The Relationship between Unemployment and Productivity in Korea

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The standard theory shows that, while demand shocks cause the long-run unemployment-productivity schedule to have a negative slope, supply shocks cause it to have a zero slope. This paper finds that low unemployment has largely been related to high labor productivity in Korea for the past two decades, creating a long-run negative relationship. Capital accumulation, better education, and high aggregate demand are cited as key factors of the inverse relationship. Empirical results show that about half of labor productivity growth is actually attributed to an increase in capital stock and that there is also a negative relationship between unemployment and the ratio of capital to the labor force. (*JEL* Classifications: E24, O47)

I. Introduction

Labor productivity, unemployment, and real wages have been central concerns of macro and labor economists. Although these three variables are interrelated each other, however, the relationship between unemployment and labor productivity has been paid less attention and thus is poorly understood. And, in some cases, unemployment and productivity have been considered as separate problems or productivity has been regarded as exogenous, as pointed out by Gordon (1995). He argues that, over the past decade, slow growth in productivity has been the central interests in America

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and high unemployment in Europe. By exemplifying some studies like those of Freeman (1994) and Lindbeck (1994) which have suggested the connection between productivity and unemployment, he explores a hypothesis that the apparently separate problems of low productivity growth in America and high unemployment in Europe may be closely related.

If the relationship indeed exists, then discussions of productivity without considering unemployment may be misleading. And policies directed at changing one variable may have effects on the counterpart variable and thus may not be optimal. This implies that it is necessary to have an idea about within-country intertemporal relationships between unemployment and productivity in order to design optimal policies.

This paper explores the relationship between unemployment and labor productivity and its changes over time in Korea with low unemployment. It finds that they are actually interrelated but low unemployment has tended to be related to high productivity in Korea as a result of upward shifts in the unemployment-productivity schedule, suggesting that a positive labor productivity shock decreases unemployment. This paper also tries to answer what factors have caused the negative relationship between unemployment and productivity in Korea.

The rest of this paper is organized as follows. The next section briefly outlines the main mechanism involved and analyzes the effects of shocks to derive the long-run unemployment-productivity schedule. The third section investigates the unemployment-productivity relationship in Korea and identifies key factors that have influenced the negative correlation. The final section summarizes and concludes the paper.

II. The Relationship between Unemployment and Productivity

A. The Unemployment-Productivity Schedule and the Mechanism

The unemployment-productivity (*UP*) schedule is implicit in the production function. Suppose that the production function is Cobb-Douglas $Q=A\ K^{\alpha 1}\ N^{\alpha 2}$, where Q is net output, K is capital, N is employment, and A is technological progress. Then we have

$$q-n=a+\alpha_1 k+(\alpha_2-1)n, \tag{1}$$

where lower case letters henceforth denote logs.

Equation (1) implies that productivity is negatively related to the level of employment, or alternatively positively related to unemployment, provided that α_2 is less than 1. Therefore, the *UP* schedule has a positive slope. Any technological progress or change in capital that affects productivity causes shifts in the *UP* schedule, while any factor that affects employment causes movements along the *UP* schedule.

Introducing a simple standard labor market model helps us understand the mechanism working in the *UP* schedule and analyze its changes over time in response to shocks. Let us start with the labor demand schedule. Assume that output is produced by two inputs, capital and labor. Under constant returns to scale, perfect competition, and profit maximizing firms, the log-linear form of the labor demand schedule can be written as[1]

$$n=\frac{\sigma}{s_k}(p-w)+k, \tag{2}$$

where P is price, W is wage, σ is the elasticity of substitution in production, and s_k is the share of capital costs in total costs.

Let us now turn to the labor supply schedule. The conventional theory argues that the real wage is equal to the opportunity cost and that the opportunity cost is proportional to the level of employment. Then we have a labor supply schedule looking something like[2]

[1]If we substitute imperfect competition for perfect competition and labor-augmenting technological progress for neutral technological progress, then equation (2) can be written as

$$n=\frac{\sigma}{s_k}(p-w-m)+k+\left(\frac{\sigma}{s_k}-1\right)a,$$

where m is the markup of price and A is labor-augmenting technological progress.

[2]If we admit the fact that wages may be preset before the price level is completely informed and thus workers tend to take a look at the lagged real wage, then equation (3) can be written as follows:

$$w-p^e=(1-\beta_0)(w-p)_{-1}-\beta_1(l-n)+\sum_{i=2}\beta_i z_i.$$

However, because the explicit inclusion of the expected real wage and slow adjustment does not add anything significant to the analytical outcome in this paper, the left-hand side is written in terms of the actual wage rate

$$w-p = -\beta_1(l-n) + \sum_{i=2} \beta_i z_i, \tag{3}$$

where L is the labor force and z_i is a vector of variables that influences the wage rate. In z_i, Bean (1994) includes the minimum wage, the replacement ratio, the price wedge between import prices and domestic prices as well as between consumer prices and producer prices, the tax wedge, and union militancy. Nickell (1990) includes the real interest rate.

B. Shifts in and Movements along the UP Schedule

Equation (2) implies that a change in capital stock shifts the labor demand schedule. New investment will shift the labor demand schedule upwards to a position like N_1^D in the left panel of Figure 1. Employment rises from N_0 to N_1 and the marginal product of labor from $(W/P)_0$ to $(W/P)_1$. Because the average product of labor is equal to the marginal product divided by labor's income share, the average product of labor is proportional to the marginal product.[3] Therefore, the rising demand for capital reduces unemployment and increases productivity, creating a negative correlation between unemployment and productivity.

The same situation can be described on the productivity-unemployment space. An increase in capital stock shifts the positive *UP* schedule up and to the left from UP_0 to a position like UP_1 in the right panel of Figure 1. Because capital accumulation creates a negative correlation between unemployment and productivity, the economy moves northwest from the initial point A to point B, which correspond to points E_0 and E_1 in the left panel. Another increase in capital shifts the equilibrium from B to C, with a higher productivity level and a lower unemployment level. In short, shocks that shift the labor demand schedule (*demand shocks* henceforth) cause the economy to move from A to B and then to C. Connecting these points yields the long-run *UP* ($LRUP^D$) schedule, which has a negative slope. However, as the unemployment rate approaches the natural rate of unemployment U^*, unemployment is prevented from falling below it. Then the $LRUP^D$ schedule becomes vertical and unemployment is neutral with respect to productivity

and the lagged wage rate is assumed to be included in z_i.

[3]In the Cobb-Douglas case $Q=A\,K^{\alpha 1}\,N^{\alpha 2}$, labor's income share equals the elasticity of output to a change in labor input α_2 which is constant.

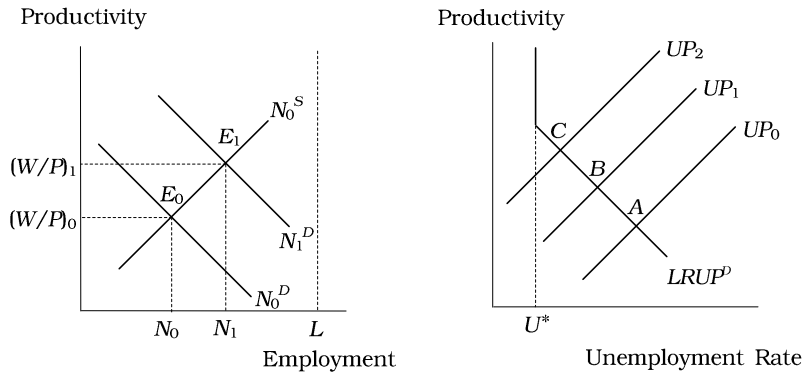


FIGURE 1

EFFECTS OF A DEMAND SHOCK ON UNEMPLOYMENT AND PRODUCTIVITY

growth, as implied by the kinked $LRUP^D$.

Let us now consider shocks in z_i that shift the labor supply schedule (*supply shocks* henceforth). An adverse supply shock shifts the labor supply schedule up and to the left, and the economy from E_0 to E_1 in the left panel of Figure 2, with a higher marginal and average product of labor and a higher unemployment rate. The same situation is shown in the right panel by the northeast movement along the *UP* schedule, from *A* to *B*. However, this does not complete the adjustment of the economy. Because the marginal product of capital declines in response to decreased employment, the demand for capital falls. Disinvestment reduces the demand for labor and shifts the labor demand schedule to N_1^D in the left panel or the *UP* schedule to UP_1 in the right panel.[4] Once the process of capital adjustment is completed, the economy settles at point *C*.

During the movement from *A* to *B* following a supply shock, productivity increases and unemployment rises. However, this positive relationship does not last long. Adjustment of capital shifts the economy from *B* to *C*, creating a negative correlation between unemployment and productivity. If we directly compare the initial point *A* with the long-run equilibrium point *C*, neither positive nor negative relationship between unemployment and productivity holds

[4]The labor demand schedule locates at N_1^D in Figure 2 so that it intersects the labor supply schedule at the original real wage $(W/P)_0$ (Gordon 1995).

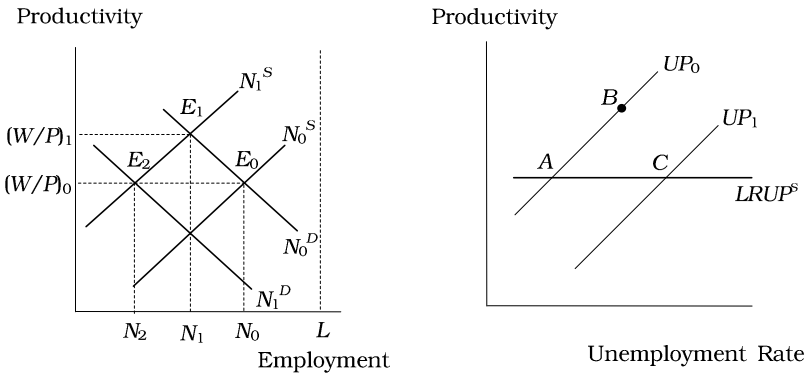


FIGURE 2

EFFECTS OF A SUPPLY SHOCK ON UNEMPLOYMENT AND PRODUCTIVITY

because unemployment rises with productivity unchanged. This mechanism yields the horizontal long-run *UP* ($LRUP^S$) schedule.

III. Korean Experience

A. Some Facts about Korean Unemployment

The Korean unemployment rate has sharply declined to 2 percent in 1995 from 4 percent in the 1970s, with a temporary big jump in 1980 caused by the oil shock. This long-run downward trend in the unemployment rate was possible largely due to rapid economic growth and thereby strong demand for labor. A recent study by Nam and Rhee (1998), using panel data, interestingly finds that, while the inflow rate to employment has fluctuated without any trends, the inflow rate to unemployment has decreased, and thereby the unemployment rate has declined. It seems to be that high economic growth rates helped to prevent the inflow rate to employment from falling and the inflow rate to unemployment from rising. Regarding the downward trend in the unemployment rate, however, a couple of caveats are due here.

First, the participation rate affects the unemployment rate. The participation rate of Korean workers is likely to reflect the state of the labor market. During recessions, in particular, the participation rate tends to fall and thus the unemployment rate tends to be

understated.[5] Without the unemployment insurance system, many female and young workers in Korea have little or no incentive to report their unemployment, and hence disappear from the active labor force when they are not employed, rather than remain in the active labor force.[6] Women are more likely to search when job prospects are more favorable than when they are less favorable. Successfully finding a job, they are employed directly from the status of non-active labor force.

Second, working hours also influence the unemployment rate. There was a drop in Korean working hours from 50.9 hours a week in 1972 to 47.7 hours in 1995. As far as the drop in working hours is voluntary, taken in the form of more leisure, it would not affect the unemployment rate. Because of the rigidity of the Korean labor market, in which firms cannot lay off workers and have to bear generous severance payments, however, cyclical fluctuations in output have been absorbed more by changes in hours than by changes in employment. To the extent that working hours and employment are substitutes, involuntary drops in hours can share the burden of high unemployment. With these caveats in mind, the relationship between unemployment and productivity in Korea is pursued.

B. The Unemployment-Productivity Relationship in Korea

When we measure labor productivity as output per employee, productivity growth is understated since hours per employee have declined rapidly in Korea. Therefore, we divide output by total labor input to measure productivity in order to make an adjustment for changes in working hours. Figure 3 plots the evolution of the unemployment-productivity relationship over the 1972-95 period. It shows that the *UP* schedule has tended to shift in an upward direction in Korea. Thus, the long-run *UP* schedule in Korea has a

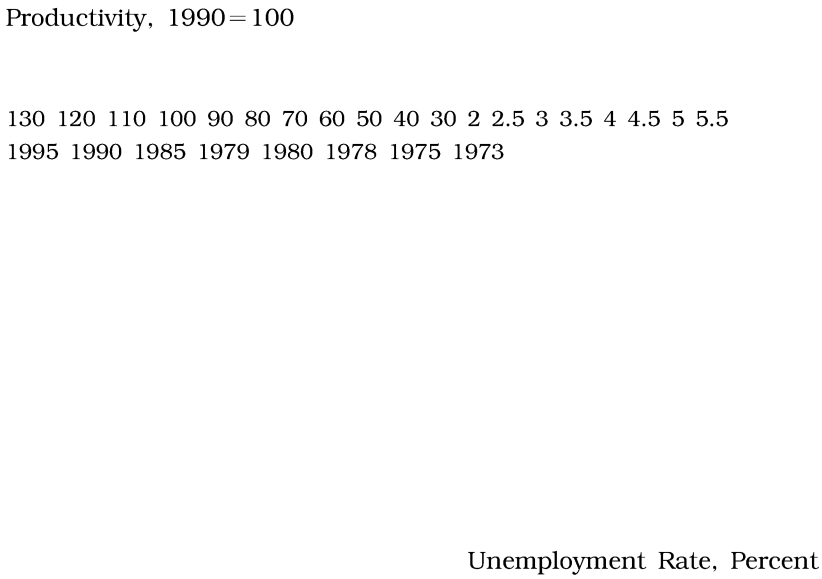
[5]The cyclical pattern of the participation rate is shown by the following estimation result.

$$PR_t = \underset{(2.01)}{13.45} + \underset{(7.41)}{0.81} PR_{t-1} - \underset{(-2.83)}{0.52} U_t,$$

$$\overline{R^2} = 0.82, \quad DW = 2.16,$$

where PR is the participation rate, U is the unemployment rate, and t-values are in parentheses.

[6]The unemployment insurance system was introduced in 1995 and the unemployed have benefited from it since July 1996 in Korea.



Source: Author's calculations based on data from the National Statistical Office, the Ministry of Labor, and the Bank of Korea.

FIGURE 3

THE RELATIONSHIP BETWEEN UNEMPLOYMENT AND PRODUCTIVITY

negative slope. The same relationship carries over to the relationship between the changes in unemployment and productivity, and so the figure is not provided. This implies that the Korean economy has largely experienced shocks that cause shifts in the labor demand schedule for the past two decades. Furthermore, the fact that the unemployment rate in Korea has tended to decline for this period naturally leads to the conclusion that favorable shocks shifting the *UP* schedule up and to the left have been prevalent.

This does not mean that there have always been favorable demand shocks in Korea for the past two decades. Adverse supply shocks were sometimes observed and thereby unemployment and productivity moved together, for example, between 1978 and 1979, as Figure 3 shows. The positive correlation during this period appeared to be caused initially by the oil shock. The mechanism operated here can be summarized as follows.

The oil shock brought about the sharp rise in import prices in

Korea. The price of imports in Korea actually rose by 26.7 percent and 58.8 percent in 1979 and 1980 respectively, a big jump from 4.5 percent in 1978. Since the consumer price index (P_c) is a weighted geometric mean of domestic (P_d) and import prices (P_m), that is, $P_c=(1+\tau)P_d^{1-\theta}P_m^{\theta}$, where τ is the rate of value added taxes, consumer prices did rise in proportion to import prices. And since workers care about the real consumption wage, any increase in consumer prices would shift up the labor supply schedule. An upward shift of the labor supply schedule changed the equilibrium points from E_0 to E_1 in the left panel of Figure 2. As a result, the economy moved along the positive *UP* schedule, and both unemployment and productivity rose between 1978 and 1979.

This is not the whole story because capital adjustment is not complete yet. The movement from E_0 to E_1 caused capital decumulation. In fact, investment declined by a startling 10.7 percent in 1980—a sharp contrast to its annual growth rate of 28 percent over the 1976-8 period and 9.7 percent in 1979. Capital decumulation caused a downward shift in the labor demand schedule from N_0^D to N_1^D in Figure 2. This situation can be shown in Figure 3 by the rise in unemployment and the fall in productivity between 1979 and 1980.

C. Sources of Upward Shifts in the UP Schedule

Three factors can be cited as causes of upward shifts in the *UP* schedule in the Korean economy.[7] First, investment grew 12.4 percent annually from 1972 to 1995, and thereby the share of investment in GDP stood at 38.2 percent in 1995, with a peak at 38.3 percent in 1991. Alternative measure, the ratio of capital to employment has also grown 10.4 percent a year in the 1970s, 7.8 percent in the 1980s, and 8.8 percent during 1991-5. Capital accumulation allows the Korean economy to be exempt from the situation that capital shortage could limit new employment, as some European economies had experienced.[8] The greater use of

[7]Some theories predict that poor countries tend to grow faster than rich ones or poor economies tend to converge toward rich ones. In particular, the neoclassical growth model assumes diminishing returns to capital as the source of this convergence. This paper ignores the convergence effect in accounting for the peculiarities of Korea.

[8]For the effect of capital shortage on unemployment, see, for example, Bean (1989, 1994), Blanchard (1990), Bruno (1986), and Malinvaud (1982,

capital substantially contributed to the rise in productivity and enhanced factor substitutability between capital and labor in the production process, shifting the *UP* schedule in a favorable direction.[9]

Second, better education also played a significant role in shifting up the *UP* schedule, although labor quality is not mentioned explicitly in the model. Better education enabled firms to replace less educated workers with more educated ones, whose demand increased rapidly in the process of economic growth, without causing significant bottleneck problems in labor input. High quality of the labor force in Korea is considerably attributed to generous expenditures in education in the private sector as well as in the public sector. High school and university (including college) graduates as a percentage of the employed stood high at 62 percent in 1995. This measure, however, tends to understate the contribution of education because it fails to take into account on-the-job training (van Ark and Pilat 1993). Actually, the Korean vocational system appeared to be of importance in lifting barriers to labor mobility across occupations and industrial sectors, and to labor migration from rural to urban areas (Hahn 1996).

Third, upward shifts in the *UP* schedule might also be caused by increases in aggregate demand. There are many regulations aimed at providing extensive employment protection to workers in the Korean labor market. Included in these regulations are restrictions on firms' freedom to dismiss workers without "proper" justification, limits on the use of temporary or part-time work, and mandated severance payment. Under these circumstances, as Bentolila and Bertola (1990) show, there is a tendency for employers to hesitate in hiring new workers if aggregate demand is not high because the present value of the cost to employers associated with hiring an extra worker is perceived relatively high. On the other hand, hirings will occur if the aggregate demand is perceived high and persistent by employers so that the present value of benefits to employers from hiring an extra worker may be high (Hahn 1996). Owing to

1986).

[9]Although international comparisons suggest that the role of physical investment should not be exaggerated in explaining productivity growth, as shown by Crafts (1992), it is likely that the role of capital accumulation in Korea cannot be overemphasized. Hall and Jones (1996) argue that infrastructure is important because it encourages capital accumulation.

the growth-oriented expansionary policy, which has been maintained since the early stage of development and has kept the aggregate demand persistently strong, high firing costs have had little effect on the employment decision and the slow response of employers' demand for labor during recessions has prevented the unemployment rate from rising sharply.

D. Empirical Analysis

The paper has examined the relationship between unemployment and productivity and shown that the correlation can be positive, negative, or zero. However, there has been largely a negative relationship in the Korean economy for the past two decades as Figure 3 displays, suggesting that adverse supply shocks might be dominated by favorable demand shocks.

To examine this relationship empirically, we run a regression equation. The linear-form regression equation we have is

$$(q_t - n_t h_t) = \gamma_0 + \gamma_1 U_t + \gamma_2 (k_t - n_t h_t) + \Gamma Z_t + \varepsilon_t, \tag{4}$$

where H is hour and Z is a vector of supply shocks that affect the labor supply schedule. From the previous analysis, γ_1 should be negative and γ_2 positive. The price wedge between import prices and producer prices (*WEDGE*) and the unionization rate (*UNION*) are considered as the variables in Z.

Data (obtained from the National Statistical Office, the Ministry of Labor, and the Bank of Korea) are from 1972 to 1995. The results of ADF(2) tests with a time trend show that ADF statistic is -1.07 for productivity and -1.59 for the unemployment rate. Because the 5 percent critical value is -3.65, both productivity and the unemployment rate are integrated of order one. The results from other ADF tests were qualitatively the same, although they are not reported. Next, the Johansen cointegration procedure is applied. Likelihood ratio tests rejected any cointegration at a 5 percent significance level ($LR = 12.38$ with the 5 percent critical value 15.41 for the null hypothesis $r = 0$; $LR = 3.52$ with the critical value 3.76 for the null hypothesis $r \leq 1$), and the results were robust to lag specifications. Therefore, we estimate equation (4) in the form of growth, instead of a level, to avoid a spurious regression.

The results are presented in Table 1. The coefficients on the unemployment change and the change of capital per labor input have

TABLE 1

REGRESSION RESULTS OF THE UNEMPLOYMENT-PRODUCTIVITY RELATIONSHIP

	(1)	(2)	(3)	(4)
Constant	0.007	0.004	0.007	0.005
ΔU	-0.03*	-0.04**	-0.03*	-0.04**
$\Delta(k-nh)$	0.50**	0.51**	0.49**	0.51**
$\Delta WEDGE$	0.05	0.04	-	-
$\Delta UNION$	0.005	-	0.005	-
R^2	0.39	0.36	0.42	0.39
DW	1.41	1.50	1.39	1.49

Notes: * indicates that coefficient is significant at 5 percent level and ** at 1 percent level. The dependent variable is $\Delta(q-nh)$. *WEDGE* is the log of the wedge between import prices and producer prices and *UNION* is the unionization rate.

TABLE 2

CONTRIBUTION OF CAPITAL TO PRODUCTIVITY GROWTH, 1973-95

Percent per year

	1973-80	1980-95	1973-95
Growth Rate of Productivity	3.94	5.34	5.32
Contribution of Capital	3.61	2.92	3.16
Contribution of TFP	0.33	2.42	2.16

the expected signs and are significant. However, the variables introduced to account for the effects of supply shocks, say the price wedge and the unionization rate, are insignificant. These results show that, in Korea, there is a negative correlation between unemployment and productivity and that the increase in productivity is attributed to capital accumulation. To measure the contribution of capital accumulation to the increase in productivity, we can decompose the growth rate of productivity into the sum of the growth rates of capital per labor input and total factor productivity (TFP).

Table 2 shows the contribution of capital accumulation to the productivity growth over the 1973-95 period, and the subperiods 1973-80 and 1980-95.[10] Most productivity growth was attributed to

[10]The year 1980 was chosen because, since then, the Korean economy began to strongly perform structural changes into high value-added and heavy industries.

capital accumulation (relative to labor force growth) in the 1970s. Although the contribution of capital slowed down, capital accumulation still accounted for about half of productivity growth in the 1980s. To summarize, a substantial part of productivity growth in Korea is explained by high growth rates of investment.

It is also worth noting from Table 2 that there was a considerable TFP contribution to productivity growth. In association with the negative correlation between unemployment and productivity found in Korea, this result suggests that technological progress, measured by TFP, did not have adverse effects on Korean unemployment, even in the short-run, contrary to some OECD countries where increased productivity as a consequence of new technologies led to a temporary rise in unemployment (Giorno *et al.* 1995). It is argued by them that the introduction of new technologies may lead to job destruction for low skill categories without creating sufficiently offsetting new job opportunities for high-skilled workers. If this is indeed the underlined story, the absence of harmful effect on Korean unemployment might be possible due to the introduction of labor-absorbing technologies and better education that enabled a rapid upward adjustment of the skill composition of the labor force.

The above analysis about the unemployment-productivity relationship yields a prediction about another relationship, that there should be a negative correlation between unemployment and the ratio of capital to the labor force, as Figure 1 suggests.[11] Estimating this relationship with a regression equation in which the dependent variable is the capital divided by the population aged 15 years and over yields

$$\Delta(k_t - l_t) = \underset{(1.89)}{0.02} + \underset{(8.01)}{1.29}\Delta(k_{t-1} - l_{t-1}) - \underset{(-4.13)}{0.58}\Delta(k_{t-2} - l_{t-2}) - \underset{(-3.20)}{0.019}\Delta U_t,$$

$$\overline{R^2} = 0.75, \quad DW = 1.81,$$

[11]Because employment as well as capital varies by a shock, the ratio of capital to the employed can rise or fall. Therefore, we cannot make a definite prediction about the correlation between unemployment and the ratio of capital to employment.

where *t*-values are in parentheses. The unemployment rate coefficient has the expected negative sign at a significance level of 1 percent.

IV. Summary and Conclusion

This paper has investigated the unemployment-productivity relationship and found that there is a negative correlation between them in Korea, although the theoretical correlation can be positive, negative or zero in a world where demand shocks and supply shocks are mixed. This implies that adverse effects of the oil shock were temporary and favorable demand shocks have been prevalent in Korea. The factors that are believed to have shifted the *UP* schedule in a favorable direction include capital accumulation, better education, and high aggregate demand in Korea. In fact, about half of productivity growth for the past two decades is attributed to capital accumulation.

However, during the following decade, some unfavorable factors might undo the negative *UP* schedule in Korea, where wage inflation is still high and unemployment is near the natural rate. Such factors include a fall in economic growth rates, an increase in the coverage of unemployment benefits, and increasing openness to foreign trade. The worsening environments imply that Korea has to actively search for policies that can boost productivity growth without having adverse side effects on unemployment.

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