Assessment of Deflation Risk in Korea

Woong Kim*

Abstract

Due to the global financial crisis, inflation in major countries such as the U.S., Europe and Japan is on the decline, and some agencies forecast inflation in major countries to be in a negative territory. These phenomena are exacerbating the concerns about deflation risk. If deflation, which is generally perceived as long-run economic recession, becomes widely contagious, it could severely affect the financial markets and might serve as a factor seriously rattling economic agents' confidence about market conditions.

Recently, with the growing concerns about the economy deteriorating more than expected, some are raising the possibility of deflation. On the basis of annual average changes, negative inflation (consumer price basis) has never been recorded in Korea since 1966. However, if the global economic downturn deepens and persists in the long run, it is difficult to deny the possibility that, starting largely with some commodities, inflation could slow down sharply. This study strives to assess the risk of deflation in Korea by calculating it into concrete figures, based upon the methodology used by the International Monetary Fund, and other econometric analyses.

On an end-of-2008 basis, the risk of deflation in Korea is evaluated by using a variety of methodologies such as the IMF Vulnerability Index and the distributional characteristics of price changes. The results show the possibility of deflation to be extremely slim. Furthermore, according to the analysis of both the upside and downside risk probabilities of inflation occurrence in 2009, former seems greater than the latter.

JEL Classification Number: C5, E31, E37
Keywords: Deflation, Inflation, Monetary policy

* The Bank of Korea (E-mail: kw@bok.or.kr)

This paper is the translated version of the paper from 「Economic Analysis」 Vol.16 No.2 in 2010.

I. Introduction

The global financial crisis has led the rate of price growth in major countries including the U.S., Europe and Japan to decline since July 2008,[1] and some institutions have released negative inflation forecast for the major countries,[2] raising concerns about the possibility of deflation. Notably, since the FRB commented officially on the possibility of deflation in its FOMC minute in October. 2008,[3] worries about deflation have been continually raised, mainly in major countries. In general, deflation is perceived as a sign of long-term economic recession. For this reason, the frequent use of the term 'deflation' could act as a factor exacerbating the psychological anxiety of economic agents.

Recently, amid growing concerns that the economy might deteriorate more than expected this year in Korea, some argue about the possibility of deflation. On an annual average basis, Korea has never witnessed a single case of negative inflation (consumer price basis). However, if the global economic downturn deepens more than expected and persists in the long-term, it is difficult to deny the possibility that, starting largely with some commodities, inflation would slow down sharply. While it is important to assess the risk of deflation, just as it is that of inflation, it is hardly known specifically what the risk of deflation in Korea is. It is also necessary for us to review the theoretical discussions of whether the problems of deflation might impact Korea. The reports of deflations in other countries discuss the possibility of its occurrence based upon several economic indicators, without analysis of how much the deflation risk is. It is even unclear by which criteria the studies judge the possibility of deflation. To discuss the concerns about occurrence of deflation, however, it is required of us to understand the current situation by conducting relative assessment of how serious the risk of deflation is, by using specific numbers.

While the real economy in Korea is now sliding into a sharp downturn since the global financial crisis, institutions[4] at home and abroad forecast that Korean

1) Comparing the consumer price growth rate in July and December, when the rates are at their lowest and highest, respectively, in major countries (relative to the previous year), the U.S. saw its rate drop from 5.5% to 0.1% while the Euro zone and Japan witnessed rate declines from 4.0% to 1.6% and 2.3% to 0.4 %, respectively.

2) In their forecasts of CPI inflation for these countries, Global Insight (△2.2%), Morgan Stanley (△1.3%), Citi (△1.2%), Goldman Sachs (△0.8%) and Barclays (△0.7%) all suggested negative inflation for the U.S. while Citi (△1.3%), Goldman Sachs (△0.7%), UBS (△0.6%) and, Barclays (△0.4%), and Global Insight (△0.3%) anticipated negative inflation for Japan. In contrast, the forecasters predicted that CPI in the Euro zone would remain at a low but positive level (0.2%~1.1%).

3) Some FOMC members thought that aggressive easing "should reduce the odds of a deflationary outcome."

consumer inflation will rise between 0.8% and 4.0% in 2009. Judging by this inflation forecast released by major institutions, it therefore seems unlikely that deflation will occur in Korea in 2009. However, as most forecasts are derived by using conditional means and do not contain information on the probabilities of upside and downside risks compared to the forecasts, assessment of the possibility of deflation should be made from the perspective of risk. As VaR (Value-at-Risk)[5] makes assessment based upon the tail of the asset return distribution, it is more appropriate that assessment of the possibility of deflation should also be focused on the tail of forecast distribution rather than conditional mean.

In this context, this study strives to calculate and assess the possibility of deflation in Korea into specific figures, and to derive the related policy implications. I would like to apply a methodology based on the index of deflation vulnerability of the IMF, and a recently published methodology based on the inflation distribution. And to supplement the limited existing methodologies with which it is difficult to reflect the characteristics of price changes for individual items, I newly apply a micro methodology using the distribution of price changes for each item. As it is quite difficult to predict the possibility of deflation, I try to verify it from a variety of perspectives.

The main analysis results gained from the various methodologies are as follows. After assessing the risk of deflation occurrence in Korea for 2009, through the vulnerability index of the IMF on an end-of-2008 basis and the characteristics of distributions, I find the possibility of deflation to be extremely slim. Further, after comparing the probabilities of both the downside and upside risks for 2009, I find that upside risk is still greater.

The remainder of this paper is organized as follows. In Section Ⅱ, I look over the definition of deflation and investigate the theoretical discussions of the problems that deflation causes. In Section Ⅲ, I assess the risk of deflation occurrence in Korea for three separate cases, using the vulnerability index of the IMF, the probability distribution of inflation forecasts and the distribution of price changes for each items. Finally, in Section Ⅳ, I summarize the analysis results and suggest some implications.

4) On an end-of-2008 basis, Global Insight (0.8%), Deutsche Bank (1.6%), Goldman Sachs (2.0%), Barclays (2.2%), Merrill Lynch · Korea Economic Research Institute (2.5%) and KDI (2.6%) suggested lower forecasts than Bank of Korea, the IMF, Morgan Stanley and CITI (3.0%) did, while other eight institutions released higher forecasts.

5) VaR implies the expected maximum potential loss in the financial asset portfolio held by a financial institution when market conditions become unfavorable.

II. Definition of Deflation and its Theoretical Discussion

As use of the term 'Deflation' itself could be perceived as indicating existence of a serious situation, I would like to examine what deflation is and the theoretical discussions of why deflation becomes an issue.

1. Definition of Deflation

Conventionally, deflation, the concept of opposite to inflation, is defined as 'negative' inflation in which the prices change falls below zero along with a sustained decline in the overall price level. However, studies (Bordo and Filado 2005, etc) about historical episodes of deflation in individual countries define it as a phenomenon in which price changes (annual average basis) decline below a certain level (for instance, the inflation bias or the floor of the inflation target range).

Deflation implies that the price level continuously falls for a certain period, rather than declining temporarily. In general, a decline in prices does not imply a decline in a specific sector but a decrease in the prices of goods and services that are subjects of the inflation targeting by central banks. Therefore, deflation is generally assessed by using the CPI. It is also assessed by using the GDP deflator or PPI, depending upon the purposes of analysis. Although some link its discussion to asset deflation because declines in the prices of assets such as stocks and real estate cause contractions in consumption and investment, it is still under debate whether the deflation in terms of goods and service prices is linked with asset deflation. In this study, I discuss deflation of the goods and service prices, which are the inflation targets of central banks. Deflation is distinguished from disinflation, in which change in price decreases while inflation still remains positive.

As the Aggregate Demand and Aggregate Supply model shows deflation to be explained by a shift in the supply or the demand curve, deflation is categorized as either benign deflation or malign deflation. Benign deflation is the phenomenon whereby prices decline in line with an increase in aggregate supply due to productivity improvement. Malign deflation is the phenomenon when prices decline in accordance with a contraction in aggregate demand such as consumption and investment. What presents problems is malign deflation both output and prices fall simultaneously.

2. Theoretical Discussion

The reason deflation emerges as policy issue is because it causes the following problems. First is the decrease in aggregate demand resulting from the increase in real interest rates. When intensified deflation reduces nominal interest rates to almost the zero level, this increases real interest rates because of the lack of room for further decline in nominal rates. Consumption and investment consequently contract. Second problem is the reduction in production and employment caused by the increases in real wages. When the deflation occurs, real wages increases due to the downward rigidity of nominal wages, and the reduction in employment and production generated by this process above, could exacerbate economic contraction. The third problem is the weakened economic activity stirred by consumers' postponing of their consumption. If the price level is expected to decline in the future, consumers postpone their consumption now and plan to consume later. This could then reduce consumption and cause economic contraction.

The fourth problem is the decrease in aggregate demand generated by debt deflation. Despite the decrease in prices, debtors witness their actual burdens of debt repayment grow because their principal remains the same, which increases the risk of debt default. The insolvencies of financial institutions caused by the above process, result in a subsequent credit crunch. After then, this crunch induces declines in consumption, investment and aggregate demand. More specifically, when monetary contraction and the decline in asset prices provoked by debt repayment and sales of assets for repayment, respectively, intensifies deflation (Fisher 1933), and contractions in consumption and investment (Minsky 1982) for financial institutions losses are generated due to deflation. Then the weakening of financial intermediaries by the above process, worsens the credit crunch (Bernanke 1983).

The fifth problem caused by deflation is the limitations of policy responses such as monetary and fiscal policy. As nominal interest rates cannot fall below 0, the policy of decreasing interest rates has a limited effect, and in the worst-case scenario, monetary policy could lose its effectiveness altogether. Fiscal policy would either not have a great effect if consumers reduce their consumption and increase their savings out of expectations of increased taxation (Ricardian equivalence effect), and a rise in government borrowing for fiscal expansion could have a crowding-out effect on consumption and investment. The sixth problem is the possibility of a vicious deflationary spiral, that is, a cycle in which deflation causes an economic downturn (credit crunch) and the downturn

leads to further deflation again, and as a result, long-term economic recession (credit crunch) occurs.

3. Trends of Price Change in Korea

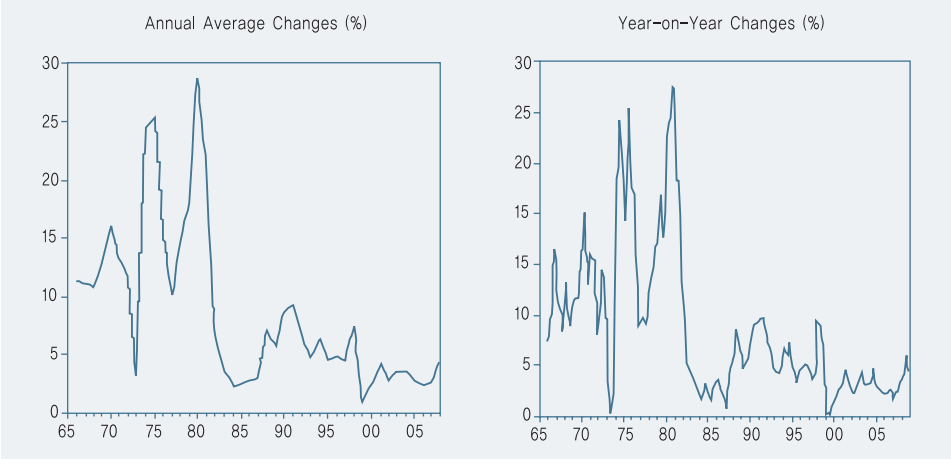
Before assessing deflation risk, I would like to examine the past cases of deflation in Korea, by using the criteria generally used in the literature. Studies of deflation cases in different countries usually conduct analyses using the annual averages of inflation. Depending upon the purpose of analysis, some studies examine deflation by using inflation compared to the same months of the previous years, although, due to the highly volatile changes in prices compared to the same months of the previous years, this method is not widely used.

As displayed in <Figure 1>, the change in consumer prices since 1966 indicates that Korea has seen disinflation but has not undergone deflation (negative inflation basis). Even compared to the same months of the previous years, consumer price change has never been in negative territory. However, there have been three periods when the rate of change dropped below 1% when we consider upward bias[6] of CPI. The three periods occurred in 1997 (between July and August, 0.3%~0.9%), 1987 (between January and February, 0.5%~0.9%) and 1999 (between February and September, 0.2%~0.9%).[7]

6) Upward bias in the consumer price index means that CPI is overestimated compared to real prices due to measurement bias in the method of constructing the index. Measurement bias consists of new product bias, quality change bias, substitution bias resulting from fixed weight and outlet bias. The conventional CPI upward bias of major countries such as the U.S., Japan and Europe is analyzed at between 1% and 1.5%. For Korea, however, no preceding study on upward bias has been carried out. Although it is necessary for us to examine whether deflation occurs based on the adjustment of measured bias, the scope of CPI upward bias is very broad and should be left for research in the future.

7) Because of the government's price stabilization measures in 1973, the price stabilization measures and exchange rate appreciation in 1987, and the currency depreciation and exchange rate appreciation crisis in 1999, excessive demand pressure did not occur in these years and, change of CPI stayed relatively low.

Figure 1 CPI Changes in Korea



Source: The Statistics Korea

III. Assessment of Deflation Risk

In this section, I would like to suggest specific figures for deflation risk in Korea. Regarding macro methodology, for the derivation of the specific figures, I apply the deflation vulnerability index of the IMF and the inflation forecast distribution, by adapting these two tools to Korean circumstances to assess deflation risk. I then apply a new micro methodology using the characteristics of the distribution of price changes for individual items to make up for the limitations of the methodology based upon macro indicators.

1. Deflation Vulnerability Index of IMF (Macro methodology ①)

In 2003, when concerns about deflation were surfacing mainly in major countries, the IMF[8] suggested a method for measuring deflation risk and released a comparative measurement of the relative deflation risks for individual countries. The IMF established its Index of Deflation Vulnerability, applying macroeconomic indicators, for use as a yardstick of deflation risk.

8) The IMF prepared the report 'Deflation: Determinants, Risks and Policy Options' by establishing on independent task force team.

A. Method of Index Measurement

The basic idea is to assess the risk of deflation by setting up for four sectors: the price index, the output gap, the asset market, and private credit, and the money supply, most of which convey the same signals related to deflation when there is a growing possibility of its occurrence. Specifically, the IMF (Kumar et al 2003) selected 11 variables included in the four sectors and converted them into an index by giving 1 point to each variables deviating from a certain threshold[9] in the direction of deflation, while giving 0 point to each variable not so doing. More details on the component variables and the threshold of the vulnerability index are presented in <Table 1>.

Table 1 Components of IMF Deflation Vulnerability Index

Aggregate Prices	− If annual inflation, measured as the change in the CPI, was less than 0.5%, the value of the binary indicator is 1.
	− If annual inflation, measured as the change in core CPI, was less than 0.5%, the value is 1.
	− If annual inflation, measured as a change in the GDP deflator, was less than 0.5%, the value is 1.
Output gap	− If the output gap widened by more than 2 percentage points over the past four quarters, the value is 1.
	− If the current output gap was more than −2%, the value is 1.
	− If real GDP growth over the past three years was less than the annual average growth over the preceding decade, the value is 1.
Asset Markets	− If the broad measure of the stock market over the previous three years had fallen by more than 30%, the value is 1.
	− If the real effective exchange rate had appreciated by more than 4% over the past four quarters, the value is 1.
Credit & Monetary Indicators	− If private, nominal credit growth was less than nominal GDP growth over the past four quarters, the value is 1.
	− If cumulative private, nominal credit growth over the past three years was less than 10%, the value is 1.
	− If broad money (M3) growth on a y/y basis grew slower than base money by 2 percentage points (or less) over the past eight quarters, the value is 1.

Note: The IMF(2003) defined output gap as $\frac{potential\ real\ GDP - actual\ real\ GDP}{potential\ real\ GDP} \times 100$

The vulnerability index is defined as the average of these 11 variables,[10] and to

9) IMF (Kumar et al, 2003) set a certain threshold in considering the cases in Japan in the past.

10) Although the IMF (Kumar et al. 2003) also considers the weighted average, which reflects the size of the stock and credit markets, I consider only the simple average in this study.

assess the possibility of deflation, four stages are classified in accordance with differing extents of vulnerability: 'High', 'Moderate', 'Low' and 'Minimal'. The criteria of deflation risk for each stage are exhibited in <Table 2>.

Table 2 IMF Deflation Vulnerability Index and Risk Assessment

Index (x)	$x < 0.2$	$0.2 \leq x < 0.3$	$0.3 \leq x < 0.5$	$x \geq 0.5$
Risk	Minimal	Low	Moderate	High

Using this index, I compute deflation vulnerability indexes for Korea, the U.S. and Japan,[11] where deflation has been emerging as issues, between the first quarter of 1990 and the 4th quarter of 2008,[12] and assess the possibility of deflation occurrence.

The results show that the possibility of deflation in Korea in the fourth quarter of 2008 was 'Minimal',[13] the lowest among the four stages. The current vulnerability is relatively lower than these classified as 'Moderate' in the first and fourth quarters of 1998 and the first and the second quarters of 1999.

To compare the index of deflation vulnerability for Korea with those of other countries, I also measure the indexes of deflation vulnerability for the U.S. and Japan. The results indicate the index for the U.S. was 'Minimal', the lowest among the four stages, while for Japan it was 'Moderate', the third stage,[14] in the third guarter of 2008.

11) For calculating the index, I use the data from the OECD website in order to maintain consistency and the data source of the IMF (Kumar et al. 2003). CPI, core CPI, the GDP deflator, real GDP, nominal GDP and the Real Effective Exchange Rate are taken from the OECD, while the stock market index, private credit, and the money supply are from Bloomberg, the CEIC, and the IFS, respectively.

12) Up until that time, the IMF (Kumar et al. 2003) had released only the 2002 index based on 35 countries.

13) The reason for the increase in the deflation vulnerability index since the second half of 2008 is that the real GDP growth rate has been reflected in the possibility of deflation since that time.

Figure 2 Deflation Vulnerability Index Trends (Korea)

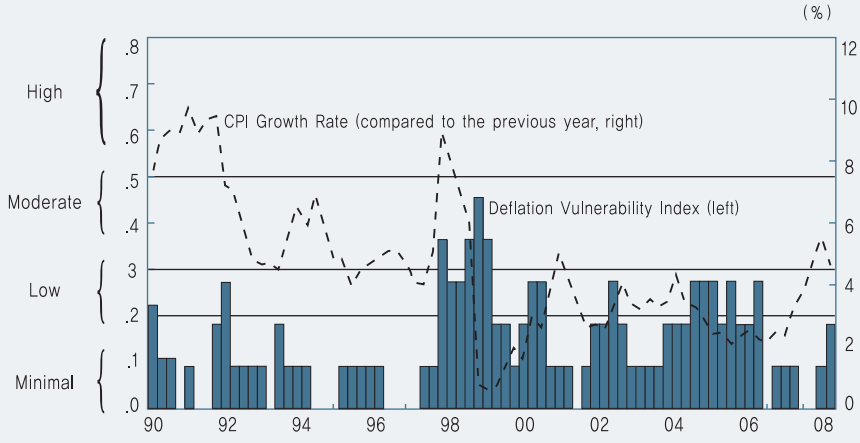
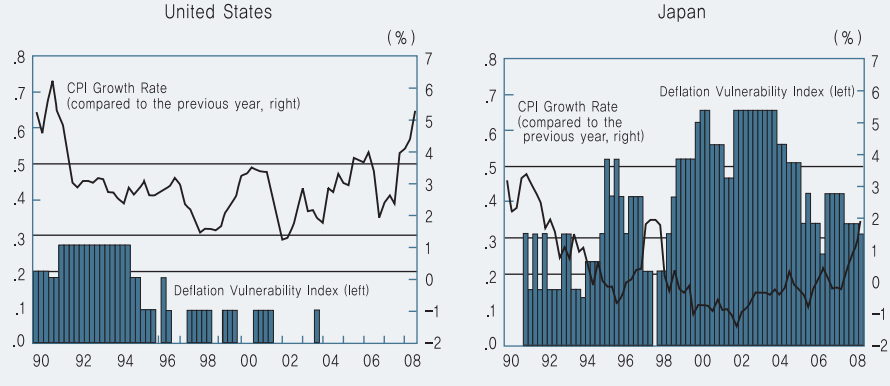


Figure 3 Deflation Vulnerability Index Trends (1990:Q1~2008:Q3)



14) On condition of anonymity, one examiner points out that it is somewhat problematic to assess the possibility of deflation by applying the index simply to Korea, because the index of deflation vulnerability is developed based on the cases of certain countries such as Japan that have experienced deflation. Another argues that, if the index is to predict the occurrence of deflation in the future, this study should clarify specifically what the index predicts the deflation risk to be after a certain particular month. The reason this study assesses the possibility of deflation in Korea using the IMF deflation vulnerability index is that, as IMF released the indexes for 35 countries including Korea in 2003 and 2009, twice, it is also to assess how vulnerable Korea is to deflation risk. As pointed out by some examiners, there are rooms for improvement in the index of deflation vulnerability such as the development of an index which can reflect the characteristics of price for each country and specification of deflation time series estimation. For instance, there seems to be more rooms to refine the vulnerability index by verifying whether the index is a leading indicator, applying the weight calculated by using signal-to-noise-ratio by correlating the IMF vulnerability index with deflation events or improving the index predictability by expanding the signaling window from just for one quarter to for two to four quarters. However, I would like to leave this for future research.

2. Inflation Forecast Distribution (Macro Methodology②)

Kilian and Manganelli (2007) suggest a method for measuring deflation risk in order to answer the question of how great it is. The basic idea is to estimate the probability distribution for inflation forecast by bootstrapping based on the estimates of inflation derived using econometrics models, and to assess the existence of the inflation risk when the inflation forecast exceeds the ceiling of the inflation targeting range and the existence of deflation risk when the inflation forecast falls below the floor.[15)]

The deflation and inflation risks are defined as follows:

$$Deflation\ \ Risk \equiv -\int_{-\infty}^{\underline{\pi}} (\underline{\pi}-\pi)^2\, dF(\pi) \tag{1}$$

$$Inflation\ \ Risk \equiv \int_{\overline{\pi}}^{\infty} (\pi-\overline{\pi})^2\, dF(\pi) \tag{2}$$

where π denotes the inflation forecasts, $\overline{\pi}$ and $\underline{\pi}$ the ceiling and floor of the inflation targeting range, respectively, and F the probability density function for inflation forecasts. The deflation and inflation risk, defined in equations (1) and (2), respectively, represent the extents to which the inflation estimates deviate from the targeting range ceiling (floor), which are expressed as an index by reflecting the weights (distribution probabilities). Therefore, the higher the absolute value of the index, the greater the risk.

Kilian and Manganelli analyze the range of inflation targeting based on the socially desirable level of inflation.[16)] However, I strive to apply the inflation targeting range of Korea. The reason I apply the definition of deflation rather than negative inflation is because I assess the possibility of deflation in the most conservative way by reflecting the behavior of central banks, on which the deviation of inflation range in Korea, acts as a burden, the fact that inflation deviates from the floor, could be interpreted as indicating deflation in the weak sense, when we give consideration to upward inflation bias.

15) The methodology of Kilian and Manganelli (2007) comes from the experienced probability distribution based on the past measurement errors, which is different from Fan Chart, the inflation forecast probability distribution based on the subjective judgement of policy authorities.

16) In their empirical analysis based on the U.S., Germany and Japan, Kilian and Manganelli (2007) set the target range to 2±1% (ceiling 3% and floor 1%).

A. Model Estimation and Method

Based on the factor model suggested by Stock and Watson (2002), the equation for predicting inflation in order to estimate the probability distribution is set as follows:

$$\pi_{t+1} = \alpha + \sum_{i=1}^{p} \beta_i \pi_{t-i+1} + \sum_{j=1}^{q} \gamma_j F_{t-j+1} \quad (3)$$

where π denotes inflation and F represents the common factor derived through principle component analysis using various information variables.

Kilian and Manganelli consider only three models,[17] which use past inflation, the money supply fluctuation rate and the rate of oil price fluctuation as explanatory variables, in setting the equation for inflation prediction for the U.S., Germany and Japan. Unlike Kilian and Manganelli, I apply a new equation for predicting inflation (equation (3)), because the previous literature (Kim and Kim 2005) comparing inflation predictability, shows the factor model suggested by Stock and Watson to have better predictability than other models in the case of Korea.

For the information variables under consideration, 16 monthly available variables[18] are used, and the estimation period is between January 1985 and December 2008, the period for which the data is available. For factors, those having additional explanatory power are selected in a systematic way (information criteria basis) and used by applying the boosting method suggested by Buhlmann and Yu (2003).[19] As the range of inflation targeting for analysis, the 3 ± 0.5% (ceiling 3.5%, floor 2.5%), and 2 ± 1% (ceiling 3%, floor 1%) mid-term inflation targets between 2007 and 2009, are used.

17) The three models are i) an autoregressive model that considers only past inflation, ii) a model which considers past inflation and the rate of money supply fluctuation and iii) a model which considers past inflation and the rate of oil price change.

18) I use variables which represent the real sector, the foreign sector, prices and financial sector: the unemployment rate, the industrial production index, the capacity utilization rate, export, import, the real effective exchange rate, M1, M2, Lf, the Call rate, the KOSPI, OECD leading indicators, the number of employed (non-farming), the average wage in the manufacturing business, the inventory cycle index, etc.

19) For more detail on the method of selecting the explanatory variables and to applying the information criteria, please refer to Kim (2008).

B. Estimation Results

The deflation risk in Korea on the basis of the end of 2008 (the current 3 ± 0.5% of inflation targeting range is applied) is estimated to be relatively lower than the inflation risk (the possibility of deviation from the target ceiling). Meanwhile, for the comparison of deflation risk among Korea, the U.S. and Japan, I recalculate the possibility of deflation by virtually adjusting the inflation targeting range. The results indicate that the possibility of deflation (the possibility of dropping below 1%) is almost zero.

For the U.S. where deflation is recently arising as a serious issue, the risk of deflation is greater than that of inflation by about 40% (November 2008 basis). The deflation risk in Japan, where deflation has been a serious issue since the mid-1990s, is four times greater than the inflation risk (October 2008 basis). Although there is also a growing concern lately that the deflation in the U.S. is approaching the level of that in Japan, it turns out not to be that serious.

Table 3 **Results of Deflation and Inflation Risk Estimation**

	Korea		U.S.	Japan
	target range 3±0.5%	target range 2±1%		
Inflation Risk (A)	0.3	0.59	0.26	0.27
Deflation Risk (B)	△0.26	△0.01	△0.37	△1.03
A+B	0.12	0.58	△0.11	△0.76
Inflation forecast (Conditional mean)	3.11	3.11	1.69	0.53

To assess the severity of the current deflation risk, I compare the current deflation risk to those in the past presented in <Figure 4>, the recent deflation risk in Korea has become higher than in the more distant past (between the 1980s and 1990s). However, it is relatively lower than in the early 2000s.

Figure 4 **Trends of Estimated Deflation and Inflation Risk in Korea (Inflation Target Range 3±0.5%)**

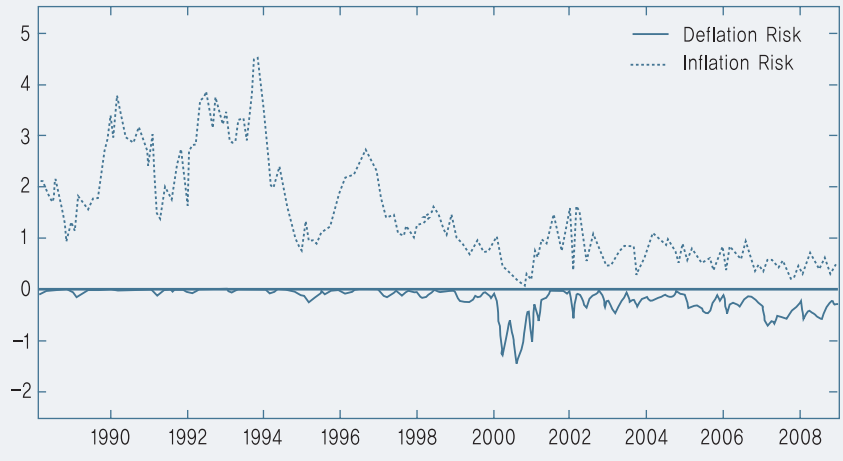


Table 4 **Average Historical Risks in Korea by Decade (Inflation Target Range 3±0.5%)**

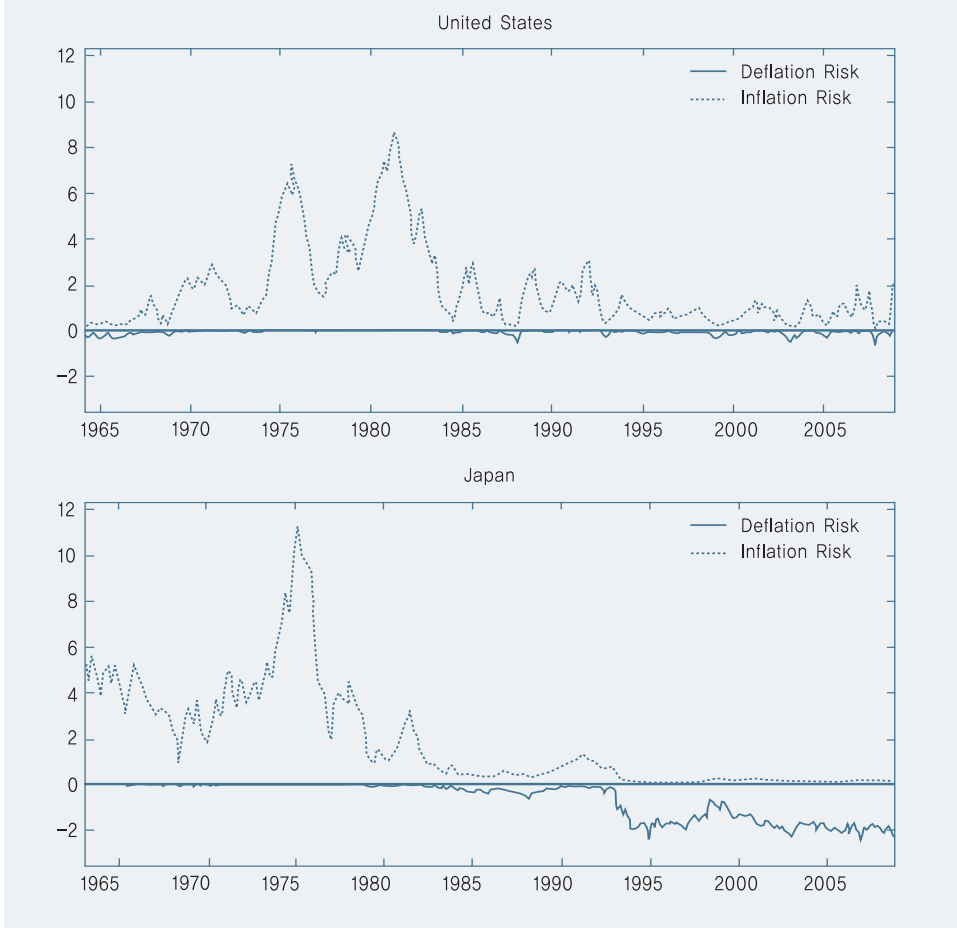
	1980s	1990s	2000s
Inflation Risk(A)	1.85	2.07	0.64
Deflation Risk(B)	△0.04	△0.05	△0.36
A+B	1.80	2.01	0.29

For the comparison among countries, the trends of deflation risk in the U.S. and Japan are presented in <Table 5> and <Figure 5 >:

Table 5 **Average Historical Risks in the U.S. and Japan by Decade (Inflation Target Range 2±1%)**

	1960s	1970s	1980s	1990s	2000s
Inflation Risk(A)					
United States	0.73	2.95	2.86	1.01	0.78
Japan	3.68	4.62	0.85	0.39	0.16
Deflation Risk(B)					
United States	△0.12	△0.00	△0.03	△0.05	△0.08
Japan	△0.00	△0.00	△0.19	△1.06	△1.84
A+B					
United States	0.61	2.95	2.83	0.96	0.70
Japan	3.68	4.62	0.67	△0.67	△1.68

Figure 5 **Trends of Estimated Deflation and Inflation Risk (Inflation Target Range 2±1%)**



3. Distribution of Price Changes for Each Item (Micro Methodology)

As the two methodologies above are based on macro indicators, they have a limitation in reflecting the characteristics of the price changes for individual items. In order to supplement them, therefore, I newly apply a micro methodology using the data on price changes for each item and assess the possibility of deflation.

The basic idea is to estimate an inflation equation using the distributional characteristics of the price changes for each item and, after that, to assess whether there is a possibility of deflation using the inflation estimates under assumption of the worst case scenario in terms of Value-at-Risk on the basis of

the characteristics of past distributions. What is most confusing in assessing deflation is that deflation is more of a concern than inflation under circumstances where liquidity is supplied excessively due to financial crisis. The biggest reason I strive to use an inflation equation based on the price changes for each item is that such an equation has a theoretical basis (the possibility of deflation resulting from relative price changes) which could suggest an answer to this confusing question.

Among economists, there is already consensus on the argument[20] that inflation is the phenomenon related to monetary policy in the long-term. From the short-term perspective, however, inflation and deflation might occur regardless of a change in monetary policy because prices are sticky. Ball and Mankiw (1995) claim that there exists a price shock skewed to the right, and that, when price setting behavior is sticky, inflation might occur.[21] They argue that deflation in contrast occurs when the price shock is skewed to the left. For more detail, please refer to <Appendix 1> "The Theoretical Relationship between Price Changes and Skewness" and <Appendix 2> "Empirical Analysis of the Relationship between Price Changes and Skewness."

Therefore, when we estimate and use an inflation equation based on the theoretical and empirical relationship between inflation and price change distribution (skewness), it seems possible to figure out the possibility of deflation caused by relative price changes in the conditions of liquidity oversupply. Another reason for using cross-sectional data is that the relationship between inflation and the moments of price change distribution has been verified as a stylized fact for a long time, since Mills (1927), and that the relationship between the two in the previous studies, which analyze the cases for several countries,[22] has consistently proven to be an empirical one.

A. Estimation Model

Based upon the theoretical relationship between inflation and moments, the inflation equation using the characteristics of price change distribution is set as follows:

---

20) The argument is represented as the one claimed by Friedman, that "inflation is always, and everywhere a monetary phenomenon."

21) The representative example is that the prices of oil-related products rose relatively significantly due to the oil shock in the 1970s and such this change led to inflation and following economic recession.

22) There are Ball and Mankiw (1995), Debell and Lamont (1997), Aucremanne et al (2002) from Belgium, Amano and Macklem (1997) from Canada, Dopke and Pierdzioch (2003) from Germany, Nishizaki (2000) from Japan, Fielding and Mizen (2000) from the EU, Florio (2005) from Italy, Caraballo and Dabus (2005) from Spain and Arrgentian and Assarsson and Riksbank (2003) from Sweden.

$$\pi_t = \alpha + \beta\pi_{t-1} + \gamma_1 SD_t + \gamma_2 SK_t + \gamma_3 (SD_t \cdot SK_t) \quad (4)$$

Here π denotes the inflation rate, and SD and SK the dispersion and skewness of price change distribution, respectively. Equation (4) is one of the equations used by Ball and Mankiw(1995) in the empirical analysis of an annual model for the U.S.[23] The estimation period for which the data are available is between 1975 and 2008, and the CPI and the price index for each CPI item (489) are used for inflation analysis and the cross sectional data. For dispersion and skewness, a robust measure[24] is applied based on the results of outlier detection test.

B. Estimation Results

As can be seen from the results of inflation equation estimation exhibited in <Table 6>, the characteristics of price change distribution (skewness and dispersion) affect inflation significantly (reflecting the interaction term[25]).

Table 6 Estimation Results

Regressor	constant	π_{t-1}	SD	SK	SD*SK	Marginal Effect (SD)	Marginal Effect (SK)
coefficient	−0.011	0.458	0.692	−0.258	6.988	1.081	0.120
p-value	(0.60)	(0.01)	(0.14)	(0.25)	(0.09)	(0.01)	(0.07)

Note: $\overline{R}^2 = 0.68$, AIC=−3.99, SC=−3.76, RMSE=0.028

Likewise, on the assumption of my estimated inflation equation and the scenario of deflation occurrence, I assess the possibility of deflation by deriving the estimates for inflation. By applying the VaR (value-at-risk) concept, which is

23) Through empirical analysis, I strive to conduct regression analysis for the various models, using the combination of the explanatory variables based on the theoretical relationship between inflation and the moments (dispersion, skewness, kurtosis). According to the results, from the perspective of model simplicity and goodness of fit (adjusted coefficient of determination, root mean square error, criterium of Akaike and Schwartz information), equation (4) appears best for an annual model. For quarterly and monthly models, in contrast, the inflation equation which includes kurtosis seems more adequate from the perspective of goodness of fit.

24) For the yardsticks of dispersion and skewness, median absolute distance and L-moment are used, respectively.

25) In order to measure the significance of the marginal effect of the explanatory variables in the regression analysis which includes the interaction term, the method suggested by Wooldridge (2006) is applied.

frequently used as a risk management tool, I assume the worst case scenario where the skewness of price change for each item in the future change into a way by which deflation intensifies.

C. Assessment of Deflation under Different Scenarios

For the scenarios in which the price change distribution is skewed to the left, the following three are considered: i) when the skewness declines more than half way toward the lowest among its historical values (Scenario 1), ii) when the skewness declines to the lowest among its historical values (Scenario 2), and iii) when the skewness declines 50% below the lowest among its historical values (Scenario 3).[26]

The results of calculating the estimates of inflation under such scenarios are shown in <Table 1>. Under the assumption (Scenario 2) of the price change distribution where the skewness is at its historically lowest level, or even under the among assumption (Scenario 3) where skewness is 50% lower than the lowest its historical values, the possibility of deflation in Korea in 2009 is extremely slim.[27]

Table 7 **Inflation Forecasts by Distributional Characteristic Scenario**

Assumption	Scenario 1 Skewness=△0.05	Scenario 2 Skewness=△0.1	Scenario 3 Skewness=△0.15
Dispersion=0.03	2.4%	2.2%	2.1%
Dispersion=0.05	2.0%	1.5%	1.1%

Note: The output gap measured by HP filtering of GDP is included in the inflation equation to capture the excessive demand pressures.

26) Besides this, the real GDP growth rate reflects the BOK forecast (2%), and the two assumed cases of dispersion (0.03 and 0.05) are selected in consideration of historical values and recent trends.

27) One examiner on condition of anonymity pointed out that such forecasts of inflation (1.1% to 2.4%) can be interpreted as indicating a high possibility of deflation considering the floor of the inflation targeting floor in Korea. As this study assumes the potential extreme loss based upon the concept of Value-at-Risk, its interpretation should reflect this.

IV. Conclusion

I carried out analysis of the extent of risk of deflation occurring in Korea by looking into the deflation vulnerability index of the IMF and the characteristics of the distribution. The results showed, on a 2008 basis, that the possibility of deflation is extremely slim. Results using the deflation vulnerability index of the IMF indicates that the possibility of deflation remaining "minimal", the lowest stage. Even in the case where I assessed the possibility of deflation using the inflation forecast distribution, that inflation risk turned out to be greater than deflation risk in Korea, and deflation risk is relatively lower than in the past. The assessment based on the characteristics of price change distribution demonstrates that the possibility of deflation is low even at the lowest historical value of deflation risk.

Considering both the downside and the upside risk probability for inflation during 2009, the upside risk still seems greater. For deflation to be in full swing, the expected inflation of economic agents should be in a negative territory. However, the results of the empirical analysis suggest that this possibility is minimal.[28)]

In order to verify whether deflation has a negative effect on the real economy, I conducted empirical analysis about the theoretical discussions in the literature. The results revealed that, even if deflation occurs in Korea, there is no evidence to support the idea that deflation could cause a deterioration in economic conditions.[29)] The starting point of the theoretical discussions pointing out the problems of deflation, is that the criteria economic agents use to make their decisions are real concepts, not a nominal concepts. When historically

28) The result of Hybrid New Keynesian Phillips Curve estimation (Kim 2008) shows that the relative ratio of the effects on current inflation of past and expected future inflation is 4 to 6. And even according to the survey of price setting behavior of Korean firms (Kim and Hong 2009), 76 % (weighted average 82.5%) of Korean firms answered that they determine their prices considering past data and future economic conditions. Such analysis results imply that the past inflation experiences gained from the skyrocketing oil prices in 2008 would be helpful in lessening the possibility of deflation in the future. The expected inflation in Korea (survey data) also stays at 4%, which is relatively high compared to the 3%, average between 2005 and 2007.

29) The biggest reason for being concerned about deflation is that deflation leads to economic recession. However, Atkeson and Kehoe (2004) argue that, with the exception of the Great Depression period (1929~1934), the correlation between deflation and economic downturn is not so high, demonstrating that deflation does not result in economic recession. According to their estimation of GDP growth rates using inflation as explanatory variables for 16 countries which have experienced deflation, the estimated coefficients of inflation during the Great Depression (1929~1934) were 0.4, which is evidence that deflation leads to economic downturn. However, regression analysis for the period outside the Great Depression and the considered period (1820~2000) indicates that the coefficients of inflation are 0.04 and 0.08, respectively, as a whole can not support the claim that deflation causes economic recession.

inexperienced deflation intensifies, it seems unclear which behavioral change the economic agents in Korea would show, considering the real variables (real interest rates and real wages).

After the recent comments of the FRB,[30] it seems desirable that official statement on the possibility of deflation should be made in a more cautious way in response to any temporary declines in prices. A more sophisticated and defined method for measuring and predicting future deflation and inflation risk should be developed. In addition, empirical analysis of the theoretical discussion of the problems caused by deflation should be carried out.

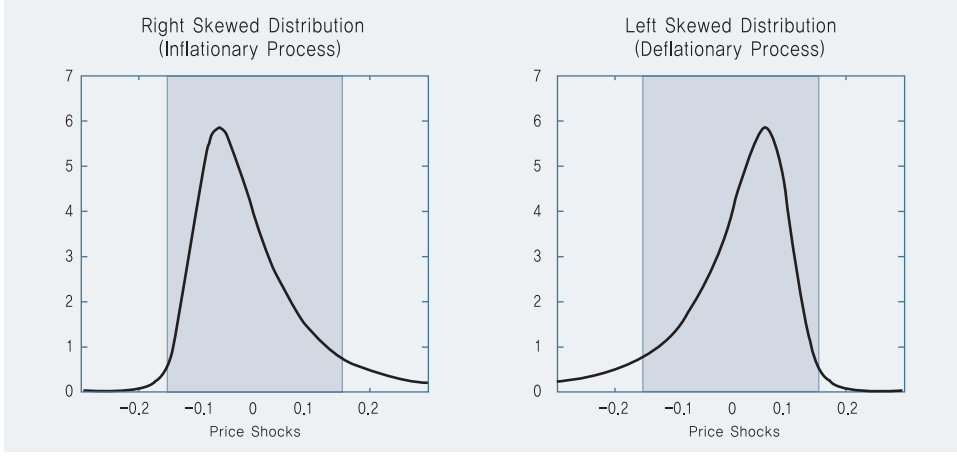
30) The FRB officially commented on the possibility of deflation in its FOMC meeting in October, 2008. That month, the growth rate of CPI in the U.S. declined 1.0% compared to the previous month, the greatest decline since the data record was started in 1947, and based on this, the FRB announced that it was necessary to reduce the possibility of deflation in the future through aggressive quantitative easing. Regarding this announcement, Professor Allen Meltzer (Carnegie Mellon) claimed that the FRB raised the possibility of deflation based on a temporary price decline rather than a sustained price fall and harshly criticized the Fed by commenting that people talking about deflation should go back to school.

[Appendix 1]

The Theoretical relationship between Price Changes and Skewness

The relationship between inflation and skewness can be drawn as follows. If all firms change their prices according to price shock distribution, (the solid line in the figures), inflation for the entire economy becomes 0. However, if it is assumed that, the menu cost (price stickiness) leads some firms (the ones whose size of price shock is smaller than menu cost, the shaded areas) to maintain their prices while others (both the tail parts outside the shaded areas) change them, the inflation for the entire economy does not become 0. As the inflation for entire economy is calculated by the difference between the areas on the left (firms which decrease prices) and the right (firms which raise prices) tail sections, the left skewed price shock causes deflation while the right one generates inflation.

Besides Skewness, dispersion and kurtosis of distribution also affect deflation. That is, when the price adjustment of firms is sticky, the change in the shape of price shock distribution affects deflation.



Notes: 1) Right skewed distribution represents the SuN distribution with a mean of 0, standard deviation of 0.12, skewness of 3, kurtosis of 25 and menu cost of ± 0.15, while left skewed distribution represents an SuN distribution with a mean of 0, standard deviation of 0.12, skewness of -3, kurtosis of 25 and menu cost of ±0.15.

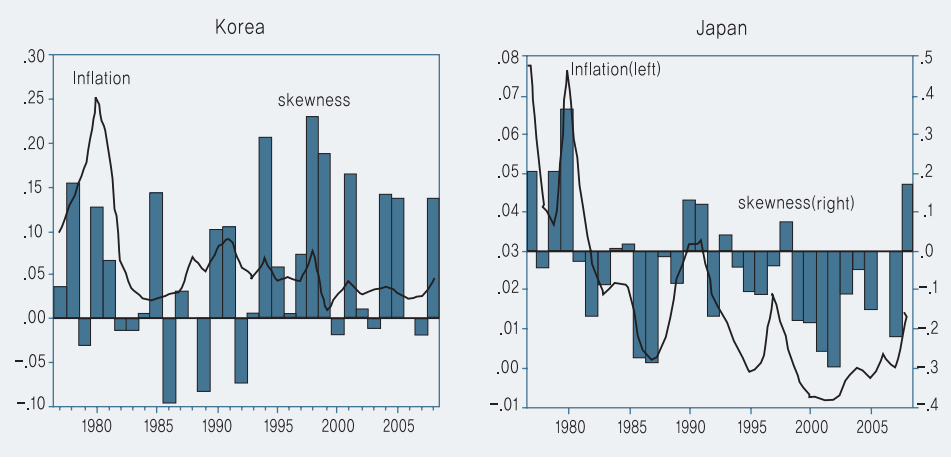
2) The computed inflation of right skewed distribution of price changes is +0.022 while that of left skewed distribution of price changes is -0.022.

[Appendix 2]

Empirical analysis of the Relationship between Price Changes and Skewness

The trends of the relationship between inflation and estimated skewness are almost similar to the theoretical relationship between the two. For the period when inflation increase, the skewness[31] increases into positive territory, while for the periods of decline in price growth rate, it moves into negative territory.

Looking at Japan, which has experienced deflation since the mid-1990s, almost all skewness appears negative during the deflationary period as expected from the theoretical relationship. This study strives to assess the possibility of deflation in Korea, on the assumption of some scenarios based upon such a relationship between deflation and skewness.



31) Outliers of 9 to 14% for the samples during the survey period exist. For this reason, instead of classical measure, I apply a robust measure (the L-moment of Greenwood (1979): the yardstick standardized between △1 and +1) in which skewness is calculated by reducing the weights of the outliers.

<References>

Amano, Robert A. and R. Tiff Macklem (1997), "Menu Cost, Relative Prices, and Inflation: Evidence for Canada," Working Paper, Bank of Canada

Assarsson, B and S Riksbank (2003), "Inflation and Higher Moments of Relative Prices Changes in Sweden," Working Paper, Bank for International Settlements (BIS)

Atkeson, Andrew and Patrick Kehoe (2004), "Deflation and Depression: Is There an Empirical Link?," *American Economic Review, 94*, 99-103

Aucremanne, Luc, Guy Brys, Mia Hubert, Peter J. Rousseeuw, and Anja Struyf (2002.), "Inflation, Relative Prices and Nominal Rigidities," Working paper, National Bank of Belgium

Ball, Lawrence and Gregory Mankiw (1995), "Relative-Price Changes as Aggregate Supply Shocks," *Quarterly Journal of Economics, 110,* 161-193.

Bernanke, Ben (1989), "Nonmonetary Effects of the Financial Crisis in Propagation of the Great Depression," *American Economic Review, 73,* 257-276.

Bordo, Michael, and Andrew Filardo (2005), "Deflation and Monetary Policy in a Historical Perspective: Remembering the Past or Being Condemned to Repeat It?," *Economic Policy, 20,* 799-844.

Buhlmann, Peter and Bin Yu (2003), "Boosting with the L2 Loss: Regression and Classfication," *Journal of American Statistical Association, 98,* 324-339.

Caraballo, Maria Angeles and Carlos Dabus (2005), "Nominal Rigidities, Relative Prices and Skewness," July, Working Paper, Centro de Estudios Andaluces

Carling, K. (2000), "Resistant Outlier Rules and the Non-Gaussian Case," *Computational Statistics And Data Analysis, 33,* 249-258.

Debell, Guy and Owen Lamont (1997), "Relative Price Variability and Inflation: Evidence from U.S. Cities," *Journal of Political Economy,* 105, 132-152.

Dopke, Jorg and Kiel Pierdzioch (2003), "Inflation and the Skewness of the Distribution of Relative Price Changes: Empirical Evidence for Germany," *Jahrbucher fur Nationalokonomie und Statistik, August, 223* (3), 136-158.

Fielding, David and Paul Mizen (2000), "Relative Price Variability and Inflation

in Europe," *Economica, 67,* 57-78.

Fisher, Irving (1933), "The Debt-deflation theory of Great Depressions," *Econometrica, 1,* 337-357.

Florio, Anna (2005), "Asymmeric Monetary Policy: Empirical Evidence for Italy," *Applied Economics, 37* (4), 751-764.

Gordon, Robert J. (1983), "Price Inertia and Policy Ineffectiveness in the United States, 1890-1980," National Bureau of Economic Research

Greenwood, J. A., J. M. Landwehr, N.C. Matalas, and J. R. Wallis (1979), "Probability Weighted Moments: Definition And Relation to Parameters of Several Distributions Expressible in Inverse Form," *Water Resources Research, 15* (5), 1049-1054.

Kilian, Lutz and Simone Manganelli (2007), "Quantifying the Risk of Deflation," *Journal of Money, Credit and Banking, 39,* 561-590.

Kumar, Manmohan S., Taimur Baig, Jorg Decressin, Chris Faulkner MacDonagh, and Tarhan Feyzioglu (2003), "Deflation: Determinants, Risks, and Policy Options-Findings of an Interdepartmental Task Force," IMF occasional paper No 221

Mills, Frederick C. (1927), *The Behavior of Prices,* National Bureau of Economic Research, New York

Minsky, Hyman (1982), "Debt-defation Processes in Today's Institutional Environment," December, Banca Nazionale del Lavoro Quarterly Review

Nishizaki, Kenji (2000), "Output-Inflation Trade-Off at Near Zero Inflation Rates," *Journal of the Japanese and International Economies, 14,* 304-326.

Stock, James H. and Mark W. Watson (2002), "Macroeconomic Forecasting Using Diffusion Indexes," *Journal of Business & Economic Statistics, 20,* 147-162.

Wooldridge, J. M. (2006), *Introductory Econometrics (Third edition),* Thomson South-Western