TWO ESSAYS IN MACROECONOMICS

The Institute of Economics and Social Sciences
of
Bilkent University

by

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In Partial Fulfillment of the Requirements for the Degree of

MASTER OF ARTS IN ECONOMICS

in

THE DEPARTMENT OF ECONOMICS
BILKENT UNIVERSITY
ANKARA

August 2002

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ABSTRACT

Two Essays in Macroeconomics

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The first chapter of this study assesses the effects of real depreciation on the economic performance of Turkey by considering quarterly data from 1987:I to 2001:III. The empirical evidence suggests that the real depreciations are contractionary even when the external factors such as world interest rates, and capital flows are controlled. Moreover, the results obtained from the analyses indicate that real exchange rate depreciations are inflationary.

In the second part of the study, it is aimed to examine the effects of the average maturity of the domestic debt stock on economic performance in Turkey by considering monthly data from 1986:5 to 2001:5. It is found that an increase in the average maturity decreases output temporarily and the price level permanently. Moreover, an increase in the average maturity appreciates the currency. These findings show that an increase in maturity mimics a tightening in the monetary policy. However, it is also observed that an increase in maturity leads to a decline in interest rates.

Keywords**:** Real exchange rate, Contractionary devaluations, Debt management, Debt maturity

ÖZET

Makroekonomi Alanında İki Makale

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Master, İktisat Bölümü
Tez Yöneticisi: Yrd. Doç. Dr. Hakan Berument

Ağustos 2002

Bu çalışmanın ilk bölümünde reel döviz kurundaki değer kaybının, Türkiye ekonomisinin performansa etkileri 1987:I-2001:III dönemini kapsayan üç aylık veriler kullanılarak ölçülmüştür. Ampirik bulgular reel döviz kuru değer kayıplarının, uluslararası piyasa faiz oranları, sermaye hareketleri gibi dış etkenler kontrol edildiğinde dahi ekonomiyi daraltıcı etkileri olduğunu göstermektedir. Buna ek olarak, analiz sonuçları reel döviz kuru değer kayıplarının enflasyonist olduğunu göstermektedir.

Çalışmanın ikinci bölümünde, iç borç stoğunun ortalama vadesinin Türkiye ekonomisinin performansına etkileri 1986:5-2001:5 dönemini kapsayan aylık veriler kullanılarak belirlenmeye çalışılmıştır. Analiz sonuçları, ortalama vadenin uzamasının üretim seviyesinde geçici, fiyat düzeyinde ise kalıcı bir azalmaya neden olduğunu göstermektedir. Bunun yanı sıra, ortalama vadenin uzaması yerli paranın değer kazanmasına yol açmaktadır. Bu bulgular, vadenin uzamasının sıkı para politikası uygulamasıyla benzer sonuçlara neden olduğunu göstermektedir. Ancak, vadenin uzaması aynı zamanda faiz oranlarında azalmaya neden olmaktadır.

Anahtar Kelimeler: Reel döviz kuru, Daraltıcı devalüasyonlar, Borç yönetimi, Borçlanma vadesi

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to Asst. Prof. Hakan Berument for his continuous support throughout this study and for providing me the necessary background for the research. I also wish to thank Assoc. Prof. Yılmaz Akdi and Asst. Prof. Ümit Özlale for their helpful comments.

I am truly grateful to my family for their strong encouragement during my education. I am also indebted to my colleagues at the Research Department of the Central Bank of the Republic of Turkey.

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CHAPTER 1

Effects of Real Exchange Rate on Output and Inflation: Evidence from Turkey

1.1. Introduction

The 1995 Mexican Tequila and the 1997 Asian crises have stimulated a growing interest among academics and policymakers on the controversial issue of exchange rate policies in general and exchange rate regimes and real exchange rates in particular. The effects of the financial crises on global economy are getting more severe, and international trade and capital movements have begun to be central factors in the evolution of crisis. Domestic factors that lead to crises in various countries are different but there are also common features of these crises: big devaluations or depreciations in domestic currency and the subsequent significant output losses of the crisis countries.

Turkey has often experienced financial crises in its history. In 1994 and 2001, the nominal domestic currency depreciated 62% and 53% respectively. This made the effects of large depreciations an interesting event to study and also provided a natural laboratory where the effect of depreciation on economic performance could be observed. Starting in 1987, in a managed float exchange rate regime, the Central Bank of the Republic of Turkey (CBRT) announced daily quotations and domestic currency was depreciated continuously parallel to inflation expectations. However, when there was considerable pressure by markets in crisis times, large devaluations occurred. As in the case of the Asian and Mexican crises, common features of crisis, such as large devaluations or high levels of depreciation in domestic currency and significant output losses, were experienced after both the 1994 and the 2001 crises. In 1994, output declined by 6.2 % after the financial crisis and the sharp devaluation. However, between these two severe financial crises, the Turkish economy exhibited strong performance on the output side, and the average growth of output between 1995 and 1999 was 4.2%, despite the detrimental effects of the 1998 Russian crisis, the two earthquake catastrophes and the recession that took place in 1999. During that period, the real exchange rate, defined as the nominal exchange rate deflated by the Wholesale Price Index was relatively stable and there were times that sizeable capital inflow entered Turkey. With the Year 2000 Disinflation Program, the exchange rate regime was shifted from a managed float regime to a crawling peg regime. With the implementation of this program, a remarkable growth rate in GDP and a decline in inflation were seen, but the real exchange rate began to appreciate because of the differential between inflation and the pre-announced change in the path of nominal exchange rates. However, after the banking and resulting liquidity crisis of November of 2000 and the serious attack on foreign exchange reserves in February of 2001, Turkish authorities decided to switch the exchange rate regime to a floating regime. As expected, the exchange rate surged immediately and there was excessive volatility in the nominal exchange rate even after the first six or seven months of the crisis. The output response was detrimental to the large depreciation of the domestic currency and the real GNP and the real GDP declined by 9.4 % and 7.4% in 2001, respectively. The level of output performances were approximately the same as in 1997, indicating a decline in the welfare level of the Turkish public to the levels of four years before.

The 1994 and 2001 crises have different origins and different characteristics; however, the crises also have common elements: namely, huge exchange rate depreciation, preceding and / or coupling capital outflows, preceding current account deficits, output declines and high interest rates. There was a sizeable increase in the current account deficit preceding the crisis in 1993 and domestic currency devalued by more than 62% in nominal terms and 12.1% in real terms after the crisis. Similarly, in 2000, the year preceding the crisis year, there was a considerable current account deficit of approximately 4.9% of the GDP in 2000 and the Turkish lira depreciated by 53% in nominal terms and by 11.9% in real terms in 2001. In addition to these facts, output declined severely after both of the devaluations. The real GDP declined by 6.2% in 1994 and by 7.4% in 2001. The output responses after the great devaluations or depreciations suggest that the Turkish case constitutes a possible example of the contractionary devaluation hypothesis and the basic aim of this study is to find empirical support for Turkey. This study mainly uses the method proposed by Kamin and Rogers (2000), which found empirical evidence for contractionary devaluation for Mexico in analyzing the output and inflation response to real exchange rate movements.

Figure 1.1 shows the real GDP deviation from the equilibrium level and the real exchange rate on a quarterly basis. As seen in the figure, large devaluations are coupled with large declines in output and appreciations are coupled with growth in output. The figure suggests a negative relationship between these two variables. In this paper, this negative correlation will be investigated. However, before proceeding further, it should be noted that the findings of this study will be carefully considered.

For example, a finding that supports the contradictory view to the contractionary devaluation hypothesis may not recommend keeping the domestic currency at highly competitive levels because of the inflationary effects of such a policy action; or a finding that supports the contractionary devaluations hypothesis may not be implemented because of the higher risk of financial crisis in the presence of an overvalued domestic currency. However, this study aims mainly at showing the output and inflation responses after the devaluation.

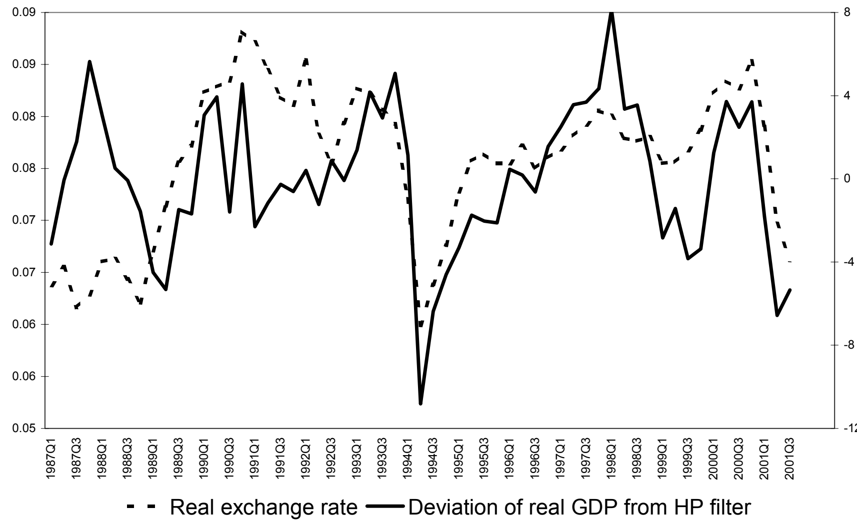


Figure 1.1: Real GDP Deviation from the equilibrium level and the real exchange rate[1]

The importance of this study lies on two grounds. First, volatile and persistent inflation and exchange rate movements allow to observe the effect of real exchange rate movements on economic performance that might not be observed for other developing countries. The Turkish case constitutes an interesting laboratory where high and persistent inflation without the case of hyperinflation has been a characteristic of the economy for three decades. During this period, although the

[1]In the figure, depreciations are shown by declines in the level of real exchange rate and appreciations by rise in the level of real exchange rate.

inflation rate was high, there were times that high growth rates were seen. Another challenging outcome is that the findings for Turkey, a developing country, are parallel to the other studies focusing on developing countries. Other empirical studies testing the contractionary devaluation hypothesis focus mostly on Latin American countries' experiences; however, this study has found a similar situation in Turkey. Hence, this may imply that the contractionary devaluation hypothesis is not contingent on a country's specific characteristics; rather it is valid for developing countries.

Section 1.2 considers the theoretical explanations and channels of the negative output-real exchange rate relationship. Section 1.3 discusses previous empirical studies regarding the contractionary devaluation hypothesis. Section 1.4 considers the data for the empirical work and gives a brief summary of the real exchange rate movements during the sample period. Section 1.5 examines the bivariate relationship and Granger causality between the variables of interest. In Section 1.6, the Vector Autoregression (VAR) models developed for the dynamic analysis of the data are formed and the results from the various models are explained. The final section summarizes the findings.

1.2. Potential Explanations for Output Real Exchange Rate Linkages

The tight negative relationship between the real exchange rate and output depicted in Figure 1.1 may emerge due to any one of three reasons. The negative relationship between output and the real exchange rate may be a spurious correlation emerging from the opposite responses of the real exchange rate and output to some external factor, it may be due to the causality running from output to the real exchange rate or it may reflect the causality running from the real exchange rate to output. The possible reasons and the related theoretical explanations of these three sources will be presented.

1.2.1. Spurious Correlation

Devaluations are, in general, responses to unfavorable external and internal developments. First, investors attack official reserves and the value of local currency is devalued when it is not sustained at its present value considering the level of interest rate and international reserves. Attacks from investors usually come with the realization of an adverse external shock, such as a deterioration in terms of trade, an increase in the world interest rate, or a decline in capital flow; or the attacks are reactions to the major deviations from sustainable equilibrium levels in domestic variables, like appreciated local currency, huge current account deficit and / or balance of payments deficits. These factors may lead to declines in output contemporaneously or in the subsequent periods. There may also be some instances in which declines in output due to these unfavorable effects may be observed earlier than the devaluations. The spurious correlation between exchange rates and output is supported by empirical evidence provided by Edwards (1989). The co-movement of real exchange rates and output in opposite directions as depicted in Figure 1.1 may be considered as a response of these variables to some exogenous shocks. Recently, prior to the exchange rate regime switch and the instability in the nominal exchange rates in February of 2001, the Turkish economy had begun to suffer important output losses starting from the November 2000 crisis. Thus, in the empirical study, external variables should be controlled to analyze the negative relationship clearly.

1.2.2. Causality Running from Output to the Real Exchange Rate

In exchange rate-based stabilization programs, there are, especially in the initial phases, strong output growth periods. In this kind of stabilization program, the domestic demand is pushed with the implementation of the program, which will increase the price of non-tradable goods where the price of tradable goods is fixed or exhibits less increase than non-tradables due to the pegged exchange rate regime; thus, the real exchange rate appreciates. This may indicate that the causality between output and the real exchange rate runs from the former to the latter. There are various explanations for why strong output performance is observed with the implementation of exchange rate-based stabilization programs. (Kiguel and Liviatan, 1992; Calvo and Vegh, 1993; Roldos, 1995 and Uribe, 1995). Such a situation indicates that the causality is directed from output to the real exchange rate. In the Turkish case, such a development of output was seen with the implementation of the Year 2000 Disinflation Program. Output expanded by 6.2% and real exchange rate appreciated by 8% in 2000. However, this hypothesis about the causality from output to real exchange rate may explain a longer-term co-movement between the variables, especially when the nominal exchange rate is fixed or pre-determined. Nevertheless, there is no observation in recent Turkish history that large depreciations of the real exchange rate are caused by large declines in the prices of non-tradable goods. The real exchange rate devaluations or large depreciations in real terms are coming from large nominal exchange rate devaluations or depreciations like the 1994 and 2001 crises.

1.2.3. Causality Running from the Real Exchange Rate to Output

From the viewpoint of the classical model, the devaluation of the real exchange rate has expansionary effects on output if the Marshall-Lerner condition is satisfied. Hence, devaluations lead to an increase in the aggregate demand. However, in the short-run, contractionary effects of devaluation may balance or even be larger than these effects, thus devaluation may depress the economy in the short-run. The various channels that explain the contractionary effect of devaluations are as follows:

a. Nominal rigidities in the economy: If some of the prices in the economy are inflexible, after a devaluation there may be a real decrease in nominal wages, money supply and related credit magnitudes relative to the value of traded goods. The decline in these variables may weaken domestic demand resulting in a decline in the level of output.
b. External debt and foreign-currency denominated liabilities: When devaluation occurs, external debt increases proportionately and so does the domestic value of the foreign currency denominated liabilities of the firms and households. This is especially important for countries where dollarization has taken place to some extent. Banks, firms or households with liabilities indexed or denominated in foreign-currency incur significant losses after

devaluation. Thus, they have to make adjustments in their balance sheets or budgets and possibly reduce their expenditures. Banks that suffer big losses from the devaluation will not extend credit to the real sector and even call in credit before the maturation date. This produces a serious negative effect on the firms and may lead to significant declines in output.

c. Weakening confidence: After a devaluation, prices do not adjust their long-run value instantly and this may raise the expected level of inflation as well as the expected level of depreciation of the nominal exchange rate. All of these are negative signals and weaken the confidence of economic agents, which may cause a decline in output.

d. Capital account problems: Devaluations are generally coupled with capital outflows. Before or with the devaluation, large amounts of foreign capital go abroad and in the initial stages of devaluation, no large amounts of foreign capital come back. This may limit the growth of the economy and cause the level of output to decrease.

e. Redistribution of income after devaluation: Devaluations generally affect income distribution. If income is redistributed after a devaluation from groups with a high marginal propensity to consume to groups with a low marginal propensity to consume, this could lead to a decline in output.

f. Associated economic policies: Governments may implement contractionary policies to contain the inflationary effects of devaluation; hence, a decline in output may be the result.

g. Supply-side related problems: If the country's real sector uses significant amounts of imported inputs in their production, increases in costs will follow after a devaluation takes place. This will lead to an upward shift in the supply curve leading to a decrease in the level of output. Another explanation of the contractionary devaluation hypothesis was proposed by Lai (1990). He showed that devaluation would definitely depress domestic output in the presence of the efficiency wage consideration.

In the next section, empirical studies on the effects of real exchange rate on output will be discussed.

1.3. Previous Empirical Studies:

Least squares analysis, panel data studies, macro model simulations and VAR models have been used previously to investigate empirically the effects of the real exchange rate on output. The empirical literature on the issue has focused generally on developing countries but there are some studies investigating developed country cases, such as Kamin and Blau (1999).

Edwards (1985) forms a reduced-form equation for twelve developing countries by using annual data for 1965-1980 in which real output is regressed to money growth surprises, government expenditure, terms of trade and the real exchange rate. The empirical findings of this analysis suggest that the effects of a real devaluation are contractionary which is reversed after one year and devaluation is neutral in the long run. Edwards (1989) finds that devaluations reduce output in developing countries in a pooled time-series/cross country analysis where the real

GDP is explained by real exchange rate, government spending, terms of trade and money growth. Agenor (1991) distinguishes anticipated and unanticipated devaluations and found that unanticipated devaluations increase the level of output, whereas anticipated devaluations decrease the level of output. Morley (1992) regresses capacity utilization to the real exchange rate, measures of fiscal and monetary policy, terms of trade, export growth and import growth in a pooled time-series/cross country analysis and found that real devaluations tended to reduce output and it took at least two years for the full effects to show. In a similar analysis, Domac (1997), based on Turkish data for the 1960-1990 period shows that unanticipated devaluations have positive effects on output but anticipated devaluations do not exert any significant effect on output. By using a panel data analysis, Kamin and Blau (1999) find that after controlling possible external variables having an effect on output, real exchange rate devaluations have negative effects on output in the short run but are neutral in the long run. In their study, Mills and Pentecost (2000) uses a Conditional Error Correction Model for four European Accession countries: Hungary, Poland, Slovakia and the Czech Republic. They find that real exchange rate depreciations have positive effects in Poland, no significant effect in Hungary and in the Czech Republic and negative effects in Slovakia. In a macro model simulation aiming at showing inflationary effects of real exchange rate targeting, Erol and Van Wijnbergen (1990) find that the real exchange rate appreciations to be contractionary for Turkey.

By using a VAR model for Mexico with four variables of output, government expenditures, inflation and money growth, Rogers and Wang (1995) find that most of the output variation is attributable to its own shocks but the response of output to devaluation is negative. Copelman and Werner (1996), by using a VAR model for Mexico with five variables - output, real exchange rate, rate of depreciation of nominal exchange rate, real interest rate and a measure for real money balances - show that declines in output are observed after a devaluation. Kamin and Rogers (2000) examine Mexican data with a four- variable VAR model where they employed the US interest rate, the real exchange rate, inflation and output for 1981–1995 on a quarterly basis and find that although the variation of output is explained mostly by its own innovations, the response of output for a permanent depreciation is permanent and negative.

In addition to direct analysis of the contractionary devaluation hypothesis in the above VAR models, there are VAR models that basically investigate output response in exchange rate-based disinflation programs; that is, the relation between output and reduced rates of depreciation of nominal exchange rate. For example, in their study, Santaella and Vela (1996) show that by using a two-variable VAR model for Mexico, a reduction in the nominal exchange rate depreciation raises the output initially but the rise is reversed after 12 quarters. Hoffmaister and Vegh (1996) estimate a VAR model for Uruguay with output, inflation, nominal exchange rate depreciation and money growth and found that a permanent reduction in exchange rate depreciation would lead to a long lasting positive effect on output.

The majority of studies discussed above found that devaluations are contractionary; however, this is not generally supported as there are studies showing that devaluations are expansionary. Thus, the contractionary devaluations hypothesis is a controversial issue for the world in general and for Turkey in particular.

This study uses the method proposed by Kamin and Rogers (2000) for Mexico. This method has advantages over other types of empirical analysis because it uses a dynamic system between the variables and controls the effects of external variables like world interest rates and balance of payments items. The theoretical framework of the model is also reported in the appendix of the above-mentioned study.

1.4. Data and Historical Analysis of Exchange Rate Movements in Turkey

To analyze the interrelationships between inflation, output and the real exchange rate in Turkey, the real exchange rate, the real GDP, inflation and the nominal US interest rate issued in the core model. The real exchange rate is computed by the nominal exchange rate basket, which is chosen in line with the official definition of the exchange rate basket adopted in the sample period and by the inflation rate used in the study. Thus, the exchange rate basket used in the study consists of 1 US dollar and 1.5 Deutsche Mark. The inflation rate that has been used is the logarithmic first difference of the Wholesale Price Index. In alternative models some other variables such as balance of payments items, current account, capital account plus official reserves, and the government purchases item of GDP are also used. The sample period covers quarterly data from 1987:I to 2001:III. The data are quarterly due to the quarterly GDP data releases. All data are available at the website (http://www.tcmbf40.tcmb.gov.tr/cbt.html) of the CBRT.

The three-monthly US Treasury bill interest rate is used as the nominal US interest rate. For variables of balance of payments items and government size, the ratio of the variables to the nominal GDP is used. The level of output exhibits a very apparent seasonality in Turkey; hence, the seasonally adjusted real GDP is used.

The exchange rate developments have been relatively stable during the sample period but with substantial exceptions during the crisis periods. Turkey applied to the IMF to the full convertibility of Turkish lira in 1989. From then until January 2 of 2000, Turkey's exchange rate regime was an intermediate exchange rate regime with a financial crisis and devaluation in 1994. In other words, the exchange rate was not fixed or previously announced but the CBRT monitored the exchange rate movements and did not allow the real exchange rate to fluctuate heavily in most of the sample period. Until February 22 of 2001, the CBRT publicly announced the daily quotations of the nominal exchange rates every morning and committed itself to intervene in the exchange rate market, i.e., buy or sell foreign exchange at these announced rates. The markets carefully followed these quotations and the level of nominal exchange rate in the markets did not deviate much from the CBRT's quotations except in the 1994 crisis period. The CBRT has used the nominal exchange rate as a policy variable throughout most of the sample period. The nominal exchange rate has been determined in consideration with inflation and current account sustainability issues, as stated by Gazi Erçel (1998), former governor of the CBRT:

> The Central Bank's exchange rate policy is affected by two factors. These are the sustainability of the current account balance and inflation. A rapid increase in exchange rates could encourage inflation, while increasing the sustainability of current account balance. The contrary effect of the exchange rate on these two variables oblige the Central Bank to steer its exchange rate policy between these two constraints to maintain equilibrium in the economy. In periods when the fight against inflation has priority in economic policymaking, exchange rate policy is pursued with by its inflationary effects in view. But when the fight against inflation recedes, exchange rate policy is redirected to strengthen the current account balance.

The CBRT considered current account sustainability and the inflationary effects of the exchange rate movements in order to achieve stability in the financial markets in the sense that a comprehensive program and effort for disinflation was lacking. The Turkish economy has had high, chronic and variable inflation since the mid-70s and the economy was characterized by rising budget deficits and a rising stock of domestic debt in the sample period. In such an environment, the objective of the CBRT was achieving stability in financial markets. The CBRT was successful in achieving this objective and except for the 1994 crisis; the financial markets were stable until November 2000. The stability was achieved to some extent in the financial markets even in the presence of negative external shocks like the Persian Gulf Crisis in 1991, the Asian Crisis in 1997 and the Russian Crisis in 1998.

In 1989, the capital account was fully liberalized. The initial effects of the liberalization of the capital account was a rapid capital inflow to the Turkish economy, coming in the form of borrowing from international markets by the banking sector and rising portfolio investments on the Istanbul Stock Exchange (Emir et.al., 2000). The real exchange rate appreciated about by 9.7% in 1990. The Persian Gulf Crisis created uncertainties about the exchange rate and the CBRT aimed at keeping these uncertainties to minimum levels. However, the real exchange rate depreciated by 8.3% in 1991. In 1992, the CBRT did not allow the exchange rate to appreciate in real terms. The exchange rate basket (1 US dollar + 1.5 Deutsche Mark) depreciated by 1.4% in 1992. In 1993, the real exchange rate did not appreciate much and stayed approximately around the same level during the year, but at the end of 1993 there was a 19% appreciation of Turkish lira left over from the 1989-1990 period. In 1994, because of the domestic imbalances and growing budget deficits, the CBRT encountered a serious attack on its reserves. Following the erosion of reserves, the financial crisis and frequent but small devaluations, the Turkish government devalued the Turkish lira by 20% on April 5, 1994. While, the nominal exchange rate stabilized towards the end of the year, the real exchange rate depreciated by 12 % in 1994. In 1995, the real exchange rate appreciated to some degree but by the end of the year it was more depreciated than it had been in 1993.

The political uncertainties after the November 1995 elections, the lack of disinflation efforts and related prudent fiscal measures caused the CBRT to make its primary objective the achievement of stability in the financial markets. To keep the financial markets stable, the CBRT used the nominal exchange rate as its main policy tool. The CBRT pursued an implicit competitive real exchange rate policy, which basically limits the percentage change of the nominal exchange rate in order not to deviate from the expected inflation rate. Another consideration in the stability of the real exchange rate was the issue of balance of payments. In the 1995-1999 period, the monthly nominal exchange rate basket depreciation was around the monthly inflation rate, so in this period the real exchange rate gained stability. Additionally, the intra-month volatility of the exchange rate was limited in general. This strategy was successful in handling big negative external shocks, like the 1997 Asian Crisis and the 1998 Russian Crisis. During those periods, there was some erosion of the CBRT reserves, but there were no big turbulences that could be considered as financial crises.

With the 2000 Disinflation Program, a crawling peg regime in the exchange rate policy was adopted starting from January 2, 2000. The 2000 Disinflation Program was an exchange rate-based disinflation strategy with prudent fiscal measures and an ambitious structural reform agenda. The CBRT announced the path of the nominal exchange rate basket (1 US dollar + 0.77 Euro) on a sliding 12-month scale. The definition of the exchange rate basket was switched from 1 US dollar + 1.5 Deutsche Mark to 1 US dollar + 0.77 Euro because Euro had become the currency unit used in accounts in international financial markets as the official European currency from 1999 on. It was announced that the nominal exchange rate basket would depreciate by 20%, the targeted WPI inflation rate for 2000. Like in other disinflation programs, the inflation rate converged to the exchange rate basket depreciation with a two-month lag. The inflation rate was 33% in the WPI for 2000, above the exchange rate basket depreciation but it was lower than the figures for the previous 14 years. However, the crawling peg policy was abandoned and a floating exchange rate policy was adopted on February 22 of 2001 after the huge attack on the CBRT reserves. On that day, the value of the US dollar against the Turkish lira increased by 40%. After switching to the floating exchange rate regime, the nominal exchange rate further rose until November 2001, and the real exchange rate depreciated by 11.9% in 2001.

1.5. Bivariate Data Analysis

As seen in Figure 1.1, there seems to be a tight negative relation between the real exchange rate and output. To analyze this negative correlation, first cross correlations between the real exchange rate and output are performed. The cross correlation analyses are repeated for different transformations. Then, the Granger causality test results will be examined in order to analyze the direction of causality. The causality tests have been performed in the full sample and in the sub-samples.

In Table 1.1, the cross correlations between the quarterly seasonally adjusted real GDP and the real exchange rate after various transformations are presented. The data are from the sample period 1987:I to 2001:III. The cross correlations are evaluated up to a four-period lead, up to a four-period lag and the contemporaneous cross correlations. The lag number indicates the number of quarters by which the real exchange rate is lagged relative to the seasonally adjusted real GDP. Hence, negative values for periods indicate that the real exchange rate is lagged relative to the seasonally adjusted real GDP and positive values for periods indicate that the seasonally adjusted real GDP is lagged relative to the real exchange rate. Different transformations, namely logarithmic form, first difference of logarithmic form, deviation from a linear trend, deviation from a quadratic trend, deviation from a cubic trend and deviation from the trend obtained by HP filter, are used because there is no general agreement about equilibrium values of the variables and it is aimed to analyze whether the co-movements of the real exchange rate and output in opposite directions are valid under different assumptions of equilibrium variables for the real exchange rate and output. The transformations were made both to the real exchange and the output. Consistent with the tight negative relationship between output and the real exchange rate in Turkey, almost all of the cross correlations exhibited in Table 1.1 are negatively correlated. However, there seems to exist a positive correlation at the four-period lag; for four filters used in the analysis, this situation exists. At the three-period lag, the situation is mixed; for three of the filters (deviation from a linear trend, deviation from the trend obtained by the HP filter and the first difference of the variables) used in the analysis, there exists a positive relationship between output and the real exchange rate and for the remaining three filters, the relationship between the variables is negative. Likewise, at the four-period lead, there exists a positive cross correlation for the same filters that indicate a positive relation at the three-period lag and remaining filters indicate a negative correlation. The magnitude of the cross correlation varies according to the filters used but all filters show that it is highest in the contemporaneous period. Hence, the cross correlations show that devaluations are associated with depressed output and appreciations are associated with increased levels of output.

Table 1.1: Cross Correlations between Real Exchange Rate and Real GDP

Lag Number	Logarithmic Form	First difference of logarithmic form	Deviation from a linear trend	Deviation from a quadratic trend	Deviation from a cubic trend	Deviation from the HP filter's trend
-4	-0.07	0.36	0.26	0.05	0.01	0.36
-3	-0.15	0.06	0.16	-0.06	-0.10	0.06
-2	-0.25	-0.02	-0.01	-0.22	-0.24	-0.02
-1	-0.34	-0.35	-0.24	-0.39	-0.38	-0.35
0	-0.43	-0.62	-0.42	-0.54	-0.51	-0.62
1	-0.43	-0.46	-0.26	-0.40	-0.30	-0.46
2	-0.42	-0.29	-0.11	-0.27	-0.29	-0.29
3	-0.38	-0.13	-0.01	-0.19	-0.22	-0.13
4	-0.33	0.18	0.05	-0.15	-0.20	0.04

From the cross correlations presented in Table 1.1, it is evident that there is a negative correlation between real exchange rates and output. The direction of the causality seems to be from the seasonally adjusted real GNP to the real exchange rate as the magnitudes of the cross correlations are greater in lead periods than in lag periods. To examine the direction of these negative correlations more precisely the relationship between the real exchange rate and output is tested in a VAR setting and relevant F-statistics are computed to perform the causality test in Granger's sense (Granger causality, hereafter). The Granger causality tests will indicate whether a set of lagged variables has explanatory power on the other variables. If the computed F-statistics are significant, then it may safely be claimed that one variable does Granger cause the other variable. The transformations of the above cross correlation analysis are repeated in the Granger causality tests, the results of which are presented in Table 1.2. The VAR model that is used in computing the Granger causality tests is a two endogenous variable model with four lags, a constant term and seasonal dummies for the first three quarters.

First relevant F-statistic values for the whole sample are computed. The results of the full sample Granger causality test state that none of the variables are helpful in explaining the movements of the other. The null hypothesis that the real exchange rate does not Granger cause real output and the null hypothesis that real output does not Granger cause the real exchange rate cannot be rejected. However, for the transformation of the first difference of the logarithms of the variables, the null hypothesis that real GDP does not Granger cause real exchange rate is rejected for 2% level of significance. In all other transformations, there seems to be no causality between these two variables.

There are two different ways to explain this failure of the Granger causality test in the full sample. The first is that the fifteen-year sample period is a long horizon when different characteristics of economic activity, monetary policy and related policy tools are considered. There may be periods when the interaction between the real exchange rate and output changes. For example, for the years between 1995 and 1999, the primary objective of the CBRT was to achieve market stability and the CBRT tried to influence exchange rate movements; however, for the year 2000, the exchange rate tool was used in the disinflation strategy. These counter developments may offset the possible effects between the variables. The second possible explanation for the failure of the Granger causality tests is that, in this test of causality the possible effects of exogenous variables cannot be removed from the considered endogenous variables.

The analysis is re-performed for different sub-samples. The 1994 devaluation was very detrimental on economic activity and high levels of depreciation were seen in this period. Therefore, it is thought that dividing the full sample into sub-samples before and after the 1994 crisis is suitable. Thus, the first sub-sample is chosen to be the period from 1987:I, the beginning period of the full sample, to 1994:I, the last period before the crisis and devaluation of 1994. The crisis and subsequent recession and the V-type of the recovery period is excluded because of the extreme behavior of the nominal exchange rates during this period. For the post-1994 sub-sample, three overlapping sub-samples are considered. The second sub-sample is the period between 1995:III and 1999:IV. The last quarter of 1999 is the last quarter of the managed float regime before the implementation of the crawling peg regime of the 2000 Disinflation Program. The analysis is repeated in order to assess whether any different relationship could be detected when disinflation strategy’s crawling peg regime is included and extended this second sub-sample to 2000:IV, the last quarter before the switch to the floating exchange rate regime. In the last sub-sample, the analysis includes all the periods between 1995:III and 2001:III. However, either the 2000 Disinflation Program’s crawling peg regime or the period of the floating exchange rate regime of 2001 has not been included alone, due to small sample size.

Table 1.2: Granger Causality Tests[2]

	Logarithmic Form		First difference of logarithmic form		Deviation from a linear trend		Deviation from a quadratic trend		Deviation from a cubic trend		Deviation from the HP filter trend	
	F statistic and significance		F statistic and significance		F statistic and significance		F statistic and significance		F statistic and significance		F statistic and significance	
Full Sample												
Real GDP	0.31	(0.87)	3.38	(0.02)	1.15	(0.35)	0.39	(0.82)	0.33	(0.86)	2.04	0.11
Real Exchange Rate	0.68	(0.61)	0.51	(0.73)	0.42	(0.79)	0.56	(0.69)	0.45	(0.77)	0.49	(0.74)
1987:1 – 1994:1												
Real GDP	1.01	(0.39)	2.20	(0.12)	3.11	(0.05)	1.54	(0.24)	1.21	(0.35	2.53	(0.08)
Real Exchange Rate	0.70	(0.60)	0.48	(0.75)	0.62	(0.66)	0.82	(0.53)	0.76	(0.57)	0.69	(0.61)
1995:3 – 1999:4												
Real GDP	2.21	(0.20)	0.28	(0.88)	0.56	(0.71)	0.26	(0.90)	0.23	(0.91)	0.65	(0.65)
Real Exchange Rate	0.78	(0.58)	0.24	(0.90)	0.59	(0.69)	0.71	(0.62)	0.77	(0.59)	1.22	(0.41
1995:3 – 2000:4												
Real GDP	1.25	(0.36)	0.89	(0.51)	1.22	(0.37)	1.43	(0.30)	1.42	(0.30)	1.23	(0.37)
Real Exchange Rate	3.26	(0.07)	1.01	(0.45)	2.19	(0.15)	3.10	(0.07)	3.40	(0.06	1.49	(0.29)
1995:3 – 2001:3												
Real GDP	3.39	(0.05)	1.35	(0.31)	1.98	(0.16)	1.74	(0.21)	1.72	(0.21	1.35	(0.31)
Real exchange Rate	3.89	(0.03)	1.07	(0.42)	6.67	(0.01)	7.43	(0.00)	7.70	(0.00)	3.64	(0.04)

The results of these sub-sample analyses of Granger causality tests give mixed results. First of all, there is no transformation that gives a statistically significant causal relationship between the real exchange rate and output in all of the sub-samples considered. In the first sub-sample, the transformation of deviation from a linear trend and deviation from HP filtered reveal that output Granger causes the real exchange rate at 5% and 8% levels of significance respectively. There is no statistically significant causality relationship in either direction in the second sub-sample presented in Table 1.2. In the sub-sample of 1995:III and 2000:IV, in three of

2 p-values are reported next to F-statistics, in parentheses.

the transformations – namely logarithmic form of the variables, deviation from a quadratic trend and deviation from a cubic trend – the null hypothesis that real exchange rate does not Granger-cause real output is rejected at a 7% level of significance. Finally, when the last sub-sample is considered it is evident that the real exchange rate Granger causes real output in the majority of the transformations. In the logarithmic form, where the real exchange rate Granger causes output, output also Granger causes the real exchange rate. In other cases, the hypothesis that output Granger causes the real exchange rate is rejected.

The results of the sub-sample Granger causality tests are mixed but they at least give an indication and an expected result at least for the last sub-sample. In the last sub-sample all periods between 1995:III and 2001:III are considered. During this period, there are times when the real exchange rate appreciated and output increased contemporaneously or with lags. Also in 2001, there is a period when the nominal and real exchange rate depreciated and a recession occurred. Thus, the last sub-sample is sufficiently large to incorporate significant variation in the endogenous variables. Hence, it is large enough to deduce significant relations between variables. However, it cannot be said that the causality from the real exchange rate to real output is homogeneous in different transformations, thus it cannot safely be concluded that the real exchange rate Granger causes real output in the last sub-sample.

As stated earlier, the Granger causality tests do not remove the possible effects of exogenous variables from the variables of interest. In other words, it is clear that other economic variables such as interest rates, inflation, capital account movements etc. may have possible effects on both variables, and their effects may limit the usefulness of the Granger causality analysis. Thus, VAR models are estimated to remove such effects so that the negative correlations and dynamic relation between the variables of interest can be analyzed.

1.6. VAR Models and Empirical Analysis

In this section, the core model and alternative models that the econometric analysis is based on are described first. In the second sub-section, the forecast error variance decomposition analysis is explained and in the last sub-section impulse responses obtained from the models are explained.

1.6.1. The Models

In the bivariate analysis, it is shown that there exists a negative correlation between the real exchange rate and output; however, the direction of causality could not be shown due to the above-mentioned reasons. In this section, a VAR model is derived in order to study the negative correlation between output and the real exchange rate more precisely and to see whether this negative relationship emerges from a spurious correlation. The VAR model will also capture the sources of important external shocks and will identify the dynamic relationship of the variables of interest and the effects of the shocks produced within the model setting.

The core model is a four-endogenous variable VAR model with the particular order of the US nominal interest rate, the real exchange rate, the inflation and the seasonally adjusted real output. The order of the variables is the same as those in Kamin and Rogers (for further reference, see the Appendix of Kamin and Rogers, 2000). The US nominal interest rate is taken as the first variable because Turkish economic variables like inflation, the real GDP and the real exchange rate are not expected to have any effect on US interest rate. The exogenous variable US nominal interest rate captures the external developments that may have significant effects on the real exchange rate, inflation and the real GDP in Turkey. In alternative models, other variables like government purchases, balance of payment items and monetary aggregates are included. The VAR models have four lags and use constant terms and seasonal dummies for the first three quarters.

1.6.2. Forecast Error Variance Decompositions

In Table 1.3, the forecast error variance decompositions of the variables used in the core VAR model is presented. These are the fractions of the forecast error variances of the variables attributed to their own innovations or the innovations of the other variables. The forecast error variances of the variables will give information about shocks of which variables have explanatory power to forecast of the other variables. After obtaining the model estimates, in order to calculate the standard errors, the bootstrap procedure is used and the number of bootstrap draws is chosen to be 3000.

The forecast error variance decompositions of the real exchange rate, inflation and output at 4, 12 and 24-period are reported. The variables in the rows are the variables whose forecast error variance decompositions are in question and the variables in the columns are the variables whose innovations constitute the fraction of the variables in the column. For example, 0.08 is the fraction of the forecast error variance in the real exchange rate that is attributable to the US nominal interest rate at the four-quarter forecast horizon and the associated standard error for this fraction is 0.05.

Table 1.3 shows that the most important source of variation in real exchange rate forecasts is its own innovations, which account for 61 - 74% of the variance of its forecast. As seen in Table 1.3, innovations in the US interest rate account for 8-15%, innovations in inflation account for 10-15% and innovations in output account for only 3-4% the of forecast error variance of the real exchange rate. These findings show that innovations in the other variables are not important in explaining the variation in the real exchange rate; hence, it may be argued that the real exchange rate is exogenous. These may also show that the CBRT could be using this variable as a policy tool in the sample period. The findings are statistically significant for all the periods.

Similar to the real exchange rate, inflation's own innovations account for the highest fraction of its forecast error variance. It accounts for 44-51% of the forecast error variance. The second important source of forecast error variance of inflation is the innovations in the real exchange rate. It explains 26-29% of the forecast error variance of inflation. These show that real exchange rate movements are important in the variability of inflation. Innovations in the US interest rate explain 13-16% of the forecast error variance of inflation. The weakest source of the forecast error variance of inflation is output growth. It accounts for only 6-7 % of the forecast error variance of inflation. All of the observations are statistically significant.

There exists an interesting case for forecast error variance of output. In contrast to the real exchange rate and inflation, the innovations of output are not the most important source in explaining the forecast error of output. Innovations in the real exchange rate account for 27-41% and innovations in inflation explain 23-33% of the forecast error variance of output. These two are the most important factors in explaining the variance of output. Innovations in output are the third most important source of the forecast error variance of output and they explain only 19-20% of the forecast error variance of output. Innovations in the US interest rate account for 5-11% of the forecast error variance of output. All findings, except those for innovations in inflation and the US interest rate for the fourth forecast period, are statistically significant.

The findings in the above forecast error variance decompositions reveal that real exchange rate movements influence the level of the real GDP and inflation but are not influenced by any endogenous variable in the model. Likewise, inflationary shocks explain the movements in output but shocks to output do not explain any of the variables in the system.

Table 1.3: Forecast Error Variance Decomposition of Variables in the Core Model[3]

	US Interest Rate			Real exchange rate			Inflation			Output		
	4	12	24	4	12	24	4	12	24	4	12	24
Real Exchange Rate	0.08	0.15	0.15	0.74	0.63	0.61	0.10	0.14	0.15	0.08	0.04	0.04
	(0.05)	(0.07)	(0.07)	(0.17)	(0.15)	(0.15)	(0.06)	(0.08)	(0.08)	(0.02)	(0.02)	(0.02)
Inflation	0.13	0.16	0.16	0.26	0.29	0.29	0.51	0.45	0.44	0.06	0.07	0.07
	(0.06)	(0.06)	(0.06)	(0.09)	(0.09)	(0.09)	(0.12)	(0.11)	(0.11)	(0.03)	(0.04)	(0.04)
Output	0.09	0.11	0.11	0.41	0.30	0.27	0.23	0.30	0.33	0.20	0.19	0.19
	(0.05)	(0.06)	(0.06)	(0.15)	(0.13)	(0.14)	(0.12)	(0.16)	(0.17)	(0.08)	(0.09)	(0.09)

After obtaining the forecast error variances of the endogenous variables in the core model, the forecast error variances of variables of the alternative models are computed to assess the robustness of the results that have been arrived at in the previous analysis. Five other VAR models with four lags are developed and a variable is added in each of the models. In the first alternative model, government size is included as an additional variable after US interest rate. The fraction of the government purchases item in the nominal GDP is used as the government size. Government size is included in the model because government purchases and public sector prices are influential in the GDP and inflation and it may also have an effect on the level of real exchange via these channels. In the second alternative model, the M1 monetary aggregate variable is augmented and used in the particular order of the US interest rate, the real exchange rate, M1, inflation and output. M1 is included to capture the monetary channel to the formation of real exchange rate, inflation and output. The third alternative model uses the added variable of the current account.

[3] Standard errors are reported in parentheses under fractions of forecast errors estimated.

The ratio of the current account to the nominal GDP is used as the current account variable. As a balance of payments item, the current account is expected to have effects on the real exchange rate. Moreover, it affects the GDP directly and it influences inflation and output via indirect channels. The size of capital flows affect the nominal exchange rate directly by changing the demand and supply in the exchange rate market, so the real exchange rate. It also has indirect effects on inflation and output. Thus, the fourth alternative model incorporates the capital account variable and the particular order of the model is the US interest rate, the capital account, the real exchange rate, inflation and output. The ratio of the capital account excluding official reserves to the nominal GDP is used as the variable of the capital account. In the last alternative model, the US interest rate is excluded and the capital account and government size are included with the other variables of interest. In order to see the dynamic interrelationship between the domestic variables in a setting that assumes the weaknesses of international links. In Table 1.4, as in Table 1.3, the variables in the columns are the endogenous variables and the variables in the rows are the variables that are the forecast error variance of the variables in question, namely the real exchange rate, inflation and output. The variables in the columns are presented in the particular order of the VAR models.

From the forecast error variance decomposition analysis of the core model, it is seen that the movements of the endogenous variables do not influence real exchange movements. From the alternative models, it is also evident that the US interest rate is helpful in explaining the forecast error variance of the real exchange rate. In the alternative models, innovations in the US interest rate explain 10-29% of the forecast error variance of the real exchange rate. Likewise, in the alternative models including the balance of payments items, the current account / GDP in the 3rd alternative model, and the capital account / GDP in the 4th and 5th alternative model; these items are helpful in explaining the forecast error variance of the real exchange rate. Hence, from the alternative models, it is concluded that the external factors, like the balance of payments items and the US nominal interest rate are effective in the forecast error variance of the real exchange rate. However, other endogenous variables of interest, inflation and output are not useful in explaining the forecast error variance of the real exchange rate. Innovations in inflation account for 7-15% and innovations in output 2-9% of the forecast error variance of the real exchange in the alternative models. Thus, parallel to the conclusion that was drawn from the forecast error variances of the alternative model, inflation and output do not influence the real exchange rate.

From the core model, it is concluded that innovations in the real exchange rate are helpful in the forecast error variance of inflation. As seen in Table 1.4, innovations in the real exchange rate are helpful in explaining the forecast error variance of inflation also in the alternative models. Innovations in the real exchange rate account for 18-24% of the forecast error variance of inflation in the alternative models. However, from the alternative models including the balance of payments items, it is found that apart from the real exchange rate, external shocks are also influential in the level of inflation. Current account / GDP accounts for 16-21% and capital account / GDP accounts for 16-19% of the forecast error variance of inflation. The results for the US interest rate are mixed as regards determining the forecast error variance of inflation. From the core model, it is concluded that innovations in the US nominal interest rate are not helpful in explaining the forecast error variance of inflation. The 1st and 2nd alternative models also support this claim, however the 3rd and 4th alternative models contradict this claim. Innovations in the US interest rate account for 10-19% of the forecast error variance of inflation in the latter VAR models. Parallel to the core model forecast error variance analysis, innovations in output account for only a small fraction of the forecast error variance of inflation in the alternative models. As presented in Table 1.4, it is concluded that other endogenous variables used in alternative models, such as, government size / GDP and M1 monetary aggregate, are not influential in forecast error variances of inflation.

From the core model, it is seen that innovations in the real exchange rate are important in explaining the forecast error variance of output. This result is also arrived in the alternative specifications. Only in the 3rd alternative model, when the current account / GDP is included in the core model, that real exchange innovations do not help to explain the forecast error variances of output. Innovations in the real exchange rate explain 18-34% of the forecast error variance of output and are the most important source of the forecast error variances of output in other alternative models. Like the case for the real exchange rate, innovations in inflation account for an important fraction of the forecast error variance of output in the core model. This finding is seen in all of the alternative models. Innovations in inflation explain 14–35% of the forecast error variance of output in alternative VAR settings. As an external variable, the US nominal interest rate was not an important determinant in the forecast error variance of output in the core model. This result is robust and innovations in output account for 8-16% of the forecast error variance of output in alternative settings. Among the variables of alternative models, only current account / GDP is significant in explaining the forecast error variance of output and innovations in this variable account for 20-30% of the forecast error variance of output.

From the findings of forecast error variance decompositions of alternative settings, it is observed that the real exchange rate is not determined by the endogenous variables of inflation and output; and the real exchange rate is influential in determining the variables of interest, inflation and output. Likewise, one of the results of the forecast error variance of the core model, the one that states that innovations in inflation are significant in explaining the forecast error variance of output, holds also in other model settings. Similarly, forecast error variance decomposition analysis of both the core model and the alternative models state that output is not influential in the forecast error variance of either the real exchange rate or inflation.

The finding of the core model, which states none of the external variables are not influential in explaining the forecast error variance of the real exchange rate is not robust to the alternative settings. Similarly, in the core model forecast variance decomposition analysis, it is found that none of the external variables are influential in explaining the forecast error variance of inflation and output, but in alternative models, contradictory evidence is found. These differences between the core model and alternative models may occur because the current account and the capital account are included in the alternative models. The finding that the capital account and the current account have explanatory power in explaining the level of inflation and output is consistent with economic theory.

Table 1.4: Forecast Error Variance Decompositions of Alternative VAR Models[4]

Panel A: 1st Alternative Model

	US Interest Rate					Government Size					Real Exhange Rate					Inflation					Output				
	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24
Real Exchange Rate	0.12	0.17	0.19	0.19	0.19	0.16	0.16	0.16	0.16	0.16	0.53	0.45	0.42	0.42	0.40	0.07	0.10	0.11	0.11	0.10	0.02	0.04	0.04	0.04	0.04
	(0.07)	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)	(0.08)	(0.08)	(0.15)	(0.14)	(0.13)	(0.13)	(0.13)	(0.04)	(0.06)	(0.06)	(0.06)	(0.06)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Inflation	0.12	0.15	0.15	0.16	0.16	0.13	0.14	0.14	0.14	0.15	0.22	0.23	0.23	0.24	0.24	0.42	0.38	0.36	0.35	0.35	0.05	0.06	0.07	0.07	0.07
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.09)	(0.08)	(0.08)	(0.08)	(0.08)	(0.11)	(0.10)	(0.09)	(0.09)	(0.09)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Output	0.08	0.10	0.10	0.10	0.10	0.13	0.15	0.16	0.16	0.17	0.31	0.27	0.26	0.24	0.24	0.18	0.19	0.19	0.19	0.19	0.18	0.17	0.16	0.15	0.15
	(0.04)	(0.05)	(0.05)	(0.06)	(0.06)	(0.08)	(0.09)	(0.10)	(0.10)	(0.10)	(0.13)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)

Panel B: 2nd Alternative Model

	US Interest Rate					Real Exhange Rate					M1 Monetary Aggregate					Inflation					Output				
	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24
Real Exchange Rate	0.11	0.17	0.19	0.20	0.20	0.56	0.46	0.43	0.42	0.41	0.12	0.11	0.11	0.11	0.11	0.08	0.13	0.14	0.14	0.15	0.03	0.05	0.05	0.05	0.06
	(0.06)	(0.08)	(0.08)	(0.08)	(0.09)	(0.16)	(0.14)	(0.13)	(0.13)	(0.13)	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.07)	(0.07)	(0.07)	(0.08)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Inflation	0.13	0.15	0.16	0.17	0.17	0.23	0.24	0.24	0.24	0.24	0.14	0.16	0.16	0.15	0.15	0.39	0.34	0.33	0.32	0.31	0.05	0.07	0.07	0.07	0.08
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.09)	(0.08)	(0.08)	(0.08)	(0.08)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.10)	(0.09)	(0.08)	(0.08)	(0.08)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Output	0.10	0.14	0.15	0.16	0.16	0.28	0.28	0.28	0.28	0.28	0.16	0.14	0.15	0.15	0.15	0.24	0.23	0.22	0.22	0.21	0.15	0.14	0.13	0.12	0.12
	(0.05)	(0.07)	(0.07)	(0.07)	(0.07)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.12)	(0.11)	(0.10)	(0.10)	(0.10)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)

Panel C: 3rd Alternative Model

	US Interest Rate					Current Account / GDP					Real Exhange Rate					Inflation					Output				
	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24
Real Exchange Rate	0.17	0.19	0.25	0.25	0.25	0.21	0.24	0.24	0.24	0.25	0.42	0.35	0.31	0.29	0.28	0.08	0.11	0.11	0.12	0.13	0.03	0.03	0.03	0.03	0.03
	(0.09)	(0.08)	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)	(0.10)	(0.10)	(0.10)	(0.14)	(0.12)	(0.11)	(0.10)	(0.10)	(0.05)	(0.06)	(0.05)	(0.06)	(0.06)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Inflation	0.15	0.17	0.18	0.19	0.19	0.16	0.19	0.20	0.20	0.21	0.18	0.19	0.19	0.18	0.18	0.42	0.37	0.35	0.34	0.34	0.04	0.04	0.04	0.04	0.04
	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.11)	(0.09)	(0.09)	(0.09)	(0.09)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Output	0.08	0.11	0.11	0.12	0.12	0.30	0.24	0.22	0.21	0.20	0.14	0.12	0.11	0.10	0.10	0.24	0.31	0.33	0.34	0.35	0.15	0.14	0.13	0.13	0.13
	(0.04)	(0.06)	(0.06)	(0.06)	(0.06)	(0.13)	(0.10)	(0.10)	(0.10)	(0.10)	(0.07)	(0.06)	(0.05)	(0.05)	(0.05)	(0.13)	(0.15)	(0.16)	(0.17)	(0.17)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)

Panel D: 4th Alternative Model

	US Interest Rate					Capital Account / GDP					Real Exhange Rate					Inflation					Output				
	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24
Real Exchange Rate	0.14	0.23	0.28	0.28	0.29	0.12	0.16	0.16	0.16	0.17	0.55	0.41	0.33	0.32	0.31	0.08	0.10	0.11	0.12	0.12	0.03	0.04	0.05	0.05	0.05
	(0.08)	(0.10)	(0.11)	(0.11)	(0.12)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)	(0.17)	(0.13)	(0.11)	(0.11)	(0.11)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Inflation	0.10	0.14	0.17	0.19	0.19	0.18	0.19	0.19	0.19	0.19	0.20	0.20	0.19	0.19	0.19	0.42	0.36	0.33	0.32	0.32	0.05	0.07	0.07	0.07	0.07
	(0.05)	(0.06)	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.10)	(0.09)	(0.09)	(0.08)	(0.08)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Output	0.08	0.13	0.13	0.14	0.14	0.13	0.13	0.11	0.11	0.10	0.31	0.23	0.21	0.19	0.18	0.19	0.24	0.28	0.28	0.29	0.19	0.17	0.17	0.17	0.17
	(0.04)	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.14)	(0.10)	(0.10)	(0.09)	(0.09)	(0.11)	(0.13)	(0.14)	(0.14)	(0.14)	(0.07)	(0.07)	(0.08)	(0.08)	(0.08)

Panel E: 5th Alternative Model

	Capital Account / GDP					Government Size					Real Exhange Rate					Inflation					Output				
	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24	4	8	12	16	24
Real Exchange Rate	0.10	0.19	0.20	0.20	0.21	0.05	0.08	0.09	0.09	0.10	0.71	0.55	0.49	0.47	0.45	0.04	0.06	0.08	0.08	0.08	0.03	0.06	0.08	0.08	0.09
	(0.05)	(0.09)	(0.09)	(0.09)	(0.10)	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)	(0.15)	(0.14)	(0.14)	(0.14)	(0.14)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.02)	(0.03)	(0.04)	(0.04)	(0.04)
Inflation	0.16	0.17	0.18	0.19	0.19	0.16	0.17	0.17	0.17	0.17	0.19	0.21	0.20	0.21	0.21	0.36	0.32	0.30	0.30	0.29	0.08	0.09	0.10	0.11	0.11
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.10)	(0.08)	(0.08)	(0.08)	(0.08)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Output	0.10	0.11	0.10	0.11	0.10	0.07	0.09	0.08	0.09	0.09	0.34	0.28	0.29	0.27	0.27	0.14	0.20	0.21	0.22	0.22	0.25	0.21	0.21	0.19	0.18
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.05)	(0.16)	(0.13)	(0.14)	(0.14)	(0.14)	(0.08)	(0.11)	(0.11)	(0.12)	(0.12)	(0.09)	(0.08)	(0.09)	(0.09)	(0.09)

1.6.3. Impulse Responses:

In Figure 1.2, the impulse response functions of the core model are presented. The impulse response functions are obtained by the above-mentioned bootstrap procedure and the median responses and 10-90% confidence intervals of impulse

4 Standard errors are reported in parentheses under fractions of forecast errors estimated.

responses is presented in the figures. The magnitude of the shocks is one standard deviation and the responses are also presented with one standard deviation. In Figure 1.2, the responses of inflation and output to US interest rate shocks, responses of inflation and output to the real exchange shocks and the response of the real exchange rate to output and inflation shocks are presented.

A positive one standard deviation shock to the US interest rate initially increases which is followed by decreases in inflation and then cyclical behavior of inflation continues. The magnitude is statistically significant for the first period only. The effect of the US interest rate shock on output is negative but not statistically significant. These results may suggest that the Turkish economy is not integrated with the US economy for the period considered.

Next, the effects of the real exchange rate shocks on inflation and output are investigated. Inflation increases for the first quarter, then decreases, and deflation occurs after the 3rd quarter and the magnitude is statistically significant in the first two periods and in the fifth quarter but only at the margin. The effect of the real exchange rate on output is negative and permanent. However, the magnitude is significant only in the first three quarters. This is parallel with the findings of Kamin and Rogers (1999), which supports the contractionary devaluation hypothesis for Mexico.

It seems that one standard deviation shock to inflation appreciates the currency in real terms. One possible reason is that inflation increases the nominal exchange rate less than the change in prices due to the non-tradable component. In other words, a one-time shock to the general price level, due to a shock in the non-tradable component of the commodity basket, will have no direct effect on the prices of tradable goods, thus no adjustment in the exchange rate is needed and the price level increases when the nominal exchange rate stays at the same level and the real exchange rate appreciates. Moreover, a positive output shock depreciates the local currency in the first two periods.

After analyzing the responses of variables in the core model, the responses of variables to shocks of endogenous variables to check the robustness of the results that have been analyzed for the core model are presented.[5] When the responses of inflation to a positive US interest rate shock are examined, it is found that related findings in the core model are robust to alternative model settings. Parallel to the core model, a positive US interest rate shock raises the inflation, and then inflation declines and a cyclical pattern is observed in the subsequent periods in all of the alternative models considered. In the core model, the magnitude was statistically significant for the first period; observations in the first and second alternative models are also statistically significant.

[5] The impulse response functions of all the variables in the core model and alternative models are presented in the Appendix A.

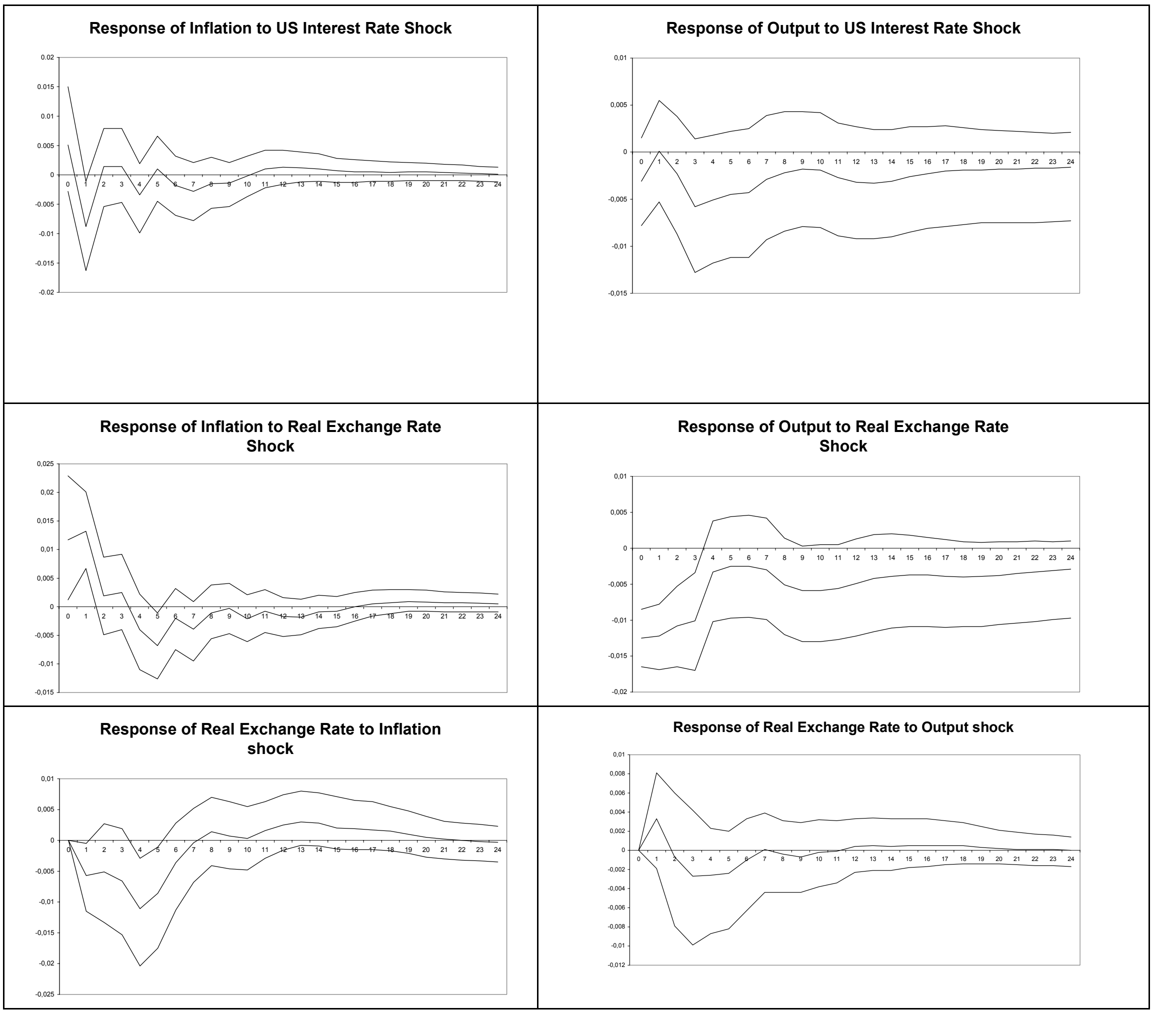


Figure 1.2: Impulse Responses of the Core Model

Similarly, a positive US interest shock initially decreases the output level; then the response of output displays an irregular pattern in all alternative settings. However, parallel to the core model findings, none of the observations is statistically significant. The findings concerning inflation and output in alternative settings support the idea that the Turkish economy in the sample period is not closely related to the US economy.

In line with the findings of the core model, a positive real exchange rate shock raises the inflation rate in all of the alternative models. The duration of the positive response of inflation varies between one to five periods among the models and a self-correcting mechanism is seen after the positive response. The magnitude of the response is statistically significant in the first period and insignificant in all other periods in the alternative settings.

The response of output to a real exchange rate shock was negative in the core model. A similar conclusion can be made when alternative models are considered. The response of output was negative for all periods in alternative models except in those that included the current account and the monetary aggregate M1. In those alternative models, there are periods when the response is positive; however, these periods constitute only a few fractions of the time horizon, the responses are positive after significant lags of the shock and they are not statistically significant. The negative response of output to a real exchange rate shock is significant in the first two periods for all the models examined including those with current account and M1. For the remaining models, observations of the 3rd quarter are also significant.

In the core model, it is found that a positive inflationary shock appreciates the real exchange rate. The alternative models, except the one that excludes the US interest rate, support this finding. An inflationary shock depreciates the real exchange rate only in the last alternative model. The duration of the negative response of the real exchange rate varies between 6 to 8-period in alternative models with US interest rate. Similar to responses in the core model, most of the observations are statistically insignificant.

Like the response examined in the core model, the response of the real exchange rate to a positive output shock is positive in the short run in the alternative models considered, except the one that incorporates the capital account with the US interest rate. The duration of the positive response varies between 1 and 4 period in other alternative models, and the response of the real exchange rate exhibits alternating pattern then. All but the 1st period response are statistically insignificant in the alternative models.

First Alternative Model (US Interest Rate, Government Size, Real Exchange Rate, Inflation, Output)

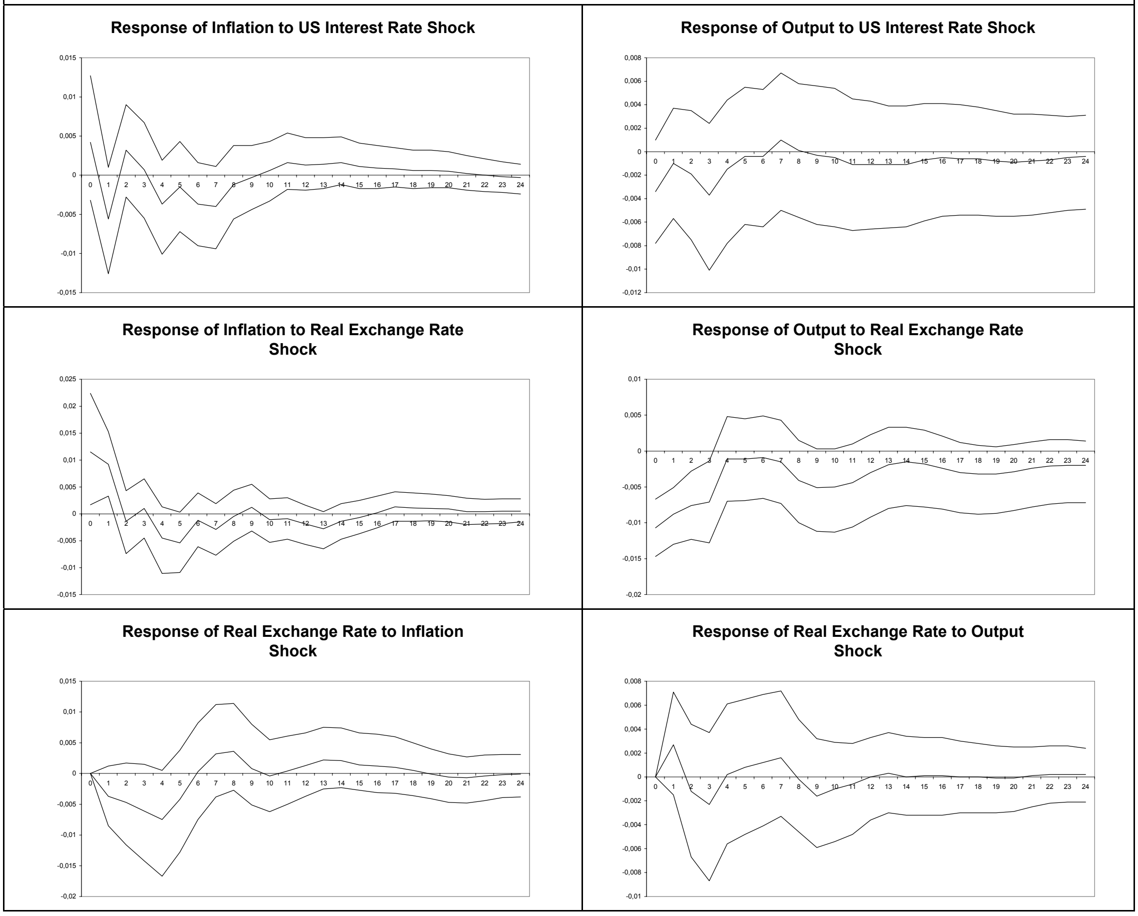
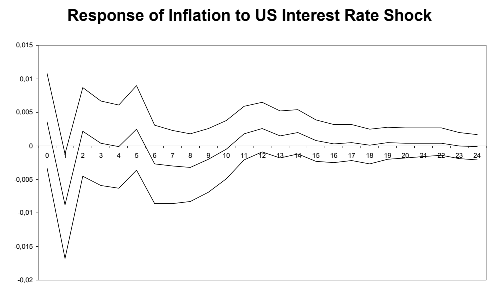
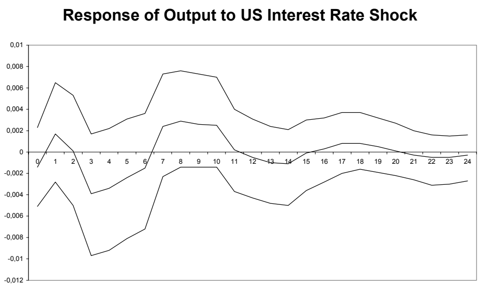
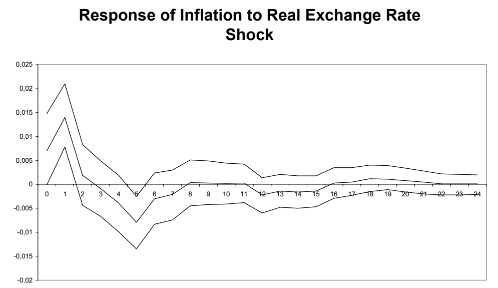


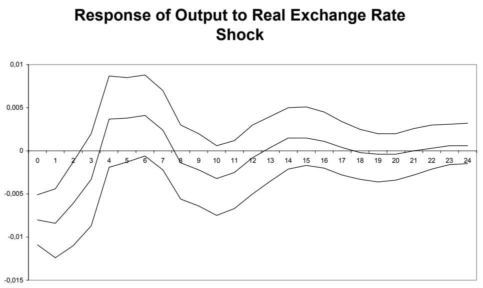
Figure 1.3: Impulse Responses of the First Alternative Model

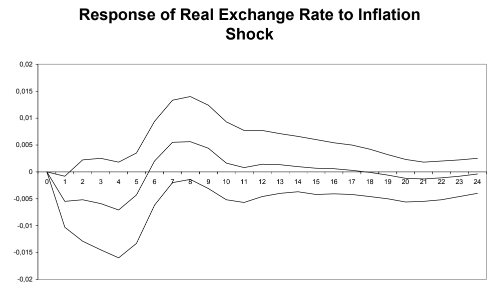
Second Alternative Model (US Interest Rate, Real Exchange Rate, M1 Monetary Aggregate, Inflation, Output)











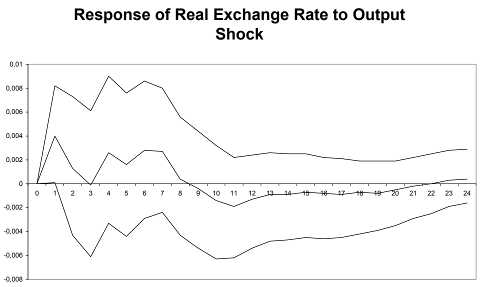
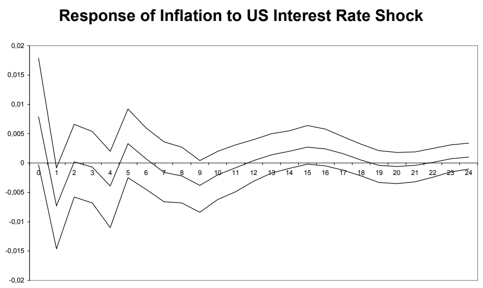
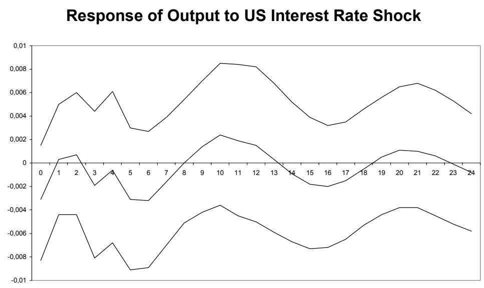
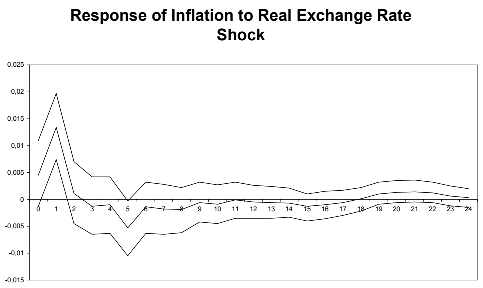


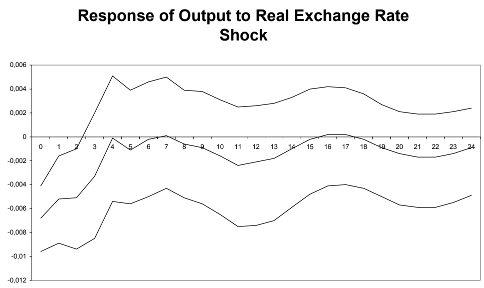
Figure 1.4: Impulse Responses of the Second Alternative Model

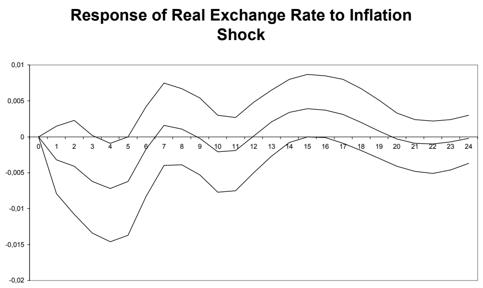
Third Alternative Model (US Interest Rate, Current Account, Real Exchange Rate, Inflation, Output)











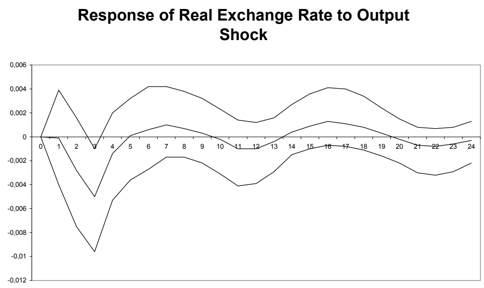
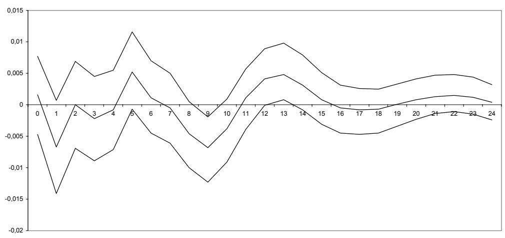


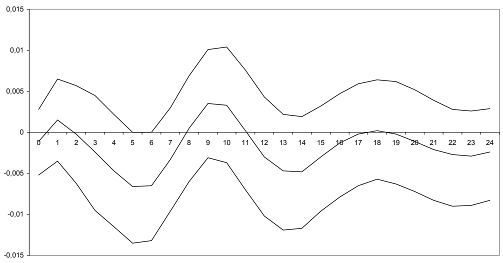
Figure 1.5: Impulse Responses of the Third Alternative Model

Fourth Alternative Model (US Interest Rate, Capital Account, Real Exchange Rate, Inflation, Output)

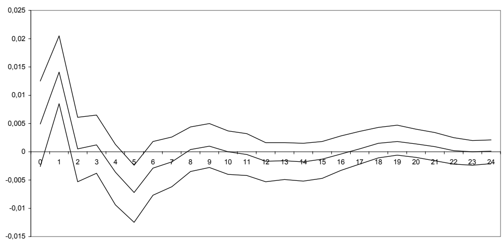
Response of Inflation to US Interest Rate Shock



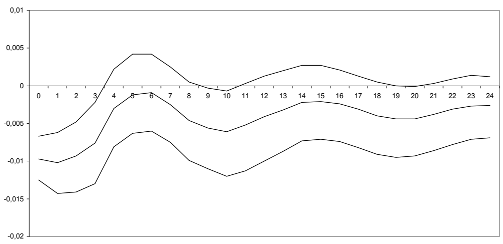
Response of Output to US Interest Rate Shock



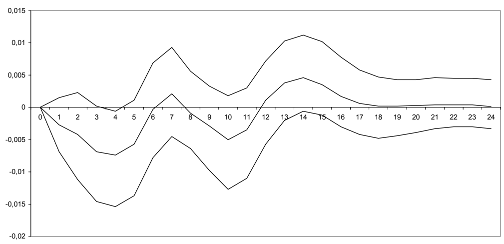
Response of Inflation to Real Exchange Rate Shock



Response of Output to Real Exchange Rate Shock



Response of Real Exchange Rate to Inflation Shock



Response of Real Exchange Rate to Output Shock

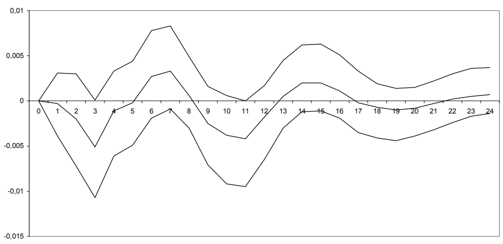
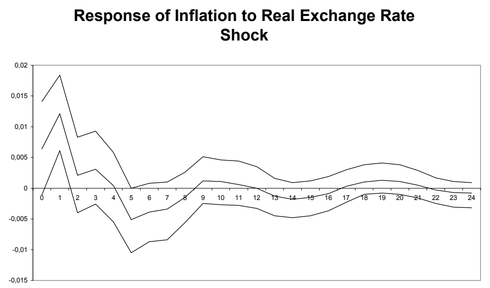
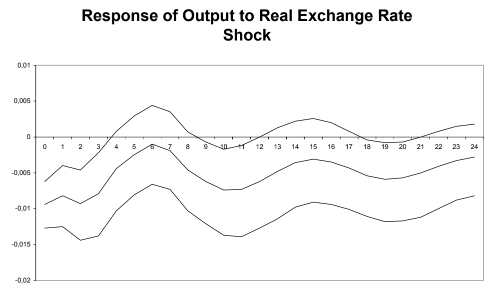
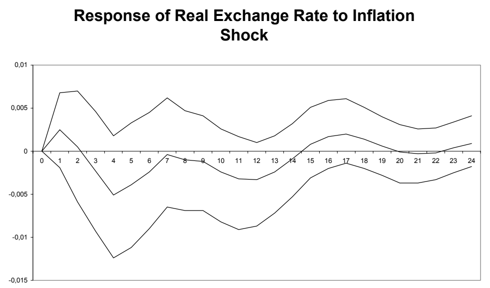


Figure 1.6: Impulse Responses of the Fourth Alternative Model

Fifth Alternative Model (Capital Account, Government Size, Real Exchange Rate, Inflation, Output)







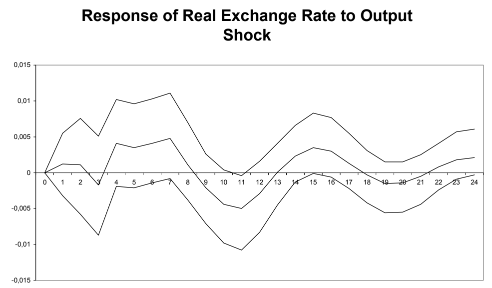


Figure 1.7: Impulse Responses of the Fifth Alternative Model

1.7. Conclusion

In this study, the negative relationship between the real exchange rate and output in Turkey is investigated empirically. First, the bivariate relationship between the real exchange rate and output is analyzed, then several VAR models are estimated and the forecast error variance decompositions and impulse responses obtained from the VAR models are examined.

In the bivariate analysis, for most of the transformations and lags, a negative correlation between output and the real exchange rate is found. However, from the Granger causality test a significant causality between the variables is not found possibly due to the inability of the Granger causality test to remove the effects of other related variables. However, after employing various VAR models for the sample period – including the variables of US interest rate, real exchange rate, government size, inflation, output, capital account and current account – it is found that real exchange rate movements are important to the level of output. The response of output is negative and permanent after devaluation. These findings also hold in most of the alternative settings, in which the possible effects of external variables are controlled. Moreover, a devaluation is inflationary. These findings are parallel to what Kamin and Rogers (2000) found for Mexico.

These findings suggest that to limit the detrimental effects of devaluation, an overvalued currency must be prevented and there is no easy way to keep output costs at moderate levels after devaluation. The findings of this study also suggest that an overvalued domestic currency may initially result in increased output but may create the risk of a financial crisis, which in turn may cause exchange rate depreciation and subsequent output losses.

CHAPTER 2:

Effects of Maturity on Economic Performance: Evidence from Turkey

2.1. Introduction

The treasury may borrow at various maturities by issuing government securities. Like all other assets, these securities have varying degrees of liquidity. When the treasury issues a long-term bond, ceteris paribus, this bond will have a lower degree of liquidity than that of short-term bonds. Thus, the treasury's debt management operations may have an important effect on liquidity level in the markets. In this respect, increasing the maturity of the debt stock will imply issuing government securities that are less like liquid money, and hence, will decrease the liquidity in the financial markets. This may mimic the effects of a tight monetary policy. This study will investigate whether changes in the maturity of the debt stock will have effects on the economic performance empirically and evaluate the monetary policy implications of the maturity decisions of the treasury. The empirical evidence gathered from Turkey for the period between 1986:5 and 2001:5 suggests that an increase in the maturity of the domestic debt stock will result in a permanent decline in the price level and exchange rate and a temporary decline in output and interest rate.

The analysis of the effects of maturity of the debt stock is important because if the change in maturity has considerable influence on economic performance and prices, this implies that policymakers have another policy tool, besides the conventional fiscal and monetary policy tools, in order to achieve price stability and economic growth. Furthermore, the effects of maturity may affect price level and central banks take into consideration such effects, especially in an inflation-targeting regime.

Debt management and its effects on economic performance have been studied extensively in the literature. Early studies assert that debt management has two objectives, minimizing interest cost and the stabilization of the economy in coordination with fiscal and monetary policies. However, some studies, such as Boothe and Reid (1992), argue that the only major objective of debt management is to minimize the interest costs in small open economies because yields for different maturities are exogenously given by the world financial markets. There are two main approaches used in studies examining the effects of the composition of the debt stock. The first one is the portfolio-balance approach, which proposes that the investors will adjust their portfolios in the case of a change in the supply of bonds with different maturities occurs. Hence, the government's decision on the maturity affects the yields of the stocks and bonds, if the short-term and long-term bonds are not perfect substitutes. Tobin (1963), a pioneer study in the portfolio approach states that the increase in the relative supply of long-term bonds, a close substitute for private assets, will increase the yields of the long-term bonds and private assets.

Wallace and Warner (1996) investigate whether the composition of debt stock has any effect on excess holding period returns and show that there is no significant relationship between changes in the average maturity of the federal debt and excess holding returns. In a portfolio balance model, by utilizing various different methods for the estimation of the covariance matrix between bonds and private assets, Agell and Persson (1992) show that increasing the supply of long-term bonds in exchange for short-term bonds raises the expected yields on equity and long-term bonds, but these effects are rather small in magnitude and vary significantly according to different econometric methods. Using a structural model, Friedman (1992) shows that the decrease in supply of long-term bonds in exchange for short-term bonds, leads to rises in economic activity and investment; and the duration of the shift in the composition of the debt stock leads to differences in the magnitudes of these effects.

The other approach used in the studies assessing the effects of debt composition is the time inconsistency approach in the optimal taxation. Lucas and Stokey (1983) show that if investors expect debt maturity to influence the government's decision on the interest rates, then the term structure of interest rates may depend on the maturity structure of the domestic debt stock. To analyze the role of debt maturity for the credibility of anti-inflationary policy, Calvo, Guidotti and Leidermann (1991) develop a model of the optimal maturity structure of nominal government debt under the assumptions of no full pre-commitment on inflation rate and incomplete markets where the first order conditions of the model describe the inflation, optimal maturity, level of debt, intertemporal tax and borrowing decisions. After estimating their specifications by Generalized Methods of Moments, they show that there was no significant difference between estimates and the realized values of the maturity.

The effect of the maturity of the debt stock on economic performance is assessed by using monthly data from Turkey for the period between 1986:5 and 2001:5. Turkey provides a unique laboratory environment for assessing this effect because Turkey has had high and volatile inflation since the mid-1970's without running into hyperinflation. Moreover, the Turkish Treasury has relied heavily on borrowing Turkish lira (TL) denominated assets rather than foreign exchange or inflation indexed assets in order to avoid foreign exchange and inflation risks in its borrowing strategy. These features play a magnifying role in assessing the effect of treasury operations on economic performance. To analyze the effects, Vector Autoregression (VAR) models that utilize the average maturity of the domestic debt stock, the industrial production, prices, nominal exchange rates, interest rate and monetary aggregates are formed.

The importance of this study is based on two aspects. First, this is the first study assessing the dynamic impact of maturity on economic performance using VAR models. Secondly, the Turkish case constitutes an interesting laboratory where high and persistent inflation without hyperinflation has been a characteristic of the economy, and domestic debt stock management has become an important policy concern in recent years. Policy actions like increasing primary surpluses and issuing domestic debt instruments rather than relying on the Central Bank of the Republic of Turkey's (CBRT) resources or external borrowing allow to observe the effect of maturity movements on economic performance because in most of the sample period domestic borrowing and domestic debt stock become a primary concern of the decision makers.

The paper is organized as follows: Section 2.2 introduces the data. The subsequent section discusses the theoretical model. Section 2.4 analyses the economic implications of a change in the average maturity of the domestic debt stock. Section 2.5 explains the models and the empirical results. Finally, Section 2.6 summarizes the findings and draws some policy implications.

2.2. Data

To analyze the effects of the maturity on economic performance, the maturity, output, price level, exchange rate, interest rate and monetary aggregate data are used. These data are readily available; however, the maturity data needs to be calculated because the readily available data do not consider the accrued interests. In a high inflationary environment like Turkey, computing the average maturity excluding the accrued interests on the government securities would be misleading because the liquidity effects of government securities would be undermined if the value of the debt stock considers its value on the auction date rather than its market value. The sample covers the period between 1986:5 and 2001:5. The starting of the sample period is the beginning period of the Interbank Money Market and the end of the sample period is the last period before the major domestic debt swap operation, which took place on July 15, 2001.

The maturity series is the average maturity of the TL denominated discounted bonds considering the accrued interests on these securities. The industrial production index is employed as the output measure. The Wholesale Price Index (WPI) is used for the price level. WPI is relevant because in a significant part of the sample period, the CBRT aimed to stabilize the real exchange rate, and the price level relevant for real exchange rate considerations is the WPI. The nominal exchange rate is defined as 1 US dollar plus 1.5 Deutsche Mark. The interest rate used in this study is the interbank O/N interest rate. The M1 monetary aggregate plus the repo (M1R) is used for monetary aggregates. M1 is used because the high and persistent inflation caused the public to prefer to hold highly liquid assets during the sample period. The repo item is included in the monetary aggregate data because of two reasons. The first is that most of the repo volume is O/N during the sample period; hence the repo item is liquid. Second, agents prefer to repo their savings because repo is highly liquid and the rates offered were more attractive than demand deposits in most of the sample period. The repo-M1 ratio was around 70 percent at the end of the sample period. Hence, the change in the interest would affect the repo rate more than the rates of the components of M1. All data, excluding the average maturity series are accessible from the data delivery system of the CBRT (http://www.tcmbf40.tcmb.gov.tr/cbt.html).

The maturity of the debt stock considering the accrued interests is not readily available data. The maturity of the nominal debt stock is computed considering the information of the auctions for Turkish lira denominated securities held since May 1985, which may be found in the website of the CBRT. The auction data includes information about the bonds and bills issued in the auctions: such as the date of the auction, the maturity of the bond or the bill issued, the total sale of the auction, the nominal value of the bill or the bond issued (the present value of the discounted bonds at the auction date), extra sales for the public institutions and the average interest rates. The sales for the public institutions are excluded. Moreover, the indexed bonds are not included. The inflation indexed bonds and foreign exchange (FX)-indexed or denominated bonds are excluded because these securities have relatively very small trading volumes in the secondary markets and indexed bonds and bonds sold to public institutions do not represent any liquidity measure of the market. The average maturity of the debt stock is computed considering their accrued interests to approximate to their market value. The data is computed in three steps as follows:

a. The auction date, the total income (i.e. the income generated by the issue of the bond), the maturity of the bond and the average simple interest rate for each auction excluding those for the indexed bonds and those cancelled by the Treasury are gathered.
b. The market value of each different bonds and bills at the end of each month during their maturation is computed considering the accrued interest and the maturity left to their redemption in monthly terms.
c. The maturities of each different bond are averaged considering their shares in the total debt stock computed with the accrued interests for each month.

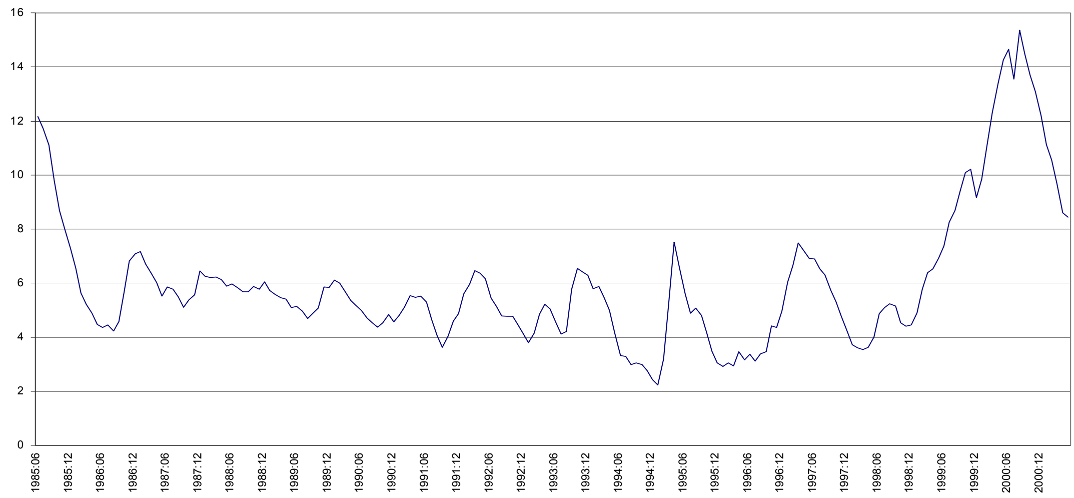


Figure 2.1: Average Maturity of the Domestic Debt Stock (in terms of months)

With this method, the maturity of debt stock is computed in monthly terms (Figure 2.1). The maturity data may suffer on three important points: First, the inflation-indexed bonds is excluded; these bonds may be counted as zero maturity (see, Blanchard and Missale, 1992) and these bonds are not well received by the Turkish financial markets for trading. However, if they are not ignored, they may lead to greater complexity as the valuation of the debt stock in the markets should then consider the expected inflation rate. Second, the FX-denominated or FX-indexed bonds is excluded. Inclusion of these bonds may also lead to complexity and the denomination of the debt stock is beyond the purpose of this study. Furthermore, the trading volume of these bonds in the secondary markets is very limited because the inflation-indexed and FX-denominated or FX-indexed bonds have been largely issued for the publicly owned banks. The last point is the exclusion of the debt stock held by the public institutions and the CBRT. This point is worth noting for at least three reasons. First, as stated in earlier studies (Tobin, 1963), the relevant debt stock is the one that shows the net liability position of the government. Second, the public institutions did not create any challenge to the government's economic policy implementation and the Turkish Treasury's borrowing strategy. Third, the stance of debt management in relation to its liquidity effect is closely related to its relationship to the private sector. As the great tension in the period following the crisis in 2001 showed, the sustainability in debt stock is based on the relationship between the markets and on government rather than on intra-governmental activities like the liability position of the treasury to central bank, public banks or public institutions.

In addition to these points, a fair objection may be raised for the approximation of the total debt stock by the accrued interests, computed by the initial auction interest rates. This may lead to important errors if the maturity is very long and the variation in the interest rates is high. The second issue is relevant in Turkey, but one cannot claim that the maturity structure of the domestic debt stock is long since the average maturity is six months for the sample period this study uses. In fact, the approximation has its own worth, whenever the interest rate data for the secondary market is lacking for a significant period of the sample. In addition, computing the accrued interests by the initial auction interest rates will have two advantages. The first is that the initial auction interest rates are exogenously given. Secondly, debt stock computed by this method shows the net liability of the government to the market at the maturity date; hence, it is the relevant debt stock that the government considers.

2.3. The Theoretical Model

Suppose the economy is represented by a structural model of

$$NP_t = B_0 NP_t + B_1 NP_t + C_0 P_t + C_1 P_{t-1} + \varepsilon_{np,t} \tag{1}$$

$$P_t = D_0 NP_t + D_1 NP_t + E_1 P_{t-1} + \varepsilon_{p,t} \tag{2}$$

where NP_t is the vector of the non-policy economic variables that the Treasury does not set, (including output, price level, exchange rate, interest rate and monetary aggregate in this study) and P_t is the policy variable, the average maturity of the domestic debt stock that the Treasury determines. $\varepsilon_{np,t}$ and $\varepsilon_{p,t}$ are orthogonal disturbance terms.

The system defined by Equations (1) and (2) is not identified. It is assumed that the policy variable, maturity, is not affected by contemporaneous movements of non-policy variables; hence this restriction implies D_0 is equal to zero and this restriction helps to identify the system.

In this structural system, the policy variable, maturity, may be thought as a function of non-policy variables and a disturbance term. Thus:

$$P_t = f(\Omega_t) + \varepsilon_{p,t} \tag{3}$$

where Ω_t includes all the non-policy variables at time t. The pure policy shock is the disturbance term of $\varepsilon_{p,t}$.

One may estimate the system defined by Equations (1), (2) and (3) by a k^{th} order vector autoregressive model:

$$Y_t = A_0 + A_1 Y_{t-1} + ... + A_k Y_{t-k} + u_t \tag{4}$$

where Y_t is the vector including both the policy variable and the non-policy economic variables and the policy variable is in the first row of the vector, Y_t. Hence, Ω_t includes all of the rows of Y_t except the first row, u_t is the residual term, which is assumed to be serially uncorrelated. The covariance matrix of u_t is V. It is assumed that the u_t is related to underlying economic shocks $\varepsilon_{p,t}$ and $\varepsilon_{np,t}$ by,

$$u_t = B\varepsilon_t \quad \text{where } \varepsilon_t = \begin{bmatrix} \varepsilon_{p,t} \\ \varepsilon_{np,t} \end{bmatrix} \tag{5}$$

ε_t is an sx1 vector that consists of orthogonalized residuals for s variables where $\varepsilon_{p,t}$ constitutes the first row. The covariance matrix of ε_t is diagonal. B is assumed to be a lower triangular matrix. The ordinary least squares method is used to estimate the coefficient matrices in Equation (4). The B matrix can be obtained by the identity $V = B'B$. Then, the impulse response functions and the forecast error variance decompositions can be computed by estimating Equations (4) and (5).

In the empirical analysis, the VAR analysis is employed in order to explore the effect of the maturity of the domestic debt stock on economic performance. The first core VAR model is a six variable VAR model with two lags. The variables are maturity, output, price level, exchange rate, interest rate and the monetary aggregates. All the variables except the average maturity and the interest rate enter the analysis in logarithms. In the second model, spread variable instead of interest rate variable is used. The logarithm of the maturity is also used but the findings remain robust to this transformation. The lag order of the VAR models is two as selected by the Akaike Information Criterion. Eleven monthly dummies are also used in order to capture the seasonality. In addition, there are two crisis dummies for 1994:4 and 2001:2. Lastly, two dummies are used in the system for the M1R series. The repo series has been available since 1995:12 and a dummy variable, which takes one in the period before 1995:12 is used. In addition, there are two different M1 series, the first series starts from 1985:12 and ends in 1989:12. The second series is the one currently announced to the public. Hence, another dummy variable, which takes one in the period between 1986:5 and 1989:12 is included. The average maturity is included as a policy tool of the Treasury.

The industrial production index is used for the output measure and the WPI as the price measure is used in order to assess the effects of the average maturity of the domestic debt stock on economic performance. The exchange rate and the Interbank interest rate are the policy tools that the CBRT used during the sample period. Hence, these variables are included to control the policy setting of the CBRT, in the analysis[1]. Lastly, M1R is used as the monetary aggregate. The order of the variables

[1] The primary objective of the CBRT during most of the sample period was to achieve stability in financial markets due to lack of political support for disinflation efforts. To this end, the CBRT announced its quotations of the exchange rate daily until February 22, 2001 and except for the crisis period of 1994 market, exchange rates did not deviate from these quotations significantly. The exchange rate during most of the period was determined with respect to monthly inflation expectations and daily depreciation of the exchange rate stayed at the same level within a month. In addition to these policy decisions in exchange rate policy, the CBRT closely followed the TL markets and started to set daily ask and bid quotations in the O/N Interbank interest rate on November 4, 1996 until 2000 in addition to its repo auctions and repo, reverse-repo transactions on the Istanbul Stock Exchange (ISE) within open market operations. The average interest rate in the Interbank Money Market stayed close to the bid quotation of the CBRT in most of the period until 2000 and the interest rates of the other mentioned transactions were close to the average interbank O/N interest rate. Hence, the policy tools of the CBRT during the sample period were the nominal exchange rate and the interbank interest rate.

in the VAR setting is also of considerable importance because the order determines the contemporaneous effects of the variables on other variables. The particular order in the first core VAR setting is maturity, output, price, exchange, interest and M1R. This order implies that the first variable, maturity, affects the remaining five variables contemporaneously but is affected by none of them contemporaneously. The order of the maturity is in line with the assumption that when the policymakers set the maturity of the domestic debt stock in a period, they do not know the exact developments concerning output and price level; hence, price level and output do not contemporaneously affect maturity. This order implies that maturity responds to the lagged values of the all variables considered; however, the disturbance term of maturity, which also affects maturity, is not affected by any contemporaneously available variable in the system. Hence, this particular order enables to identify a policy shock, which is captured by the disturbance term of maturity. Output affects price level, exchange rate, interest rate and M1R contemporaneously and is affected by none of the variables, except maturity. The core model assumes that exchange rate developments affect the interest rate contemporaneously but are not affected by contemporaneous interest rate. This is in line with the practice of the CBRT during most of the sample period. The CBRT announced the daily quotation for the exchange rate in the morning by imposing a daily constant depreciation rate within the month before the financial markets were open (see, Berument 2001).

In this VAR setting it is assumed that monetary policy shocks affect the variables only with lag, but the monetary aggregate, M1R, is an exception, which is expected to be affected by the policy shock contemporaneously. Hence, M1R is the last variable in the VAR setting. This ordering incorporates the extreme information assumption that the monetary authority knows the exact levels of the current state of output developments and prices. One way to avoid such a problem is to use quarterly data; however, some studies show that the inference they gather in quarterly data is also valid in monthly data (for example, see, Agell and Persson, 1992)[2] .

2.4. Economic Implications of an Increase in the Average Maturity

The debt stock will become less liquid in the case of an increase in the maturity. This will be in effect because an increase in maturity means that market agents will keep their wealth in less liquid assets for an increased period in return for the extra yield that domestic debt instruments offer. In this respect, an increase in maturity may mimic a tight monetary policy.

In the literature, the effects of a monetary tightening are extensively investigated, theoretically and empirically (Christiano, Eichenbaum and Evans, 1999 and the references cited therein). Theoretically, a monetary contraction will result in an increased level of interest rates, as the price of money will increase in the event of a decreased supply. In addition, monetary aggregates will fall as a response to a monetary contraction. However, the output level would not increase. If money is non-neutral in the short-run, it is expected that output will give a negative response if a monetary tightening occurs. The theory suggests that the price level will decline in the case of a tightening in monetary policy stance. The effect of the monetary

[2] Agell and Persson (1992) show that the effects of a maturity change on relative assets do not change but the magnitudes of these effects vary between the monthly and quarterly models in estimating the covariance matrix of the short-, long-term bonds and private assets.

tightening will lead to an appreciation in the domestic currency given the inflation expectations. On the other hand, if the monetary policy tightening is due to an increase in the expected inflation, the effect on the exchange rates might be a depreciation of the domestic currency because the exchange rate is a forward-looking asset price that considers the real interest rate differentials. Hence, a tightening in monetary policy may lead to a depreciation of the domestic currency due to the fact that the increase in the nominal interest rate is less than the increase in the inflation expectations.

In this respect, it is expected that an increase in the average maturity of the domestic debt stock, leading to a decline in the liquidity of the market, will result in a decline in monetary aggregates and price level, an appreciation of the domestic currency and a decline in the output if the monetary policy is non-neutral in the short-run.

2.5. Empirical Evidence

In this section, the impulse response functions and the forecast error variance decompositions of the core and alternative models are discussed. The impulse response functions show the effect of a variable to a shock on another variable, whereas the forecast error variance decompositions show the fractions of the forecast error variances of the variables attributed to their own innovations or the innovations of the other variables. Hence, the forecast error variances of the variables will give information about shocks of which variables have explanatory power to forecast other variables. After obtaining the estimates, the coefficients and the residual terms are used in order to obtain the impulse response functions and the forecast error variance decomposition. In order to obtain the standard errors for the impulse response functions and the forecast error variance decomposition, the bootstrap procedure is used. The number of draws in the bootstrap procedure is 500 and the number of steps in the impulse response functions, the forecast horizon, is 24.

2.5.1 Impulse Response Functions

The first core model in the empirical analysis is the VAR model with two lags with the particular order of maturity, output, price level, exchange rate, interest rate and M1R with the exogenous terms of the dummy variables as stated above. Figure 2.2 shows the impulse response functions of the variables to a positive one standard deviation shock to maturity. The middle line shows the impulse response of a variable, whereas the outer lines show the confidence intervals at the 10% level of significance. When the impulse response functions are analyzed, it is observed that the response of the price level to a positive one standard error shock to maturity is negative and the currency appreciates throughout the 24-month period. The response of output to a maturity shock displayed a volatile trend and is positive in some periods but negative in others. The response of interest rate is negative in all periods. The monetary aggregate, M1R, displays a positive response for a positive shock to maturity for 10 months; the response becomes negative after that.

When the response of output for a positive shock to maturity is analyzed, it is seen that the response of output to a maturity shock is statistically insignificant in all periods. The response is initially positive but it displays a negative response starting from the 1st period. However, output starts to display a positive response after the 7th period and then after 16th period, it is negative again. As the forecast period increases, the response of output converges to zero. The insignificance of the results and the convergence of output to zero indicate the long-run neutrality of maturity increase on output. Historically, maturity increases tend to be associated with positive developments in output; however, as impulse response functions show, in most of the forecast period, negative output responses for most of the forecast period are seen after a positive maturity shock, which is in line with the economic theory suggestions. This suggests that the order of the core model captures the solution of this identification problem.

The response of price level is in line with the economic theory suggestions in the sense that a positive shock to maturity results in a negative and permanent decline in price level. The response increases in absolute terms and converges to a negative value at the end of the period. The response of price level to a positive shock to maturity is statistically significant between the 2nd and 13th periods. This finding shows that a maturity increase implies a decline in price level. A positive shock to maturity appreciates the currency in all periods. The response of exchange rate increases in absolute terms until the 17th period, and then converges. The response of exchange rate is statistically insignificant for all periods; however, the negative response of exchange rate suggests that a maturity increase leads to a permanent appreciation of the domestic currency.

When the response of O/N interest rate to a maturity shock is examined, it is seen that the response of interest rate is negative throughout the period. The response is largest initially and then declines in absolute terms until the 3rd period. After that, the response starts to increase and continues a cyclical movement until it converges to zero at the end of the period. The negative response of interest rate may be due to the fact that when the effects of the Treasury's increasing maturity affect the liquidity in the market negatively, by using its policy tool (the interest rates) the CBRT provides liquidity to the market via interbank operations in order to balance the market liquidity. The response of interest rate is significant only in the initial period.

The response of M1R is positive in the first ten periods and negative in the remaining periods. The response is at its peak in the third period and then starts to decline throughout the later periods. The negative response of M1R is the largest in absolute terms in the 24th period, which suggests that the increase in maturity leads to a permanent decline in M1R, which is in line with the theoretical suggestions. However, the responses of M1R are significant only in the first two periods.

Using the interbank O/N interest rate as an indicator of monetary policy stance leads to abnormalities like liquidity, exchange rate and price puzzles (see Berument 2001). The liquidity puzzle is rising, rather than decreasing interest rates after a positive innovation in monetary aggregates. The exchange rate puzzle is the positive correlation between interest rates and exchange rates. Finally, the price puzzle emerges when positive interest rate innovations, which represent tight monetary policy, are associated with increases in prices. Taking into consideration the use of exchange rate as a policy tool by the CBRT during most of the sample period, in the second core model, the spread variable, which is the spread between the interbank interest rate and the monthly depreciation rate of TL is used instead of the interest rate as suggested by Berument (2001)[3].

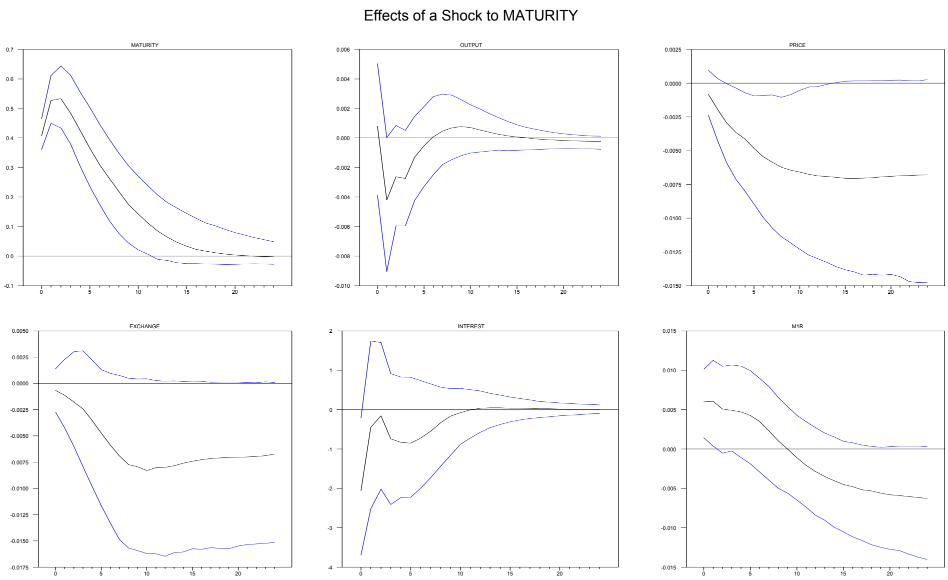


Figure 2.2: Impulse Responses to a Maturity Shock in the First Core Model

The responses of the variables to a maturity shock in the model using spread are parallel to those of the model using interbank interest rate. The impulse responses of the variables and associated confidence intervals to a positive one standard error

[3] Berument (2001) shows that using the *spread* variable as an indicator of the monetary policy eliminates the above mentioned puzzles. In his analysis, by using the *spread* variable, he shows a tight monetary policy is associated with a decrease in income and prices and the appreciation of the domestic currency.

shock to maturity in the model using spread are reported in Figure 2.3. After a maturity shock, price level declines permanently and the currency appreciates. Output response initially shows an increase followed by a decline for seven periods. Like interbank interest rate in the first core model, spread showed a negative response which converges to zero at the end of the forecast period. M1R first increases for ten periods and the response turns negative after that.

The response of output is negative between the 1st and 7th periods; during the 9th through the 17th periods, it is again positive; and the response converges to zero at the end of the forecast horizon. This shows the long-run neutrality of a maturity increase on economic performance. However, the results are significant only in the first period at the margin.

It can be observed from the impulse response function of the price level to a maturity shock that a maturity shock clearly decreases price level. The response increases in absolute terms until the end of the 24th period, where it starts to converge to a negative value. The response is significant between the 3rd and 13th months. It can be seen that a maturity shock appreciates the currency; the response is largest in the 17th period and the response started to converge to a negative value at the end of the forecast horizon. However, the findings are insignificant in all forecast periods.

Like the response of interest rate in the first model, the response of spread is negative throughout the forecast period. However, the responses are statistically insignificant throughout the forecast horizon. Parallel to the first core model, the response of M1R to a positive maturity shock shows a declining trend throughout the forecast period and converges to a negative value at the end of the forecast period. The response is positive during the first ten periods and starting from the 11th period, it starts to be negative. The response of M1R is significant in the first two periods.

Output response to a maturity shock is volatile with a positive response in some periods and a negative response in other periods and converges to zero at the end of the forecast horizon. However, the findings regarding price level and exchange rate support the findings drawn from the first model and show that maturity increase mimics a tight monetary policy stance with respect to its effects on price level and exchange rate. In addition, the variable representing the monetary policy stance, spread, also shows a temporary decline after a positive maturity shock like interest rate. These may be due to the measures taken by the CBRT in order to balance market liquidity during the sample period.

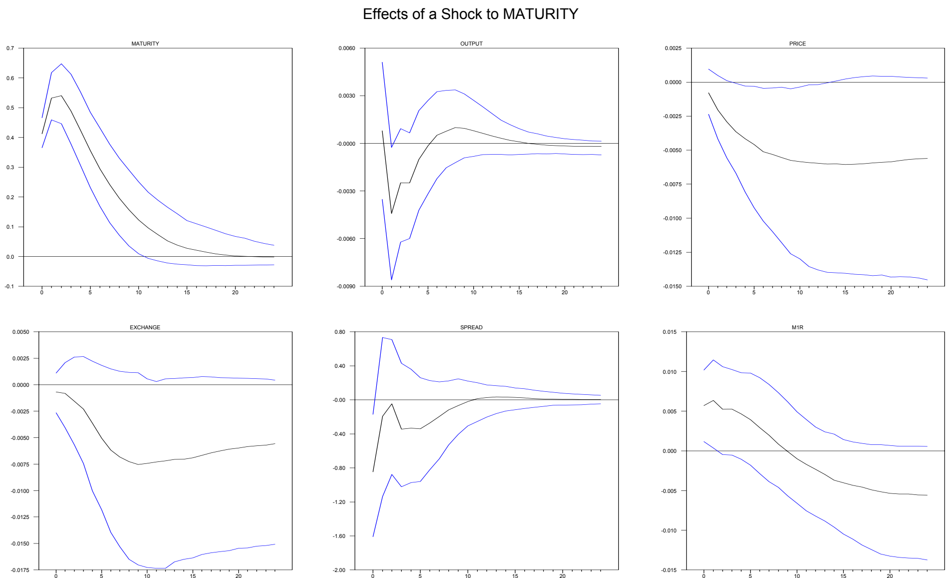


Figure 2.3: Impulse Responses to a Maturity Shock in the Second Core Model

In the two models above, (Figure 2.2 and 2.3), it is assumes that the policy variable, maturity, is not affected by the contemporaneous movements in any other variables. However, the two core models may not capture the essentials of the interrelations among these variables. In order to analyze whether the findings of the two models considered are valid under different specifications regarding the interrelations among the variables, different specifications are estimated and the impulse response functions of these models are analyzed.

In the core models, it is assumed that maturity is the policy variable and it is not affected by any other variables contemporaneously. However, the movements in maturity may be a response to the general market sentiment or a response to the capital inflows in Turkey. Hence, in the first alternative model, to capture the general market sentiment, the ISE 100 index is used as an information variable and the order of this variable is just before the policy variable, maturity. In the second alternative model, reserves which is the gross foreign exchange reserves of the CBRT and the banking sector to control the capital inflow movements is used in the VAR model with the particular order starting with reserves before maturity. The third alternative specification utilizes the particular order of output, price level, maturity, exchange rate, interest rate and M1R. This is done to analyze the effects of maturity in the event that the maturity is affected by the economic performance contemporaneously.

Three other alternative specifications, the fourth, the fifth and the sixth alternative models, use the variable, fiscal. This variable is used for assessing the stance of the fiscal authority. In the sample period, the Treasury had given importance to the sustainability of the debt stock as well as to the interest costs. The stance of the fiscal authority may also be characterized by budgetary aggregates, such as expenditures in the consolidated budget or the public sector borrowing requirement (PSBR). However, there are important problems related to the latter two aggregates. The consolidated budget covers only 60-80 percent of the total expenditures by the public sector. There are budgets other than the consolidated budget in Turkey; for example, State Economic Enterprises and municipalities budgets. On the other hand, there are at least two standing reasons for not using the PSBR. The first is that the PSBR data is available only in annual terms. The second, and more important reason, is that the PSBR does not reflect the actual borrowing requirement of the government as the government used the sources of public banks in form of duty losses. Hence, another variable should be used to assess the stance of the fiscal policy. In the analysis, fiscal, the extra monthly return of the auction interest rates over the short-term assets, the O/N interbank interest rate as suggested by Berument (2002) is used.

In the fourth and the fifth alternative models, the fiscal variable is ordered just before interest rate with the implicit assumption that the auction interest rate affects interbank interest rate contemporaneously but the auction interest rate is not affected by interbank interest rate within the period. The order of the fourth alternative specification is maturity, output, price level, exchange rate, fiscal, interest rate and M1R. The fifth specification uses maturity after output and price level, i.e., the order is output, price level, maturity, exchange rate, fiscal, interest rate and M1R. Another approach to the ordering may be based on the assumption that fiscal may affect maturity contemporaneously. However, it should be noted that maturity is the average maturity series, which also includes the debt instruments issued and not matured up to that period. Hence, even if the contemporaneous auction interest rate affects the maturity of the debt instruments issued in that period, the effect of the auction interest rate on the average maturity of the debt stock would be minor. However, this assumption is tried in the sixth alternative model, where the particular order assumes fiscal variable before maturity variable and fiscal is ordered after output and price level. Hence, the order of this specification is output, price level, fiscal, maturity, exchange rate, interest rate and M1R.

Apart from all the above models, the specification of the core model with different lag orders is tried in order to cover the uncertainty related to the lag order of a VAR setting. Lastly, the first core model specification is used with the logarithm of the maturity variable.

When the impulse response functions of the variables to a maturity shock are examined, it is seen that the findings of the core models are robust to the alternative specifications[4]. The positive shock to maturity will decrease price level permanently and appreciates the currency in all the periods considered. On the other hand, in the alternative models where maturity is ordered before output, output displays a volatile trend with positive response initially, which turns negative in the subsequent periods. In the models, with the order of output before maturity, the response is negative for all periods. However, in all of the specifications, the response of output converges to

[4] The impulse response functions of the alternative models are not reported here but are presented in Appendix A.

zero, as expected. The interest rate clearly declines throughout the whole period in response to a positive maturity shock. The M1R increases in the first 10 - 15 periods depending on the specification, then turns negative in the rest of the periods.

Considering the results of the core models and the alternative specifications, the results show that an increase in maturity leads to a permanent decline in price level and appreciates the currency. The output response is zero at the end of the 24-month period and is statistically insignificant in all the models considered, which shows the long-run neutrality of output to an increase in maturity. All these show that an increase in maturity mimics the characteristics of a monetary tightening. However, interest rate declines after a positive maturity shock, which indicates that the CBRT takes measures in order to balance the liquidity of the market after a maturity increase and hence provides liquidity to the market. The injection of liquidity also has considerable impacts on M1R, which increases in the first ten periods after a positive maturity shock.

2.5.2 Forecast Error Variance Decompositions

The forecast error variance decompositions for maturity, output and price level in the core model using interest rate for the 6^{th}, 12^{th}, 18^{th} and 24^{th} periods are reported in Table 2.1. When the forecast error variance decompositions of maturity, output and price level are examined, it is seen that most of the variations of the forecast error of these variables are attributed to the innovations of themselves. 74 - 83 percent of the forecast error variance of the maturity is attributed to its own innovations. The forecast error variance of maturity attributed to its own innovations is statistically significant. This supports the proposition that maturity can be taken as a policy variable for the Treasury. Innovations of output, which constituted 11 - 16 percent of the forecast error variance of maturity is the second important factor and the findings for output innovations are statistically significant at the 10 percent level. The innovations of exchange rate explain 3 - 5 percent of the forecast error variance of maturity; however, the findings are statistically insignificant. The forecast error variance of maturity attributed to interest rate innovations is significant in the 18^{th} and 24^{th} periods; however, they do not explain more than 3 percent of the forecast error variance of maturity. The innovations of the other variables account for a negligible part of the forecast error variance of maturity. These results show that other than output, no other variable seems to explain the movements in maturity.

When the forecast error variance decomposition of output is examined, it is observed that 82 percent of the forecast error variance of output is explained by the innovations to itself. It seems that the innovations of maturity, price level, exchange rate and interest rate explain some portion of the forecast error variance of output; however, the magnitudes are negligible for all of the variables. The innovations of exchange rate and interest rate seem to be the second most important source of the forecast error variance of output. They each explain 7 percent of the forecast error variance of output. The innovations of maturity and M1R explain only 2 percent of the forecast error variance of output and price level could explain only 1 - 2 percent of the forecast error variance of output.

When the forecast variance decomposition of price level is analyzed, it is seen that own innovations of price level account for most of the forecast error variance of price level; 40 - 67 percent of the forecast error variance is attributed to these innovations. However, output innovations seem to explain some portion of the forecast error variance of price level. 13 - 25 percent of the forecast error variance of price level is explained by these innovations. In addition to these two important sources of the forecast error variance of price level, the innovations of exchange rate and maturity seem to play an important role. 12 - 17 percent of the forecast error variance of price level is attributed to the former innovations whereas the latter innovations account for the 6 - 14 percent of the forecast error variance of price level. However, the fractions for maturity innovations are not statistically significant for any of the periods, whereas the exchange rate innovations are significant in the 6^{th} and 12^{th} periods. These results show that maturity affects the forecast error of price level more than interest rate and M1R does and the movements in maturity are important in explaining the forecast error variance of price level. The forecast error variance fractions of price level innovations are significant in all periods at the 1 percent level, whereas those of output are significant in all periods at the 10 percent level.

Table 2.2 reports the forecast error variance decomposition of the maturity, output and price level for the core model using spread for the 6th, 12th, 18th and 24th periods. In line with the findings of the model using interest rate, the forecast error variance decompositions of the model using spread show that the major factors in the forecast error variance of maturity, output and price level are their own innovations. 74 - 83 percent of the forecast error variance of maturity is attributed to its own innovations. The innovations of output explain 82 percent of the forecast error variance of output, whereas, 40 - 67 percent of the forecast error variance of price level is attributed to its own innovations. These findings are statistically significant.

Table 2.1: Forecast Error Variance Decompositions of the Maturity, Output and Price Level in the First Core Model[5]

	Periods	Maturity	Output	Price Level	Exchange Rate	Interest Rate	M1R
Maturity	6	83.377***	10.782*	0.089	2.504	3.106	0.142***
		(6.293)	(1.773)	(0.010)	(1.468)	(1.555)	(7.903)
	12	76.726***	15.485*	0.397***	4.267	2.925	0.201***
		(4.755)	(1.675)	(3.061)	(1.475)	(1.637)	(85.760)
	18	74.512***	16.363	0.821**	5.188	2.905*	0.210
		(4.607)	(1.641)	(2.551)	(1.483)	(1.669)	(0.010)
	24	73.776***	16.474	1.148**	5.489	2.898*	0.215
		(4.621)	(1.639)	(2.466)	(1.485)	(1.669)	(0.010)
Output	6	1.780*	82.179***	1.245**	6.504**	6.645**	1.646*
		(1.957)	(7.276)	(1.965)	(2.013)	(2.057)	(1.700)
	12	1.795**	82.003***	1.294**	6.506**	6.635**	1.769*
		(2.222)	(6.753)	(2.121)	(2.229)	(2.065)	(1.726)
	18	1.796**	81.897***	1.402**	6.509**	6.628**	1.769*
		(2.247)	(6.662)	(2.173)	(2.367)	(2.067)	(1.736)
	24	1.806**	81.772***	1.514**	6.521**	6.621**	1.766*
		(2.278)	(6.678)	(2.280)	(2.377)	(2.071)	(1.755)
Price Level	6	4.734	12.747*	67.276***	11.937**	3.289	0.017
		(1.456)	(1.836)	(4.781)	(2.036)	(1.465)	(0.010)
	12	9.425	19.657*	52.682***	14.501*	3.727	0.008
		(1.397)	(1.785)	(3.843)	(1.690)	(1.491)	(0.010)
	18	12.484	22.937*	44.797***	15.867	3.910	0.005
		(1.384)	(1.766)	(3.525)	(1.578)	(1.489)	(0.010)
	24	14.369	24.793*	39.937***	16.862	4.035	0.004
		(1.371)	(1.733)	(3.353)	(1.512)	(1.484)	(0.010)

5
*   : significant at the 10% level.
**   : significant at the 5% level.
*** : significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

Innovations in output seem to be important in the forecast error variance of maturity in addition to its own innovations. 11 - 17 percent of the forecast error variance of maturity is explained by output innovations and this finding is significant at the 10 percent level of significance. Exchange rate innovations seem to be the third contributing factor of the forecast error variance of maturity; however, they do not account for more than 6 percent of the forecast error of maturity and they are statistically insignificant. Innovations in other variables do not explain more than 3 percent of the forecast error variance of maturity and the findings concerning these innovations are statistically insignificant.

The innovations of exchange rate and spread seem to be two important sources of the forecast error variance of output; however, they do not explain more than 7 percent of the forecast error variance of output. These findings are statistically significant at the 10 percent level.

Like the model using interest rates, the innovations of output, exchange rate and maturity are important factors contributing to the forecast error variance of price level. Respectively, they explain 13 - 25, 12 - 17 and 5 - 14 percent of the forecast error variance of price level. However, only the results for output innovations attributed to the forecast error variance of price level are statistically significant. These results show that movements in maturity have a more important effect on price level than spread and M1R do.

When the forecast variance decompositions of the alternative specifications, which are explained in the subsection where the impulse response functions were discussed, are analyzed, it can be seen that, like in the core models, the major contributors of the forecast error variances of maturity, output and price level are their own innovations[6]. The innovations of output are the second most important factor of the forecast error variance of maturity in all of the alternative specifications. Exchange rate innovations constitute the third important factor of the forecast error variance of maturity in all but one of the specifications. Other than output innovations, no other variable seems to explain the forecast error variance of maturity.

In all of the alternative specifications, it can be seen that at least 78 percent of the forecast error variance of output is explained by its own innovations and no other variable's innovations account for more than 9 percent of the forecast error variance of output. However, an exception to the latter case is the second alternative model, where the innovations of reserves account for 18 - 20 percent of the forecast error variance of output. This shows that economic performance in Turkey is affected by capital inflows. These results show that none of the variables, except for reserves, has the power to explain the forecast error variance of output.

[6] The forecast error variance decompositions of alternative models are not reported here but are presented in Appendix B.

Table 2.2: Forecast Error Variance Decompositions of the Maturity, Output and Price Level in the Second Core Model[7]

	Periods	Maturity	Output	Price Level	Exchange Rate	Spread	M1R
Maturity	6	83.309***	10.831*	0.090	2.483	3.147	0.140***
		(5.709)	(1.779)	(0.010)	(1.467)	(1.492)	(4.167)
	12	76.620***	15.572*	0.400***	4.239	2.971	0.198
		(4.271)	(1.719)	(3.282)	(1.504)	(1.585)	(0.010)
	18	74.404***	16.461*	0.824***	5.152	2.953	0.207
		(4.306)	(1.688)	(2.624)	(1.490)	(1.586)	(0.010)
	24	73.669***	16.573*	1.152**	5.449	2.946	0.211
		(4.298)	(1.685)	(2.470)	(1.506)	(1.592)	(0.010)
Output	6	1.795**	82.167***	1.244**	6.476*	6.679*	1.637
		(2.383)	(7.449)	(1.980)	(1.861)	(1.953)	(1.595)
	12	1.810***	81.991***	1.292**	6.478**	6.669**	1.760*
		(3.249)	(6.870)	(2.211)	(2.046)	(1.961)	(1.718)
	18	1.810***	81.885***	1.400**	6.482**	6.662**	1.761*
		(3.548)	(6.814)	(2.361)	(2.059)	(1.979)	(1.737)
	24	1.821***	81.761***	1.512**	6.494**	6.656**	1.757*
		(3.559)	(6.819)	(2.450)	(2.071)	(1.983)	(1.742)
Price Level	6	4.676	12.871*	67.228***	11.837*	3.374	0.015
		(1.435)	(1.751)	(5.086)	(1.910)	(1.485)	(0.010)
	12	9.323	19.853*	52.619***	14.373	3.825	0.007
		(1.391)	(1.812)	(3.678)	(1.625)	(1.422)	(0.010)
	18	12.355	23.161*	44.747***	15.719	4.012	0.005
		(1.375)	(1.791)	(3.282)	(1.498)	(1.398)	(0.010)
	24	14.223	25.033*	39.899***	16.703	4.138	0.004
		(1.366)	(1.762)	(3.081)	(1.474)	(1.380)	(0.010)

The primary source of the forecast error variance of price level is its own innovations. Depending on the alternative model and forecast period, 26 - 69 percent of the forecast error variance is attributed to price level innovations. However, other than its own innovations, there seem to be three other important contributors to the forecast error variance of price level; the innovations of output, exchange rate and maturity. In most of the alternative models, output innovations account for the

7 * : significant at the 10% level.
** : significant at the 5% level.
*** : significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

forecast error variance of price level more than exchange rate and maturity innovations do. Similarly, the fraction of the exchange rate innovations in forecast error variance of price level is more than those of maturity innovations in most of the alternative models. However, maturity innovations account for up to 22 percent of the forecast error variance of price level, which shows that movements in maturity are an important source of variance in price level forecast. In all of the specifications, the innovations of maturity explain the forecast error variance of price level more than the innovations in interest rate and M1R do.

The findings of the core models and alternative models show that other than output, no other variable is helpful in explaining maturity movements, whereas output movements may be explained partly by the movements in reserves. In addition output, exchange rate and maturity movements are important factors in the movement of price level.

2.6. Conclusion

In this study, the effects of a change in the average maturity of the domestic debt stock are assessed. Various VAR models that enable to capture the dynamic relationship between variables of average maturity, output, price level, exchange rate, interest rate and money aggregates are formed for Turkish data in the period from 1986:5 to 2001:5. From the impulse response analysis, it is shown that changes in the maturity have an effect on the price level and exchange rate. An increase in the average maturity decreases the price level permanently and appreciates the domestic currency, whereas no significant change in output is observed. In addition, an increase in the maturity leads to a decline in the interest rate, which may be due to the CBRT's operations during the sample period. Moreover, from the forecast error variance decomposition analysis, it is shown that in addition to output and exchange rate developments, maturity developments are also important to the explanation of the variability in price level.

These findings suggest that the Treasury's decisions on the maturity of the domestic debt instruments will be of considerable importance, especially in an inflation-targeting regime where the utmost concern of the monetary policy is price stability.

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APPENDICES

In this part, two appendices, each related to either of the chapters are presented. In Appendix A, the impulses responses of all of the variable to shocks of all variables in the core model and alternative models derived in the first chapter are presented. In Appendix B, the impulse responses and the forecast error variance decompositions of all of the variables in the core and the alternative models employed in the second chapter are presented.

APPENDIX A

In this appendix, the impulse responses of various models considered for the analysis of the first chapter are presented. As explained in the empirical section of the first chapter, a core model for analysis and five alternative models is derived as a robustness check. The core VAR model has four lags in the particular order of US nominal interest rate, real exchange rate, inflation and output. The alternative models also have four lags and the variables written in their specific orders are given here. The first alternative model uses US interest rate, government size, real exchange rate, inflation and output. The second alternative model includes US interest rate, real exchange rate, M1 monetary aggregate, inflation and output. The third alternative model uses US interest rate, current account, real exchange rate, inflation and output. The variables of fourth alternative model are US interest rate, capital account, real exchange rate, inflation and output. The fifth alternative model includes capital account, government size, real exchange rate, inflation and output.

As the core model has three endogenous variables and an exogenous variable, 16 different impulse responses are presented in figure A.1. The alternative models have four endogenous variables and an exogenous variable, thus 25 different impulse responses are shown in figures A.2 through A.6.

Impulse Responses of the Core Model (US Interest Rate, Real Exchange Rate, Inflation, Output)

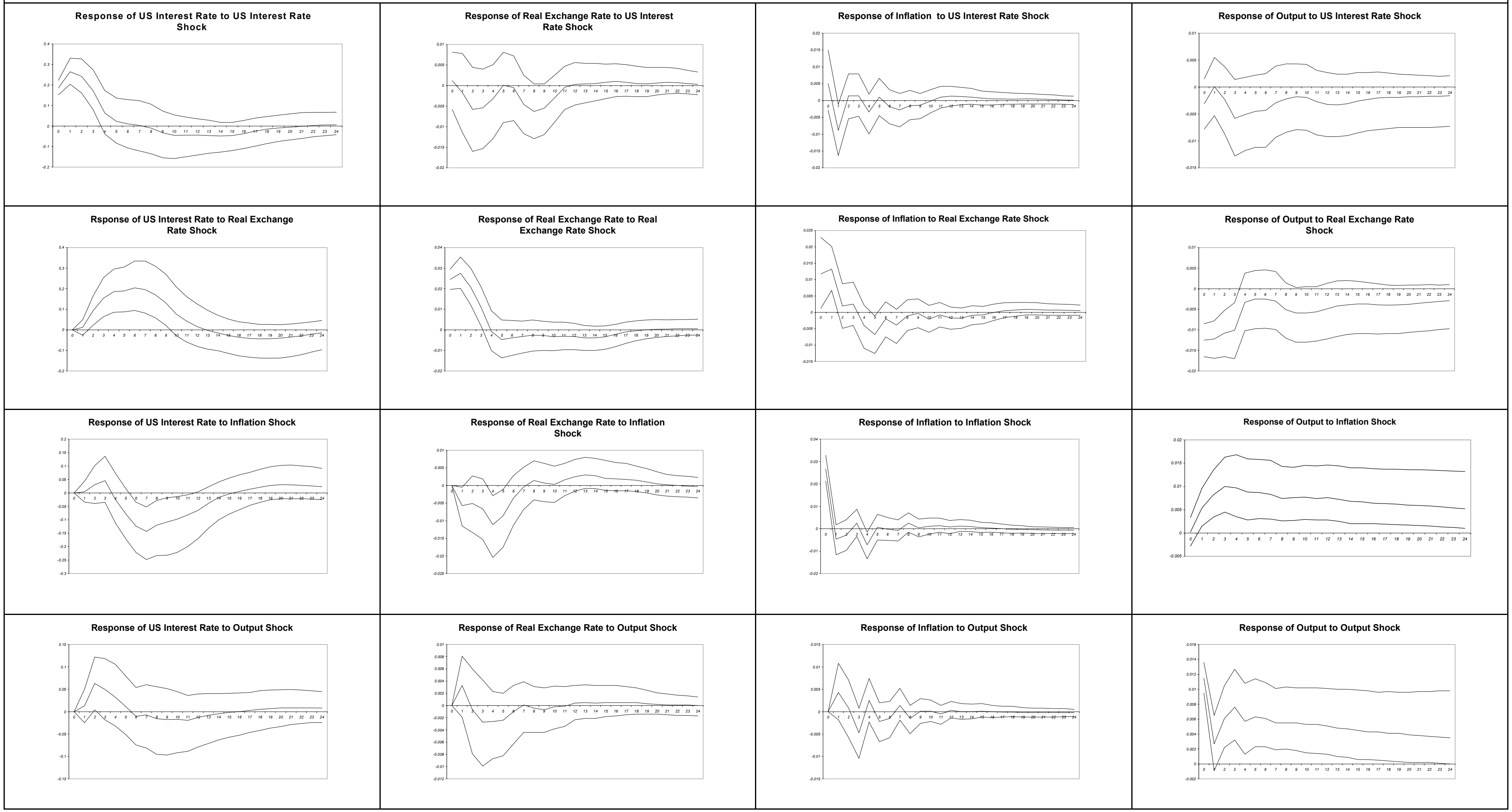

Figure A.1: Impulse Responses of the Core Model

Impulse Responses of the First Alternative Model (US Interest Rate, Government Size, Real Exchange Rate, Inflation, Output)

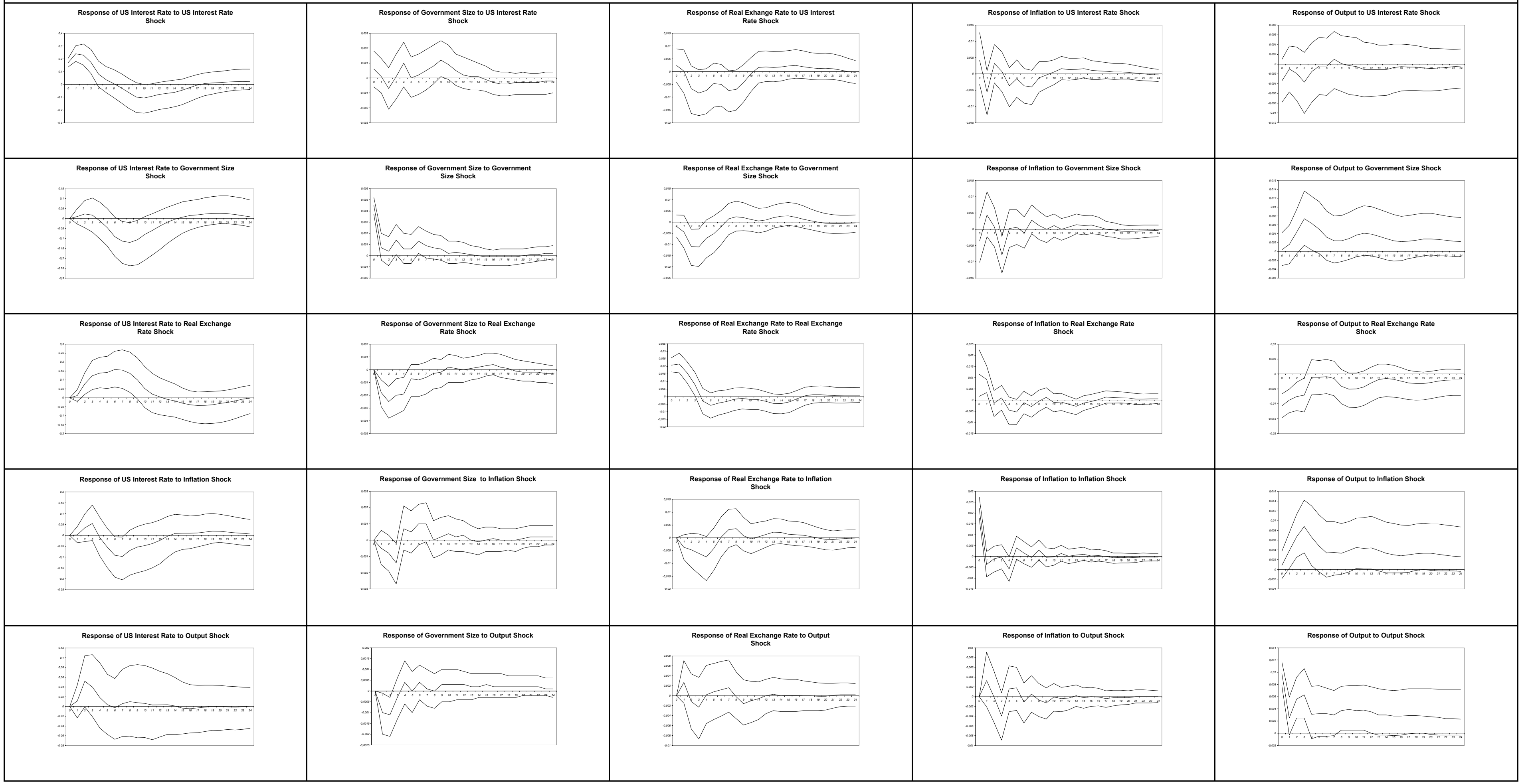

Figure A.2: Impulse Responses of the First Alternative Model

Impulse Responses of the Second Alternative Model (US Interest Rate, Real Exchange Rate, M1 monetary aggregate, Inflation, Output)

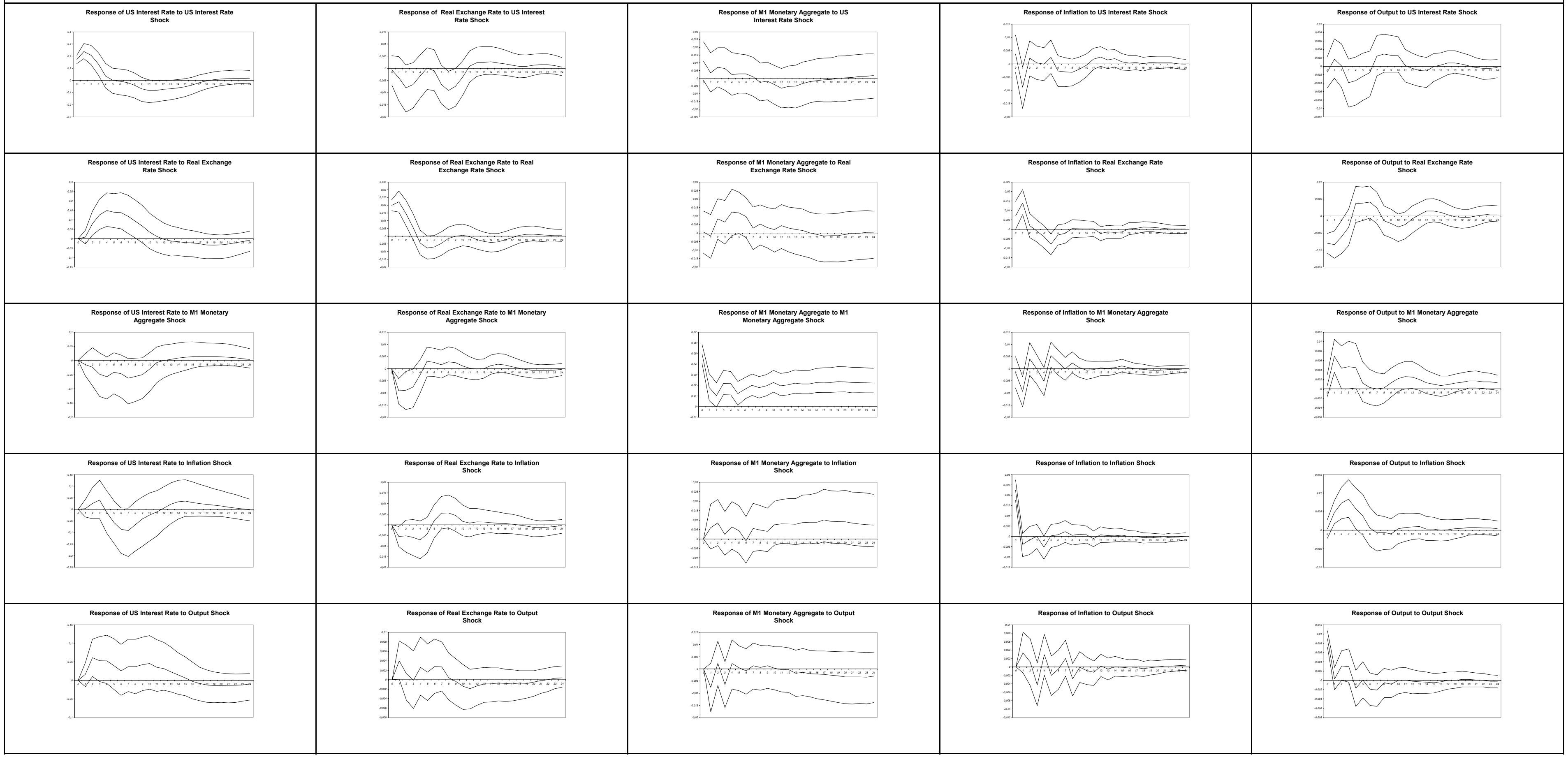

Figure A.3: Impulse Responses of the Second Alternative Model

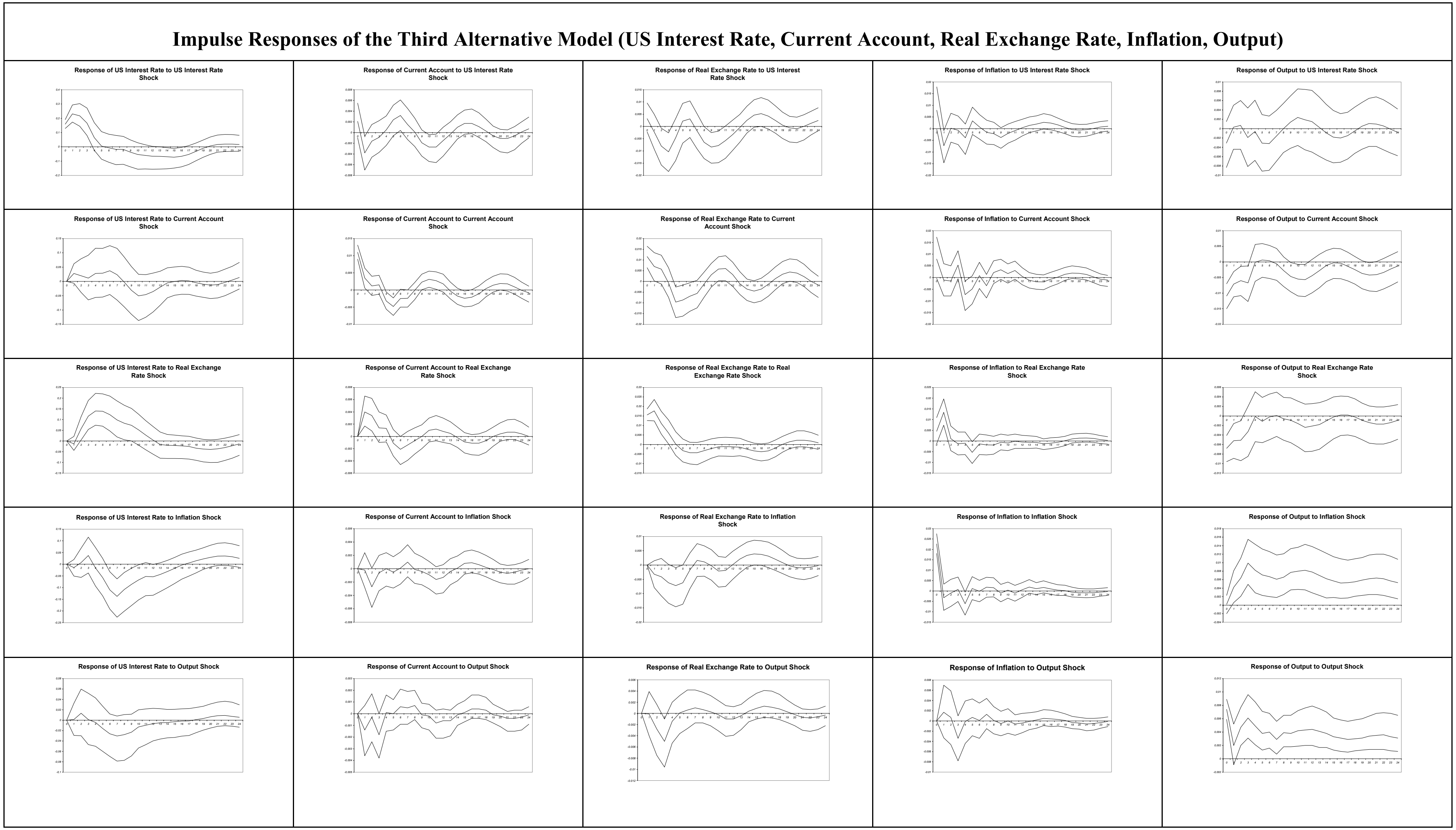

Figure A.4: Impulse Responses of the Third Alternative Model

Impulse Responses of the Fourth Alternative Model (US Interest Rate, Capital Account, Real Exchange Rate, Inflation, Output)

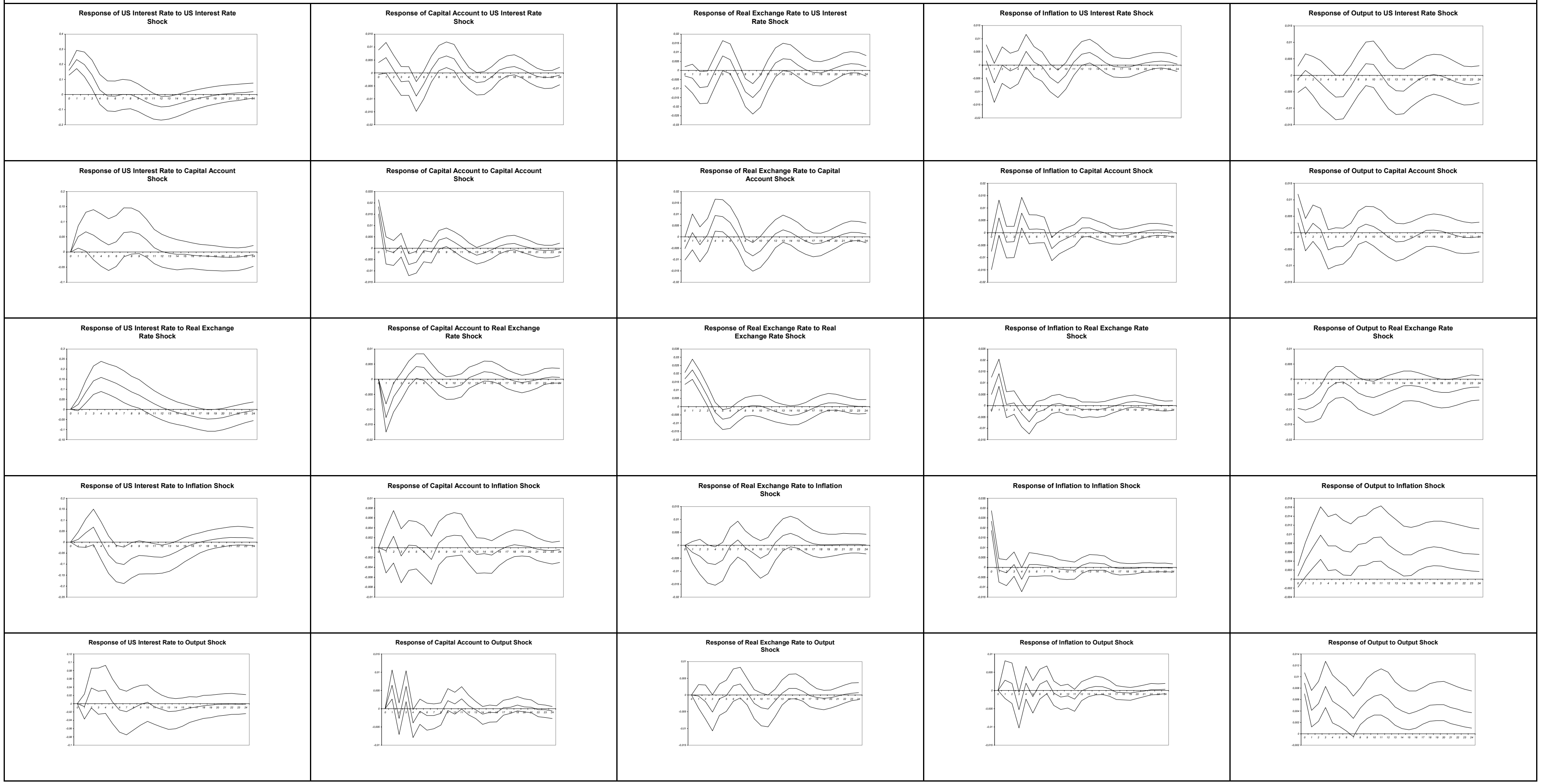

Figure A.5: Impulse Responses of the Fourth Alternative Model

Impulse Responses of the Fifth Alternative Model (Capital Account, Government Size, Real Exchange Rate, Inflation, Output)

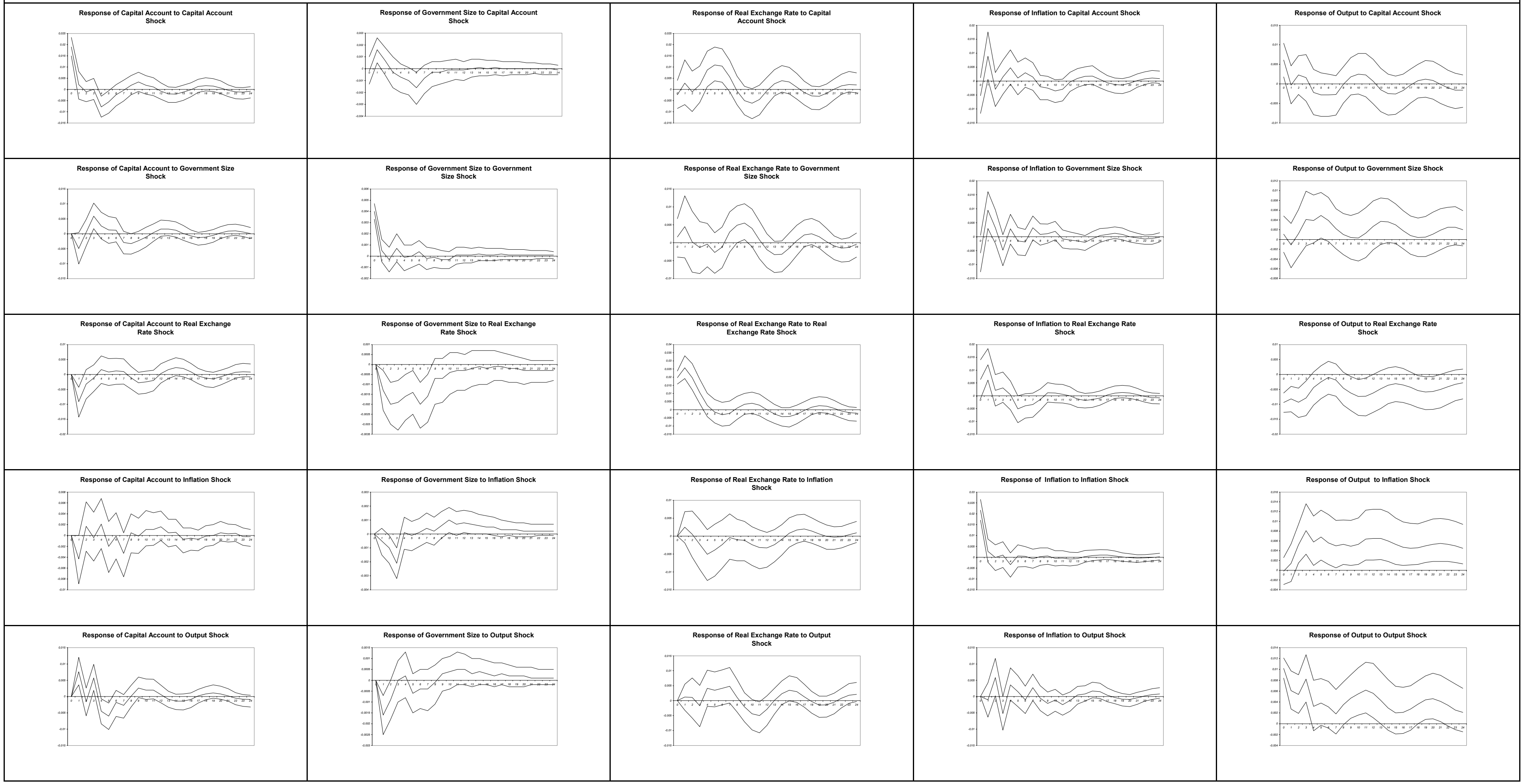

Figure A.6: Impulse Responses of the Fifth Alternative Model

APPENDIX B

In this appendix, the impulse responses of the variables to a one standard deviation shock to maturity as well as the forecast error variance decompositions of maturity, output and price level for ten different models including the core and the alternative models in the second chapter are presented. As explained in the empirical section, two core models for analysis and eight alternative models for robustness check are derived. In one of the core models, the interbank interest rate (Figure B.1, Table B.1) is employed, whereas in the other spread is used (Figure B.2, Table B.2). The core VAR models have two lags in the particular order of maturity, output, price level, exchange rate, interest rate (spread in the second core model) and M1R. The exogenous variables of eleven monthly dummies, two dummies for the crisis periods of 1994:4 and 2001:2 and also two dummies in the system for M1R are also used in the core models. The alternative models also have two lags and use the same exogenous variables. The variables are given in their specific orders here. The first alternative model uses the logarithm of ISE 100 index and the other variables of maturity, output, price level, exchange rate, interest rate and M1R (Figure B.3, Table B.3). The second alternative model includes the logarithm of reserves and the other variables of maturity, output, price level, exchange rate, interest rate and M1R (Figure B.4, Table B.4). In the third alternative model, we have ordered the variables as output, price level, maturity, exchange rate, interest rate and M1R (Figure B.5, Table B.5). The variables of the fourth alternative model are in the order of maturity, output, price level, exchange rate, fiscal, interest rate and M1R (Figure B.6, Table

B.6) where fiscal is the extra return of the Treasury auction interest rate over the previous month's O/N interest rate. The fifth alternative model includes the variables in the particular order of output, price level, maturity, exchange rate, fiscal, interest rate and M1R (Figure B.7, Table B.7). The order of the sixth alternative model is output, price level, fiscal, maturity, exchange rate, interest rate and M1R (Figure B.8, Table B.8). In addition to these models we used the core model specification but with three lag orders as the seventh alternative model specification. Hence, the seventh alternative model includes the variables maturity, output, price level, exchange rate, interest rate and M1R (Figure B.9, Table B.9). The last alternative model is the core model using interest rate but with maturity in logarithms (Figure B.10, Table B.10).

The two core models and the third, seventh and eighth alternative models use six variables, hence for these models; we present six impulse response functions. The remaining models have seven variables; hence, we report seven impulse response function figures for these models. Similarly, for the core models and the third, seventh and eighth alternative models, we give the fractions of six variables in explaining the forecast error variance of maturity, output and price level and for the other models we give the fractions of seven variables.

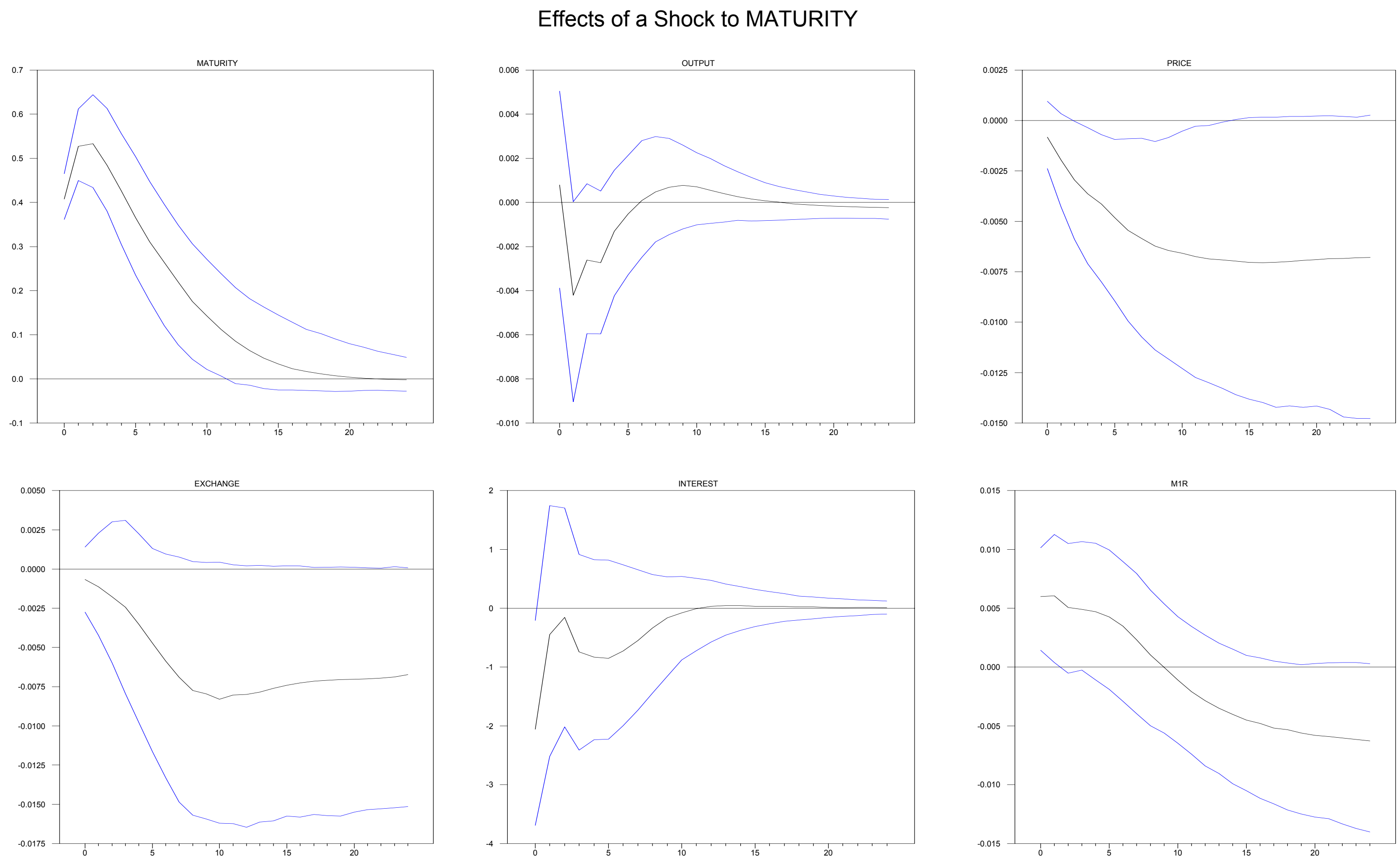

Figure B.1: Impulse Responses of the Variables to a Maturity Shock in Core Model 1

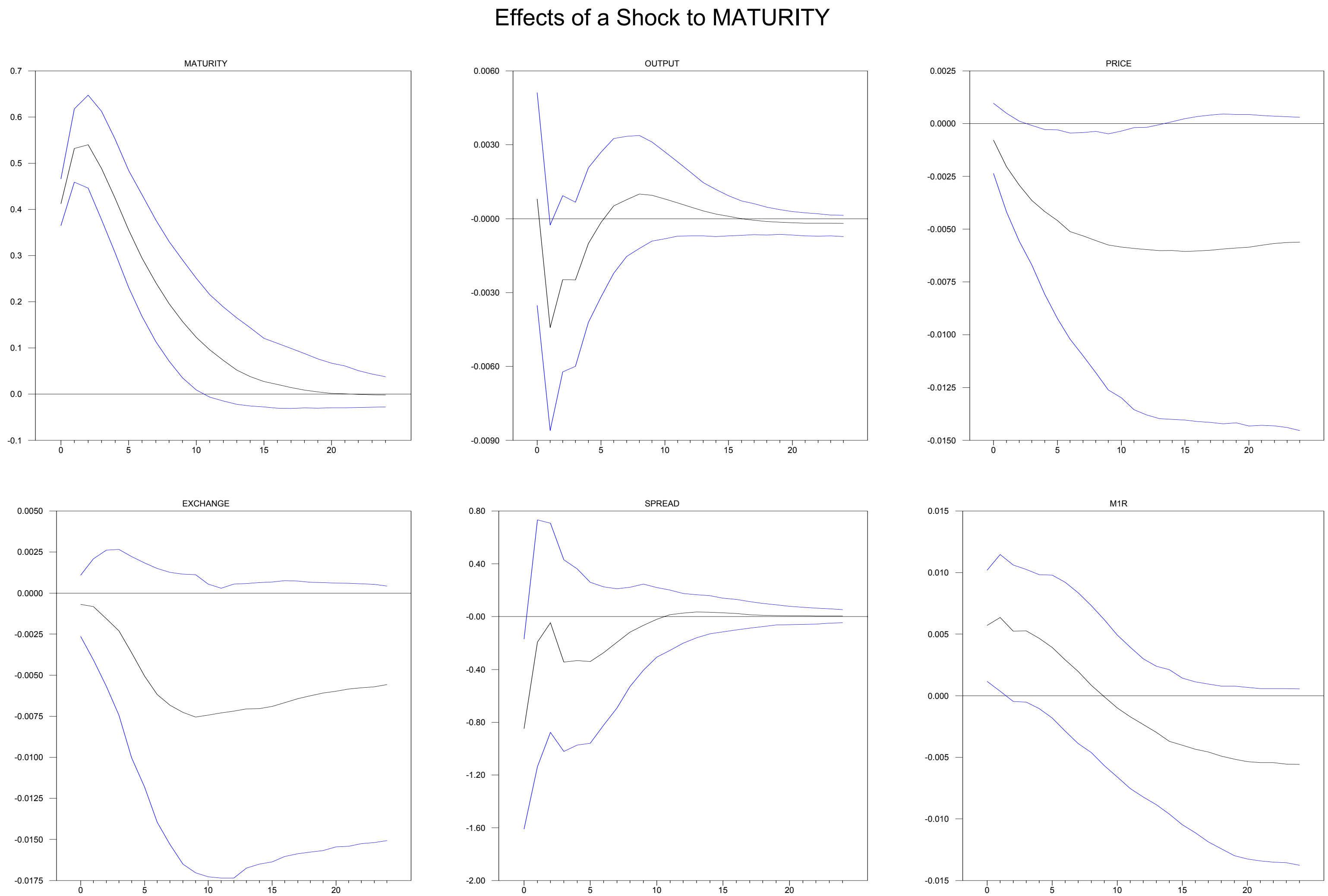

Figure B.2: Impulse Responses of the Variables to a Maturity Shock in Core Model 2

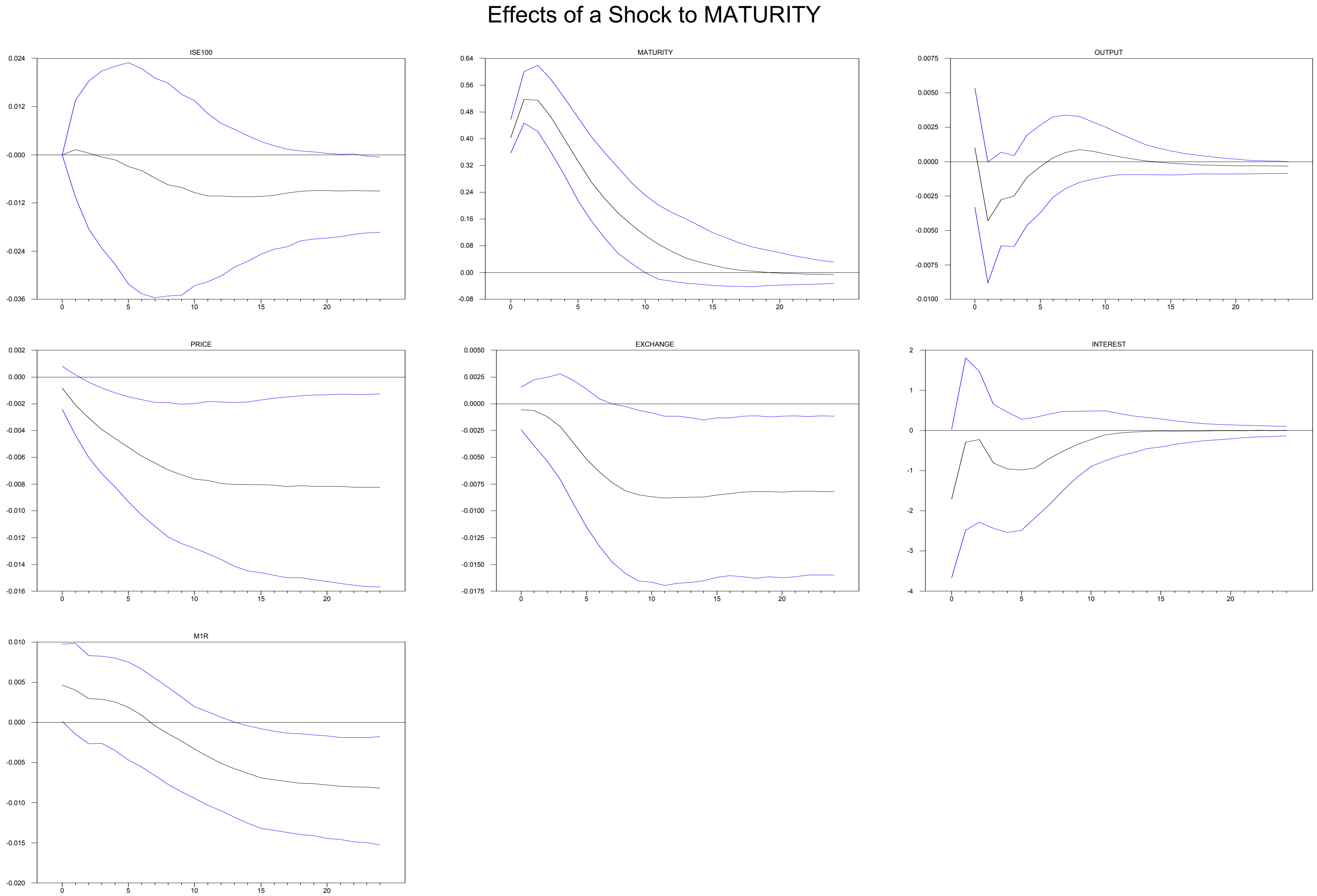

Figure B.3: Impulse Responses of the Variables to a Maturity Shock in Alternative Model 1

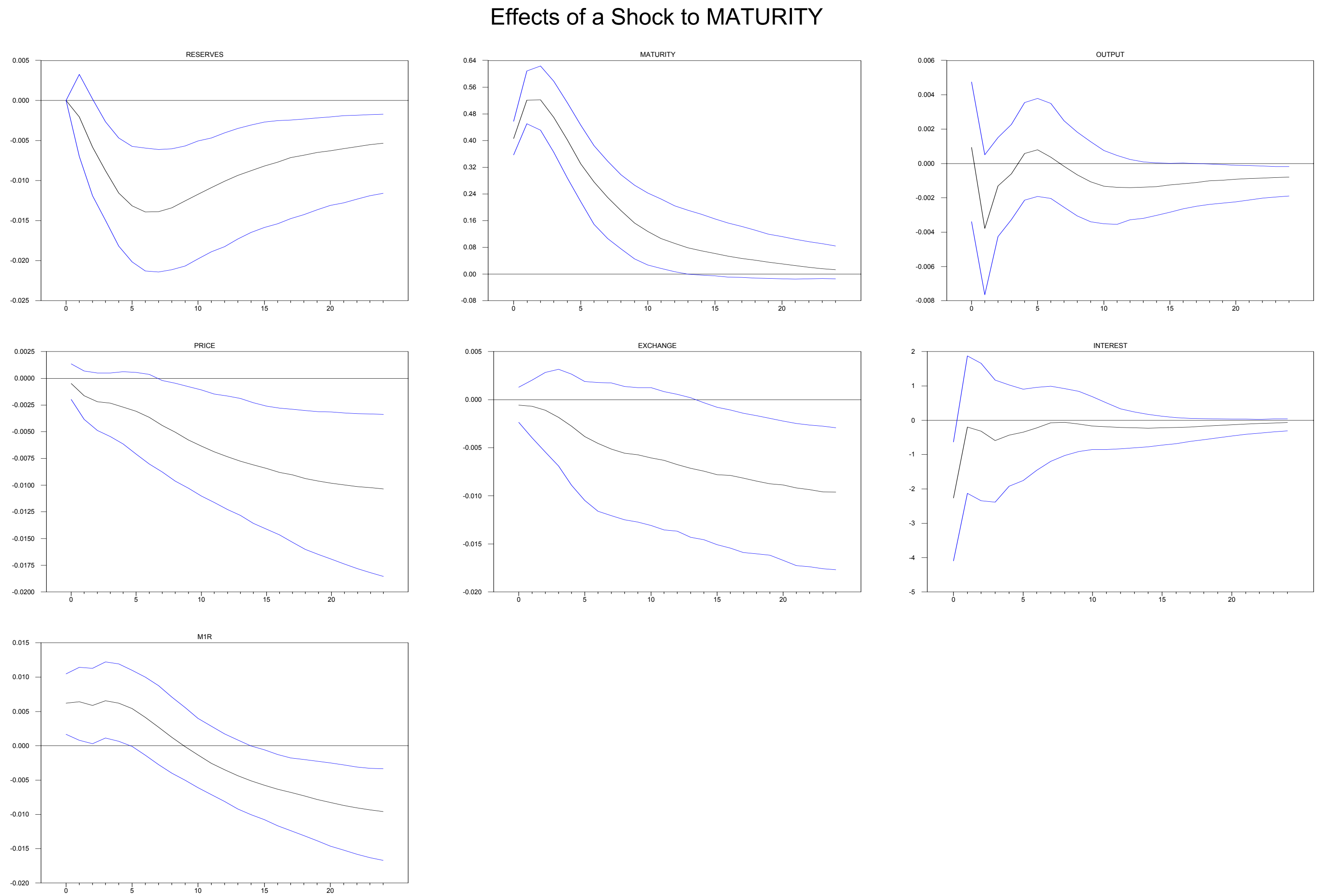

Figure B.4: Impulse Responses of the Variables to a Maturity Shock in Alternative Model 2

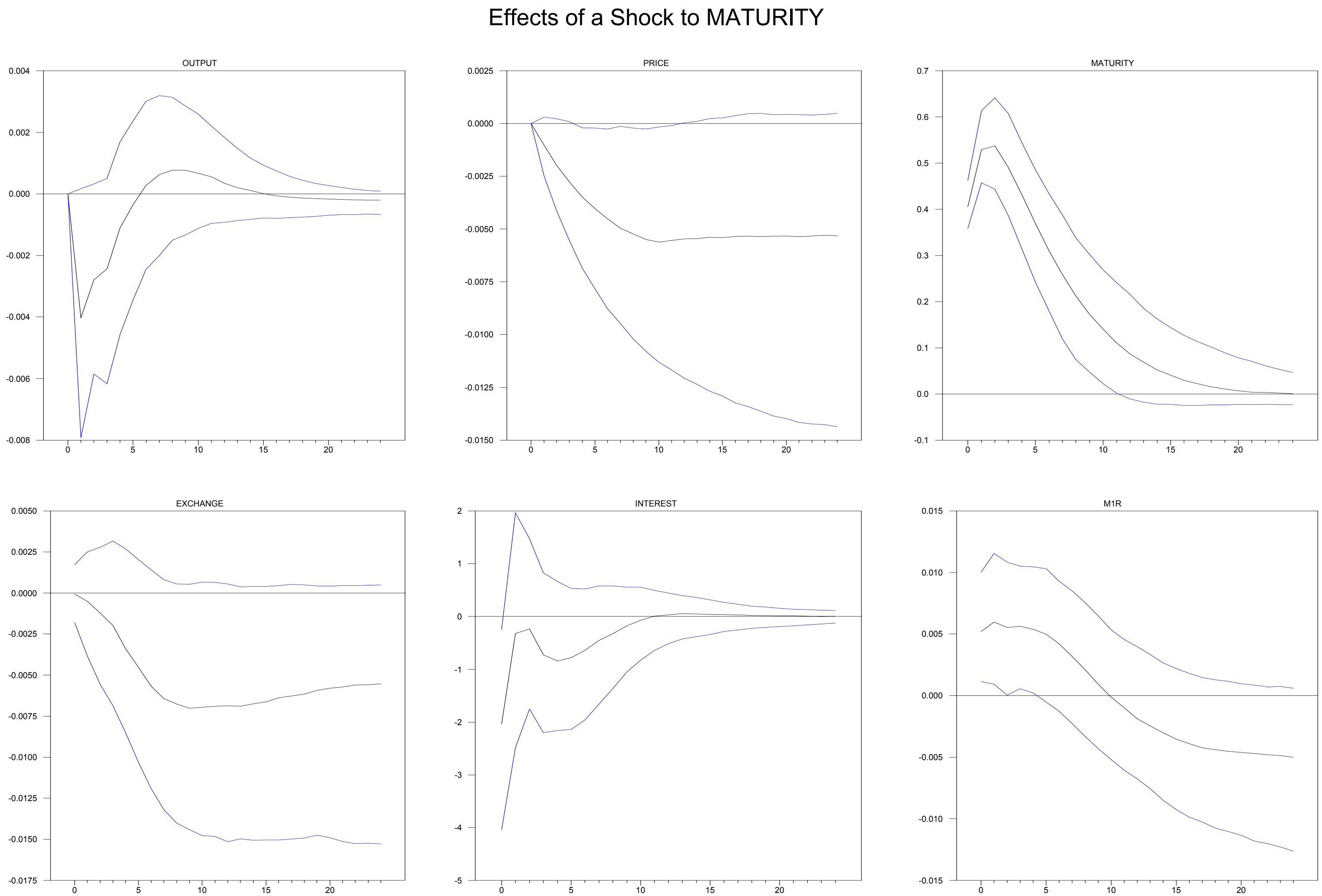

Figure B.5: Impulse Responses of the Variables to a Maturity Shock in Alternative Model 3

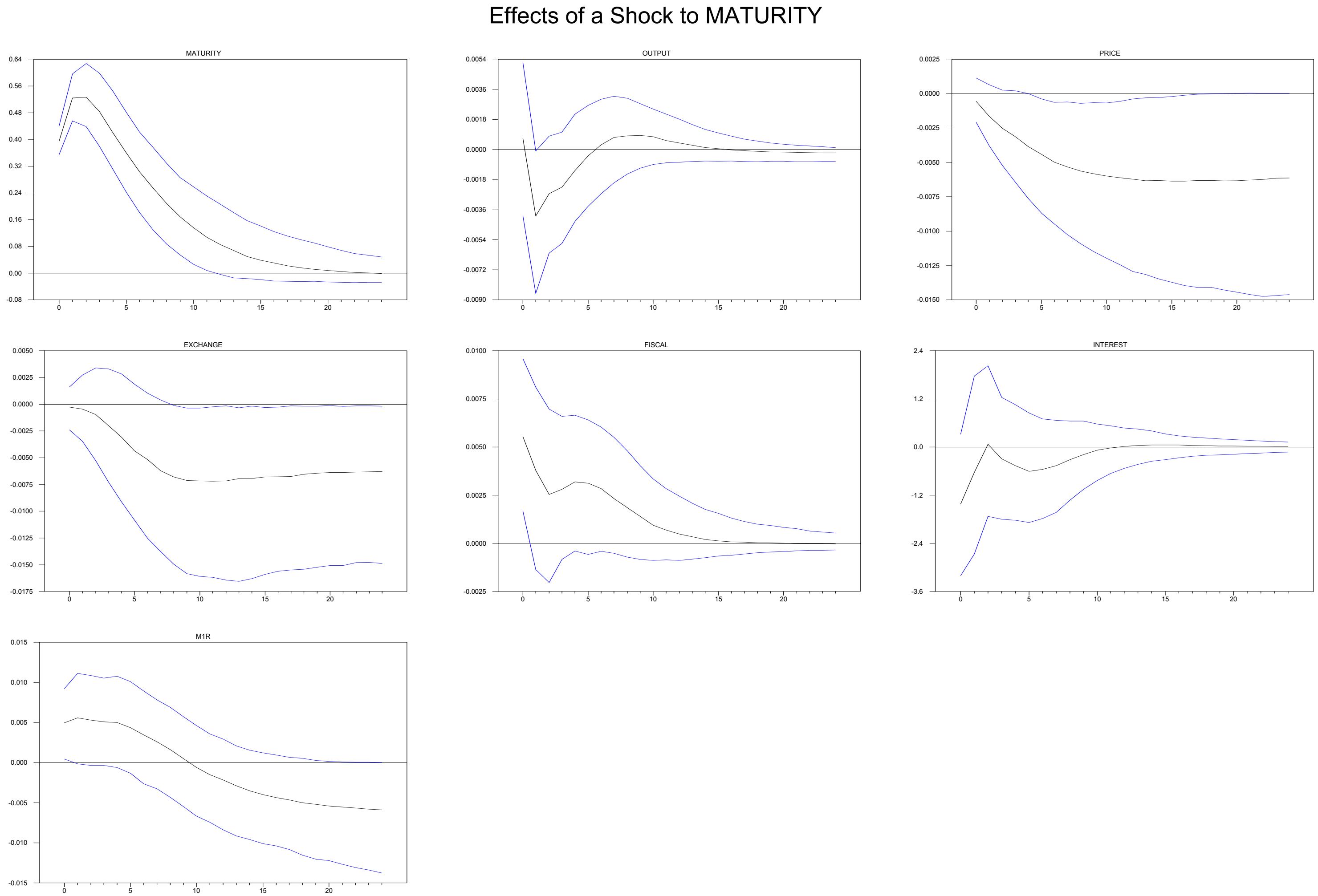

Figure B.6: Impulse Responses of the Variables to a Maturity Shock in Alternative Model 4

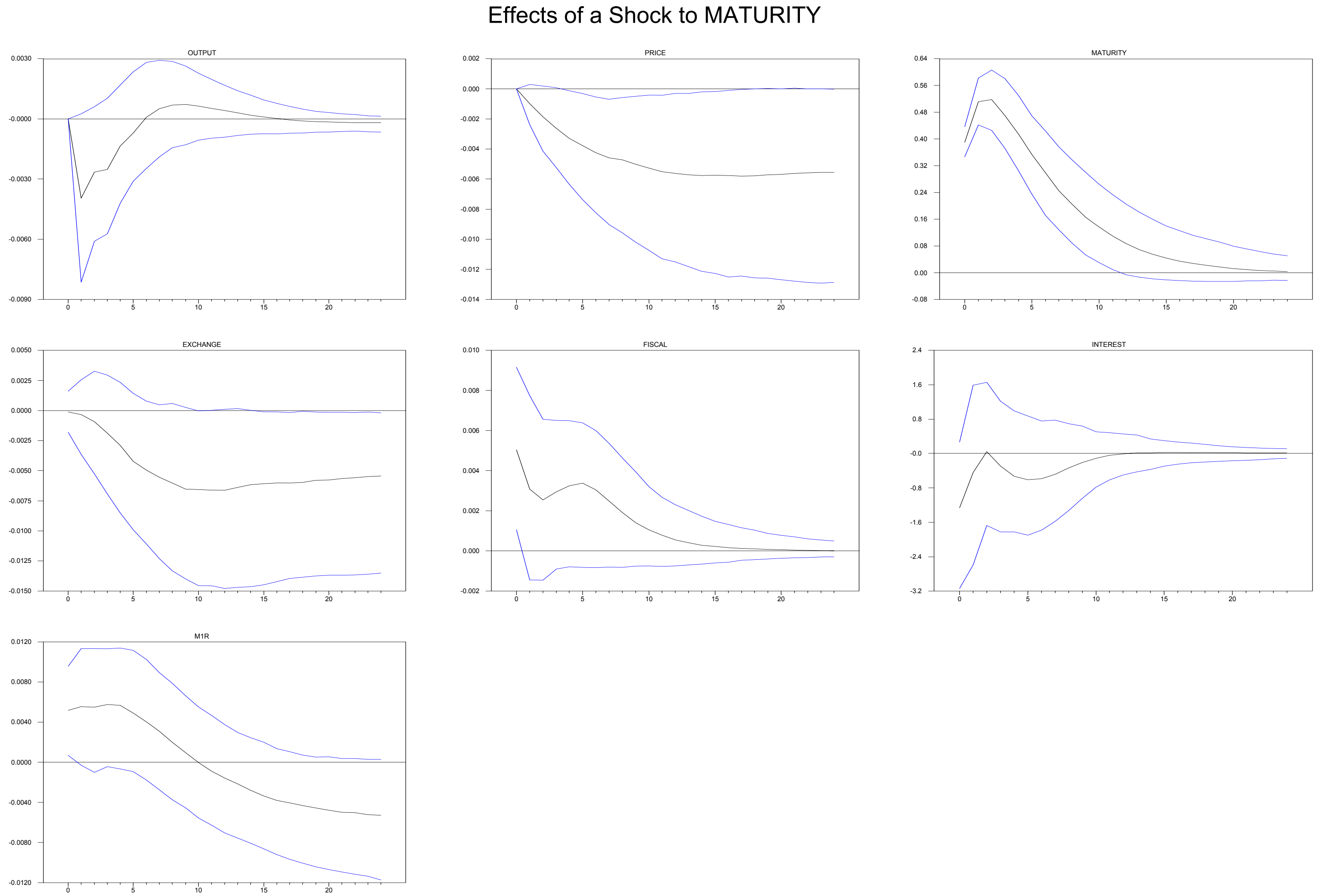

Figure B.7: Impulse Responses of the Variables to a Maturity Shock in Alternative Model 5

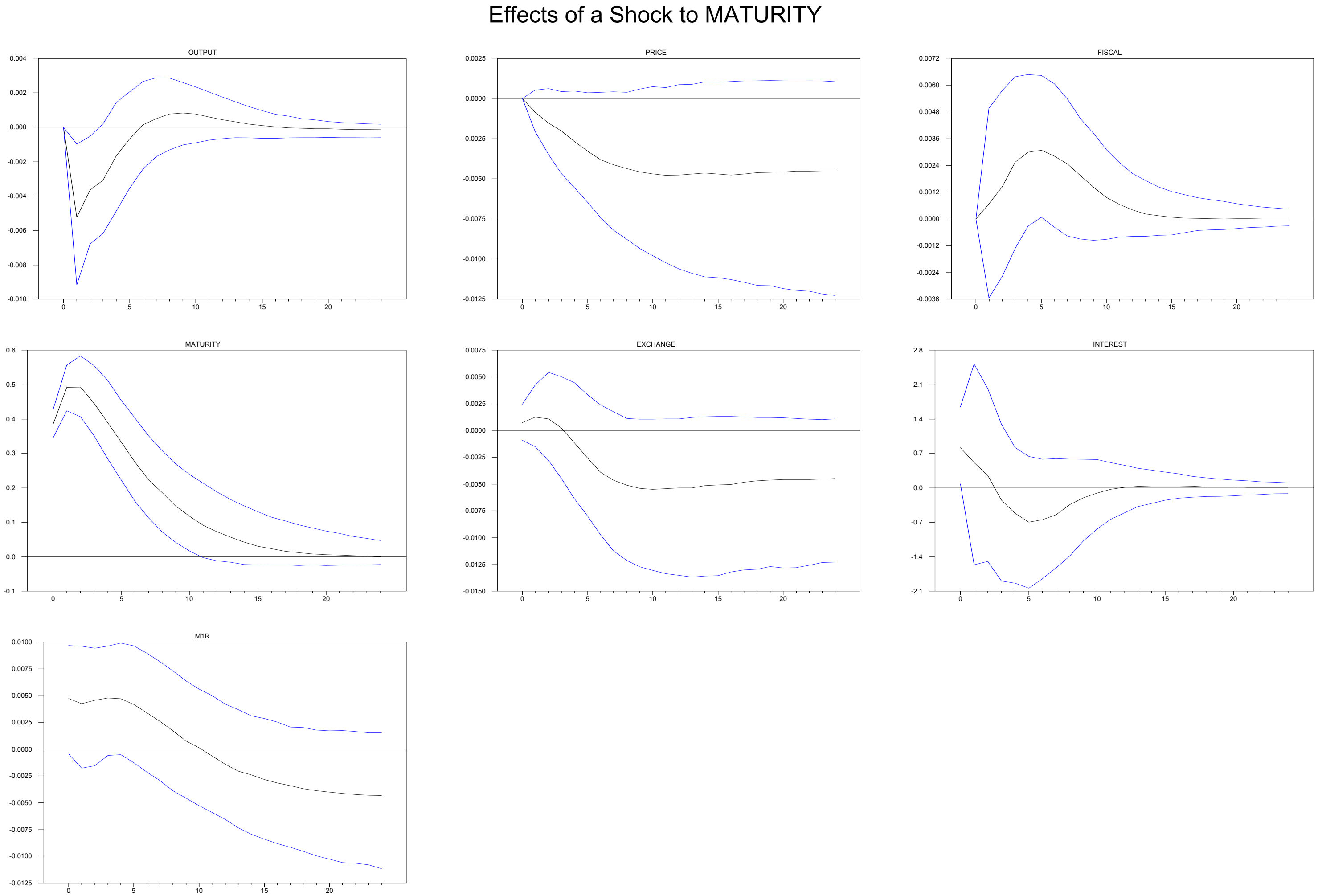

Figure B.8: Impulse Responses of the Variables to a Maturity Shock in Alternative Model 6

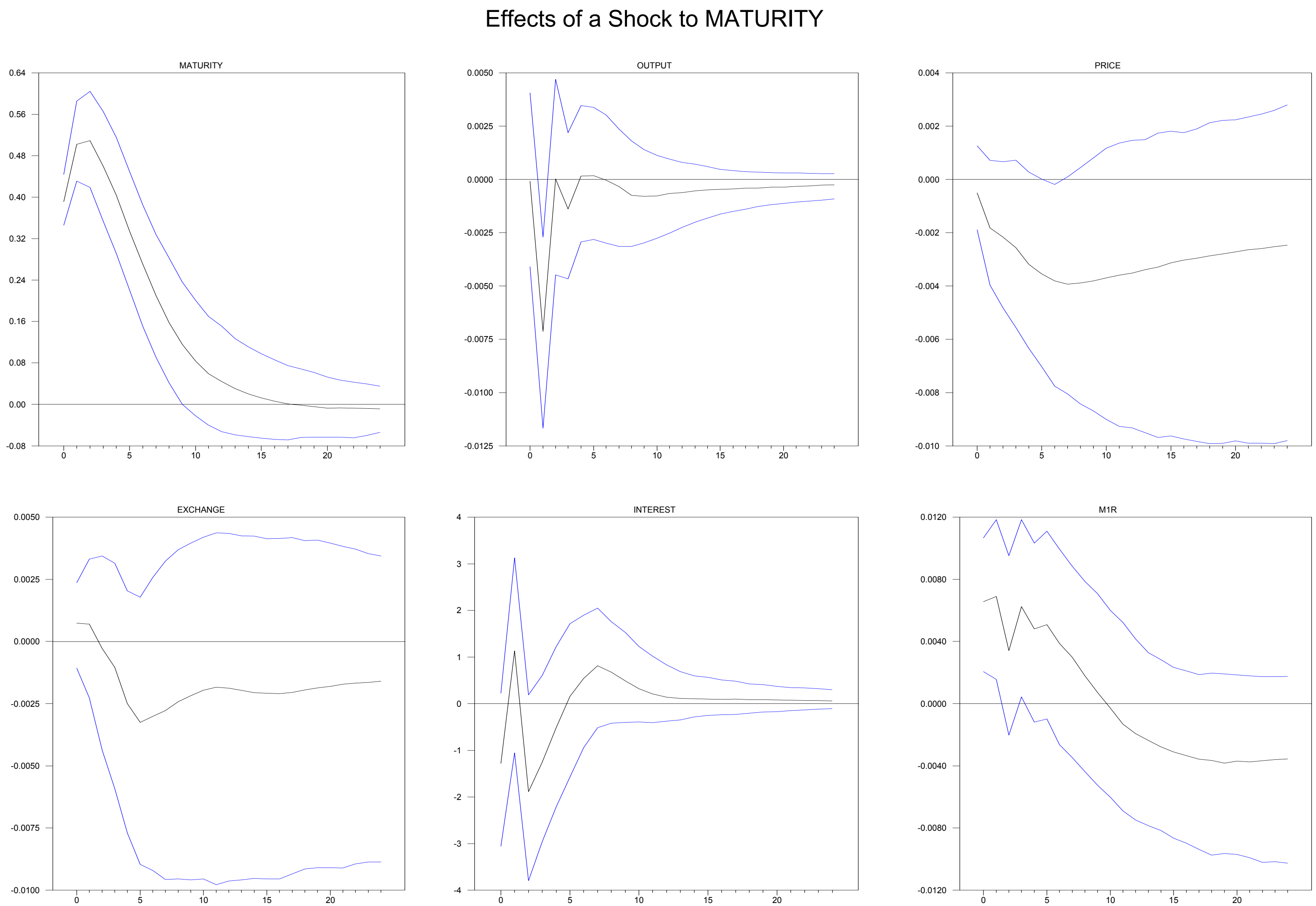

Figure B.9: Impulse Responses of the Variables to a Maturity Shock in Alternative Model 7

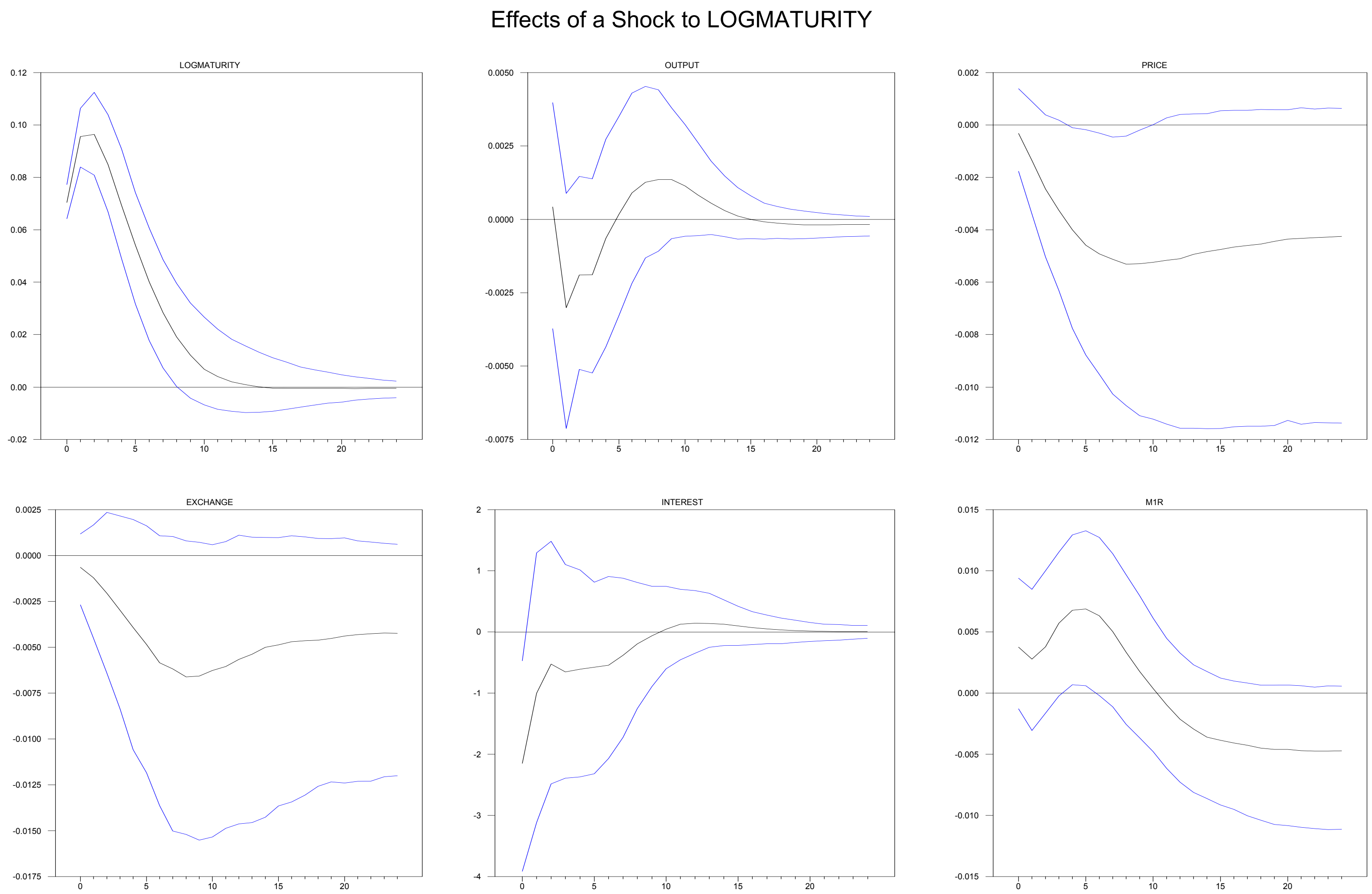

Figure B.10: Impulse Responses of the Variables to a Maturity Shock in Alternative Model 8

Table B.1: Forecast Error Variance Decompositions of maturity, output and price level in Core Model 1

	Periods	Maturity	Output	Price Level	Exchange Rate	Interest Rate	M1R
Maturity	6	83.377***	10.782*	0.089	2.504	3.106	0.142***
		(6.293)	(1.773)	(0.010)	(1.468)	(1.555)	(7.903)
	12	76.726**	15.485*	0.397***	4.267	2.925	0.201***
		(4.755)	(1.675)	(3.061)	(1.475)	(1.637)	(85.760)
	18	74.512***	16.363*	0.821**	5.188	2.905*	0.210
		(4.607)	(1.641)	(2.551)	(1.483)	(1.669)	(0.010)
	24	73.776***	16.474	1.148**	5.489	2.898*	0.215
		(4.621)	(1.639)	(2.466)	(1.485)	(1.669)	(0.010)
Output	6	1.780*	82.179***	1.245**	6.504**	6.645**	1.646*
		(1.957)	(7.276)	(1.965)	(2.013)	(2.057)	(1.700)
	12	1.795**	82.003***	1.294**	6.506**	6.635**	1.769*
		(2.222)	(6.753)	(2.121)	(2.229)	(2.065)	(1.726)
	18	1.796**	81.897***	1.402**	6.509**	6.628**	1.769*
		(2.247)	(6.662)	(2.173)	(2.367)	(2.067)	(1.736)
	24	1.806**	81.772***	1.514**	6.521**	6.621**	1.766*
		(2.278)	(6.678)	(2.280)	(2.377)	(2.071)	(1.755)
Price Level	6	4.734	12.747*	67.276***	11.937**	3.289	0.017
		(1.456)	(1.836)	(4.781)	(2.036)	(1.465)	(0.010)
	12	9.425	19.657*	52.682***	14.501*	3.727	0.008
		(1.397)	(1.785)	(3.843)	(1.690)	(1.491)	(0.010)
	18	12.484	22.937*	44.797***	15.867	3.910	0.005
		(1.384)	(1.766)	(3.525)	(1.578)	(1.489)	(0.010)
	24	14.369	24.793*	39.937***	16.862	4.035	0.004
		(1.371)	(1.733)	(3.353)	(1.512)	(1.484)	(0.010)

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

Table B.2: Forecast Error Variance Decompositions of maturity, output and price level in Core Model 2

	Periods	Maturity	Output	Price Level	Exchange Rate	Spread	M1R
Maturity	6	83.309***	10.831*	0.090	2.483	3.147	0.140***
		(5.709)	(1.779)	(0.010)	(1.467)	(1.492)	(4.167)
	12	76.620***	15.572*	0.400***	4.239	2.971	0.198
		(4.271)	(1.719)	(3.282)	(1.504)	(1.585)	(0.010)
	18	74.404***	16.461*	0.824***	5.152	2.953	0.207
		(4.306)	(1.688)	(2.624)	(1.490)	(1.586)	(0.010)
	24	73.669***	16.573*	1.152**	5.449	2.946	0.211
		(4.298)	(1.685)	(2.470)	(1.506)	(1.592)	(0.010)
Output	6	1.795**	82.167***	1.244**	6.476*	6.679*	1.637
		(2.383)	(7.449)	(1.980)	(1.861)	(1.953)	(1.595)
	12	1.810***	81.991***	1.292**	6.478**	6.669**	1.760*
		(3.249)	(6.870)	(2.211)	(2.046)	(1.961)	(1.718)
	18	1.810***	81.885***	1.400**	6.482**	6.662**	1.761*
		(3.548)	(6.814)	(2.361)	(2.059)	(1.979)	(1.737)
	24	1.821***	81.761***	1.512**	6.494**	6.656**	1.757*
		(3.559)	(6.819)	(2.450)	(2.071)	(1.983)	(1.742)
Price Level	6	4.676	12.871*	67.228***	11.837*	3.374	0.015
		(1.435)	(1.751)	(5.086)	(1.910)	(1.485)	(0.010)
	12	9.323	19.853*	52.619***	14.373	3.825	0.007
		(1.391)	(1.812)	(3.678)	(1.625)	(1.422)	(0.010)
	18	12.355	23.161*	44.747***	15.719	4.012	0.005
		(1.375)	(1.791)	(3.282)	(1.498)	(1.398)	(0.010)
	24	14.223	25.033*	39.899***	16.703	4.138	0.004
		(1.366)	(1.762)	(3.081)	(1.474)	(1.380)	(0.010)

*   significant at the 10% level.
**   significant at the 5% level.
*** significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

Table B.3: Forecast Error Variance Decompositions of maturity, output and price level in Alternative Model 1

	Periods	ISE100	Maturity	Output	Price Level	Exchange Rate	Interest Rate	M1R
Maturity	6	2.598	80.505***	11.497*	0.068	2.272	2.948	0.111
		(1.555)	(5.237)	(1.745)	(0.010)	(1.416)	(1.499)	(0.010)
	12	3.394	72.493***	16.966*	0.267***	3.985	2.698	0.198
		(1.625)	(4.098)	(1.690)	(37.973)	(1.461)	(1.558)	(0.010)
	18	3.767*	69.716***	18.122*	0.596***	4.935	2.639	0.225
		(1.660)	(4.065)	(1.677)	(3.101)	(1.463)	(1.602)	(0.010)
	24	3.916*	68.778***	18.308*	0.874**	5.269	2.618	0.237
		(1.684)	(4.070)	(1.666)	(2.560)	(1.463)	(1.614)	(0.010)
Output	6	1.466***	2.025**	81.756***	1.184*	6.095**	5.848*	1.626*
		(3.333)	(2.069)	(6.660)	(1.813)	(2.062)	(1.831)	(1.724)
	12	1.465***	2.038***	81.591***	1.243**	6.098**	5.840*	1.725*
		(5.041)	(2.915)	(5.997)	(2.091)	(2.167)	(1.838)	(1.778)
	18	1.477***	2.039***	81.486***	1.338**	6.101**	5.836*	1.723*
		(5.266)	(3.144)	(5.918)	(2.299)	(2.254)	(1.839)	(1.815)
	24	1.488***	2.064***	81.353***	1.428**	6.111**	5.835*	1.720*
		(5.365)	(3.172)	(5.883)	(2.440)	(2.258)	(1.842)	(1.833)
Price Level	6	0.628**	6.721	10.729	65.265***	12.455	4.097	0.106***
		(2.138)	(1.486)	(1.616)	(4.464)	(2.011)	(1.628)	(6.784)
	12	1.730*	14.167	15.087	49.157***	14.790	5.017	0.052
		(1.675)	(1.452)	(1.544)	(3.426)	(1.631)	(1.569)	(0.010)
	18	2.027*	19.086	17.121	40.737***	15.596	5.398	0.034
		(1.648)	(1.409)	(1.489)	(3.266)	(1.515)	(1.530)	(0.010)
	24	2.019	22.048	18.436	35.767***	16.123	5.581	0.026
		(1.618)	(1.384)	(1.444)	(2.912)	(1.459)	1.483)	(0.010)

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

Table B.4: Forecast Error Variance Decompositions of maturity, output and price level in Alternative Model 2

	Periods	Reserves	Maturity	Output	Price Level	Exchange Rate	Interest Rate	M1R
Maturity	6	0.061	83.640***	8.646	0.444	3.301	3.816	0.092
		(0.010)	(5.157)	(1.777)	(1.882)	(1.439)	(1.615)	(0.010)
	12	0.780***	76.119***	11.891	1.576	5.657	3.858	0.119
		(5.516)	(4.002)	(1.675)	(1.588)	(1.451)	(1.625)	(0.010)
	18	1.256***	74.023***	12.330	2.256	6.196	3.821	0.117
		(3.228)	(3.754)	(1.653)	(1.536)	(1.480)	(1.623)	(0.010)
	24	1.417***	73.411***	12.408	2.585	6.271	3.788	0.118
		(3.064)	(3.695)	(1.651)	(1.547)	(1.501)	(1.637)	(0.010)
Output	6	18.295***	0.732***	72.015***	1.521**	1.607**	3.915*	1.914*
		(2.888)	(6.790)	(6.610)	(2.261)	(2.469)	(1.916)	(1.805)
	12	20.137***	1.231***	69.647***	1.555***	1.632***	3.803*	1.995*
		(2.734)	(14.324)	(6.297)	(2.893)	(3.023)	(1.949)	(1.924)
	18	20.350***	2.054***	68.584***	1.628***	1.617***	3.798**	1.969**
		(2.695)	(3.667)	(6.185)	(2.994)	(3.777)	(1.975)	(2.010)
	24	20.401***	2.625***	67.889***	1.661***	1.660***	3.818**	1.947**
		(2.688)	(2.721)	(6.231)	(3.122)	(4.094)	(1.980)	(2.053)
Price Level	6	0.375***	2.556	7.048	63.105***	20.568**	6.338*	0.011
		(10.667)	(1.497)	(1.564)	(4.184)	(2.347)	(1.720)	(0.010)
	12	2.442**	8.124	11.551	44.594***	25.349**	7.887	0.053
		(2.109)	(1.440)	(1.535)	(3.324)	(1.961)	(1.634)	(0.010)
	18	4.946*	14.870	13.304	33.251***	25.192*	8.362	0.074
		(1.669)	(1.421)	(1.520)	(2.981)	(1.815)	(1.618)	(0.010)
	24	6.705	20.422	14.193	25.983***	24.166*	8.457	0.074
		(1.561)	(1.430)	(1.514)	(2.724)	(1.733)	(1.584)	(0.010)

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

Table B.5: Forecast Error Variance Decompositions of maturity, output and price level in Alternative Model 3

	Periods	Output	Price Level	Maturity	Exchange Rate	Interest Rate	M1R
Maturity	6	9.634*	0.050	84.564***	2.504	3.106	0.142**
		(1.706)	(0.010)	(5.561)	(1.444)	(1.566)	(25.966)
	12	14.147*	0.195	78.265***	4.267	2.925	0.201
		(1.654)	(0.010)	(4.339)	(1.460)	(1.630)	(0.010)
	18	15.006	0.522	76.168***	5.188	2.905	0.210
		(1.630)	(0.010)	(4.197)	(1.485)	(1.627)	(0.010)
	24	15.118	0.810***	75.470***	5.489	2.898	0.215
		(1.632)	(8.429)	(4.152)	(1.488)	(1.642)	(0.010)
Output	6	82.042***	1.368*	1.794	6.504**	6.645**	1.646*
		(7.796)	(1.956)	(1.600)	(2.033)	(2.001)	(1.698)
	12	81.867***	1.413**	1.811*	6.506**	6.635**	1.769*
		(7.090)	(2.182)	(1.909)	(2.230)	(2.072)	(1.810)
	18	81.761***	1.521**	1.813**	6.509**	6.628**	1.769*
		(6.974)	(2.389)	(1.989)	(2.262)	(2.076)	(1.823)
	24	81.636***	1.636**	1.820**	6.521**	6.621**	1.766*
		(6.989)	(2.557)	(2.003)	(2.264)	(2.078)	(1.829)
Price Level	6	12.390*	68.738***	3.629	11.937**	3.289	0.017
		(1.666)	(5.236)	(1.406)	(1.977)	(1.422)	(0.010)
	12	19.034*	54.579***	8.150	14.501	3.727	0.008
		(1.666)	(4.007)	(1.372)	(1.679)	(1.433)	(0.010)
	18	22.164*	46.860***	11.194	15.867	3.910	0.005
		(1.653)	(3.641)	(1.355)	(1.570)	(1.417)	(0.010)
	24	23.931*	42.063***	13.105	16.862	4.035	0.004
		(1.652)	(3.716)	(1.340)	(1.510)	(1.391)	(0.010)

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

Table B.6: Forecast Error Variance Decompositions of maturity, output and price level in Alternative Model 4

	Periods	Maturity	Output	Price Level	Exchange Rate	Fiscal	Interest rate	M1R
Maturity	6	83.202***	10.010*	0.133***	2.217	4.243*	0.110	0.084
		(6.427)	(1.874)	(4.365)	(1.485)	(1.743)	(0.010)	(0.010)
	12	76.740***	13.890*	0.768*	4.576	3.676*	0.215***	0.136
		(4.951)	(1.735)	(1.928)	(1.467)	(1.797)	(6.880)	(0.010)
	18	73.687***	14.692*	1.476*	6.154	3.563*	0.271***	0.157
		(4.871)	(1.691)	(1.733)	(1.434)	(1.832)	(4.564)	(0.010)
	24	72.483***	14.805*	1.979*	6.753	3.525*	0.288***	0.167
		(4.820)	(1.684)	(1.717)	(1.461)	(1.836)	(4.389)	(0.010)
Output	6	1.871**	82.513***	1.305**	6.621*	4.485*	1.637*	1.566*
		(1.979)	(7.185)	(2.035)	(1.790)	(1.769)	(1.955)	(1.690)
	12	1.883***	82.307***	1.354**	6.630**	4.484*	1.643**	1.699*
		(2.611)	(6.773)	(2.308)	(1.964)	(1.804)	(2.001)	(1.744)
	18	1.883***	82.196***	1.464**	6.635**	4.481*	1.641**	1.700*
		(2.723)	(6.693)	(2.479)	(2.004)	(1.813)	(2.031)	(1.843)
	24	1.892***	82.070***	1.578***	6.647**	4.479*	1.638**	1.697*
		(2.749)	(6.625)	(2.633)	(2.012)	(1.818)	(2.032)	(1.850)
Price Level	6	4.221	12.378*	67.669***	12.204*	3.249	0.274*	0.005
		(1.438)	(1.843)	(4.783)	(1.961)	(1.410)	(1.694)	(0.010)
	12	8.834	18.815*	52.980***	15.256	3.798	0.312*	0.006
		(1.376)	(1.819)	(3.517)	(1.645)	(1.389)	(1.759)	(0.010)
	18	11.974	21.950*	44.594***	17.108	4.007	0.360*	0.007
		(1.352)	(1.773)	(3.105)	(1.543)	(1.372)	(1.682)	(0.010)
	24	13.963	23.757*	39.205***	18.528	4.140	0.400	0.006
		(1.342)	(1.746)	(2.823)	(1.503)	(1.364)	(1.600)	(0.010)

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

Table B.7: Forecast Error Variance Decompositions of maturity, output and price level in Alternative Model 5

	Periods	Output	Price Level	Maturity	Exchange Rate	Fiscal	Interest Rate	M1R
Maturity	6	9.208	0.048	84.089***	2.217	4.243*	0.110	0.084
		(1.632)	(0.010)	(5.119)	(1.443)	(1.900)	(0.010)	(0.010)
	12	12.973	0.479***	77.946***	4.576	3.676*	0.215***	0.136
		(1.593)	(10.756)	(4.103)	(1.462)	(1.878)	(4.439)	(0.010)
	18	13.768	1.086***	75.002***	6.154	3.563*	0.271***	0.157
		(1.569)	(2.603)	(3.944)	(1.453)	(1.899)	(3.613)	(0.010)
	24	13.885	1.546**	73.835***	6.753	3.525*	0.288***	0.167
		(1.591)	(2.293)	(3.908)	(1.444)	(1.934)	(3.478)	(0.010)
Output	6	82.403***	1.408**	1.878	6.621*	4.485*	1.637*	1.566*
		(7.228)	(1.996)	(1.573)	(1.907)	(1.783)	(1.791)	(1.724)
	12	82.198***	1.455**	1.891*	6.630**	4.484*	1.643*	1.699*
		(6.779)	(2.143)	(1.812)	(1.995)	(1.824)	(1.891)	(1.823)
	18	82.087***	1.564**	1.893*	6.635**	4.481*	1.641*	1.700*
		(6.754)	(2.280)	(1.871)	(2.008)	(1.843)	(1.896)	(1.824)
	24	81.960***	1.680**	1.899*	6.647**	4.479*	1.638*	1.697*
		(6.697)	(2.427)	(1.918)	(2.024)	(1.845)	(1.929)	(1.828)
Price Level	6	12.144*	68.785***	3.339	12.204**	3.249	0.274*	0.005
		(1.861)	(4.729)	(1.390)	(1.964)	(1.401)	(1.906)	(0.010)
	12	18.400*	54.457***	7.772	15.256*	3.798	0.312*	0.006
		(1.834)	(3.509)	(1.375)	(1.700)	(1.385)	(1.875)	(0.010)
	18	21.428*	46.205***	10.885	17.108	4.007	0.360*	0.007
		(1.836)	(3.175)	(1.354)	(1.587)	(1.375)	(1.807)	(0.010)
	24	23.171*	40.863***	12.893	18.528	4.140	0.400*	0.006
		(1.808)	(3.095)	(1.342)	(1.538)	(1.369)	(1.662)	(0.010)

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

Table B.8: Forecast Error Variance Decompositions of maturity, output and price level in Alternative Model 6

	Periods	Output	Price Level	Fiscal	Maturity	Exchange Rate	Interest Rate	M1R
Maturity	6	9.208	0.048	12.458*	77.370***	0.722*	0.110	0.084
		(1.605)	(0.010)	(1.935)	(4.434)	(1.760)	(0.010)	(0.010)
	12	12.973	0.479***	12.464*	71.407***	2.326	0.215***	0.136
		(1.548)	(9.151)	(1.865)	(3.616)	(1.533)	(5.855)	(0.010)
	18	13.768	1.086***	12.739*	68.517***	3.463	0.271***	0.157
		(1.543)	(2.608)	(1.845)	(3.549)	(1.496)	(5.256)	(0.010)
	24	13.885	1.546**	12.819*	67.387***	3.907	0.288***	0.167
		(1.541)	(2.256)	(1.832)	(3.566)	(1.473)	(4.496)	(0.010)
Output	6	82.403***	1.408*	7.131**	2.998*	2.856*	1.637*	1.566*
		(7.464)	(1.873)	(1.979)	(1.657)	(1.749)	(1.854)	(1.737)
	12	82.198***	1.455**	7.132**	3.011*	2.862**	1.643*	1.699*
		(6.881)	(2.116)	(2.063)	(1.821)	(2.008)	(1.951)	(1.761)
	18	82.087***	1.564**	7.130**	3.012*	2.867**	1.641*	1.700*
		(6.770)	(2.234)	(2.072)	(1.832)	(2.035)	(1.959)	(1.797)
	24	81.960***	1.680**	7.137**	3.013*	2.876**	1.638**	1.697*
		(6.738)	(2.435)	(2.085)	(1.833)	(2.058)	(1.978)	(1.827)
Price Level	6	12.144*	68.785***	9.743*	2.070	6.979*	0.274*	0.005
		(1.740)	(5.241)	(1.704)	(1.419)	(1.745)	(1.662)	(0.010)
	12	18.400*	54.457***	12.392	5.574	8.859	0.312*	0.006
		(1.725)	(3.751)	(1.590)	(1.361)	(1.532)	(1.744)	(0.010)
	18	21.428*	46.205***	13.810	8.116	10.073	0.360	0.007
		(1.694)	(3.257)	(1.520)	(1.348)	(1.453)	(1.634)	(0.010)
	24	23.171*	40.863***	14.781	9.758	11.022	0.400	0.006
		(1.648)	(3.073)	(1.489)	(1.330)	(1.428)	(1.571)	(0.010)

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

Table B.9: Forecast Error Variance Decompositions of maturity, output and price level in Alternative Model 7

	Periods	Maturity	Output	Price Level	Exchange Rate	Interest Rate	M1R
Maturity	6	81.398***	12.414*	0.694*	1.600	3.807	0.086
		(5.649)	(1.690)	(1.766)	(1.503)	(1.608)	(0.010)
	12	70.295***	18.949	2.473*	4.787	3.320*	0.177
		(4.236)	(1.604)	(1.760)	(1.453)	(1.808)	(0.010)
	18	63.536***	19.297	5.164*	8.191	3.512*	0.300
		(4.413)	(1.619)	(1.697)	(1.410)	(1.775)	(0.010)
	24	59.279***	18.787	7.429	10.453	3.651*	0.400
		(4.856)	(1.636)	(1.640)	(1.410)	(1.791)	(0.010)
Output	6	2.366***	79.729***	3.201**	3.221*	8.483*	3.000*
		(3.725)	(7.010)	(1.966)	(1.879)	(1.945)	(1.900)
	12	2.835***	78.484***	3.781**	3.513*	8.350*	3.037*
		(4.269)	(6.749)	(2.114)	(1.922)	(1.937)	(1.953)
	18	3.005***	77.920***	4.188**	3.574**	8.287**	3.025*
		(4.260)	(6.720)	(2.062)	(2.013)	(1.971)	(2.006)
	24	3.088***	77.697***	4.377**	3.565**	8.257**	3.016*
		(4.117)	(6.667)	(2.034)	(2.154)	(1.998)	(2.015)
Price Level	6	2.975	16.336*	67.123***	7.722*	5.810	0.035
		(1.565)	(1.811)	(4.393)	(1.779)	(1.631)	(0.010)
	12	5.355	26.862*	45.794***	15.144*	6.822	0.023
		(1.468)	(1.859)	(3.282)	(1.655)	(1.622)	(0.010)
	18	6.308	31.730*	31.055***	22.802	8.030	0.075
		(1.460)	(1.814)	(3.123)	(1.582)	(1.604)	(0.010)
	24	6.360	33.801*	21.447***	29.285	8.937	0.171
		(1.489)	(1.797)	(3.410)	(1.544)	(1.591)	(0.010)

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.

Table B.10: Forecast Error Variance Decompositions of maturity, output and price level in Alternative Model 8

	Periods	Maturity	Output	Price Level	Exchange Rate	Interest Rate	M1R
Maturity	6	81.398***	12.414*	0.694*	1.600	3.807	0.086
		(5.649)	(1.690)	(1.766)	(1.503)	(1.608)	(0.010)
	12	70.295***	18.949	2.473*	4.787	3.320*	0.177
		(4.236)	(1.604)	(1.760)	(1.453)	(1.808)	(0.010)
	18	63.536***	19.297	5.164*	8.191	3.512*	0.300
		(4.413)	(1.619)	(1.697)	(1.410)	(1.775)	(0.010)
	24	59.279***	18.787	7.429	10.453	3.651*	0.400
		(4.856)	(1.636)	(1.640)	(1.410)	(1.791)	(0.010)
Output	6	2.366***	79.729***	3.201**	3.221*	8.483*	3.000*
		(3.725)	(7.010)	(1.966)	(1.879)	(1.945)	(1.900)
	12	2.835***	78.484***	3.781**	3.513*	8.350*	3.037*
		(4.269)	(6.749)	(2.114)	(1.922)	(1.937)	(1.953)
	18	3.005***	77.920***	4.188**	3.574**	8.287**	3.025**
		(4.260)	(6.720)	(2.062)	(2.013)	(1.971)	(2.006)
	24	3.088***	77.697***	4.377**	3.565**	8.257**	3.016**
		(4.117)	(6.667)	(2.034)	(2.154)	(1.998)	(2.015)
Price Level	6	2.975	16.336*	67.123***	7.722*	5.810*	0.035
		(1.565)	(1.811)	(4.393)	(1.779)	(1.631)	(0.010)
	12	5.355	26.862*	45.794***	15.144*	6.822	0.023
		(1.468)	(1.859)	(3.282)	(1.655)	(1.622)	(0.010)
	18	6.308	31.730*	31.055***	22.802	8.030	0.075
		(1.460)	(1.814)	(3.123)	(1.582)	(1.604)	(0.010)
	24	6.360	33.801*	21.447***	29.285	8.937	0.171
		(1.489)	(1.797)	(3.410)	(1.544)	(1.591)	(0.010)

* significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.
t-statistics are reported under the forecast error variance fractions in parentheses.