The Natural Rate of Unemployment in Korea and Its Usefulness

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This paper examines the usefulness of the unemployment gap as an inflationary pressure index in Korea. It also introduces and applies various methods of estimating the natural rate of unemployment.

It was found from the estimation results that the natural rate of unemployment in Korea has been as follows: having running at about 4% during the period from 1983 to 1986 it declined to 2.5% during the period from 1987 to 1997, but after a sharp rise due to the currency crisis in late 1997 it has shown a more stable patten, moving around 3% in 2002.

Secondly, inflation models with an unemployment gap as an independent variable are superior to models without it in terms of model fitness.

Meanwhile, the unemployment gap estimated using a latent component model is more useful in inflation forecasting than that estimated from a regression model.

The diffusion effect of the unemployment gap on inflation is highest after 3~5 quarters, and the magnitude of the effect of a negative unemployment gap is three times as large as that of a positive unemployment gap.

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Ⅰ. Introduction

In Korea, the rate of unemployment, increased sharply to 7.9 percent in July 1998 due to the currency crisis that broke out in late 1997, fell rapidly from the end of 1999 and has been stable at around 3 percent since the beginning of 2002. However, despite the lower level of the unemployment rate, labor market conditions still seem to be unstable, judging from the severe unemployment among the young, the rise of long-term unemployment and the problems arising from the expansion of temporary jobs, and so on. Recent consumer credit problems such as private credit risk and personal bankruptcy also seem to be related with these negative symptoms of the labor market.

In such ways, as the unemployment rate does not appropriately reflect labor market conditions and the actual economic circumstances, some economists suggest alternative indexes such as an effective unemployment rate, which is a kind of adjusted unemployment rate.[1] In contrast, other economists suggest that the recent low unemployment rate represents the demand pressure of the labor market and the consequent inflationary pressure, because they consider the rate of unemployment as the supply-demand condition index of the labor market.[2]

The theoretical background as to usefulness of the unemployment rate, as an indicator of inflationary pressure, can be found in the Phillips curve, which describes the trade-off relationship between the rate of unemployment and inflation rate. In a word, the Phillips curve tells us that inflationary pressure would appear if labor demand outstrips labor supply, and vice versa.

However, the dispute, as to whether the rate of unemployment is useful in examining labor market conditions, was largely soothed by the stagflation of the 1970s. That is, after stagflation, economists reached a common agreement that it is not suitable to evaluate the labor market condition only with unemployment rate(Murphy 1998). Since then, the direction of research about labor market conditions has largely fallen into two groups. The first research group has been trying to make alternative indices such as a job-vacancy rate or a quit rate to diagnose labor market conditions. On the other hand, the second group has been trying with various methods to estimate a natural rate of unemployment, which is determined by the structural and frictional factors of labor market, because the deviation of unemployment rate from its natural rate, we call it unemployment gap, shows the inflationary pressure in the labor market.

1) Kim(2001).
2) Shin(1999, 2001), Ahn & Chun(2000), and Yoo(2000) estimated the natural rate of unemployment in Korea to be around 3~4% in their studies.

The purpose of this paper is to examine the usefulness of the unemployment gap as an inflationary pressure index in Korea. It also introduces and applies various methods of estimating the natural rate of unemployment, since the natural rate itself has important information as to labor market, especially in the Korean economy since the crisis.

This study is organized as follows. First, Chapter Ⅱ discusses the concept of the natural rate of unemployment and introduces its estimation methods. Chapter Ⅲ reviews the structural changes and general features of the labor market in Korea during the period from 1980 to 2002. Chapter Ⅳ estimates the natural rate of unemployment through representative estimation models such as the regression model and the latent component model, and evaluates the usefulness of the unemployment gap derived from the estimates. Finally, the last chapter summarizes the results and draws some policy implications.

Ⅱ. The Concepts of the Natural Rate of Unemployment and Estimation Models

1. The Concepts of the Natural Rate of Unemployment

The natural rate of unemployment is defined as either "the unemployment rate which has no tendency to accelerate or decelerate inflation in the long-run when there is no disturbance in the supply side" or "the unemployment rate which is determined by structural or frictional forces regardless of the fluctuation of aggregate demand"(Friedman 1968). Sometimes, it also has been called as a guaranteed unemployment rate, a fully-employed unemployment rate, and so on. The concept of the natural rate of unemployment was coined in the late 1960s by the Monetarists, who had been taking a different view from the Keynesians regarding both public policy for reducing the unemployment rate and the opinions about the relationship between the inflation rate and the rate of unemployment. However, after the stagflation in the 1970s, both schools reached the same view that the negative relationship between unemployment and inflation held only in the short-run but not in the long-run. And, since this consensus, the concept of the natural rate of unemployment has been widely used among both side economists, and by policy-makers.

At this stage, it would be helpful to review the background of the "Philips curve" and the conceptual development of the natural rate of unemployment in detail. After the introduction of the "Philips curve" in 1958, throughout the 1960s and the early 1970s it was generally believed that there was a long-run tradeoff between inflation and unemployment.

However, Monetarists who had insisted on 'monetary neutrality', did not agree with an expansionary monetary policy for reducing unemployment, because they believe that an expansionary monetary policy only increase inflation without reduction of unemployment in the long-run. Notably, Friedman(1968) and Phelps(1967) had insisted that the rate of unemployment would be occasionally lowered only in the case of unexpected inflation. But, workers might demand higher wages, if they expected higher inflation, by updating their information. So, in the long-run, the unemployment rate comes to converge with the level of the natural rate despite the expenses in higher inflation.[3)]

Since the natural rate of unemployment is determined by structural and frictional factors of the labor market, it does not necessarily equal to a zero rate. Economists agree that unemployment is determined by four types of factor: first, structural factors such as industrial structural change or technological progress; second, cyclical factors arising from a recession or boom; third, seasonal factors induced by sensitive seasonal variation in special industries such as construction, agriculture and the fishing industry, and finally frictional factors usually caused by job transfer. Of these four types of factor, the natural rate of unemployment can be considered as being the sum of three of them: structural, frictional and seasonal unemployment, but not cyclical unemployment. Accordingly, even though there is no structural unemployment thanks to the achievement of full-employment, the natural rate of unemployment may be higher than zero due to the frictional unemployment occurring in the process of job searching.

Through the experience of stagflation in the mid 1970s, the Monetarist view, which argues the uselessness of an expansionary monetary policy for lowering unemployment in the long-run, was eventually accepted by the Keynsians who had insisted on a demand-pull policy based on the classical Phillips curve. Moreover, the Keynsians then introduced the concept of NAIRU(Non-Accelerating Inflation Rate of Unemployment), which implies a specific level of the unemployment rate, a kind of threshold, that does not affect inflation

3) Friedman(1976) objected to the policies of unemployment decrease through the inflation increase by quoting Abraham Lincoln's famous phrase, "You can fool all the people some of the time, and some of the people all the time, but you cannot fool all the people all the time."

changes, neither lowering nor raising, in the short-run.[4)]

The concept of NAIRU is the same as the natural rate of unemployment because it also means the stable unemployment rate neither increasing nor decreasing inflation.[5)] However, there are some differences between these two concepts in that the natural rate of unemployment was originally introduced to oppose the demand-pull policy admitting inflation rise, while the concept of NAIRU was coined to support the scope for policy in reducing unemployment in the short-run.[6)]

Paradoxically, the concept of the natural rate of unemployment, which was introduced by the Monetarists to explain the uselessness of monetary policy for lowering unemployment rate, was widely adopted by the Keynesians as policy index from the late 1970s, interpreting the natural rate of unemployment as a constraint on the demand-pull policy. That is, the lack of understanding[7)] about the background of the natural rate of unemployment and the aftermath appeared in the long run through the monetary policy on unemployment, caused the following the simple rule of thumb for monetary policy to become widespread: if the unemployment rate is lower than the natural rate or the real wage rate, the monetary policy should be tightened, and vice versa.

However, quite a few economists took a negative view of immediate policy actions on the unemployment gap, because not only is it difficult to estimate the natural rate accurately, but also there exists uncertainty as to the policy horizon due to the lagged effect of monetary policy. And moreover, it is difficult to ignore the ineffectiveness of policy in view of the rational expectations of economic participants.

4) NAIRU which is a transformation of NIRU(the non-inflationary rate of unemployment) introduced by Modigliani & Papademos(1975), more clearly represents the relationship between the unemployment rate and inflation in that the low unemployment rate is related not to higher fixed rates of inflation but to accelerating inflation.

5) The unemployment rate not accelerating inflation rate (the natural rate of unemployment) has been usually called the non-accelerating inflation rate of unemployment, or NAIRU for short.(Cha & Yoon, 1998, p. 362)

6) That is, as they are estimated under the same assumption despite differences on the use of these indexes, we define them as 'the natural rate of unemployment' without any distinction between 'the natural rate of unemployment' and NAIRU. For reference, Richardson *et al*.(2000) identified three different NAIRU concept which can be distinguished by the time framework to which they relate: the long-term equillibrium unemployment rate, NAIRU, and the short-term NAIRU.

7) Okun recalls, "It was hard to cast aside a tool that had traced the United States record so well from 1954 through the late sixties. And it was easy to ignore the Friedman and Phillips attack on the stability of the short-run Phillips curve, and their prophetic warning (issued at a time when the Phillips curve was still performing admirably) that the curve would come unstuck in a prolonged period of excess demand. Unfortunately, most of the profession (including me) took too long to recognize that"(Espinosa-Vega, M. *et al*. 1997)

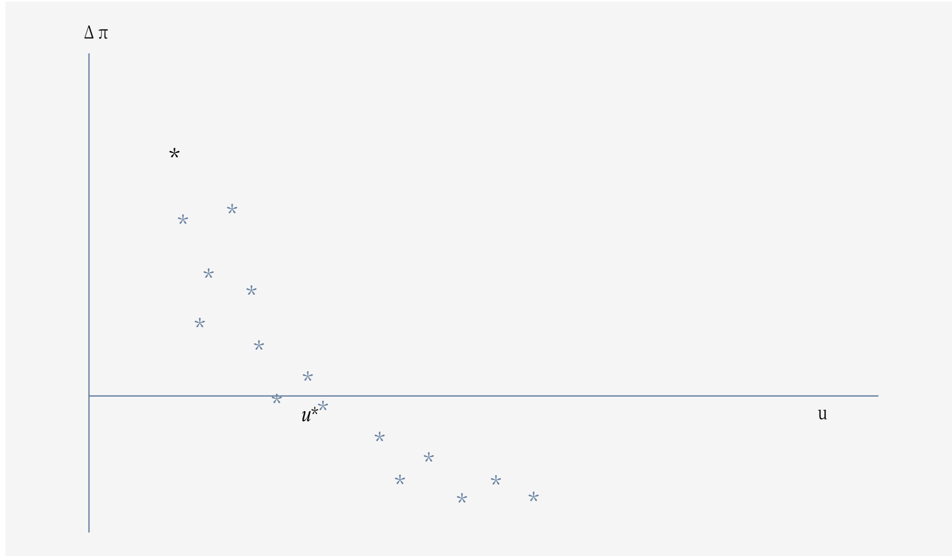
Summarizing the above arguments, the meaning of the natural rate can be sought from two aspects. Under the short-term horizon, a positive(+) unemployment gap implies abundant labor supply, so inflationary pressure may be rarely arise, while a negative(-) gap indicates high inflationary pressure due to wage increases caused by excessive labor demand. That is, the natural rate of unemployment is important as the reference index of the unemployment rate. Therefore, judging from the standpoint of a monetary authority targeting price stability, the unemployment gap may be useful not only as an index of inflationary pressure by way of the labor market but also as an index for judging the effectiveness of monetary policy on the labor market.

On the other hand, in a long-term horizon, a high natural rate denotes the inefficiency of the labor market, so it brings about macroeconomic inefficiency by reducing both income and production since a lot of people cannot participate in productive activities. The frictional factors that induce unemployment have some positive aspects for the labor market in that they may promote efficient competition through normal turnover and job seeking. However, the structural factors exert pressure against the employment of valuable human resources, therefore policy for the unemployed has to focus on resolving this structural unemployment problem. Structural unemployment may be caused by various reasons : skill mismatches in the process of industrial structural changes, locational mismatches, as well as institutional factors such as 'minimum-wage laws', imperfect information flows, and sometimes changes of job preference, etc. The inefficiency of the labor market caused by this structural unemployment cannot be solved by macroeconomic policies such as demand-pull policy, but by microeconomic tools. Various microeconomic solutions may be put forward according to the underlying reasons for the market inefficiency. Technological unemployment, for example, may be solved by upgrading the high-tech skills of workers through education and job-training programs.

2. Estimates of the Natural Rate of Unemployment

The natural rate of unemployment is only a theoretical concept, so it cannot be directly observed, but just be estimated. We can easily show the relationship between the rate of unemployment and the inflation rate thorough a simple scatter diagram. In [Figure 2-1], which shows the trade-off between unemployment rate and inflation rate, the natural rate of unemployment is defined as the unemployment rate when there is neither inflationary pressure nor deflationary pressure, that is, $\Delta\pi$ is 0.

Figure 2-1 Relationship between the rate of unemployment and inflation difference



A lot of economists have studied the main determinants and estimation methods of the natural rate of unemployment over the past thirty years, since Friedman(1968) introduced the concept. The estimation methods can be divided largely into two categories; regression method and time series analysis method.

First, the regression model for estimating the natural rate of unemployment can be derived by a "price equation (1)" corresponding to the labor demand and a "wage equation (2)" describing the labor supply.

$$\Delta p_t = a_p + \Delta w_t + \varepsilon_{pt} \quad (1)$$

$$\Delta w_t = a_w + \Delta p_{t-1} - \beta u_t + \varepsilon_{wt} \quad (2)$$

The variables, p and w are log transformations of the price index and wages respectively, and u is a rate of unemployment. Together, a_p and a_w denote constants, and ε_{pt} and ε_{wt} represent residuals. If we put equation (1) into equation (2), the so-called Phillips curve, equation (3), can be derived as follows.

$$\Delta p_t = a + \Delta p_{t-1} + \beta u_t + \varepsilon$$

$$\Leftrightarrow \Delta\pi = a + \beta u_t + \varepsilon \quad (3)$$

Where, $a = a_p + a_w$, $\varepsilon_t = \varepsilon_{wt} + \varepsilon_{pt}$, π_t is inflation. In equation (3), if we assume that $\Delta\pi_t = 0$, the natural rate of unemployment, u^* is expressed in the form of equation (4), which is the same as the natural rate of unemployment shown in [Figure 2 - 1].

$$u^* = -\frac{a}{\beta} \tag{4}$$

Furthermore, this estimation method based on a regression model for the natural rate of unemployment, can be extended to various formulas considering the lag effects of both unemployment rate and inflation rate, together with supply shocks such as energy price rise, the change of trade conditions, and so on. Adding the lagged effects of the unemployment rate on inflation rate, the estimation model for the natural rate is presented, for instance, as follows(Staiger, Stock & Watson 1997).

$$\Delta\pi_t = \beta_1(u_{t-1} - u^*) + \beta_2(u_{t-2} - u^*) + \gamma X_t + v_t, \tag{5}$$

$$\Delta\pi_t = u + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \gamma X_t + v_t, \tag{6}$$

where, X is a variable set consisting of the past inflation rate, supply-shock variable, and so on. From the above two equations, the natural rate can be derived as $u^* = -u/(\beta_1 + \beta_2)$. In addition, the above regression method can be applied to disaggregated approach based on disaggregagted data series. In the case of a disaggregated approach, the natural rate of unemployment is induced by estimating the natural rate of each group within the population separately based on the labor indexes such as the unemployment rate and the economically active population by age and by gender and then, weighting these by the share of each group in the labor force (Weiner 1993).

Second, the time series method, such as trend-extracting method and unobserved component model, also can be applied to estimate the natural rate of unemployment by focusing on the behavior of the time series itself. The representative trend-extracting method is HP-filtering.[8] Next, the unobserved component model estimates the natural rate in reference to the trend by combining equations (7) and (8) on the statistical features of unemployment and equation (9) on the economic relationship between the unemployment rate and the inflation rate. The model is becoming more widely used nowadays because it makes it possible to estimate the time-varying natural rate according to the changes of economic situation by time.[9]

$$u_t = u_t^T + u_t^C \tag{7}$$

$$u_t^T = u_{t-1}^T + \varepsilon_t \tag{8}$$

$$\pi_t = a(L)\,\pi_{t-1} + b(L)(u_t - u_t^T) + c(L)s_t + e_t \tag{9}$$

In the above equations, u is unemployment, u^T the natural rate of unemployment which is equal to the trend sector of unemployment, u^C the cyclical element within the unemployment rate, π inflation, s the other variable vectors, $a(L)$, $b(L)$, $c(L)$ the lag operators, e and ε residuals.

This method, containing unobserved variables like the natural rate of unemployment, reconstitutes the model equation as a state-space model, and estimates the parameter through the MLE(Maximum Likelihood Estimation), and then reestimates the natural rate according to the procedure of forecasting and revising each time based on the estimated parameter.[10]

In addition, various other methods could also be applied to estimate the natural rate of unemployment. For example, Mankiw(2000), regarding the natural rate as the long-term period average of the real unemployment rate, used a moving average method which calculates a unemployment rate average over around 10 years.

8) The basic idea of the HP-filter is to find a trend that minimizes the weighted sum of two parts; the first part is the square of the difference between the trend and the real value, and the second part is the square of the variation in trend values.

$$Min.\left(\sum_{t=1}^{T}(y_t - s_t)^2 + \lambda\sum_{t=2}^{T}[(S_{t+1} - s_t) - (s_t - s_{t-1})]^2\right)$$

Where, y_t is real value, s_t trend, and λ constant value for restricting the variation in trend.
Meanwhile, recently, more advanced models, such as the HPMV(Hodrick Prescott Multivariate) filter method, integrating the HP-filter and economic equations have been used to estimate the natural rate of unemployment(Richardson *et al*. 2000).

9) Watson(1986) and Clark(1987) introduced the latent component method. At first, this model depended only on statistical features in decomposing the trend and cyclical components. Later, after Kuttner(1994) rebuilt this model adding economic equations, the latent component model became more popular for estimating trend factors, especially these such as potential GDP and the natural rate of unemployment.

10) The natural rate of unemployment has been estimated by a process of forecasting and revision procedure each time. First, after estimating the forecast value($X_t|_{t-1}$) in time t using the natural rate in t - 1 period, reestimate the final value($X_t|_t$) for the natural rate in time t by revising the forecast value, and temporary value for natural rate in time t, through reflecting some part of inflation forecast error. In this process, the Kalman Filter is generally used when considering the inflation forecast error.

Ⅲ. Structural Change of Labor Market in Korea

In this chapter, I would like to survey the structural change of the labor market in Korea by separating the demand and supply side, not only to examine the underlying causes of changes in unemployment but also to review the important factors in determining the level of natural rate of unemployment in the Korean labor market since 1980.

1. Structural Change of Labor Demand

First of all, it is necessary to review the trend of employment by industry. [Table 3 - 1] indicates that the rate of employment growth was sharply blunted during the period from 1981 to 1985, the third business cycle, and the recent period from 1998 to 2002. Although the low employment growth occurred during times of domestic and international shocks such as the oil shock in 1979, the political and social instability at the beginning of 1980s, and crops failures etc, the fundamental reason for the flattening out of employment growth may be attributed to economic structural weaknesses resulting mainly from duplicated investment in the heavy and chemical industry in the late 1970s. The recent low growth of employment may similarly be attributed to structural economic problems accumulated during the high growth period in the mid 1990s, though it appeared suddenly as a response to the exchange crisis in late 1997.

Looking at the employment structure by industry, the major feature is the remarkable decrease in employment in manufacturing since 1990. The truth is that its capacity to absorb has been lowered by the weak competitiveness of the light industry, the enlargement of facilities investment for manpower reduction since late 1980s, and employees' avoidance of production work, which was inferior to office work in terms of working conditions(Han & Lee 1995).[11] However, such manpower reduction due to the development of labor-saving technology development is not confined to manufacturing. After the currency crisis, a lot of employees in service industries such as finance and public enterprises, lost their jobs. The reason why the service sector cut down human resources may have been attributable, in part, to the structural adjustment in those industries due to the currency crisis, but fundamentally it resulted from the formation of a less labor-intensive working environment supported by the use of computers and advanced business techniques. Since these changes have also reflected in the work landscape, the number of semi-skilled workers has been gradually decreasing.[12] The development of labor-reducing technologies and the 'polarization of job categories' have already become generalized in advanced countries, and have been pointed out to be the major factors of structural unemployment rise as well as of the natural rate's increase.

11) What are termed the 3D industries, which means those that are dirty, difficult and dangerous, have been suffering from severe manpower shortages since 1990, in Korea, which has resulted in the permission being given for the use of foreign workers. This phenomenon previously emerged in advanced countries such as the U.S. and those of the E.U including Germany and France in order to alleviate the mismatch between labor supply and demand.

Table 3-1 Rate of Increase and Share of Persons of Employed by Industrial Sector[13]

(thousand person, %)

	1972~75 (1st cycle)[1]	1976~80 (2nd cycle)	1981~85 (3rd cycle)	1986~89 (4th cycle)	1990~92 (5th cycle)	1993~97[2]	1998~2002[2]
Agriculture etc.	2.80 (48.5)[3]	-2.66 (38.9)	-4.23 (29.6)	-2.04 (21.4)	-7.93 (15.5)	-3.04 (11.9)	-1.91 (10.7)
Mining & Manufacturing	12.32 (16.8)	6.92 (22.7)	3.58 (23.0)	8.06 (27.7)	0.52 (27.4)	-1.94 (23.4)	-1.13 (19.8)
(Manufacturing)	13.20 (16.3)	6.65 (21.9)	3.54 (22.1)	8.73 (26.8)	0.76 (27.0)	-1.84 (23.2)	-1.09 (19.7)
Service	2.50 (34.7)	7.70 (38.5)	4.97 (47.4)	4.83 (50.9)	7.30 (57.1)	4.92 (64.7)	2.05 (69.5)
(Construction)	10.56 (3.8)	11.23 (5.5)	1.71 (6.0)	6.00 (6.0)	13.99 (8.3)	3.75 (9.3)	-2.22 (7.6)
Total	4.13 (100.0)	3.22 (100.0)	1.83 (100.0)	4.07 (100.0)	2.68 (100.0)	2.22 (100.0)	0.95 (100.0)
Employment	11,108	13,184	14,461	16,572	18,581	20,313	21,025

Notes : 1) The officially announced business cycles in Korea, as is published by the National Statistical Office are as follows.
1st cycle: Mar. 1972~June 1975, 2nd cycle: June 1975~Sep. 1980, 3rd cycle: Sep. 1980~Sep. 1985,
4th cycle: Sep. 1985~July 1989, 5th cycle: July 1989~Jan. 1993, 6th cycle: Jan. 1993~Aug. 1998
2) In order to identify trends in employment after the crisis as an exception, the periods here are additionally divided to include 1993~97, 1998~2002.
3) The values in ( ) represents the fraction of the employed each industry.
Data : NSO(National Statistical Office)

12) Looking at the work environment during the period from 1993 to 2000 in terms of classification of jobs, jobs that increased during this period are skilled-jobs such as specialists, technicians, quasi-specialists, and service jobs for selling, and unskilled job depending mainly on physical work, while jobs showing a decrease during the period are office jobs, agricultural and fishing relating jobs, and machine-operating jobs.

13) Since the NSO revised the labor statistics by reflecting both the results of the survey in 2000 as to population, housing and the change of weight in the economically active population, this study uses these revised labor statistics.

In addition, according to increase of the reservation wage due to the rise of income and education levels, the preferences have been rapidly changing, resulting in a mismatch between labor supply and demand, which has led to the rise of structural unemployment. From the late 1980s, the avoidance of 3D working places in the Korean labor market and the ensuing supply-demand mismatch did not result in rise of unemployment thanks to favorable economic conditions and the enlargement of the service industry, but these favorable conditions no longer applied after the exchange crisis.

Meanwhile, we should not overlook the institutional changes to enhance the labor market flexibility when considering the causes of the natural rate. A series of institutional changes were rapidly undertaken after the currency crisis, having not only a positive effect in contributing to the efficient human resource distribution, but also a negative effect in raising the instability of employment, which has been affecting the rise of frictional unemployment.[14] Also, unemployment insurance, which was brought into general effect after the currency crisis, has had some effect on the increase of the unemployment rate. There is some evidence that those who become unemployed are more likely to stay in the labor market due to the inducement of the unemployment insurance.[15]

2. Structural Change in Labor Supply

As the main factors causing fluctuations of the natural rate of unemployment, changes in the labor force can be also pointed out, besides the structural change of industry, technological improvement, and so forth, mentioned above. If a stable labor force having high levels of skill makes up the major part of the labor market, the unemployment rate may be reduced(Murphy 1998). It is necessary, therefore, to review the factors of the labor supply affecting the fluctuation of the natural rate so as to review the trend of the change in the components of the labor force by status. In other words, skill differences and working activity by

14) The share of temporary and daily workers was about 51 percent in December 2002.

15) As benefit under unemployment insurance is only available to individuals who keep on searching for work, the actual rate of unemployment may be higher than would be the case without the insurance. In reality, searching the trend of the applicants and recipients, the numbers of both groups are much higher than before expanding the insurance, which supports the possibility of rise in the unemployment rate owing to the institutional change in unemployment insurance.

<Table> Trend of unemployment insurance applicants and recipients

	1997	1998	1999	2000	2001	2002.Jan.~July
applicants	50,991	438,455	327,929	260,407	349,245	177,370
recipients	50,774	434,199	325,220	258,727	347,388	176,496

Source : Yearbook of Unemployment Insurance, National Central Job Information Center

the gender and age within the population are very important forces in determining the labor supply. Looking at the trends of the shares in labor force in Korea by gender and age, it is easy to recognize the severe changes in labor supply structure over the past two decades. The proportion of males in the labor force, which stood at 62.5% in 1980, had steadily decreased by as much as 3.9 percentage points to 58.6 percent in 2002, while that of females, which had stood at 37.5% in 1980, had steadily increased to 41.4 percent in 2002. By age, there was a remarkable reduction of labor force in their late teens and twenties. In the case of late teens, the share of the labor force sharply decreased in the beginning of the 1980s, and has become stable since 1990. In the case of males in their 20's, the share of the labor force sharply decreased at the end of the 1980s and became stable at the beginning of the 1990s, has again been showing a sharp decrease since the crisis. On the other hand, the shares of males and females in their 30's, have steadily increased since 1980.

Table 3-2 Economically Active Populations by Gender and Age

(%)

	1980	1985	1990	1995	1997	2002
Males	62.5	61.7	59.5	59.7	59.0	58.6
15-19 years	3.9	2.0	1.3	0.9	0.8	0.7
20-29 years	16.5	16.9	13.9	13.6	12.7	10.6
over 30 years	42.2	42.8	44.2	45.1	45.5	47.4
Females	37.5	38.3	40.5	40.3	41.0	41.4
15-19 years	4.4	2.6	2.1	1.3	1.2	0.8
20-29 years	10.0	11.2	11.3	11.5	11.3	10.4
over 30 years	23.1	24.5	27.1	27.5	28.5	30.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

Data : NSO, KOSIS

For the reason why the Korean labor market shows such dramatic changes on the supply side, many economists point out the transformation of the population structure such as the ageing of baby-boom generation,[16] the slowdown of the rate of increase of the population, and so on. Together with this, higher

16) The so-called baby-boom generation indicates individuals who were born after the Korean War, during 1955~1963, so their age was about 39~47 in 2003. Since members of the generation always have major share among the population, the demographic structure has changed in accordance with aging of the baby-boom generation. For example, in the 1970s, when these generations was in its 10s, the structure resembled '10s > 20s

education induced by the change of social structure and income improvement, can be pointed as one of the major factors affecting the change of labor market. The enlargement of college admission may have induced a decrease of those in their teens in the labor market during the period of the 1980s, and the enlargement of graduate admissions and study abroad may have had an effect on the decreased share of those in their twenties during the 1990s.

Although younger people eagerly want to broaden their work experience through the first job selection, jobs for them are usually simple and repetitious work, so the possibility of a job mismatch for younger generations is generally higher. Because of these frictional reasons for unemployment, the unemployment rate of younger age bracket is notably higher than any other ages bracket. These features have been observed in Korea as well.[17]

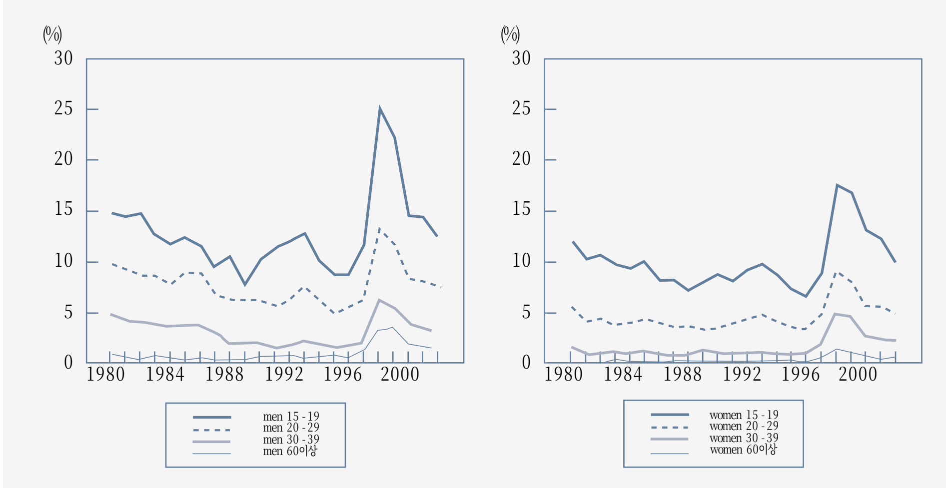
This is almost the same in the case of females. Since the working file of females is notably shorter than that of males, due to child rearing, house work, and so on, the rate of unemployment is generally higher than that of males. However, in Korea, the unemployment rate of females is much lower than that of males, which is the opposite to industrialized countries′ case. The reason may be that Korean women tend to have little inducement to stay in the labor market because members of the policies to support the unemployed are inferior to advanced countries and as a result, they show a tendency to exit the labor market as soon as they lose their jobs.

Accordingly, considering the trend of the changing components of the labor force in Korea during the period from 1980 to 2002, we guess that the structure of labor supply has been acting as a factor making for a decline of the unemployment rate. There are several representative examples to support this. Firstly, the baby-boom generation, composing the major part of the labor force has been getting older, which would mean that the labor market has been getting more stable on the supply side. Secondly, the labor force participation of females, whose unemployment rate is much lower than males′ in Korea, has been increasing steadily. Thirdly, the younger age groups subject to high frictional unemployment have a lower share of the labor market. However, it

> 30s > 40s > 50s > 60s′; however in future when these baby-boomers are in their 60s, around 2020, the demographic structure will be an inverted pyramid resembling ′60s > 50s > 40s > 30s > 20s > 10s′, and will enter the ultra-aging society, which means the share of people over 65 years old will be over 20 percent, by around 2026.

17) Interestingly, both males and females show the same pattern in the level of unemployment rate such like ′10s > 20s > 30s > 40s > 50s > 60s′. The reason of this phenomenon may be that the older are workers, the greater their job stability and the lower their job mobility, mainly due to progress in job skills.

Figure 3-1 Trend of Unemployment rate by Gender and Age



seems hard to expect that the labor supply side will continue to be a factor making for a decrease of unemployment, if we consider the limit to the younger age groups′ exit from the labor market, the reduction of the stable labor force due to the progress of the aging of society, and so on.

Ⅳ. Estimates of the Natural Rate of Unemployment and Its Usefulness

1. Estimates of the Natural Rate of Unemployment

In this section, using regression and time-series analysis methods, we estimate the natural rate of unemployment and evaluate which series is more useful in respect of fitness and forecasting power for inflation.

According to the analysis of the previous chapter, as the Korean labor market revealed severe structural changes, it is very meaningful to reflect these structural factors of the labor force when estimating the natural rate. Therefore, it would be appropriate to invoke Weiner(1993) which is able to consider the labor market features by age and gender. For more information, a latent component model, with which it is possible to estimate the time-varying natural rate by updating new information by time, is also applied. The sample period is from 1980. Ⅰ to 2002.Ⅲ.

A. Natural rate of unemployment using a regression model

For estimating the natural rate by taking into account the general structural changes in the labor force, it is necessary to follow a two-step estimation procedure: first, estimate each group′s natural rate reflecting the labor market′s structural and institutional changes, and second, estimate the overall natural rate by considering the change of the labor market′s supply side, that is, the composition of labor force by each group.

(1) Natural rate estimates by gender and age

As regards periods of structural changes as in 1987 and in 1998 in Korea[18], it is reasonable to divide the sample period into three periods, namely 1980~86, 1987~97, 1998~2002, to consider the labor market′s structural and institutional changes.

Each group′s natural rate by gender and age can be estimated as follows : first, estimate the natural rate of a reference group based on the equation between unemployment and inflation rate. Second, estimate the natural rate of the other groups using the relationship between the unemployment rate of a reference group and the others.

In order to get the natural rate of the reference group, we need to choose a reference group, and then estimate the Phillips curve of the group. Accordingly, in this research, we select the group of men aged 35~39, as the reference group, who are regarded as the most active job-searching group.[19] [20]

Equation (10) is the Phillips curve which shows the relation between inflation and unemployment. Where, π represents the inflation rate[21] and u^{mm} is a seasonally adjusted unemployment rate of a reference group. X, which subtracts fundamental inflation from overall inflation rate, is a variable for reflecting the supply shock such as the price fluctuation of energy and agricultural products. And, this equation includes the restriction, $\sum a_i = 1$, for considering the inflation stabilization condition.[22]

$$\pi_t = \gamma + \sum_{i=1}^{p} \alpha_i \pi_{t-i} + \sum_{j=0}^{q} \beta_j u_{t-j}^{mm} + \delta X_t + \xi_t \qquad (10)$$

[Table 4-1] shows that the relationship between inflation and unemployment rate is significant, though the coefficient value is not so high. The sign of unemployment rate is negative(-) during 1980~86, 1998~2002, which corresponds to theoretical relationship, that is, the trade-off relation between inflation and unemployment rate. However, during 1987~97, the traditional Phillips relationship is no longer effective. This phenomenon also appeared in [Appendix 3], on scatter plots using annual data which is roughly showing the relationship between unemployment rate and inflation rate.[23]

Table 4-1 Estimation Results of Phillips Curve for Reference Group

	1980. Ⅰ ~ 1986.Ⅳ	1987. Ⅰ ~ 1997.Ⅳ	1998. Ⅰ ~ 2002.Ⅲ
constant	0.0207	-0.0082	0.0161
	(1.37)[1]	(-1.89**)	(2.04*)
inflation$_{\{1\sim5\}}$	1.0	1.0	1.0
unemployment rate$_{\{0\sim1\}}$	-0.0066	0.0046	-0.0047
	(-1.72*)	(1.94**)	(-2.60**)
supply shock	0.70	0.67	1.53
	(0.94)	(2.67**)	(2.65**)
$\bar{R}^2$	97.9	89.2	91.3
D.W.	1.7	2.2	2.0
$\bar{\mu}^{mm}$	3.18	1.79	3.46

Nates : 1) The values in ( ) are t-values, and *, ** mean that the coefficient is significant at the 10%, 5% significance levels.

18) According to the results of Perron′s unit root test, from which it is possible to judge the time of a structural break through the lowest t-statistics, the Korean labor market seems to have experienced structural breaks around 1987 and 1998.

19) Weiner(1993) selected married men as a reference group.

20) The labor-relating features of the reference group are as follows. First of all, this group shows the highest participation rate in the labor market of any group. In addition, the unemployment rate of this group is more likely to have a high level of volatility which may mean that the labor market information of the group is the most reliable to reflect the market conditions. Conversely, the same age group of women shows a very low participation rate and a very low level of unemployment rate with weak volatility(Refer to [Appendix 1]).

21) As a proxy variable, we used the change over the previous quarter of the seasonally adjusted CPI(Consumer Price Index).

22) In addition, even though I analyzed with another revised model(below (10)′) in order to reflect the economic shock in late 1997 by adding dummy variable into the model (10), the estimation results, in terms of fitness and the significance of coefficients, are less satisfactory than those of model (10).

$$\pi_t = \gamma + \sum_{i=1}^{p} \alpha_i \pi_{t-i} + \sum_{j=0}^{q} \beta_j u_{t-j}^{mm} + \delta X_t + \lambda Dummy + \xi_t \qquad (10)'$$

$$Dummy = \begin{cases} 1, & 1998.\text{Ⅰ} \sim 1998.\text{Ⅳ} \\ 0, & \text{other periods} \end{cases}$$

23) Furthermore, the positive relation between inflation and unemployment rate still continues even when considering other independent variables such as housing prices, rents, etc. The reason may be that inflation, during 1987~97, was influenced largely by the price stabilization policy, and the labor market also did not operate on market principle due to rigidities.

Meanwhile, as the coefficient of the supply shock has positive sign and is significant as well, it is thought that supply shock was important factor to inflation variation during the overall sample periods. In particular, since its coefficient after the exchange crisis is much higher than those of other periods, the supply shock may have greatly affected on the price fluctuation during the period of the latest crisis.

Through the estimation results by way of equation (10), it is possible to derive the natural rate of the reference group, which is expressed as equation (11), if we assume that the estimation coefficients are stable.

$$\bar{u}^{mm} = \frac{-\hat{\gamma}}{\Sigma\hat{\beta}} \tag{11}$$

According to equation (11), the natural rate of the reference group in Korea is estimated to be 3.2 percent from 1980 to 1986, and 1.8 percent, and 3.5 percent, during periods 1987~97, and 1998~2002, respectively.

Next, in order to estimate the natural rates of the other groups, it is necessary to introduce some relationship between the reference group and the others such as that below (12). The background idea for this equation is a phenomenon that shows some consistent patterns in the unemployment gap among groups as in [Figure 3 - 1] (Weiner 1993).

$$u_t^j = \gamma + \sum_{i=1}^{3} \delta_i S_i + \rho u_t^{mm} + \xi, \quad j = 1, \dots, n \tag{12}$$

In equation (12), u^{mm} represents the natural rate of the reference group made up of 35~39 years old men, and u^j the unemployment rate of each five-year age group divided by gender. That is, we separate groups into men and women at intervals of 5 years, for example, 15~19 year old men, 15~19 year old women, 20~24 year old men, 20~24 year old men, and so on. And S_1, S_2, S_3, are dummy variables for seasonal adjustment of u^j, u^{mm}.

Accordingly, the equation for the natural rate of each group can be derived by substituting the natural rate of reference group, $\bar{u}^{mm}$, and smoothing a seasonal factor of unemployment.[24) 25)]

24) Because of the seasonal factor, the natural rate of the 1st quarter is $\hat{\gamma} + \hat{\delta}_1 + \hat{\rho}\,\bar{\mu}^{mm}$, and of the 2nd quarter $\hat{\gamma} + \hat{\delta}_2 + \hat{\rho}\,\bar{\mu}^{mm}$, of the 3rd quarter $\hat{\gamma} + \hat{\delta}_3 + \hat{\rho}\,\bar{\mu}^{mm}$, and of the 4th quarter $\hat{\gamma} + \hat{\rho}\,\bar{\mu}^{mm}$. As a result, the natural rate after removing the seasonal factor by averaging the constant terms become $\hat{\gamma} + (\hat{\delta}_1 + \hat{\delta}_2 + \hat{\delta}_3)/4$.

25) Refer to [Appendix 2] for the natural rate of unemployment by gender and age.

$$\bar{u}^j = \hat{\gamma} + \frac{\hat{\delta}_1 + \hat{\delta}_2 + \hat{\delta}_3}{4} + \hat{\rho}\bar{u}^{mm} \tag{13}$$

(2) Overall natural rate of unemployment integrating the changes in the labor force

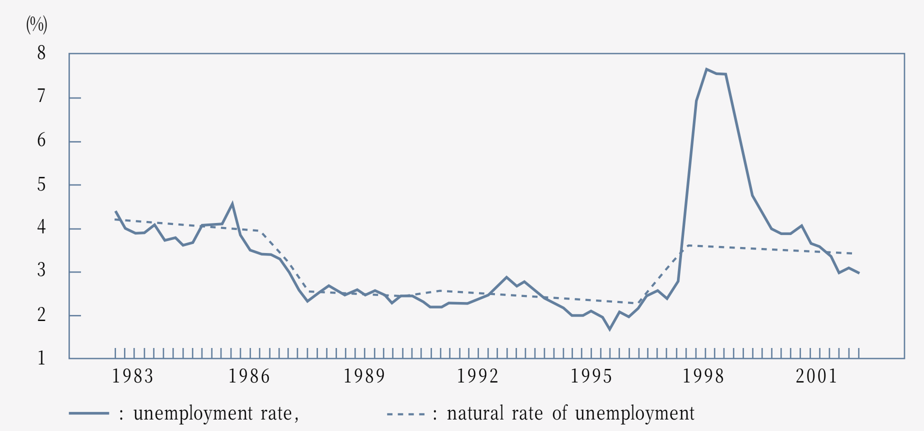
Next, based on the natural rate by gender and age estimated above, we expect to derive the overall natural rate in consideration of the composition change of the labor force. Equation (14) is a equation to estimate the overall natural rate using the economically active population by each group as weights.

$$\bar{u}_t^T = \sum_{i=1}^{n} \bar{u}^i \left(\frac{e_t^i}{\sum_{i=1}^{n} e_t^i} \right) \tag{14}$$

i = 1, ..., n, t =1980. Ⅰ ~ 2002.Ⅲ

where $\bar{u}^i$ is the natural rate of i group and e^t_i and $\sum e^i_t$ represent the economically active population of i group at time t and the overall economically active population at time t, respectively. The natural rate derived from equation (14) is [Figure 4 - 1].[26)]

Figure 4-1 The natural rate of unemployment by regression model using disaggregated data



26) For smoothing the natural rate of unemployment during the period of structural break, I adjust the estimated natural rate of unemployment at the time in the form of an equally increasing or decreasing rate.

B. Time-varying natural rate estimates using the latent component model

For estimating the natural rate by Kuttner(1994)'s latent component model, we need to set up the behavioral equation of the natural rate presenting the statistical relationship and inflation equation the presenting economic relationship. First, it is supposed that the natural rate U^T follows a random walk process. Next, inflation is assumed to be determined by the unemployment gap(unemployment rate-natural rate), past inflation, and supply shocks. That is, this equation has been constructed on the idea that inflation effects through the labor market are decided by the unemployment gap reflecting the business cycle.

$$U_t^T = U_{t-1}^T + \xi_t \tag{15}$$

$$\pi_t = \pi_\mu + A(L)(U_t - U_t^T) + B(L)\pi_{t-1} + C(L)X_t + e_t \tag{16}$$

$$B_k = 1 - \sum_{j=1}^{k-1} B_i, \quad \xi_t \sim N(0, \sigma_\xi^2), \; e_t \sim N(0, \sigma_e^2)$$

Here, U is unemployment rate using the average unemployment rate of overall industry as a proxy variable, and U^T is its natural rate. And, π is the inflation rate from the CPI, and X is a supply shock. The proxy variables for π and X are the same as in the previous regression model. $A(L)$, $B(L)$, and $C(L)$ are the polynomial equations composed of the lag operator and their lags are appointed by 2, 4, 1 respectively in consideration of the statistical significance of the coefficient and model stability. The sample period of this model is from 1980. I to 2002.III.

Meanwhile, we have exogenously endowed the standard deviation of a error term in the behavioral equation, following the idea of Gordon(1997). Because this error term decides the fluctuation of the natural rate, when σ_ξ is zero, the natural rate is constant during the sample periods and the larger is σ_ξ the larger is the fluctuation of the natural rate we estimate. In addition, for inflation stability, we add the restriction, $\sum B_i = 1$, to the equation.

Estimation results and estimates of the natural rate[27)] can be seen in [Table 4-2] and [Figure 4-2], respectively. Judging from these results, because signs of the estimate equation correspond to theoretical signs and the significances are also generally satisfactory, we can conclude the estimation model is acceptable.

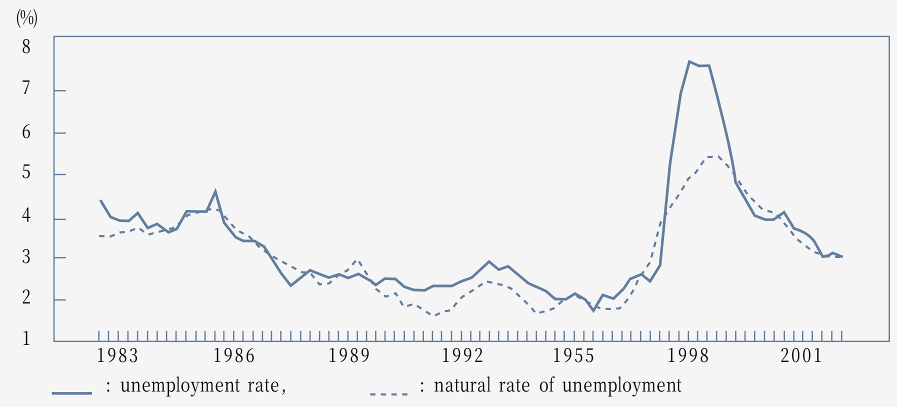
27) The natural rate of unemployment is the result of using a Kalman smoother.

Table 4-2 Estimation results of the latent component model[1)]

Variables	coefficient	t-value[2)]
A_1	-1.0829	-5.352**
A_2	0.3315	1.387*
B_1	0.7891	2.238**
B_2	0.0075	0.020
B_3	0.3813	1.496*
π_μ	0.1299	0.156
C	1.3494	8.491**
σ_e	0.6016	5.964**

Notes : 1) These results are based on the assumption that the standard error of natural rate equation, σ_ξ, is equal to 0.4.
2) *, ** means that the coefficient is significant in 10%, 5% significance level, respectively.

Figure 4-2 Trend of natural rate of unemployment estimated by the latent component model



The trend of the natural rate estimated by the latent component model is similar to the series estimated by the regression model, though the fluctuation patterns of two series show a slight difference. Summing up the results of the scatter plot and two estimation methods(see [Table 4-3]), the natural rate in Korea, had been running at about 4 percent from 1983 to 1986 and declined to 2.5 percent from 1987 to 1997, but after a sharp rise due to the currency crisis in late 1997, it showed a more stable pattern, moving at around 3 percent in 2002.

Table 4-3 Comparison of Estimation Results

(%)

	1983 ~ 86	1987 ~ 97	1998 ~ 2001	1998	1999	2000	2001	2002. I ~ III
Natural rate of unemployment								
scatter plot	around 4	around 2.5	-	-	-	-	-	-
regression	4.1	2.5	3.6	3.6	3.6	3.5	3.5	3.4
latent component	3.8	2.3	4.2	4.7	5.3	4.3	3.4	3.0
Rate of unemployment	3.9	2.5	4.9	6.8	6.3	4.1	3.7	3.0

2. Examination of Usefulness of the Unemployment Gap

Now, we intend to evaluate the natural rate estimates through unemployment gap, which is the deviation of unemployment from its natural rate, in the light of the reasonability as an inflationary pressure index. In other words, we are planning to compare the usefulness of the estimated unemployment gaps in respect of both the fitness of inflation behaviour and forecasting power of inflation. Together with this, it would be meaningful to examine the lag structure and asymmetric effect of the unemployment gap on the inflation rate in terms of the monetary authority's decision.

First of all, we set up the inflation forecasting model as below, with independent variables such as past inflations, unemployment gaps, and supply shock variables. The lag of independent variables was selected through the general to specific method.

$$\pi_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \pi_{t-i} + \sum_{j=0}^{q} \delta_{1i} NGAP_{t-i} + \alpha_1 X_t + \varepsilon_t \tag{17}$$

As a proxy variable for the inflation rate, π we have used two series; the one is the inflation rate over the previous quarter, and the other is the rate over the same quarter of the previous year. *NGAP* indicates an unemployment gap, and is denoted as *NGAP*1 when using the unemployment gap from the regression model and as *NGAP*2 when using the unemployment gap from the latent component model. For the variable of *X*, the difference between overall inflation and the underlying inflation rate was used. Therefore, considering all possible combinations, there are six estimation models to use for comparing the usefulness of the two series unemployment gaps. The sample period is during 1983. I ~ 2002. II.

Meanwhile, we intend to use Theil's inequality coefficient as fitness test statistics. π_t^S, π_t represent the fitted value and the real value respectively. Since the range of Theil's value is $0 \leq U \leq 1$ and $U = 0$ means $\pi_t^S = \pi_t$, the nearer U is to zero, the greater the forecasting power.

$$U = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(\pi_t^S - \pi_t)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}\pi_t^{S2}} + \sqrt{\frac{1}{T}\sum_{t=1}^{T}\pi_t^{S2}}} \tag{18}$$

[Table 4 - 4] show the estimation results of the inflation forecasting model. According to these results, the model's explanatory power, judging from adjusted R^2, is much higher when considering the unemployment gap than without it, in any episode of inflation. In particular, judging from adjusted R^2 and Theil's inequality coefficient, the unemployment gap through the latent component model is more powerful than that of the regression model.

Table 4-4 Estimation Results of Inflation Forecasting Model (1983. I ~ 2002. III)

	inflation rate over previous quarter			inflation rate over same quarter last year		
(p,q)[2)]	I - 1[1)] (p = 3)	I - 2 (p = 3,q = 1)	I - 3 (p = 3,q = 2)	II - 1 (p = 5)	II - 2 (p = 5,q = 4)	II - 3 (p = 5,q = 4)
constant	0.39 (2.82**)[3)]	0.50 (3.92**)	0.26 (2.36**)	0.40 (1.66)	0.32 (1.31)	0.26 (1.29)
inflation	0.59 (5.57**)	0.54 (5.58**)	0.82 (9.55**)	0.89 (18.93**)	0.91 (18.98**)	0.98 (23.72**)
unemployment gap	-	-0.24 (-4.16**)	-0.50 (-6.12**)	-	-0.20 (-1.98*)	-0.92 (-6.06**)
supply shock	1.11 (7.50**)	1.11 (8.31**)	1.09 (9.55**)	1.22 (5.70**)	1.28 (6.39**)	1.26 (7.42**)
D.W.	1.71	1.81	2.00	1.71	1.92	2.13
$\bar{R}^2$	0.51	0.60	0.76	0.87	0.87	0.92
Theil's inequality coefficient	0.211	0.182	0.138	0.076	0.064	0.057

Notes: 1) Models I - 2 and II - 2 use the unemployment gap from regression, while models I - 3 and II - 3 use those of the latent component method.
2) Notifying in Eq. (17), p, q indicate the maximum lag of inflation and unemployment gap, respectively.
3) The values in ( ) are t-value, and *, ** mean that the coefficients are significant in 10%, 5% significance level, respectively.

Next, in order to examine the usefulness of the unemployment gap in future inflation forecasts, we will check the forecasting power of each unemployment

Table 4-5 Comparison of Forecasting Power (1997 ~ 2002)

(p,q)[2]	inflation rate over previous quarter			inflation rate over same quarter last year		
	Ⅰ-1 (p=3)	Ⅰ-2 (p=3,q=1)	Ⅰ-3 (p=3,q=2)	Ⅱ-1 (p=5)	Ⅱ-2 (p=5,q=4)	Ⅱ-3 (p=5,q=4)
1997	0.17422	0.18705	0.16337	0.06564	0.08569	0.05450
1998	0.39872	0.45863	0.13021	0.11095	0.18999	0.09920
1999	0.37738	0.55078	0.46189	0.59394	0.68262	0.77628
2000	0.22259	0.26029	0.23413	0.14478	0.14706	0.16136
2001	0.20797	0.22056	0.14696	0.09037	0.08851	0.08533
2002	0.14410	0.16216	0.05380	0.12532	0.12939	0.08152

Notes : 1) The shaded parts represent that Theil's inequality coefficient is the lowest.
2) Notifying in Eq. (17), p and q indicate the maximum lag of inflation and unemployment gap, respectively.

gap during the period from 1997.Ⅰ to 2002.Ⅲ using the above forecasting model and equation (17). Where the forecast model has been used the estimated results under the same independent variables and lag structure are as those of the above model during 1983.Ⅰ~1996.Ⅳ periods. See [Table 4-5], the forecast values using the unemployment gap estimated by the latent component model are superior to that of regression model except for 1999 and 2000.[28)]

As [Figure 4-3] represents the forecast results during from 2001.Ⅰ to 2002.Ⅲ periods, we know that the forecast value using the unemployment gap of the latent component model has approximately followed the real inflation, as well as the turning point of the real value.

And now, it would be informative to grasp the spillover effect of the unemployment gap on inflation through an impulse-response experiment based on VAR(Vector Auto-Regression) model.[29)] [Figure 4-4] shows the spillover effect of the 1 percent point shock in unemployment gap on inflation. Seeing the impulse response results, the shock of the unemployment gap on inflation reaches its highest level after 3~5 quarters, and the effects disappear after 3 years. The effect of the unemployment gap on inflation can be also confirmed through the cross-correlation coefficient between the two variables. As in [Figure 4-5], the negative correlation between the unemployment gap and inflation is the highest after 3 and 4 quarters, and this relationship becomes extinct after 12 quarters(3 years).

Lastly, we need to examine the asymmetric effect of the unemployment gap on inflation. If the unemployment gap affects inflation with a different scale by each business cycle phase, it would be possible to augment the forecasting power by reflecting asymmetric behaviors of the unemployment gap. In order to

28) The inflation forecast errors in 1999, 2000 are much greater in all forecasting models. The reason may be that not only was economic uncertainty very high, but also some institutional changes such like the introduce of inflation targeting seemed to be at work. Meanwhile, the order of forecasting power is the same in case of changing the period of estimation model.

29) The VAR model contains only two variables, inflation rate and unemployment gap, and adds supply shock as an exogenous variable. The time lags are 4 quarters, and the order of variables is inflation first, unemployment gap next.

$$\pi_t = \alpha_{10} + \sum_{i=1}^{p} \beta_{1i}\pi_{t-i} + \sum_{j=1}^{q} \delta_{1i} NGAP_{t-i} + \alpha_{11}X_t + \varepsilon_{1t}$$

$$NGAP_t = \alpha_{20} + \sum_{i=1}^{p} \beta_{2i}\pi_{t-i} + \sum_{j=1}^{q} \delta_{2i} NGAP_{t-i} + \alpha_{21}X_t + \varepsilon_{2t}$$

Where, π is inflation, *NGAP* unemployment gap from latent component model, and *X* supply shock. The estimation period is from 1990.Ⅰ to 2002.Ⅱ.

Figure 4-3 Inflation Forecast (2001.Ⅰ~2002.Ⅲ)

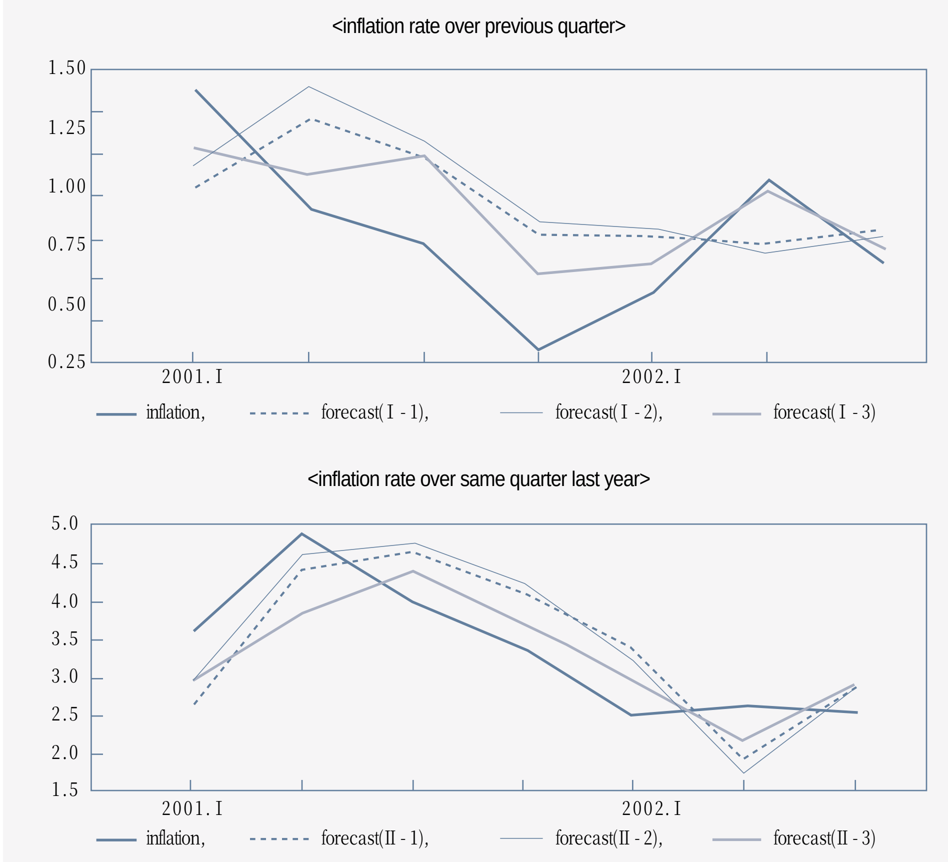


Figure 4-4 Response of Inflation to a -1 Percentage Point Shock of the Unemployment Gap

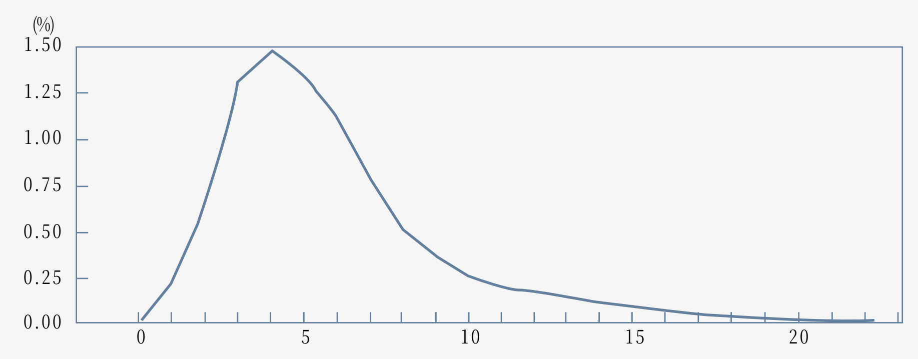
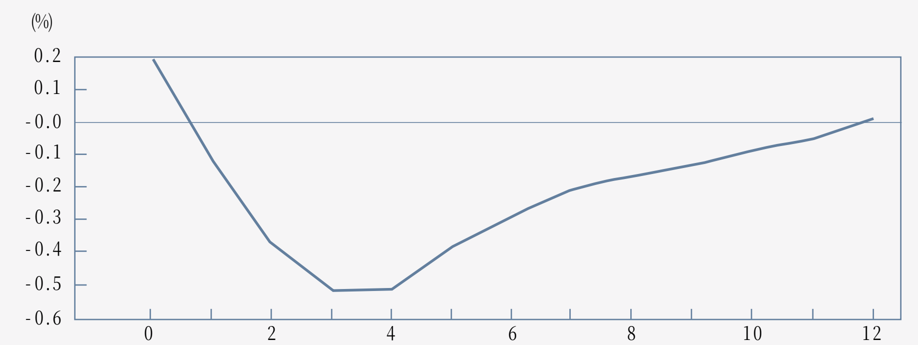


Figure 4-5 Cross-Correlation between Unemployment Gap and Inflation Rate



Note: Cross-correlation between unemployment gap(t-i) and inflation rate(t), where, i=0, 1, 2, ... , 12

measure inflation effect differences according to positive or negative unemployment gaps, we set up a model as in equation (19) which divides the unemployment gap according to its sign. The unemployment gap is the value from the latent component model.

$$\pi = \alpha_0 + \sum_{i=1}^{p} \beta_i \pi_{-i} + \sum_{j=0}^{q} \delta_{1i}(D^+_t + D^-_t)\, NGAP_{t-i} + \alpha_1 X_t + \varepsilon_t \qquad (19)$$

$$= \alpha_0 + \sum_{i=1}^{p} \beta_i \pi_{-i} + \sum_{j=0}^{q} \delta^+_i NGAP^+_{t-i} + \sum_{j=0}^{q} \delta^-_i NGAP^-_{t-i} + \alpha_1 X_t + \varepsilon_t$$

Where, D^+ is 1 when unemployment gap is positive(+), and 0 in other cases

D^- is 1 when unemployment gap is negative(+), and 0 in other cases

$NGAP^+$ is the value of the unemployment gap when it is positive(+), and 0 in other cases

$NGAP^-$ is the value of the unemployment gap when it is negative(+), and 0 in other cases

Seeing the estimation result(See [Table 4-6]), the coefficient of the negative unemployment gap is three times larger than that of the positive unemployment gap. As it means that the effect of the negative unemployment gap on inflationary pressure are about 3 times higher than the effect of the positive unemployment gap on deflationary pressure, it can be interpreted as showing that the authority should be much more careful when the unemployment gap is negative.

Table 4-6 Effect of Positive(+) and Negative(-) Unemployment Gap on Inflation (1983. Ⅰ ~ 2002. Ⅲ)

		constant	inflation [1~5]	positive(+) unemployment gap[1~4]	negative(+) unemployment gap[1~4]	supply shock	D.W.	$\bar{R}^2$
inflation rate	over previous quarter	0.18 (1.59)	0.82 (9.85**)	-0.42 (-4.75**)	-1.51 (-3.94**)	1.09 (10.37**)	1.95	0.78
	over same quarter last year	-0.24 (-0.11)	1.00 (25.37**)	-0.81 (4.36**)	-2.96 (-2.85**)	1.19 (6.70**)	2.04	0.93

Note : 1) The values in ( ) are t-value, and *, ** mean that the coefficients are significant at the 10%, 5% significance levels, respectively.

Ⅴ. Conclusion

This paper has examined the usefulness of the unemployment gap as an inflationary pressure index in Korea. It also introduced and applied various methods of estimating the natural rate of unemployment.

First of all, as estimation methods for the natural rate of unemployment, we applied the regression method using disaggregated data and a latent component model using aggregated data. The former has the merit of being able to estimate the natural rate properly reflecting the labor supply-demand structure in Korea, while the latter has the merit that is able to estimate the time-varying natural rate reflecting the economic changes by each time-period.

According to estimation results, the estimates of the natural rate of unemployment in Korea were running at about 4 percent from 1983 to 1986, and declined to 2.5 percent from 1987 to 1997, but after a sharp rise due to the currency crisis in late 1997 it has shown a more stable patten, moving around 3% in 2002. Judging from the abrupt change of the natural rate after a domestic or overseas shock, the Korean labor market seems to be very vulnerable to economic shocks. One of the major factors causing the weakness of labor market might be pointed out as its rigidity, which did not allow it to keep pace with the rapid industrial structural changes. The troubles caused by labor market rigidity are expected to be largely solved thanks to the structural and institutional improvements after the crisis. However, since job polarization and labor-saving technology development are gradually becoming widespread in Korea, the possibility of structural unemployment is expected to be much higher.

Secondly, according to the estimation results for testing the usefulness of the unemployment gap, which is the deviation of the unemployment rate from its natural rate, inflation models with the unemployment gap as an independent variable are superior to models without it in terms of model fitness. Furthermore, the unemployment gap estimated using a latent component model is more useful in inflation forecasting than that estimated from a regression model.

Lastly, the diffusion effect of the unemployment gap on inflation is the highest after 3~5 quarters, and the effect disappeared after 3 years. Regarding the asymmetric effect of the unemployment gap on inflation, the magnitude of a negative unemployment gap is, also, three times as large as that of a positive unemployment gap.

<References>

[In Korean]

Kim, B., "Recent Behavior of Labor Market and Effective Unemployment Rate," *SERI Issue Paper*, 2001. 12.

Kim, C., "Economic Structural Changes and Labor Supply-Demand," 『Macroeconomic Paradigm for the Korean Economy』, 2001, Hangilsa, pp. 530~71.

______ · S. Moon, "Potential GDP and Inflation in Korea," *Economic Analysis*, Vol. 6 No. 1, Economic Studies Office, Bank of Korea, 2000, pp. 1~32.

Sin, K., "The Rate of Unemployment and Natural Rate of Unemployment in Korea," 『Economic Crisis and Change in Unemployment Structure』, Korea Labor Institute, 1999. 12, pp. 97~132.

______, "Estimation of the Natural Rate of Unemployment in Korea and the Rise of the Unemployment Rate After the Crisis in 1997," in 『Understanding the Korean Economy』, Korea Institute of Finance,, 2001. 4, pp. 1~55.

Ahn, J., "Economically Active Population and Revised Weights-Changes in Labor-related Indices," *Monthly Labor Trend*, Korea Labor Institute, 2003. 4., pp. 39~52.

______ · J. Chun, "NAIRU of Korea," *Quarterly Analysis of Labor Trend*, Korea Labor Institute, 2000. 3 · 4.

Yu, K,. "Estimation of NAIRU and Its Implications," *KDI Economic Prospects*, Korea Development Institute, Vol. 17 No. 2, 2000.

Lee, J., "Determinants and Dynamic Process of Inflation in Korea," *Economic Analysis*, Vol. 5 No. 2, Bank of Korea, 1999, pp. 29~77.

Lim, Y., "Structural Change of Labor Market and Its Impact," *Monthly Bulletin*, Bank of Korea, 2000. 7, pp. 27~42.

Chang, D., "Potential GNP of Korea," *Economic Analysis*, Bank of Korea, Vol. 2 No. 1, 1996, pp. 29~68.

Chang, S. and P. Baek, 『IMF and Unemployment』, SERI, 1998. 6.

Cho, W., and B. Jeong, "Effect of Minimum Wage System," *Working Paper* 90-14, Korea Labor Institute, 1990. 11.

Han., S. and S. Lee, "Structural Changes in the Korean Labor Market," *Monthly Bulletin*, Bank of Korea, 1995. 5, pp. 8~29.

Huh, J., "Features of Wage and Price Equation of Korea-Comparison of Korea and Other Industrialized Countries, Germany, France, Italy, U.K., U.S., and Japan," *Quarterly Analysis of Labor Trends*, Korea Labor Institute, 2001. 1 · 4.

[In English]

Blanchard, Olivier and Lawrence F. Katz, "What We Know and Do Not Know About the Natural Rate of Unemployment," *Journal of Economic Perspectives*, Vol. 11, No. 1, Winter 1997, pp. 51~72.

Clark, Peter K., "The Cyclical Component of U.S. Economic Activity," *Quarterly Journal of Economics*, November 1987. pp. 797~814.

Espinosa-Vega, M., and Steven Russel, "History and Theory of the NAIRU: A Critical Review," FRB of Atlanta *Economic Review*, Second Quarter 1997, pp. 4~25.

Estrella, Arturo and Frederic S. Mishikin, "Rethinking the Role of NAIRU in Monetary Policy:Implications of Model Formulation and Uncertainty," *NBER Working Paper Series*, No. 6518, April 1998, pp.1~46.

Friedman, Milton, "The Role of Monetary Policy," *American Economic Review*, Vol 68 No. 1, 1968, pp.1~17.

Gordon, Robert J., "The Time-Varying NAIRU and Its Implications for Economic Policy," *Journal of Economic Perspectives*, Vol. 11, No. 1, Winter 1997, pp. 11~32.

Lucas, Robert E., Jr., "Expectations and the Neutrality of Money," *Journal of Economic Theory*, Vol 4, 1972, pp.103~24.

Lucas, Robert E., Jr. and Thomas Sargent, "After Keynesian Macroeconomics," Federal Reserve Bank of Minneapolis *Quarterly Review* 3(Spring), 1979, pp. 1~16.

Kuttner, Kenneth N., "Estimating Potential Output as a Latent Variable," *Journal of Business & Economic Statistics*, Vol. 12, No. 3, July 1994, pp. 361~68.

Mankiw, N. Gregory, 「Macroeconomics」, Worth Publishers Inc., 2000.

Modigliani, Franco & Lucas Papademos, "Targets for Monetary Policy in the Coming Year," *Brookings Papers on Economic Activity*, No. 1, 1975, pp. 141~63.

Murphy, Robert G., "Accounting for the Recent Decline in the NAIRU," paper presented at the 40th Annual Meeting of the National Association for Business Economics, Washington, D. C., Oct. 1998.

Phelps, Edmund, "Phillips Curves, Expectations of Inflation, and Optimal Unemployment over Time," *Economica* Vol 34, August 1967, pp. 254~81.

Richardson, Pete, Laurence Boone, Claude Giorno, Mara Meacci, David Rae and David Turner, "The Concept, Policy Use and Measurement of Structural Unemployment: Estimating a Time Varying NAIRU Across 21 OECD Countries," *Economics Department Working Papers* No. 250, OECD, June 2000, pp. 1~75.

Staiger, Douglas, James H. Stock and Mark W. Watson, "The NAIRU, Unemployment and Monetary Policy," *Journal of Economic Perspectives*, Vol. 11, No. 1, Winter 1997, pp. 33~49.

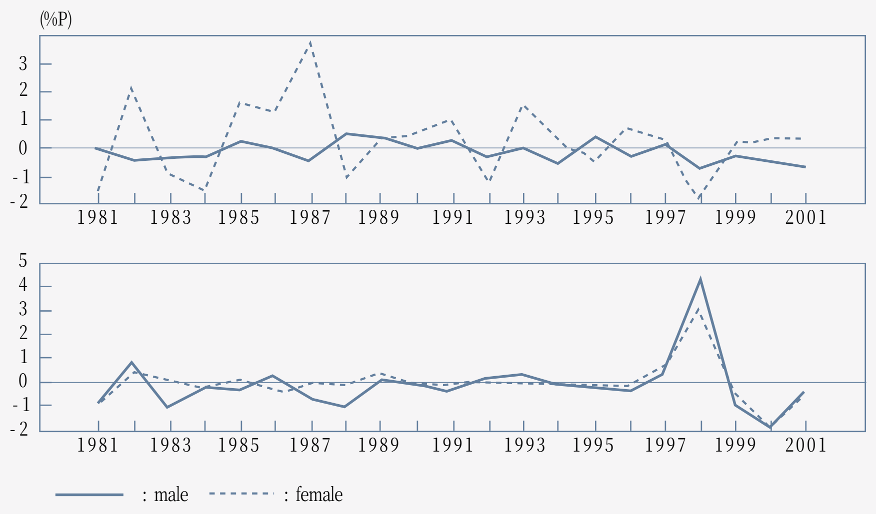
Watson, Mark W., "Univariate Detrending Methods with Stochastic Trends," *Journal of Monetary Economics* 18, 1986, pp. 49~75.

Weiner, Stuart E, "The Natural Rate of Unemployment: Concepts and Issues," Federal Reserve Bank of Kansas City, *Economic Review*, 1986 Jan., pp.11-24.

Weiner, Stuart E, "New Estimates of the Natural Rate of Unemployment," Federal Reserve Bank of Kansas City, *Economic Review*, 1993 Jan., pp.53-69.

Appendix 1. The Rate of the Economically Active Population and nemployment of 35~39 Year Old Men

<The Variation Trend of Two Indexes>



<The Trend of Two Indexes>

		1980	1985	1990	1995	1997	1998	1999	2000	2001
Male	Economically Active Population	97.3	96.5	97.0	97.0	97.0	96.3	96.1	95.7	95.2
	Unemployment Rate	4.8	3.2	1.7	1.7	1.8	6.1	5.2	3.5	3.3
Female	Economically Active Population	53.1	52.9	57.9	59.2	60.4	58.5	58.7	59.1	59.5
	Unemployment Rate	1.5	1.0	0.8	0.8	1.8	4.7	4.4	2.5	2.2

Sources : NSO, KOSIS DB

Appendix 2. The Natural Rate of Unemployment by Gender and Age

(%)

	1980. I ~1986. II	1987. I ~1997. II	1998. I ~2002. II
Male			
15~19	13.31	9.89	13.94
20~24	11.68	9.15	12.12
25~29	6.39	4.78	6.70
30~34	3.54	2.21	3.82
35~39	3.18	1.79	3.46
40~44	3.03	1.74	3.30
45~49	3.12	1.64	3.45
50~54	2.91	1.52	3.22
55~59	2.52	1.20	2.82
over 60	1.02	0.50	1.12
Female			
15~19	10.27	7.97	10.67
20~24	6.46	5.08	6.68
25~29	2.43	1.73	2.56
30~34	1.63	0.89	1.77
35~39	1.49	0.72	1.64
40~44	1.45	0.67	1.60
45~49	1.10	0.51	1.23
50~54	0.94	0.29	1.08
55~59	0.68	0.27	0.75
over 60	0.28	0.10	0.33

Appendix 3. Scatter Plot of the Unemployment rate(u_{t-1}) and Inflation Variation($\Delta\pi$)