Estimates from the model provide

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7) Series on Industrial activities [Industry Shocks: Yi,t] "*Annual report on National Accounts of 2003*"

8) We estimate models with and without inventories, but we report results from a model without inventories. We need to make points be clear in conjunction with employment and wage flexibility across industry, by mentioning some feature of industry in Japan in terms of inventory.

9) Since we treat demand variable as given as Topel (1982) and Hashimoto (1993), this paper focuses on traditional models that assume independent relation across industries, rather times series analysis. Main purpose of our study is to identify distribution of adjustment pattern by comparing between quantity factors and wage factors among industries in the relative sense. In this sense, we assume an individual industry shock as a driving force, rather than system as a whole. However, under the model under the interdependent relation among industries, information from non-stationary characteristics of variables will provide useful implications to figure it out how both own and cross interrelations are distributed and persisted over time. Note that when there are structural breaks in the economy, the various statistics such as Dickey-Fuller and Phillips-Perron test statistics may be biased toward the non-rejection of a unit root. This issue will be on future research agenda. Refer Park (2006) for the time series analysis of Japanese aggregate data where demand is also endogenous in the model.

evidences about (i) the effects of demand changes on adjustment variables and (ii) the own-speed of adjustment of each variable. The combination of two types of evidence helps us to know about not only the sensitivity of adjustment among employment, hours, and wages but also their speeds of adjustment. The seemingly wide variety of patterns across industries also helps deepen the behavior of adjustment pattern as a whole by looking at how the patterns of adjustment in industries interact each other to offset or accelerate the effects in the disaggregate level.

Our primary interest is to examine how these industries respond to changes in demand measured by the unexpected and expected change in demand. The estimates are summarized in Table 2, where we report the disaggregate effects of change in demand on employment, total hours and total earnings.

Consider first the sensitivity of employment to the short-run demand shock that is measured by the unexpected component of current demand. Evidence (column 1, table2) shows that the average employment effect in the some three industries are more than double of that in others. These findings of divergent employment effects across industries within an economy are consistent with ones of Topel (1982) which examined manufacturing industries

Table 2. Elasticity of adjustments across industries to changes in demand: Reponses of employment, total hours, and total earnings from industry level data

	Demand shock			Current expected demand			Future expected demand		
Industry	Employment (1)	Hours (2)	Earnings (3)	Employment (4)	Hours (5)	Earnings (6)	Employment (7)	Hours (8)	Earnings (9)
Manufacturing	0.167 (0.21)	0.542 (1.03)	0.594 (0.47)	−0.009 (−0.12)	−0.189 (2.59)	−0.312 (2.47)	0.128 (1.69)	−0.042 (−0.82)	−0.338 (−2.76)
Construction	0.187 (0.41)	−0.202 (1.08)	−0.117 (−0.15)	−0.021 (−0.28)	0.046 (1.50)	−0.224 (−1.76)	0.087 (1.28)	0.013 (0.48)	−0.084 (−0.73)
Mining	0.893 (0.69)	−0.662 (−2.99)	0.664 (1.23)	0.154 (0.27)	−0.246 (2.54)	0.372 (1.58)	0.042 (0.25)	−0.053 (1.83)	0.015 (0.21)
Electricity, Gas,Water	0.298 (3.17)	0.221 (2.79)	0.931 (1.00)	0.885) (2.074)	−0.079 (−0.97)	−0.095 (−0.33)	0.353 (0.97)	−0.068 (−1.03)	−0.144 (−0.58)
Whole Sale, Retail	0.063 (0.04)	0.192 (0.56)	0.454 (2.92)	0.009 (0.40)	0.154 (2.11)	0.059 (0.33)	0.053 (0.59)	0.015 (0.30)	0.427 (3.45)
Transporat, Communication	0.377 (0.99)	−0.150 (−0.63)	−0.111 (−0.14)	0.039 (0.36)	0.033 (0.48)	0.322 (1.42)	−0.015 (−0.14)	0.035 (0.51)	0.229 (0.98)
Service	−0.091 (−0.63)	0.258 (1.55)	0.182 (0.33)	−0.039 (−1.08)	0.048 (1.14)	−0.029 (−0.21)	−0.085 (−2.02)	0.030 (0.63)	−0.11 (−0.73)
Industry elasticity on average	0.5173	0.3181	0.436	0.151	0.002	0.013	0.065	−0.008	−0.075

Note: Estimates are elasticity to measure responses coefficients from employment, total hours, and total earnings in the model (1)-(3) with wage flexibility. The data covers the full sample period: Jan. 1969−Dec. 2001. Absolute t-ratios are in parentheses.

in USA[10]. One of the important findings is that, though the aggregate effects of employment are generally less sensitive to the short-run demand shock, there are divergence in the employment effects at disaggregate levels. Some industries such as mining, electricity and gas, transportation and communications, are relatively more and highly sensitive to short-run unanticipated demand change while other industries are less sensitive at an aggregate level.

The sensitivity of the wage effect is greater than those of the employment effect and the hour effect in general. For most of all industries except transportation & communication, the wage effect to unanticipated demand is the most sensitive effect of all (column 3 at table 2). The highest effect of employment is in both the transportation & communication industry and the mining industry (column 1). The highest effect of work-hours is in both construction industry and service industry (column 2). In most industries, effects of both wages and hours are similar in size, meaning that responses to cyclical change in demand have been achieved through adjustments of wages and hours in most industries with exceptions.

Note that the largest contemporaneous effects, both on employment and on total man-hours are industries with largest layoff and unemployment rate. In mining and transportation & communication, the average contemporaneous impact elasticity is more than two or four times (0.893, 0.377) than in the remaining industries, where coefficients ranges from 0.06 to 0.19 (column 1). It is interesting that there are industries with relatively flexible employment effect in Japan, though wage effect is prevalent in aggregate level.

Measuring the effect of expected demand change: The findings associated with the forecasted future demand turn out to be weak but those are informative to uncover several features over the period we investigated. The findings for anticipated current and future demand are mixed, which is consistent with evidence of Hashimoto (1991) covering the period of January 1969～December 1986[11].

The results of the effect to current expected demand are in column (5) at table 2.

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10) In the previous study, Orazem and Park (2003), we reported the aggregate effects of shipments on employment, average hours, inventories based on monthly aggregate data. Unanticipated demand change; cyclical or short-run: generally speaking, the coefficients for unanticipated demand change are consistent with prediction over period of Hashimoto (1991) where covers 1969 through 1986. Employment adjustment is less sensitive while adjustments in hours and inventory are more sensitive within the same sample period. However, when we estimate adjustments by using the extended data set including 1969 through 2001, we could find stronger adjustments in all of employment, hours and inventories while maintaining the same relative flexibility among adjustment variables. Flexibility in employment has been increased much compared to the previous period (0.004 vs 0.061), while inventories and hours play more important role relative role. Evidences from aggregate data implies the possibility of asymmetricity, that is, there is strong indications of asymmetric characteristics in adjustments.

11) In particular, we have same results for inventory adjustment in that the coefficients are negative for anticipated future demand, as was expected for the case of the cyclical demand changes. Our concern is whether the responses of labor adjustments to anticipated demand have been changed over time. To address this issue, we extended the period of Hashimoto (1991) from December 1986 to December 2000 which include both boom or bubble period and post-bubble or recessionary periods in Japan.

Regarding the sensitivity of employment to anticipated current demand, estimated coefficients range from zero in manufacturing and whole sale & retail and 3 and 4 percents in construction and transportation & communication, up to 16 percent in mining. The pattern is apparent in the flexibility of wages for current forecasted demand change (column 6), where the average wage effect is about 32-37 percent in four industries out of seven. It is surprising that these wage effects of unanticipated demand are often greater than the effect of their forecasted counterpart in most but not all industries.

Evidence regarding the effect for the future expected demand are found in column (7)-(9) in table 2. The results for anticipatory effects are mixed, though generally consistent with the prediction that less employment effect and more wage effect. Wages appear to play a forward-looking role in mining, wholesale & retail, transportation & communication (column 9). Evidence indicate that employment and hours are built in advance in both electricity, gas, and water industry and manufacturing industry (column 7).

In summary, the empirical evidence from Japanese data, we can find several important characteristics of the industry's representative firm in conjuntion with adjustments in order to cope with changes in demand in the industries. First, wages play an important role in adjustment in that it is relatively more flxible than other adjustment variables of labor inputs, i.e. emplyment and work-hours. Difference in relative elasticity among adjustment variables implies that sequences of adjustment seem to be the first adjustment in hour-worked, via overtime hours and through wages and then the final adjustment is employment once the former adjustments are not enough for firms to response to changes in demand or shocks.

Second, there are variations across industries to the extent that wages are more flexible and employment is less flexible in response to change in demand in the product market. When we compare elasticity between wages and labor inputs measured by estimate of $\eta_1+\eta_2$ that is the sum of elasticity of employment and work-hours, evidence indicate that there are divergences across industries in terms of the pattern of adjustment. One interesting result is that wages also contribute overall adjustment to demand shocks. This result is contrast to the traditional wisdom that wages is, in general, sticky or rigid in the short-run. The explanations why wages are sticky have been an important part of supply side of economics, necessary to understand economic fluctuation in the short-run.

Evidence displayed at Table 3 compare own-speeds of adjustments parameters (a_{ii}) across industries for employment, hours, and wages. Though there are differences in self-adjustment elasticity across industry, the behaviors of own adjustment show that hours-work and wages are relatively more flexible than employment. Evidence indicates that employment is more sticky than other adjustment variables in terms of own-adjustment.

Table 3. Estimated Own-Adjustment Parameters from the model based on industry level data: 1969-2001

Industries / Adjustments	Manufacturing	Construction	Mining	Electricity, Gas, Water Supply	Whole Sale, Retail Trade	Transport, Communication	Service Industry
Employment	0.661 (5.05)	0.672 (3.76)	0.658 (4.78)	0.282 (1.65)	1.024 (1.3)	0.339 (1.23)	0.884 (9.21)
Hours	0.515 (4.75)	0.824 (4.91)	0.617 (2.84)	0.537 (2.57)	0.218 (2.69)	0.662 (3.75)	1.098 (9.11)
Wages	0.858 (13.8)	0.776 (3.83)	0.810 (10.9)	0.709 (7.47)	0.480 (4.39)	0.910 (6.11)	0.705 (4.11)

Note: Absolute t-ratios are in parentheses. Estimates are own lag coefficients from model (1)-(3) with wage flexibility.

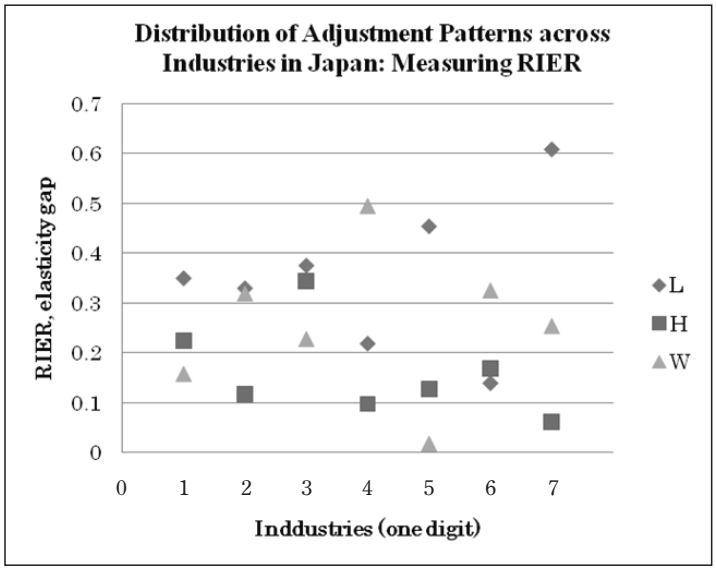
Figure 1 Speed of Own Adjustment: Elasticity

Measuring the relative isndustrial elasticity of responses

In order to see whether adjustment patterns vary across industries in Japan, we construct a new measurement, called as the *relative industrial elasticity of response index* (hereafter RIER index) which indicates the gap defined as the deviation of industry's elasticity from the economy's elasticity that is measured by the average of all industries. Estimates of RIER index are summarized at Figure 2.

Figure 2 only shows responses of adjustment variable when the industry face demand shock that is measured by the unexpected change in demand. Evidence indicates that there are differences in adjustment patterns across industries in response to cyclical change in demand. The values of RIER index represent elasticity gap, that is, the deviation of each adjustment variable in each industry from the aggregate response of the economy that is measured by the average elasticity of all the industries considered in the estimation. It is evident that the RIER elasticity gap varies across industries in Japan over the sample period.

Figure 2. RIER index



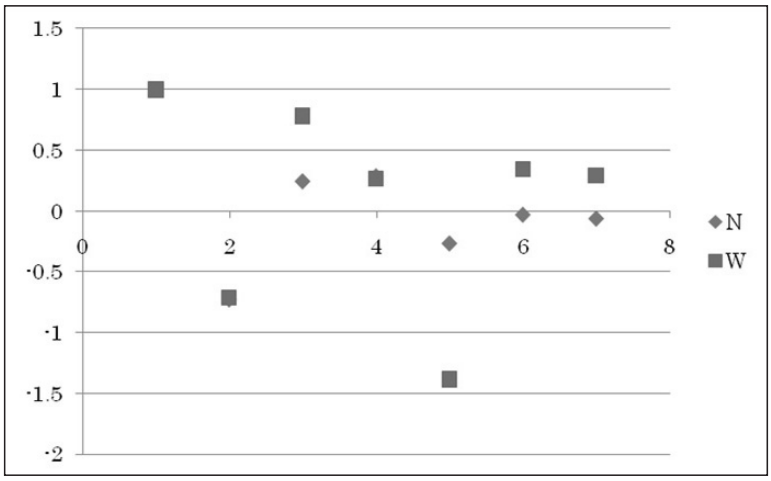
Note: Measurement of differences in cross-industry responses among employment, work-hours and wages:
RIER index (The *relative industrial elasticity of response* index) = the deviation of industry's elasticity from the aggregate responses that is measured by the economy's elasticity, i.e. the average of all industries, $\hat{\xi}_f$.

$RIER_{if} = \xi_{if} - \hat{\xi}_f$, where $\hat{\xi}_f = \sum_{i=1}^{I} \xi_{fi}$

The previous studies on labor inputs adjustment usually considered the manufacturing sector and draw implications on the relative roles among employment, hours and inventories. Since we consider all industrial sectors, here the eight industries at one digit classification, our natural focus would be on difference of adjustment behaviors between manufacturing and non-manufacturing industries. In order to measure how adjustment variables respond to change in demand when we treat manufacturing sector to respond as one unit, we use adjustment in manufacturing sector as a benchmark and construct the normalized index, called as *normalized relative industrial elasticity of response* index (NRIER index). NRIER index is constructed to see whether pattern of adjustment varies across industries relative to a reference industry such as manufacturing industry. Empirical results to identify differences of responses between manufacturing sector and non-manufacturing sectors are summarized at Figure 3.

Figure 3 shows behaviors of labor inputs and wage variables across industries in Japan over the sample period. Since the manufacturing sector is normalized, responses of non-manufacturing sectors are represented by the distance from the value of one. Evidence indicates that responses of wage measured by NRIER elasticity seem to be greater than ones

Figure 3. Industrial Distribution of NRIER Mesaures: Labor Inputs and Wage Responses



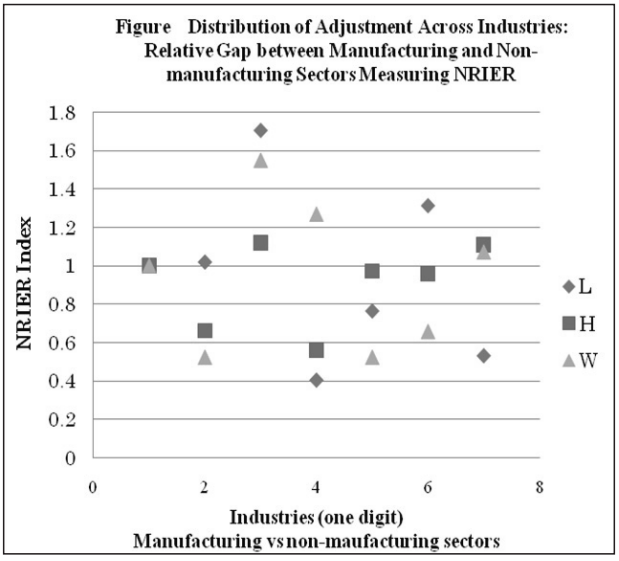
Note: The *normalized relative industrial elasticity of response* index to measure how adjustment variables respond to change in demand when we treat manufacturing sector to respond as one unit. NRIER index is used to see whether pattern of adjustment varies across industries. IRIER is constructed in this study in order to identify differences of responses between manufacturing sector and non-manufacturing sectors. Let ξ_{if} be each industry i's elasticity of adjustment variables in response to change in demand.

$NRIER_{if} = \xi_{if} - \xi_{mf}$, i= non-manufactruing industrires, m= manufactruing industrires, f= employment, work-hours and wage.

of labor inputs in the most industries. Note that the response of labor inputs is defined and calculated as the sum of elasticity of employment and work-hours as in the log-linear version of equation for labor inputs, (4). It is possible for our results to underestimate the true value because we ignore residual term, η_{i0} that may include factors of industry specifics regarding labor inputs, for example, aspects of human asset or human capital.

To confirm the response of the three adjustment variables, we decompose the labor inputs into employment and work-hours. The results of normalized responses among employment, hours and wages are measured by NRIER index and summarized at Figure 4. Though it is not easy to interpret the empirical results, we can confirm that there exist differences in adjustment patterns between manufacturing and non-manufacturing sectors. Evidence shows that there are divergences in behavior of adjustment variables aross industries in Japan. The responses through adjustment variables to demand shocks seem to be offset in some portion in that the shape of distribution looks similar to symmetric shape. This implies that the response of each industry may be more sensitive or elastic than adjustment behavior revealed by aggregate response. This means that, in order to have better picture for adjustment behavior,

Figure 4. Decompsition of Adjustments and Industrial Distribution: NRIER Mesaures of Emplyment, Hours and Wage



Note: Definition of index measure is same as Figure 3.

we need to consider both aggregate and disaggregate responses to demand shocks.

V. Concluding Remarks and Future Research Agenda

In summary, we examine the industrial aspects of macroeconomic adjustment, in particular, flexibility and/or rigidity of wage, employment and work-hours. Using a time series of industry data, we estimate the model of labor inputs and wage adjustments to empirically identify the existence of industrial differences in adjustment patterns and further to measure the relative responses of adjustments across industries in terms of employment, wages, and hours. As measurements for the industrial distribution of labor inputs and wage flexibility across industries, we constructed the indices: the RIER index (5) and the NRIER index (6). The RIER index measures the deviation of each industry's elasticity from the economy's elasticity, the NRIER index measures how adjustment variables respond to change in demand of product markets when the elasticity of manufacturing sector is set to be one unit. We find that there are variations across industries in the extent that wages are more flexible and employment is less flexible in response to change in demand in the product market. Differences in relative elasticity among adjustment variables implies that sequences of adjustment seem to be first adjusted in hour-worked, via overtime hours and through wages and if the former adjustments are not enough for firms to respond to changes in demand or shocks, then the final adjustment is employment. Evidence suggests that further research is

needed to understand the mechanisms for how wages are adjusted across industries. This requires an empirical study on the price and wage setting in Japanese industry. One mechanism regarding the wage setting process seems to be through components of aggregate wage, for example, via non-base wages such as bonuses.

Recent developments in the Japanese labor market seem to reveal the possibility of structural change in employment. The interaction of between employment and wages needs to be further investigated. For that, changes in the composition of employment and total earnings may provide useful information for understanding mechanisms of structural changes and their transmission effects.

Several facts and features from the recent development in the behavior of Japan's employment and wages in the 1990's include the following. First, Japanese firms tried to achieve flexibility with regard to both employment and wages through the increased use of non-regular employees such as, in particular, part-timers. The portion of non-regular employees has risen rapidly since the mid 1990's and reached nearly about 30 percent of Japan's total employees. Second, a major portion of non-regular employees are from part-time workers, but the portion of contract workers and temporary workers has also increased. The larger portion of contract worker-type-non regular employees consists of professional and technical workers. This may reflect the effect of the information and communication advances.

Third, the high flexibility of wages has been largely attributed to the fact that bonuses, which are a significant portion of total earnings, are highly flexible. Note that this case seems to be attributable to a higher degree of flexibility in regular wages. However, it is possible that the increase in wage flexibility for overall employees may be mainly due to the higher portion of non-regular employees because cost for them can be easily adjusted by changing the number of days or hours. Further, we need to focus on some facts from non-manufacturing industry such as the service industry, wholesale & retail industry, and other high tech related industry.

A future research agenda would address the related questions regarding economic adjustment under uncertainty. Is there evidence that, for some industries, the Japanese response pattern has changed after the high growth and boom period when the bubbles[12] burst in the early 1990s? If so, what are the main reasons which make adjustment behaviors of those industries different from other industries? Can we empirically identify when the structural change has occurred in the Japanese economy, in particular, in the labor market? Price and wage setting issues require further study both theoretically and empirically.

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12) There were two bubbles in Japan. One is the bubble in real assets such as land, buildings and houses. The other is a bubble in price of financial assets, for example, stock prices. In Japanese economy, this *twin bubbles* are closely related each other in the sense that real assets is mostly commonly used *collaterals* when firms and households are allowed to get loan and borrowing from Bank. Given the lack of screening, the loan and borrowed money backed by real asset had attributed to change in stock prices beyond the fundamentals in Japan. The causal relation and the degree of impact regarding the twin bubbles in Japan remain to be little studied.

The main focus in this study is on the existence of distribution or divergent patterns of adjustment across industries in Japan when the economic environment becomes uncertain, rather than on test hypotheses on coefficients. We constructed measures of differences across industries such as the RIER index and the NRIER index to order identify the extent of the divergences. Those measurements constructed in this study also remain to be improved in various ways, especially to include both cross-industry effect and structural changes. To draw further implications as to why there exists divergence over adjustment patterns across industries, information that is drawn from empirical investigation for structural change would be most helpful. For example, it is useful to identify when a trend is broken to see whether the timing of structural changes coincides across industries. We would discuss theoretical and empirical issues for structural change by employing Chow-type of tests and a rolling estimation for parameter path in question. The evidence of seemingly structural changes with time lags within industries could provide important clues for reasons why there exist differences or divergences in adjustments in conjunction with events study of regulation and deregulation in administration sector and the related change in legal sector.

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