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# Macroeconomic uncertainty and investment relationship for Turkey

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**Abstract**

Macroeconomic uncertainties are expected to affect investment decisions. This study analyzes the effect of the real exchange rate, inflation, and growth uncertainties on private investment in Turkey, an emerging country. While a generalized autoregressive conditional heteroskedasticity (GARCH) model is adopted to measure uncertainties, the existence of a long-run relationship of the variables is assessed using the bound testing approach. Finally, an error correction model is estimated to capture the dynamic relationship. **Findings/Originality**: The results for the short-run dynamic estimation show that both inflation and real exchange rate uncertainties have a significant negative effect on investments. As for the long-run equilibrium, exchange rate, inflation, and growth uncertainties have a negative impact on private investments. The application of inflation targeting and exchange rate stabilization policy might effectively reduce uncertainty on investments, thus supporting economic growth in the short term.

## Introduction

The ability to invest is one of the essential determinants of economic development. In this context, private investments play a crucial role in terms of its help to allocate resources efficiently. Previous studies argued that besides many factors such as macroeconomic and microeconomic policies, financial institutions, and property rights, investment decisions could be affected by the uncertainty about macroeconomic variables. Theoretical literature presents different mechanisms about this process. Abel (1983), Hartman (1972), and Lee (2016) suggest that price uncertainty may stimulate investments by increasing the expected profitability of the capital.

On the other hand, according to the argument of the option value of waiting, because of irreversibility and adjustment costs of investments that are under uncertainty, it is not easy for firms to decide whether to undertake a capital expenditure (Dixit & Pindyck, 1994). In this case, firms may reduce or delay investment. Another approach states that uncertainty increases default risks, and it makes external financing more expensive, which can lead to investment contraction (Gilchrist, Sim, & Zakrajšek, 2014). Furthermore, Sarkar (2000) argues that the effect may change according to the uncertainty level, in which the impact is positive when uncertainty is low and can be negative when the uncertainty exceeds a certain level.

According to Lucas (1973), an economic agent's response to price signals can be a function of the amount of inflation uncertainty. Increased inflation uncertainty means an increase in unexpected inflation. Therefore, the costs caused by inflation uncertainty are related to the costs caused by unexpected inflation. Inflation uncertainty may have an impact on interest rates and thereby affect investment decisions. Moreover, investors generally see inflation uncertainty as an indicator of macroeconomic instability. The high inflation uncertainty can be perceived as a weak control of the government over the economy. In this case, where the risk is considered to be high,

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investments may decrease. Fischer and Modigliani (1978) stated that inflation uncertainty makes planning difficult for the future. Another view says that inflation uncertainty may stimulate investment. Because in economies that experience a high level of inflation, and hence a volatile price, increased marginal profitability of capital leads to an increase in investments. In addition, Dotsey and Sarte (2000) state that due to the precautionary savings, the relationship between inflation variability and investment may be positive. As it is seen, there is no consensus on the impact of inflation uncertainty on investments.

In addition to inflation uncertainty, other uncertainties regarding different macroeconomic variables may affect investment decisions. For example, under the uncertainty of the exchange rate, it is difficult for investors to estimate the cost of new investment and the relative advantages of investing in traded or non-traded goods sectors. Investment decisions are becoming more complex, especially in developing countries where real exchange rates tend to show higher volatility. Pindyck and Solimano (1993) stated that uncertainties in real exchange rates have a negative effect on investments. Moreover, the degree of openness of the economy and the level of development of financial markets are expected to have an impact of exchange rate uncertainty on the investment. Darby, Hallett, Ireland, and Piscitelli (1999) has shown that it is not theoretically possible to say that investments will increase automatically if the exchange rate uncertainty decreases. There may be situations where investments increase or situations where they decrease.

Greene and Villanueva(1991) and Servén and Solimano (1993) found that changes in output are one of the fundamental determinants of investment. In this sense, growth uncertainty represents the unpredictability of demand, and it is likely to have an adverse effect on investment.

In empirical studies, different forms of uncertainties are considered. Darby et al. (1999) deal with uncertainties in the real exchange rate for five OECD countries, and they show that exchange rate volatility has a negative impact on investment on average. But they found that this impact is temporary in Italy and the United Kingdom. Other study considering advanced economies, Ferderer (1993), used the risk premium to measure uncertainty and shows that macroeconomic uncertainty is effective in the negative direction on investments in the United States. Driver and Moreton (1991) found that while output uncertainty has an adverse impact on investment for the United Kingdom, inflation uncertainty has a short-run effect only. Lensink (2002) showed that in developed countries, the impact of uncertainty measured by the volatility of the stock market return on investments changes according to the size of the uncertainty. Accordingly, the low-level uncertainty affects investments positively, while high uncertainty affects negatively. Byrne and Davis (2005) found that the exchange rate and interest rate volatility has a negative effect on a group of developed economies.

A limited number of studies focus on developing country groups. For example, Servén (2003) considered 61 developing countries and showed that exchange rate uncertainty negatively affects investments. Furthermore, he argues that uncertainty has influence only if it exceeds a critical level. Similarly, Ruzima and Boachie (2018) showed that exchange rate uncertainty had a negative effect on investment in BRICS countries. Servén and Solimano (1993) considered both inflation and exchange rate uncertainties. They showed that these uncertainties had a negative effect on investment in a sample of developing economies. On the other hand, Pradhan, Schuster, and Upadhyaya (2004) show that the real exchange rate uncertainty and investment relationship are inconclusive for four developing countries. Servén (1999) considers alternative measures of macroeconomic uncertainty and shows that macroeconomic uncertainty has a negative impact on investment in developing countries.

Using an error correction modeling approach, Folorunso and Akinlo (2010) showed that macroeconomic uncertainty indicators such as uncertainties in the inflation rate, exchange rate, and fiscal deficit have a negative effect on the aggregate private investment in Nigeria. The analysis of Ndiwulu and Manzongani (2011) implies a negative impact of inflation uncertainty on investment

levels in the Democratic Republic of Congo. In another study, Iyke and Ho (2017) found that exchange rate uncertainty has a positive effect on investment in the long-run in Ghana. Redl (2018) developed an index of economic uncertainty for South Africa and showed that a rise in uncertainty causes a decline in investment.

Some studies are analyzing the non-linear effects of uncertainty. Saman (2010) uses both linear and non-linear models and finds that inflation and exchange rate uncertainties reduce investment in Romania. To the best of our knowledge, Demir (2009) is only one study analyzing the effect of uncertainty on investment decisions for Turkey. The different aspects of our study from Demir (2009) can be listed as follows. First, Demir made panel data analysis at the micro-level. In addition, he used manufacturing inflation to measure uncertainty. His findings show that uncertainty significantly decreases the investment of industrial firms in Argentina, Mexico, and Turkey.

In this current study, we investigate the effect of macroeconomic uncertainty on private investment in Turkey. As summarized above, theoretical approaches reveal different relationships between uncertainty and investments, which is, therefore, an empirical question. Our core question is, do inflation, growth, and exchange rate uncertainties affect investment in Turkey? Although most studies focus on developed counties, developing economies face more macroeconomic uncertainty than industrial countries do. In this sense, this study aims to contribute to the literature by analyzing the theoretically ambiguous uncertainty-investment relationship for Turkey.

The Turkish economy has been a high and volatile inflation country during the 1990s and the beginning of the 2000s. During this period, the Turkish economy has experienced two economic crises in 1994 and 2001. These crises have caused a recession in the Turkish economy, resulted in GDP declined by 6.1% in 1994 and by 5.7% in 2001. Additionally, the global financial crisis in 2009 negatively affected the Turkish economy, and GDP declined by 4.8%.

The high budget deficits were the main factor behind the inflationary process, and the budget deficits were initially financed from central bank resources. After introducing domestic borrowing instruments in 1984, domestic borrowing became more important in financing the budget deficits, and this increased the interest rates. High domestic interest rates had attracted huge capital inflows commencing from 1989 when the capital account was liberalized. Since 1993, to cover budget deficits, interest rates continued to rise, and the maturity of domestic borrowing has shortened further (Guney, 2007). In Turkey, various stabilization programs were implemented to solve the inflation problem. With the stabilization program launched on April 5, 1994, the crisis was successfully defeated, but it had only a limited impact. Another program was the exchange rate-based stabilization program that began in 1999. However, this program was not successful and abandoned in February 2001. The Turkish economy experienced its severest economic crisis in 2001. With the change in the central bank law, the central bank was gained instrument independence, and Turkey adopted implicit inflation targeting from January 2002 to December 2005. The 2001 program aimed to achieve stability with lower inflation and higher and sustainable growth. After some reforms, the explicit inflation targeting regime started to be implemented in January 2006. The main instrument of the Central Bank of the Republic of Turkey (CBRT) was the short-term interest rate. Since 2010, the CBRT has started to concern both financial stability and price stability. To achieve these goals, it has begun to use new policy instruments such as interest rate corridor and liquidity policies (Güney, 2016). The Turkish economy has experienced high and stable growth between 2002 and mid-2007. While inflation was over 60% in 1999, it decreased to single-digit numbers by 2004. GDP growth was approximately 7% on average in the period 2010-2017.

The international trade performance of Turkey plays a vital role in the economy. High current account deficits in the 2000s have been a critical vulnerability of the Turkish economy. Turkish exports are mostly dependent on EU's demand. From 1996 to 2007, more than 50% of Turkish exports were realized in EU countries. With the global crisis, the share of export to the

EU fell below 50%, while the share of exports to Africa and the Middle East increased (Uygur, 2010). In Turkey, although the tradable sector has improved its performance over the past decade, its technological base is still low. The share of medium-to-high and high-technology goods in total manufactured exports was 39% in 2017 (OECD, 2018). Private investments were about 26% of GDP in 2017. Housing and construction sectors constitute a considerable share of investments in Turkey. Global uncertainty during the worldwide crisis adversely affected investment in Turkey. In addition, as reported by OECD (2018), private business investment was more subdued over most of 2016-17, reflecting wait and see attitudes amid various domestic, regional, and international uncertainties.

Aggregate investments are regarded as a driving force of economic growth. In developing countries such as Turkey, to ensure stable economic growth is one of the main policy objectives. Therefore, determining the factors affecting the investments is essential in terms of designing policies that minimize the negative impacts on investment and ensure stable economic growth. The rest of the article organized as follows: In the following section, we summarize the methodology. Then, we present and discuss the results. The last section concludes the paper.

## Methods

Previous studies use different methods to measure uncertainty (Lensink, 2002), and several sources of uncertainties are considered. One approach to measurement uncertainty is modeling relevant variables as autoregressive conditional heteroskedasticity (ARCH) or generalized autoregressive conditional heteroskedasticity (GARCH) process. It is argued that the GARCH models have some advantages (Grier & Perry, 2000). Firstly, with these models, the variance of unpredictable innovations in variables can be estimated, which provides the closest measure of uncertainty. Secondly, the GARCH approach can be used to estimate the conditional mean and the conditional variance of variables simultaneously, which is more efficient than a two-step method (Hasanov & Omay, 2011).

In this current study, concerning the source of uncertainty, we consider the uncertainty of exchange rate (EX_UNC), inflation uncertainty ($\pi_{UNC}$), and growth uncertainty (GRW_UNC). USD_UNC shows the uncertainty of United States Dollar/Turkish Lira (USD/TRY) exchange rate, and EUR_UNC shows the uncertainty of Euro/Turkish Lira (EUR/TRY) exchange rate. We use the generalized autoregressive conditional heteroskedasticity (GARCH) approach, and the variance of the unforeseen part of the GARCH model is taken as uncertainty:

$$y_t = \beta_0 + \sum_{j=1}^{q} \beta_j y_{t-1} + \varepsilon_t \quad (1)$$

$$h_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1}^2 \quad (2)$$

where $y_t$ is the variable the volatility of which we desire to find, $\varepsilon_t$ is stochastic processes with zero mean and $h_t$ is conditional variance. We estimate ARCH(1) and GARCH(1,1) models, and then we chose the GARCH model according to Akaike Information Criteria (AIC). Equation (2) implies that the residuals of the inflation, real exchange rate, and growth equations follow a GARCH (1,1) process provided by Bollerslev (1986). The above two-equation model was estimated to find each uncertainty variables. We take the conditional variances from Equation (2) as a measure of uncertainty of $y_t$.

To examine the relationship between three types of uncertainties and investment, we use quarterly data from 1994Q1 to 2018Q1. We estimate two types of models. In addition to the uncertainty variables, we include the current real GDP and the real interest rate in Model 1 as the determinant of the investment. It is argued that the higher price of capital goods in less developed countries plays a vital role in explaining low investment rates (Lian, Novta, Pugacheva, Timmer, & Topalova, 2019). Also, high risk and inflation rates make it difficult and expensive to access loans

in developing countries. Considering these facts, in Model 2, in addition to the real interest rate, we include the relative price of capital, which allows us to measure the cost of the capital and domestic credit to the private sector to measure the tightness of the credit market. In Model 2, since the relative price of capital data is available until the first quarter of 2014, our estimates include data up to 2014Q4.

Hence, we estimated the following models:

Model 1:

$$I_t = f\left(I_{t-1}, R_t, GDP_t, EX_{UNC_t}\right)$$
$$I_t = f\left(I_{t-1}, R_t, GDP_t, INF_{UNC_t}\right)$$
$$I_t = f\left(I_{t-1}, R_t, GDP_t, GRW_{UNC_t}\right)$$

Model 2:

$$I_t = f\left(I_{t-1}, R_t, GDP_t, RELP_t, CRD_t, EX_{UNC_t}\right)$$
$$I_t = f\left(I_{t-1}, R_t, GDP_t, RELP_t, CRD_t, INF_{UNC_t}\right)$$
$$I_t = f\left(I_{t-1}, R_t, GDP_t, RELP_t, CRD_t, GRW_{UNC_t}\right)$$

where $I$ is the private investment to GDP, $R$ is the real interest rate, $GDP$ is the log of current real GDP, $RELP$ is the relative price of capital, and $CRD$ is domestic credit to private sector relative to nominal GDP. As an uncertainty measure, our model includes inflation uncertainty, growth uncertainty, and real exchange rate uncertainty. To achieve the real exchange rate against USD, the log of nominal exchange rate is multiplied by the United States consumer price index and divided by the domestic price index. Similarly, we get the real exchange rate against EUR using the Euro Area consumer price index. The real interest rate implies the cost of capital goods and measured as $R = ln\left[\frac{(1+i)}{1+\pi}\right]$, where $\pi$ is the inflation rate, and $i$ presents the nominal interest rate. The real GDP is calculated as $Real\ GDP = Nominal\ \frac{GDP}{\frac{GDPDeflator}{100}}$. We obtained all the above data from International Financial Statistics (IFS) published by the International Monetary Fund (IMF). We obtain the relative price of capital $\left(RELP = Investment\frac{Deflator}{GPD}Deflator\right)$ from the Penn World Table, and we interpolate this data from annual to quarterly. Domestic credits to the private sector relative to nominal GDP data $(CRD)$ are taken from World Development Indicators. We include a dummy variable where it is significant to account for the effects of the global crisis in 2008. We define the dummy variable as:

$dummy_{2008}$=1 over the period 2008Q2-2009Q2, 0 elsewhere.

First, we adopt the bound testing approach developed ARDL framework by Pesaran and Shin (1999) and Pesaran, Shin, and Smith (2001) to explore the long-run relationship between the variables. We choose this method because to use the conventional cointegration tests such as Engle and Granger (1987) and Johansen (1988), all-time series need to be integrated of order one. The bound testing approach, however, allows testing for cointegration among variables with a different order of integration. In addition, unlike standard cointegration tests, the ARDL method uses only one reduced form equation, does not require as many specifications as conventional tests, and can be applied when sample data are limited (Pesaran & Shin, 1999; Pesaran & Smith, 1998).

To conduct the bound test, the following unrestricted error correction model (ECM) is used for the above models. In Model 1, we exclude the RELP and CRD variables.

$$\Delta I_t = \beta_0 + \beta_1 I_{t-1} + \beta_2 R_{t-1} + \beta_3 GDP_{t-1} + \beta_4 CRD_{t-1} + \beta_5 RELP_{t-1} + \beta_6 EX_{UNC\,t-1} + \sum_{i=1}^{n} \beta_7\, \Delta I_{t-i} + \sum_{i=0}^{n} \beta_8\, \Delta R_{t-1} + \sum_{i=0}^{n} \beta_9\, \Delta GDP_{t-i} + \sum_{i=0}^{n} \beta_{10}\, \Delta CAP_{t-i} + \sum_{i=0}^{n} \beta_{11}\, \Delta CRD_{t-i} \sum_{i=0}^{n} \beta_{12}\, \Delta EX_{UNC\,t-i} + \theta w_t + \gamma_{t,1} \quad (3)$$

$$\Delta I_t = \alpha_0 + \alpha_1 I_{t-1} + \alpha_2 R_{t-1} + \alpha_3 GDP_{t-1} + \alpha_4 CRD_{t-1} + \alpha_5 RELP_{t-1} + \alpha_6 \pi_{UNC\,t-1} + \sum_{i=1}^{n} \alpha_7 \Delta I_{t-i} + \sum_{i=0}^{n} \alpha_8 \Delta R_{t-1} + \sum_{i=0}^{n} \alpha_9 \Delta GDP_{t-i} + \sum_{i=0}^{n} \alpha_{10} \Delta CAP_{t-i} + \sum_{i=0}^{n} \alpha_{11} \Delta CRD_{t-i} \sum_{i=0}^{n} \alpha_{12} \Delta INF_{UNC\,t-i} + \theta w_t + \gamma_{t,2} \quad (4)$$

$$\Delta I_t = \gamma_0 + \gamma_1 I_{t-1} + \gamma_2 R_{t-1} + \gamma_3 GDP_{t-1} + \gamma_4 CRD_{t-1} + \gamma_5 RELP_{t-1} + \gamma_6 GRW_{UNC\,t-1} + \sum_{i=1}^{n} \gamma_7 \Delta I_{t-i} + \sum_{i=0}^{n} \gamma_8 \Delta R_{t-1} + \sum_{i=0}^{n} \gamma_9 \Delta GDP_{t-i} + \sum_{i=0}^{n} \gamma_{10} \Delta CAP_{t-i} + \sum_{i=0}^{n} \gamma_{11} \Delta CRD_{t-i} \sum_{i=0}^{n} \gamma_{12} \Delta GRW_{UNC\,t-i} + \theta w_t + \gamma_{t,3} \quad (5)$$

where Δ denotes the first differences of series, *n* shows the optimal lag length, and $w_t$ is an exogenous component, which as a dummy variable. Our test to see if the lagged levels of the variables had a significant effect on the dependent variable have the following null and alternative hypothesis in Equation (3):

$H_0$: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$

$H_1$: $\beta_1 \neq 0, \beta_2 \neq 0, \beta_3 \neq 0, \beta_4 \neq 0, \beta_5 \neq 0, \beta_6 \neq 0$.

The null hypothesis and the alternative hypothesis in Equation (4) can be written as:

$H_0$: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$

$H_1$: $\alpha_1 \neq 0, \alpha_2 \neq 0, \alpha_3 \neq 0, \alpha_4 \neq 0, \alpha_5 \neq 0, \alpha_6 \neq 0$.

Finally, the null hypothesis and the alternative hypothesis in Equation (5) can be written as:

$H_0$: $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6 = 0$

$H_1$: $\gamma_1 \neq 0, \gamma_2 \neq 0, \gamma_3 \neq 0, \gamma_4 \neq 0, \gamma_5 \neq 0, \gamma_6 \neq 0$.

These hypotheses can be examined using *F* statistics. Pesaran et al. (2001) report two groups of critical values; the first level refers to I(1), and the second level to the I(0) series. If the computed F-statistics falls outside the upper critical values, we can reject the null hypothesis and conclude that there is cointegration.

Finally, to capture the dynamic relationship, we estimate the following conditional ECM regressions associated with the level relationship:

$$\Delta I = b_0 + \sum_{i=1}^{m} b_1 \Delta I_{t-i} + \sum_{i=0}^{n} b_2 \Delta R_{t-i} + \sum_{i=0}^{p} b_3 \Delta GDP_{t-i} + \sum_{i=0}^{q} b_4 \Delta CRD_{t-i} + \sum_{i=0}^{r} b_5 \Delta RELP_{t-i} + \sum_{i=0}^{s} b_6 \Delta EX_{UNC} + b_7 dummy + b_8 EC_1 + v_1 \quad (6)$$

$$\Delta I = k_0 + \sum_{i=1}^{m} k_1 \Delta I_{t-i} + \sum_{i=0}^{n} k_2 \Delta R_{t-i} + \sum_{i=0}^{p} k_3 \Delta GDP_{t-i} + \sum_{i=0}^{q} k_4 \Delta CRD_{t-i} + \sum_{i=0}^{r} k_5 \Delta RELP_{t-i} + \sum_{i=0}^{s} k_6 \Delta INF_{UNC} + k_7 dummy + k_8 EC_2 + v_2 \quad (7)$$

$$\Delta I = z_0 + \sum_{i=1}^{m} z_1 \Delta I_{t-i} + \sum_{i=0}^{n} z_2 \Delta R_{t-i} + \sum_{i=0}^{p} z_3 \Delta GDP_{t-i} + \sum_{i=0}^{q} z_4 \Delta CRD_{t-i} + \sum_{i=0}^{r} z_5 \Delta RELP_{t-i} + \sum_{i=0}^{s} z_6 \Delta \pi_{UNC} + z_7 dummy + z_8 EC_3 + v_3 \quad (8)$$

where $EC_1$, $EC_2$ and $EC_3$ are the error correction terms and $v_1$, $v_2$ and $v_2$ are the error terms. The error correction terms are obtained from the level relationship between dependent and all the independent variables in the model.

## Results and Discussion

First, we test each variable for stationary. The results of the augmented Dickey-Fuller tests are presented in Table 1. Our estimates show that we have both $I(0)$ and $I(1)$ variables. Next, we investigate whether there is a long-run relationship between the variables we are dealing with. Since unit root tests yield mixed results, bound testing methodology becomes the most useful approach.

Table 2 presents our findings from the bound test. Calculated F-statistics are greater than the upper bound critical value in each case. Accordingly, we reject the hypothesis of no cointegration and this means that there is a long-term cointegrating relationship among the variables.

**Table 1:** ADF unit root test results

| Variables | |
|---|---|
| I | -1.567 |
| R | -5.319* |
| GDP | -3.547** |
| CRD | -1.978 |
| RELP | -2.014 |
| USD_UNC | -4.412* |
| INF_UNC | -3.305*** |
| GRW_UNC | -10.988* |

Note: *** and ** denote rejection of the unit root null at 1% and 5% level, respectively.

**Table 2:** F - statistics for the analysis of a long run relationship

| Included Variable | Model 1 | Model 2 |
|---|---|---|
| USD_unc | F= 7.767* | F=5.851* |
| EUR_unc | F=4.683* | F=4.795* |
| INF_unc | F= 10.431* | F=6.339* |
| GRW_unc | F= 7.395* | F=6.951* |

Notes: *, ** and *** denote significance at 1%, 5% and 10% levels respectively. We compared the F - statistic with the critical bounds of the F-statistic provided in Pesaran et al. (2001), Table CI(iii) Case III. We used Akaike Information Criteria as lag length selection criteria.

Next, we estimate the level of relations and short-run dynamics. Following Pesaran & Shin (1999), we adopt the *ARDL* approach. The orders of an *ARDL*(*m,n,p,q,r,s*) model in six variables $(I, R, GDP, CAP, RELP, UNC)$ were selected using the *AIC* criterion. The estimates of the levels of relationship are shown in Table 3.

**Table 3:** Long-run results

| Regressors | Model 1 | | | | Model 2 | | | |
|---|---|---|---|---|---|---|---|---|
| $R$ | 0.214* | 0.300* | -1.359*** | 0.080 | -0.046 | 0.161*** | -0.270 | -0.046 |
| $GDP$ | 1.023* | 0.722* | -0.554 | -0.475*** | 1.052* | 0.685* | -0.226 | 0.083 |
| $CRD$ | - | - | - | - | -0.001 | 0.001 | -0.002 | -0.001 |
| $RELP$ | - | - | - | - | 0.099** | 0.063 | -0.432 | -0.074 |
| $\Delta EUR\_UNC$ | -0.654* | - | - | - | -0.246 | - | - | - |
| $\Delta USD\_UNC$ | - | -3.765* | - | - | - | -11.424** | - | - |
| $\Delta INF\_UNC$ | - | - | -0.055*** | - | - | - | -0.021 | - |
| $\Delta GRW\_UNC$ | - | - | - | -0.020*** | - | - | - | -0.007 |
| $Dummy$ | - | - | -0.210*** | -0.051 | - | - | -0.042 | -0.043*** |
| Trend | -0.005* | -0.003* | - | 0.004** | -0.004* | -0.005* | - | - |
| $Constant$ | -4.996* | -3.368* | 3.534 | 2.660** | -5.214* | -2.826* | 1.737 | -0.142 |

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

As reported in Table 3, the coefficients of the real interest rate are significant in four cases, but it has an expected sign only in one case. The level coefficients of the domestic credit to the private sector to nominal *GDP* and the relative price of capital are insignificant in most of the estimates. In Model 1, our level estimates of the effects of the inflation uncertainty, exchange rate uncertainty (both exchange rate against *EUR* and *USD*), and growth uncertainty on private investment are negative and significant. In Model 2, these coefficients also have a negative sign. However, only the uncertainty of the *USD/TRY* real exchange rate has a significant effect on private investments.

**Table 4:** Short-run results of the Model 1

| | *ARDL*(1,3,0,2) | *ARDL*(3,4,0,4) | *ARDL*(3,4,0,0) | *ARDL*(1,4,4,2) |
|---|---|---|---|---|
| Constant | | | | |
| $\Delta I_{t-1}$ | - | 0.022 | 0.213** | - |
| $\Delta I_{t-2}$ | - | 0.192** | 0.167** | - |
| $\Delta R$ | -0.028 | 0.0003 | 0.095*** | 0.122** |
| $\Delta R_{t-1}$ | -0.069** | -0.069** | 0.072 | 0.155** |
| $\Delta R_{t-2}$ | 0.056** | 0.041 | -0.059 | -0.084 |
| $\Delta R_{t-3}$ | - | -0.042*** | -0.049*** | -0.063 |
| $\Delta GDP$ | -0.042 | 0.053 | 0.782* | 0.717* |
| $\Delta GDP_{t-1}$ | - | -0.082 | - | -0.258 |
| $\Delta GDP_{t-2}$ | - | 0.089 | - | 0.019 |
| $\Delta GDP_{t-3}$ | - | 0.102*** | - | 0.311** |
| $\Delta EUR_{UNC}$ | - | - | -0.500* | - |
| $\Delta USD_{UNC}$ | - | - | - | 1.235 |
| $\Delta USD_{UNC_{t-1}}$ | - | - | - | -1.238 |
| $\Delta INF_{UNC}$ | -0.003** | - | - | - |
| $\Delta INF_{UNC_{t-1}}$ | -0.004* | - | - | - |
| $\Delta GRW_{UNC}$ | - | -0.0001 | - | - |
| $\Delta GRW_{UNC_{t-1}}$ | - | -0.0001 | - | - |
| $\Delta GRW_{UNC_{t-2}}$ | - | 0.001*** | - | - |
| $\Delta GRW_{UNC_{t-3}}$ | - | 0.002* | - | - |
| $EC$ | -0.076* | -0.196* | -0.764* | -0.623* |
| *Dummy* | -0.016* | -0.010*** | - | - |
| *Trend* | - | 0.001* | -0.003* | -0.002* |
| | **Diagnostic Statistics** | | | |
| Adjusted $R^2$ | 0.929 | 0.921 | | 0.961 |
| LM test | 1.138 | 5.608 | 0.569 | 1.669 |
| $Q_4$ | 5.344 | 5.872 | 1.126 | 2.776 |
| | (0.254) | (0.209) | (0.890) | (0.590) |
| $Q_{12}$ | 14.610 | 16.735 | 10.152 | 9.978 |
| | (0.263) | (0.160) | (0.603) | (0.618) |

Notes: *, ** and *** denote significance at 1%, 5% and 10% significant levels respectively. $Q_4$ is the fourth-order Ljung-Box test for standardized residuals. $Q_{12}$ is the 12th order Ljung-Box test for standardized residuals. P-values are provided in parenthesis. LM is the Lagrange Multiplier statistic to test for autocorrelation. The null hypothesis of the LM test is there is no serial correlation.

Table 4 shows the estimation of the conditional error correction model for Model 1. It can be seen that the real interest rate and its lags generally have a negative sign as expected. In most cases, the lag of investment has a significant and positive effect on current investments. The coefficients of the current *GDP* and its lags have both positive and negative signs, but only the positive coefficients are significant. These findings are consistent with the theory of accelerator, which states that the increase in *GDP* increases the level of investment. Also, negative and significant error correction terms imply a mean reversion. In other words, this confirms that there is a long-run relationship between the variables.

The main focus of our study is the coefficients of the uncertainty variables. We see that inflation uncertainty has a negative effect on investment. However, the coefficient of the lag of inflation uncertainty is positive and significant. The uncertainty of the *EUR/TRY* real exchange rate has a negative and significant effect on investment in Turkey. On the other hand, the coefficients of the uncertainty of the *USD/TRY* real exchange rate are insignificant. The diagnostic

tests are presented at the bottom of the table. Except, the model, including the growing uncertainty, all the short-run models pass the diagnostic tests for autocorrelation. CUSUM test plots in Figure 2 also indicate parameter instability in that model. The graphs suggest that our estimates, except the model including the growing uncertainty, are stable over time since the plot of the CUSUM and CUSUMQ statistics fall inside the critical bounds presented straight lines.

**Table 5:** Short-run results of the Model 2

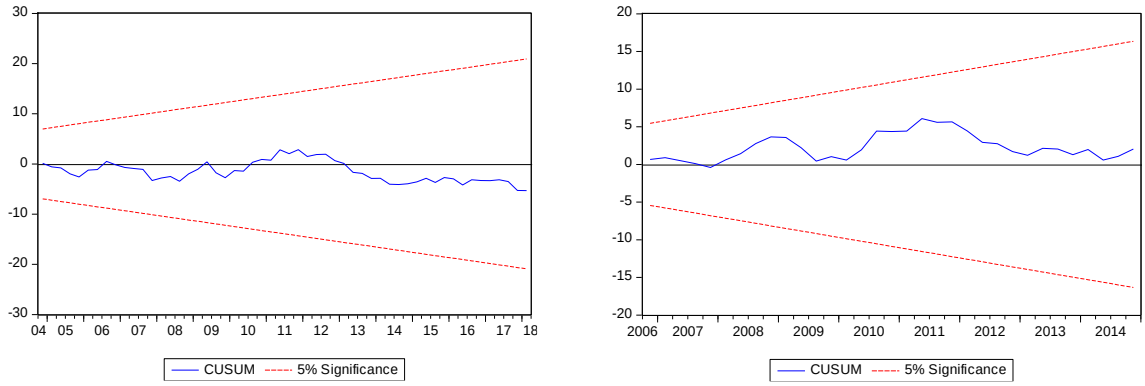
| | ***ARDL*(4,1,4,4,4,2)** | ***ARDL*(3,2,4,4,0,4)** | ***ARDL*(4,0,2,3,3,0)** | ***ARDL*(2,3,4,4,4,4)** |
|---|---|---|---|---|
| Constant | 1.737 | | | |
| $\Delta I_{t-1}$ | -0.020 | -0.094 | 0.476* | 0.370** |
| $\Delta I_{t-2}$ | 0.132 | 0.160*** | 0.268** | - |
| $\Delta I_{t-3}$ | -0.187*** | - | 0.003 | - |
| $\Delta R$ | -0.005 | -0.010 | -0.043 | 0.185** |
| $\Delta R_{t-1}$ | - | -0.035 | - | 0.216* |
| $\Delta R_{t-2}$ | - | - | - | -0.126** |
| $\Delta R_{t-3}$ | - | - | - | - |
| $\Delta GDP$ | 0.101 | 0.182* | 0.796* | 0.791* |
| $\Delta GDP_{t-1}$ | -0.089 | -0.103 | -0.491** | -0.917* |
| $\Delta GDP_{t-2}$ | 0.042 | 0.033 | - | 0.398*** |
| $\Delta GDP_{t-3}$ | 0.171** | 0.185* | - | 0.189 |
| $\Delta CRD$ | 0.004** | 0.005* | 0.001 | 0.003 |
| $\Delta CRD_{t-1}$ | 0.002 | 0.002 | -0.007** | -0.008** |
| $\Delta CRD_{t-2}$ | -0.003 | -0.003 | 0.003 | 0.007** |
| $\Delta CRD_{t-3}$ | 0.003*** | 0.003** | - | -0.004*** |
| $\Delta RELP$ | 0.016 | -0.0002 | 0.061 | 0.081 |
| $\Delta RELP_{t-1}$ | 0.119 | - | 0.0413** | 0.419** |
| $\Delta RELP_{t-2}$ | -0.370** | - | -0.288** | -0.599* |
| $\Delta RELP_{t-3}$ | 0.202** | - | - | 0.284** |
| $\Delta EUR_{UNC}$ | - | - | -0.230* | - |
| $\Delta USD_{UNC}$ | - | - | - | 1.974 |
| $\Delta USD_{UNC_{t-1}}$ | - | - | - | 4.031** |
| $\Delta USD_{UNC_{t-2}}$ | - | - | - | 2.567 |
| $\Delta USD_{UNC_{t-3}}$ | - | - | - | 2.994** |
| $\Delta INF_{UNC}$ | -0.005** | - | - | - |
| $\Delta INF_{UNC_{t-1}}$ | -0.003*** | - | - | - |
| $\Delta GRW_{UNC}$ | - | 0.001 | - | - |
| $\Delta GRW_{UNC_{t-1}}$ | - | -0.0002 | - | - |
| $\Delta GRW_{UNC_{t-2}}$ | - | 0.0004** | - | - |
| $\Delta GRW_{UNC_{t-3}}$ | - | 0.002* | - | - |
| $EC$ | -0.154** | -0.221* | -0.934* | -0.909* |
| *Dummy* | -0.006*** | -0.011*** | - | - |
| *Trend* | - | - | -0.003** | -0.004** |
| | **Diagnostic Statistics** | | | |
| Adjusted $R^2$ | 0.934 | 0.936 | 0.954 | 0.967 |
| LM test | 2.204 | 0.224 | 0.858 | 4.539 |
| $Q_4$ | 3.961 | 4.531 | 6.750 | 5.125 |
| | (0.411) | (0.339) | (0.150) | (0.275) |
| $Q_{12}$ | 7.442 | 7.346 | 11.244 | 18.184 |
| | (0.827) | (0834) | (0.508) | (0.110) |

Notes: *, ** and *** denote significance at 1%, 5% and 10% levels respectively. $Q_4$ is the fourth order Ljung-Box test for standardized residuals. $Q_{12}$is the 12th order Ljung-Box test for standardized residuals. P-values are provided in parenthesis. LM is the Lagrange Multiplier statistic to test for autocorrelation. The null hypothesis of LM test is there is no serial correlation.

In Table 5, we report the estimates of Model 2, which includes *CRD* and *RELP* variables in addition to the variables included in Model 1. A comparison of Tables 4 and 5 reveals little difference concerning the estimated coefficients of the lag of investment and the real *GDP* and its lags. The coefficients of the error correction terms are negative and significant as expected. The coefficients of the real interest rate and its lags are negative but insignificant. Only the model presented in the last column, we find positive and significant coefficients. However, this model fails to diagnostic tests for autocorrelation, as can be seen at the bottom of the table. Credit availability has a significant positive impact on investments, as presented in the first two columns. The coefficients on the relative price of capital have both positive and negative signs. If we look at the estimated coefficients of the uncertainty indicators, we see that inflation uncertainty has a significant negative impact on investments. Besides, the coefficient of the uncertainty of the *EUR/TL* real exchange rate is negative and significant. We could not find a clear effect of the remaining uncertainty indicators. The plots of CUSUM and CUSUMQ tests for parameter stability are presented in Figure 1. The results indicate that our models are stable over time, except the model, including uncertainty of the *USD/TRY* real exchange rate.

Summarize the empirical findings, we have been observed that macroeconomic uncertainty indicators have a significant negative impact on private investments in the long run, especially according to the estimation results of Model 1, where we use data covering a longer period. Moreover, our short-term forecasts show that the uncertainty in the inflation rate and the *EUR/TRY* real exchange rate adversely affects the investments. As mentioned before, there is no definite judgment about the sign of the relationship between investments and uncertainty in the theoretical literature (Darby et al., 1999; Dotsey & Sarte, 2000; Fischer & Modigliani, 1978; Pindyck & Solimano, 1993). In this context, our results contribute to some extent to reduce this unclear relationship. Investors may view the increasing uncertainty as an indicator of macroeconomic instability, and under uncertainty investment decisions may become more complex as asserted by Dixit and Pindyck (1994), Fischer and Modigliani (1978), and Pindyck and Solimano (1993).

Similar to the limited number of the empirical literature, such as Folorunso and Akinlo (2010), Redl (2018), Ruzima and Boachie (2018), Saman (2010), Servén and Solimano (1993), and Servén (2003), which focuses on developing economies, our findings support the negative impact of uncertainties on investments. Hence, we can conclude that inconsistent macroeconomic policies will reduce the success of politicians aiming to promote economic growth through investments. Also, it can be said that neglecting the subject of uncertainty in investment models may lead to the misspecification of the models.




Model 1 EUR_UNC Model 2 EUR_UNC

**Figure 1a:** CUSUM and CUSUMQ tests

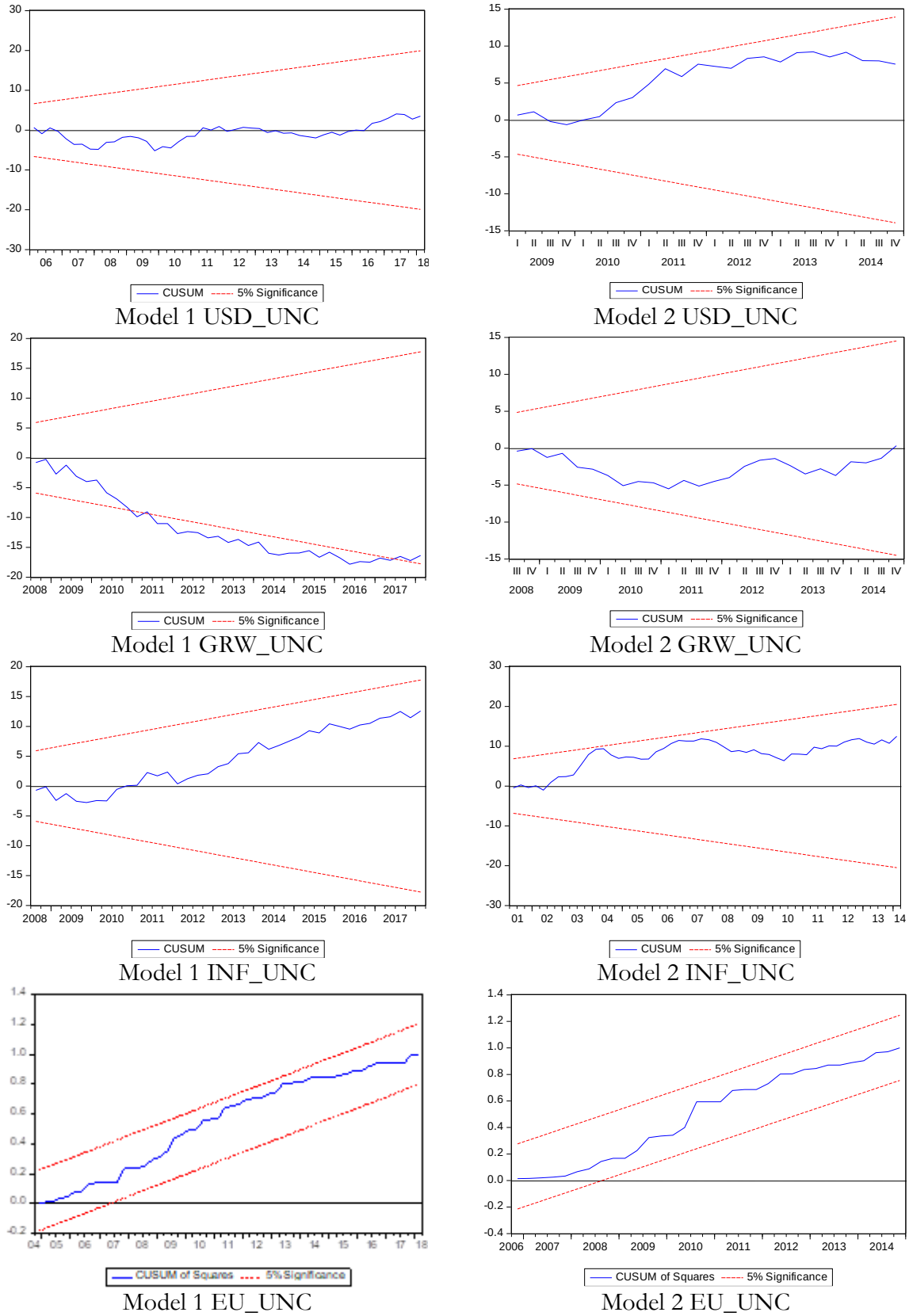



**Figure 1b:** CUSUM and CUSUMQ tests

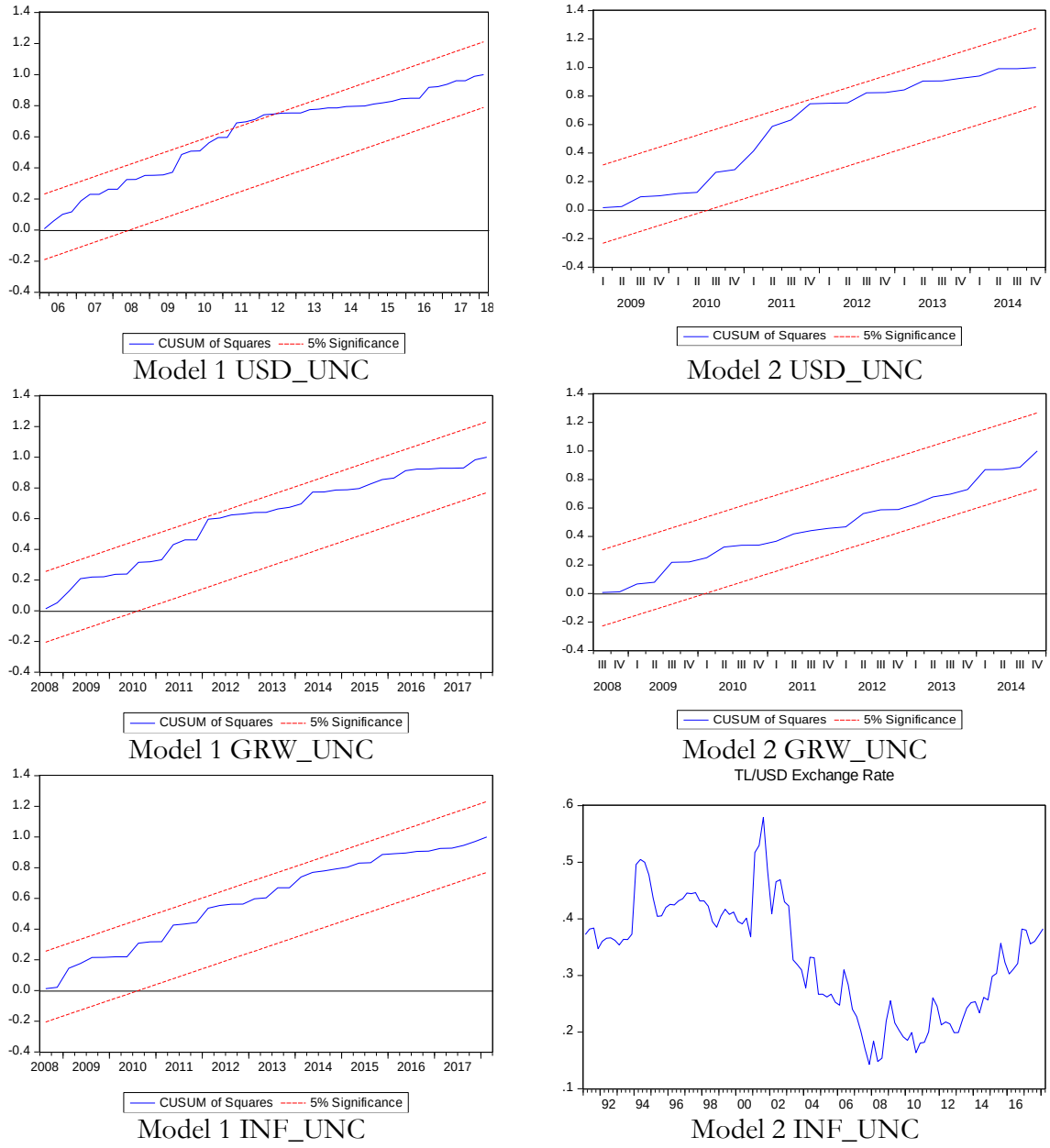



**Figure 1c:** CUSUM and CUSUMQ tests

## Conclusion

In the theoretical literature, there is no consensus on the impact of uncertainty on investments. Some models predict a positive sign, while others suggest a negative sign. Therefore this is an empirical issue. These findings observed that empirical studies on uncertainty and investment are generally focused on developed countries. However, developing economies face more macroeconomic uncertainty than developed countries. This paper has examined the impact of alternative measures of uncertainty based on three macroeconomic variables on private investment in Turkey. While two of them related the macroeconomic environment- inflation and growth, the other concerned the relative profitability of the traded and non-traded sectors- the real exchange rate. We use the GARCH model to get the uncertainty measures. Then we perform the cointegration test developed by Pesaran et al. (2001). Finally, we estimate an error correction model. We find that in the long run, exchange rate, inflation, and growth uncertainties have a negative

impact on private investments. Meanwhile, in the short-run, our results show that inflation uncertainty and the uncertainty of the *EUR/TRY* real exchange rate have a significant negative effect on investments. Due to the excessive dependence of industrial production to imported intermediate inputs in Turkey, it is not surprising to find a negative impact of exchange rate uncertainty on investments. On the other hand, the Turkish economy suffered from high and volatile inflation over the past three decades. In this respect, the applied inflation targeting program, which focuses on reducing inflation expectations, may be expected to be effective in reducing inflation uncertainty. Thus, the negative impact of inflation uncertainty on investments can be reduced.

There are different approaches in the literature about what the main target of central banks should be. In general, it is accepted that the primary purpose of the central banks is to ensure price stability, while some argue that central banks should target economic growth. According to this approach, the low-interest rate leads to economic growth by stimulating consumption. On the other hand, our results show that *CBRT* can support economic growth by decreasing inflation uncertainty. Namely, the decrease in inflation uncertainty will increase private investment and thus support economic growth in the short term, similar to the increase in consumption expenditures. In addition, increasing production capacity will contribute to economic growth in the long term. So we can conclude that the *CBRT* should implement a transparent and credible policy in order to reduce uncertainty. In this context, communication with the public became an essential factor, and the CBRT should continue to use tools such as inflation reports to provide more information to the public.

Another policy implication of our findings is that the *CBRT* should decrease exchange rate uncertainty. To this aim, although the *CBRT* does not intervene in the foreign exchange rate in level, it may intervene in the exchange rate market aimed at reducing the volatility in the exchange rate.

Overall, our results provide evidence that macroeconomic stabilization is an important condition for the continuity of investments in Turkey. In addition, for developing countries such as Turkey, investments have an important effect on economic performance. Therefore we can conclude that one of the priorities of the economic policy in Turkey should be providing stability. Future research can consider other investment determinants and take into account the non-linear effect of uncertainty on investment for developing countries.

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## References

Abel, A. B. (1983). Optimal investment under uncertainty. *American Economic Review*, *73*(1), 228–233. https://doi.org/10.4324/9780203004937

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, *31*(3), 307–327. https://doi.org/10.1016/0304-4076(86)90063-1

Byrne, J. P., & Davis, E. P. (2005). Investment and uncertainty in the G7. *Review of World Economics*, *141*(1), 1–32. https://doi.org/10.1007/s10290-005-0013-0

Darby, J., Hallett, A. H., Ireland, J., & Piscitelli, L. (1999). The impact of exchange rate uncertainty on the level of investment. *The Economic Journal*, *109*(454), 55–67. https://doi.org/10.1111/1468-0297.00416

Demir, F. (2009). Macroeconomic uncertainty and private investment in Argentina, Mexico and Turkey. *Applied Economics Letters*, *16*(6), 567–571. https://doi.org/10.1080/13504850701206528

Dixit, A., & Pindyck, R. (1994). *Investment under uncertainty*. Princeton, NJ: Princeton University Press.

Dotsey, M., & Sarte, P. D. (2000). Inflation uncertainty and growth in a cash-in-advance economy. *Journal of Monetary Economics*, *45*(3), 631–655. https://doi.org/10.1016/S0304-3932(00)00005-2

Driver, C., & Moreton, D. (1991). The influence of uncertainty on UK manufacturing investment. *The Economic Journal*, *101*(409), 1452–1459. https://doi.org/10.2307/2234895

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, *55*(2), 251–276. https://doi.org/10.2307/1913236

Ferderer, J. P. (1993). The impact of uncertainty on aggregate investment spending: An empirical analysis. *Journal of Money, Credit and Banking*, *25*(1), 30–48. https://doi.org/10.2307/2077818

Fischer, S., & Modigliani, F. (1978). Towards an understanding of the real effects and costs of inflation. *Weltwirtschaftliches Archiv*, *114*(4), 810–833. https://doi.org/10.1007/BF02696381

Folorunso, B. A., & Akinlo, A. (2010). Macroeconomic uncertainty and private investment in Nigeria. *Pakistan Journal of Applied Economics*, *20*(1 & 2), 47–65.

Gilchrist, S., Sim, J., & Zakrajšek, E. (2014). *Uncertainty, financial frictions, and investment dynamics* (NBER Working Papers No. 20038).

Greene, J., & Villanueva, D. (1991). Private investment in developing countries: An empirical analysis. *Staff Papers (International Monetary Fund)*, *38*(1), 33–58. https://doi.org/10.2307/3867034

Grier, K., & Perry, M. (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

Güney, P. Ö. (2007). Fiscal theory of exchange rate determination: empirical evidence from Turkey. *Economics Bulletin*, *5*(7), 1–12.

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

Hartman, R. (1972). The effects of price and cost uncertainty on investment. *Journal of Economic Theory*, *5*(2), 258–266. https://doi.org/10.1016/0022-0531(72)90105-6

Hasanov, M., & Omay, T. (2011). The relationship between inflation, output growth, and their uncertainties: Evidence from selected CEE Countries. *Emerging Markets Finance and Trade*, *47*(sup3), 5–20. https://doi.org/10.2753/REE1540-496X4704S301

Iyke, B. N., & Ho, S.-Y. (2017). Exchange rate uncertainty and domestic investment in Ghana. *Cogent Economics & Finance*, *5*(1), 1–12. https://doi.org/10.1080/23322039.2017.1362157

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, *12*(2), 231–254. https://doi.org/10.1016/0165-1889(88)90041-3

Lee, J. (2016). The impact of idiosyncratic uncertainty when investment opportunities are endogenous. *Journal of Economic Dynamics and Control*, *65*, 105–124. https://doi.org/10.1016/j.jedc.2016.02.004

Lensink, R. (2002). Is the uncertainty-investment link non-linear? Empirical evidence for developed economies. *Weltwirtschaftliches Archiv*, *138*(1), 131–147. https://doi.org/10.1007/BF02707327

Lian, W., Novta, N., Pugacheva, E., Timmer, Y., & Topalova, P. B. (2019). *The price of capital goods: A driver of investment under threat* (SSRN Electronic Journal). https://doi.org/10.2139/ssrn.3386368

Lucas, R. (1973). Some international evidence on output-inflation tradeoffs. *American Economic Review*, *63*(3), 326–334.

Ndiwulu, X. B., & Manzongani, J.-P. M. (2011). *Uncertainty and investment behaviour in the Democratic Republic of Congo*. https://econpapers.repec.org/RePEc:aer:wpaper:226

OECD. (2018). *OECD economic surveys: Turkey*. http://www.oecd.org/eco/surveys/economic-survey-turkey.htm

Pesaran, M. H., & Shin, Y. (1999). An autoregressive distributed lag modelling approach to cointegration analysis. In S. Storm (Ed.), *Econometrics and Economic Theory in the 20th Century: the Ragnar Frisch Centennial Symposium* (pp. 1–31). Cambridge: Cambridge University Press. https://doi.org/10.1017/CCOL521633230

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*, 289–326. https://doi.org/10.1002/jae.616

Pesaran, M. H., & Smith, R. P. (1998). Structural analysis of cointegrating VARs. *Journal of Economic Surveys*, *12*(5), 471–505. https://doi.org/10.1111/1467-6419.00065

Pindyck, R., & Solimano, A. (1993). Economic instability and aggregate investment. In O. J. Blanchard & S. Fischer (Eds.), *NBER Macroeconomics Annual 1993, Volume 8* (pp. 259–318). National Bureau of Economic Research, Inc.

Pradhan, G., Schuster, Z., & Upadhyaya *, K. P. (2004). Exchange rate uncertainty and the level of investment in selected South-east Asian countries. *Applied Economics*, *36*(19), 2161–2165. https://doi.org/10.1080/0003684042000282498

Redl, C. (2018). Macroeconomic uncertainty in South Africa. *South African Journal of Economics*, *86*(3), 361–380. https://doi.org/10.1111/saje.12198

Ruzima, M., & Boachie, M. K. (2018). Exchange rate uncertainty and private investment in BRICS economies. *Asia-Pacific Journal of Regional Science*, *2*(1), 65–77. https://doi.org/10.1007/s41685-017-0062-0

Saman, C. (2010). Macroeconomic uncertainty and investment – empirical analysis for Romania. *Journal for Economic Forecasting*, *13*(2), 155–164.

Sarkar, S. (2000). On the investment–uncertainty relationship in a real options model. *Journal of Economic Dynamics and Control*, *24*(2), 219–225. https://doi.org/10.1016/S0165-1889(99)00005-6

Servén, L. (1999). *Macroeconomic uncertainty and private investment in developing countries: An empirical*

*investigation*. The World Bank. https://doi.org/10.1596/1813-9450-2035

Servén, L, & Solimano, A. (1993). *Striving for growth after adjustment: The role of capital formation* (No. 12530). *Word Bank Regional and Sectoral Studies*. http://documents1.worldbank.org/curated/en/303511468739161482/pdf/multi0page.pdf

Servén, Luis. (2003). Real-exchange-rate uncertainty and private investment in LDCS. *The Review of Economics and Statistics*, *85*(1), 212–218. https://doi.org/10.1162/rest.2003.85.1.212

Uygur, E. (2010). *The global crisis and the Turkish Economy* (Turkish Economic Association Discussion Paper No. 2010/3).