

Kang, In-bong

Research Report

The Yield Curve, Inflation Expectations, and Economic Uncertainty

KDI Policy Study, No. 2001-01

Provided in Cooperation with:

Korea Development Institute (KDI), Sejong

Suggested Citation: Kang, In-bong (2001) : The Yield Curve, Inflation Expectations, and Economic Uncertainty, KDI Policy Study, No. 2001-01, ISBN 89-8063-108-1, Korea Development Institute (KDI), Seoul,
<https://doi.org/10.22740/kdi.ps.e.2001.01>

This Version is available at:

<https://hdl.handle.net/10419/200923>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

The Yield Curve, Inflation Expectations, and Economic Uncertainty

June 2001

In-Bong Kang

Korea Development Institute

I have benefited much from conversations with Inseok Shin and Dongsoo Kang in writing this paper. I thank them. I also thank two referees for their constructive comments and suggestions. All remaining errors are mine.

KDI Policy Study 2001-01

June 2001

Korea Development Institute
207-41, Cheongnyangni-dong, Dongdaemun-gu
P.O. Box 113, Cheongnyang
Seoul, Korea

Price : ₩4,000

ISBN 89-8063-108-1

Foreword

During the nineties not only individual interest rates but spreads between long-term and short-term interest rates experienced large fluctuations. In particular, at the height of the recent foreign exchange crisis, some individual interest rates jumped up to almost 30 per cent per annum and long-short spreads enlarged to almost 500 basis points.

In-Bong Kang of the Korea Development Institute makes an important contribution to our understanding of what factors are responsible for causing such large fluctuations in long-short interest rate spreads. He develops an empirical model of the term structure of interest rates, where long-short spreads are related to inflation expectations (or short-term interest rates) and economic uncertainty. He then estimates and tests the model using Korean monthly macro data along with several measures of economic uncertainty. Employing a vector autoregression model, he also examines how long-short spreads respond to innovations to the two factors and which of the two factors is more important in explaining the forecast error variance of long-short spreads.

Kang finds that although both economic uncertainty and inflation expectations appear to influence long-short interest rate spreads, economic uncertainty dominates expected inflation. However, he finds that there is only weak evidence for the thesis that an increase in expected inflation or economic uncertainty leads to a larger long-short spread. In the case of expected inflation, the evidence is weak in the sense that the positive relationship is not robust across different specifications. In the case of economic uncertainty, the evidence is weak in the sense that the positive relationship does not show up immediately but only sluggishly.

Kang concludes that based on the findings it would be difficult to draw any strong implications for economic policy. Nevertheless, he implies, a policy prescription would not be ill-advised if it involved not short-run macroeconomic stabilization measures but

intermediate to long-run microeconomic structural measures – that is, measures that are geared toward eliminating factors that contribute to systemic risk and thus improving the economy's ability to absorb shocks. Included in such structural measures would be, among others, the development of primary as well as secondary bond markets for assorted maturities, the improvement of the system of credit rating of bond issuers, and the enhancement of the efficiency in issuing and trading bonds.

I believe that this study will benefit not only scholars but policymakers interested in the recent developments in Korean financial markets in general and bond markets in particular.

Bong-Kyun Kang

President

Korea Development Institute

Abstract

The present paper develops an empirical model of the term structure of interest rates, where the slope of the term structure (or the long-short spread) is related to the expected inflation and economic uncertainty. The model is estimated and tested with various measures of these two factors to see if the relationship is supported by the data. A vector autoregression model is also estimated to further investigate how long-short spreads respond to innovations to the two factors and which of the two factors is more important in explaining the forecast error variance of long-short spreads. The main findings are as follows. First, both economic uncertainty and inflation expectations appear to influence the long-short spread, regardless of which of the two classes of bonds considered is used to construct the spread. Second, as far as the relative importance is concerned, economic uncertainty appears to dominate expected inflation, regardless of which measures of economic uncertainty and spread are used. Third, only weak evidence exists, however, for the thesis that an unexpected increase in expected inflation or economic uncertainty leads to a larger long-short spread. In the case of expected inflation, the evidence is weak in the sense that the positive relationship is not robust across different specifications. In the case of economic uncertainty, the evidence is weak in the sense that the positive relationship does not show up immediately but only sluggishly. Based on these findings, it would be difficult to draw any strong implications for economic policy. Nevertheless, a policy prescription would not be ill-advised if it involved not short-run macroeconomic stabilization measures but intermediate to long-run microeconomic structural measures – that is, measures that are geared toward eliminating factors that contribute to systemic risk and thus improving the economy's ability to absorb shocks. Included in such structural measures would be, among others, the development of primary as well as secondary bond markets for assorted maturities, the improvement of the system of credit rating of bond issuers, and the enhancement of the efficiency in issuing and trading bonds.

Contents

Foreword

Abstract

Summary 1

. Introduction 5

. Interest Rate Spreads, Expected Inflation, and Economic
Uncertainty 8

1. The Model 8

2. Measures of Economic Uncertainty 11

3. Expected Inflation 13

4. Long-Short Interest Rate Spreads 14

5. Estimation Results 16

. Variance Decomposition and Impulse Response Analysis 19

. Summary and Conclusion 25

References 27

Summary

Not only individual interest rates but spreads between long-term and short-term interest rates experienced large fluctuations during the period covering several months before and after the recent foreign exchange crisis. In June 1997 the market yields on 3-year corporate bonds and 3-month commercial papers were 11.65% and 12.05%, respectively, and the spread between them (i.e. the 3-year corporate bond yield minus the 3-month commercial paper yield; henceforth CCP) was just -40 basis points. Six months later the 3-year and 3-month rates jumped up to 24.31% and 29.26%, respectively, with the spread enlarging to -495 basis points. During the same period the yields on the 3-year and 1-year industrial finance debentures (IFD) that were issued by the government-owned Korea Development Bank also fluctuated large: from 12.08% and 12.25%, respectively, in June 1997 to 22.41% and 20.02% in January 1998 and then down to 6.90% and 6.92% in June 1999. So did the long-short spread between them (henceforth FF): from -17 basis points to $+239$ basis points to -2 basis points.

The present paper makes an attempt to understand what factors are responsible for causing such large fluctuations in long-short interest rate spreads. It develops an empirical model of the term structure of interest rates, based on the preferred habitat theory, where long-short spreads are related to inflation expectations (or short-term interest rates) and economic uncertainty. The model is then estimated and tested to see if the relationship is supported by data. A vector autoregression (VAR) model is also used to examine how long-short spreads respond to innovations to the two factors and which of the two factors is more important in explaining the forecast error variance of long-short spreads. The sample period under study is January 1991 – September 2000 and the frequency of the data is monthly.

The standard deviations of various financial asset prices are used as measures of

economic uncertainty. These include daily Won/USD exchange rates, daily overnight call rates, and daily KOSPI-measured stock prices. In addition, two other risk-related variables are also taken as alternative measures of economic uncertainty. They are the default risk premium (measured by the yield spread between 3-year corporate bonds and Korea Development Bank industrial finance debentures) and the rate of default on commercial paper obligations by private businesses. The expected inflation rate is estimated with the one-period-ahead forecasts of the CPI inflation rate that are computed based on the regression of the inflation rate on the lagged values of its own and call rates.

The main findings of the present study are as follows. First, both economic uncertainty and inflation expectations appear to influence long-short interest rate spreads, regardless of which of the two classes of bonds is used in constructing the spreads, industrial finance debentures or corporate bonds. Second, the variance decomposition analysis indicates that as far as the relative importance in explaining the long-short spread is concerned, economic uncertainty appears to dominate expected inflation, regardless of which measure of economic uncertainty and spread is used. Third, the impulse response analysis indicates that a positive innovation to expected inflation tends to have positive (at least, nonnegative) impact effects on long-short spreads, whereas an unexpected rise in economic uncertainty tends to have negative impact effects. But these negative impact responses are followed by positive responses in the second or third period.

The last finding is attributed to the possibility that long-term and short-term interest rates may differ in their speed of response to exogenous shocks. For example, long-term interest rates may respond more slowly to exogenous shocks (e.g. an unexpected change in monetary policy during the recent foreign exchange crisis) than short-term interest rates do. If this is the case, an innovation that causes short-term interest rates to rise can actually make long-short spreads turn negative – at least, at impact – resulting in a negative relationship between the innovation and long-short spreads. This interpretation is not inconsistent with the finding that the negative impact responses are

reversed in the second or third period after an innovation.

The finding that an unexpected rise in economic uncertainty tends to have negative impact effects, followed by positive responses in the second or third period, may also have to do with the market expectations on the duration of the sudden short-term interest rate hikes witnessed during the recent foreign exchange crisis. That is, as the government raised short-term interest rates by an unprecedented magnitude, the market might have expected that the interest rate hikes would not last long but be reversed in the near future. Such expectations on the movement of future short-term interest rates could have led to long-term rates falling below short-term rates. In our analysis in which two factors (economic uncertainty and the current and past inflation expectations and/or short-term rates) were focused on as the potential determinants of long-short spreads, the role of such short-term rate expectations might have been picked up by the economic uncertainty term, with the long-short spread forced to have a negative relationship with economic uncertainty. This is particularly so because it is difficult to expect the other term, that is, the current and past inflation expectations and/or short-term rates, to have fully picked up the role of the market expectations on short-term rates.

In short, the present study has found that although economic uncertainty seems to be a more important factor in explaining long-short spreads, only weak evidence is there for the thesis that an increase in expected inflation or economic uncertainty leads to a larger long-short spread. In the case of expected inflation, the evidence is weak in the sense that the positive relationship is not robust across different specifications. In the case of economic uncertainty, the evidence is weak in the sense that the positive relationship does not show up immediately but only sluggishly.

Based on these findings, it would be difficult to draw any strong implications for economic policy. Nevertheless, a policy prescription would not be ill-advised if it involved not short-run macroeconomic stabilization measures but intermediate to long-run microeconomic structural measures – that is, measures that are geared toward eliminating

factors that contribute to systemic risk and thus improving the economy's ability to absorb shocks. Included in such structural measures would be, among others, the development of primary as well as secondary bond markets for assorted maturities, the improvement of the system of credit rating of bond issuers, and the enhancement of the efficiency in issuing and trading bonds.

I. Introduction

Not only individual interest rates but spreads between long-term and short-term interest rates experienced large fluctuations during the period covering several months before and after the recent foreign exchange crisis. In June 1997 the market yields on 3-year corporate bonds and 3-month commercial papers were 11.65% and 12.05%, respectively, and the spread between them (i.e. the 3-year corporate bond yield minus the 3-month commercial paper yield; henceforth CCP) was just -40 basis points. Six months later the 3-year and 3-month rates jumped up to 24.31% and 29.26%, respectively, with the spread enlarging to -495 basis points. (See Figure 1.) During the same period the yields on the 3-year and 1-year industrial finance debentures (IFD) that were issued by the government-owned Korea Development Bank also fluctuated large: from 12.08% and 12.25%, respectively, in June 1997 to 22.41% and 20.02% in January 1998 and then down to 6.90% and 6.92% in June 1999. So did the long-short spread between them (henceforth FF): from -17 basis points to $+239$ basis points to -2 basis points. (See Figure 2.)

Recently, much literature has shown that one can derive from fluctuations in long-short interest rate spreads various useful information about real economic activity and future inflation. For example, Estrella and Hardouvelis (1991) and Estrella and Mishkin (1995), among others, have shown that when the long-term interest rate falls below the short-term interest rate (i.e. when the yield curve inverts), the economy tends to enter a recession in the near future.¹ Others [e.g. Fama (1990), Mishkin (1990)] have used the term structure to study the relationship between inflation and the term structure. In particular, they have found some empirical evidence that the term structure with maturities ranging

¹ This feature is clearly shown in the United States data, as can be seen in Figure 3. The slope of the yield curve, measured with the yield spread between 30-year Treasury bonds and 1-year Treasury notes, turned negative several months before each of the three recessions since the 1980s. Similar results obtain when the spread is measured with yields on 3-year and 3-month Treasury securities.

nine to twelve months contains information about future inflation.²

This paper looks at the term structure of interest rates from a different perspective. It makes an attempt to understand what factors are responsible for causing the large swings in long-short interest rate spreads.³ Understanding those factors and further investigating which of the factors plays a more important role in explaining long-short spreads can provide various implications for economic policy and a valuable guide in designing a policy prescription. For example, according to the preferred habitat theory, which is a variant of the expectations hypothesis of the term structure, long-short spreads depend on two factors: (current and future) short-term interest rates (or expected inflation rates) and risk premium.⁴ If a large long-short spread is found to be caused by inflation expectations rather than economic uncertainty, then an appropriate policy prescription for reducing long-short spreads would involve measures to stem future inflation (e.g. a tightening in monetary and/or fiscal policy). On the other hand, if a large long-short spread is found to be caused by economic uncertainty rather than inflation expectations, then an appropriate policy prescription would involve measures to reduce the systemic risk (e.g. microeconomic/structural policy).⁵

² However, Mishkin (1990) reported that the shorter end of the term structure (the maturities of six months or shorter) did not contain any significant information about the future path of inflation.

³ A similar issue was also examined by Kang and Oh (2000).

⁴ Other factors can also affect spreads between bonds of different maturities. One is the state of the economy over the business cycle. When the economy gets overheated nearing the top of the business cycle, profit opportunities get exhausted, consequently depressing incentives for investment in physical capital and the demand for long-term funds. The result is a decrease in long-term interest rates. At the same time, the overheating of the economy tends to involve rising factor prices, causing inflationary expectations and an increase in short-term interest rates (the Fisher effect). So as the economy approaches the peak of the business cycle, long-term rates tend to fall and short-term rates tend to rise, inverting the yield curve. The opposite happens when the economy approaches the bottom of the business cycle with the shape of the yield curve turning normal (i.e. upward sloping). Second, monetary policy can also affect the slope of the yield curve. If the long-term interest rate responds to shocks more sluggishly than the short-term interest rate, then the short-term rate may rise above the long-term rate when monetary authorities raise the short-term rate to stem inflationary expectations. For this latter argument, see Estrella and Hardouvelis (1991). The present paper is going to focus on the two factors implied by the preferred habitat theory of the term structure.

⁵ For a similar argument, see Kang and Oh (2000).

The present paper develops an empirical model of the term structure of interest rates, based on the preferred habitat theory, where the slope of the term structure is related to inflation expectations (or short-term interest rates) and economic uncertainty. The model is then estimated and tested to see if the relationship is supported by the data. A vector autoregression (VAR) model is also used to examine how long-short spreads respond to innovations to the two factors and which of the two factors is more important in explaining the forecast error variance of long-short spreads.

Before proceeding, let us summarize the main findings of the present study. First, both economic uncertainty and inflation expectations appear to influence the long-short interest rate spread, regardless of which class of bonds is used to construct the spread, industrial finance debentures or corporate bonds. Second, the variance decomposition analysis indicates that as far as the relative importance in explaining the long-short spread is concerned, economic uncertainty appears to dominate expected inflation, regardless of which measure of economic uncertainty and spread is used. Third, the impulse response analysis indicates that a positive innovation to expected inflation tends to have positive (at least, nonnegative) impact effects on long-short spreads, whereas an unexpected rise in economic uncertainty tends to have negative impact effects. But these negative impact responses are followed by positive responses in the second or third period, making the negative impact effects only temporary.

The rest of the paper is organized as follows. The next section develops and estimates an empirical model of the term structure of interest rates, based on the preferred habitat theory, in which the slope of the term structure is related to economic uncertainty and expected inflation. This section also discusses how the expected inflation rate is estimated and what proxy measures of economic uncertainty are used. Section III uses a vector autoregression model to study how long-short spreads respond to innovations to the two variables and which of the two variables is more important in explaining (the forecast error variance of) long-short spreads. Section IV contains some concluding remarks and policy implications.

II. Interest Rate Spreads, Expected Inflation, and Economic Uncertainty

1. The Model

In this section we are going to see how a variant of the expectations hypothesis of the term structure, the so-called preferred habitat theory, relates the long-short interest rate spread to inflation expectations (or short-term interest rates) and economic uncertainty. Let us first assume that an m -period bond with a period-by-period yield to maturity of $i_t(m)$, where $m > 1$, is a perfect substitute for a 1-period bond with a yield to maturity of $i_t(1)$. Then arbitraging opportunities will lead to the following equality:

$$[1 + i_t(m)]^m = \prod_{j=0}^{m-1} [1 + i_{t+j}^e(1)], \quad (1)$$

where $i_{t+j}^e(1)$ denotes the expected yield to maturity on a one-period bond to be issued at time $t+j$ and mature at time $t+j+1$, for $j = 0, 1, 2, \dots, m-1$. Taking logarithms on both sides of the equation above and using the approximation rule that $\ln(1+x) \approx x$ for small x , we can rewrite equation (1) as follows:

$$i_t(m) = \frac{1}{m} \sum_{j=0}^{m-1} i_{t+j}^e(1). \quad (2)$$

Note that $i_t^e(1) = i_t(1)$. Equation (2) basically states that the long-term interest rate equals the average of current and expected future one-period interest rates. Thus this equation represents the so-called expectations hypothesis of the term structure of interest rates. The spread between the m -period interest rate and the one-period interest rate, $R_t(m)$, is given by the following:

$$R_t(m) \equiv i_t(m) - i_t(1) = \frac{1}{m} \sum_{j=0}^{m-1} [i_{t+j}^e(1) - i_t(1)]. \quad (3)$$

This equation implies that if future one-period interest rates are expected, on average, to rise above the current one-period interest rate, the long-short spread turns out positive. Similarly, if future one-period interest rates are expected, on average, to fall below the current one-period interest rate, the long-short spread turns out negative.

In order to derive testable implications, let us assume that the expected future one-period interest rates in the equation above are each linearly related to current and lagged one-period interest rates.⁶ Then the yield spread between the m -period bond and the one-period bond is also a linear function of current and lagged one-period interest rates:

$$R_t(m) = \mathbf{a} + \mathbf{f}_0 i_t(1) + \mathbf{f}_1 i_{t-1}(1) + \cdots + \mathbf{f}_p i_{t-p}(1), \quad (4)$$

Furthermore, under the assumption that real interest rates are constant, equation (4) can be rewritten as:⁷

$$R_t(m) = \tilde{\mathbf{a}} + \mathbf{f}_0 E_t \mathbf{p}_t(1) + \mathbf{f}_1 E_{t-1} \mathbf{p}_{t-1}(1) + \cdots + \mathbf{f}_p E_{t-p} \mathbf{p}_{t-p}(1), \quad (5)$$

where $\tilde{\mathbf{a}}$ is a constant term that includes constant real interest rates, and $E_{t-j} \mathbf{p}_{t-j}(1)$ denotes the rate of one-period-ahead expected inflation at time $t-j$, for $j = 0, 1, \dots, p$. As is to be discussed later, a 11-month centered moving average of *ex post* inflation rates is taken for its proxy.

Equations (4) and (5) imply that tests of the null hypothesis that $\mathbf{f}_j = 0$ for all $j = 0, 1, \dots, p$ are tests of whether short-term interest rates (or expected inflation rates under the assumption of constant real interest rates) have any statistically significant effects on

⁶ For studies that employed a similar assumption, see, for example, the bond market section of Shiller (1997).

⁷ We employ this assumption for a practical reason that there are no yield data available for one-period (i.e. one-month) bonds.

long-short spreads. The tests are also tests of the expectations hypothesis of the term structure under the assumption that expected future short-term interest rates are functions of current and lagged short-term interest rates. If we reject the null hypothesis, it will be the evidence that there exists a statistically significant relationship between long-short spreads and short-term interest rates (or expected inflation rates), as implied by the expectations theory of the term structure.

If we relax the assumption of perfect substitution between short-term and long-term bonds and instead assume they are only imperfect substitutes for each other, we can add to equation (2) an extra term that can help explain why bond market participants prefer one class of bonds (say, short-term bonds) over another (say, long-term bonds), even when both bonds have the same return.⁸ Let \mathbf{y}_t denote this extra term, which is often called term premium or liquidity premium. Imposing the restriction $\mathbf{y}_t > 0$ implies that long-term bonds are more risky or less liquid than short-term bonds and thus investors require a compensation for holding long-term bonds instead of short-term bonds. Below we assume that \mathbf{y}_t is a linear function of the current and lagged values of a measure of economic uncertainty, which we denote by V_t . Shortly we will discuss how to measure economic uncertainty.

Based on the discussion above, we now have the following linear regression equation:

$$R_t(m) = \tilde{\mathbf{a}} + \sum_{j=0}^p \mathbf{f}_j X_{t-j} + \sum_{j=0}^q \mathbf{b}_j V_{t-j} + \mathbf{g}R_{t-1}(m) + \mathbf{e}_t, \quad (6)$$

where X_{t-j} represents the short-term interest rate or the rate of one-period-ahead expected inflation rate at time $t-j$. Above, the lagged dependent variable is added to capture the effects of other factors than the short-term interest rate (or expected inflation) and economic

⁸ This modified version of the expectations hypothesis is often called the preferred habit theory of the term structure.

uncertainty. \mathbf{e}_t is assumed to be an independently and identically distributed white noise. p and q are the optimal lag lengths that are going to be chosen using the Akaike information criterion (AIC). Now another null hypothesis that we are going to test is $\mathbf{b}_j = 0$ for all $j = 0, 1, \dots, q$. If this null hypothesis is rejected, we will have evidence that economic uncertainty plays a statistically significant role in explaining long-short spreads.

2. Measures of Economic Uncertainty

Economic decision-making can be influenced by various kinds of uncertainty, including not only economic but non-economic factors. To the extent that the uncertainty caused by non-economic factors does eventually reveal itself as forces affecting demands and supplies, we may take as a measure of economic uncertainty the volatility of various prices that are determined in the market place. These include the prices of financial assets (i.e. stocks, bonds, loanable funds, foreign currencies, etc) as well as real commodities (i.e. productive factors and produced goods). Below, however, we limit our interest to the prices of financial assets, mainly because we have an easier access to high frequency (i.e. daily) financial data than nonfinancial data.

So we may use the standard deviations of various financial asset prices as measures of economic uncertainty. One example is the monthly standard deviation of daily Won/USD exchange rates, which we denote by SDW. It can be a useful measure of economic uncertainty (more specifically, foreign exchange market uncertainty), because volatile foreign exchange rates can influence cross-border capital flows and foreign trade⁹ and thus the entire economy – especially when the shares of exports and imports in GDP are large. Another example is the standard deviation of daily overnight call rates, which we denote by

⁹ Volatile exchange rates can have negative effects on international trade. See, for example, Eichengreen and Irwin (1993), Kroner and Lastrapes (1993), and Caporale and Doroodian (1994). If exchange rates are highly volatile, the exchange-rate-adjusted value of foreign sales will be less predictable and hence firms may become less willing to engage in international trade. High exchange-rate volatility can also adversely affect long-term capital flows across countries, as investors may equate volatility with risk. See, for example, Engel and Hakkio (1993).

SDC. If firms meet a significant share of their funding needs through bank loans or credit, the fluctuations in the call rate, which affect credit market conditions, can affect corporate investment decisions and thus real economic activity in general.¹⁰ A third example is the standard deviation of daily stock prices, which we denote by SDK. To the extent that stock price movements can affect consumption through wealth effects [Starr-McCluer (1998), Ludvigson and Steindel (1999), Fair (2000)] and investment through the Tobin's q theory mechanism, an increase in stock market volatility can be related to an increase in economic uncertainty in general.

Figure 4 contains three plots, which show the time series behavior of the three standard deviations discussed above. One striking feature about the first two plots is that both the Won/USD exchange rate and the overnight call rate experienced extremely large volatility during the 1997-98 foreign exchange crisis. (The relatively small volatility of the Won/USD exchange rate during the first half of the decade may have to do with the managed float system that was in place.) But it appears that both measures of economic uncertainty fail to pick up the financial turmoil caused by Daewoo Group's liquidity problems in mid 1999.¹¹ Although the movement over time of the standard deviation of daily KOSPI closing quotes is quite different from that of SDW or SDC, there seems to be a slightly upward trend in the volatility of the Korean stock price index, as can be seen in the third plot. In particular, the plot indicates a surge in the volatility at the height of the recent Daewoo episode as well as the foreign exchange crisis.

¹⁰ Recently efforts have been made to explain how monetary policy can affect real economic activity through its effects on bank loans or credit to the small companies that do not have direct access to capital markets. This line of argument is called the "bank lending channel" or "credit channel." See, among others, Kashyap, Stein, and Wilcox (1993), Walsh and Wilcox (1995), and Bernanke, Gertler, and Gilchrist (1996).

¹¹ As investment trust companies and other financial institutions announced in June 30, 1999 that they would refuse to roll over Daewoo-issued bonds and commercial papers, most of the corporations belonging to the Daewoo Group immediately suffered from severe liquidity shortages. The rest of the economy also suffered. A massive amount of funds were drained away from the investment trust industry. The yield on 3-year corporate bonds increased 42 basis points and KOSPI lost 152 points or 14.9% in one week after the July 19 announcement that 12 Daewoo corporations would be placed into work-out programs.

Other measures than the volatility of financial asset prices may also be considered. In general, as economic uncertainty increases, the probability of default on private obligations and the risky-riskfree yield spread (or the required premium on risky bonds) also increase. So one may take the two risk-related variables as alternative measures of economic uncertainty. The first plot in Figure 5 shows the default risk premium (measured by the yield spread between 3-year corporate bonds and Korea Development Bank industrial finance debentures), which we denote by CRSK. The second plot shows the rate of default on commercial paper obligations by private businesses in the Seoul area, which we denote by DFLT. CRSK seems to pick up the foreign exchange crisis only, whereas DFLT picks up quite successfully both the foreign exchange crisis and the recent Daewoo-related financial calamity.

The coefficients of correlation between the three standard deviation measures and CRSK are 0.85 for SDW, 0.35 for SDC, and 0.17 for SDK. The coefficients of correlation between the three standard deviation measures and DFLT are 0.70 for SDW, 0.23 for SDC, and 0.21 for SDK.

3. Expected Inflation

In order to estimate the expected inflation rate used in equation (6), we first regress the current period inflation rate, \mathbf{p}_t , on p lags of its own and q lags of the overnight call rate, s_t .¹²

$$\mathbf{p}_t = \mathbf{r}_0 + \mathbf{r}_1 \mathbf{p}_{t-1} + \mathbf{r}_2 \mathbf{p}_{t-2} + \cdots + \mathbf{r}_p \mathbf{p}_{t-p} + \mathbf{g}_1 s_{t-1} + \mathbf{g}_2 s_{t-2} + \cdots + \mathbf{g}_q s_{t-q} + \mathbf{h}. \quad (7)$$

The optimal lag lengths p and q chosen by the Akaike information criterion are 3 and 1, respectively. Based on the parameter estimates, we then compute one-period-ahead forecasts of inflation rates, $\hat{\mathbf{p}}_{t+j}$ for $j > 0$, as follows:

¹² For a similar approach, see, for example, Mishkin (1981).

$$\hat{\mathbf{p}}_{t+j} = \hat{\mathbf{r}}_0 + \hat{\mathbf{r}}_1 \mathbf{p}_{t+j-1} + \hat{\mathbf{r}}_2 \mathbf{p}_{t+j-2} + \cdots + \hat{\mathbf{r}}_p \mathbf{p}_{t+j-p} + \hat{\mathbf{g}}_1 s_{t+j-1} + \hat{\mathbf{g}}_2 s_{t+j-2} + \cdots + \hat{\mathbf{g}}_q s_{t+j-q}.$$

Finally, we take these forecasts as our estimates of expected inflation rates:

$$E_{t+j-1} \mathbf{p}_{t+j-1}(1) = \hat{\mathbf{p}}_{t+j}, \text{ for } j > 0. \text{ The results are presented in Figure 6.}$$

4. Long-Short Interest Rate Spreads

As for long-short interest rate spreads, we use two kinds. One is the spread between the 3-year and 1-year industrial finance debentures (IFD), issued by the government-owned Korea Development Bank.¹³ We denote this yield spread by FF. The other is the spread between 3-year corporate bonds and 3-month commercial papers. We denote this spread by CCP. The frequency of the data used is monthly with each observation representing a monthly average of daily observations. The sample period is 1991.1 – 2000.9 for FF and 1995.6 – 2000.9 for CCP.

Figures 1 and 2 show the movements of FF and CCP over time. There are two notable features about these two time series. First, yields on longer-term bonds were not necessarily higher than yields on shorter-term bonds.¹⁴ As discussed in footnote 3, a yield curve inversion is often thought of as one of the precursors of a recession in the near future. As a matter of fact, both CCP and FF were negative before the 1996.3-1998.8 recession. Since FF was positive before the 1992.1-1993.1 recession, however, it would be premature to conclusively relate the yield curve inversions in the 1990s to a higher probability of near future recessions.

¹³ As of June 1996 the Korea Development Bank is owned 100% by the Korean government and in principle not subject to the laws that govern the central bank and commercial banks. The payment of the principals and interests on the Bank-issued debentures can be guaranteed by the government, but the National Assembly's approval is required. See *The Financial System of Korea* (1999, pp. 102-108) published by The Bank of Korea.

¹⁴ In general, long-short yield spreads are expected (and tend) to be positive. This is because longer-term bonds are more risky to hold than shorter-term bonds, meaning that returns on longer-term bonds are subject to greater fluctuations in response to shocks. Positive premiums are thus required on longer-term bonds, helping to result in a typical, positively-sloped yield curve shape.

Second, at the height of the recent foreign exchange crisis, the negative long-short spread even further enlarged unprecedentedly – in excess of 500 basis points per annum. This was caused by a large decrease in the demand for short-term bonds and a simultaneous increase in the supply. Before the crisis, merchant banking corporations borrowed heavily from overseas money markets¹⁵ and invested the borrowed funds mainly in the Korean commercial paper market,¹⁶ nonguaranteed medium to long-term loans, and emerging markets. When the foreign exchange crisis broke out, these particular financial institutions found themselves in a sudden liquidity crunch and became the target of the comprehensive financial sector reform led by the Korean government.¹⁷ Consequently, the demand side of the commercial paper market was choked up. At the same time, as the government raised interest rates on the recommendation of the International Monetary Fund, corporations were reluctant to issue long-term bonds at the high interest rates. Instead, they preferred to issue short-term bonds now, hoping the sudden interest rate hikes would be reversed in the near future.

It should be noted that this study does not follow the practice that measures long-short interest rate spreads using differentials between long-term government bond yields and overnight call rates. When we talk about the term structure of interest rates, we generally maintain all the characteristics such as the default risk of the issuer are the same except for the term to maturity. So a set of bonds that are considered in a particular term structure should be substitutable to a certain degree, unless one group of investors prefers one particular maturity only and another group prefers another particular maturity only. Since both the demand and the supply in the call market are limited to banks and some other

¹⁵ In 1996 and 1997 merchant banking corporations as a whole borrowed from overseas money markets twice as much as from domestic money markets. See the 1998 issues of *Money and Banking Statistics* published by the Bank of Korea.

¹⁶ As of the end of 1997, merchant banking corporations accounted for 79.8% of the total amount of commercial papers discounted. See the *Financial and Corporate Restructuring Report: What Has Been Done?* (2000, p. 104) published by the Financial Supervisory Commission.

¹⁷ 16 out of the 30 merchant banking corporations that existed in 1996 were forced out of business by 1998.

financial institutions (such as investment trust companies, merchant banking corporations, and securities firms), while the supply in the primary government bond market is limited to the government only, it makes little sense to assume substitutability between funds in the two markets and treat the two yields in the same term structure.

5. Estimation Results

We estimate equation (6) with OLS for two different interest rate spreads: FF and CCP. In each case we use five different measures of economic uncertainty: CRSK, DFLT, SDW, SDC, and SDK. In the case of CCP, we also report the results that are obtained when the assumption of constant real interest rates is dropped and so the 3-month commercial paper yield (denoted by CP3M) is used in lieu of the expected inflation rate (denoted by EXPINF) on the right hand side of equation (6).

We conduct Dickey-Fuller and Phillips-Perron tests of nonstationarity to see if the variables used in our regression analysis contain unit roots. Given the criticism that these unit root tests suffer from low power, we also conduct Kwiatkowski-Phillips-Schmidt-Shin (1992) LM tests of stationarity. Unlike Dickey-Fuller or Phillips-Perron tests, the null hypotheses of these LM tests are level stationarity and the alternative hypotheses are a unit root. We find that FF, EXPINF, CRSK, DFLT, and SDW are stationary, whereas S, CP3M (the 3-month CP rate), CCR (the spread between the 3-year corporate bond yield and the overnight call rate), and CCP are nonstationary. So we use the five stationary series in levels and the three nonstationary series in first differences in our regression analysis.

Since the Durbin-Watson statistic fall well below 2 in some cases, we report in each of the tables to be discussed below the t -ratios that are computed based on the Newey-West's (1987) heteroskedasticity and serial correlation consistent covariance matrix.

The Case of FF

Table 1 reports the estimation results with FF as a measure of the long-short yield

spread. The optimal lag lengths determined by Akaike information criterion vary depending on which measure of economic uncertainty is employed. The optimal values of p range from 3 to 12, while those of q from 2 to 12. As can be seen in columns (1)-(5), for three out of the five measures of economic uncertainty under consideration (the exceptions are SDC and SDK), we reject at the conventional significance level the joint null hypothesis that none of the economic uncertainty terms is statistically significant.¹⁸ On the other hand, in four out of the five specifications considered (the exception is column (4)), we also reject the joint null hypothesis that none of the expected inflation rate terms is statistically significant. Based on this evidence, we conclude that the movement of the long-short spread measured by FF appears to be determined not only by economic uncertainty but also by inflationary expectations.

The Case of CCP

Table 2 reports the estimation results that were obtained with FF replaced with the first difference of CCP. The optimal values of p range from 0 to 11 and those of q from 5 to 12. For four out of the five measures of economic uncertainty (the exception is DFLT), we reject at the conventional significance level the joint null hypothesis that none of the economic uncertainty terms is statistically significant. The same can be said about the expected inflation rate: In four out of the five specifications considered, we reject the joint null hypothesis that none of the expected inflation rate terms is statistically significant.

Even when the constant real interest rate assumption was dropped and so the expected inflation rate was replaced with the 3-month commercial paper yield (CP3M), we find that in all five specifications both economic uncertainty and the 3-month CP yield play

¹⁸ The Wald statistic for a joint null hypothesis depends not only on the vector of distances between the true parameter values and the hypothesized values but also on the covariance among the parameter estimates. This implies that if the parameter estimates are strongly negatively correlated with each other, the joint null hypothesis can be rejected even when individual parameters cannot be rejected.

a statistically significant role in explaining the movement of CCP.¹⁹ See Table 3.

In summary, it appears that both economic uncertainty and inflation expectations influence the long-short spread regardless of which of the two measures (FF and CCP) is used.

¹⁹ The results did not change much even when CP3M was replaced with the overnight call rate (see Table 5) and CCP with CCR, which is the spread between the 3-year CB yield and the overnight call rate (see Table 4).

III. Variance Decomposition and Impulse Response Analysis

In this section we estimate a three-variable vector autoregression (VAR) model and further investigate the role of the expected inflation rate (EXPINF) and economic uncertainty in explaining long-short interest rate spreads. In particular, we analyze how long-short spreads respond to innovations to the two factors and which of the two factors is more important in explaining the forecast error variance of long-short spreads.

As is well known, the ordering of variables is important in a VAR system that employs the so-called Choleski factorization for the orthogonalization of innovations.²⁰ This is because there is a different factorization for each ordering of the variables. Here we assume an ordering of $[V, E\mathbf{p}, R]$. This corresponds to the assumption that there is contemporaneous influence from the first two variables to long-short interest rate spreads but no such influence from long-short interest rate spreads to the first two variables.²¹ The order of autoregression is determined by AIC.

The top row of plots in Figures 7-11 show the variance decomposition results for the long-short spread measured by FF. The average percentage of the forecast error variance of FF that is attributable to innovations to the CRSK, DFLT, SDW or SDC measure of economic uncertainty is larger than that attributable to EXPINF over all horizons up to 24 months. This means that each of these four measures of economic uncertainty plays a more important role than EXPINF in explaining (the forecast error variance of) FF.

The variance decomposition results remain about the same even when the first

²⁰ Bernanke (1986) and Sims (1986) noted that the Choleski factorization procedure was mechanical, lacking any economic structural interpretations, and proposed alternative ways of factorizing the innovation covariance matrix by imposing more of an economic structure. But their procedures are not always preferable because unlike the Choleski procedure they suffer from identification problems. For further details, see Doan (1996, pp. 8-10).

²¹ I have tried several different orderings and found that the impulse response functions and variance decompositions are not very different across different orderings. This result has much to do with the fact the residuals are almost uncorrelated. Low correlation means little explanation of a variable's variance by

difference of CCP replaces FF. (See Figures 12 through 16.) In all five cases, the average percentage of the forecast error variance of CCP that is attributable to innovations to economic uncertainty exceeds that attributable to expected inflation. So the variance decomposition results may be summarized as follows. As far as the relative importance in explaining the long-short spread is concerned, economic uncertainty appears to dominate expected inflation, regardless of which measure of economic uncertainty and spreads is used.

The bottom row of plots in Figures 7-11 show how the long-short spread measured by FF responds to one-standard-deviation innovations to various measures of economic uncertainty, the expected inflation, and FF itself. We find that at impact FF declines 12 to 15 basis points at an annual rate in response to a positive innovation to economic uncertainty. (There is one exception, though. In the case of SDK, the impact response is a 10 basis point increase.) But in the very next period FF increases 13 to 21 basis points, making the negative impact effects only temporary. Both the negative impact and positive second-period responses are all statistically significant. On the other hand, the impact effects of an innovation to inflationary expectations on FF are positive in all five specifications. Three specifications in which economic uncertainty is measured with CRSK, DFLT, and SDC produce an impact response of FF that is not only positive but also statistically significant.

The impulse responses of (the first difference of) CCP are shown in the bottom row of plots in Figures 12 and 16. We find that when economic uncertainty unexpectedly rises, the change in CCP declines at impact by 10 to 30 basis points at an annual rate. (This means that CCP itself either increases at a slower pace or decreases). The impact decline is also statistically significant when economic uncertainty is measured by CRSK, SDW, or SDC. In the third month after an innovation, however, the change in CCP turns positive and stays so (with the fourth month excluded, though), gradually approaching zero. As for the

the other variables.

impulse responses of the change in CCP to a positive innovation to expected inflation, we find that they are positive at impact in three out of the five specifications considered. Even in those three specifications, however, the effects on the change in CCP are not only quantitatively small but also statistically insignificant.

Overall, the impulse response analysis indicates that a positive innovation to expected inflation tends to have positive (at least, nonnegative) impact effects on long-short spreads, whereas an unexpected rise in economic uncertainty tends to have negative impact effects. But these negative impact responses to an innovation to economic uncertainty are followed by positive responses of FF and CCP in the second and third periods, respectively, making the negative impact effects only temporary.

In general, when inflation expectations and/or short-term interest rates rise,²² bond market investors try to reduce the share of long-term bonds in their portfolios in order to minimize potential capital losses, whereas borrowers decrease the supply of short-term bonds (or the demand for short-term funds) in order to avoid higher funding costs now. In equilibrium, rising expected inflation rates thus tend to place an upward pressure on the current interest rate on long-term bonds, resulting in a larger spread between long and short-term bonds. As far as the impact responses are concerned, this interpretation is roughly consistent with the results that long-short spreads respond positively to an unexpected rise in inflationary expectations.

On the other hand, the result that the impact effect of a positive innovation to economic uncertainty on FF or CCP is negative seems to defy our common sense. In general, with all other things held constant, the probability of default increases in economic uncertainty and the term to maturity. Accordingly, risk-averse investors require a larger

²² This can happen when the economy moves along an expansion phase of the business cycle, during which aggregate output, employment, and factor prices increase, causing inflationary expectations and short-term interest rates to rise over time. For the sample period of 1991:I – 1997:III, the coefficient of correlation between the overnight call rate and the (one-quarter lagged) rate of real GDP growth is small (0.172) but positive. The estimated coefficient in the regression of the overnight call rate on the lagged

compensation for the increased risk on long-term bonds, as they try to reduce the share of long-term bonds in their portfolios. The increased risk premium shows up as larger long-short spreads. Apparently, it is not what we observe in the data under study.

Why is it then that the positive relationship between economic uncertainty (or more precisely the required risk premium) and the long-short spread, as postulated by the preferred habitat theory, is not borne out by the data? We can think of a few reasons. First, long-term and short-term interest rates may differ in their speed of response to exogenous shocks. For example, short-term interest rates may adjust more quickly to exogenous shocks than long-term interest rates do.²³ If this is the case, an innovation that causes short-term interest rates to rise can actually make long-short spreads turn negative²⁴ – at least, at impact – resulting in a negative relationship between the innovation and long-short spreads. This interpretation is not inconsistent with the finding that the negative impact responses are reversed in the second or third period after an innovation.

Second, as mentioned in section II.4, the yield curve inversion witnessed during the recent foreign exchange crisis may have to do with the market expectations on the duration of the sudden short-term interest rate hikes. That is, as the government raised short-term interest rates by an unprecedented magnitude, the market might have expected that the interest rate hikes would not last long but be reversed in the near future. Such expectations on the movement of future short-term interest rates could have led to long-term rates falling below short-term rates. In our analysis in which two factors (economic uncertainty and the current and past inflation expectations and/or short-term rates) were focused on as the potential determinants of long-short spreads, the role of such short-term rate expectations might have been picked up by the economic uncertainty term, with the long-short spread forced to have a negative relationship with economic uncertainty. This is particularly so

rate of real GDP growth is also positive (0.124) and statistically significant at the 3 percent level.

²³ For this argument, see Estrella and Hardouvelis (1991).

²⁴ The negative spreads observed during the recent foreign exchange crisis might have resulted from the sudden, sharp increases of short-term interest rates by the Korean monetary authorities.

because it is difficult to expect the other term, that is, the current and past inflation expectations and/or short-term rates, to have fully picked up the role of the market expectations on short-term rates.

Third, the quality of the data that we have examined may well be open to discussion. It is widely known that the sample period under study (at least, the pre-crisis period) contains data that are contaminated by various irregularities such as thin corporate bond markets, the wide-spread practice of issuing corporate bonds with guarantees,²⁵ government controls and interventions in financial markets, etc.²⁶ These data contaminations may have to do with the relatively low volatility of Won/USD exchange rates and the negative spreads between corporate bonds and the Korea Development Bank-issued debentures that existed for an extended period of time before the crisis. See the plots in Figures 1, 4, and 5. Only very recently have corporations in Korea widely started issuing bonds without guarantees and has the Won/USD exchange rate been left to float freely. Analysis only with the post-crisis data (1998.06-2000.09) indicates that as far as the role of economic uncertainty is concerned, the results are overall not very different from the results with the entire sample utilized. (See Table 5 for details.) On the other hand, the results are less supportive (in the case of CCP, little supportive) of the thesis that inflation expectations play a statistically significant role in explaining the spread. This tells us that care needs to be exercised in interpreting our results.

Fourth, due to the lack of data on the one-month yields on corporate bonds and industrial finance debentures, we substituted one-month-ahead expected inflation rates for the required one-month yields on the right hand side of equation (6). This substitution was made possible by the assumption that real interest rates were constant. In order to see if the results were robust to the possible misspecification problem caused by the constant real interest rate assumption, however, we also tried the 3-month CP yield on the right hand side

²⁵ This point was made by Lee (1999).

²⁶ See Bank of Korea (1996) for various government controls and interventions in corporate bond markets.

of equation (6) in the case of CCP. It remains to be further examined whether these assumptions are supportable.

IV. Summary and Conclusion

We have developed an empirical model of the term structure of interest rates, where long-short interest rate spreads are related to expected inflation and economic uncertainty. After discussing various measures of these two factors, we have tested if they play a statistically significant role in explaining long-short spreads. We have also estimated a vector autoregression model and further investigated how long-short spreads respond to innovations to the two factors and which of the two factors plays a more important role in explaining long-short spreads.

The main findings of the present study are as follows. First, both economic uncertainty and inflation expectations appear to influence long-short interest rate spreads, regardless of which class of bonds is used in constructing the spreads, industrial finance debentures or corporate bonds. Second, the variance decomposition analysis indicates that as far as the relative importance in explaining the long-short spread is concerned, economic uncertainty appears to dominate expected inflation, regardless of which measure of economic uncertainty and spread is used. Third, the impulse response analysis indicates that a positive innovation to expected inflation tends to have positive (at least, nonnegative) impact effects on long-short spreads, whereas an unexpected rise in economic uncertainty tends to have negative impact effects. But these negative impact responses are followed by positive responses in the second or third period, making the negative impact effects only temporary. We have attributed this last finding to the possibility that long-term interest rates may respond more slowly to exogenous shocks (e.g. an unexpected change in monetary policy during the recent foreign exchange crisis) than short-term interest rates do. The negative impact relationship between economic uncertainty and the long-short spread has also been related to a plausible way in which the market formed expectations on the movement of future short-term interest rates and at the same time the possible spuriousness with which such market expectations might have been picked up by our measures of

economic uncertainty.

In short, we have found that although economic uncertainty seems to be a more important factor in explaining long-short spreads, only weak evidence is there for the thesis that an increase in expected inflation or economic uncertainty leads to a larger long-short spread. In the case of expected inflation, the evidence is weak in the sense that the positive relationship is not robust across different specifications. In the case of economic uncertainty, the evidence is weak in the sense that the positive relationship does not show up immediately but only sluggishly.

Based on these findings, it would be difficult to draw any strong implications for economic policy. Nevertheless, a policy prescription would not be ill-advised if it involved not short-run macroeconomic stabilization measures but intermediate to long-run microeconomic structural measures – that is, measures that are geared toward eliminating factors that contribute to systemic risk and thus improving the economy's ability to absorb shocks. Included in such structural measures would be, among others, the development of primary as well as secondary bond markets for assorted maturities, the improvement of the system of credit rating of bond issuers, and the enhancement of the efficiency in issuing and trading bonds.

References

- Bank of Korea (1999), *U-ri Na-ra-eui Geum-yoong Je-do (The Korean Financial System)*, Jeon-Gwang Press: Seoul.
- Bank of Korea (1998), *Tong-hwa Geum-yoong (Money & Banking Statistics)*, January-December.
- Bank of Korea (1996), *U-ri Na-ra Hoi-sa-chae See-jang-eui Hyon-hwang-gwa Gwa-je (The Current State and Future of the Korean Corporate Bond Market)*, Research Report No. 96-15.
- Financial Supervisory Commission (2000), *Geum-yoong Gi-eop Goo-jo Jo-jeong Baek-seo: Geum-yoong Gi-eop Goo-jo Jo-jeong Eo-teo-ke E-roo-eo Jeot-neun-ga? (Financial and Corporate Restructuring Report: What Has Been Done?)*
- Bernanke, B. (1986), "Alternative Explanations of the Money-Income Correlation," *Carnegie-Rochester Conference Series on Public Policy*, Vol. 25, 49-100.
- Bernanke, B.S., M. Gertler, and S. Gilchrist (1996), "The Financial Accelerator and the Flight to Quality," *Review of Economics and Statistics*, Vol. 78, 1-15.
- Caporale, T. and K. Doroodian (1994), "Exchange Rate Variability and the Flow of International Trade," *Economics Letters*, Vol. 46, 49-54.
- Doan, T.A. (1996), *RATS User's Manual Version 4.0*, Estima: Evanston, IL.
- Eichengreen, B. and D.A. Irwin (1993), "Trade Blocs, Currency Blocs and the Disintegration of World Trade in the 1930s," National Bureau of Economic Research Working Paper No. 4445.
- Engel, C. and C.S. Hakkio (1993), "Exchange Rate Regimes and Volatility," *Federal*

- Reserve Bank of Kansas City Economic Review*, Vol. 78, 43-58.
- Estrella, A., and G.A. Hardouvelis (1991), "The Term Structure as a Predictor of Real Economic Activity," *Journal of Finance*, Vol. 46, 555-576.
- Estrella, A. and F.S. Mishkin (1995), "Predicting U.S. Recessions: Financial Variables as Leading Indicators," National Bureau of Economic Research Working Paper No. 5379.
- Fama, E.F. (1990), "Term-Structure Forecasts of Interest Rates, Inflation, and Real Returns," *Journal of Monetary Economics*, Vol. 25, 59-76.
- Fama, E.F. and M.R. Gibbons (1982), "Inflation, Real Returns and Capital Investment," *Journal of Monetary Economics*, Vol. 9, 297-323.
- Hamilton, J.D. (199?), *Time Series Analysis*, Princeton University Press: Princeton.
- Harvey, A.C. (1981), *Time Series Models*, Philip Allan: Oxford.
- Kang, H. and Y. Oh (2000), "Jang-dan-gi Geum-ni-gyeok-cha-ga Keu-ge Hwahk-dae-dwen Yee-yoo? (What is the Reason for the Large Increase in Long-Short Interest Rate Spreads?)," LG Economic Research Institute Weekly Economic Report #580.
- Kashyap, A., J.C. Stein, and D.W. Wilcox (1993), "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance," *American Economic Review*, Vol. 83, 78-98.
- Kroner, K.F. and W.D. Lastrapes (1993), "The Impact of Exchange Rate Volatility on International Trade: Reduced Form Estimates Using the GARCH-in-Mean Model," *Journal of International Money and Finance*, Vol. 12, 298-318.
- Kwiatkowski, D., P.C.B. Phillips, P. Schmidt, and Y. Shin (1992). "Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root: How Sure Are We That Economic Time Series Have a Unit Root?" *Journal of Econometrics*, Vol.

54, 159-178.

Lee, J.H. (1999), "Sin-yong-wi-heom Cheuk-jeong-eh Dae-han So-go (A Note on the Measurement of Credit Risk)," *EXIM Monthly Bulletin*, August, 26-39.

Luetkepohl, H. (1991), *Introduction to Multiple Time Series Analysis*, Springer-Verlag: Berlin.

Mishkin, F.S. (1990), "What Does the Term Structure Tell Us about Future Inflation?" *Journal of Monetary Economics*, Vol. 25, 77-95.

Mishkin, F.S. (1981), "The Real Interest Rate: An Empirical Investigation," *Carnegie-Rochester Conference Series on Public policy*, Vol. 15, 151-200.

Newey, W. and K. West (1987), "A Simple Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, Vol. 55, 703-708.

Schwarz, G. (1978), "Estimating the Dimension of a Model," *Annals of Statistics*, Vol. 6, 461-464.

Sims, C. A. (1986), "Are Forecasting Models Usable for Policy Analysis?" *Federal Reserve Bank of Minneapolis Quarterly Review*, Winter.

Shiller, R. J. (1997), *Market Volatility*, The MIT Press: Cambridge.

Walsh, C.E. and J.A. Wilcox (1995), "Bank Credit and Economic Activity," In J. Peek and E. Rosengren (eds.), *Is Bank Lending Important for the Transmission of Monetary Policy?*, 83-112, Federal Reserve Bank of Boston Conference Series, No. 39.

Table 1. Long-Short Spread (FF), Expected Inflation, and Economic Uncertainty

$$FF_t = \tilde{\alpha} + \sum_{j=0}^p \phi_j E_{t-j} \pi_{t-j} (1) + \sum_{j=0}^q \beta_j V_{t-j} + \gamma FF_{t-1} + \varepsilon_t$$

	(1) V=CRSK	(2) V=DFLT	(3) V=SDW	(4) V=SDC	(3) V=SDK
p	12	3	12	3	12
q	12	8	10	3	2
Adj. R ²	0.868	0.704	0.862	0.613	0.501
D.W.	2.193	1.988	2.325	2.352	2.283
$\phi_j = 0 \forall j$	39.09(0.000)*	9.569(0.048) [#]	44.22(0.000)*	8.442(0.077) ⁺	12.92(0.454)
$\beta_j = 0 \forall j$	2082(0.000)*	34.78(0.000)*	867.8(0.000)*	7.499(0.112)	2.606(0.456)

Notes: FF = the yield spread between 3-year and 1-year IFD's. $E\pi$ = the rate of expected CPI inflation. p = the optimal lag length for the expected inflation term. q = the optimal lag length for the economic uncertainty term. CRSK = the risk premium on 3-year CB's over 3-year IFD's. DFLT = the rate of default on CP obligations by private businesses in the Seoul area. SDW = the monthly standard deviation of daily Won/USD exchange rates. SDC = the monthly standard deviation of daily overnight call rates. SDK = the monthly standard deviation of KOSPI closing quotes. *, #, and + represent the 1%, 5%, and 10% significance levels, respectively. The last two rows contain Wald statistics for the joint null hypotheses. The numbers in parentheses represent p-values.

Table 2. Long-Short Spread (CCP), Expected Inflation, and Economic Uncertainty

$$DCCP_t = \tilde{\alpha} + \sum_{j=0}^p \phi_j E_{t-j} \pi_{t-j} (1) + \sum_{j=0}^q \beta_j V_{t-j} + \gamma DCCP_{t-1} + \varepsilon_t$$

	(1) V=CRSK	(2) V=DFLT	(3) V=SDW	(4) V=SDC	(5) V=SDK
p	11	0	11	11	11
q	6	5	6	7	12
Adj. R ²	0.415	0.049	0.464	0.569	0.315
D.W.	1.630	1.778	1.624	1.873	1.773
$\phi_j = 0 \forall j$	41.54(0.000)*	0.305(0.581)	31.19(0.002)*	58.54(0.000)*	60.13(0.000)*
$\beta_j = 0 \forall j$	560.6(0.000)*	5.634(0.465)	447.7(0.000)*	169.9(0.000)*	59.45(0.000)*

Notes: DCCP = the first difference of the yield spread between 3-year CB's and 3-month CP's. $E\pi$ = the rate of expected CPI inflation. p = the optimal lag length for the expected inflation term. q = the optimal lag length for the economic uncertainty term. CRSK = the risk premium on 3-year CB's over 3-year IFD's. DFLT = the rate of default on CP obligations by private businesses in the Seoul area. SDW = the monthly standard deviation of daily Won/USD exchange rates. SDC = the monthly standard deviation of daily overnight call rates. SDK = the monthly standard deviation of KOSPI closing quotes. *, #, and + represent the 1%, 5%, and 10% significance levels, respectively. The last two rows contain Wald statistics for the joint null hypotheses. The numbers in parentheses represent p-values.

Table 3. Long-Short Spread (CCP), Short-Term Interest Rate, and Economic Uncertainty

$$DCCP_t = \tilde{\alpha} + \sum_{j=0}^p \phi_j DCP_{t-j} + \sum_{j=0}^q \beta_j V_{t-j} + \gamma DCCP_{t-1} + \varepsilon_t$$

	(1) V=CRSK	(2) V=DFLT	(3) V=SDW	(4) V=SDC	(5) V=SDK
p	12	8	12	12	12
q	3	2	3	2	7
Adj. R ²	0.768	0.681	0.748	0.706	0.689
D.W.	2.150	2.046	2.097	2.154	1.942
$\phi_j = 0 \forall j$	373.7(0.000)*	386.1(0.000)*	919.5(0.000)*	718.4(0.000)	306.8(0.000)*
$\beta_j = 0 \forall j$	20.12(0.000)*	9.070(0.028) [#]	13.22(0.010) [#]	7.457(0.059)+	17.77(0.023) [#]

Notes: DCCP = the first difference of the yield spread between 3-year CB's and 3-month CP's. DCP = the first difference of the yield on 3-month CP's. p = the optimal lag length for the short-term interest rate term. q = the optimal lag length for the economic uncertainty term. CRSK = the risk premium on 3-year CB's over 3-year IFD's. DFLT = the rate of default on CP obligations by private businesses in the Seoul area. SDW = the monthly standard deviation of daily Won/USD exchange rates. SDC = the monthly standard deviation of daily overnight call rates. SDK = the monthly standard deviation of KOSPI closing quotes. *, #, and + represent the 1%, 5%, and 10% significance levels, respectively. The last two rows contain Wald statistics for the joint null hypotheses. The numbers in parentheses represent p-values.

Table 4. Long-Short Spread (CCR), Short-Term Interest Rate, and Economic Uncertainty

$$DCCR_t = \tilde{\alpha} + \sum_{j=0}^p \phi_j DS_{t-j} + \sum_{j=0}^q \beta_j V_{t-j} + \gamma DCCR_{t-1} + \varepsilon_t$$

	(1) V=CRSK	(2) V=DFLT	(3) V=SDW	(4) V=SDC	(5) V=SDK
p	1	0	1	0	0
q	11	4	10	3	4
Adj. R ²	0.822	0.577	0.808	0.411	0.312
D.W.	1.968	1.825	2.065	2.073	2.032
$\phi_j = 0 \forall j$	226.6(0.000)*	27.14(0.000)*	272.0(0.000)*	50.29(0.000)*	7.028(0.008)*
$\beta_j = 0 \forall j$	2355(0.000)*	19.29(0.002)*	2227(0.000)*	12.36(0.015) [#]	6.520(0.259)

Notes: DCCR = the first difference of the spread between the 3-year CB yield and the overnight call rate. DS = the first difference of the overnight call rate. p = the optimal lag length for the short-term interest rate term. q = the optimal lag length for the economic uncertainty term. CRSK = the risk premium on 3-year CB's over 3-year IFD's. DFLT = the rate of default on CP obligations by private businesses in the Seoul area. SDW = the monthly standard deviation of daily Won/USD exchange rates. SDC = the monthly standard deviation of daily overnight call rates. SDK = the monthly standard deviation of KOSPI closing quotes. *, #, and + represent the 1%, 5%, and 10% significance levels, respectively. The last two rows contain Wald statistics for the joint null hypotheses. The numbers in parentheses represent p-values.

Table 5. Long-Short Spread, Expected Inflation, and Economic Uncertainty
Sample Period: 1998.06 – 2000.09

$$FF_t = \tilde{\alpha} + \sum_{j=0}^p \phi_j E_{t-j} \pi_{t-j}(1) + \sum_{j=0}^q \beta_j V_{t-j} + \gamma FF_{t-1} + \varepsilon_t$$

	(1) V=CRSK	(2) V=DFLT	(3) V=SDW	(4) V=SDC	(5) V=SDK
p	2	6	0	0	0
q	1	1	1	5	1
Adj. R ²	0.867	0.737	0.693	0.821	0.700
D.W.	2.215	1.707	1.921	2.026	1.978
$\phi_j = 0 \forall j$	14.05(0.003)*	14.39(0.045) [#]	0.795(0.373)	0.000(0.991)	0.603(0.437)
$\beta_j = 0 \forall j$	140.9(0.000)*	7.610(0.022) [#]	0.243(0.886)	70.19(0.000)*	1.236(0.539)

$$DCCP_t = \tilde{\alpha} + \sum_{j=0}^p \phi_j E_{t-j} \pi_{t-j}(1) + \sum_{j=0}^q \beta_j V_{t-j} + \gamma DCCP_{t-1} + \varepsilon_t$$

	(1) V=CRSK	(2) V=DFLT	(3) V=SDW	(4) V=SDC	(5) V=SDK
p	3	0	3	3	0
q	3	4	0	6	1
Adj. R ²	0.243	0.050	0.082	0.310	0.165
D.W.	1.880	1.867	2.117	2.654	1.998
$\phi_j = 0 \forall j$	5.298(0.258)	2.284(0.131)	3.422(0.490)	3.842(0.429)	0.580(0.446)
$\beta_j = 0 \forall j$	23.20(0.000)*	22.91(0.000)*	3.898(0.048) [#]	26.290(0.000)*	8.909(0.012) [#]

Notes: FF = the yield spread between 3-year and 1-year IFD's. $E\pi$ = the rate of expected CPI inflation. DCCP = the first difference of the yield spread between 3-year CB's and 3-month CP's. p = the optimal lag length for the expected inflation term. q = the optimal lag length for the economic uncertainty term. CRSK = the risk premium on 3-year CB's over 3-year IFD's. DFLT = the rate of default on CP obligations by private businesses in the Seoul area. SDW = the monthly standard deviation of daily Won/USD exchange rates. SDC = the monthly standard deviation of daily overnight call rates. SDK = the monthly standard deviation of KOSPI closing quotes. *, #, and + represent the 1%, 5%, and 10% significance levels, respectively. The last two rows contain Wald statistics for the joint null hypotheses. The numbers in parentheses represent p-values.

Figure 1. 3-Year CB and 3-Month CP Yields and Spread (CCP)

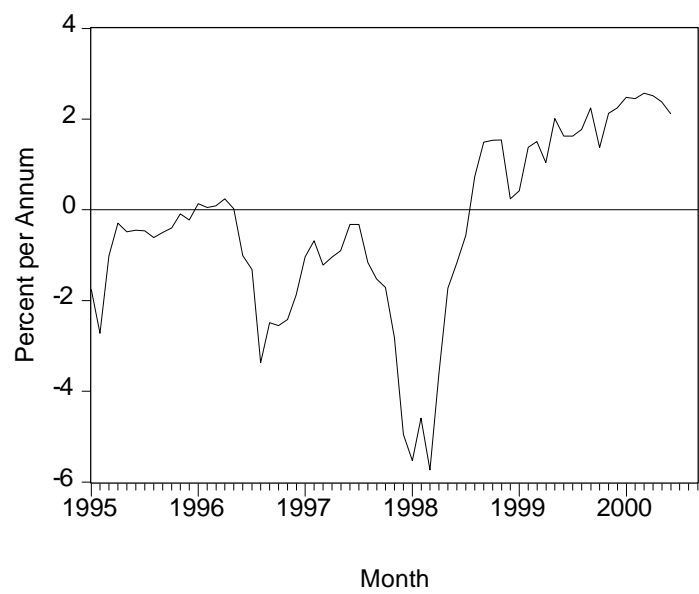
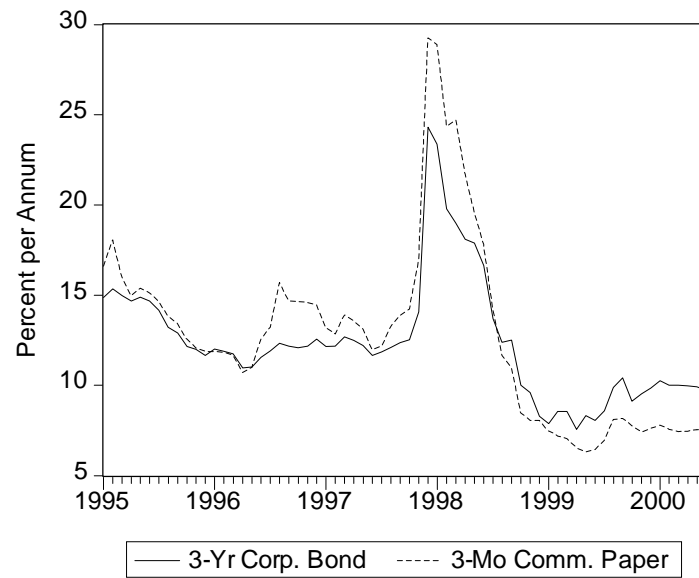


Figure 2. 3-Year and 1-Year IFD Yields and Spread (FF)

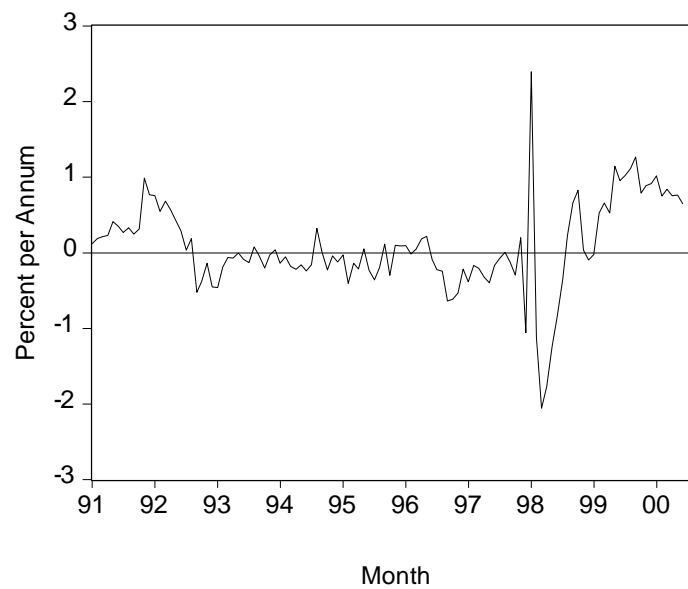
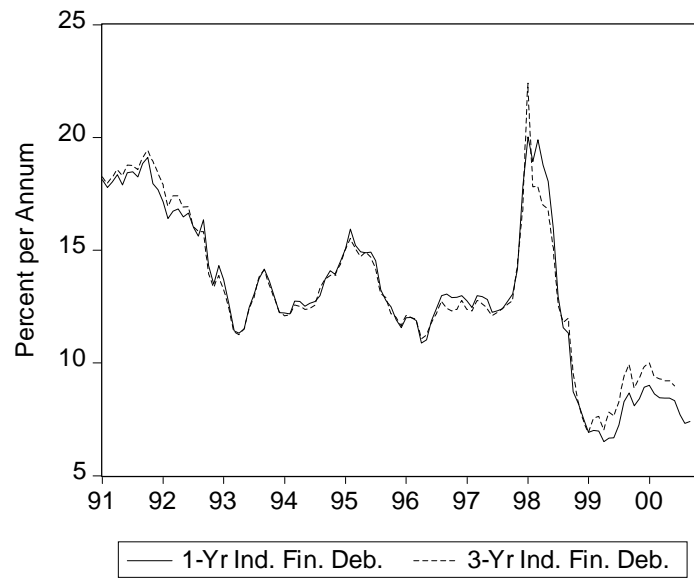


Figure 3. U.S. Treasury Yield Spread and Recessions

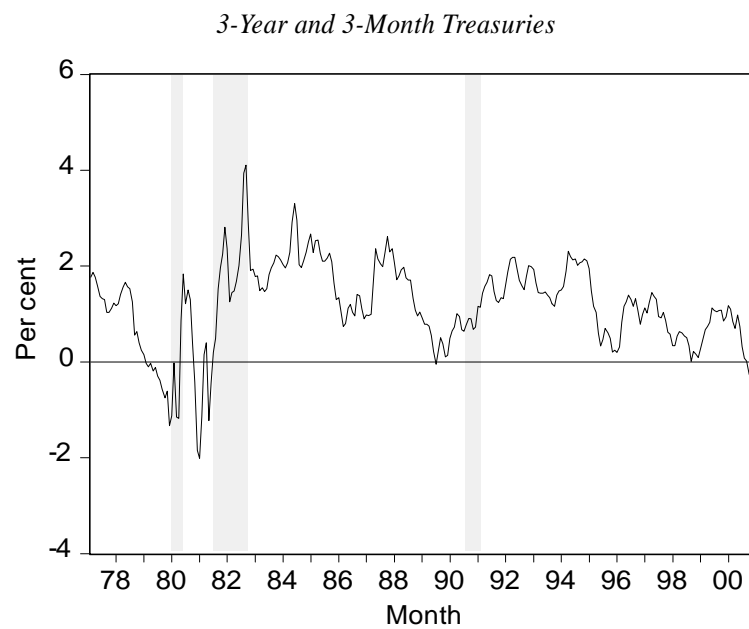
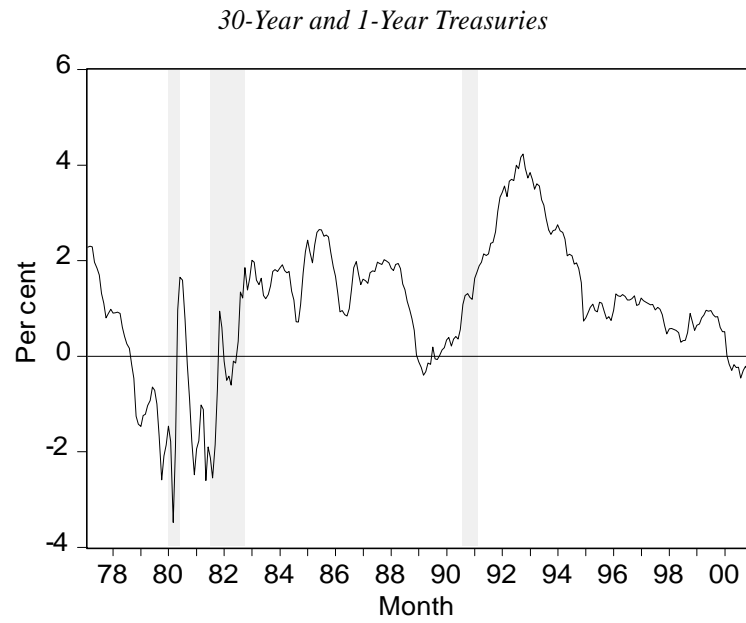
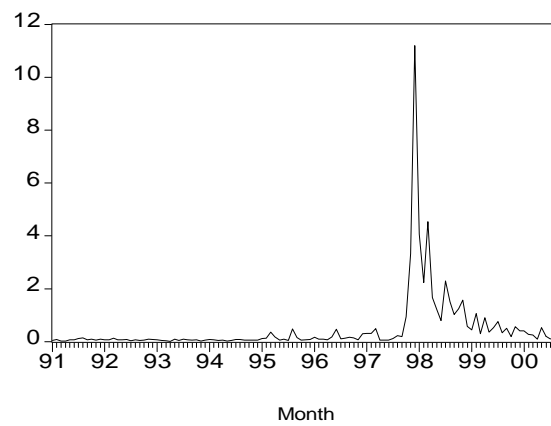
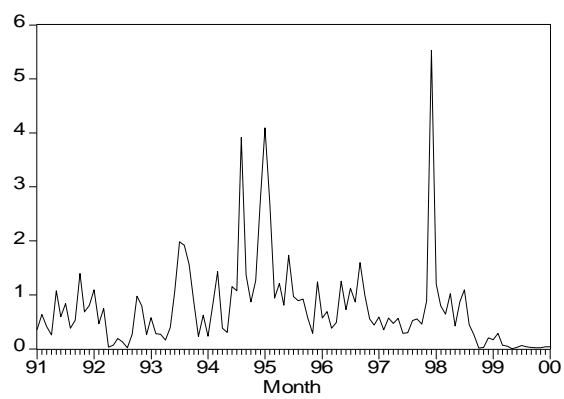


Figure 4. Volatility Measures of Economic Uncertainty

Standard Deviation of Won/USD Exchange Rates (SDW)



Standard Deviation of Overnight Call Rates (SDC)



Standard Deviation of KOSPI Closing Quotes (SDK)

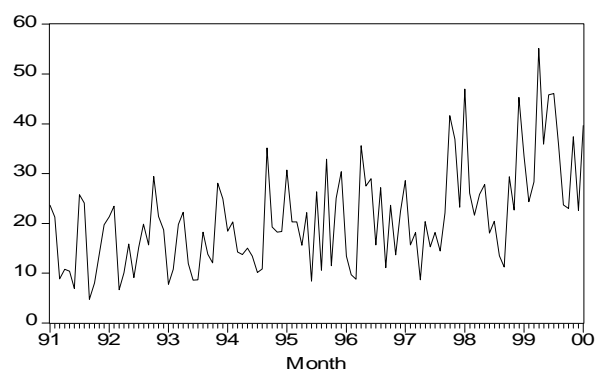
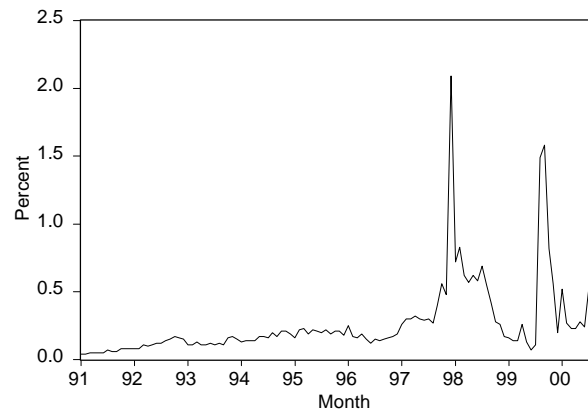


Figure 5. Risk Measures of Economic Uncertainty

*The Rate of Default on Commercial Paper Obligations
by Private Businesses in the Seoul area (DFLT)*



Yield Spread between 3-Year CB and 3-Year IFD (CRSK)

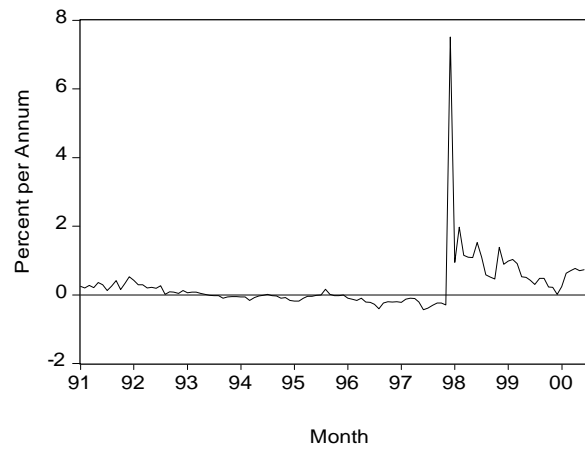


Figure 6. Actual vs. Expected Inflation Rates

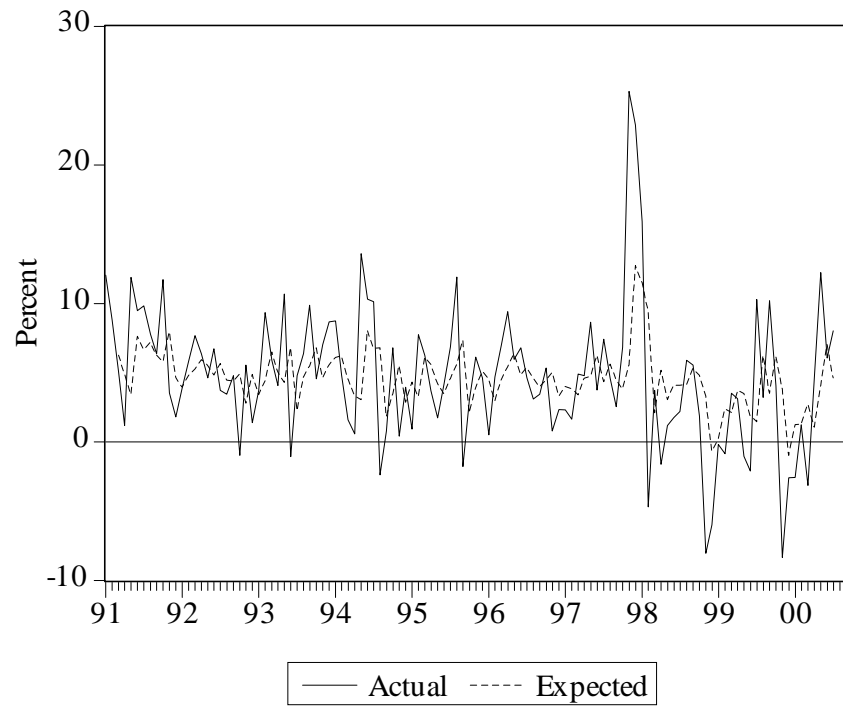


Figure 7. Variance Decomposition and Impulse Responses: FF with CRSK

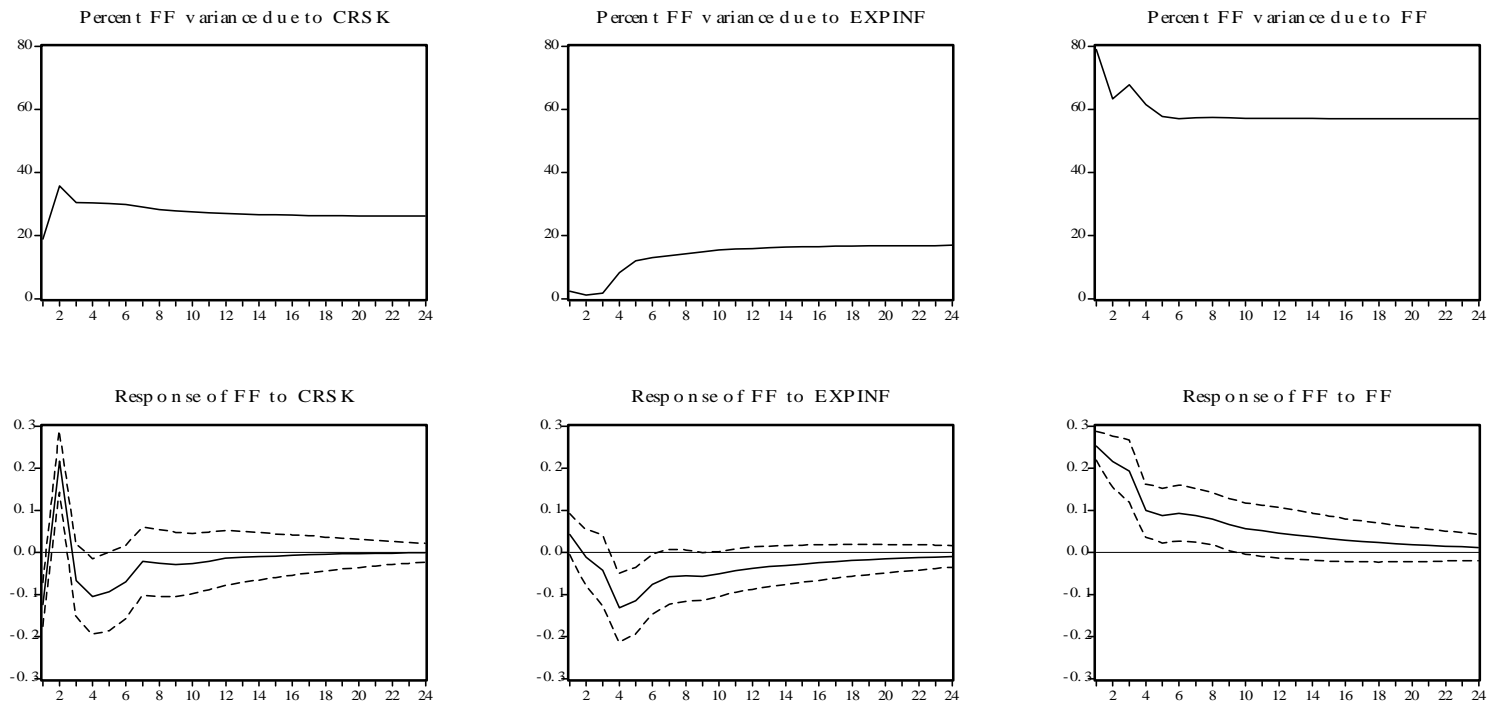


Figure 8. Variance Decomposition and Impulse Responses: FF with DFLT

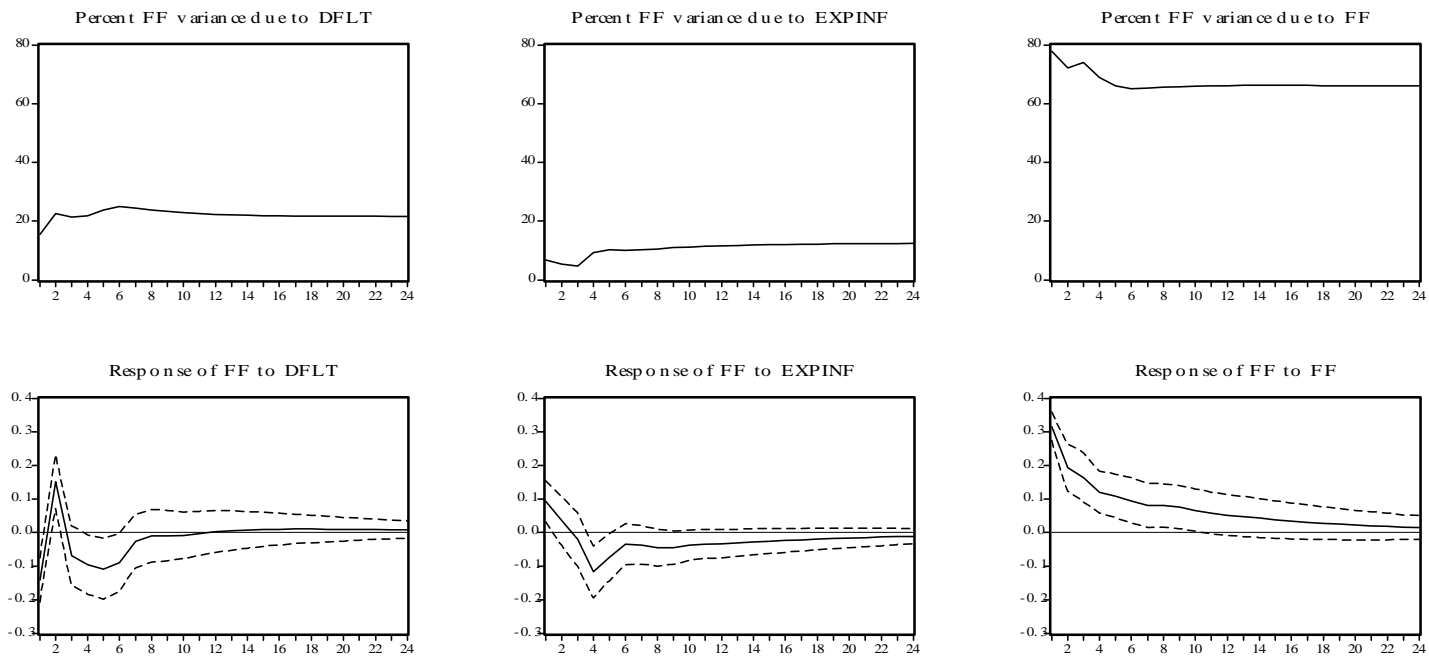


Figure 9. Variance Decomposition and Impulse Responses: FF with SDW

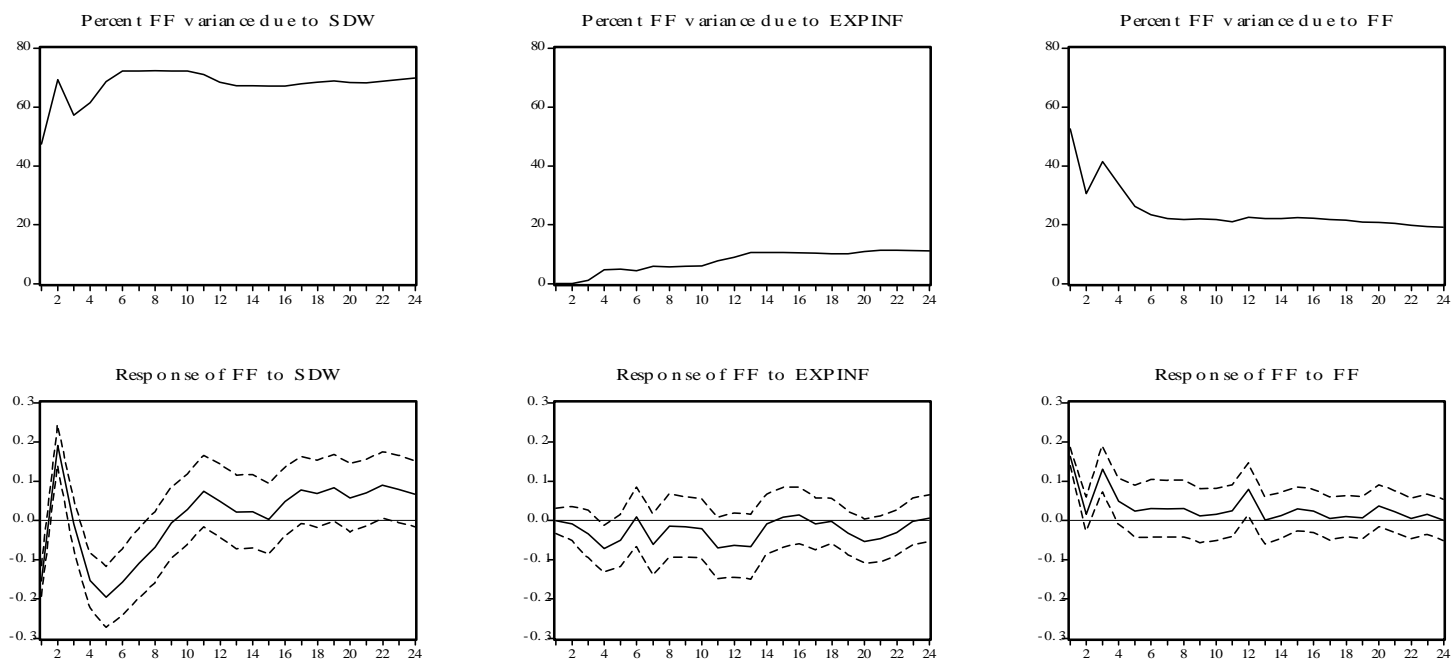


Figure 10. Variance Decomposition and Impulse Responses: FF with SDC

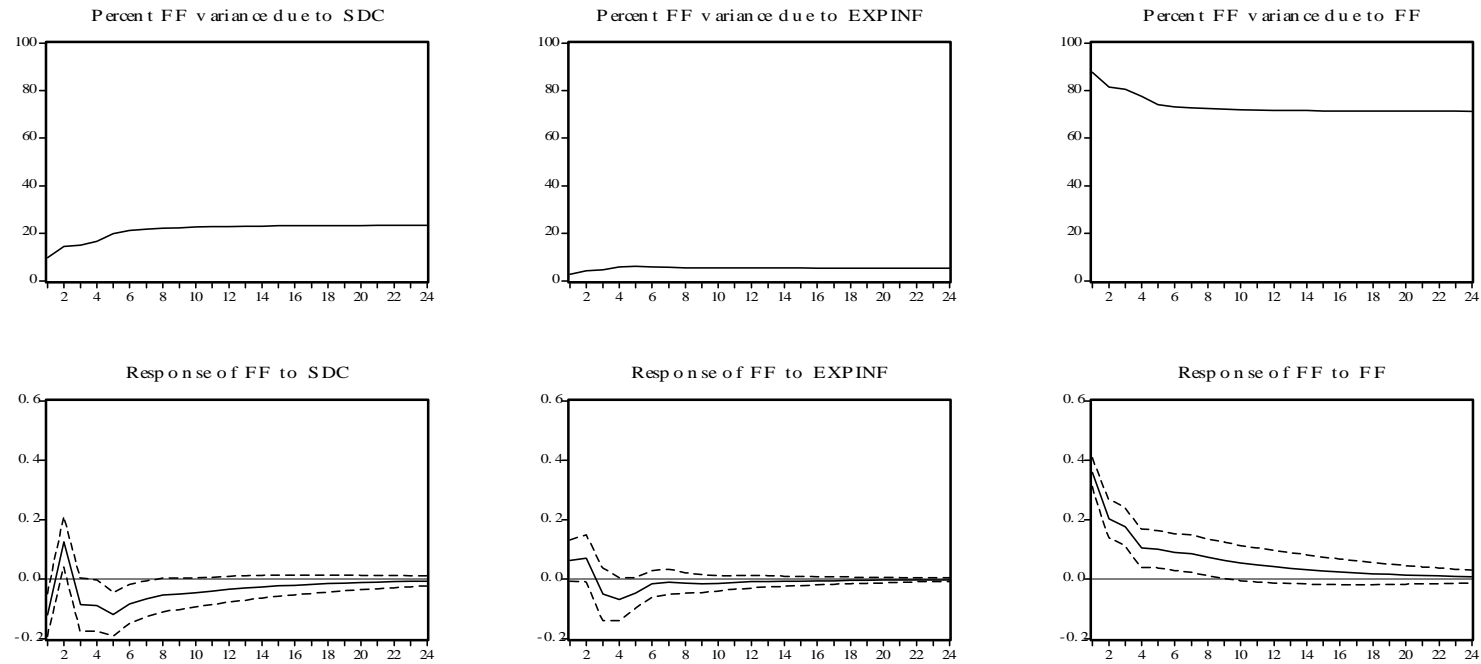


Figure 11. Variance Decomposition and Impulse Responses: FF with SDK

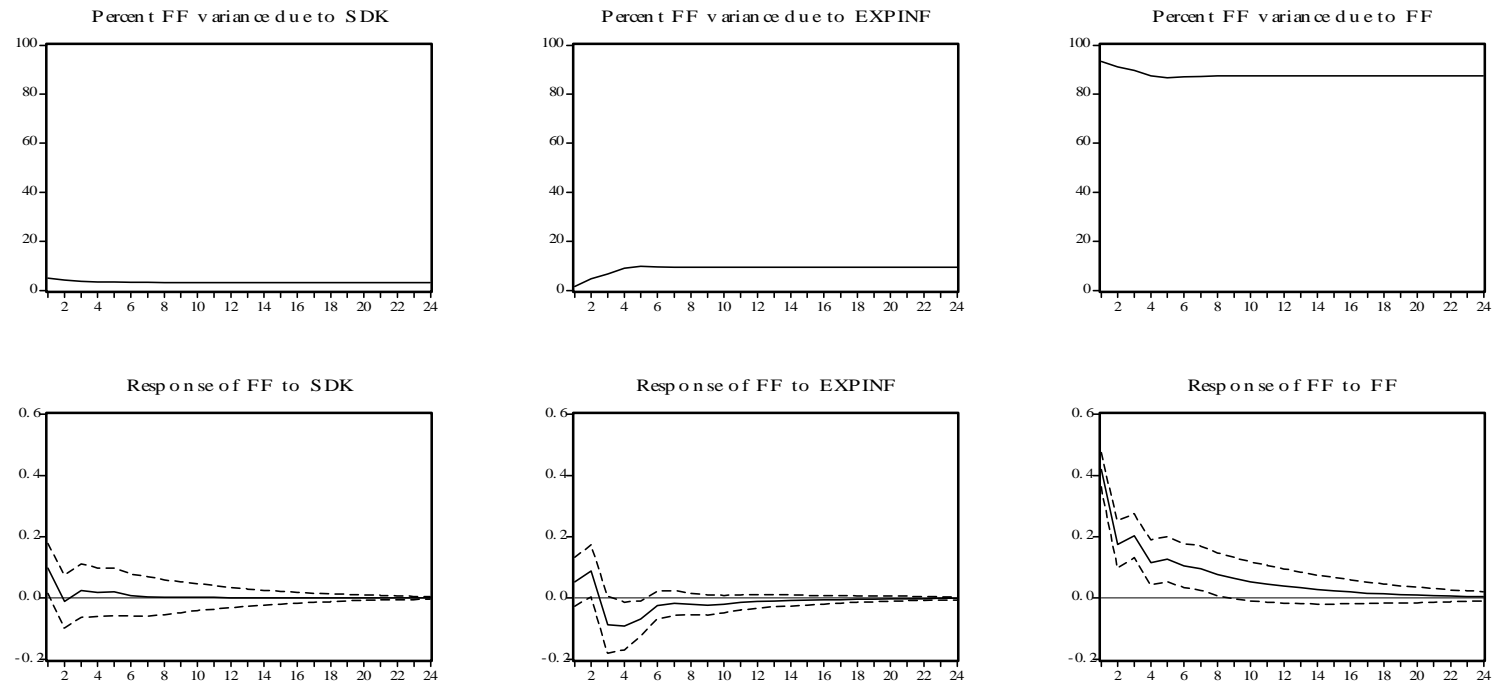


Figure 12. Variance Decomposition and Impulse Responses: CCP with CRSK

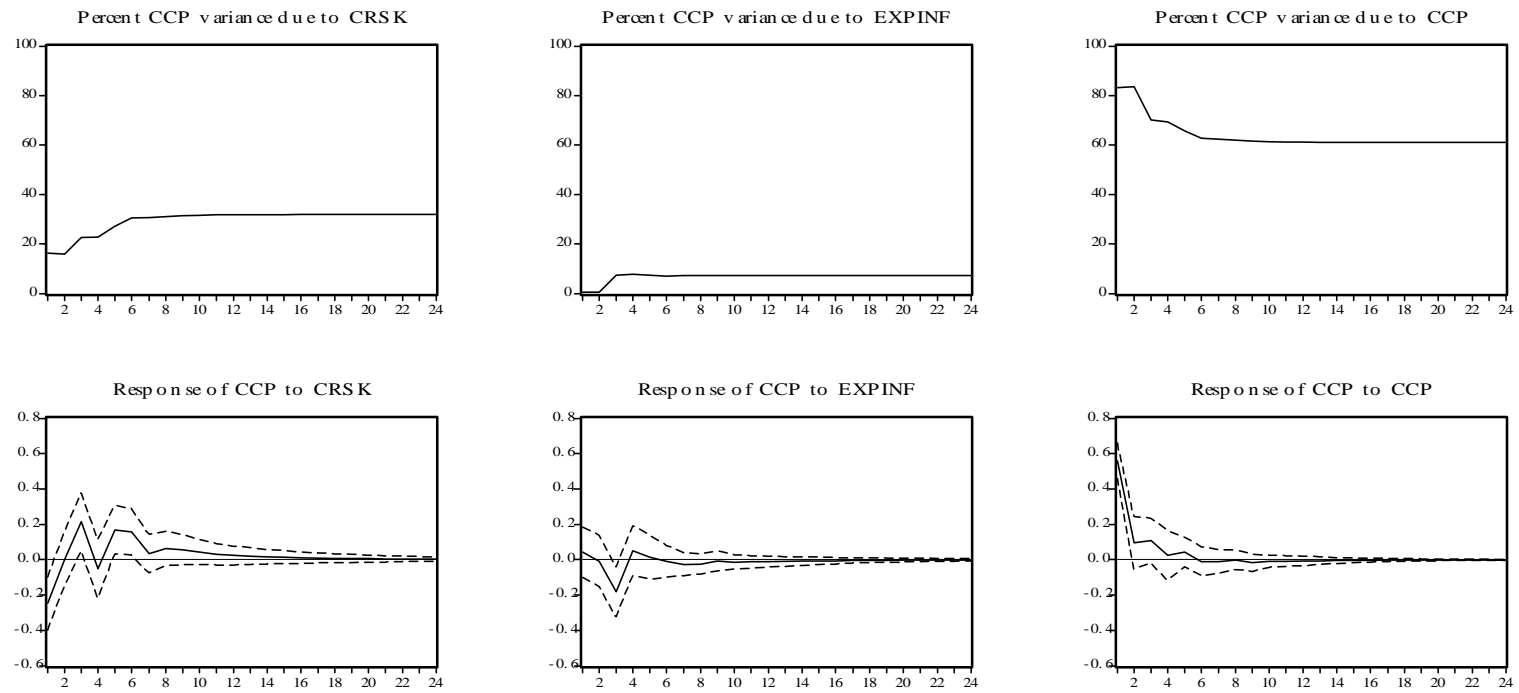


Figure 13. Variance Decomposition and Impulse Responses: CCP with DFLT

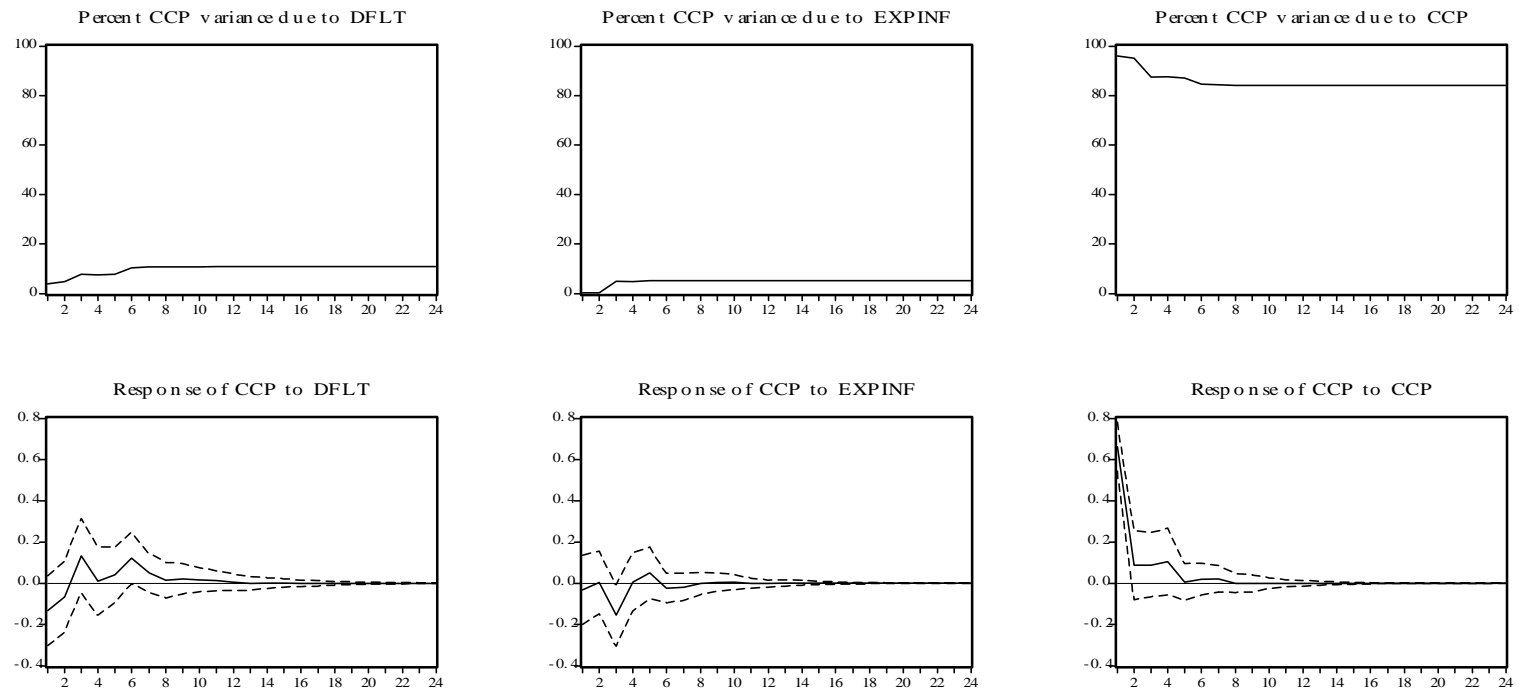


Figure 14. Variance Decomposition and Impulse Responses: CCP with SDW

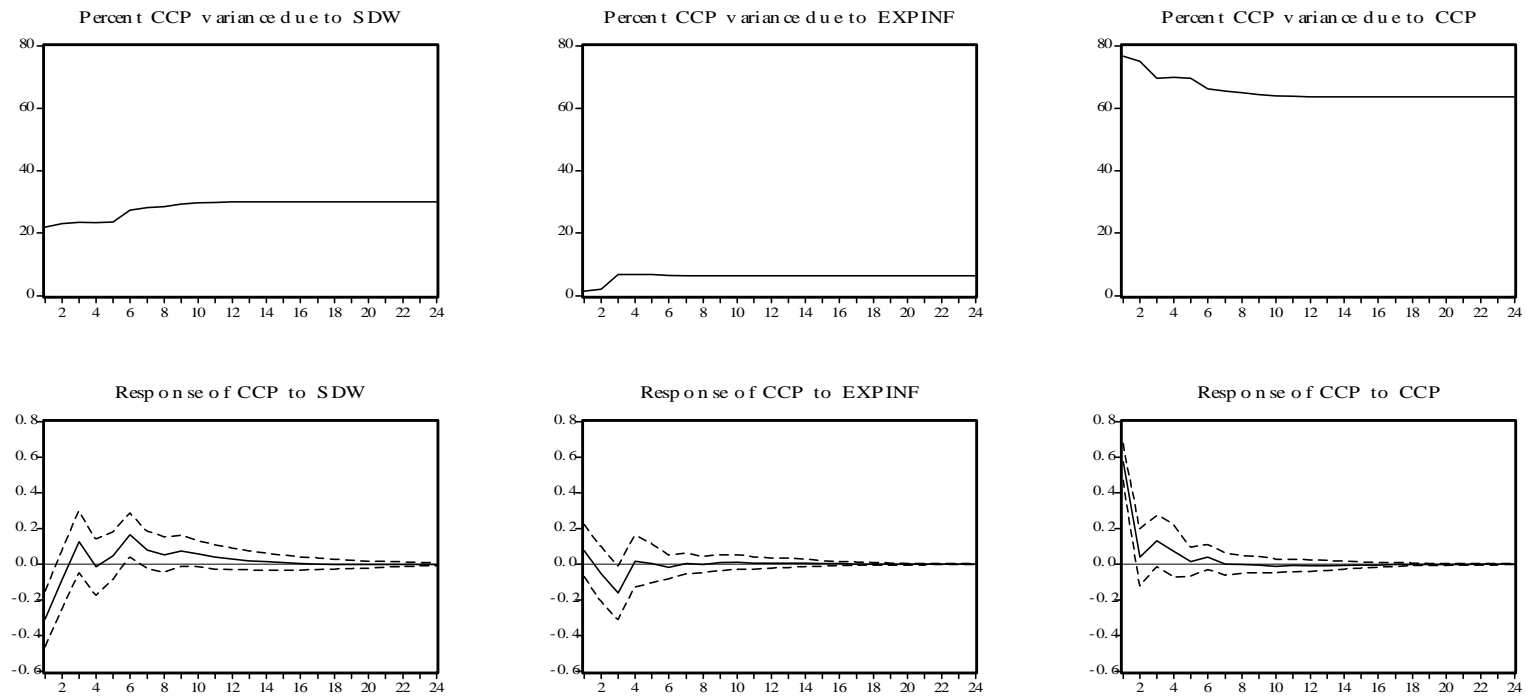


Figure 15. Variance Decomposition and Impulse Responses: CCP with SDC

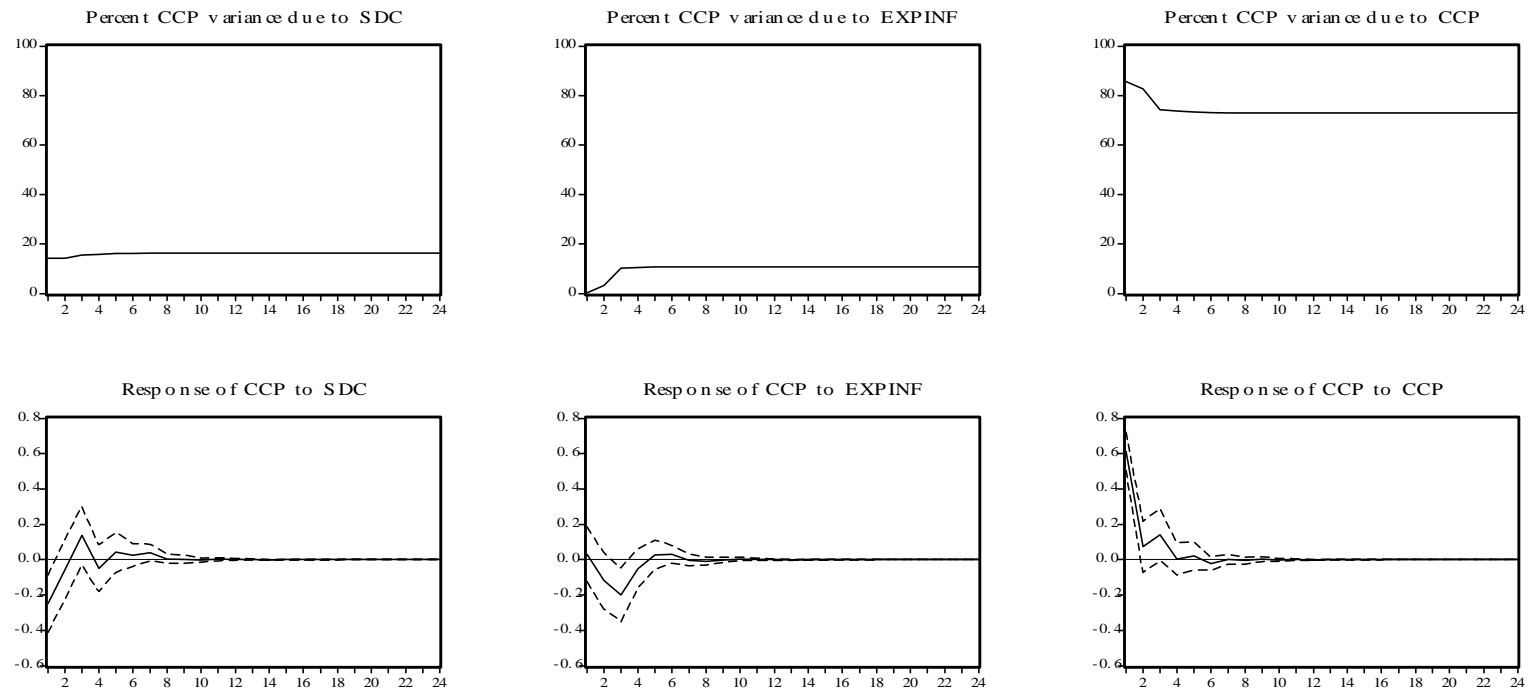


Figure 16. Variance Decomposition and Impulse Responses: CCP with SDK

