

Interest Rate Uncertainty and Macroeconomics in Turkey*

Pelin Öge Güney  ^a

a Hacettepe University, Faculty of Economics and Administrative Sciences, Department of Economics, Ankara, Turkey.

E-mail: pelinoge@hacettepe.edu.tr

Abstract

Uncertainty about monetary policy associated with uncertainty in interest rate is an important determinant of economic decisions. Due to the dominant position of the US economy on global financial markets, in addition to countries' own uncertainties, uncertainty related to the monetary policy of the USA may have an impact on other economies. In this study, we investigated the impact of interest rate uncertainties for different maturities on industrial production, inflation, unemployment and exchange rate. We used the impulse response functions based on the vector error correction model (VECM). We also conducted the Granger causality test to analyse the causality. We examined the impact of US monetary policy uncertainty on the mentioned variables of Turkey. Our findings suggest that uncertainty in long-term interest rates increases unemployment and inflation rates. Although we find that uncertainty in interest rate reduces growth of industrial production, we do not find a causal relationship between these variables. Finally, we show that a shock related to US monetary policy uncertainty tends to increase unemployment significantly, while reducing the growth of production.

Keywords: uncertainty, interest rate, VAR model, macroeconomics

JEL Classification: E43, E52, E58

1. Introduction

Monetary authorities can affect the behaviour of economic agents by changing the interest rate. Uncertainty in the interest rate can be related to uncertainty in monetary policy. That is, uncertainty in monetary policy indicates potential future changes in interest rates.

* This work was sponsored by the Economic Research Forum (ERF) and has benefited from both financial and intellectual support. The contents and recommendations do not necessarily reflect the ERF's views. I am grateful also to the anonymous reviewers for their helpful suggestions.

In general, uncertainty influences decisions about consumption, investment, trade or employment. Uncertainty in the interest rates can be expected to affect the economy in various ways. For example, uncertainty in interest rates leads to an increase in the risk of holding bonds. In this situation, economic agents prefer to increase their money holdings, and as a result, as the money demand increases, interest rates increase. Higher levels of interest rates reduce investment and output. In addition, interest rate uncertainty in a country makes that economy's debt riskier and discourages capital inflows. Central banks try to ensure that expectations of the public regarding future monetary policy and interest rates are more accurate by following transparent policies. Reduced uncertainty about interest rates allows a more accurate estimation of financial costs. Thus, decreasing public risk perception positively affects investment decisions and firm hiring activity.

Although traditional wisdom is that reducing volatility of the future direction of interest rate has a positive effect on the economy, the impact of uncertainty in the interest rate may differ according to countries' economic and institutional structures. For example, countries whose economies rely on manufacturing industries that require long-term projects are more sensitive to uncertainty in the interest rate. Alternatively, in countries with strict labour market regulations, it is difficult to lay off according to changes in expectations. In addition, although they use the same data, economic decision makers' expectations about future interest rates may differ. In this study, we conduct an empirical analysis of the relationship between uncertainty in interest rate and macroeconomic variables for Turkey.

In Turkey, after the 2001 crisis, transition to inflation targeting was launched and implicit inflation targeting was adapted by the Central Bank of the Republic of Turkey (CBRT) from January 2002 to December 2005. An explicit inflation targeting regime started to be implemented in January 2006. In this policy framework, the main policy tool is the short-term rates. Following the implementation of inflation targeting, a stronger link was observed between the spending decisions and the interest rate (see Kara et al., 2007; Başçı et al., 2008). Although the monetary policy transmission mechanism for Turkey is widely investigated (see, e.g., Us, 2004; Aydın, 2007; Kara et al., 2007; Başçı et al., 2008), as far as we know, the effect of interest rate uncertainty on macro variables has not been analysed.

The experience of the last global crisis has led the CBRT to implement a new monetary policy that takes into account both price stability and financial stability. In order to achieve these objectives, new policy tools, such as the interest rate corridor, have been adopted. According to this policy, the policy interest rate of the CBRT fluctuates within the band and the central bank has the ability to increase uncertainty about the future policy rate by widening this corridor. This

policy is already a source of uncertainty on its own. In addition to this policy change, other factors have also led to uncertainty in monetary policy in Turkey. We can list these factors as follows: frequent changes of the CBRT governor, interest rate cuts to support economic growth through consumption, interventions in the foreign exchange market. From this point of view, in this study, we investigate the relationship between uncertainties in the interest rates and macroeconomic variables in Turkey. Understanding how interest rate uncertainties affect macroeconomic variables can be a guide for central banks in planning monetary policies.

In addition to countries' own monetary policies, the Federal Open Market Committee's (FOMC) decisions about monetary policy are closely followed by investors around the world due to countries' trade integration and financial links with the USA. Besides, the dominant position of the US economy on global financial markets causes economies that are not geographically close to the USA or less integrated in terms of trade to be affected by US monetary policy. Lastauskas and Nguyen (2021) state that monetary policy uncertainty can be the source of global business cycles. Taking into account the argument that uncertainties regarding the US monetary policy significantly affect other economies, we also analyse the impacts of uncertainty about the monetary policy of the USA (MPU) on the Turkish economy. To the best of our knowledge, this effect has not been analysed for Turkey in previous studies.

According to our findings, the first effect of the uncertainty in the 5-year yield on the exchange rate is depreciation. Following an initial depreciation, the exchange rate temporarily appreciates. If we consider inflation, we see that shocks in interest rate uncertainty lead to an increase in inflation rate. On the other hand, we observe that the responses of the growth of industrial production to the uncertainty in the interest rate shocks are negative. However, the Granger causality test does not imply a causal relationship between these variables. Additionally, we observe that unemployment worsens in response to a shock in long-yield uncertainty. Finally, considering the response of Turkish macroeconomic variables to a shock in US monetary policy uncertainty, we observe that a shock in US monetary policy uncertainty increases unemployment and decreases growth of production.

The paper is organized as follows. In Section 2, we present the existing literature. The methodology is provided in Section 3. In Section 4, we present estimation results. Finally, in the last section, we discuss policy implications and provide concluding remarks.

2. Literature Review

A growing body of empirical and theoretical literature investigates the effect of uncertainty on macroeconomic variables and monetary policy (see, e.g., Bloom, 2009; Baker et al., 2015; Aastveit et al., 2013; Fernández-Villaverde et al., 2011; Bekart et al., 2013; Ludvigson et al., 2015; Ulrich, 2012; Pastor and Veronesi, 2012; Güney, 2016). Furthermore, a limited number of studies investigate the macroeconomic impacts of uncertainty in interest rates. For example, Creal and Wu (2017) investigated the relationship between interest rate uncertainty and selected macro variables for the USA. They divide the long-term interest rate into two components, namely risk premium uncertainty and uncertainty in monetary policy. According to their analysis using a vector autoregression (VAR) model, uncertainty affects economic activity negatively. In addition, they found that monetary policy uncertainty and term premium uncertainty react in opposite directions to the unemployment rate. Istrefi and Mouabbi (2016) analysed the impact of uncertainty about short and long-term interest rates on the economy for ten developed economies. According to their findings, uncertainty in the interest rate has a negative effect on unemployment and industrial production. In addition, they showed that uncertainty about short-term rates has stronger quantitative effects on the economy relative to uncertainty about long-term rates. Using a vector autoregression, Bundick et al. (2017) found that a decline in the interest rate uncertainty leads to an increase in industrial production and inflation for the USA.

Fasolo (2019) found that an increase in monetary policy volatility, meaning unexpected decisions about interest rates, causes higher inflation and lower output in Brazil. In addition, according to his findings, monetary policy shocks depreciate the exchange rate. Contrary to that, Benigno et al. (2012) provided evidence that unexpected changes in monetary policy cause an appreciation of the domestic currency. Using a SVAR model, Mumtaz and Zanetti (2013) showed that there is a positive correlation between monetary policy volatility shocks and prices and output level for the USA. Mumtaz and Theodoridis (2020) showed that monetary policy shocks increase macroeconomic volatility. According to Husted et al. (2017), a greater uncertainty in monetary policy causes an increase in credit costs and a decrease in output.

Some papers analyse the impact of uncertainty in US monetary policy on other economies. Park et al. (2020) showed that uncertainty about US monetary policy tends to increase the volatility of the exchange rate for some Asian economies. Bhattarai et al. (2020) emphasized that US stock market uncertainty has an adverse effect on some macroeconomic variables such as exchange rate, output and inflation in emerging countries. Lastauskas and Nguyen (2021) stated that US interest rate uncertainty can be the source of global business cycles. According to their findings,

the magnitude of the negative effect of monetary policy uncertainty on economies depends on cross-country interdependence. Lakdawala et al. (2021) showed that US monetary policy uncertainty has a significant effect on global bond and equity markets. They also found that financial openness in developing economies is closely related to the response to uncertainty.

For Turkey, there are few papers in the literature regarding monetary policy uncertainty. Aktaş et al. (2009) investigated the effect of policy rate changes on financial markets by separating monetary policy into expected and unexpected components. They showed that monetary surprises have a significant impact on financial variables. Çevik and Erduman (2020) measured monetary policy uncertainty for Turkey using survey-base data. They showed that the impact of monetary policy uncertainty on economic activity is negative.

3. Methodology and Analysis

The main question of our study is whether interest rate uncertainty is a matter for the Turkish economy. For this purpose, we investigate the responses of growth in industrial production, inflation, unemployment and exchange rate to interest rate uncertainties for different maturities.

Recent studies that focus on the relationship between uncertainty and macroeconomics generally use vector autoregressive (VAR) models and impulse responses (Bekaert et al., 2013; Aastveit et al., 2013; Baker et al., 2016; Jurado et al., 2015; Creal and Wu, 2017). This method allows examining the interaction of variables with each other. In addition, necessary constraints can be placed on the model.

The structural form of the VAR model is presented as:

$$Az_t = \tau + \Psi_1 z_{t-1} + \dots + \Psi_p z_{t-p} + BV_t \quad (1)$$

where z_t is an $(nx1)$ vector of time series. V_t are the structural disturbances, which are assumed to be a white noise process. A is an (nxn) matrix. B is a normalized matrix whose diagonal contains only ones. We pre-multiply Equation (1) by A^{-1} to obtain the reduced form of the equation system:

$$\begin{aligned} z_t &= A^{-1}\tau + A^{-1}\Psi_1 z_{t-1} + \dots + A^{-1}\Psi_p z_{t-p} + A^{-1}BV_t \\ z_t &= \mu + \theta_1 z_{t-1} + \dots + \theta_p z_{t-p} + u_t \end{aligned} \quad (2)$$

where

$$A\mu = \tau$$

$$A\mu_\tau = BV_\tau$$

$$\Psi_j = A\theta_j, \quad j = 1, 2, \dots, p$$

θ_i is an $(n \times n)$ matrix, u represents reduced-form disturbances, p represents maximum lag in the VAR model. The Akaike information criterion was used to select the lag length. $E(u_t) = 0$, $E(u_t, u'_t) = \theta$, $E(u_t, u'_{t-k}) = 0$, for any non-zero k . After identifying A and B , the impulse response functions are defined (see Neusser, 2016).

Usually, cointegration analysis is performed before the estimation of the VAR model. Depending on the existence of cointegrating vectors, the type of VAR model to be used can be determined (i.e., VECM). Therefore, at the first stage of our estimation, we performed an ADF unit root test to determine the orders of integration for the variables. Even if a variable is individually not stationary, a long-term relationship between series can exist, i.e., series are cointegrated.

To examine the existence of cointegration, we used the bound testing approach developed by Pesaran and Shin (1999) and Pesaran et al. (2001), based on the ARDL model. The advantage of this approach is that it can be used to test for the existence of a long-run relationship between variables, irrespective whether the variables are $I(0)$ or $I(1)$. In order to reject the null hypothesis of no cointegration, the calculated F-statistical value must be greater than the upper critical value.

The vector error correction model (VECM) is used when the variables in the vector are not stationary and there are at least one or more cointegration relationships between the variables. The VECM can have the following form:

$$\Delta z_t = \mu + \pi z_{t-1} + \sum_{i=1}^{p-1} \phi_i \Delta z_{t-i} + u_t \quad (3)$$

where Δ is the first-difference operator. As can be seen from the above equation, the VECM is a VAR in first differences with the addition of the error correction term πz_{t-1} , which is derived from the cointegrating relationship. To evaluate the interaction between variables, an impulse response function based on the VECM is used.

Since the cointegration between two variables itself does not imply causality, to clarify our findings we investigated the causal relationship between variables. We performed the Granger causality tests to specify the direction of causality, if any. If the lagged values of the X series (along with the lagged Y values) provide statistically significant information about the future values of Y , it means that X is the Granger cause of Y . The test can be based on an F-statistic.

It is important to determine the identification strategy at this stage. However, there is no consensus in the literature on the best way to identify shocks to uncertainty. It is argued that simultaneous changes in uncertainty both cause fluctuations in macroeconomic variables

and can be affected by these fluctuations. This can be excluded by using particular recursive ordering because in this way, it is assumed that some variables respond to others with a lag. It is useful in this respect that we use a survey-based measure of uncertainty. Following Leduc and Sill (2013) and Istrefi and Mouabbi (2016), we took the timing of the survey into account in assessing the impact of the shock on future macroeconomic variables. That is to say, while economic agents make forecasts at the time t , the estimation is made using only macroeconomic data for the past period. Measuring interest rate uncertainty ex-ante in this way allows us to follow a recursive identification strategy. In our model, the uncertainty measure is positioned first in the VEC ordering. Thus, innovations in uncertainty will affect macro variables immediately, while uncertainty will respond to other innovations with a delay.

Our model includes the interest rate uncertainty measures, industrial production (IP), inflation rate (INF), real exchange rate ($REXC$) and the unemployment rate ($UNEM$) as endogenous variables. In addition, we include oil prices (OIL) as an exogenous variable.

To obtain the error correction term and then specify the VECM, we first define the long-run relationship as follows:

$$REXC_t = a_1 + a_2 UNC_t + a_3 INF_t + a_4 IP_t + a_5 UNEMP_t + u_t \quad (4)$$

where u_t is the error-correction term that is an indicator of the rate of convergence of each variable towards the long-run equilibrium value. The VECM model including the error-correction term can be written as:

$$\begin{aligned} \Delta REXC_t = & \alpha_1 + p_1 u_{t-1} + \sum_{i=0}^n \beta_i \Delta REXC_{t-i} + \sum_{i=0}^n \delta_i \Delta UNC_{t-i} + \sum_{i=0}^n \gamma_i \Delta INF_{t-i} + \\ & + \sum_{i=0}^n \phi_i \Delta IP_{t-i} + \sum_{i=0}^n \theta_i \Delta UNEMP_{t-i} + \Delta OIL_t + \varepsilon_{1t} \end{aligned} \quad (5)$$

$$\begin{aligned} \Delta INF_t = & \alpha_2 + p_2 u_{t-1} + \sum_{i=0}^n \beta_i \Delta REXC_{t-i} + \sum_{i=0}^n \delta_i \Delta UNC_{t-i} + \sum_{i=0}^n \gamma_i \Delta INF_{t-i} + \\ & + \sum_{i=0}^n \phi_i \Delta IP_{t-i} + \sum_{i=0}^n \theta_i \Delta UNEMP_{t-i} + \Delta OIL_t + \varepsilon_{2t} \end{aligned} \quad (6)$$

$$\begin{aligned} \Delta IP_t = & \alpha_3 + p_3 u_{t-1} + \sum_{i=0}^n \beta_i \Delta REXC_{t-i} + \sum_{i=0}^n \delta_i \Delta UNC_{t-i} + \sum_{i=0}^n \gamma_i \Delta INF_{t-i} + \sum_{i=0}^n \phi_i \Delta IP_{t-i} + \\ & + \sum_{i=0}^n \theta_i \Delta UNEMP_{t-i} + \Delta OIL_t + \varepsilon_{3t} \end{aligned} \quad (7)$$

$$\begin{aligned}\Delta UNEMP_t = & \alpha_4 + p_4 u_{t-1} + \sum_{i=0}^n \beta_i \Delta REXC_{t-i} + \sum_{i=0}^n \delta_i \Delta UNC_{t-i} + \sum_{i=0}^n \gamma_i \Delta INF_{t-i} + \sum_{i=0}^n \varphi_i \Delta IP_{t-i} + \\ & + \sum_{i=0}^n \theta_i \Delta UNEMP_{t-i} + \Delta OIL_t + \varepsilon_{4t}\end{aligned}\quad (8)$$

where β_i , δ_i , γ_i , φ_i , and θ_i are short-run coefficients, ε_{it} are residuals and p are error-correction coefficients.

We use a CPI-based real effective exchange rate. Since the real effective exchange rate and unemployment variable are non-stationary at level, we use the first difference of their log. We use the log of seasonally adjusted industrial production series. Percentage change in the consumer price index presents the inflation series. Data on crude oil prices in US dollars per barrel are the price of Dubai Fateh crude oil. We focus on different yield uncertainties. Firstly, we use uncertainty in the central bank policy rates as a measure of short-term interest rate uncertainty (*unc_policy rate*). In addition, we use uncertainty in 5-year government bond rates (*unc_5Y bond yield*), which is a measure of long-term interest rate uncertainty. Different methods are suggested in the literature to measure uncertainty (see Lensink, 2002). Some of them are based on conditional volatility series or ex-post forecast errors. Some others belong to keyword counts in newspapers or expectation surveys. Following Zarnowitz and Lambros (1987), Bomberger (1996), Bachmann et al. (2013) or Istrefi and Mouabbi (2018), we use survey-based uncertainty. We obtained the uncertainty in interest rate data from the Central Bank of the Republic of Turkey (CBRT) survey of expectations. In this survey, participants were asked about their views for variables such as interest rate, GDP growth rate, exchange rate and inflation rate. The survey was conducted one week before the Monetary Policy Committee meetings. Participants consisted of economists and experts of banks, other financial institutions, academia and large non-financial firms. We take the series of the standard deviation of expected one-week CBRT repo auction interest rate as the uncertainty in policy rate. The 5-year government bond uncertainty rate is the series of standard deviation of expected compound interest rate of government bond with maturity of about five years.

To investigate whether uncertainty in US monetary policy is a matter for the Turkish economy, we use the MPU index for the US economy obtained from Baker et al. (2016) (*mpuusa*). To construct the MPU index, they identified the occurrence of certain keywords in newspaper articles.

Our data include monthly data from 2002:01 to 2020:12. The reason for choosing the starting year is that it is the year in which implicit inflation targeting started to be implemented. We obtained the data from International Monetary Fund International Financial Statistics (IFS) and

the CBRT's Electronic Data Delivery System (EDDS). The MPU index for the US economy is obtained from Baker et al. (2016). For reasons of data availability, our model with policy rate and 5-year government bond rate uncertainty covers the period 2010M06-2020:12 and 2006:04-2020:12, respectively.

4. Empirical Results

4.1 Stationarity test

The results presented in Table 1 indicate that we have both stationary and non-stationary variables at level and the first difference of all variables is $I(0)$. Next, it is necessary to test the possibility of cointegration. By determining whether cointegrating vectors exist or not, the type of VAR model to be used can also be determined.

Table 1: ADF unit root test results

	Level			First difference		
	Intercept	Trend and intercept	No trend and no Intercept	Intercept	Trend and intercept	No trend and no intercept
INF	−9.432*	−9.004*	−6.174*	−8.228*	−8.764*	−8.117*
IP	−15.793*	−15.763*	−15.560*	−12.607*	−12.586*	−12.370*
REXC	−0.191	−1.404	−1.002	−11.584*	−11.673*	−11.653*
UNEMP	−2.577***	−3.034	0.423	−4.219*	−4.284*	−4.189*
OIL	−2.734***	−2.600	−0.888	−9.103*	−9.134*	−9.121*
unc_policy rate	−6.913*	−6.911*	−2.340**	−6.911*	−6.922*	−2.340**
unc_5Y bond yield	−3.318**	−3.299***	−1.152*	−11.608*	−11.613*	−11.643*
mpuusa	−7.463*	−7.473*	−2.756*	−10.866*	−10.842*	−10.891*

Source: author's calculations

Note: *, ** and *** denote significance at 1%, 5% and 10% levels respectively.

4.2 Cointegration test

Since we have variables with different order of integration, the most appropriate method for cointegration analysis is the bound testing methodology. The results of the bound testing are presented in Table 2. The computed F-statistics fall above the upper critical values for the two models, which include the *unc_5y* bond yield and *mpuusa*, respectively. This means that we can reject the null hypothesis of no cointegration for these models. Thus, we can say there is cointegration. Given that the cointegration relationship is identified, impulse response analyses are performed based on the VECM presented in Equations (5)–(8).

Table 2: Results of ARDL bound test

	Lap order (<i>n</i>)	F-statistics
With <i>unc_policy</i> rate	2	2.073
With <i>unc_5Y</i> bond yield	2	3.730***
With <i>mpuusa</i>	3	9.127*

Source: author's calculations

Notes: * and *** denote significance at 1% and 10% levels respectively. The F -statistic is compared with the critical bounds of the F-statistic for unrestricted intercept and no trend provided in Pesaran et al. (2001), Table CI(iii) Case III. The lag length for each model is determined according to Akaike information criteria.

4.3 Impulse response function

The effects of different yield uncertainties on the real exchange rate, inflation, industrial production and unemployment were assessed by impulse response functions. The ordering in computing impulse responses was interest rate uncertainty, real exchange rate, inflation, industrial production and unemployment rate.

We present the impulse response functions in Figure 1. As the figure evidences, an unexpected increase in 5-year bond rates uncertainty causes volatility in the real exchange rate. In response to this uncertainty, the real exchange rate temporarily depreciates within two months after the shock hits. Following, increases in policy rate uncertainty lead to a temporary appreciation of the real exchange rate.

Figure 1: Impulse responses to interest uncertainty shock

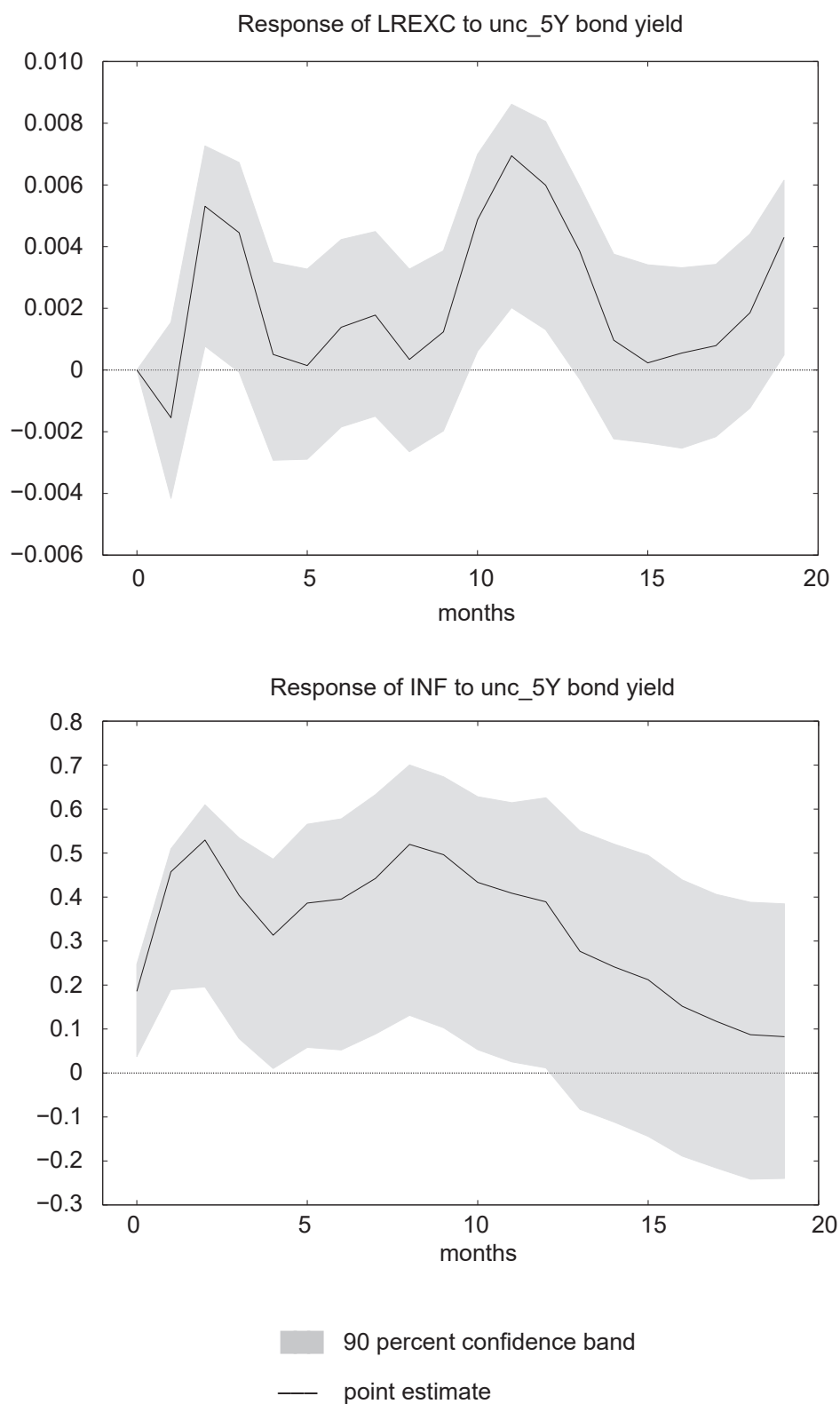
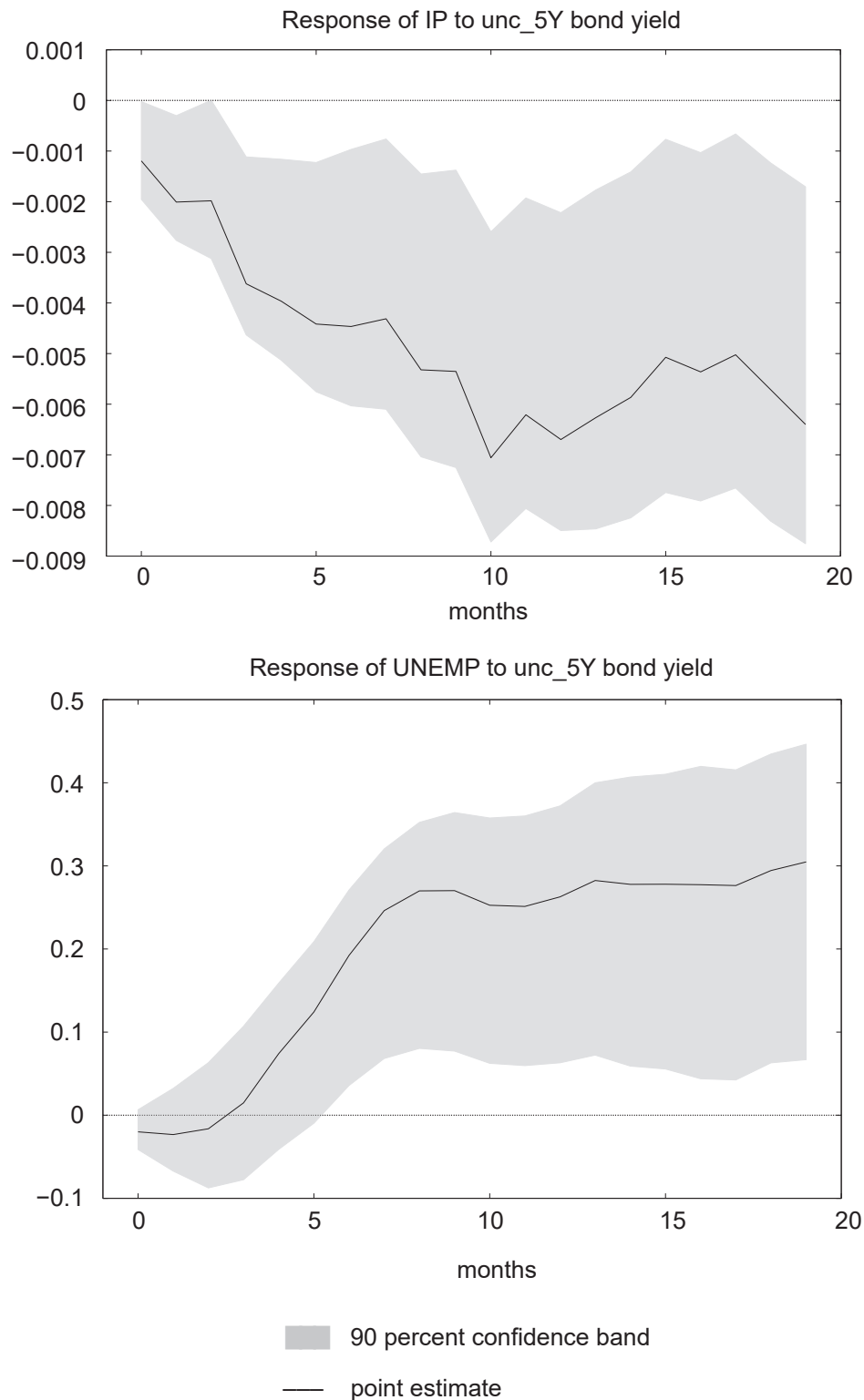


Figure 1: Continuation

Source: author's calculations

Note: The figure presents the response of the Turkish macroeconomy to a shock in interest rate uncertainty for 5-year bond rates. The VECs include oil prices as an exogenous variable. The horizontal axis is in months.

From Figure 1, we can see that the inflation rate responds immediately and positively to uncertainty in the 5-year yield, with rates increasing around 0.5 percentage points following these shocks. Additionally, we observe that the response of inflation to an increase in interest rate uncertainty remains relatively stable over time. We observe that growth of industrial production responds negatively to uncertainty in the 5-year yield. However, the decline in growth of industrial production is not quantitatively relevant. If we look at the effect of shock in the interest rate uncertainty on unemployment, it is seen that when there is a shock in the 5-year yield, the unemployment rate responds positively to the uncertainty shock, with a rate of approximately 0.3 percentage points. That is, a shock in interest rate uncertainty further increases the unemployment level.

Figure 2 shows the impulse responses of the real exchange rate, industrial production, inflation and unemployment to an uncertainty shock in US monetary policy. It is seen that an uncertainty shock in US monetary policy results in a depreciation in the real exchange rate after the shock hits. However, this response is not statistically significant. On the other hand, the inflation rate increases after a positive MPU shock. The response takes two months to reach its maximum level and remains effective for a long time. Inflation responds with rates increasing around 0.1 percentage points two months after the shocks. However, this response is not statistically significant. In the case of industrial production, we see that although quantitatively irrelevant, the reaction of growth of industrial production to an MPU shock is negative and long-lived. Finally, we observe that when there is a shock in the MPU, about two months after the shock, the unemployment rate responds positively to the uncertainty shock, with a rate of approximately 0.6 percentage points.

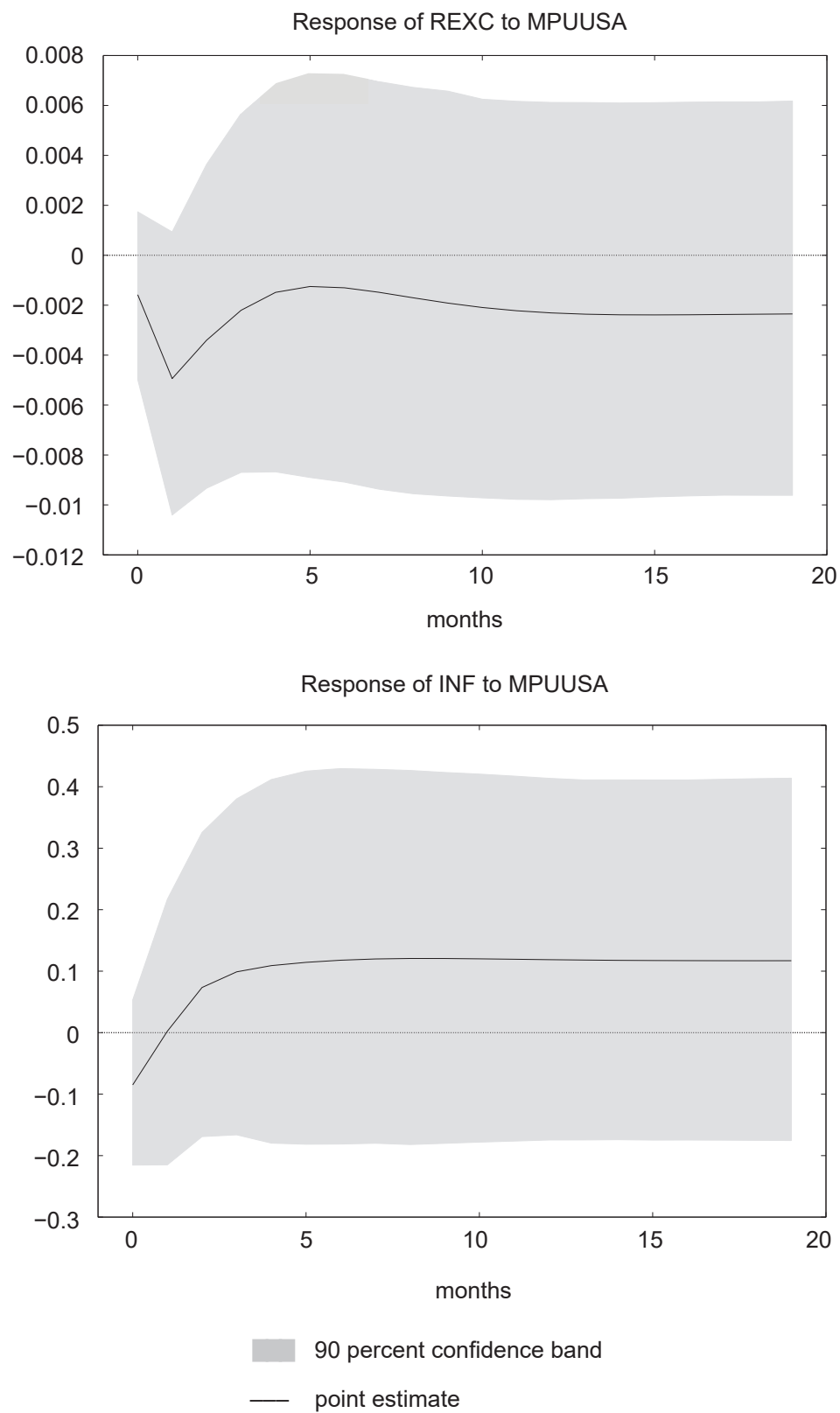
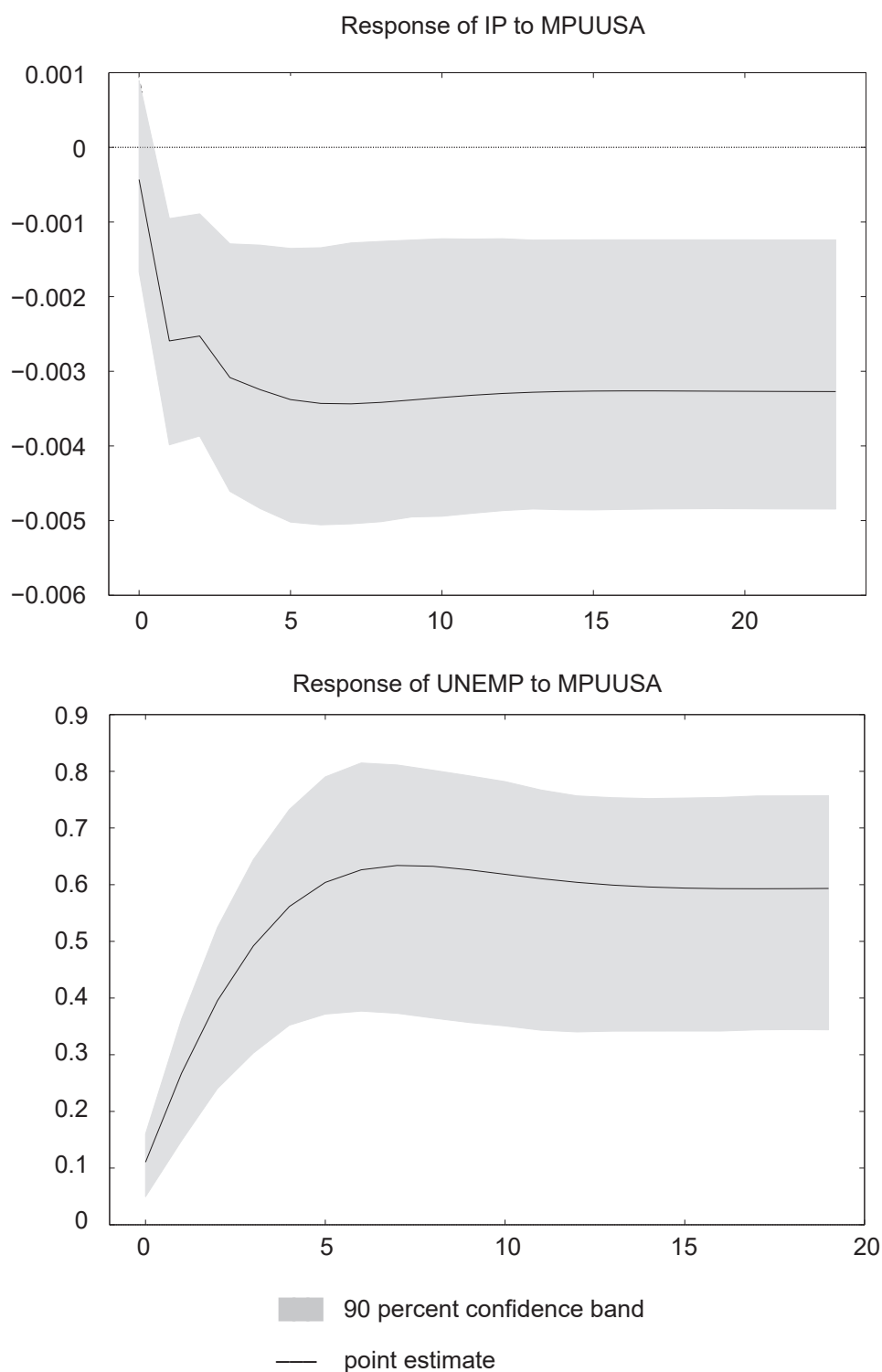
Figure 2: Impulse responses to US monetary policy uncertainty shock

Figure 2: Continuation



Source: author's calculations

Note: The figure presents the response of the Turkish macroeconomy to a shock in US monetary policy uncertainty. The VECs include oil prices as an exogenous variable. The horizontal axis is in months.

4.4 Granger causality tests

Since the cointegration between two variables itself does not imply a causal relationship, we performed Granger causality tests. We provide the estimates in Table 3.

Table 3: Granger causality test

Null hypothesis	F-statistic	Probability	Decision
UNC_5Y BOND YIELD does not Granger-cause REXC	3.043	0.050	Reject
REXC does not Granger-cause UNC_5Y BOND YIELD	5.036	0.008	Reject
UNC_5Y BOND YIELD does not Granger-cause INF	8.924	0.000	Reject
INF does not Granger-cause UNC_5Y BOND YIELD	1.962	0.144	Do not reject
UNC_5Y BOND YIELD does not Granger-cause IP	0.295	0.745	Do not reject
IP does not Granger-cause UNC_5Y BOND YIELD	0.364	0.696	Do not reject
UNC_5Y BOND YIELD does not Granger-cause UNEMP	5.630	0.004	Reject
UNEMP does not Granger-cause UNC_5Y BOND YIELD	0.132	0.877	Do not reject
MPUUSA does not Granger-cause REXC	0.027	0.870	Do not reject
REXC does not Granger-cause MPUUSA	0.364	0.547	Do not reject
MPUUSA does not Granger-cause INF	0.118	0.731	Do not reject
INF does not Granger-cause MPUUSA	1.333	0.249	Do not reject
MPUUSA does not Granger-cause IP	5.345	0.021	Reject
IP does not Granger-cause MPUUSA	0.587	0.444	Do not reject
MPUUSA does not Granger-cause UNEMP	11.400	0.001	Reject
UNEMP does not Granger-cause MPUUSA	0.409	0.523	Do not reject

Source: author's calculations

According to the test results, it is seen that there is a bi-directional causality between the uncertainty in the 5-year yield and the real exchange rate. However, the test results show that

there is a unidirectional causality running from the uncertainty in the 5-year yield to the inflation rate; thus, there is no reverse causality. Similarly, there is a unidirectional causality running from the uncertainty in the 5-year yield to the unemployment rate. Finally, it seems that the uncertainty in the 5-year yield is not the Granger cause of the growth of industrial production. Nor is the growth of industrial production the Granger cause of uncertainty in 5-year yield. In other words, there is no causal relationship between the uncertainty in the 5-year yield and the growth of industrial production.

The test results show that there is no causality between uncertainty in the US monetary policy and the real exchange rate. Similarly, our findings indicate that there is no causality between uncertainty in the US monetary policy and the inflation rate. The impulse-response functions are not statistically significant for the relationships where we did not find Granger causality. On the other hand, uncertainty in the US monetary policy is the Granger cause of the growth of industrial production at the 5% significance level, and no reverse causality is observed. Therefore, we can conclude that there is a unidirectional causality running from uncertainty in the US monetary policy to the growth of industrial production. Finally, there is unidirectional causality running from the MPU to the unemployment rate, implying that the past values of the MPU are influential in determining the unemployment rate.

5. Policy Implications and Conclusion

While uncertainty about the future is always present, large increases in uncertainty can make forward-looking decisions even more difficult. These uncertainties do not only arise from countries' own uncertainties but also uncertainties from abroad. Due to the dominant position of the US economy on global financial markets, uncertainty about the monetary policy of the USA (MPU) may have an impact on other economies. Our study presents the macroeconomic implications of uncertainties regarding Turkey's own interest yields and the MPU.

When we consider impulse response functions and Granger causality test results together, we reach the following results: If we look at the response of the exchange rate, we observe that a shock in uncertainty in the long-yield causes temporary appreciation in the real exchange rate. Our results show that in order to understand movements in exchange rates, one needs to consider uncertainty in the interest rates. Inflation increases in response to an interest rate uncertainty shock and the response remains effective for a long time. In addition, our findings of a unidirectional causality running from uncertainty in interest rates to the inflation rate confirm this relationship. Similarly, there is a unidirectional causality running from uncertainty in interest

rates to the unemployment rate and the impulse response analysis shows that unemployment worsens in response to a shock in interest rate uncertainty. Although it is not quantitatively relevant, shocks to long-yield uncertainties have a negative effect on the growth of industrial production. However, since no causality was found between uncertainty in interest rate and the growth of industrial production in either direction, this response is statistically insignificant. Overall, our results put forth the importance of reducing uncertainties about interest rates to achieve economic stability. Our findings also support Filardo and Hofmann's (2014) argument that conducting interest rate expectations has significant impacts on the economy. As discussed in the literature on the real options effect of uncertainty on firm investment decisions, firms may prefer to obtain more information about future interest rates before making major investment decisions. Therefore, high interest rate uncertainty may adversely affect economic activity and employment today.

Finally, we observe that a US monetary policy shock causes a long-lived decline in the growth of industrial production. Besides, unemployment increases following an MPU shock. In addition, causality tests demonstrate a unilateral causality from the MPU to the growth of industrial production and also to the unemployment rate. These findings indicate that US monetary policy uncertainty can be one of many sources of the decline in output growth and increasing unemployment rate for Turkey. This may be due to the fact that US monetary policy uncertainty is seen as a source of uncertainty by investors in Turkey. The degrees of trade and financial integration with the USA may lead to this response.

To reach their goals, central banks should be able to influence expectations regarding the future path of the interest rate. However, uncertainties in the interest rate can weaken this effect. The interest rate policies may not have the desired stimulating effects if it is not interpreted as desired by the public. That is, interest rate uncertainty may cause decision-makers to be less sensitive to the central bank policies. If the uncertainties in the interest rate constitute a negative factor for the effectiveness of monetary policy, we can conclude that our findings provide evidence for the importance of transparency, clear communication and accountability of central banks. Central banks can use these tools to alleviate interest rate uncertainty. Mishkin (2000) examined the principles that central banks should follow in order not to cause uncertainty. Accountability, transparency and communication are some of those principles. By reducing uncertainty in the interest rate, economic agents can be enabled to plan, invest and trade with little need for hedging.

While it is crucial for the central bank to communicate clearly with the public in terms of reducing the uncertainty regarding the future path of interest rates, the central bank may

not be able to implement its plans due to unexpected macroeconomic developments. Most economic policies respond to underlying economic conditions. Therefore, it is impossible to be sure exactly what the policy will be if there is uncertainty in the underlying conditions. While it is impossible to eliminate all economic uncertainty, setting clear policy targets would prevent uncertainty arising from monetary policy itself.

References

- Aastveit, K., Natvik, G. J., Sola, S. (2013). Economic uncertainty and the effectiveness of monetary policy. *Unpublished manuscript*, Norges Bank.
- Aktaş, Z., Alp, H., Gürkaynak, R., Kesriyeli, M., Orak, M. (2009). Türkiye’de Para Politikasının Aktarımı: Para Politikasının Mali Piyasalara Etkisi. *İktisat İşletme ve Finans*, 24(278), 9–24.
- Aydın, H. İ. (2007). *Interest Rate Pass-Through in Turkey*, Research and Monetary Policy Department, Central Bank of the Republic of Turkey. Working Papers No. 0705.
- Bachmann, R., Elstner, S., Sims, E. R. (2013). Uncertainty and Economic Activity: Evidence from Business Survey Data. *American Economic Journal: Macroeconomics*, 5(2), 217–49, <https://doi.org/10.1257/mac.5.2.217>
- Baker, S. R., Bloom, N., Davis, S. J. (2016). Measuring Economic Policy Uncertainty. *The Quarterly Journal of Economics*, 131(4), 1593–1636, <https://doi.org/10.1093/qje/qjw024>
- Basci, E., Özel, Ö., Sarıkaya, C. (2008). The Monetary Transmission Mechanism in Turkey: New Developments. BIS Papers chapters in: Bank for International Settlements (Ed.), *Transmission Mechanisms for Monetary Policy in Emerging Market Economies*, Bank for International Settlements, 35, 475–499.
- Bekaert, G., Hoerova, M., Duca, M. L. (2013). Risk, Uncertainty and Monetary Policy. *Journal of Monetary Economics*, 60, 771–788, <https://doi.org/10.1016/j.jmoneco.2013.06.003>
- Benigno, G., Benigno, P., Nisticò, S. (2012). Risk, Monetary Policy, and the Exchange Rate. *NBER Macroeconomics Annual*, 26(1), 247–309.
- Bhattarai, S., Chatterjee, A., Park, W. Y. (2020). Global spillover effects of US uncertainty. *Journal of Monetary Economics*, 114, 71–89, <https://doi.org/10.1016/j.jmoneco.2019.05.008>
- Bloom N. (2009). The Impact of Uncertainty Shocks. *Econometrica* 77(3), 623–685, <https://doi.org/10.3982/ECTA6248>
- Bollerslev, T. (1986). Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics*, 31(3), 307–327, [https://doi.org/10.1016/0304-4076\(86\)90063-1](https://doi.org/10.1016/0304-4076(86)90063-1)
- Bomberger, W. A. (1996). Disagreement as a Measure of Uncertainty. *Journal of Money, Credit and Banking*, 28(3), 381–392, <https://doi.org/10.2307/2077981>
- Bundick, B., Herriford, T., Smith, A. (2017). Forward Guidance, Monetary Policy Uncertainty, and the Term Premium. <http://dx.doi.org/10.2139/ssrn.3009962>

- Caporale, T., McKiernan, B. (1998). Interest Rate Uncertainty and the Founding of the Federal Reserve. *The Journal of Economic History*, 58(4), 1110–1117, <https://doi.org/10.1017/S0022050700021756>
- Creal, D. D., Wu, J. C. (2017). Monetary Policy Uncertainty and Economic Fluctuations. *International Economic Review*, 58(4), 1317–1354, <https://doi.org/10.1111/iere.12253>
- Cevik, S., Erduman, Y. (2020). Measuring Monetary Policy Uncertainty and Its Effects on the Economy: The Case of Turkey. *Eastern European Economics*, 58(5), 436–454, <https://doi.org/10.1080/00128775.2020.1798161>
- Fasolo, A. M. (2019). Monetary Policy Volatility Shocks in Brazil. *Economic Modelling*, 81, 348–360, <https://doi.org/10.1016/j.econmod.2019.06.012>
- Fernández-Villaverde, J., Guerrón-Quintana, P., Rubio-Ramírez, J. F., Uribe, M. (2011). Risk Matters: The Real Effects of Volatility Shocks. *American Economic Review*, 101, 2530–2561, <https://doi.org/10.1257/aer.101.6.2530>
- Filardo, A. J., Hofmann, B. (2014). Forward Guidance at the Zero Lower Bound. *BIS Quarterly Review*.
- Grier, K. B., Perry, M. J. (2000). The Effects of Real and Nominal Uncertainty on Inflation and Output Growth: Some Garch-m Evidence. *Journal of Applied Econometrics*, 15(1), 45–58, [https://doi.org/10.1002/\(SICI\)1099-1255\(200001/02\)15:1<45::AID-JAE542>3.0.CO;2-K](https://doi.org/10.1002/(SICI)1099-1255(200001/02)15:1<45::AID-JAE542>3.0.CO;2-K)
- Güney, P. Ö. (2016). Does the Central Bank Directly Respond to Output and Inflation Uncertainties in Turkey? *Central Bank Review*, 16(2), 53–57, <https://doi.org/10.1016/j.cbrev.2016.05.001>
- Husted, L., Rogers, J. H., Sun, B. (2017). *Monetary Policy Uncertainty*. International Finance Discussion Papers. Board of Governors of the Federal Reserve System.
- Istrefi, K., Mouabbi, S. (2018). Subjective Interest Rate Uncertainty and the Macroeconomy: A Cross-Country Analysis. *Journal of International Money and Finance*, 88, 296–313, <https://doi.org/10.1016/j.jimonfin.2017.07.015>
- Jurado, K., Ludvigson, S. C., Ng, S. (2015). Measuring Uncertainty. *American Economic Review*, 105, 1177–1216, <https://doi.org/10.1257/aer.20131193>
- Kara, H., Küçük-Tuğer, H., Özlale, Ü., Tuğer, B., Yücel, E. (2007). Exchange Rate Regimes and Pass-Through: Evidence from the Turkish Economy. *Contemporary Economic Policy*, 25 (2), 206–225, <https://doi.org/10.1111/j.1465-7287.2007.00037.x>
- Lakdawala, A., Moreland, T., Schaffer, M. (2021). The International Spillover Effects of US Monetary Policy Uncertainty. *Journal of International Economics*, 133, 103525, <https://doi.org/10.1016/j.jinteco.2021.103525>
- Lastauskas, P., Nguyen, A. D. M. (2021). *Global Impacts Of Us Monetary Policy Uncertainty Shocks*. Working Paper Series 2513, European Central Bank.
- Lensink, R. (2002). Is the Uncertainty-Investment Link Non-linear? *Review of World Economics*, 138(1), 131–147, <https://doi.org/10.1007/BF02707327>

- Ludvigson S. C., Ma, S., Ng, S. (2015). *Uncertainty and Business Cycles Exogenous Impulse or Endogenous Response?* NBER Working Paper No. 21803, NBER Working Paper.
- Mishkin, F. S. (2000). What should central banks do? *Federal Reserve Bank of St. Louis Review*. 82(Nov), 1–14.
- Mumtaz, H., Zanetti, F. (2013). The Impact of the Volatility of Monetary Policy Shocks. *Journal of Money, Credit and Banking*, 45(4), 535–558, <https://doi.org/10.1111/jmcb.12015>
- Mumtaz, H., Theodoridis, K. (2020). Dynamic Effects of Monetary Policy Shocks on Macroeconomic Volatility. *Journal of Monetary Economics*, 114, 262–282, <https://doi.org/10.1016/j.jmoneco.2019.03.011>
- Neusser, K. (2016). *Time Series Econometrics*. Springer.
- Park, D., Qureshi, I., Tian, S., Villaruel, M. L. (2020). Impact of US Monetary Policy Uncertainty on Asian Exchange Rates. *Economic Change and Restructuring*, 1–10. . <https://doi.org/10.1007/s10644-020-09307-3>
- Pastor, L., Veronesi, P. (2012). Uncertainty about Government Policy and Stock Prices. *The Journal of Finance*, 67(4), 1219–1264, <https://doi.org/10.1111/j.1540-6261.2012.01746.x>
- Pesaran, M. H., Shin, Y. (1999). An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. In *Econometrics and Economic Theory in the 20th Century*, edited by S. Strom. The Ragnar Frisch Centennial Symposium, Cambridge University Press, Cambridge.
- Pesaran, M. H., Shin, Y., Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, 16(3), 289–326.
- Ulrich, M. (2012). *Economic Policy Uncertainty and Asset Price Volatility*. Unpublished manuscript, Department of Economics, Columbia University. Available at SSRN 1566909.
- Us, V. (2004). Monetary Transmission Mechanism in Turkey Under the Monetary Conditions Index: An Alternative Policy Rule. *Applied Economics*, 36(9), 967–976, <https://doi.org/10.1080/0003684042000233195>