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A New Empirical Investigation of Employment, Wages and Output

—A Comparative Study of the US and Japan—

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Abstract

In this paper, I pursue an empirical analysis of different patterns of employment and wage adjustments to demand changes for the US and Japan. Analyzed are the data in the 70's and 80's, the period that the two countries are believed to show most conspicuous diverging patterns. Using the framework of cointegration and error correction, I establish that in the US it is employment level, while in Japan it

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is wages, that is more responsive to output fluctuations both in the long run and the short run. All the comparisons on the long run relationships are estimated and tested based on the system cointegrating regressions, and the transition from the short run to the long run responses are investigated using impulse response analysis of the error correction models. I also study differences across genders and establishment sizes within each country. For males and females in Japan, the adjustments are significantly different both in the long run and the short run, but for the firms of different sizes they diverge only in the short run. In contrast to some of the earlier work, the gender effect turns out to be insignificant in the US.[1)]

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I. Introduction

The different patterns of employment and wage responses to the output fluctuations in the US and Japan have long been a subject of much interest. Though the case of the US and Japan can, of course, simply be put in a broader context of international comparisons, the subject matter seems to have drawn some special attention. This is partly because of the cultural and traditional differences which are widely believed to exist in the two industrialized countries. Layoffs are commonly practiced by the US firms as means to adjust to demand fluctuations (see Hall (1980) for some supporting evidence). In Japan, however, their use for the same purpose is thought to be much more restricted by what is frequently referred to as the "lifetime employment system". Wages, on the other hand, are thought to be more flexible in Japan, leaving some leverage for Japanese firms to respond to declining demand. Once again, this is in contrast with the US, where its rigidity is widely observed, arguably as a result of wage contract in the unionized sector (see

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Freeman and Medoff (1984) for more detailed discussions on this subject).

Therefore, one may well expect that wages are more rigid, and employment more volatile, in the US than Japan. It has, in fact, been empirically tested by several authors in the 70's and 80's, including Gordon (1982) and Hashimoto and Raisian (1986, 1987, 1988). Though based on empirical models which vary widely, they unanimously provide support for the relative volatility of employment and relative rigidity of wages in the US, compared to Japan. Abraham and Houseman (1989) investigated the patterns of employment and hours adjustments to demand changes in the US and Japan, and draw a similar conclusion on employment and hours of work. See also Hall (1982) and Tachibanaki (1987), among many others, for some related work.

The validity of some of their results may, however, be legitimately questioned. It is now well established that many economic time series such as employment, wages and industrial output have unit roots (see, for example, Nelson and Plosser (1978) and Park and Choi (1988)). Given the presence of unit roots, the regressions in levels may be nonsensical or spurious, as pointed out by Granger and Newbold (1974) and Phillips (1986). Also, the classical tests are invalid in such models, as first shown in Phillips and Durlauf (1986). One should therefore be cautious in interpreting regressions of employment and wages on industrial output which were used, for example, by Hashimoto and Raisian (1986). The regressions in differences as in Abraham and Houseman (1989), on the other hand, do not utilize important information on the long run relationships, and consequently are not quite satisfactory. More importantly, the differences regressions are susceptible to various model misspecifications such as simultaneity bias, omitted variables and errors-in-variables problems. Finally, the regressions in Gordon (1982) are hard to interpret, since they include the regressand and regressors that are of different orders of stochastic magnitudes.

I employ in the paper the framework of cointegration and error correction, which has recently been popularized by Engle and Granger (1987), to examine the difference in responses of employment and wages to output fluctuations in the US and Japan. My approach has several important advantages over those in the past works, though none of them are directly comparable to mine. First, I investigate both the long run and short run responses of employment and wages to output

fluctuations. The comparison between the long run and short run responses is made, which can be very informative for the comparative study of the US and Japan. Second, my results on the long run relationships among output, employment and wages are robust with respect to many potential misspecifications including those mentioned above. In particular, omitted variables do not matter, as long as they are stationary. This greatly simplifies my model, and also makes the results much easier to interpret. Third, due to the benefit of methodology developed by Park (1992) and extended later to the SUR system by Ogaki and Park (1998), all long run comparisons made are based on formal statistical tests, which are robust, especially, with respect to serial correlation in individual time series of output, employment and wages, and/or endogeneity of output. Cross serial correlations are, of course, also allowed.

Analyzing the monthly manufacturing industry data for US and Japan during the period of 1974. 1 - 1986. 12, I have found the following. First, employment and wages are individually cointegrated with output. This is true for both the US and Japan. The cointegration result implies that there exist a stable long run relationship between employment and output, and also between wages and output. On the equilibrium paths, however, the adjustments of employment and wages to output fluctuations are truly different in the US and Japan. The elasticity of employment is much, much larger than that of wages in the US. In contrast, wages are much more elastic than employment in Japan. It is therefore well expected that employment for the US, and wages for Japan show much greater relative volatilities. Direct comparisons of the elasticities also show that the elasticity of employment is larger in the US, but the converse is true for wages. All these results are confirmed using formal statistical tests based on SUR systems.

Second, I look at the short run responses of employment and wages to output fluctuations. This is done using error correction models, which are essentially the reduced form VAR's with cointegrating restrictions. My impulse response analysis shows that the short run responses of employment and wages parallel, from a comparative point of view, the long run responses. An increase in demand is responded predominantly by an increase in employment in the US after about one year and on, but wage adjustment is shown to play a much more important role in Japan. The adjustments of employment and wages to the new long run equilibria,

however, seem to occur rather slowly in both the US and Japan. Also, I found some evidence of "overshooting" in the adjustments of wages in the US, and employment in Japan.

I also investigated within country differences with respect to the gender for both the US and Japan, and establishment sizes for Japan. In the US, the variations in the male and female employment due to demand fluctuations are not significantly different, although the estimated elasticity for female employment is slightly higher. The adjustment of female employment (or male wages) is, however, significantly larger in Japan, which of course implies that women are more vulnerable to being laid off in the event of demand decrease. The comparison between large and small establishments in Japan is expected to be quite similar to that of male and female workers. More precisely, it is expected that demand fluctuations are met more by the wage adjustment than by employment adjustment in large firms. This is because the life time employment system is known to be more strictly applied to male workers than female workers, and to workers in large establishments than those in small establishments. The evidence for the dual structure of the labor market in Japan seems, however, much weaker across the establishments of different sizes than male and female workers. In contrast to gender-specific finding, the difference in the long run behavior of large and small firms turns out to be insignificant. The difference of significance only concerns the short run response of employment: the adjustment of employment to its long run equilibrium level is much faster for large firms.

The plan for the rest of the paper is as follows: Section 2 introduces my empirical models, along with the specifications of the individual time series. The procedures and the results for the tests of my model specifications are presented in Section 3. The data used for my study are described in detail in this section as well. Section 4 discusses the procedures for the statistical inference in my model, and summarizes the major findings with interpretations. Some concluding remarks will follow in Section 5.

Ⅱ. The Models

In this section, I describe the models that are used in the paper for my empirical analysis. I denote throughout the paper by $\{e_t\}$, $\{w_t\}$ and $\{q_t\}$, respectively employment, real wages and output in logs.

1. Specification of Individual Series

Let $\{e_t\}$, $\{w_t\}$ and $\{q_t\}$ be given by

$$\begin{aligned} e_t &= \pi_e{}^t + e^0_t \\ w_t &= \pi_w{}^t + w^0_t \\ q_t &= \pi_q{}^t + q^0_t \end{aligned} \quad \cdots\cdots (1)$$

where $\{e^0_t\}$, $\{w^0_t\}$ and $\{q^0_t\}$ denote the stochastic components of the series, which I assume to have unit roots. The presence of the unit roots in these series will later be tested.

The time trends in $\{w_t\}$ and $\{q_t\}$ are, of course, included to allow for positive productivity growth. With my log specification, the parameter π_q in (1) has an obvious interpretation as the output growth rate. Note also that, under the given assumption of no drift term in $\{e_t\}$, π_q represents the growth rate of labor productivity as well as that of the output. The growth, of course, may be a result of such phenomena as technological advance and capital accumulation, which I will not consider in this paper.

2. Longrun Relationships

It is reasonable to expect that both the employment and the wages have stable long run relationships with output. I formulate the long run relationships which may exist among employment, wages and output using the concept of cointegration.

Given the above specifications for individual series, I may postulate

$$e^0_t = \beta_e q^0_t + u_t \quad \cdots\cdots (2)$$

$$w_t = \beta_w q_t + v_t \quad \cdots\cdots (3)$$

where $\{u_t\}$ and $\{v_t\}$ are assumed to be stationary.

In (2), I have cointegration between employment and output net of deterministic trend due to the productivity growth. Given the clear evidence of positive productivity growth for the both countries, it seems to make little sense to impose long run relationship between $\{e_t\}$ and $\{w_t\}$. I define the cointegration between $\{w_t\}$ and $\{q_t\}$ in a way slightly different from that of Engle and Granger (1987). In (3), I postulate that the deterministic parts, as well as the stochastic components, of $\{w_t\}$ and $\{q_t\}$ have common trend. More precisely, (3) implies the cointegration of $\{w^0_t\}$ and $\{q^0_t\}$ in the sense of Engle and Granger (1987), i.e.,

$$w^0_t = \beta_w q^0_t + v_t \quad \cdots\cdots (4)$$

I, however, impose additional restriction on the deterministic trends, which can be explicitly given by

$$\pi_w - \beta_w \pi_q = 0 \quad \cdots\cdots (5)$$

The parameters βe and β_w in (2) and (3) (or (4)) have obvious interpretations, respectively, as the long run elasticities of employment and wages with respect to the output. They measure the percentage changes of employment and wages corresponding to one percent change in demand in the long run. Also, the sum of these two parameters, $\beta e + \beta_w$, roughly, measures the portion of an output increase paid directly to the workers.

3. Error Correction Representation

I now represent the cointegrations given in (2) and (3) (or (4)) in terms of error correction models. The purpose is to investigate the short run dynamics of

employment and wage adjustments to output fluctuation. It will be convenient to define

$$\chi_t = (e_t, w_t^0, q_t^0)'$$

and let $\{\chi_t\}$ follow a p-th order VAR, which is given by

$$\chi_t = \sum_{i=1}^{p} \Pi_i x_{t-i} + \varepsilon_t \quad \cdots\cdots (6)$$

where $\{\varepsilon_t\}$ is white noise. To represent the VAR in (6) in an error correction form, I now rewrite it as

$$\Delta x_t = \Pi x_{t-1} + \sum_{i=1}^{p-1} \Phi_i x_{t-i} + \varepsilon_t \quad \cdots\cdots (7)$$

where Δ is the difference operator, i.e., $\Delta x_t = \chi_t - x_{t-i}$. The coefficients Φ_i for i = 1,···, p-1 in the error correction model (7) are, of course, defined accordingly from the coefficients Π_i, i = 1, ..., p, of the VAR in (6). As shown in Johansen (1987), the presence of cointegration in $\{\chi_t\}$ imposes a restriction on Π, i.e.,

$$\Pi = \alpha \beta' \quad \cdots\cdots (8)$$

where each of the column vectors in β is a cointegrating vector. The rank of Π is therefore restricted to be the same as the number of cointegrations in $\{\chi_t\}$. With the restriction (8) given by the presence of cointegrations in $\{\chi_t\}$, (7) explains the short run adjustment, or an error correction, mechanism to the long run equilibrium. Notice that $\beta' x_{t-i}$ defines the equilibrium errors at time t-1, where

$$\beta = \begin{vmatrix} 1 & 0 \\ 0 & 1 \\ -\beta_e & -\beta_w \end{vmatrix} \quad \cdots\cdots (9)$$

given the cointegrations between $\{e_t\}$ and $\{q_t\}$ in (2), and between $\{w_t^0\}$ and $\{q_t^0\}$ in (4).

Ⅲ. Data and Model Specification Tests

In this section, I describe the data that are used in the paper for my empirical analysis. I also discuss and summarize the results of the specification tests of my models presented in the previous section. Specifically, I consider the tests for the unit roots and cointegrations, upon which specifications of my models heavily depend.

1. Data

For the empirical analysis in the paper, I make use of the monthly data on employment, real wages and industrial output for the manufacturing sector, which span the period of January 1974 to December 1986. The number of observation is 156 for all the series. The data are seasonally adjusted for both the US and Japan. For the US, seasonally adjusted data were available for all the series that I used in the paper. This, however, was not so for the Japanese data. Except for the output data, the original series were seasonally unadjusted, and for these data I performed the seasonal adjustment myself using the X-11 method implemented in SAS.

The employment and wage data for the US were obtained from Supplement to Employment and Earnings, United States (1984, 1985, 1988), which is published annually by the US Department of Labor. For employment, I used the numbers of production or nonsupervisory workers in manufacturing industries. Male and female employment data come from the same source. For wages, I used the real average weekly earnings per worker in manufacturing industries, published in 1977 dollars. The same data may also be obtained by multiplying average weekly hours (which include overtime hours) by time average hourly earnings. The data for the industrial output are from the production index for manufacturing industries in Survey of Current Business, published monthly by the US Department of Commerce (some obvious adjustments were made to merge data sets with different base years).

The output data for Japan that I use in the paper is the production index (with base year 1970) for manufacturing industries. It is published in Current Production Statistics Survey of MITI, an annual report by the Japanese Ministry of International Trade and Industry. The gross employment data were obtained from the Japanese Economic Planning Agency through personal communications. These data are not published, but seem to be most reliable. For the comparisons of male and female workers, and large and small firms, I used the employment data in Monthly Labor Survey (more specifically, "Type A" survey which is for the establishments with 30 or more employees), a Japanese monthly publication of the Ministry of Labor. The data, however, appear to have some serious problems in the form of obvious discrepancies in April 1979 and April 1982. This problem in the dataset is, of course, taken into consideration for my study, as will be explained later in detail. Unfortunately, other more reliable employment data are not broken down by gender or establishment size. Nominal wages, aggregated and disaggregated by gender and establishment size, were drawn from Monthly Labor Survey. These are contractual wages which include both base payments and overtime payments. The nominal values were deflated by the price indices, which are implicitly defined by the real and nominal gross wages in the Japanese Economic Panning Agency dataset. This conversion from the nominal to real values was made prior to seasonal adjustment.

2. Testing for Unit Roots

For the test of the unit roots, I have employed various methods developed by Dickey and Fuller (1979, 1981), Phillips (1987), Ouliaris, Park and Phillips (1989) and Park and Choi (1988). The presence of a unit root has, of course, far-reaching implications, both economic and statistical, as pointed out by many authors. The interested reader is referred to Campbell and Mankiw (1987), for example, for its economic implications. Statistical problems, however, seem to be more important from the practical point of view. Standard theory on statistical inference does not apply to models with integrated processes except for some very special cases, as pointed out by Park and Phillips (1988, 1989). At worst, inferences on such models in the absence of cointegration can be totally nonsensical as shown in Granger and

Newbold (1974) and Phillips (1986).

I tested for unit roots in the output and wage series with a maintained linear time trend. As mentioned in Section 2, this is to allow for positive productivity growth. The presence of linear trends in output and wages seem to be evident, for both the US and Japan. The evidence, however, seems much stronger for Japan. In contrast, employment in the manufacturing industry has not been growing noticeably during the period under consideration. This is true, once again, for both the US and Japan. For employment, I therefore test for a unit root without maintained trend (but with the constant term to avoid the dependency of the tests on the initial values). The test results are summarized in Table 1 given below. The Phillips statistics, which I report in Table 1, were obtained using the Parzen window (see, for example, Fuller (1976)) with the lag truncation number 12 to estimate the long run variances. Also, the Dickey and Fuller test was based on autoregression with 4 lagged differences.

The results in Table 1, in general, support presence of the unit roots in the stochastic components of all the series. With the five percent size, at least two of the three tests considered here fail to reject the presence of unit roots in all but one series. The case of output in Japan is rather exceptional, where the unit root is rejected for the five percent size Phillips and Dickey-Fuller tests. The null of a unit root for output in Japan, however, is not rejected if the test by Park and Choi is used. The Phillips and Dickey-Fuller tests depend, respectively, on the length of the lag window in the estimation of the long run variance and the order of autoregression. These test results, though not reported here, were found to become more favorable for the unit roots, if I decrease (increase) the lag truncation number (the order of autoregression).

The test results for the disaggregated employments and wages by gender and establishment size also strongly support the presence of the unit root though I do not report the details to save the space. There is only one exception. The evidence for the unit root seems relatively weaker in the Japanese wage data. The presence of the unit roots in the series is, however, not rejected by the tests of Dickey and Fuller and Park and Choi with the five percent size. It is rejected only when the Phillips test is used.

〈Table 1〉 Tests for Unit Roots

	Employment		Wages		Output	
	U.S.	Japan	U.S.	Japan	U.S.	Japan
Phillips	-1.98	-1.65	-2.50	-4.42	-2.35	-3.51
Dickey-Fuller	-2.44	-2.58	-1.79	-2.30	-2.86	-3.62
Critical Values	-2.86		-3.41			
5%(1%)	-3.43		-3.96			
Park-Choi	0.26	30.12	1.98	0.92	2.22	2.14
Critical Values	0.33		0.29			
5%(1%)	0.11		0.12			

I also estimated the time trend coefficients π_e, π_w and π_q, in (1), and tested their significance. The estimation and tests were based on the regression of the first difference on the constant term. For the tests of their significance, are needed consistent estimates for the asymptotic variances of $\{\Delta e_t^0\}$, $\{\Delta w_t^0\}$ and $\{\Delta q_t^0\}$, which I obtained using the Parzen kernel with the data dependent automatic bandwidth selection recently proposed by Andrews (1990). The results are summarized in Table 2.

〈Table 2〉 Estimated Coefficients and t-Statistics for Time Trends

	U.S	Japan
Output	0.0019(1.05)	0.0022(1.78)
Employment	-0.0005(-0.41)	-0.0002(0.33)
Wages	0.0005(0.68)	0.0044(3.59)

It seems rather decisive that the employment series does not include a linear time trend, for both the US and Japan. In fact, employment in the manufacturing industry has not been changed, on the average, noticeably during the period under consideration. In contrast, the presence of linear trends in output and wages, especially for Japan, seems to be evident. It is supported by my test results in Table 2.

3. Testing for Cointegration

My specifications in (2) and (3) in Section 2, as mentioned earlier, rely on cointegrations, respectively, between employment and output, and between wages and output. Legitimacy of such specifications can be addressed by various tests for cointegration, including those in Engle and Granger (1987), Johansen (1987), Stock and Watson (1988) and Phillips and Ouliaris (1990). Most widely used are perhaps the residual based tests, which are essentially the unit root tests, such as the ones that I considered previously, but now applied to the residuals from the cointegrating regressions (2) and (4). These tests are analyzed in Phillips and Ouliaris (1990). The presence of a unit root in the residuals, of course, implies no cointegration. Alternatively, the tests by Johansen (1987) and Stock and Watson (1988) are based on VAR's.

Strictly speaking, however, all these tests are the tests for no cointegration rather than cointegration. The tests take no cointegration as the null hypothesis, and I am led to accept the presence of cointegration only when the tests reject the null hypothesis. Clearly, it is much more preferable to test for cointegration directly in my case (and probably in many other cases as well, since what is implied by economic theory in most cases is the presence, not the absence, of cointegration). The reason is that I may truly control the size of rejecting my maintained models (2) and (3) only when a test takes cointegration as the null hypothesis. The test of cointegration may, of course, yield the result opposite to that of the test of no cointegration if the type II error is larger than the type I error (or the size) for these tests. It is a consequence likely in the finite samples, though not in the large samples.

For my study, I used the variable addition test for cointegration developed by Park, Ouliaris and Choi (1988) and Park (1990) (it will be called POC henceforth). The test is simple to compute and intuitively appealing : it tests whether the coefficients of the superfluously added time polynomials using a modified Wald test. In the presence of cointegration, the regression becomes authentic and the test should be able to detect the redundancy of the added time polynomials. This, however, is not the case in the absence of cointegration, since the regression

becomes spurious and the test statistic diverges in this case as shown in Phillips (1986). As the standard Wald test, it has asymptotic chi-square distribution. The reader is referred to Park (1990) for the detailed discussion of the procedure. For the test of cointegration in (2), I used the demeaned employment and the detrended output, and superfluously included the time polynomials t, t2, t3 and t4 in the regression. Also, the demeaned wages and demeaned output were tested to be cointegrated for (3) by including the same time polynomials.

In addition to the POC test of cointegration, I also performed the augmented Dickey-Fuller (ADF) test, which is one of the most popularly used residual based tests for no cointegration. This is mainly for the purpose of comparison. The distribution of the ADF test is nonstandard: some of the critical values may be found in Engle and Granger (1987), Engle and Yoo (1991) and Phillips and Ouliaris (1990). Like other existing tests for no cointegration, the ADF test is not directly applicable to my models, which involve cointegration between (demeaned) employment and detrended output, and deterministic as well as stochastic cointegration between (demeaned) wages and (demeaned) output. For the precise tests, new sets of critical values must be computed. This, however, was not done, since my purpose is mainly for the comparison with the POC tests. I just use in the paper the critical values computed by Engle and Yoo (1991) for the detrended series. The results for the ADF tests are therefore only suggestive.

The test results are summarized in Table 3. As in the tests of unit roots, I used the Parzen window to estimate the long run variances which are needed to compute the POC tests. In every case the serial dependency of the underlying series dies out only very slowly. The test results for this reason are somewhat dependent on the lag truncation number ℓ, say, for the Parzen window. They, however, remain stable after about 24 lags. The POC test results for ℓ = 12, 24 and 36 are reported in Table 3. Likewise, the actual values of the ADF tests are dependent on the number p of the included lagged differences in the unit root regression of the cointegrating regression residuals. In Table 3, the results for the ADF tests are reported for p = 4, 8 and 12.

〈Table 3〉 Tests for Cointegration

POC ℓ = 12	Employment-Output		Wages-Output	
	U.S.	Japan	U.S.	Japan
POC ℓ = 12	14.76	16.84	13.52	9.60
24	9.55	9.96	7.78	5.28
36	7.71	7.21	5.81	5.40
Critical Values 5%(1%)	9.49 (13.28)			
ADF p = 4	-1.81	-2.48	-1.65	-3.09
8	-2.26	-1.84	-1.22	-2.76
12	-2.50	-1.26	-2.03	-2.61
Critical Values 5%(1%)	-3.82 (-4.34)			

The POC test generally supports the cointegrations that I postulate in Section 2. The evidence for the cointegration of wages and output is somewhat stronger than that of employment and detrended output for both the US and Japan. These two cointegrations, however, are not directly comparable since I impose the deterministic, as well as stochastic, co-movements for wages and output. It is interesting to note that the cointegration between employment and output is relatively stronger in the US than in Japan. The converse, however, is true for the cointegration between wages and output: it is relatively weaker in the US than in Japan. This suggests that wages and output in Japan, and employment and detrended output in the US, have relatively more conspicuous co-movements in the long run.

In contrast with the results from the POC test for the null of cointegration, the ADF test does not seem to reject the null of no cointegration in all cases. Given some evident co-movements existing among employment, wages and output, this looks strange. This is perhaps indicative of substantial finite sample size distortions of the ADF tests for my dataset. Moreover, I believe that the negative results from the ADF test of no cointegration do not constitute direct evidence against those from the POC test of cointegration. In the light of my previous discussion about the test of cointegration and that of no cointegration, this may just reveal low powers of the tests (the POC test as well as the ADF test) in the finite samples.

Ⅳ. Main Empirical Results

I now present the main empirical results on the relationships among employment, wages and output in the US and Japan. The long run relationships are based on the cointegrations in (2) and (3), and the short run dynamics are inferred from the error correction model (ECM) (7). These two results are reported and interpreted separately.

1. Estimations and Tests of Long Run Relationships

The inferences on the long run relationships are based on the SUR systems of cointegrating regressions (2) and (3) fitted with the aggregated and/or disaggregated data for employment, wages and output in the US and Japan. The precise formulations of SUR's will be specified later for within- and cross-country comparisons. The reason that I consider the SUR, instead of the single equation least squares (SELS), for example, is primarily for the purpose of testing. The hypotheses of interest involve cross equation restrictions, and therefore cannot be tested by the SELS.

With the presence of cointegrations in (2) and (3), it is now well known that the SUR or SELS estimates of the parameters ψe and ψw are consistent (see for instance Stock (1988) and Ogaki and Park (1998) respectively for the consistency the SELS and SUR estimates). It seems important to point out here that the choices of the regressands and the regressors in (2) and (3) are just for the convenient normalizations. None of the exogeneity conditions for the regressors, such as those in Engle, Hendry and Richard (1983), are assumed. Yet, the estimates are super-consistent and converge at a faster rate than those in the stationary regressions. Specification errors such as simultaneity, errors-in-varia and omitted variables do not affect the consistency of the estimates. The interested reader is referred to Phillips and Durlauf (1986) for a detailed discussion.

Unfortunately, the standard SUR or SELS estimates, although super-consistent, are asymptotically biased, unless the regressors are strongly exogenous in the sense of Engle, Hendry and Richard (1983). This, of course, is very unlikely to be satisfied in my model. More importantly, standard tests directly based on the SUR system are not valid, due to the nonstandard nature of its limiting distribution and the nuisance parameter dependency. This is also true for the SELS, though not applicable for my case which includes cross equation restrictions. Various methods of tests in a cointegrated system have been developed by several authors, including Johansen (1988), Phillips (1989) and Phillips and Hansen (1990). None of these methods, however, are directly applicable for SUR systems. Also, there are some additional difficulties in applying these methods to my models, mainly due to the extended notion of cointegration for wages and output in my models.

I used in the paper the method developed by Park (1992) and extended later by Ogaki and Park (1998). This requires the transformation of the data to construct what is called the seemingly unrelated canonical cointegrating regression (SUCCR). The reader is referred to Ogaki and Park (1998) for more discussions on the SUCCR. The SUCCR estimates are asymptotically unbiased (in contrast with the SUR or SELS estimates), and efficient. Also, the standard tests with only modified covariance matrix in the SUCCR are asymptotically chi-square. The test based on the SUCCR is robust, and is valid under quite general circumstances. I, in particular, may allow for serial correlation in the errors, and the serial as well as contemporaneous correlation between the errors and the innovations of the regressors in the SUR. For the estimation of the long run variances that are needed to construct the SUCCR's, I used the Parzen window with the lag truncation number 24.

In the subsequent studies of the long run relationships among employment, wages and output in the US and Japan, I present the SELS and SUR estimates, as well as the SUCCR estimates. The interpretations of the results, however, will be based on the SUCCR estimates, which are asymptotically unbiased and more efficient than the other two. Also, I report not only the results of the modified Wald tests based on the SUCCR's, but also those of the standard Wald tests based on the SUR's. This is just for the purpose of comparison. As I mentioned before, the latter are incorrect and not to be used.

1) The US versus Japan

My comparison of the long run relationships for the US and Japan is based on the SUR system which consists of employment and wage equations, i.e., (2) and (3), for the US and Japan. The SUR is therefore four equation system, the coefficients for which I denote respectively by β_e^1, β_w^1, β_e^2, and β_w^2, where the superscripts "1" and "2" are used respectively for the US and Japan. The hypotheses of interest are

$$\begin{aligned} &H_1 : \beta_e^1 = \beta_w^1 \text{ against } H_1^* : \beta_e^1 > \beta_w^1 \\ &H_2 : \beta_e^2 = \beta_w^2 \text{ against } H_2^* : \beta_e^2 < \beta_w^2 \\ &H_3 : \beta_e^1 = \beta_e^2 \text{ against } H_3^* : \beta_e^1 > \beta_e^2 \\ &H_4 : \beta_w^1 = \beta_w^2 \text{ against } H_4^* : \beta_w^1 < \beta_w^2 \end{aligned} \quad \cdots\cdots (10)$$

The hypothesis H_1 tests whether the long run employment adjustment to output fluctuations is bigger than that of wages in the US, and similarly, H_2 tests if the wage adjustment is relatively bigger in Japan. The hypotheses H_3 and H_4 are concerned with international comparisons of the similar implications.

〈Table 4〉 Estimates of Long Run Relationships

	Elasticity of Employment		Elasticity of Wages	
	U.S.	Japan	U.S.	Japan
SUCCR	0.581	0.068	0.029	0.350
SUR	0.594	-0.044	0.032	0.364
SELS	0.594	0.040	0.065	0.369

My estimates of the parameters β_e^1, β_w^1, β_e^2 and β_w^2, and the test results of the hypotheses in (10) are summarized respectively in Tables 4 and 5. The SUR and SELS estimates are largely close to those from the SUCCR. The sign of the SUR estimate for the employment elasticity in Japan, however, is contrary to what I may expect. It seems interesting to note that the estimates for the elasticity of employment for the US, and those for the elasticity of wages for Japan, are

relatively more stable across different methods of estimation. This appears to be closely related to my earlier finding that employment in the US, and wages in Japan, have stronger cointegrations. As clearly seen from Table 5, tests of the all the hypotheses reject the null at one percent level. All are, in fact, even rejected at well beyond the one percent level. The results, of course, strongly support the notion that the long run employment adjustment to the output fluctuations is bigger in the US, while wages play a more important role in Japan for the adjustment to the output fluctuations in the long run.

It should be noted here that wage variations are partly due to those of working hours. It is quite well known that Japanese firms primarily adjust overtime working hours to cope with demand fluctuations, though other means through employment adjustments, such as reduction or stoppage of recruitment and/or denial of recontracting temporary workers, are also used. There are several reasons for this behavior. A study by the Japanese Ministry of Labor, Annual White Paper on the Labor Market (1986), found that the cost of new hire is substantially higher in Japan than the current overtime premium rate. Also, Tachibanaki (1987) argues that, after the oil shock in the beginning of 1970's, Japanese firms tend to keep employment at a marginal level and utilize overtime hours as the primary means to adjust to demand fluctuations, due to their pessimistic expectations of the future. In sharp contrast, overtime work in the US is mostly on the voluntary basis. In fact, overtime hours in Japanese manufacturing firms are quite volatile, while those in US firms are pretty stable at about 2.8 hours per week.

〈Table 5〉 Tests of Hypotheses (10)

	H_1	H_2	H_3	H_4
SUCCR	6.05	-2.92	3.81	-4.63
SUR	16.41	-8.31	10.64	-14.74

There are, of course, other reasons why wages are more flexible in Japan than in the US. As is well known, wage contracts for manufacturing employees are mostly on a three year basis in the US, while they are usually renewed every year in Japan. Different roles of labor unions may be another reason for the relative rigidity

of wages in the US, and employment in Japan. Freeman and Medoff (1984) argue that the primary objective of the US labor unions is to maximize earnings for their members. It is widely known, however, that the Japanese labor unions place more importance on securing jobs for the members.

Total earnings paid to workers are more elastic (procyclically with output fluctuation) in the US than in Japan. This may be inferred from my result showing that $\beta_e^1 + \beta_w^1 > \beta_e^2 + \beta_w^2$ (which is significant at one percent level, though not reported in the paper). This is perhaps partly due to the fact that I did not include bonus payments, which constitute as much as 3 months' base payments in Japan, in wages. It would therefore be difficult to conclude that total earnings are less elastic in Japan. My results on the relative comparison of employment and wage elasticities, however, seem to be valid. Freeman and Weitzman (1986), in fact, found some strong evidence that bonus payments move more closely with output fluctuations, than regular wages. Therefore, it may well be expected that the relative flexibility (rigidity) of wages (employment) in Japan would be amplified, if bonuses are included in wages.

2) Males versus Females

To pinpoint the difference in the long run adjustment behavior for male and female workers in the US, I estimated the SUR system consisting of two employment equations (2) for males and females. The wage equation (3) is not included for the US, because I lack the data. The SUR and SUCCR, of course, yield identical results respectively as the SELS and CCR in this case. For Japan, however, I fitted the SUR system which includes both employment and wage equations (2) and (3) for male and female workers. The system is therefore composed of four equations. I use the superscript "m" and "f", respectively for males and females, to represent the coefficients in the SUR's, in addition to "1" and "2" for the US and Japan.

As mentioned earlier in Section 3.1, I observed somewhat serious discrepancies in the disaggregated Japanese employment data. Specifically, for April 1979 and April 1982, the numbers of employees substantially differ from the values computed by adding the reported changes to the values for the previous months. This is so for both the employment data disaggregated by gender and establishment size. For this

reason, I prefiltered individual series (all series, not just employments, of course) by regressing on the two dummy variables representing April 1979 and April 1982, prior to the estimation of my models here and in the next section. Clearly, this is equivalent to including the dummy variables in my models.

The hypotheses of interest are

$$\begin{aligned} H_1 &: \beta_e^{1m} = \beta_e^{1f} \text{ against } H_1^*: \beta_e^{1m} < \beta_e^{1f} \\ H_2 &: \beta_e^{2m} = \beta_e^{2f} \text{ against } H_2^*: \beta_e^{2m} < \beta_e^{2f} \\ H_3 &: \beta_w^{2m} = \beta_w^{2f} \text{ against } H_3^*: \beta_w^{2m} > \beta_w^{2f} \end{aligned} \quad \cdots\cdots (11)$$

The hypothesis H1 in (11) implies that there is no difference in employment elasticity between male and female workers, and is tested against the alternative hypothesis H1* that female workers are more vulnerable to output fluctuations in the US. The same implication is tested for Japan in H1. In H3, I test whether wage adjustments are the same for male and female workers.

As is well documented in the literature, there are several reasons to believe the employment elasticity for female workers is higher both in the US and Japan. It is known that the female workers have relatively higher quit propensity and shorter eventual tenure in the US (see Viscuci (1980) and Hall (1982)). This tendency also seems to be quite evident in Japan. Given lower skill formation due to shorter tenure, it is reasonable to expect that female workers are more vulnerable to being laid off in case of a decrease in demand. Also, it is a quite common presumption in Japan that the life time employment system applies primarily to male workers (Hashimoto and Raisian (1987)).

〈Table 6〉 Estimates for Male and Female Workers

	Elasticity of Employment				Elasticity of Wages	
	U.S.		Japan		Japan	
	male	female	male	female	male	female
SUCCR	0.632	0.639	0.018	0.239	0.246	0.077
SUR	0.579	0.637	-0.038	0.075	0.250	0.082
SELS			0.067	0.349	0.333	0.188

〈Table 7〉 Tests of Hypotheses (11)

	H_1	H_2	H_3
SUCCR	-0.71	-2.08	7.30
SUR	-0.024	-2.38	20.02

My empirical results are given in Tables 6 and 7. As expected, the estimated long run employment elasticity for female is larger in both the US and Japan. The difference between male and female workers, however, is not statistically significant for the US. This is consistent with other earlier findings, in particular, those by Abraham and Houseman (1989) based on a differences regression of employment on production (more precisely, separation rates minus accession rates on differenced lead and lags of production). My result here also supports their conclusions. In Japan, on the contrary, the long run elasticities for male and female workers are significantly different at well beyond one percent level. Perhaps, the stronger evidence for the gender difference in Japan reflects a social feature that the life time employment applies primarily to male workers. Conversely, the long run wage elasticity for female workers in Japan is significantly lower than that of male workers.

3. Large versus Small Establishments

I also investigated the establishment size effect on the adjustment patterns of employment and wages to output fluctuations. Here attention is restricted to Japan because I lack relevant data for the US. For the comparison between the large and small firms in Japan, I used the data for the establishments with employees 1,000 and over, and between 30 and 99. The SUR used in this section consists of four equations, i.e., the equations (2) and (3) for the large and small establishments. As mentioned in Section 4.1.2, I prefiltered individual series by regressing on the two dummy variables for April 1979 and April 1982, prior to estimating my model.

It is commonly believed that employment is more rigid, and the wages are more flexible, in the large firms than in the small firms in Japan. I therefore consider the hypotheses

$$H_1 : \beta_e^{2\ell} = \beta_e^{2s} \text{ against } H_1^*: \beta_e^{2\ell} < \beta_e^{2s}$$
$$H_1 : \beta_w^{2\ell} = \beta_w^{2s} \text{ against } H_1^*: \beta_w^{2\ell} > \beta_w^{2s} \quad \text{.....(12)}$$

where I use, similarly as before, the superscript "l" and "s" to denote large and small firms respectively. The estimated coefficients and the test results for (12) are reported below in Tables 8 and 9.

The relative magnitudes of the long run elasticities of employment and wages for large and small firms are as expected. Elasticity of employment is smaller, and that of wages is bigger, for large firms. This difference between large and small firms, however, is not statistically significant. The evidence for the duality in Japan seems to be much weaker across the establishment size than across gender.

〈Table 8〉 Estimates for Large and Small Firms

	Elasticity of Employment		Elasticity of Wages	
	Large Firms	Small Firms	Large Firms	Small Firms
SUCCR	0.026	0.073	0.258	0.212
SUR	-0.086	-0.075	0.284	0.212
SELS	0.081	0.103	0.376	0.276

〈Table 9〉 Tests of Hypotheses (12)

	H_1	H_2
SUCCR	0.39	1.33
SUR	-0.31	4.35

2. Short run Dynamics: Impulse Response Analysis

To analyze the short run dynamics, or more precisely, the disequilibrium effects, I estimated the ECM (7) with the (demeaned) employment, detrended wages and detrended output for the US and Japan. The ECM's with the disaggregated employment and wages data by gender and establishment size were also fitted for

Japan. Following Engle and Granger (1987), I used the two step procedure: the long run parameter β in (9) was first estimated by the cointegrating regressions, and then the ECM (7) was fitted with the estimated β. My method, however, differs in that I based my estimation of β on the SUCCR rather than the single equation regressions. As I mentioned earlier, the SUCCR yields asymptotically unbiased and efficient estimates, while the OLS estimates from single equations are biased and inefficient. In what follows, I will report the results with four months lags, i.e., p = 4 in (7). Additionally, I also estimated the ECM's with various other p's. Though not reported here in detail, the length p of the lags did not change any qualitative aspect of my subsequent results.

Instead of enumerating the results from the ECM estimation which are not much interpretable, I present the impulse responses of employment and wages to output fluctuation, for both the US and Japan. I used the impulse response analysis only as a convenient tool to summarize my results. The impulse response analysis in the paper should be interpreted in a conventional way. It should, in particular, be distinguished from the structural VAR methodology advocated by Sims and others. More explicitly, I do not impose any causal chain in my model, and the ECM (7) is simply regarded as a system of reduced form equations. The figures that I present later in this section trace the short run responses of employment and wages to the one unit increase in demand, ceteris paribus.

My analysis, however, diverges from the conventional one in two important aspects. First, unlike the conventional methodology based on the unrestricted VAR, mine is based on the restricted VAR with the restrictions given by the presence of cointegrations between employment and (detrended) output, and between wages and output. The restrictions on the coefficients are explicitly given by (8) and (9). It is well predicted from the theoretical results of Sims, Stock and Watson (1990) and Park and Phillips (1989) that the estimated coefficients from the unrestricted VAR's would approximately satisfy the restrictions (8) and (9) in large samples. However, the unrestricted VAR's would certainly yield less efficient coefficient estimates.

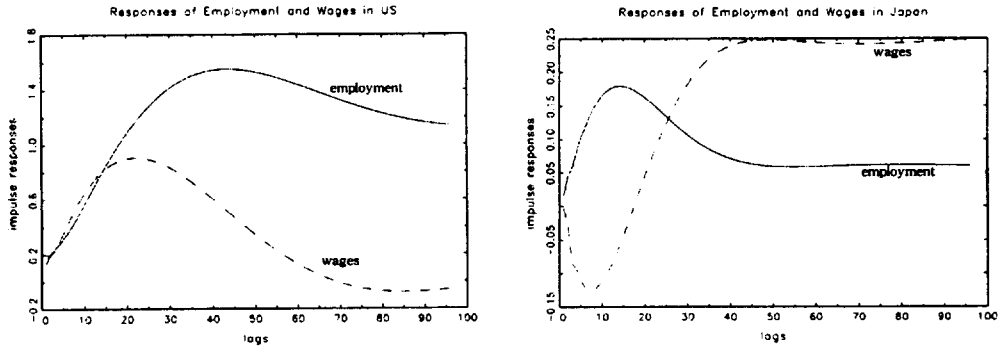
Second, in contrast to the traditional method which assumes the stationarity of the underlying VAR system, mine is based on a nonstationary VAR containing unit roots. The existence of the unit root in output implies that the effect of an increase in output on its future level is persistent, and tends to be unity in the long run.

Likewise, its cross effects on the future levels of employment and wages are also everlasting, due to the presence of cointegrations of employment and wages with output. More precisely, the long run impulses to employment and wages to one unit increase in output are given respectively by the cointegrating coefficients βe and β w in (2) and (3) (or (4)). In stationary models, on the other hand, all of the own and cross effects of an increase in demand would only be transient, and expected to vanish in the long run. The traditional impulse response analysis is therefore concerned only with the short run effects. My analysis, however, shows the transition from the short run to the long run of the impulse responses.

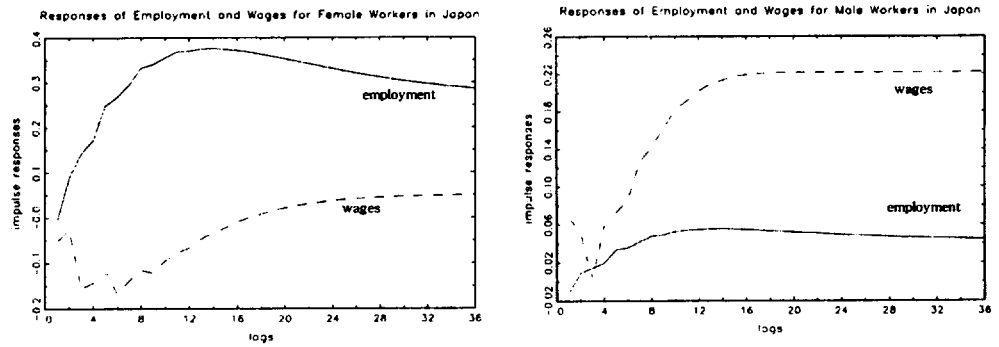
The main results of my impulse response analysis are presented in Figures 1-3. In these pictures, I trace out the responses of employment and wages up to the point when they are stabilized, supposedly around their long run values. The adjustment speed looks to be different in each case and this is why the lag lengths in the presented figures are different. The overall comparison between the US and Japan of the transitory responses of employment and wages parallels what I inferred from the estimation of the long run relationships. Much bigger in magnitude are the short run responses of wages than those of employment in Japan, but the converse is true in the US. It seems worth noticing, however, that the responses of employment and wages in the US are not much different in the very short run. They diverge only after about one year. Also, as clearly seen from Figure 1, there appears to be overshooting in wages adjustment for the US, and in employment adjustment for Japan.

In terms of magnitudes, the transitory responses of employment and wages to output fluctuations are bigger in the US than in Japan. This seems to suggest that the US system responds more flexibly to output fluctuations. The short run responses of wages in Japan are much bigger if compared with those of employment in Japan, but they are not so if compared with their counterpart in the US. Wage responses in the relatively short run are even bigger in magnitude for the US than for Japan. This, of course, is not so in the long run, as revealed in my previous result in Section 4.1.1 on the long run comparison of the US and Japan.

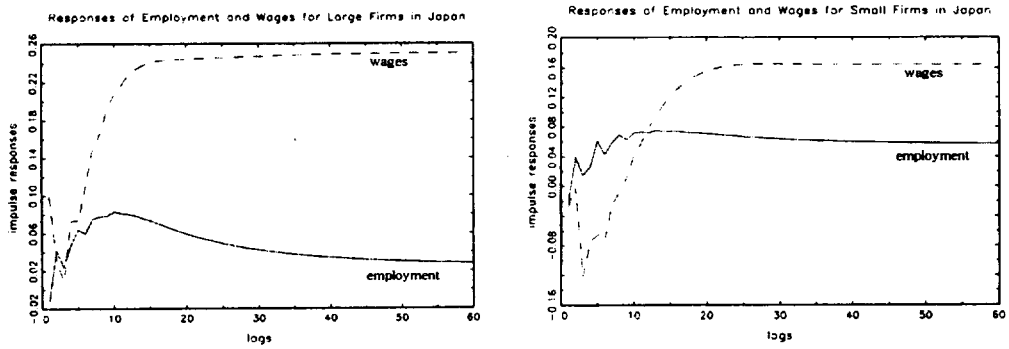
(Figure 1) Impulse Responses for the US and Japan



(Figure 2) Impulse Responses for Male and Female Workers in Japan



(Figure 3) Impulse Responses for Large and Small Firms in Japan



The transitory responses of employment and wages for male and female workers, and large and small firms in Japan are largely parallel to the long run responses, except for one case. This is the case for the employment responses of the large and small firms, presented in Figure 3. Even though small firms' long run response of employment is larger, their speed of adjustment to the long run equilibrium level appears to be substantially slower than that of the large firms. This is clearly seen from Figure 3. This evidence, of course, may well indicate the relative efficiency of large firms in Japan, or more broadly, the duality of the Japanese labor market which is based on the firm size.

Ⅳ. Concluding Remarks

My main purpose in this study was to investigate the differences in the patterns of employment and wages adjustments to output fluctuations in the US and Japan. I employed the cointegration and error correction approach to statistically analyze the long run and short run dynamics of employment, wages and industrial output. My conclusion is strong and unambiguous. Employment response to the output fluctuations is much, much bigger in the US than in Japan both in the long run and short run. Wage response, on the contrary, is relatively bigger in Japan. All the long run comparisons were made with rigorous statistical tests based on the so-called seemingly unrelated canonical cointegrating regressions (SUCCR). The tests are robust with respect to many potential model misspecifications, which may well invalidate the results from the conventional analysis. I believe my results provide firm empirical ground, by which much of the future theoretical work on the subject are likely to be motivated.

In the paper, I also looked at the differences which might exist across genders and establishment sizes. Though employment was found to be more responsive for female workers, both in the US and Japan, the difference was tested to be significant only for Japan. Wages in Japan are, on the other hand, less elastic for female workers. The effect of establishment size difference on employment and

wage responses to output fluctuations in Japan turned out to be insignificant in the long run. This is consistent with the result obtained by Abraham and Houseman (1989). The transitory responses, however, were found to be somewhat different across firms of different size. This may indicate that in Japan the dual labor market structure, based on the size of the firms, exists in the short run, but not in the long run.

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