

**TWO ESSAYS ON THE LINK BETWEEN INFLATION UNCERTAINTY
AND INTEREST RATES AND EFFECT OF FOREIGN INCOME ON
ECONOMIC PERFORMANCE OF A SMALL-OPEN ECONOMY**

**THE INSTITUTE OF ECONOMICS AND SOCIAL SCIENCES
OF
BİLKENT UNIVERSITY**

BY

ZÜBEYİR KILINÇ

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE
OF
MASTER OF ARTS**

in

**THE DEPARTMENT OF
ECONOMICS
BİLKENT UNIVERSITY
ANKARA**

June 2005

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for degree of Master of Arts in Economics.

Supervisor
Asst. Prof. Ümit ÖZLALE

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for degree of Master of Arts in Economics.

Examining Committee Member
Assoc. Prof. Hakan BERUMENT

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for degree of Master of Arts in economics.

Examining Committee Member
Asst. Prof Yılmaz AKDİ

Approval of the Institute of Economics and Social Sciences
Prof. Erdal EREL
Director

ABSTRACT

TWO ESSAYS ON THE LINK BETWEEN INFLATION UNCERTAINTY AND INTEREST RATES AND EFFECT OF FOREIGN INCOME ON ECONOMIC PERFORMANCE OF A SMALL-OPEN ECONOMY

Kılınç, Zübeyir

Master of Economics

Supervisor: Asst. Prof. Ümit Özlale

June, 2005

This study includes two studies on the relationship between inflation uncertainty and interest rates and examines the effects of foreign income on economic performance of a small open economy. In the literature, there is no consensus about the direction of the effects of inflation uncertainty on interest rates. The second chapter of this study states that such a result may stem from differentiation in the sources of the uncertainties and analyzes the effects of different types of inflation uncertainty on a set of interest rates for the UK within interest rate rule framework. Three types of inflation uncertainties – impulse uncertainty, structural uncertainty and steady-state uncertainty – are derived by using a time-varying parameter model with a Generalized Autoregressive Conditional Heteroskedasticity specification. It is shown that the impulse uncertainty is positively and the structural uncertainty is negatively correlated with the interest rates. Moreover, these two uncertainties are important to explain short-term interest rates for the period of inflation targeting era. However, this time, the impulse uncertainty is negatively and the structural uncertainty is positively correlated with the overnight interbank interest rates, which is consistent with the general characteristic of the inflation targeting regimes. The evidence concerning

the effect of the steady state inflation uncertainty on interest rates is not conclusive. The third chapter uses the same methodology of the second chapter and calculates the effects of those three types of inflation uncertainties on interest rate spreads. It is found that both the structural and steady-state inflation uncertainties increase interest rate spreads, while the empirical evidence for the impulse uncertainty is not conclusive. Finally, the last chapter examines how the changes in a large foreign economy affect the economic performance of a small country. It finds the values of effects by calculating impulse response functions of the domestic economy and confidence intervals for those functions. Turkey is chosen as the domestic economy and Germany, the US, and the industrial countries are used as proxies for the large economy. The results state that a positive shock in the foreign economy positively affects domestic economy, increases the inflation rates, and appreciates the real exchange rate.

Keywords: Interest Rates, Inflation Uncertainty, GARCH, Kalman Filter, International Transmission, Small-Open Economy, Structural VAR.

ÖZET

ENFLASYON BELİRSİZLİĞİ İLE FAİZ ORANLARI ARASINDAKİ İLİŞKİ HAKKINDA İKİ ÇALIŞMA VE DIŞ ÜLKELERİN GELİRLERİNİN KÜÇÜK VE AÇIK ÜLKE EKONOMİSİ ÜZERİNE ETKİLERİ

Kılınç, Zübeyir

Yüksek Lisans, İktisat Bölümü

Tez Danışmanı: Yrd. Doç. Dr. Ümit Özlale

Haziran, 2005

Bu çalışma, enflasyon belirsizliği ile faiz oranları arasındaki ilişki üzerine yazılmış iki bölümle birlikte yabancı ülkelerin gelir düzeylerindeki değişmelerin küçük ve açık bir ülke ekonomisi değişkenleri üzerindeki etkilerini inceleyen bir bölümü içermektedir. Ekonomi literatüründe faiz oranları ile enflasyon belirsizliği arasındaki ilişkinin yönü hakkında kesin bir sonuç bulunmamaktadır. Bu çalışmanın ikinci bölümünde, bu belirsizliğin sebebinin enflasyon belirsizliğinin çeşitli kaynaklardan gelmesi nedeniyle gerçekleştiği baz alınmış ve farklı enflasyon belirsizliklerinin faiz oranları üzerindeki etkileri araştırılmıştır. Üç tip enflasyon belirsizliği tanımlanmıştır: Öngörülemeyen enflasyon belirsizliği, yapısal enflasyon belirsizliği ve uzun vade enflasyon belirsizliği. Bu belirsizlikler, zamana bağlı değişken parametrelere GARCH spesifikasyonu uygulanarak türetilmişlerdir. Sonuç olarak da öngörülemeyen enflasyon belirsizliği ile faiz oranlarını arasında pozitif, yapısal enflasyon belirsizliği ile faiz oranları arasında negatif bir ilişki olduğu gösterilmiştir. Ayrıca bu iki belirsizliğin özellikle enflasyon hedeflemesi yapılan dönemde kısa dönem faiz oranlarını büyük oranda açıkladığı tespit edilmiştir. Ancak, bu dönem içerisinde öngörülemeyen enflasyon belirsizliği, faiz oranlarını

negatif yönde etkilerken, yapısal enflasyon belirsizliğinin pozitif yönde etkilediği sonucuna varılmıştır. Bu sonuç da enflasyon hedeflemesinin genel karakterine uygundur. Son olarak da uzun vade enflasyon belirsizliğinin faiz oranları üzerindeki etkisi konusunda kesin bir sonuca varılamamıştır. Çalışmanın üçüncü bölümünde ise, ikinci bölümde kullanılan metodoloji sonucu türetilen üç tip enflasyon belirsizliğinin faiz aralığı üzerine etkileri incelenmiştir. Sonuç olarak ise yapısal ve uzun vade enflasyon belirsizliklerinin faiz aralığını artırdığı bulunup, öngörülemeyen enflasyon belirsizliğinin etkileri hakkında ise kesin bir sonuca varılamamıştır. Bu çalışmanın son bölümünde ise dış ülkelerin gelir düzeylerindeki değişmelerin küçük ve açık bir ülkenin ekonomi parametrelerini nasıl etkilediği araştırılmıştır. Bunu yaparken, yerel ülkenin öngörülemeyen cevap fonksiyonları ve bu fonksiyonların güven aralıkları hesaplanmıştır. Yerel ülke olarak Türkiye seçilmiş Almanya, Amerika gelir endeksleri ile Gelişmiş Ülkeler gelir endeksi ise dış ülke ekonomi gelirine yaklaşım olarak kullanılmıştır. Yapılan hesaplamalar sonucunda ise dış ülkeye verilen pozitif bir şokun yerel ülke ekonomisini pozitif yönde etkilediği, bu ülkedeki enflasyon oranını artırdığını ve döviz fiyatlarını artırdığı bulunmuştur.

Anahtar Kelimeler: Faiz Oranları, Enflasyon Belirsizliği, GARCH, Kalman Filtre, Uluslararası Geçiş, Küçük-Açık Ekonomi, Yapısal VAR

...to THEONE

ACKNOWLEDGEMENTS

I would like thank to Asst. Prof. Ümit Özlale for his supervision and guidance through the development of this thesis. I also would like thank to Assoc. Prof. Hakan Berument, Anita Akkaş, Christopher F. Baum, Michael Claxton, Martin Evans, Richard Froyen, and Peter N. Ireland for their invaluable suggestions.

TABLE OF CONTENTS

ABSTRACT.....	iii
ÖZET.....	v
ACKNOWLEDGEMENTS.....	viii
TABLE OF CONTENTS.....	ix
CHAPTER 1: INTRODUCTION.....	1
CHAPTER 2: THE MISSING LINK BETWEEN INFLATION UNCERTAINTY AND INTEREST RATES.....	7
2.1. Literature Survey.....	7
2.2. Model.....	11
2.2.1. Interest Rate Equation.....	11
2.2.2. Modeling Inflation Uncertainty.....	12
2.2.3. Data Set.....	17
2.2.4. Justification of the Model.....	19
2.3. Empirical Evidence.....	20
2.3.1. Inflation Targeting Period.....	23
2.4. Conclusion and Policy Implications.....	25
CHAPTER 3: THE EFFECTS OF DIFFERENT INFLATION RISK PREMIUMS ON INTEREST RATE SPREADS.....	27
3.1 Literature Survey.....	27

3.2 Empirical Evidence.....	29
3.3 Conclusion.....	31
CHAPTER 4: THE EFFECT OF FOREIGN INCOME ON ECONOMIC PERFORMANCE OF A SMALL-OPEN ECONOMY: EVIDENCE FROM TURKEY.....	33
4.1. Literature Survey.....	33
4.2. Methodology.....	34
4.3. Model Specification.....	35
4.4. Empirical Evidence.....	36
4.5. Conclusion.....	38
SELECT BIBLIOGRAPHY.....	40
APPENDIX.....	46

LIST OF TABLES

1.	Table 1: Model Selection Criteria.....	47
2.	Table 2: Unit Root Tests.....	47
3.	Table 3: Estimates of the Fischer Equation, 1961:06-2002:02.....	48
4.	Table 4: Estimates of the Interest Rate specification – Whole Sample (1961:06-2002:01).....	49
5.	Table 5: Estimates of the Interest Rate Specification – Whole Sample (1961:06-2002:01).....	50
6.	Table 6: Regression Results for the Interest Rate Spreads.....	51

LIST OF FIGURES

1. Figure 1: Impulse Response of Output, Inflation and Real Exchange Rate to a Shock in the US industrial production.....52
2. Figure 2: Impulse Response of Output, Inflation and Real Exchange Rate to a Shock in Germany Industrial Production.....53
3. Figure 3: Impulse Response of Output, Inflation and Real Exchange Rate to a Shock in the Industrial Production of Industrial Countries.....54

CHAPTER 1

Introduction

In this study, I work on three topics in three chapters. In the next chapter, I explain the effects of inflation uncertainty on different interest rates and use the results as a proxy to the possible elimination methods and policy implications of inflation uncertainty. Then, I analyze the effects of inflation uncertainty on interest rate spreads using the same methodology of chapter 2. Finally, in the last chapter, I explore a different topic in which I analyze the effects of a shock in the foreign economic performance on the domestic economy.

There has been keen interest on the part of both policymakers and academicians in understanding the effects of inflation uncertainty on economic performance. The variables such as inflation, employment, and output have been used as the indicators of economic performance. Negative and positive effects of inflation uncertainty on these variables have been analyzed both theoretically and empirically. During the last decades, the effects of inflation uncertainty on interest rates have become much more popular than the effects of it on other indicators of economic performance. The reason for this is mainly the dominance of the price stability and to establish this stability the interest rates have been used as the main policy instrument during the policymaking process. Especially, after price stability emerged as the primary goal for monetary policy, it has been often argued that a

credible monetary policy is associated with lower inflation uncertainty. Moreover, within this period, the inflation uncertainty itself has become a critical issue for policymakers because most of the industrialized economies applied inflation targeting regimes.

Here, the transmission mechanism of inflation uncertainty on economic performance should be explained. In the theory it is explained in a way that interest rates play a critical role. It is claimed that higher interest rates depress out further by decreasing consumption and investment and moreover higher interest rates deepen the debt burden and thus threaten the stability of the financial system. This financial instability causes to large amount of capital outflows and may cause financial crises. Therefore, the relationship between inflation uncertainty and interest rates should be analyzed much more carefully.

However, in the literature there is not a consensus on the effects of inflation uncertainty on interest rates. Where finance theory, asset pricing model and term structure of interest rate model suggesting a positive relationship between inflation uncertainty (risk) and interest rates, some other researches provide a negative relationship by employing loanable funds theory. Another line of literature claims a negative relationship by saying that the difference between the volatility of money income and inflation cause loss of consumer confidence and therefore consumers seek to protect themselves from inflation. Therefore, the inflation volatility will affect the real income volatility. As a result, it can be claimed that the effects of inflation uncertainty on interest rates is not well-defined in the literature.

Having said that it is not clear that the inflation uncertainty affects interest rates positively or negatively, I tried to find the answer of the question that why there is not a consensus on this effect. In this study, I showed that the reason for this differentiation is the source of inflation uncertainty. I defined three types of inflation uncertainties – impulse inflation uncertainty, structural inflation uncertainty, and steady-state inflation uncertainty - and explored the effects of these three types on a set of interest rates which vary in terms of liquidity, maturity, tax treatment and their responsiveness to the market conditions. I used the UK data for this study - the reasons for choosing this country is provided in the data set section - and employed a time varying parameter model with a GARCH specification. I found that different type inflation uncertainties affect interest rates in different ways and the inflation targeting regime plays an important role in the direction of this effect. If the whole data set is considered, the impulse uncertainty affects interest rates positively while structural uncertainty affecting negatively. When only the inflation targeting period is considered, the directions of the effects change dramatically.

In the measurement of inflation uncertainty, there are basically three methods. One of them is the survey-based approach, employed by Hafer (1986) and Davis and Kanogo (1996). In this method, the inflation uncertainty is measured by the standard deviation of inflation forecasts. Another method is employing the Kalman Filter, which is capable of measuring inflation uncertainty by estimating the time-varying parameters of an inflation specification. And as the last approach the Autoregressive Conditional Heteroskedasticity (ARCH) or the Generalized

ARCH (GARCH), which measure the uncertainty concerning the inflation shocks by using the conditional variance of residuals can be used. In this study, I combined the last two methods and explained the reasons for choosing this approach in Section 2.2.

After defining and calculating three different inflation uncertainties, I estimated a revised version of Fischer Hypothesis to calculate the effects of these uncertainties on interest rates.

In the third chapter, I analyze the effects of three inflation uncertainties, defined in chapter 2, on interest rate spreads. The reason for this estimation is that there are many studies which use the term structure of interest rates by using interest rate spread as an indicator of economic performance. Moreover, just like the effects of inflation uncertainty on interest rates, there is not a consensus on the effects of inflation uncertainty on interest rate spreads. Detailed explanation on this subject is provided in related chapter. I conclude that investors demand higher returns due to increasing levels of the structural and steady-state inflation uncertainties. On the other hand, the evidence about the effect of the impulse uncertainty on the interest rate spreads is not conclusive.

In the last chapter, I work on a different topic that the effect of a shock in the foreign economic performance on the domestic economy, which also has been an attractive research area in last decades. As the world's economies have become more interconnected, the analysis of the effects of foreign countries economic performance on a domestic economy has become more important. Thus, economists have begun to pay more attention to this topic over the last decades. In the fourth

chapter, I examine the effects of a shock in foreign economy on the economic performance of Turkey. In order to do this, I utilize from the literature about the relationship between a large country and a small country. I basically follow a structural vector autoregressive model. I construct a block recursive model where a foreign economic performance is determined by its own dynamics and Turkish economic performance is determined by a 3-variable VAR model and the economic performance of the foreign economy. The foreign output (used as a proxy of the economic performance) enters the model as an exogenous variable for domestic country. For the foreign output, I use the seasonally adjusted industrial production of Germany, the United States and the Industrial Countries and for the indicators of Turkish economy I use the industrial production, the inflation rate, and the real exchange rate. The inflation rate is calculated from wholesale price index. I have chosen Germany because she is the largest trade partner of Turkey. The other countries, the US and Industrial countries have been chosen as proxies for the rest of the world.

After gathering the whole data set, I calculate the impulse response functions of the domestic economy to a positive shock in foreign economy. I repeat same analysis for three countries and construct confidence intervals for the impulse response functions by using the Bayesian Simulation Method. The estimates suggest that a positive shock in the foreign economy positively affects Turkish output, increases the inflation rate, and appreciates the real exchange rate. These results are promising as compared to the previous researches and this is the first

study that includes a developing country within the large-small country relationship framework.

Instead of providing a large literature survey for the three topics that I analyze later on, I chose to provide them in the beginning of each chapter. In other words, one can find the related literature survey for regarding topic in the first sections of each chapter.

CHAPTER 2

The Missing Link between Inflation Uncertainty and Interest Rates

2.1 LITERATURE SURVEY

There is considerably a huge literature that tries to understand the effects of inflation uncertainty on economic performance. Most of these studies used inflation, employment and output as benchmark variables to explain the economic performance and showed different effects of inflation uncertainty. For the effects of inflation uncertainty on inflation, Cukierman and Wachtel (1979), Cukierman and Meltzer (1986), Ball and Cecchetti (1990), Evans (1991), Ball (1992), Evans and Wachtel (1993) and Holland (1993 and 1995) find a positive relationship. For negative effects of inflation uncertainty on employment, Hafer (1986) and Holland (1986) are the best examples. Moreover, Friedman (1977), Froyen and Waud (1987), and Holland (1988) report a negative relationship between inflation uncertainty and output.

The literature regarding the relationship between inflation and interest rates has intensified further in the last decade, especially after the emergence of price stability as the overriding goal of monetary policy. Along with the dominance of price stability, interest rates have become the main policy instrument during the policymaking process. More importantly, this period witnessed the implementation

of inflation targeting regimes in many industrialized economies, where inflation uncertainty as well as inflation itself became more critical issues for the policymakers. Surprisingly, despite the extensive literature concerning monetary policy rules in an inflation targeting framework, there have been only limited number of studies, such as Johnson (2002) and Kontonikas (2003), which analyze inflation uncertainty in an inflation targeting regime. While Johnson (2002) studies four industrialized countries and finds that the decrease in expected inflation during the inflation targeting period does not coincide with an equal decrease in inflation uncertainty; Kontonikas (2003) reports that there has been an improvement in inflation uncertainty for the UK during the inflation targeting period.

In the transmission mechanism of inflation uncertainty on economic performance, interest rates play a key role. Higher interest rates depress out further by decreasing consumption and investment. More importantly, for many emerging economies where debt sustainability is still a critical issue, higher interest rates deepen the debt burden and threaten the stability of the financial system by leading to massive capital outflows, as stressed in Blanchard (2003). Therefore, the relationship between inflation uncertainty and interest rate emerges as an important research area. Finance theory suggests that risk is priced. Other specifications, such as the asset pricing and term structure of interest rate models, also suggest positive relationship between inflation risk and interest rates. Fama (1975), Fama and Schwert (1977), Mishkin (1981), Fama and Gibbons (1982), Chan (1994), Kandel, Ofer and Sarig (1996), and Berument (1999) provide empirical evidence for this by using different specifications.

Although various studies find a positive relationship between interest rates and inflation uncertainty, there are some important exceptions. Hahn (1970) reports a negative relationship between inflation uncertainty and interest rates by employing loanable funds theory. Furthermore, Juster and Wachtel (1972a, 1972b), and Juster and Taylor (1975) provide a negative relationship by claiming that consumers seek to protect themselves against inflation and if the variability of money income does not match inflation volatility, then the latter will affect the real income variability due to loss of consumer confidence. Thus, consumers will increase their savings, and this will cause consumption and interest rates to decrease. Cukierman and Meltzer (1986), on the other hand, argue that governments can generate unanticipated inflation in order to stimulate their economies by decreasing interest rates.

Another line of literature, initiated by the theoretical works of Fischer (1975), Merton (1975) and Malliaris and Malliaris (1991), argues that there is a positive relationship between inflation uncertainty and real interest rate. When the inflation rate is stochastic, the nominal interest rate is equal to the real interest rate plus the sum of the expected inflation rate and the covariance between the nominal rate and the inflation rate less the variance of the rate of inflation. Their specification suggests that there is a negative relationship between inflation uncertainty and nominal interest rates.

After elaborating on the literature devoted to the effects of inflation uncertainty on interest rates, it can be claimed that the overall impact is not known *a priori*. The reason for this differentiation in the literature may stem from the

identification of different types of inflation uncertainties. Evans (1991) defines three types of inflation uncertainties and claims that their effects on the interest rates are different.

Following his lead, I define three types of inflation uncertainty: (1) the impulse uncertainty that is measured by the conditional variance of inflation to capture the inflation risk, which could be induced for the future by the information content of past inflation¹; (2) the structural uncertainty, which captures the instability on the predictive power of past inflation for the future; and (3) the steady-state uncertainty, which captures the instability in the long run steady-state inflation rate.

In particular, I identify these three types of inflation uncertainty within a time-varying parameter model with a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) specification. Next, in order to assess the effects of these uncertainties on interest rates, I regress these three uncertainty variables along with the expected inflation and output gap on a set of interest rates for the UK. Then, I analyze their role in the monetary policymaking process. The results are promising both from the perspective of the inflation targeting and the role of inflation uncertainty in the policymaking process. The empirical evidence provided in this chapter suggests that there is a positive relationship between impulse uncertainty and interest rates, and there is a negative relationship between structural inflation uncertainty and interest rates. The evidence on the negative relationship between steady-state inflation uncertainty and interest rates is weak. However, once the era of inflation targeting is considered, I find a statistically significant negative

¹ Such an uncertainty can also be seen to arise from the unforeseen shocks that hit the economy.

relationship between the overnight interbank interest rate and impulse uncertainty. On the other hand, the relationship with structural inflation uncertainty is positive.

2.2 The Model

2.2.1 Interest Rate Equation

The original Fischer equation is specified as the relationship between interest rates and expected inflation. However, especially for overnight interest rates, which are viewed to be the main policy instruments for central banks, there are other factors that they respond to. The first of these is aggregate demand pressure. It is well documented that output gap, which shows the pressure of aggregate demand on price level, is a key variable in this context. Secondly, interest rate smoothing could be another concept. As mentioned in Clarida, Gali and Gertler (1999), central banks avoid big changes in interest rates in short period of time. Instead, they adjust the interest rates slowly. Therefore, the original Fischer equation can be modified with an interest rate rule such as:

$$R_t = \alpha_o + \alpha_1 \pi_{t+1}^e + \alpha_2 gap_t + \sum_{i=1}^p \alpha_{3i} R_{t-i} + \omega_t \quad (1)$$

where R_t is the nominal interest rate at time t , π_{t+1}^e is the expected inflation for time $t+1$, gap_t is the output gap at time t , ω_t is the residual term and p is the lag order. The Fischer equation suggests that there is a positive relationship between expected inflation and interest rates. When actual output exceeds potential level, the monetary authority will most likely increase interest rates since the positive output gap, as a measure of excess aggregate demand, will put extra pressure on inflation.

When the output gap is negative, in order to stimulate output, the Central Bank can follow an accommodative way and ease monetary policy.

In this chapter, I consider another set of interest rates in addition to overnight rates. These interest rates vary in terms of liquidity, maturity, tax treatment and their responsiveness to the market conditions. I also allow that these interest rates are subject to changes in expected inflation and business cycle conditions, which is measured with the output gap.

2.2.2 Modeling Inflation Uncertainty

One obvious method for measuring inflation uncertainty is the survey-based approach as employed by Hafer (1986) and Davis and Kanogo (1996). Such an approach measures uncertainty by the standard deviation of inflation forecasts. More recently, Johnson (2002) employed absolute value of inflation forecast errors to measure inflation uncertainty. However, Bomberger (1996) claims that using the dispersion of the survey forecast does not provide a mean of measuring uncertainty, rather it provides a way to measure disagreement. Furthermore, he claims that some forecasters may try to avoid deviating from other's forecasts, which causes the value of expected inflation to be biased. In a newer study, Mankiw et al (2003) provides further support for the disagreement about survey results.

Another method would be to employ the Kalman Filter, which can be used to measure the uncertainty regarding the structural variability of the parameters of an equation. In other words, this method is capable of measuring inflation uncertainty by estimating the time-varying parameters of an inflation specification.

Finally, one can use the Autoregressive Conditional Heteroskedasticity (ARCH) or the Generalized ARCH (GARCH) processes, which measure the uncertainty concerning the inflation shocks by using the conditional variance of residuals.² Grier and Perry (1998) and Kontonikas (2003) are two recent examples adopting such a methodology.

In this study, similar to Evans (1991), I combine the last two methods to measure the three types of inflation uncertainty within a time-varying parameter model with a GARCH specification. Formally, inflation uncertainty is modeled as:

$$\pi_{t+1} = X_t \beta_{t+1} + \varepsilon_{t+1}, \quad \text{where} \quad \varepsilon_{t+1} \sim N(0, h_t) \quad (2)$$

$$h_t = h + \sum_{i=0}^m \phi_i \varepsilon_{t-i}^2 + \sum_{i=1}^n \gamma_i h_{t-i} \quad (3)$$

$$\beta_{t+1} = \beta_t + v_{t+1} \quad (4)$$

where X_t is the set of explanatory variables for inflation, ε_t is a normally distributed error term with a time-varying conditional variance of h_t at time t and stands for describing the shocks that hit the economy, β_{t+1} is the parameter vector, which is normally distributed with a homoskedastic covariance matrix of Q and v_{t+1} is the vector of shocks to β_{t+1} . Here, Equation 3 is very important because it implies that if past forecasts deviate substantially from the real rate, uncertainty will increase.

In the model, the inflation equation is specified as the k -th order time-varying autoregressive process and the residuals of the inflation equation follow a GARCH process. In such a setting, the Kalman Filter enters into process for two

² The ARCH model was first introduced by Engle (1982) and the GARCH model is provided by Bollerslev (1986).

reasons. Firstly, in a time-varying parameter framework, the Kalman Filter emerges as an efficient estimation method. Secondly, and more importantly, the updating equations regarding the Kalman Filter allow to decompose different types of inflation uncertainties. These updating equations are:

$$\pi_{t+1} = X_t E_t \beta_{t+1} + \eta_{t+1} \quad (5)$$

$$H_t = X_t \Omega_{t+1|t} X_t^T + h_t \quad (6)$$

$$E_{t+1} \beta_{t+2} = E_t \beta_{t+1} + [\Omega_{t+1|t} X_t^T H_t^{-1}] \eta_{t+1} \quad (7)$$

$$\Omega_{t+2|t+1} = [I - \Omega_{t+1|t} X_t^T H_t^{-1} X_t] \Omega_{t+1|t} + Q \quad (8)$$

In the Kalman Filter updating equations, Equation 6 clearly shows that two types of “randomness”, which cause two types of inflation uncertainties, can be decomposed. Equations 7 and 8 show how past forecast errors are built into new estimates about inflation, which provides a link from inflation uncertainty to inflation. The conditional covariance matrix of β_{t+1} , which represents the role of the structural uncertainty in the inflation process, is denoted by $\Omega_{t+1|t}$. Equation 7 shows the innovations in updating the estimates of β_{t+1} , which are used for forecasting future inflation. The updating of the conditional distribution β_{t+1} over time in response to new information is also shown in Equations 7 and 8. Thus, this model enables us to evaluate the uncertainties that originate from both inflation shocks (ε_{t+1}) and the structure of the inflation v_{t+1} .

In the model presented above, “ ε ” can be viewed as describing the shocks that hit the economy. Then, the time-varying parameter β will show how these shocks are propagated through the economy. Such terminology leads us to Frisch

and Slutsky's distinction between impulses and propagation.³ As a result, I can refer to inflation uncertainty associated with randomness in β as “structural uncertainty”, which we measure by $X_t \Omega_{t+1|t} K_t^T$, while the uncertainty associated with randomness in “ ε ” can be called “impulse uncertainty”, which is measured by the conditional variance of $\varepsilon_{t+1}(h_t)$.

In addition to structural and impulse uncertainties, I employ the steady-state uncertainty as the third type of inflation uncertainty measure. I believe that this might capture the credibility of central banks in their long term commitment to inflation control. In particular, the inflation equation is defined as an AR(2) process⁴:

$$\pi_{t+1} = \beta_{1t+1} + \beta_{2t+2}\pi_t + \beta_{3t+3}\pi_{t-1} + \varepsilon_{t+1} \quad (9)$$

Therefore, the steady-state inflation is defined as

$$\pi_{t+1}^* = (1 - \beta_{2t+1} - \beta_{3t+1})^{-1} \beta_{1t+1} \quad (10)$$

and the conditional variance of steady-state inflation is

$$\nabla_t^2(\pi_{t+1}^*) = \nabla E_t \beta_{t+1} \Omega_{t+1} \nabla E_t \beta_{t+1}' \quad (11)$$

where

$$\nabla(E_t \beta_{t+1})' = \begin{bmatrix} [(1 - E_t \beta_{2,t+1} - E_t \beta_{3,t+1})^{-1}] \\ E_t \beta_{1,t+1} [(1 - E_t \beta_{2,t+1} - E_t \beta_{3,t+1})^{-2}] \\ E_t \beta_{1,t+1} [(1 - E_t \beta_{2,t+1} - E_t \beta_{3,t+1})^{-2}] \end{bmatrix} \quad (12)$$

³ For a detailed discussion, see Blanchard and Fischer (1989:277).

⁴ Following Engle (1982), I also estimated a version of the Phillips curve, which also includes real wages in the inflation specification. However, in those specifications, the real wage variable could not explain the behavior of prices in a statistically significant fashion. This finding is parallel to Berument (1999). Therefore, in order to avoid over-parameterization, the real wage variable is dropped from the inflation specification and model the inflation as an AR process.

Finally, after defining the three sources of inflation uncertainty, I can modify the interest rate specification (Equation 1). The positive relationship between interest rate and inflation uncertainty, as suggested by Fama and Schwert (1977), Mishkin (1981), Fama and Gibbons (1982), Chan (1994) and Berument (1999), can be elaborated further now. In particular, I extended Berument (1999) by allowing the output gap to enter the interest rate specification and using three different types of inflation uncertainty. Thus, I estimate the following specification.

$$R_t = \alpha_0 + \alpha_1 \pi_{t+1}^e + \alpha_2 gap_t + \sum_{i=1}^p \alpha_3 R_{t-i} + \alpha_4 h_t + \alpha_5 S_t + \alpha_6 \nabla_t^2(\pi_{t+1}^*) + \omega_t \quad (13)$$

where S_t is the structural uncertainty, which denotes $X_t \Omega_{t+1|t} X_t^T$. h_t and $\nabla_t^2(\pi_{t+1}^*)$ stand for the impulse uncertainty and steady-state uncertainty, respectively. Furthermore, π_{t+1}^e is the forecast value for inflation (from Equation 9), gap_t is the deviation of output from its long-run trend, which is calculated with the HP filter. In addition, α_0 is the constant term, α_1 is the coefficient for the expected inflation, α_2 is the coefficient for the output gap, α_{3i} is the coefficient of the i^{th} lagged value of the interest rate, α_4 is the coefficient for the impulse uncertainty, α_5 is the coefficient for the structural uncertainty and α_6 is the coefficient for the steady-state uncertainty. Equation 13 can also be regarded as “Enriched Taylor-Type”, where there is a room for eliminating the inflation uncertainty, other than the response of interest rate to price stability and output stability together with its lagged values.

Instead of estimating the inflation specification and interest rate equations jointly, I estimate the inflation equation with the rolling regression by using all the

sample data which is known at a given time for the estimation of the parameters. If I estimated the inflation and the interest rate specifications jointly, then I would be implicitly assuming that agents know the inflation rates for the full sample to estimate β_{t+1} for each $t+1$. In particular, by using rolling regressions; first, I estimate Equations 5, 6, 7, 8 and 11 for each t . Then I use these estimates to calculate the expected inflation and three uncertainty measures for time $(t+1)^{th}$ observation. Finally, I include these derived series in the interest rate specification.

2.2.3 Data Set

I use monthly UK data from 1961:06 to 2002:02. The main reason for choosing the UK to assess the effects of different types of inflation uncertainty on interest rates is the vast amount of literature devoted to inflation uncertainty for the UK, pioneered by Engle (1982). The inflation series is obtained by taking the logarithmic first difference of the seasonally adjusted CPI series. For robustness purposes, I consider several types of interest rates, which vary in terms of liquidity, maturity, tax treatment and their responsiveness to market conditions: the Overnight minimum interbank interest rate, the Treasury bill rate, the Treasury bill rate bond equivalent, the Deposit rate, the Lending rate (clearing banks), and the Government bond yields (both short- and long-term). It is important to note that all of these series are not available for the full sample size: the data for the Overnight interbank interest rate is available after 1972:01; the Treasury bill rate data is available after 1946:01; the Treasury bill rate bond equivalent data is available after 1974:06; the Deposit rate data is available after 1962:01; the Lending rate data is available after

1966:06; the Government bond yields (short-term) data is available after 1966:01; and the Government bond yields (long-term) data is available after 1961:06.

An important remark about the estimation process is that while estimating the inflation, I did not include the conditional variance to the inflation specification. There is considerable literature regarding the positive relationship between inflation and inflation uncertainty. However, the direction of this relationship is a subject of debate. Following, Grier and Perry (1998), I did not include inflation uncertainty in the inflation specification.⁵ I also included two intercept dummy variables that characterize the institutional developments of the Bank of England pursued during the sample period. These dummies stand for the adoption of an inflation targeting regime for the post October 1992 era and the change in the independence of the Bank of England for the post May 1997 era. Several studies; including Nelson (2000), Johnson (2002), and Kontonikas (2003), report that the nature of monetary policy changed significantly after the implementation of inflation targeting. Communicating more clearly the goals of monetary policy and creating accountability for the achievement of goals led to a decline in expected inflation. Granting more independence to Bank of England further strengthened the positive aspects of the inflation targeting framework. Therefore, two dummies about these two institutional features are included in the regressor matrix.

⁵ The positive relationship between inflation and inflation uncertainty is often elaborated in the literature. However, the direction of the effect is still an unsettled issue: wherever inflation uncertainty causes inflation or inflation causes inflation uncertainty. Grier and Perry (1998) argues that for the UK inflation causes inflation uncertainty, the evidence for the reverse is weak. This is similar to my experiments – not reported in the text. Thus, I did not include the inflation risk in the inflation specification.

2.2.4 Justification of the Model

The purpose of this sub-section is to justify the selection of the GARCH-Kalman Filter specification that is used in this chapter. Parallel to Berument (1999) and Grier and Perry (2000), I model the inflation equation as an AR process which is enriched with two types of level dummies. The lag order is selected by the Final Prediction Error Criteria (FPE), which selects the optimal lag length such that residuals of the inflation equation are no longer autocorrelated. This is important because ARCH-LM tests of autocorrelated residuals wrongly suggest the presence of an ARCH effect, even there is no ARCH effect (see Jansen and Casimona (1988)). The FPE criterion suggests the lag order of two. Next, I estimate the inflation equation as an AR(2) process and apply the ARCH-LM test for the 1, 6 and 12 lags, respectively. The ARCH-LM test statistics are 64.142, 79.617 and 85.544 for these three lags. These test statistics clearly suggest the presence of an ARCH effect. Various specifications of GARCH are considered next. GARCH(1, 1) is selected as the process to assess the conditional variance.

Time-varying parameter models give superior estimates to many other estimation techniques since the time-varying parameter β will show how the shocks hitting the inflation dynamics are propagated through the system over time. Different specifications for the evolution of the parameters are also estimated. These specifications include models with a return-to-normality assumption, which can be written as:

$$(\beta_{t+1} - \bar{\beta}) = F(\beta_t - \bar{\beta}) + v_{t+1}$$

and models with constant mean, which take the form:

$$\beta_{t+1} = F\bar{\beta} + v_{t+1}.$$

However, the evidence from Table 1 suggests that the random walk assumption used in this study outperforms its alternatives, both in terms of Schwarz Information Criteria (SIC) and Akaike Information Criteria (AIC).

2.3 EMPIRICAL EVIDENCE

Table 2 reports a set of unit root tests for the inflation rate and seven interest rates. The first three tests – Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) – take the presence of unit root as their null hypothesis. Except for inflation, the null hypothesis for the variables in interest cannot be rejected. This is similar to Berument and Froyen (1998). However, failing to reject the null hypothesis does not mean that one can accept the alternative. Thus, I also report the Kwiatowski, Phillips, Schmidt and Shin (KPSS) test in the last column and with this test; I can reject the null hypothesis of stationarity for all of the variables. Therefore, I assume all the variables of interest have unit roots. Even if it is not a formal test, I perform the two-step Engle and Granger cointegration test for each interest rate paired with the inflation rate. The estimates show that these series are cointegrated. Thus, I could analyze the relationship between inflation and each of the interest rates in a level.

Table 3 reports the parameter estimates of Equation1 when the expected inflation is gathered from the predicted value of Equation 9 for the whole sample by using the OLS method. The estimated coefficients for the expected inflation and the

output gap⁶ are always positive, which is consistent with the economic priors. These coefficients are statistically significant only when the interest rate is taken as the overnight minimum interbank rate and the lending rate. The last three columns report the estimated coefficients of lag dependent variables up to three lags, where the lag order is determined by the FPE for the largest length among seven interest rates. The positive coefficient for the output gap suggests that interest rate increases when there is an inflation pressure. Note that I include three dependent variables; therefore, I cannot interpret the coefficients of the expected inflation to see the interest rates increase more or less than the expected inflation. In order to observe the long run effect of inflation interest rates, one needs to estimate $(1 - \alpha_{31} - \alpha_{32} - \alpha_{33})^{-1} \alpha_1$. If this coefficient is observed to be greater than one, then this suggests that interest rates increase more than the expected inflation. Alternatively, the estimated $(1 - \alpha_{31} - \alpha_{32} - \alpha_{33})^{-1} \alpha_1$ being less than one would suggest that interest rate increases are less than the expected inflation. The estimates are always less than one for all of the interest rates except the overnight minimum interbank interest rate. This is quite important, since the Bank of England can control the overnight minimum interbank interest rate and affect the other types of interest rates. The Bank of England's increasing the short-term interest rate more than expected inflation indicates a tight monetary policy. The estimates of $(1 - \alpha_{31} - \alpha_{32} - \alpha_{33})^{-1} \alpha_1$ is 1.21, this suggests that as expected inflation increases by 1%, the Bank of England increases the nominal interest rate by 1.21% or the expected real interest rate by .21%.

⁶ The output gap is derived by employing an HP filter.

As a robustness test, I report the inflation and conditional variance specification for the full sample where D_{1t} is the dummy variable for the post October 1992 era and D_{2t} is the dummy variable for the post May 1997 era. Here, the estimate of the GARCH(1, 1) specification is of interest. Estimated coefficients of GARCH(1, 1), which are of interest, are all positive and statistically significant. Moreover, the estimate of the sum of $(\phi_1 + \gamma_1)$ is less than one and this satisfies the non-explosiveness of the conditional variances. Thus, the robustness tests provide support for our specification (standard errors are reported in parentheses under the corresponding estimated coefficients).

$$\pi_{t+1} = 0.4219 - 0.1636\pi_t - 0.2384\pi_{t-1} - 0.274D_{1t} + 0.0702D_{2t} + \varepsilon_{t+1}$$

(29.83) (-11.57) (-23.84) (-5.98) (1.88)

$$h_t = 0.028 + 0.238\varepsilon_t^2 + 0.632h_{t-1}$$

(1.98) (3.51) (5.68)

Next, in order to evaluate whether the derived inflation uncertainty series play any role in the interest rate rule for the monetary authority, three types of uncertainties are added to the regression equation in Table 3. The estimates are reported in Table 4.

The estimates of the coefficients for the impulse uncertainty, h_t , are always positive for all of the interest rates, and the coefficients for the structural uncertainty, S_t , are always negative; but these estimates are statistically significant for only the overnight minimum interbank rate. The estimates for the coefficients of impulse uncertainty are on a parallel line with Fama (1975), Chan (1994) and Berument (1999). Interest rates increase with higher impulse uncertainty. The

negative coefficients of the structural uncertainty are parallel to Hahn (1970), Juster and Wachtel (1972a, 1972b) and Juster and Taylor (1975). The estimated coefficients for the expected inflation and output gap are always positive, and these coefficients are statistically significant when the interest rate is taken as the overnight interest rate and the lending rate. The positive coefficient for the output gap parallels the economic priors mentioned above. Lastly, the estimate of $(1 - \alpha_{31} - \alpha_{32} - \alpha_{33})^{-1} \alpha_1$ is greater than one only for the overnight interest rate, but it is not statistically significant. This suggests that the interest rate increases more than expected inflation for overnight rates in the long run, while other interest rates increase less than the increase in inflation.

2.3.1 Inflation Targeting Period

In October 1992, the Bank of England adopted an inflation targeting regime. This policy shift, which could induce structural changes in the macroeconomic environment, could not be addressed simply by the dummy variable in Equation 2. Thus, I reestimate the whole system for the post-inflation targeting regime, for which the results are presented in Table 5.

None of the estimated coefficients for the impulse uncertainty and structural uncertainty were statistically significant except the ones for the overnight minimum interbank interest rates. The estimated coefficients for steady-state inflation uncertainty have alternating signs across interest rates, but only for the deposit rate and government bond yield (short-term) are statistically significant. The estimates on the overnight interbank rate are important. Bearing in mind that the overnight

rate is the main policy instrument for the Bank of England especially after the implementation of inflation targeting, the results imply that the uncertainties related to the structure of the inflation process and the long-run level of inflation induce the Bank of England to increase the interest rates, while any uncertainty due to unforeseen shocks leads the monetary authority to ease its policy. The estimates on the overnight rate make sense in terms of an inflation targeting framework. When the monetary authorities announce their inflation targets, they make it explicit (in order to enhance credibility), that any uncertainty which could lead to a permanent change in the structure of the inflation or its long-run level will be eliminated. Therefore, agents in the economy can have a clear idea about the long-term goals of the monetary authority. This runs parallel with the insignificant coefficients of the steady-state inflation uncertainty measures. On the other hand, in case of shocks that are unforeseen and viewed to be temporary, inflation targeting regimes have “escape clauses” [as mentioned in Bernanke et al (1999)], which cause the monetary policy to stabilize the economy by easing monetary policy. Clarida, Gali and Gertler (1999) also suggests that unless the long-run inflation targets are distorted, there should be a way for the monetary policy to stabilize these unforeseen shocks. The results in this chapter provide empirical support for these suggestions. Finally, the coefficients for the output gap in each equation are positive, implying that the Bank of England increases interest rates to curb any demand pressure that might be inflationary. However, the t-statistics for that coefficient are mostly low and the response of interest rates to the output gap is mostly lower than the response to expected inflation, which also implies that price

stability has become a more dominant factor in the monetary policy making process after the adoption of inflation targeting.

2.4 CONCLUSION AND POLICY IMPLICATIONS

There are conflicting views about the effects of inflation uncertainty on interest rates. While some studies find evidence of a positive effect of inflation uncertainty on interest rates due to an increase in the inflation risk premium, others argue that higher saving incentives under high inflation uncertainty or political motives to generate surprise inflation may actually lead to a negative relationship between those two variables. However, most of these studies stop short of breaking down inflation uncertainty to its components and analyzing the effects of each type of uncertainty on the interest rates.

This study analyzes the impact of different types of inflation uncertainties on interest rates for the United Kingdom within the context of a time-varying parameter model with a GARCH specification. Since the relationship between inflation uncertainty and interest rates may have changed significantly after the implementation of the inflation targeting regime, the role of each type of inflation uncertainty in the monetary policy reaction function is investigated for the inflation targeting period also. It is shown that when the whole sample is considered, the impulse uncertainty is positively, and the structural inflation uncertainty negatively, correlated with interest rates.

When the inflation targeting period is considered alone, the results imply that any uncertainty regarding the structure or the long-run level of the inflation

process causes the Bank of England to follow a tight monetary policy and increase the overnight interest rates, which is the main policy instrument for that particular period. On the other hand, if the uncertainty arises due to unforeseen shocks, then monetary policy has an accommodative characteristic.

The results are promising in terms of policy implications. In an inflation targeting framework, where price stability and long-term goals of monetary policy are explicitly stated, two distinctive characteristics emerge: credibility and accountability. An increase in inflation uncertainty that would change either the structure of inflation dynamics or the long-run level of inflation has the potential to disrupt these two features and undermine the success of the regime. Taking this fact into consideration, the monetary authorities seem to attempt to eliminate such uncertainties. On the other hand, if the uncertainty emerges due to unforeseen shocks that are mostly viewed as temporary, then the monetary policy can be accommodative and interest rates may be reduced. Actually, the findings in this chapter provide further empirical support to this notion of inflation targeting regimes.

CHAPTER 3

The Effects of Different Inflation Risk Premiums on Interest Rate Spreads

3.1 Literature Survey

Analyzing interest rate spreads has always been popular among economists. While some academicians use spreads as an indicator of future economic performances⁷ others try to explain the behavior of spreads themselves⁸ often by testing the expectations hypothesis of the term structure of interest rates by using interest rate spreads.

Although there are some empirical findings that are agreed upon, some studies find conflicting results about the dynamics of the term structure of interest rates (see, Campbell et al, 1997 and Christiano et al, 1999). Fuhrer (1996) and Chen (2001) argue that the reason behind these mixed results stems from the fact that short term interest rates are not volatile enough to explain long term interest rates. Moreover, Balduzzi et al (1997) argue that longer-term rates are more heavily influenced by the persistent expectation for future target changes in short term interest rates, possibly due to expected changes in monetary policy. Thus, the nature

⁷ Bernanke (1990), Stock and Watson (1989), Friedman and Kuttner (1992, 1993 and 1998).

⁸ See, Chapter 11 of Campbell et al (1997) and the references cited therein.

of the spreads or their predictive powers for the future economic performance might be influenced by different factors, which concern monetary policy makers. McCallum (1994) and Walsh (1998) discuss the effect of an exogenous rise in the risk premium on the interest rates, and Evans (1998) and Chen (2001) report that there is a time varying inflation risk premium throughout the term structure of interest rates. Thus, uncertainty stemming from inflation is a well recognized variable in the literature to explain the behavior of interest rates.

Some of these studies mentioned above suggest that inflation uncertainty is an indicator of interest rate spreads. One common factor in these studies is that they stop short of (1) identifying different sources of inflation uncertainty, and (2) observing the effects of these inflation uncertainties on interest rate spreads.⁹ Evans (1991) and Berument et al (2002) elaborates three types of inflation uncertainty: structural uncertainty, which arises from the instability of the relationship between current and lag values of inflation; impulse uncertainty, which arises from temporary shocks that hit the economy; and steady-state inflation uncertainty, which arises from the uncertainty on the level of long-run inflation. They show that the effects of these inflation uncertainties on inflation and interest rates can be different.

This study takes the above discussion as its starting point and analyzes the effects of different types of inflation uncertainty on interest rate spreads for the UK. The main reason for choosing the UK is the availability of the vast literature devoted to inflation risk in the UK. In order to assess the different types of inflation

⁹ To the best of my knowledge, Balaban(1999) is the only study that decomposes inflation volatility; he decomposes the inflation volatility by considering its sub-indexes. However, this study is short of assessing the effect of sub-index volatility on the real economic performance.

uncertainty, a time-varying parameter model with a generalized autoregressive conditional heteroskedasticity (GARCH) specification is employed. Such a model allows me to identify different types of inflation uncertainty and see their effects on interest rate spreads. As a result, I conclude that while the structural inflation uncertainty and the steady state inflation uncertainty increase the interest rate spreads, the evidence on the effect of the impulse inflation uncertainty on the interest rate spreads is not conclusive. These findings suggest that investors demand higher compensation to hold longer term and less liquid bonds as the steady-state and the structural inflation uncertainty increase. On the other hand, the inflation uncertainty, which is caused by unexpected temporary shocks to inflation, does not have an uniform effect on the interest rate spreads.

3.2 Empirical Evidence

In modeling the inflation uncertainty, I used the same methodology in the second chapter by using the same data set. The interest rate spreads are calculated by subtracting the overnight interbank minimum interest rate (which has the shortest maturity) from the remaining six interest rates. It is expected that an increase in overall inflation uncertainty will also increase the risk premium for less liquid and longer-term interest rates, which will cause a positive relationship between inflation uncertainty and interest rate spreads.

After assessing the three inflation uncertainty measures, it is possible to observe the correlation between the six interest rate spreads and these uncertainties. For this purpose, I estimate the following equation:

$$Spread_t = \lambda_0 + \lambda_1 * h_t + \lambda_2 * X_t \Omega_{t+1|t} X_t^T + \lambda_3 * \nabla_t^2(\pi_{t+1}^*) + z_t \quad (14)$$

It should be noted that h_t , $X_t \Omega_{t+1|t} X_t^T$, $\nabla_t^2(\pi_{t+1}^*)$, and z_t denote the impulse uncertainty, the structural uncertainty, the steady-state inflation uncertainty and the *iid* error term, respectively. The estimates are reported in Table 6. Note that where their standard errors are calculated by using the Newey-West's heteroskedastic consistent formula, the *t*-statistics are reported in parenthesis under the corresponding coefficients. I estimate the inflation equation and the three uncertainty measures jointly by using the rolling regression method. Then, I include these uncertainty measures to estimate the equation. The fact that I do not estimate the equation along with other equations is due to the unavailability of the full sample observations for the mid-sample periods. In particular, if I must estimate equation along with the uncertainty measures, I need to estimate all the equations at once. Doing this would suggest that agents knew all the observations for the full sample to get the mid point estimates for the three uncertainty variables; however, this is not true.

Table 6 suggests that the estimated coefficients of the structural and steady-state uncertainties are always positive and statistically significant; however, the estimated coefficients of the impulse uncertainty variable have mixed signs and are not statistically significant.¹⁰ Therefore, increases in the structural uncertainty and the steady-state uncertainty increase interest rate spreads. This supports the proposition that risk averse investors want to be compensated for bearing higher risk. While the highest compensation requested by investors is on the spread

¹⁰ The level of significance is at the 5% level, unless otherwise noted.

between the long-term government bond yields and the interbank rate, the lowest compensation is on the spread between the deposit and the interbank rate for both the structural and steady-state inflation uncertainties. Moreover, a similar pattern on the order of the spread variables from highest to lowest compensation requested by investors is observed for the effects of these two uncertainties on the six spreads. Thus, I can conclude that these two uncertainties affect similarly the different risk premiums, which ultimately dictate the spreads.

On the other hand, even if the estimated coefficients of the impulse uncertainty are not statistically significant, the evidence is mixed. The impulse uncertainty decreases the deposit-interbank rate spread and the lending-interbank rate spread. On the contrary, the impulse uncertainty increases the other four spreads. Thus, it leads to a conclusion that the impulse uncertainty of inflation does not affect the interest rate spreads similarly.

3.3 CONCLUSION

There is an extensive literature that studies relationships between interest rate spreads and various macroeconomic variables. Within this context, some of these works analyze the predictive power of interest rate spreads for future economic performance, while some others attempt to explain the dynamics of the term structure itself. Moreover, some argue that inflation uncertainty is one of the variables that explain the behavior of interest rate spreads. However, different types of inflation uncertainty may affect the interest rate spreads differently.

This chapter investigates the effects of different types of inflation uncertainty on various interest rate spreads. The time-varying parameter model with a GARCH specification is employed to derive three different types of uncertainties. These are the structural uncertainty, which indicates uncertainty about the structure of inflation process; the impulse uncertainty, which arises due to the nature and magnitude of the temporary shocks that hit the economy; and the steady-state inflation uncertainty, which is the uncertainty about the level of long-run inflation that ultimately determines the long-run real returns. This study argues that the structural uncertainty and the steady-state uncertainty increase the spreads between the six interest rates and the overnight interbank minimum interest rate. Therefore, one can conclude that investors demand higher returns due to increasing levels of the structural and steady-state inflation uncertainties. On the other hand, the evidence about the effect of the impulse uncertainty on the interest rate spreads is not conclusive.

CHAPTER 4

THE EFFECT OF FOREIGN INCOME ON ECONOMIC PERFORMANCE OF A SMALL-OPEN ECONOMY: EVIDENCE FROM TURKEY

4.1 Literature Survey

As the world's economies become more interconnected, the analysis of the effects of foreign countries economic performance on a domestic economy has become more important. Thus, economists have begun to pay more attention to this topic over the last decades. Cross-country correlations among macroeconomic performances have been widely documented in papers such as Burdekin (1989), Lastrapes and Koray (1990), Joyce and Kamas (1994). In particular, studies such as Backus, Kehoe and Kydland (1992), Stockman and Tesar (1995) consistently find that cyclical variations in output as well as in other macroeconomic aggregates are positively correlated across countries.¹¹ A prominent paper on this topic, Schmitt-Grohe (1997), studies the effects of US economic performance on Canada. In that study she accounted for the scale of these economies. She notes that a shock, which directly affects the output of a large country, may also affect a small country, but the reverse is generally not the case. She uses this as an identification property and argues that the macroeconomic variables (output, employment, investment, exports,

¹¹ For a vast literature survey in this topic, see Backus, Kehoe and Kydland (1994).

imports, and terms of trade) of Canada, a small country relative to the US, respond to a positive shock in the US gross national product.

In this chapter, I examine the effects of the economic performance of the US, Germany and harmonized data for industrial countries (Industrial Countries hereafter) on the economic performance of Turkey. The connection between Turkey and each foreign country is represented in a block recursive VAR model as in Cushman and Zha (1997). The research cited above examines the relationships among developed countries and this chapter differs from the literature in that I use data from a small but developing country -- Turkey. To the best of my knowledge, this is the first study that uses the data of a developing country and I hope that it will be a starting point for new discussion areas for other developing countries. Providing data from developing countries is important because there is not enough evidence from developing economies. While developed economies might be subject to similar shocks, it is unlikely that both developed and developing economies are subject to similar adverse shocks. Thus, providing evidence from developing economies is important.

4.2 Methodology

In order to make the assessment of an effect of a large economy's output on a small economy, I basically follow the similar structural vector autoregressive (SVAR) model suggested by Cushman and Zha (1997). To be specific, I construct a block recursive model where foreign economic performance is determined by its own dynamics (an AR process is used as a proxy) and Turkish macroeconomic

variables follow a 3-variable VAR model. Moreover, foreign output affects the Turkish economic performance as an exogenous variable. The difference between this system and a 4-variable VAR setup is such that none of the lag variables of Turkish economic variables enter the foreign country specification but lag value and instantaneous values of foreign income affect the Turkish economic performance.

The utilization of a VAR model, instead of the conventional single equation model, has some advantages. The VAR model captures dynamic relationships among variables of interest and has comparatively higher predictive power than single equation specifications. For this reason, I use a VAR model. If I were to use the standard form of VAR, I would have a serious problem in that the income of the foreign economy would be affected by the variables of the domestic one with their lags. In order to overcome this problem, I constructed an identified VAR model with block exogeneity. This block exogeneity also enables me to specify economically simultaneous interactions among variables.

4.3 Model Specification

The general specification of the identified VAR model of Cushman and Zha (1997) is;

$$A(L)y(t) = \varepsilon(t) \quad (15)$$

in which, the $A(L)$ is an $m \times m$ matrix polynomial in the lag operator L , $y(t)$ is the $m \times 1$ observations vector, and $\varepsilon(t)$ is the $m \times 1$ vector of structural disturbances.

Equation 16 shows the specification of the model.

$$y(t) = \begin{bmatrix} y_1(t) \\ y_2(t) \end{bmatrix}, \quad A(L) = \begin{bmatrix} A_{11}(L) & 0 \\ A_{21}(L) & A_{22}(L) \end{bmatrix}, \quad \varepsilon(t) = \begin{bmatrix} \varepsilon_1(t) \\ \varepsilon_2(t) \end{bmatrix}. \quad (16)$$

In equation 16, it is assumed that ε_t is uncorrelated with $y_{(t-s)}$ for $s > 0$ and A_0 is non-singular. Moreover, the block exogeneity is represented by $A_{12}(L)$, which is zero. In other words, $y_I(t)$ is exogenous to the second block both contemporaneously and for lagged values. The maximum likelihood estimation (MLE) and inference for the second block are computed with the conventional Choleski normalization with the modified error bands of Bernanke, Hall, Leeper, Sims and Zha (1996). This is because the MLE of the VAR model is not applicable to the identified VAR model with block exogeneity.¹²

The observation matrices are such that $y_1 = [Foreign\ Income]$, $y_2 = [Domestic\ output, Inflation, Real\ exchange\ rate]'$ and the lag order of the identified VAR model is 6. The order of the variables of the latter block is taken from Berument and Pasaogullari (2003), in which the model that Kamin and Rogers (2000) used for Mexico is applied to Turkey. All the variables in the system enter the specification in logs except the inflation rate.

4.4 Empirical Evidence

The industrial production (seasonally adjusted) data for Germany, the US, and Industrial Countries were compiled from the International Financial Statistics (IFS) of the International Monetary Fund (IMF); the industrial production, inflation rate, and the real exchange rate of Turkey were gathered from the Central Bank of

¹² See Sims (1986) and Gordon and Leeper (1994).

the Republic of Turkey's data delivery system. The inflation is calculated as the first logarithmic difference of the wholesale price index.

In this study, I discuss the impulse response functions of the domestic economy to a positive shock in foreign income by using the data from 1986:05 to 2003:12 where the seasonality is accounted for by using monthly dummies. I make the same analysis for three different foreign income data: The US, Germany, and Industrial Countries. The reason for choosing Germany is that it is the most important trade partner of Turkey. The US and the Industrial Countries were chosen to demonstrate the responses of the Turkish economy to the rest of the world. The US is also an important trade partner of Turkey. Following Sims and Zha (1999), the confidence intervals for the impulse response functions are constructed by using the Bayesian Simulation Method, where 2500 replicates for the simulations are used and confidence bands are reported at the 90% level.

Figure 1 reports the impulse response functions of domestic output, inflation and real exchange rate when 1 standard deviation shock is given to the US industrial production. The figure suggests that Turkish output responds positively to a positive shock in the foreign output. The evidence is statistically significant except for the first month. The response of inflation is introduced in the second diagram and it is positive for all the periods, but it is significant for the sixth and seventh months. According to the last of the three diagrams, in Figure 1, the response of the real exchange rate is positive, which means that there is a real appreciation of domestic currency and the responses are statistically significant for all months.

In Figure 2, I make the same analysis as in Figure 1, with the industrial production of Germany instead of that of the US. According to the diagrams, a positive shock in the industrial production of Germany generally increases Turkish output. The peak point occurs in the second month, which is also statistically significant. Moreover, another statistically significant effect is seen in the fourth month, which is also positive. The response of inflation is presented in the second diagram and it suggests that Turkish inflation increases for four months and decreases after that. However, the effect is statistically significant only after the seventh month. The real exchange rate responds positively to the shock contemporaneously, and then decreases. However, the effect on the real exchange rate is not statistically significant.

Figure 3 reports the impulse responses of the same variables to a positive shock in the industrial production of Industrial Countries. The figures suggest that Turkish output positively responds to a shock in the industrial production of the Industrial Countries, where the responses are statistically significant for all periods except for the first month. Moreover, inflation responds positively, but is not statistically significant, and the real exchange rate responds with an appreciation as well as a statistically significant response for the first three months.

4.5 Conclusion

In this chapter, I assessed the effects of a foreign income shock of a large country on the domestic income of a small open economy by using a data set from Turkey, Germany, the US and weighted average of industrial production of

Industrial Countries. To the best of my knowledge, this is the first study that looks at the effect of a large economy's output on a small economy by using data from a developing country. The empirical evidence provided here suggests that a positive shock in the foreign income positively affects the domestic income. In other words, the domestic income responds positively to the shock. The real exchange rate responds to a similar shock with an appreciation and the inflation responds positively at first but negatively afterwards. These results are consistent with the findings of Schmitt-Grohe (1997), where she reports that a positive shock in the larger of a small-large country pair positively affects the economic performance of the smaller one.

SELECTED BIBLIOGRAPHY

- Backus, D., P. J. Kehoe and F. E. Kydland 1992. "International business cycles" *Journal of Political Economy*, 100, 745-75.
- Backus, D., P. J. Kehoe and F. E. Kydland 1994. "International business cycles: Theory and evidence," *In: Thomas Cooley (Ed.)* 331-56
- Balaban, E. 1999. "Core Inflation Measurement: A New Approach," *mimeo*.
- Balduzzi, P., G. Bertola, S. Foresi and L. Klapper 1997. "Interest Rate Targeting and the Dynamics of Short-Term Rates," *NBER Working Paper* 5944, February.
- Ball, L. 1992. "Why does high inflation raise inflation uncertainty?" *Journal of Monetary Economics* 1: 371-388.
- Ball, L. and S. Cecchetti. 1990. "Inflation uncertainty at short and long horizons," *Brookings Papers on Economic Activity*: 215-254.
- Bernanke, B. S. 1990. "On the Predictive Power of Interest Rates and Interest Rate Spreads," *New England Economic Review*, Federal Reserve Bank of Boston, pp. 51-68.
- Bernanke, B. S. and Blinder, A. S. 1992. "The federal funds rate and the channels of monetary transmission," *American Economic Review*, vol. 82, No. 4, pp. 901-21.
- Bernanke, B. S., R. E. Hall, E. M. Leeper, C. Sims and T. Zha 1996. "What does monetary policy do?" *Brookings Papers on Economic Activity*, 1996 (2), 1-78.
- Berument, H. 1999. "The impact of inflation uncertainty on interest rates in the UK," *Scottish Journal of Political Economy* 46: 207-18.
- Berument, H. and Froyen, R. T. 1998. "Potential information and target variables for UK monetary policy." *Applied Economics*, vol. 30(4), pp. 449-63.
- Berument, H. and M. Pasaogullari 2003. "Effects of the real exchange rate on output and inflation: Evidence from Turkey," *Developing Economies*, 41(4), 401-35.

- Blanchard, O. J. and S. Fischer 1989. *Lecture on Macroeconomics*. Cambridge, Mass.: MIT Press.
- Bollerslev, T. 1986. "Generalized autoregressive conditional Heteroskedasticity," *Journal of Econometrics* 31: 307-327.
- Bomberger, T. 1996. "Disagreement as a measure of uncertainty," *Journal of Money, Credit and Banking* 28: 381-392.
- Burdekin, R. C. K. 1989. "International transmission of US macroeconomic policy and the inflation record of western Europe," *Journal of International Money and Finance*, 8, 401-24.
- Campbell, J.Y., Lo, A., MacKinlay, A. 1997. "Econometrics of Financial Markets," *Princeton University Press*, Princeton NJ.
- Chan, L. K. C. 1994. "Consumption, inflation risk, and real interest rates: an empirical analysis," *Journal of Business* 67: 69-96.
- Chen, L. 2001. "Inflation and real short-term interest rates - A Kalman filter analysis of the term structure." *Applied Economics* 33, pp. 855-861.
- Christiano, L., M. Eichenbaum and C.L. Evans 1999. "Monetary Policy Shocks: What Have we Learned and to What End?" eds Taylor J.B. and M. Woodford, in *Handbook of Macroeconomics Volume 1A*, Elsevier Science, Amsterdam/Netherlands.
- Cukierman, A. and A. Meltzer. 1986. "A theory of ambiguity, credibility, and inflation under discretion and asymmetric information," *Econometrica* 17: 1099-1128.
- Cukierman, A. and P. Wachtel. 1979. "Differential inflationary expectations and the variability of the rate of inflation," *American Economic Review* 69: 595-609.
- Cushman, D. O. and T. Zha 1997. "Identifying monetary policy in a small open economy under flexible exchange rates," *Journal of Monetary Economics*, 39, 433-48.
- Darby, M. R. 1975. "The financial and tax effects of monetary policy on interest rates," *Economic Inquiry* 13: 266-276.
- Davis, G. and B. Kanogo. 1996. "On measuring the effect of inflation uncertainty on real GNP growth," *Oxford Economic Paper* 48: 163-175.

- Deaton, A. 1977. "Involuntary saving through unanticipated inflation," *American Economic Review* 67: 899-910.
- Engle, R. 1982. "Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation," *Econometrica* 50: 987-1007.
- Evans, M. 1991. "Discovering the link between inflation rates and inflation uncertainty," *Journal of Money, Credit, and Banking* 23: 169-184.
- Evans, M. (1998). "Real rates, expected inflation, and inflation risk premia," *The Journal of Finance*, vol. LIII, no. 1, pp. 187-218.
- Evans, M. and P. Wachtel. 1993. "Inflation regimes and the sources of inflation uncertainty," *Journal of Money, Credit, and Banking* 25: 475-511.
- Fama, E. 1975. "Short term interest rates as predictor of inflation," *American Economic Review* 65: 269-282.
- Fama, E. and M. Gibbons. 1982. "Inflation, real returns and capital investment," *Journal of Monetary Economics* 9: 297-323.
- Fama, E. and G. Schwert. 1977. "Asset returns and inflation," *Journal of Financial Economics* 5: 115-146.
- Feldstein, M. 1976. "Inflation, income taxes, and the rate of interest: a theoretical analysis," *American Economic Review* 66: 809-820.
- Fisher, I. 1930. *The theory of interest*, New York: McMillan.
- Friedman, M. 1977. "Nobel lecture: inflation and unemployment," *Journal of Political Economy* 85: 451-472.
- Friedman, B. M. and Kuttner, K. N. 1989. "Money, income and prices after the 1980s," *NBER Working Paper*, No: 2852.
- Friedman, B. M., and K. N. Kuttner 1992. "Money, income, prices and interest rates," *American Economic Review* 82, no. 3, pp. 472-492.
- Friedman, B. M., and K. N. Kuttner 1993. "Economic Activity and the Short-Term Credit Markets: An Analysis of Prices and Quantities," *Brookings Papers on Economic Activity*, vol. 40, iss. 2, pp. 193-266.
- Friedman, B. M., and K. N. Kuttner 1998. "Indicator Properties of the Paper-Bill Spread: Lessons from Recent Experience," *Review of Economics and Statistics*, vol. 80, iss. 1, pp. 34-44.

- Fuhrer, J. C. 1996. "Monetary policy shifts and long-term interest rates," *The Quarterly Journal of Economics*, v. 111, iss. 4, pp. 1183-1209.
- Froyen, R. and R. Waud. 1987. "An examination of aggregate price uncertainty in four countries and some implications for real output," *International Economic Review* 28: 353-373.
- Gordon, D. B., and E. M. Leeper 1994. "The dynamic impacts of monetary policy: An exercise in tentative identification," *Journal of Political Economy*, vol. 102, iss. 6, 1228-47.
- Grier, K. B. and M. J. Perry. 2000. "The effects of real and nominal uncertainty on inflation and output growth: some GARCH-M evidence," *Journal of Applied Econometrics* 15: 45-58.
- Hafer, R. W. 1986. "Inflation uncertainty and a test of the Friedman Hypothesis," *Journal of Macroeconomics*: 365-372.
- Hahn, F. H. 1970. "Savings and uncertainty," *Review of Economic Studies* 37: 21-24.
- Holland, S. 1986. "Wage indexation and the effect of inflation uncertainty on employment: an empirical analysis," *American Economic Review*: 235-244.
- Holland, S. 1988. "Indexation and the effect of inflation uncertainty on real GNP," *Journal of Business*: 473-484.
- Holland, S. 1993. "Comment on inflation regimes and the sources of inflation uncertainty," *Journal of Money, Credit and Banking* 27: 514-520.
- Holland, S. 1995. "Inflation and uncertainty: test for temporal ordering," *Journal of Money, Credit and Banking* 27: 827-837.
- Jansen, D. W. and T. F. Casimona. 1988. "Estimates of the variance of US. Inflation based upon the ARCH model: Comment (in notes, comments, replies)," *Journal of Money Credit and Banking* 20: 409-421.
- Joyce, J. P. and L. Kamas 1994. "Money and output under alternative exchange rate regimes in the USA," *Journal of International Money and Finance*, 13, 679-97.
- Juster, F. T. and D. Taylor. 1975. "Towards a theory of saving behavior," *American Economic Review* 65: 203-209.
- Juster, F. T. and P. Wachtel. 1972a. "Inflation and the consumer," *Brookings Papers* 1: 71-114.

- Juster, F. T. and P. Wachtel. 1972b. "A note on inflation and the saving rate," *Brookings Papers* 3: 765-778.
- Kamin, S. B. and J. H. Rogers 2000. "Output and the real exchange rate in developing countries: An application to Mexico," *Journal of Development Economics*, 61, 85-109.
- Lastrapes, W. D. and F. Koray 1990. "International transmission of aggregate shocks under fixed and flexible exchange rates: United Kingdom, France, and Germany, 1959 to 1985," *Journal of International Money and Finance*, 9, 402-23.
- Lucas, R. E. 1973. "Some international evidence on the output-inflation trade-offs," *American Economic Review* 63: 327-334.
- Markowitz, H. M. 1952. "Portfolio selection," *Journal of Finance*: 77-91.
- McCallum, B. T. 1994b. "Monetary policy and the term structure of interest rates," *NBER Working Paper*, no. 4938, November.
- Mishkin, F. S. 1981. "The real interest rate: an empirical investigation," *Carnegie-Rochester Conference Series on Public Policy* 15: 151-200.
- Mishkin, F. S. 1992. "Is the Fisher effect for real?" *Journal of Monetary Economics* 30: 195-215.
- Mishkin, F. S. and J. Simmons. 1995. "An empirical investigation of the Fisher effect in Australia," *NBER Working Paper*, No: 5080.
- Schmitt-Grohe, S. 1998. "The international transmission of economic fluctuations: effects of US business cycles on the Canadian economy," *Journal of International Economics*, 44, 257-87.
- Sims, C. and T. Zha 1999. "Error bands for impulse responses," *Yale University, Cowles Discussion Paper*, 1085, 26.
- Stock, J. H., and M. W. Watson 1989. "Interpreting the evidence on money-income causality," *Journal of Econometrics* 40, no. 1, pp. 161-181.
- Stockman, A. C. and L. L. Tesar 1995. "Tastes and technology in a two-country model of the business cycle: explaining international comovements," *American Economic Review*, 85, 197-221.

Tobin, J. 1965. "Money and economic growth," *Econometrica* 33: 671-684.

Walsh, C. E. 1998. *Monetary Theory and Policy*, Cambridge, Mass.: MIT Press.

APPENDIX

Table 1: Model Selection Criteria

	AIC	SIC
Our model	3.15	3.68
Model with Return-to-Normality Assumption	3.96	3.99
Model with Constant Mean	4.18	4.21

Table 2: Unit Root Tests

	DF	ADF	PP	KPSS
Inflation	-12.212*	-4.570*	-12.491*	1.761*
Overnight min. interbank rate	-3.067	-2.034	-2.446	1.110*
Treasury bill rate	-1.836	-2.524	-2.379	1.418*
Treasury bill rate bond equiv.	-1.196	-1.911	-1.788	3.103*
Deposit rate	-2.106	-2.408	-2.407	2.011*
Lending rate	-1.594	-1.848	-1.781	1.50*
Govt. bond yields (short-term)	-1.710	-2.078	-2.133	2.252*
Govt. bond yields (long- term)	-1.016	-1.285	-1.268	2.160*

Note: * indicates rejecting the null at 5% level.

Table 3: Estimates of the Fischer Equation, 1961:06-2002:02

	Const.	π_{t+1}^e	gap_t	R_{t-1}	R_{t-2}	R_{t-3}
Overnight min. interbank rate	-0.002 (-0.133)	0.034* (1.760)	0.074* (1796)	0.583** (5.599)	0.142 (1.453)	0.247** (2.561)
Treasury bill rate	0.015** (2.952)	0.007 (1.265)	0.020 (1.456)	1.351** (17.421)	-0.422** (-3.707)	0.045 (0.807)
Treasury bill rate bond equiv.	0.014** (2.392)	0.006 (0.990)	0.019 (1.010)	1.408** (17.851)	-0.513** (-4.375)	0.082 (1.340)
Deposit rate	0.014** (2.896)	0.008 (1.167)	0.036 (1.610)	1.146** (18.181)	-0.181** (-2.244)	0.003 (0.073)
Lending rate (clearing banks)	0.013** (2.471)	0.010** (2.515)	0.035** (2.163)	1.092** (18.372)	-0.419* (-1.804)	0.033 (0.555)
Govt. bond yields (short- term)	0.016** (2.283)	0.004 (0.721)	0.004 (0.335)	1.318** (20.526)	-0.413** (-4.563)	0.071 (1.412)
Govt. bond yields (long- term)	0.005 (1.224)	0.001 (0.348)	0.006 (0.646)	1.340** (22.978)	-0.482** (-5.312)	0.134** (2.294)

Note 1: t-statistics are reported in the parentheses under the corresponding coefficients where standard errors are calculated with the Newey-West's heteroskedastic consistent formula.

Note 2: * and ** indicate significance at the 5% and 10% levels, respectively.

Table 4: Estimates of the Interest Rate specification – Whole Sample (1961:06-2002:01)

	Const.	π_{t+1}^e	gap_t	h_t	S_t	$\nabla_t^2(\pi_{t+1}^*)$	R_{t-1}	R_{t-2}	R_{t-3}
Overnight min. interbank rate	-0.011 (-0.552)	0.055 (1.609)	0.067* (1.667)	0.022 (0.595)	-0.024 (-0.285)	-0.015 (-0.960)	0.594** (6.009)	0.132 (1.378)	0.258** (2.665)
Treasury bill rate	0.011 (1.589)	0.006 (0.925)	0.019 (1.373)	0.028* (1.719)	-0.069** (-2.029)	-0.001 (-0.110)	1.351** (17.323)	-0.421** (-3.704)	0.043 (0.778)
Treasury bill rate bond equiv.	0.012 (1.568)	0.006 (0.789)	0.016 (0.855)	0.030* (1.911)	-0.077** (-2.285)	-0.001 (-0.264)	1.408** (17.741)	-0.509** (-4.367)	0.076 (1.280)
Deposit rate	0.007 (0.850)	0.006 (0.702)	0.034 (1.522)	0.041* (1.663)	-0.095* (-1.894)	-0.001 (-0.100)	1.149** (18.115)	-0.182** (-2.248)	0.003 (0.067)
Lending rate (clearing banks)	0.002 (0.211)	0.016** (3.064)	0.029* (1.892)	0.049** (2.250)	-0.108** (-2.429)	-0.007 (-1.538)	1.106** (18.166)	-0.158* (-1.866)	0.035 (0.574)
Govt. bond yields (SR)	0.014 (1.535)	0.002 (0.196)	0.005 (0.397)	0.037** (2.518)	-0.090** (-2.823)	0.001 (0.212)	1.301** (20.988)	-0.392** (-4.393)	0.063 (1.249)
Govt. bond yields (LR)	0.001 (0.108)	0.003 (0.462)	0.004 (0.509)	0.025** (3.447)	-0.068** (-4.042)	-0.002 (-0.592)	1.327** (22.774)	-0.468** (-5.106)	0.136** (2.324)

Note 1: t-statistics are reported in the parentheses under the corresponding coefficients where standard errors are calculated with the Newey-West's heteroskedastic consistent formula.

Note 2: * and ** indicate significance at the 5% and 10% levels, respectively.

Table 5: Estimates of the Interest Rate Specification – Whole Sample (1961:06-2002:01)

	Const.	π_{t+1}^e	gap_t	h_t	S_t	$\nabla_t^2(\pi_{t+1}^*)$	R_{t-1}	R_{t-2}	R_{t-3}
Overnight min. interbank rate	0.094** (3.818)	0.060** (2.292)	0.060* (1.745)	-0.113** (-3.669)	0.222** (3.368)	0.007 (0.414)	0.315** (2.264)	0.375** (2.964)	0.110 (1.328)
Treasury bill rate	0.043* (1.739)	0.004 (0.197)	0.013 (0.842)	-0.010 (-0.756)	0.018 (0.624)	-0.002 (-0.388)	1.461** (17.422)	-0.631** (-2.736)	0.080 (0.544)
Treasury bill rate bond equiv.	0.050* (1.714)	0.004 (0.153)	0.027 (1.339)	-0.019 (-1.028)	0.034 (0.902)	-0.002 (-0.233)	1.405** (16.439)	-0.649** (-3.998)	0.145 (1.478)
Deposit rate	0.048** (3.162)	-0.009 (-0.580)	0.076 (1.513)	0.010 (0.493)	-0.009 (-0.201)	0.030** (2.546)	1.126** (7.322)	-0.297* (-1.167)	-0.022 (-0.105)
Lending rate (clearing banks)	0.036** (2.182)	-0.009 (-0.569)	0.022 (1.181)	0.003 (0.202)	-0.005 (-0.198)	0.001 (0.232)	1.150** (9.455)	0.117 (0.566)	-0.339** (-2.343)
Govt. bond yields (SR)	0.041** (2.055)	-0.011 (-1.134)	0.016 (0.902)	-0.003 (-0.181)	0.000 (0.008)	-0.017* (-1.668)	1.389** (15.281)	-0.652** (-3.352)	0.202 (1.546)
Govt. bond yields (LR)	0.009 (0.813)	0.002 (0.249)	0.016 (1.086)	0.001 (0.051)	-0.016 (-0.450)	-0.010 (-1.342)	1.210** (12.360)	-0.339 (-2.212)	0.115 (1.077)

Note 1: t-statistics are reported in the parentheses under the corresponding coefficients where standard errors are calculated with the Newey-West's heteroskedastic consistent formula.

Note 2: * and ** indicate significance at the 5% and 10% levels, respectively.

Table 6: Regression Results for the Interest Rate Spreads

	Const.	h_t	$X_t \Omega_{t+1 t} X_t^T$	$\nabla_t^2(\pi_{t+1}^*)$
Treasury bill rate spread	0.009 (0.29)	0.009 (0.16)	0.123 (2.37)	0.061 (2.42)
Treasury bill rate bond equiv. spread	-0.019 (-0.92)	0.010 (0.19)	0.132 (2.54)	0.078 (3.12)
Deposit rate spread	-0.088 (-2.49)	-0.023 (-0.80)	0.077 (2.34)	0.045 (2.07)
Lending rate (clearing banks) spread	0.043 (1.89)	-0.012 (-0.36)	0.091 (2.62)	0.056 (2.95)
Government bond yields (SR) spread	0.060 (1.38)	0.018 (0.23)	0.170 (2.41)	0.059 (1.66)
Government bond yields (LR) spread	0.040 (0.74)	0.050 (0.45)	0.238 (2.38)	0.094 (1.99)

Note 1: t-statistics are reported in the parentheses under the corresponding coefficients where standard errors are calculated with the Newey-West's heteroskedastic consistent formula.

FIGURE 1: Impulse responses of output, inflation and real exchange rate to a shock in the US industrial production.

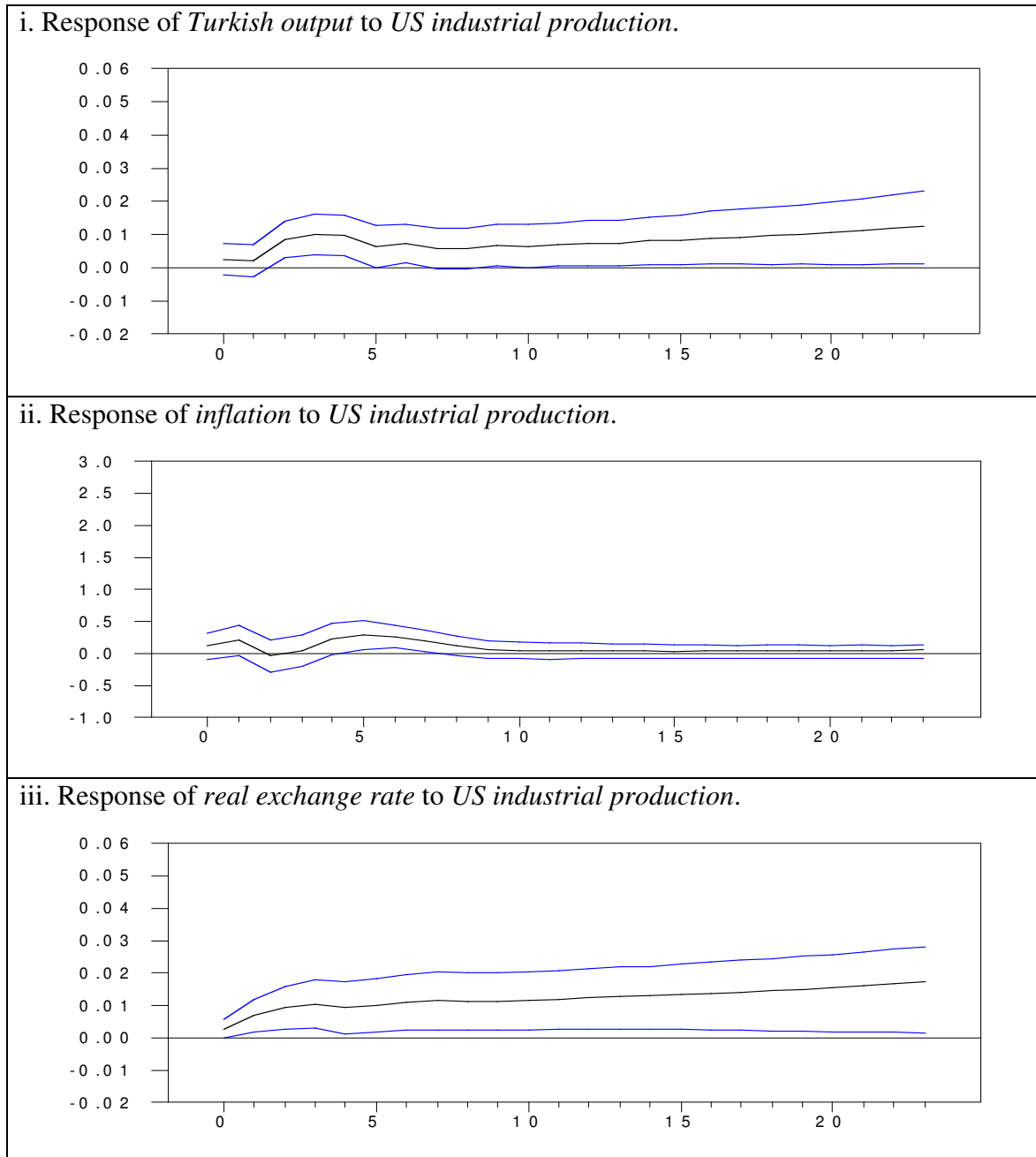
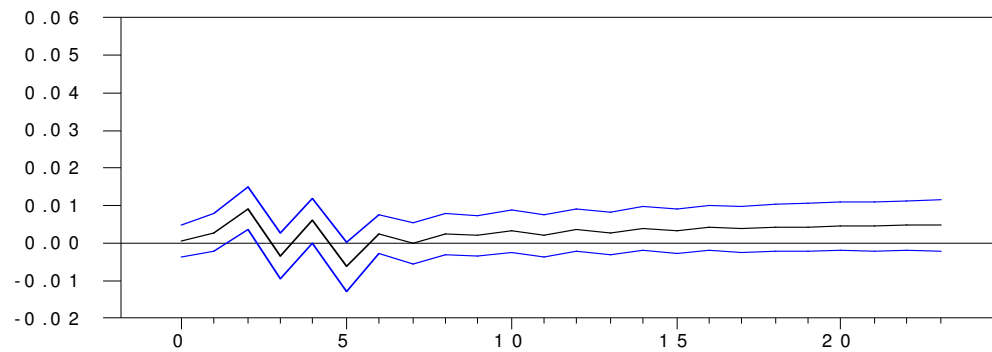
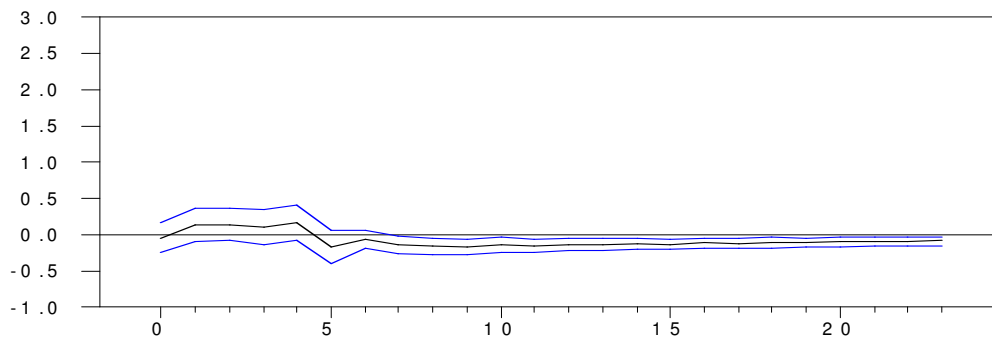


FIGURE 2: Impulse responses of output, inflation and real exchange rate to a shock in Germany industrial production.

i. Response of *Turkish output* to *Germany industrial production*.



ii. Response of *inflation* to *Germany industrial production*.



iii. Response of *real exchange rate* to *Germany industrial production*.

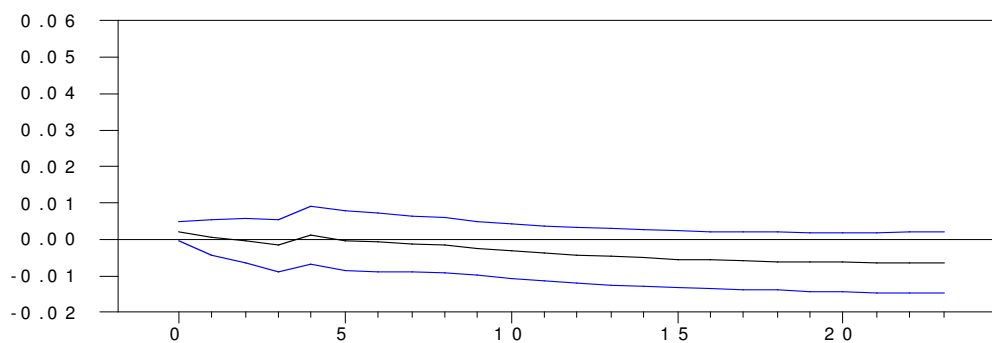


FIGURE 3: Impulse responses of output, inflation and real exchange rate to a shock in the industrial production of industrial countries.

