Do Employers Pay Efficiency Wages? Evidence from Japan*

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Economists have long been interested in the seemingly cooperative nature of Japanese industrial relations. It has been hypothesized that information sharing in the wage-setting process has been used to promote efficiency. But have Japanese employers really paid efficiency wages, that is, can productivity gains be linked to pay raises? Efforts to test for efficiency wage setting face the problem of sorting out the extent to which pay influences labor productivity and vice versa. For the 1975–1997 sample period, we used an innovative statistical technique developed by Geweke to disentangle the linear association between pay and productivity growth. Efficiency wage behavior has not *been the norm in Japan. Nevertheless, efficiency wage setting cannot be ruled out for some key areas of manufacturing.*

I. *Introduction and Review*

Conventional wage theory predicts that profit-maximizing employers hire labor up to the point where the marginal product of labor equals the real wage. Thus, improvements in productivity will stimulate labor demand and exert upward pressure on real pay. Influence can also work in the opposite direction. Efficiency wage hypotheses suggest that pay adjustments may improve labor productivity. For example, it has been argued that raising pay can stimulate worker effort and solidify long-term employment relationships (Salop, 1979; Shapiro and Stiglitz, 1984). Akerlof (1982) has proposed that when firms raise pay, workers put forth greater effort out of a sense of loyalty to those employers.

Efforts to test for efficiency wage behavior have analyzed whether wage increases resulted in less turnover or better effort by workers. One country drawing the attention of researchers is Japan, for it is well known for long-term employment, cooperative industrial relations, and especially strong worker loyalty. In fact, Hashimoto (1990a, p. 245) has written that any "study of Japan's high postwar productivity growth would be incomplete" without understanding the country's distinctive labor practices. Moreover, Hart and Kawasaki (1999) have argued that the process used to achieve labor settlements has been used to motivate workers' efforts. Does the wage-setting process really promote labor efficiency? Do increases in contractual pay actually lead to productivity improvements?

From a sample of 34 manufacturing plants, Levine (1993) found that the self-reported effort of Japanese workers was directly related to wage differentials across plants. Ohashi (1987) examined manufacturing data for 1970–1982, and although he did not have observations for worker effort, he inferred that the average level of wages must have positively affected effort.

Despite attempts to verify efficiency wage setting, efforts to test for such behavior face a basic identification problem, whether productivity gains are the *result* of higher pay or the *cause* of pay hikes.[1] To overcome this problem we utilize an innovative technique developed by Geweke (1982, 1984) to assess bi-directional causality between time series, which we use to disentangle pay-productivity relationships in Japan.

Geweke has developed measures of statistical feedback which also account for any interdependence between time series, thereby extending Granger's (1969) definition of causality. Because this method measures feedback while controlling for any instantaneous association, it can be used to disentangle the direction and magnitude of the linear relationships between two time series. Although known to statisticians, economists only recently have incorporated the method to clarify relationships among variables.

Using data from Japanese industries for 1975–1997, Geweke's linear feedback technique allows us to measure the extent to which (1) productivity has led employee earnings and (2) contractual earnings have led productivity, while separately identifying any simultaneous association between the two series. We use the feedback measures to verify whether pay adjustments indeed have influenced productivity gains.

II. *Setting Pay in Japan*

Before attempting to sort out pay and productivity, one must consider how pay is set in Japan. This topic has been addressed elsewhere in detail (Hart and Kawasaki, 1999; Hashimoto, 1990a, 1990b), so we present only a brief overview.

Many business practices in Japan focus on building consensus between parties. Whether or not firms are unionized, labor-management joint consultation committees typically meet regularly and share information about corporate financial conditions. These meetings are used to promote harmony regarding many aspects of company operations, including pay. The consultation committees do not actually negotiate labor contracts, but the information shared is used to build consensus about pay settlements.

Regular, full-time employees in Japan have annual contracts. Companies begin a new fiscal year on April 1, and their employees' monthly pay is set for a one-year period starting on this date. During the winter and early spring firms and organized labor negotiate over pay for the coming fiscal year. In this "Spring Wage Campaign" (*shunto*) concurrent bargaining occurs across the economy between individual companies and their unions.[2] Meanwhile, at many nonunion establishments there are consultations about worker pay; then employers set pay regulations for the fiscal year. Payments according to labor pacts or company regulations are known as contractual pay.

At the outset of *shunto,* organized labor publicizes pay demands, through industrial federations of company unions or a national confederation (*Rengo*). Employer groups, industry associations, or the Federation of Employers' Associations (*Nikkeiren*), typically urge restraint. After general positions have been declared publicly, bargaining occurs at the company level.[3] Pacts in strategic manufacturing industries often set a pattern for others to follow. Nonunion firms typically base their pay regulations on the pattern of *shunto* accords.

The *shunto* process, in conjunction with the joint consultation that occurs routinely between employers and workers, has yielded relative harmony in settling labor contracts. According to Hart and Kawasaki (1999, p. 53), information sharing generates consensus between labor and management, so "workers not only restrain their wage demands, but they also are motivated to work hard and less likely to shirk," which should enhance productivity. Analyzing a survey of 97 large corporations from 1981, Morishima (1991a, 1991b) found that the more companies were engaged in joint consultation, the shorter and easier was the pay-settlement process. Moreover, he reported that information sharing had a beneficial effect on labor productivity. But more generally, do consensus-based contractual agreements go beyond goodwill and actually enhance labor productivity? To test for efficiency wage contracting, it is necessary to identify how pay and productivity are related.

III. *The Geweke Linear Feedback Method: Overview*

Consider two time series vectors p (productivity) and w (wage earnings). Geweke (1982) decomposes linear dependence between the series into three separate components: (1) feedback from p to w, (2) feedback from w to p, and (3) the contemporaneous (simultaneous) association between the series.[4] Feedback from p to w shows whether productivity affects worker earnings. Feedback from w to p illustrates whether pay innovations have efficiency consequences.

The interrelationship between pay and productivity is likely to differ according to labor market conditions. The basic method described below can be extended to include what Geweke (1984) calls *conditioning information*, that is, a control variable. Including a conditioning variable allows us to decompose w and p, conditional on different states of the labor market.

According to conventional theory, a productivity improvement will induce a pay raise. Presumably, increases will be more responsive at a time when the labor market is particularly tight. Likewise, the pay hikes necessary to stimulate productivity are likely to be different when the labor market is relatively tight than when it is slack.

To gauge the utilization of labor in an industry, Japan's Ministry of Labour records the average number of hours worked monthly by a regular employee in that sector.

For a given industry, if hours worked per month by a regular employee is relatively high (low), then the market for labor can be interpreted as being relatively tight (slack). Let *hr* represent a vector of observations on hours worked.[5]

In measuring linear dependence, consider the following forecasting (projection) equations. A forecast of productivity at time t (p_t) can be made using past values of productivity (p_{t-s}), wages paid (w_{t-s}), and hours worked (hr_{t-s}):

$$p_t = \Sigma_{s=1}\, a_1(s)p_{t-s} + \Sigma_{s=1}\, a_2(s)w_{t-s} + \Sigma_{s=1}\, a_3(s)hr_{t-s} + \varepsilon_{1t}, \qquad (1a)$$

where the a's are coefficient vectors, and ε_{1t} is the random prediction error with variance $\sigma^2{}_1$.

To identify the feedback from worker earnings to productivity, $F_{w\to p|hr}$, we must account for the marginal contribution of pay in the productivity projection. So we compare the p_t forecast generated *with* the earnings series to a prediction created *without* the series. Therefore we modify equation (1a) and estimate p_t again as follows:

$$p_t = \Sigma_{s=1}\, b_1(s)p_{t-s} + \Sigma_{s=1} b_2(s)hr_{t-s} + \varepsilon_{2t}, \qquad (1b)$$

where $\mathrm{var}(\varepsilon_{2t}) = \sigma^2{}_2$. Feedback from pay to productivity is determined by comparing the prediction error variance from equation (1b) with that of equation (1a). Specifically, conditional feedback from worker earnings to productivity is defined as

$$F_{w\to p|hr} \equiv \log\,(\sigma^2{}_2 \,/\, \sigma^2{}_1). \qquad (1c)$$

If the two variances are the same, w_{t-s} values do not improve the precision of the productivity forecast. That is, if $\sigma^2{}_2 = \sigma^2{}_1$, then $F_{w\to p|hr} = 0$, and past pay does *not* influence current productivity.

Estimating feedback from productivity to pay, $F_{p\to w|hr}$, follows a similar process. We estimate w_t as a function of past earnings, productivity, and hours worked, obtaining the prediction error variance $\sigma^2{}_3$. Then we reestimate w_t without past productivity, obtaining the error variance $\sigma^2{}_4$. Thus, feedback from productivity to earnings can be written:

$$F_{p\to w|hr} \equiv \log\,(\sigma^2{}_4 \,/\, \sigma^2{}_3). \qquad (2)$$

A distinguishing feature of the Geweke method is that it also accounts for any contemporaneous (simultaneous) association between two series, that is, linear association that cannot be disentangled. To identify this simultaneous component, we modify the forecast of p_t by also including *current* earnings:

$$p_t = \Sigma_{s=1}\, c_1(s)p_{t-s} + \Sigma_{s=0}\, c_2(s)w_{t-s} + \Sigma_{s=1}\, c_3(s)hr_{t-s} + \varepsilon_{5t}, \qquad (3a)$$

where $\mathrm{var}(\varepsilon_{5t}) = \sigma^2{}_5$. Including current earnings may improve the forecast's precision. Thus, the measure of contemporaneous association is:

$$F'_{w\bullet p|hr} \equiv \log\,(\sigma^2{}_1 \,/\, \sigma^2{}_5). \qquad (3b)$$

If including current pay does not reduce the prediction error, $\sigma^2{}_5 = \sigma^2{}_1$ and $F_{w\bullet p|hr} = 0$, meaning there is no contemporaneous association between the series.

Given the different types of feedback defined above, we can assess the pay-productivity relationship. The feedback measure $F_{p \to w|hr}$ indicates whether productivity influences worker earnings, conditional on the state of the labor market. The measure $F_{w \to p|hr}$ shows whether pay leads productivity, that is, if there are efficiency consequences from pay adjustments. Finally, $F_{w \cdot p|hr}$ shows the extent of simultaneity between w and p.

The feedback measures defined above can be transformed using the formula $[1 - \exp(-F)]$. For example, transforming $F_{w \to p|hr}$ shows the proportional reduction in the error variance of p_t that can be attributed to past values w_{t-s}, conditional on the utilization of labor. In other words, the transformation illustrates the capacity of past earnings to reduce the variance of the prediction error in the productivity projection.

IV. *Disentangling Pay and Productivity: Geweke Feedback Measures*

Implementing the Geweke Method. To determine whether pay leads productivity in Japan, we implemented Geweke's linear feedback method. The Japan Productivity Center for Socio-Economic Development gauges physical labor productivity in three areas of that economy: (1) public utilities, (2) mining, and (3) manufacturing. Coincidentally, these sectors exhibit some of the most widespread programs of joint consultation between management and workers.[6] They also have tended to be more unionized than other sectors of the economy.

Productivity indices (1990 = 100) compiled by the Center can be found in the *Japan Statistical Yearbook* (for details, see "Data Appendix"). Furthermore, the *Yearbook* reports productivity data for several subsectors of manufacturing, with yearly observations available back to 1975. These subsectors include such mainstays of Japanese manufacturing as electrical machinery, iron and steel, and transportation equipment. The *Yearbook* also reports the average number of hours worked monthly by a regular employee in the industrial (sub)sectors (see appendix). Our sample covers the years 1975–1997.

Japan's Ministry of Labour surveys employers and uses the results to compute the earnings of regular, full-time employees. Each of its *Year Book of Labour Statistics* reports average contractual earnings per regular employee (yen per month) for various industries and subsectors.[7] Contractual earnings are simply wages paid according to (1) collective bargaining contracts, (2) wage regulations of firms, or (3) individual worker contracts (see appendix).

The productivity and pay series are expressed in real terms (base year, 1990). To implement the Geweke method, the productivity and earnings forecasts must be estimated with stationary time series, otherwise estimations may be subject to spurious correlation. We employed the Dickey-Fuller (1981) unit root test for stationarity.

Ideally one would use productivity and pay levels to estimate the projection equations. But for the pay and productivity series — in levels and first differences — we cannot reject the null hypothesis of nonstationarity. Economists often specify earnings equations in logarithmic form, so that coefficients can be interpreted as elasticities, yet the log(p) and log(w) series are also non-stationary. We are, however, able to reject the null hypothesis of a unit root using the first differences of the logarithms. Therefore, in implementing the Geweke method we used $p_t^* \equiv [\log(p_t) - \log(p_{t-1})]$, which approximates the productivity growth rate, and $w_t^* \equiv [\log(w_t) - \log(w_{t-1})]$, which reflects the rate of pay growth.[8]

To estimate the p_t^* and w_t^* forecasts we used OLS regression.[9] Then we computed the conditional feedback measures $F_{p^* \rightarrow w^* | hr^*}$, $F_{w^* \rightarrow p^* | hr^*}$, and $F_{w^* \cdot p^* | hr^*}$ for industrial (sub)sectors. The feedback estimators are consistent, but because they are based on variances they are nonnegative by construction and potentially biased upward in small samples. Following the method developed by Cushing and McGarvey (1990), we adjusted the point estimates for small sample bias and then created 90-percent confidence bands for each estimator.[10]

Conditional Feedback Results. With data for the 1975–1997 sample period, we estimated forecasts for p_t^* and w_t^*. Taking the prediction error variances from these forecasts, we computed conditional feedback point estimates, adjusted each one for potential bias, and created 90-percent confidence bands. Using $[1 - \exp(-F)]$, we transformed the adjusted conditional feedback measures and associated confidence bands, which allows us to gauge the rate of change in the prediction error variance of a projection.

Table 1, Panel A reports results for the public utilities, mining, and manufacturing sectors. The first row identifies the feedback from p^* to w^*. For public utilities, past productivity gains have affected contract settlements. The prediction error variance of w_t^* is reduced 4.7 percent when including p_{t-s}^*; the confidence interval shows as much as 49 percent feedback. For mining, in contrast, conditional feedback from p^* to w^* is negligible. In both utilities and mining, the point estimates indicate relatively little simultaneous association between p^* and w^* (third row, Panel A).

To see whether contractual pay actually has led productivity, consider feedback from w^* to p^*, $F_{w^* \rightarrow p^* | hr^*}$ (Panel A, second row). For utilities, w_{t-s}^* improves the prediction error variance of p_t^* by 4.2 percent, with the confidence interval exceeding 65 percent. In mining, w_{t-s}^* reduces the variance of the p_t^* forecast by 2.6 percent, with the confidence band approaching 48 percent. For these sectors, faster pay growth may influence productivity gains.

The case of manufacturing appears to offer a stark contrast. Whereas p_{t-s}^* improves the earnings forecast (by as much as 36 percent), w_{t-s}^* barely influences the productivity prediction. Before jumping to any conclusions about manufacturing, observe that measures of simultaneous association between p^* and w^* are relatively large. Such a finding might not be surprising considering that this sector spans diverse activities — production of food and tobacco, iron and steel, and transportation equipment. Consequently, it may be useful to evaluate feedback results for individual subsectors of manufacturing.

Table 1, Panel B presents the conditional feedback measures for manufacturing subsectors. For some areas, there is barely any feedback between contractual w^* and

Table 1

Disentangling Contractual Earnings and Productivity, 1975–1997: Geweke Conditional Linear Feedback Measures[a]

Percent Reduction in the Prediction Error Variance of the Contractual Wage (w_t^*) and Productivity (p_t^*) Projections: Adjusted Point Estimates (90-Percent Confidence Bands)[b]

PANEL A: FEEDBACK BY SECTOR

Feedback Measures[c]	**Public Utilities**	**Mining**	**Manufacturing**
$F_{p^* \rightarrow w^* \mid hr^*}$	4.69 (1.42, 48.99)	0.36 (0.11, 4.90)	3.15 (0.95, 36.19)
$F_{w^* \rightarrow p^* \mid hr^*}$	4.15 (1.33, 65.24)	2.58 (0.82, 47.88)	0.08 (0.03, 1.95)
$F_{w^* \cdot p^* \mid hr^*}$	0.72 (0.23, 42.43)	0.19 (0.06, 13.78)	9.25 (3.02, 99.94)

PANEL B: FEEDBACK BY MANUFACTURING SUBSECTORS

Feedback Measures[c]	**Chemicals**	**Ceramic, Stone & Clay Products**	**Electrical Machinery**	**Fabricated Metals**	**Food & Tobacco**
$F_{p^* \rightarrow w^* \mid hr^*}$	0.14 (0.04, 1.87)	10.92 (3.39, 80.26)	9.67 (2.99, 76.00)	5.05 (1.53, 51.64)	0.18 (0.05, 2.49)
$F_{w^* \rightarrow p^* \mid hr^*}$	0.08 (0.02, 1.92)	2.21 (0.70, 42.70)	1.18 (0.37, 25.64)	4.97 (1.60, 72.01)	0.01 (0.00, 0.25)
$F_{w^* \cdot p^* \mid hr^*}$	19.49 (6.61, 100.00)	2.62 (0.83, 86.87)	7.13 (2.31, 99.65)	1.31 (0.42, 63.59)	6.05 (1.95, 99.16)
	General Machinery	**Iron & Steel**	**Leather & Furs**	**Nonferrous Metals**	**Petroleum & Coal Products**
$F_{p^* \rightarrow w^* \mid hr^*}$	0.02 (0.01, 0.22)	1.21 (0.36, 15.70)	0.83 (0.25, 11.02)	0.10 (0.03, 1.37)	0.78 (0.23, 10.42)
$F_{w^* \rightarrow p^* \mid hr^*}$	0.06 (0.02, 1.48)	3.55 (1.13, 59.38)	0.03 (0.01, 0.71)	1.32 (0.42, 28.18)	0.01 (0.00, 0.34)
$F_{w^* \cdot p^* \mid hr^*}$	36.28 (13.26, 100.00)	24.97 (8.68, 100.00)	4.09 (1.31, 95.93)	20.88 (7.13, 100.00)	8.53 (2.78, 99.89)
	Precision Machinery	**Pulp & Paper Products**	**Rubber Products**	**Textiles**	**Transportation Equipment**
$F_{p^* \rightarrow w^* \mid hr^*}$	2.67 (0.81, 31.62)	1.95 (0.59, 24.11)	0.43 (0.13, 5.90)	0.00 (0.00, 0.05)	8.67 (2.67, 71.96)
$F_{w^* \rightarrow p^* \mid hr^*}$	0.08 (0.02, 1.85)	0.12 (0.04, 3.01)	0.15 (0.05, 3.55)	0.23 (0.07, 5.68)	2.57 (0.82, 47.72)
$F_{w^* \cdot p^* \mid hr^*}$	1.15 (0.37, 58.81)	0.21 (0.07, 14.73)	16.23 (5.44, 100.00)	1.57 (0.50, 70.14)	22.04 (7.56, 100.00)

Note: [a]For the earnings, productivity, and hours worked data, see the "Data Appendix." Contractual earnings are received according to labor contracts or wage regulations of firms. [b]$w_t^* \equiv [\log(w_t) - \log(w_{t-1})]$; $p_t^* \equiv [\log(p_t) - \log(p_{t-1})]$; $hr_t^* \equiv [\log(hr_t) - \log(hr_{t-1})]$. [c]Conditional feedback from p^* to w^*, $F_{p^* \rightarrow w^* \mid hr^*}$, see equation (2). Conditional feedback from w^* to p^*, $F_{w^* \rightarrow p^* \mid hr^*}$, see equations (1a-c). Conditional contemporaneous association between w^* and p^*, $F_{w^* \cdot p^* \mid hr^*}$, see equations (1a, 3a-b).

p^*. Specifically, both the $F_{p^* \rightarrow w^* | hr^*}$ and $F_{w^* \rightarrow p^* | hr^*}$ point estimates are practically zero. For product areas such as chemicals, food and tobacco, general machinery, rubber products, and textiles the only connection between w^* and p^* is one of simultaneous association. Nevertheless, many areas of manufacturing do exhibit relationships between contractual pay and productivity.

Consistent with conventional wage setting, past productivity growth has affected contractual pay hikes (Panel B). For areas such as ceramics, electrical machinery, and transportation equipment, p^*_{t-s} improves the w^*_t prediction error variance by 9 to 11 percent. Moreover, for five of the subsectors — representing the majority of manufacturing jobs — the confidence band upper limits exceed 30 percent.

Conditional feedback measures also can be used to search for possible efficiency wage setting. In many areas w^* clearly has no influence on p^* (Table 1, Panel B). For eight of the fifteen subsectors, the feedback point estimates are zero and confidence band upper limits are quite low (less than 3.6 percent). Despite widespread information sharing and consensus-building consultations about pay settlements, in Japanese manufacturing it is *not* the norm for contractual pay raises to affect productivity growth. Nevertheless, there are some manufacturers for which the $F_{w^* \rightarrow p^* | hr^*}$ feedback measures are not negligible, suggesting that efficiency wage contracting could have occurred.

One of the largest and most prestigious areas of manufacturing has been transportation equipment. In this key area of the economy, w^*_{t-s} does cut the p^*_t projection error variance. Although the point estimate is 2.6, the confidence band upper bound indicates that past contractual earnings growth improves the productivity forecast by as much as 47.7 percent.

Contractual earnings growth has led productivity gains in some other areas of heavy manufacturing, especially those areas processing metals, iron and steel. For the iron and steel industry, past w^* reduces the p^* projection error variance by 3.6 percent, with a confidence interval ranging as high as 59.4 percent. In the case of fabricated metals, the feedback point estimate is 5.0 percent, with an upper bound of 72.0 percent.

Despite claims of the beneficial effects of joint consultation and cooperative labor relations, contractual pay growth generally has not led productivity gains. Yet efficiency wage contracting cannot be ruled out altogether. In some key areas of production — transportation equipment, metals, iron and steel — w^* improves the productivity projection, by as much as 47 to 72 percent.

V. *Clarifying the Geweke Feedback Measures: Impulse Response Analysis*

The conditional feedback measures ($F_{w^* \rightarrow p^* | hr^*}$) indicate that pay growth has led productivity gains in some areas. Strictly speaking, we have not verified that pay hikes have a *positive* impact on productivity growth. To confirm this response, we trace out the reaction of a productivity sequence to a wage stimulus. The impulse response method developed by Sims (1980) is commonly used to illustrate the response of one time series to an innovation in another series.

With our feedback measures in hand, we implemented the Sims technique to illustrate the response of a productivity series to a one standard deviation innovation in worker earnings. A positive $p^*(t)$ response to a $w^*(t)$ innovation would confirm that faster pay growth improves productivity growth, which would be consistent with efficiency wage contracting. Estimates of the $p^*(t)$ responses are simply point estimates; we also used the standard errors of the impulse responses to construct 90-percent significance intervals for the estimates.[11]

Graphs of the impulse response functions and confidence intervals appear in Figure 1. The Geweke conditional feedback measures (Table 1) indicate that w^* led p^* in public utilities, mining, and three manufacturing subsectors. Consequently, we estimated impulse responses for these areas and graphed them in Figure 1.

Under the auspices of joint consultation, evidently some efficiency wage setting has occurred in Japan. In the manufacture of transportation equipment, there is a strongly positive productivity reaction to an innovation in contractual pay. The point estimates show an immediate improvement in productivity growth of more than three percentage points.[12] Likewise, the lower bound for the significance interval is positive for the first period after the innovation. In this key area of manufacturing, contractual pay gains do indeed have a positive impact on productivity growth.

The results for iron and steel also support efficiency wage contracting. The figure depicts a positive p^* response for two periods immediately after a w^* impulse; moreover, the lower bound for the significance interval is positive for the first year following the impulse. Likewise for fabricated metals, point estimates are consistent with efficiency wage setting.[13]

The findings for utilities and mining are different. The impulse response point estimates and intervals illustrate that contractual pay growth does not necessarily have a beneficial impact on productivity (Figure 1). Widespread joint-consultation notwithstanding, efficiency wage contracting has not necessarily occurred in these two sectors.

VI. *Summary and Concluding Remarks*

It has been hypothesized that Japan's cooperative industrial relations have promoted efficiency. But have Japanese employers really paid efficiency wages, that is, has pay growth resulted in productivity gains?

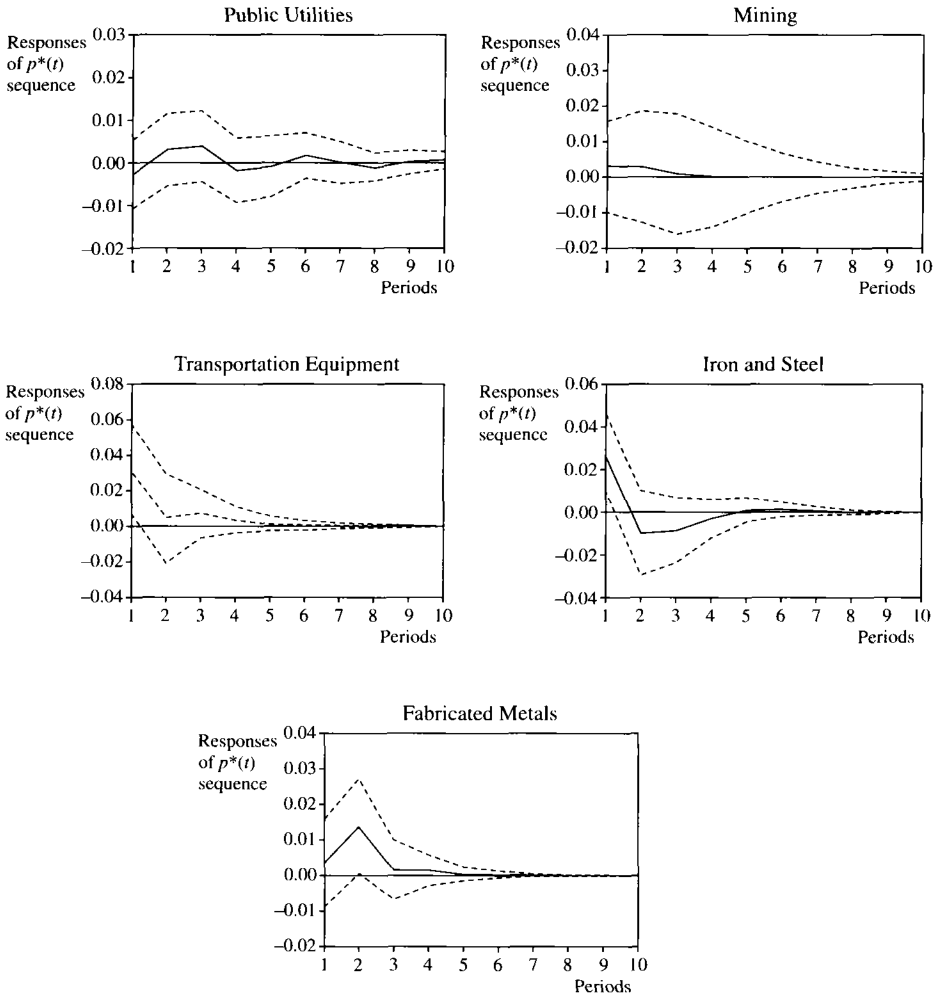
Efforts to test for efficiency wage setting face the problem of sorting out the extent to which pay influences labor productivity and *vice versa*. We used an innovative technique developed by Geweke (1982, 1984) to evaluate pay-productivity relationships in Japan. For the 1975–1997 sample period, we used the Geweke method to disentangle the linear association between pay and productivity growth, generating bi-directional measures of feedback while controlling for contemporaneous association.

Despite claims that the pay setting process in Japan has benefitted labor productivity, in public utilities, mining, and most subsectors of manufacturing we cannot confirm efficiency wage contracting. But in some areas of manufacturing — notably,

Figure 1

Impulse Response Functions for the Japanese Industrial Sectors

Response of the Productivity Sequence $p^*(t)$ to an Innovation in the Wage Sequence $w^*(t)$



Legend:

——— Impulse response point estimates

- - - - - - - 90 percent confidence bands transportation equipment, metals, and iron and steel — we find that productivity gains have followed increases in contractual pay. Under the practices of joint consultation and *shunto* settlements, there have been efficiency wage gains in some high profile areas of manufacturing.

It remains to be seen why efficiency wage contracting has been limited to certain sectors. Perhaps conditions of competition are a factor in wage setting. Manufacturers of motor vehicle and related components face relatively strong competition overseas. Because they must compete in both domestic and global markets, firms may structure worker pay to improve labor productivity. But in areas like public utilities, mining, or the manufacture of food products — areas heavily regulated and sheltered from competition — employers may not have the same imperative to stimulate productivity gains. When competition is limited or restricted, pushing up wages may actually result in productivity losses.

Contractual pay raises in key manufacturing industries, usually the leading industries of the time, typically set a pattern for other pay hikes to follow. This practice results in similar rates of contractual pay growth throughout the economy. Over the sample period, pattern-setting pay increases occurred in the transportation equipment and iron and steel subsectors, the very industries which exhibited efficiency wage contracting.

Perhaps among "leading" companies there are incentives to share information and reach labor settlements which encourage productivity gains. But in "following" industries employers find it more convenient simply to copy pay hikes rather than settle independently. Thus, among the "followers" it may be less likely for a given pay increase to affect productivity. Or perhaps company size or the nature of the production process influences efficiency wage behavior, with larger firms using pay as a managerial tool. We would expect future studies to concentrate on these issues, examining the role of producer or industry characteristics on the interplay between pay and productivity.

NOTES

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[1]For discussion of this identification problem, see Campbell (1993), Cappelli and Chauvin (1991), and Carmichael (1990).

[2]The *shunto* process was initiated in 1956 in an effort to pacify the turbulent labor relations that had developed after World War II.

[3]Ito (1992, p. 239) noted that bargaining sometimes occurs at the industry level for an average industry-wide pay increase.

[4]For detailed analysis and discussion of the Geweke method, including economists' adaptations of the method, see Millea (1998).

[5]Given concerns expressed about "quality of life" and "overwork," in 1994 the Japanese government announced a desire to reduce working hours across the economy, setting a "target" of 150 hours per month by 1996. By 1996 not a single industrial sector had reached that target; overall, a regular employee aver-

aged 159.9 hours per month, up from 158.7 hours in 1994. Working hours had risen in every industry. As the economy slumped in 1997, average monthly hours dropped to 158.3. Thus, we presume that increasing (decreasing) hours worked reflects a relatively tight (slack) labor market. Unemployment data might be used to reflect the state of a labor market. But data for individual industries are not available and the national unemployment measure may not reflect the circumstances of a particular industrial sector.

[6]As of 1995, more than two-thirds of manufacturing establishments and ninety percent of utilities conducted regular programs of joint consultation. Economy-wide, approximately 56 percent of establishments engaged in such programs of information sharing.

[7]Of the manufacturing areas for which productivity data are reported, earnings are available for fifteen subsectors. The earnings data are for establishments with thirty employees or more, which typically account for at least three-fifths of regular employees in Japan.

[8]The hours series are not stationary in levels, first differences, or logarithms; they are stationary when using the difference of the logarithms.

[9]To determine the optimal lag lengths in the regression equations, we employed the Akaike information criterion. In estimating the projections the optimal lag length was either one or two.

[10]The adjusted feedback point estimates do not have associated test statistics, meaning there is no procedure for direct hypothesis testing. Following the simulation process of Cushing and McGarvey (1990), we can construct bands to indicate the potential magnitude of the feedback measures. Technical details on the bias adjustment and construction of the confidence intervals are available from the authors on request.

[11]Technical details on implementing the impulse response technique are available from the authors.

[12]Recall that $p^*(t)$ is defined as $\log(p_t) - \log(p_{t-1})$, with this difference approximating the growth rate of productivity. Increasing this difference by 0.03 units implies improvement in the productivity growth rate of approximately three percentage points.

[13]Instead of efficiency wage behavior, perhaps employers in these subsectors reacted to contractual pay growth by implementing new technology or otherwise boosting capital-labor ratios, which might explain labor productivity gains. According to Figure 1, labor productivity growth improves *immediately* after an innovation in pay, with the improvement wearing off soon thereafter. It is unlikely that Japanese manufacturers have been able to adjust capital-labor ratios instantly following contractual pay settlements. In heavy manufacturing substantial changes in the quantity or quality of capital can take years to implement and are difficult to reverse. Japanese manufacturers also have been extremely reluctant to layoff or terminate large numbers of regular, full-time employees (another distinctive feature of Japanese industrial relations). If the capital-labor explanation were to hold, we would expect the impulse response functions to look different. Productivity gains would not appear immediately following contractual wage impulses; rather, they would occur only after some periods had passed.

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DATA APPENDIX

Productivity. The productivity observations can be found in the table "Indexes of Labour Productivity by Industry" in *Japan Statistical Yearbook*, Tokyo: Statistics Bureau, Management and Coordination Agency, 1980, 1985, 1986, 1990, 1991, 1995–1999.

Labor productivity is defined as physical output per labor input (man-days). Productivity figures for 1997 were expressed using 1995 as the base year. We recalibrated the 1997 figures using 1990 as the base year.

Hours Worked. Observations for hours worked are in the table "Average Monthly Hours Worked per Regular Employee by Industry" in *Japan Statistical Yearbook*, Tokyo: Statistics Bureau, Management and Coordination Agency, 1980, 1985, 1986, 1990, 1991, 1995–1999.

Worker Earnings. Figures for contractual earnings can be obtained from the table "Average Monthly Cash Earnings by Industry, Size of Establishment and Item" in *Year Book of Labour Statistics*, Tokyo: Public Planning and Research Department, Minister's Secretariat, Ministry of Labour, 1975–1997.

The table reports only nominal earnings. We used Japan's GDP deflator (1990 = 100) to compute real contractual earnings. We downloaded yearly observations for the GDP deflator from Japan's Economic Planning Agency. The data appear in the file "Deflators" (file: def984e), Tokyo: Economic Planning Agency <http://www.epa.go.jp>, June 3, 1999.