The Relative Wage Variability in Korean Manufacturing Industries*

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The relative wage variability in Korean manufacturing industries shows considerable flctuation over time. This paper claims that, the higher inflation people expect, the wider becomes the dispersion of wage growth rates among industries. The wage differential also increases with the variability of industry output growth. The policy authority should consider that price stability prevents widening of wage differential across sectors. High inflation may cause income redistribution among wage earners as well as between wage earners and the unemployed.

I. Introduction

It is widely known that substantial wage difference exists across industries in most countires.[1] Park(1983) claims that the wage differential between industries in Korea also seems persistent and does not vanish over time. According to Krueger and Summers

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1) See Krueger and Summers(1988) for the U.S. and Edin and Zetterberg(1992) for Sweden.

(1986), relative wage dispersion in Korea was the largest among 14 countries in 1982. The competitive labor market approach has difficulties explaining the wage differential among industries because it predicts that, after controlling for human and demographic characteristics, the same wage should be paid in all industries.

The efficiency wage theory is one of plausible approaches to explore inter-industry wage differences. It claims that, because of industry characteristics, the seemingly same laborers are paid differently across industries.

Although the efficiency wage approach can explain why wage differential exists across industries at a certain time, it fails to explain the fluctuations of wage dispersion. In fact Krueger and Summers(1988) report that the industry wage structure remains fairly constant over time in the U.S.[2)]

However, the observed relative wage variability in Korea shows a cyclical pattern, implying that the magnitude of industrial wage differential changes over time. This prediction is not implied by a canonical efficiency wage theory. Since human and demographic characteristics of laborers, and industry-specific characteristics are invariant to business cycles, there is no reason for inter-industry variation of the efficiency wage level to fluctuate severely over business cycles.

Cyclical variations in the inter-industry wage structure was analyzed by Wachter (1970). He found that the size of the wage differentials is a function of the excess demand conditions in the labor market, and inflation rate. Hamermesh(1986) and Allen (1987) also explored the relative wage variability over time, using the distinction between expected and unexpected inflation rate.

The cyclical pattern of relative wages can be explained by the different responsiveness of industry wages to inflation rate. If the adjustment speed of wage in response to shocks differs widely across sectors, the size of wage differential fluctuates over business cycles.

In this paper, I derive a relative wage variability equation from individual wage settlement equations and analyze the determinants of relative wage variability. In my model relative wage dispersion is related nonlinearly to the rate of expected inflation

2) However, it should be noted that they did not use continuous time-series data but discrete data of every 5 years (1974, 1979, 1984). They might miss the short-run property of wage dispersion.

and other variables.

While much literature empirically analyzes the wage dispersion phenomenon by using panel data, I use the aggregate data classified into industries to shed light on the industrial wage variability.[3] The proxy for relative wage variability is the variance of wage growth rates across industries.

The main empirical findings are, first, that the wage differential across sectors widens as people expect higher inflation. Secondly, the wage differential increases with the variability of output growth.

The policy implication of these results is that price stability prevents widening of wage differential across sectors. In a highly inflationary environment, there happens income redistribution among wage earners as well as between wage earners and the unemployed. This should be considered seriously when the policy authority implements inflationary aggregate demand policy to increase aggregate output.

In the following section, relative wage variability equation is derived from individual wage settlement equations. Section 3 presents data description and section 4 includes empirical analysis. Section 5 is brief concluding remarks.

II. The Model

The wage in the industy i at time t is described as :

$$w_{it} = \beta_i \pi_i^e + \varepsilon_{i,t} \quad \cdots\cdots (1)$$

where $w_{i,t}$ is the rate of wage growth in industry i at time t ; π_i^e is the expected inflation rate ; and $\varepsilon_{i,t}$ is industry-specific factors which may influence the wage growth rate. The $\varepsilon_{i,t}$ reflects the changes in market conditions and the labor productivity. Equation (1) implies that wage change rate in the industry i is determined by the expected inflation rate and industry-specific factors.[4] The responsiveness of wage to the expected in-

3) It is not misleading to use the average wage data without quality control since it is unlikely that controls would change the cyclical pattern of industry wages in this data.

flation rate, β_i differs across i because it depends on the ability to pay, the bargaining power of labor union and so on in each industry.

The inflation surprise is relevant only for contracts that contain a contingent COLA (cost-of-living adjustments) clause. Such clauses typically increase realized wages when the inflation surprise surpasses minimum changes in the consumer price index(CPI) required to produce an adjustment. Since such clauses are very rarely imposed in Korean labor contracts, I exclude the unexpected inflation term in the wage equation. Instead, if necessary, the lagged unexpected inflation rate is incorporated to consider catch-up effects.

The average wage growth rate in the economy is derived by averaging (weightedly) all the industry wage growth rates.

$$w_t = \beta\pi_t^e + E(\varepsilon_{i,t}) \quad \cdots\cdots (2)$$

where β is an (weighted) average of β_i and $E(\varepsilon_{i,t})$ is an (weighted) average of industry-specific factors.

The relative wage growth rate in industry i at time t is calcluated as:

$$w_{i,t} - w_t = (\beta_i - \beta)\pi_t^e + \varepsilon_{i,t} - E(\varepsilon_{i,t}) \cdots\cdots (3)$$

The relative wage growth rate in the ith industry is determined by two factors, that is, the relative responsiveness of wages to the expected inflation rate and industry-specific factors.

It is straightforward to derive the variance in relative wage growth rates across industries at time t.

$$Var(w_{i,t} - w_t) = Var(\beta_i - \beta)(\pi_t^e)^2 + Var(\varepsilon_{i,t}) + 2Cov(\beta_i, \varepsilon_{i,t})\pi_t^e \quad \cdots\cdots (4)$$

The variance of relative wage change rate is determined by the variance of sensitivity of

4) I ignore the possibility of nonuniform inflationary expectations across industries because of recently increasing communication between labor unions.

wage growth rate to the expected inflation rate, the variance of industry-specific factors and the covariance between β_i and ε_i.

The above relative wage variability equation seems to have some distinct features. First, expected inflation has positive effects on the variance of relative wages if expected inflation rate exceeds some level. Note that

$$\frac{\partial \mathrm{Var}(w_{i,t}-w_t)}{\partial \pi_t^e} > 0, \text{ if } \pi_t^e > -\frac{\mathrm{Cov}(\beta_i, \varepsilon_i)}{\mathrm{Var}(\beta_i)} \qquad (5)$$

Secondly, the variance of industry-specific factors has a positive effect on the relative wage variability. Thirdly, equation (4) makes clear that it is inappropriate to use a linear regression to relate relative wage variability to macroeconomic variables.[5] The underlying industry wage equations are linear with respect to the expected inflation rate, but the relative wage variability equation is nonlinear and, in addition, will incorporate the cross products of all explanatory variables.

The relative wage variabilty equation (4) is of empirically testable form. The variance of relative wages across industries will be regressed on the square of expected inflation rate, the level of expected inflation rate, and the proxy for variance in industry-specific factors. The expected sign of coefficient in the square of expected inflation rate is clearly positive unless all the industries have identical β_i. The sign of coefficient in expected inflation rate is ambiguous, since it depends upon covariance.

III. The Data

The data set covers most of 3-digit manufacturing industries in Korea.[6] I use annual data from 1971 to 1991. The sample period ends in 1991 because new industry grouping is adopted in 1992. Since wage is renewed annually and the timing of wage

5) Although Wachter(1970), Hamermesh(1986), and Allen(1987) used nonlinear specifications in the estimation of relative wage variability, they do not explicitly present any theoretical justification for the nonlinearity.

6) Some industries are excluded because of insufficiency of data(for example, tobbacco and footwear industries).

change is not synchronized across industries, more frequent data may overestimate the variability of wages.

The variability of relative wage changes at time t, VW_t is calculated as :

$$VW_t = \Sigma E_{i,t}(w_{i,t} - w_t)^2 \quad \cdots\cdots (6)$$

where $E_{i,t}$ is the weight of industry i and $w_{i,t}$ is the wage growth rate in industry i and w_t

Table 1. Summary Statistics of Relative Wage Changes

(unit : %)

Industry	mean	standard dev	maximum	minimum
food	-0.451	4.771	7.36	-10.541
beverage	-0.118	7.009	12.414	-17.206
textiles	0.183	3.492	6.684	-7.117
apparel	-0.133	5.172	7.239	-15.875
leather	0.151	7.475	12.541	-24.671
wood	-0.220	4.126	5.810	-8.931
furniture	1.477	12.975	33.142	-21.287
paper	-0.975	5.671	16.045	-13.676
printing	0.026	7.253	13.631	-15.762
chemicals	0.390	11.515	37.730	-21.818
other chemicals	-0.228	4.039	8.785	-8.494
petroleum	0.491	11.101	32.173	-18.152
coal	-0.127	9.847	18.778	-17.288
rubber	0.199	8.396	16.471	-18.605
plastic	-0.900	8.185	20.906	-16.445
mineral	-0.133	6.379	14.698	-13.723
glass	1.230	10.874	27.069	-19.891
other mineral	0.002	5.180	15.913	-6.524
basic metal	0.752	6.954	12.024	-19.932
non-ferrous	0.014	11.633	26.689	-24.264
fabricated metal	0.169	4.960	8.782	-15.076
machinery	0.695	4.959	14.683	-9.978
electrical	-0.527	5.954	11.587	-10.916
transport	1.055	8.670	28.698	-14.370
precision	-0.132	6.934	9.865	-22.871

is the weighted-average wage growth rate. The hourly wage is obtained by dividing average monthly earnings of regular employees by average monthly hours worked. The weight in industry i is the ratio of employment in industry i to the total employment. The proxy for employment is the number of workers employed by establishments employing 10 workers and over.[7)]

Table 1 reports summary statistics of relative wage changes in each industry. The average growth rate of wage during the sample period is relatively high in furniture, glass, and transport industries while relatively low in paper, and plastic industries.[8)] Very small mean and large standard deviation of relative wage growth rate in most industries suggest that wage structure is very stable in the long-run despite short-run fluctuations.[9)]

The constructed series for VW_t is plotted in Figure 1. The pattern of unweighted variability of relative wages is very similar to that of weighted one.[10)] There is a slightly downward trend in the series of relative wage variability.

Figure 1 indicates that inter-industry variations in wage growth rate is lower in the 1980s than the 1970s. The average VW in the 1970s is 35.132 while 11.761 in the 1980s.

I used the variance of output growth (VIP) as a proxy for the variability of industry-specific factors, Var ($\varepsilon_{i,t}$). The measure is constructed analogously to (5) using industrial production index. The incorporation of the variance of productivity growth rates across industries as a proxy for var($\varepsilon_{i,t}$) yields very poor results in the estimation of relative wage variability.[11)]

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7) The industry with more small firms can be underweighted in this measure. To correct this bias, I also tried unweighted variance of relative wages.

8) Note that the growth rate of wage, not the wage level in each industry is of major concern.

9) The rank correlations of industry wage levels are very high while those of wage growth rates are very low. For example, rank correlation of wage levels between 1971 and 1991 is 0.84 but that of wage growth rates is -0.01.

10) The correlation coefficent between weighted and unweighted VW's is 0.967.

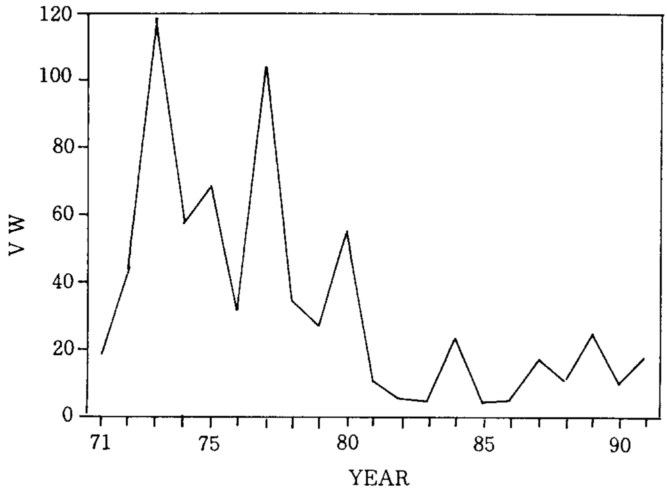
11) This finding is consistent with Park(1983), which reports that changes in labor productivity have little impact on industry wages in Korea.

Ⅳ. Empirical Analysis

Ⅳ. 1. Actual and Expected Inflation Rates

First, I use actual annual inflation rate in the estimation of relative wage variabiltiy equation. Because wage bargaining is sometimes protracted until summer or even fall, actual inflation rate may be almost revealed to both parties of bargaining.

Figure 1. Plot of Relative Wage Variability



Next, I use two measures of expected inflation rates. Because survey data like Livingston data in the U.S. is not available in Korea, I have to construct a time series of expected inflation rates. The first is based on the predicted rate of change in the quarterly consumer price index (CPI) as determined by an ARMA model.

I use quarterly data on consumer prices beginning in 1965 : 1. The annualized inflation rate at each quarter is defined by the growth rate of the CPI, that is, $\pi_t = (CPI_t/CPI_{t-4} - 1) * 100$. An appropriate ARMA model is applied on the quarterly inflation rates. The expected inflation rates for dates t=1971 to 1991 are based on regression forecasts for inflation rate. Each regression uses data on inflation from 1965 : 2 up to the fourth quarter prior to date t. That is, the data before date t are used, but later data are not used to calaculate forecasts. The annual measure of expected inflation rate is the forecasted inflation rate in the first quarter.

Model selection is carried out by estimating all ARMA(p, q) models up to (2, 2) for annualized quarterly inflation rate. On the criterion of root mean squared percent error (RMSE), Akaike's information criterion (AIC), and Schwartz's criterion(SC), ARMA(1, 1) specification was chosen.[12] This specification has the most stable lag structure over the entire sample period.

The estimated equation that applies over the sample, 1965 : 2 - 1990 : 4 is :

$$\pi_t = \underset{(2.253)}{11.720} + \underset{(0.036)}{0.878}\,\pi_{t-1} + \varepsilon_t + \underset{(0.094)}{0.396}\,\varepsilon_{t-1}, \qquad \cdots\cdots (7)$$

$$\bar{R}^2 = 0.874, \quad D.W. = 2.00,$$

where standard errors are in parentheses.

The second measure of expected inflation rate is based on adaptive expectation scheme.

$$\pi_t^e = \alpha\pi_{t-1} + (1-\alpha)\pi_{t-1}^e \qquad \cdots\cdots (8)$$

$\alpha=0.294$ was selected to minimize the sum of squared forecast error. I use the forecasted inflation rate in the first quarter every year.

Ⅳ. 2. Econometric Specifications

The empirically testable specification of equation (4) is :

12) The followings are the statistics used for the selection of the model.

ARMA	RMSE	AIC	SC
(2,2)	35.15	-8.18	-8.06
(2,1)	35.19	-8.21	-8.11
(2,0)	34.15	-8.23	-8.15
(1,0)	44.35	-8.23	-8.15
(1,2)	35.09	-8.20	-8.12
(1,1)	34.65	-8.22	-8.16
(0,2)	85.25	-8.24	-8.11
(0,1)	114.00	-7.93	-7.85

$$VW_t = a + b(\pi_t^e)^2 + c\pi_t^e + d\ VIP_t + u_t \quad \cdots\cdots (9)$$

where b, c, and d are parameters to estimate; u_t is a disturbance term. As predicted in section 2, b and d is expected to be positive. However, the sign of c is ambiguous, since the sign of covariance is indeterminate.

Ⅳ.3. Empirical Results

The estimation results are presented in Table 2. Overall goodeness of fit is satisfactory. The $\bar{R}^2$ is fairly low for time series: however, one should recognize that the equations do not simply regress one trending series on another.

Table 2. Estimation Results

(dependent variable: VW)

independent variable	(1) actual inflation rate	(2) ARMA specification	(3) adaptive expectation
constant	-8.999	-12.777	0.206
	(14.122)	(19.293)	(15,261)
π^2	-0.162	-0.160	-0.102
	(0.093)	(0.094)	(0.108)
π	5.537*	5.693*	3.592
	(2.627)	(3.056)	(2.997)
VIP	0.048**	0.037**	0.042**
	(0.012)	(0.014)	(0.013)
ρ	-0.474		-0.335
	(0.228)		(0.249)
D.W.	2.187	2.414	2.043
$\bar{R}^2$	0.234	0.302	0.175

Notes: ρ is the first order autocorrelation coefficient in the error term. Standard errors are in parentheses.

*) significant at the 10% level

**) significant at the 5% level

VW: variance of relative wage changes, π: actual or expected inflation rates, VIP: variance of relative output changes

Inconsistent with the prediction, the coefficient in π^2 was estimated to be negative, but insignificant at the 10 percent level. It suggests that the dispersion of sensitivity of wages to expected inflation rate is not significantly large across industries. The positive coefficient in expected inflation rate indicates that an increase in expected inflation widens inter-industry variations in relative wages. An increase in expected inflation rate per annum by one percentage point raises variance of relative wages by 5.69 units(see column (2)). Since the wage can be more easily raised in the industry with more favorable micro shocks, high inflation disturbs relative wage structure.

This result is in contrast to Hamermesh(1986). He reports that the dispersion in relative wages is reduced by greater price inflation in the U.S. economy. The empirical results in this paper suggest that price inflation is associated with greater dispersion of relative wage changes. These findings are robust to different choices of measures of inflation expectations.

The variability of micro factors has more siginificant impacts on the relative wage variability. An increase in the variability of changes in output has a positive effect on the dispersion of relative wage changes. An increase in relative output variability by one unit increases relative wage variability by 0.037 units. (see column 2) This impact is significantly positive for all formulations. Since an increase in labor demand proxied by output growth generally causes a raise in wage, uneven output growth across industries disturbs relative wage structure.

Ⅴ. Concluding Remarks

Despite a lot of interest on the wide difference in inter-industry wage levels, the cyclical property of relative wages draws little attention in the recent literature. In Korea, there have actually been wide variations in relative wages over time although strict wage guideline policy has been carried out. The variance of relative wages in manufacturing industries fluctuates very severely over time.

This paper suggests that actual or expected inflation widens inter-industry relative wages. In a highly inflationary environment, the wage in the industry with favorable micro shocks can be raised faster. The relative wage variance in 3-digit manufacturing industries is significantly associated with inflation rate, especially expected inflation rate.

The policy implication of this empirical result is that an inflationary policy has differential impacts on the industry wage. This point should be considered seriously when the policy authority implements aggregate demand policy.

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