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Abstract

In the literature it is suggested that, in addition to many factors such as macroeconomic and microeconomic polices, financial institutions and property rights; macroeconomic uncertainties are affecting the investment decisions. In this paper, we analyzed the effect of the real exchange rate, inflation and growth uncertainties on private investment in a developing country; Turkey. We used a generalized autoregressive conditional heteroskedasticity (GARCH) model to measure uncertainties. Then, we investigated the long-term relationship of the variables using bound testing approach. Finally, we adopt an error correction model to capture the dynamic relationship. According to our results macroeconomic uncertainties have a significant negative effect on private investments in Turkey. Therefore, our findings showed the importance of the macroeconomic stability for the continuity of investments in Turkey.
Keywords: Investment, Uncertainty, Bound Testing, Turkey
JEL Classifications: E2; E6

1. Introduction

Countries ability to invest is one of the essential determinants of economic growth and development. In this context, private investments play an important role in terms of its help to allocate resources efficiently. In the literature it is argued that besides many factors such as macroeconomic and microeconomic policies, financial institutions and property rights, investment decisions can be affected by uncertainty about macroeconomic variables. Theoretical literature presents different mechanisms about this process. For example, Hartman (1972), Abel (1983) and Lee (2016) suggest that price uncertainty may stimulate investments by increasing expected profitability of the capital. On the other hand, according to the argument of 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 (see Dixit and Pindyck, 1994). In this case, firms may reduce or delay investment. Another approach states that uncertainty increases default risks and this makes external financing more expensive, which can lead to investment contraction (Gilchrist et al., 2014). Furthermore, Sarkar (2000) argues that the effect may change according to the uncertainty level. Namely, the effect that is positive when uncertainty is low can be negative when the uncertainty exceeds a certain level.

According to Lucas (1973), economic agent's responses 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, investments may decrease. Fischer and Modigliani (1978) stated that inflation uncertainty makes planning difficult for the future. Another view states that inflation uncertainty may stimulate investment. Because in economies which experience a high level of inflation, and hence a volatile prices, an increased marginal profitability of capital leads to 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 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) and Darby et al. (1999) stated that uncertainties in real exchange rates have a negative affect on investments. Besides that, some factors such as the degree of openness of the economy and the level of development of financial markets are expected to affect the impact of exchange rate uncertainty on the investment.

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

In this paper, 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 have an effect on 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. Our results will help governments to design policies that minimize the negative impacts on investment.

The rest of the article organized as follows: In section 2 we summarize the Turkish Economy. In Section 3 we briefly introduce the literature, in section 4 we discuss measuring uncertainty. Section 5 explains the data and methodology. Section 6 reports empirical results and Section 7 concludes the paper.

2. An Overview of the Turkish Economy

The Turkish economy has been a high and volatile inflation country during the 1990's and the beginning of 2000's. During this period, Turkish economy has experienced two economic crises, in 1994 and in 2001. These crises have caused a recession in the Turkish economy and 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 have attracted huge capital inflows commencing from 1989 when capital account were liberalised. Commencing from 1993, in order to cover budget deficits, interest rates continued to rise and maturity of domestic borrowing has shortened further (Öge Güney 2007). In Turkey, various stabilization programs were implemented to solve the inflation problem. With the stabilisation program launched on April 5, 1994 the crisis was successfully defeated, however, 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, central bank was gained instrument independence and Turkey adopted implicit inflation targeting from January 2002 to December 2005. The aim of the 2001 program was 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 CBRT was short-term interest rate. Since 2010, the CBRT has started to concern both financial stability and price stability. In order to achieve these goals, it has begun to use new policy instruments such as interest rate corridor and liquidity policies (Öge Güney 2016). 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.

International trade performance of Turkey plays an important role in the economy. High current account deficits in the 2000's has been a key vulnerability of the Turkish economy. Turkish exports are largely dependent on EU's demand. From 1996 to 2007 more than 50% of Turkish exports were realized to EU countries. With the global crisis, the share of export to EU fell below 50%, while the share of exports to Africa and Middle East increased (Uygur 2010). In Turkey, although tradable sector has improved its performance over the past decade, its technological base is still low. The shares 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 very large share of investments in Turkey. Global uncertainty during the global 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."

3. Literature Review

In the literature, papers that deal with uncertainties in the real exchange rate generally show that the uncertainty in the exchange rate has a constrictive effect on investment. For example, Serven (2003) shows that exchange rate uncertainty negatively affects investments in 61 developing countries. In addition, he argues that uncertainty has influence only if it exceeds a critical level. Darby et al. (1999) investigate five OECD countries and they show that exchange rate volatility can have a negative impact on investment. Byrne and Davis (2005) find similar result for a group of developed economies. Dursun (2015) shows that exchange uncertainty is an important determinant of investment decisions in Turkey. On the other hand, Pradhan et al. (2004) shows that the real exchange rate uncertainty and investment relationship is inconclusive for four developing countries.

Serven and Solimano (1993) considered both inflation and exchange rate uncertainties and they showed that these uncertainties have a negative effect on investment. Serven (1998) considers alternative measures of macroeconomic uncertainty and shows that macroeconomic uncertainty has a negative impact on investment in developing countries. Demir (2009) uses micro-level data and finds that macroeconomic uncertainty significantly decreases the investment of industrial firms in Argentina, Mexico and Turkey. Federer (1993) uses the risk premium to measure uncertainty and shows that macroeconomic uncertainty is effective in the negative direction on investments in US. Driver and Moreton (1991) show an adverse affect of macroeconomic uncertainty on investment for UK. In addition, there are some studies analyzing the non-linear effects of uncertainty. For example, Saman (2010) uses both linear and non-linear models and finds that inflation and exchange rate uncertainties reduce investment in Romania. Lensink (2002) showed that in developed countries the effect of uncertainty on investments changes according to the size of the uncertainty. Accordingly, the low level uncertainty affects investments positively, while high uncertainty affects negatively.

4. Measuring Uncertainty

In the literature, different methods are used to measure uncertainty (see Lensink, 2002) and several sources of uncertainties are considered. One approach to measure 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 (see Grier and Perry 2000): First, 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, 2011).

In this study, with regard to the source of uncertainty we consider the uncertainty of exchange rate (EX_UNC), inflation uncertainty (π_UNC) and growth uncertainty (GRW_UNC). USD_UNC shows the uncertainty of USD/TL exchange rate and EUR_UNC shows the uncertainty of EUR/TL 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:

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

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

where y_t is the variable the volatility of which we desire to find, ε_t is stochastic processes with zero mean and h_t is its conditional variance. We estimate ARCH(1) and GARCH(1,1) models, then we chose GARCH model according to Akaike Information Criteria (AIC). Eq. (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 Eq. (2) as a measure of uncertainty of y_t.

5. Data and Methodology

In order to examine the relationship among three types of uncertainties and investment, we use quarterly data from 1994:Q1 to 2018Q1. We estimate two types of models. In the Model 2, in addition to the real interest rate, we include the relative price of capital, which allow us to measure the cost of the capital and domestic credit to private sector to measure the tightness of credit market. In the Model 2, since the relative price of capital data is available until the first quarter of 2014, our estimates include data up to 2014Q4. Data graphs are presented in Figure 1.

Hence we estimated following models:

Model 1:

$$I_t = f(I_{t-1}, R_t, GDP_t, EX\_UNC_t)$$
$$I_t = f(I_{t-1}, R_t, GDP_t, INF\_UNC_t)$$
$$I_t = f(I_{t-1}, R_t, GDP_t, GRW\_UNC_t)$$

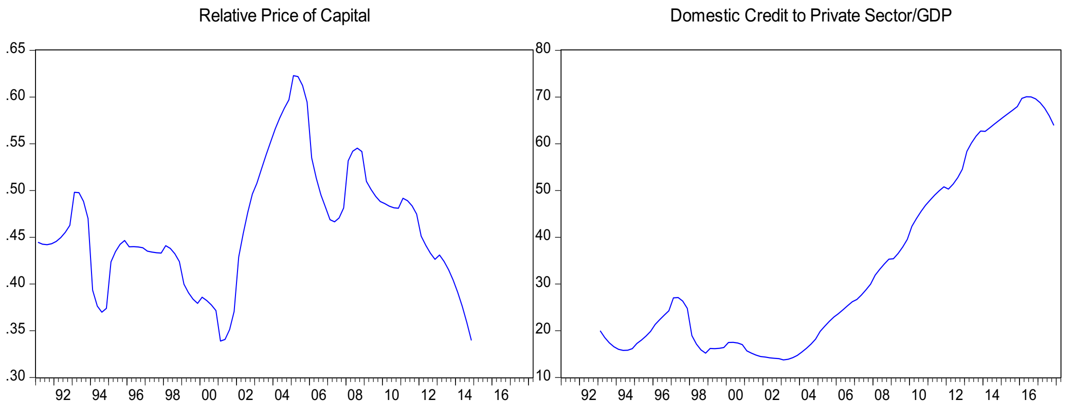
Model 2:

$$I_t = f(I_{t-1}, R_t, GDP_t, RELP_t, CRD_t, EX\_UNC_t)$$
$$I_t = f(I_{t-1}, R_t, GDP_t, RELP_t, CRD_t, INF\_UNC_t)$$
$$I_t = f(I_{t-1}, R_t, GDP_t, RELP_t, CRD_t, GRW\_UNC_t)$$

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 State 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 $R = ln[(1+i)/(1+\pi)]$ where π is the inflation rate and i presents the nominal interest rate. The real GDP is calculated as $Real\ GDP = Nominal\ GDP/(GDPDeflator/100)$. We obtained all the above data from International Financial Statistics (IFS) published by International Monetary Fund (IMF). We obtain the relative price of capital ($RELP = Investment\ Deflator/GPD\ Deflator$) from *Penn World Table* and we interpolate this data from annual to quarterly. Domestic credits to 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 global crisis in 2008. We define the dummy variable as:

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

Figure 1: Graph of the Data



6. Results

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 variables we are dealing with. Since unit root tests yields mixed results, we use the bound testing approach developed ARDL framework by Pesaran and Shin (1999) and Pesaran et al. (2001). We choose this method because to use the conventional cointegration tests such as Engle and Granger (1987) and Johansen (1998) all-time series need to be integrated of order one. The bound testing approach, however, allows testing for cointegration among variables with different order of integration. Since in our models we have both I(0) and I(1) variables, bound testing methodology becomes the most useful approach.

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_UN	-10.988*
C	

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

To conduct the bound test, following unrestricted error correction model (ECM) is used for above models. In Model 1 we exclude the *RELP* and *CRD* variables. In Model 3 we also exclude the *RELP* and *CRD* variables but the time period is same as Model 2 that is until 2014Q4. Finally in Model 4 interest rate is omitted but the *RELP* is not.

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

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

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

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

H0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$

H1: $\beta_1 \neq 0, \beta_2 \neq 0, \beta_3 \neq 0, \beta_4 \neq 0, \beta_5 \neq 0, \beta_6 \neq 0.$

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

H0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$

H1: $\alpha_1 \neq 0, \alpha_2 \neq 0, \alpha_3 \neq 0, \alpha_4 \neq 0, \alpha_5 \neq 0, \alpha_6 \neq 0.$

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

H0: $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6 = 0$

H1: $\gamma_1 \neq 0, \gamma_2 \neq 0, \gamma_3 \neq 0, \gamma_4 \neq 0, \gamma_5 \neq 0, \gamma_6 \neq 0.$

These hypotheses can be examined using the *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.

Table 2: F - Statistics for the Analysis of a Long Run Relationship

Included Variable	Model 1	Model 2	Model 3	Model 4
USD_unc	F= 7.767*	F=5.851*	F=7.139*	F=3.173
EUR_unc	F=4.683*	F=4.795*	F=3.603	F=5.217*
INF_unc	F= 10.431*	F=6.339*	F=9.260*	F=5.091*
GRW_unc	F= 7.395*	F=6.951*	F=6.538*	F=7.551*

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, Shin, and Smith (2001), Table CI(iii) Case III. We use Akaike Information Criteria as lag length selection criteria.

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 we have concerned. (The exceptions are Model 3 including EUR_unc and Model 4 including USD_unc variable.) Next, we want to estimate the level relations and short-run dynamics. Following Pesaran and 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 AIC criterion. The estimates of the ARDL models are given in Table 3 for Model 1 and in Table 4 for Model 2[2].

[2] We do not report ARDL estimates for Model 3 and for Model4 to save space.

Table 3: Estimates of the ARDL Model for Model 1

	ARDL(1,3,0,2)	ARDL(3,4,0,4)	ARDL(3,4,0,0)	ARDL(1,4,4,2)
Constant	0.269*		-3.817*	-2.097*
I_{t-1}	0.924*	0.826*	0.449*	0.377*
I_{t-2}		0.169	-0.046	-
I_{t-3}		-1.192***	-0.167***	-
R	-0.028	0.0003	0.095***	0.122**
R_{t-1}	-0.089*	-0.056***	0.033	0.074
R_{t-2}	-0.070**	0.069**	-0.072	-0.155**
R_{t-3}	-0.056**	-0.041	-0.059	0.084
R_{t-4}		0.042***	0.049***	0.063
GDP	-0.042*	0.053	0.782*	0.716*
GDP_{t-1}	-	-0.038	-	-0.194
GDP_{t-2}	-	0.082	-	0.258
GDP_{t-3}	-	0.089	-	-0.019
GDP_{t-4}		-0.102***		-0.311*
EUR_UNC	-	-	-0.500*	-
USD_UNC	-	-	-	1.235
USD_UNC_{t-1}	-	-	-	-1.341
USD_UNC_{t-2}				-2.238
INF_UNC	-0.004**	-	-	-
INF_UNC_{t-1}	0.004***	-	-	-
INF_UNC_{t-2}	-0.004***			
GRW_UNC	-	0.0001	-	-
GRW_UNC_{t-1}	-	-0.0001	-	-
GRW_UNC_{t-2}	-	0.001	-	-
GRW_UNC_{t-3}	-	-0.001***	-	-
GRW_UNC_{t-4}		-0.002*		
Dummy	-0.016*	-0.01***	-	-
Trend	-	0.001*	-0.003*	-0.002*

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

Table 4: Estimates of the ARDL Model for 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	0.268	-0.030	-5.733*	-2.569*
I_{t-1}	0.826*	0.709*	0.459*	0.461*
I_{t-2}	0.152	0.253***	-0.224	-0.370*
I_{t-3}	-0.319**	-0.179**	-0.298**	-
I_{t-4}	0.187***		-0.022	
R	-0.005	-0.009	-0.049	0.185**
R_{t-1}	-0.037***	-0.041	-	0.052
R_{t-2}	-	0.040***	-	-0.216*
R_{t-3}	-	-	-	0.126**
GDP	0.101	0.165**	0.868*	0.791*
GDP_{t-1}	-0.012	-0.051	-0.282	-0.499***
GDP_{t-2}	0.089	0.105	0.570**	0.917*
GDP_{t-3}	-0.042	-0.026	-	-0.398***
GDP_{t-4}	-0.171*	-0.175*		-0.189
CRD	0.004**	0.005*	0.001	0.003
CRD_{t-1}	-0.002	-0.003	-0.007***	-0.006***
CRD_{t-2}	-0.002	-0.002	0.008**	0.008**
CRD_{t-3}	0.003	0.003	-0.003	-0.007**
CRD_{t-4}	-0.003**	-0.003**		0.004***
$RELP$	0.016	-0.016	0.062	0.081
$RELP_{t-1}$	-0.132	-	0.192	0.082
$RELP_{t-2}$	-0.119	-	-0.288**	-0.419**
$RELP_{t-3}$	0.370*	-	-0.467**	0.599*
$RELP_{t-4}$	-0.202**		0.307*	-0.284**
EUR_UNC	-	-	-0.400	-
USD_UNC	-	-	-	1.974
USD_UNC_{t-1}	-	-	-	-2.768
USD_UNC_{t-2}	-	-	-	-4.031**
USD_UNC_{t-3}	-	-	-	-2.567
INF_UNC	-0.005**	-	-	-2.994**
INF_UNC_{t-1}	-0.002	-	-	-
INF_UNC_{t-2}	0.003***			
GRW_UNC	-	0.001	-	-
GRW_UNC_{t-}	-	-0.0003	-	-
GRW_UNC_{t-}	-	0.0002	-	-
GRW_UNC_{t-}	-	-0.0004	-	-
GRW_UNC_{t-}		-0.002*		
Dummy	-0.006***	-0.009**	-	-
Trend	-	-	-0.003**	-0.004*

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

The estimates of the levels relationship are given in Table 5.

Table 5: 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
EUR_UNC	-0.654*	-	-	-	-0.246	-	-	-
USD_UNC	-	-3.765*	-	-	-	-11.424**	-	-
INF_UNC	-	-	-0.055***	-	-	-	-0.021	-
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

Regressors	Model 3				Model 4			
R	-	0.073***	-0.887**	0.054	-	-	-	-
GDP	-	0.732*	-0.331	-0.478**	1.047*	-	-0.234	-0.051
CRD					-0.001	-	-0.001	-0.001
$RELP$					0.103**	-	-0.522	-0.087
ΔEUR_UNC	-				-0.258	-	-	-
ΔUSD_UNC		-9.223*			-	-	-	-
ΔINF_UNC			-0.032**		-	-	-0.019	-
ΔGRW_UNC				-0.016	-	-	-	-0.006
$Dummy$				-0.095*	-	-	-0.079	-
$Trend$	-	-0.004*		0.004**	-0.004*	-	-	-
$Constant$	-	-3.140*	2.200	2.674**	-5.173*	-	1.783	0.010

As reported in Table 5, the coefficients of the real interest rate are significant four cases but it has an expected sign only in one case. The level coefficients of the domestic credit to 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 against USD) and growth uncertainty on private investment are negative and significant. In Model 2 these coefficients also has a negative sign. However, only the uncertainty of the USD/TL real exchange rate has a significant effect on private investments. Model 3 shows that the inflation uncertainty and exchange rate uncertainty against USD have a negative and significant effect on private investment. In the case of Model 4, the signs of uncertainty variables are negative but insignificant.

Finally, to capture the dynamic relationship, we estimate 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 υ_1, υ_2 and υ_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.

In Table 6 we see 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. For 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. This is consistent with the theory of accelerator. 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. Uncertainty of the EUR/TL 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/TL real exchange rate are insignificant. The diagnostic tests are presented at the bottom of the table. Except, the model including the growth 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 indicate that our other estimates are stable over time since the plot of the CUSUM and CUSUMQ statistics fall inside the critical bounds presented straight lines.

Table 6: 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, ,2)
Constant				
ΔI_{t-1}	-	0.022	0.213**	-
ΔI_{t-2}	-	0.192**	0.167**	-
ΔR	-0.028	0.0003	0.095***	0.122**
ΔR_{t-1}	-0.069**	-0.069**	0.072	0.155**
ΔR_{t-2}	0.056**	0.041	-0.059	-0.084
ΔR_{t-3}	-	-0.042***	-0.049***	-0.063
ΔGDP	-0.042	0.053	0.782*	0.717*
ΔGDP_{t-1}	-	-0.082	-	-0.258
ΔGDP_{t-2}	-	0.089	-	0.019
ΔGDP_{t-3}	-	0.102***	-	0.311**
ΔEUR_UNC	-	-	-0.500*	-
ΔUSD_UNC	-	-	-	1.235
ΔUSD_UNC_{t-1}	-	-	-	-1.238
ΔINF_UNC	-0.003**	-	-	-
ΔINF_UNC_{t-1}	0.004*	-	-	-
ΔGRW_UNC	-	-0.0001	-	-
ΔGRW_UNC_{t-1}	-	-0.0001	-	-
ΔGRW_UNC_{t-2}	-	0.001***	-	-
ΔGRW_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% 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.

Table 7: Short-run Results of the Model 2

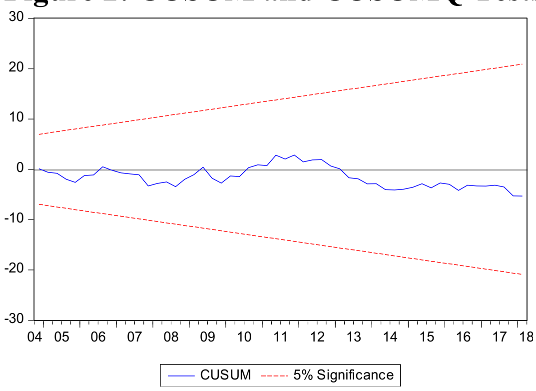
	ARDL(4,1,4,4,4,2)	ARDL(3,2,4,4,0,4)	ARDL(4,0,2,3,3,0)	ARDL(2,3,4,4,4,4)
Constant	1.737			
ΔI_{t-1}	-0.020	-0.094	0.476*	0.370**
ΔI_{t-2}	0.132	0.160***	0.268**	-
ΔI_{t-3}	-0.187***	-	0.003	-
ΔR	-0.005	-0.010	-0.043	0.185**
ΔR_{t-1}	-	-0.035	-	0.216*
ΔR_{t-2}	-	-	-	-0.126**
ΔR_{t-3}	-	-	-	-
ΔGDP	0.101	0.182*	0.796*	0.791*
ΔGDP_{t-1}	-0.089	-0.103	-0.491**	-0.917*
ΔGDP_{t-2}	0.042	0.033	-	0.398***
ΔGDP_{t-3}	0.171**	0.185*	-	0.189
ΔCRD	0.004**	0.005*	0.001	0.003
ΔCRD_{t-1}	0.002	0.002	-0.007**	-0.008**
ΔCRD_{t-2}	-0.003	-0.003	0.003	0.007**
ΔCRD_{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**
ΔEUR_UNC	-	-	-0.230	-
ΔUSD_UNC	-	-	-	1.974
ΔUSD_UNC_{t-}	-	-	-	4.031**
ΔUSD_UNC_{t-}	-	-	-	2.567
ΔUSD_UNC_{t-}	-	-	-	2.994**
ΔINF_UNC	-0.005**	-	-	-
ΔINF_UNC_{t-}	-0.003***	-	-	-
ΔGRW_UNC	-	0.001	-	-
ΔGRW_UNC_t	-	-0.0002	-	-
ΔGRW_UNC_t	-	0.0004**	-	-
ΔGRW_UNC_t	-	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.

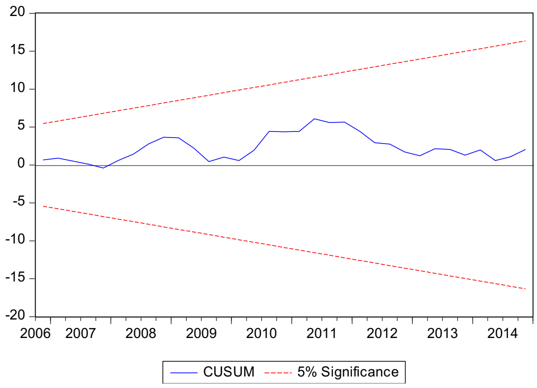
In Table 7, we report the estimates of the Model 2 that includes *CRD* and *RELP* variables in addition to the variables included in Model 1. A comparison of Table 6 and 7 reveals little difference concerning the estimated coefficients of the lag of investment and the real GDP and its lags[3]. The coefficients of the error correction terms are negative and significant as expected. The coefficients of the real interest rate and its lags are negative however insignificant. Only the model presented at 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 have a significant negative impact on investments. The coefficient of the uncertainty of the EUR/TL real exchange rate is negative and insignificant. 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 2. The results indicate that our models are stable over time.

To summarize the empirical findings, our estimates reveal that macroeconomic uncertainty indicators have a significant negative effect on private investment in Turkey.

Figure 2: CUSUM and CUSUMQ Tests

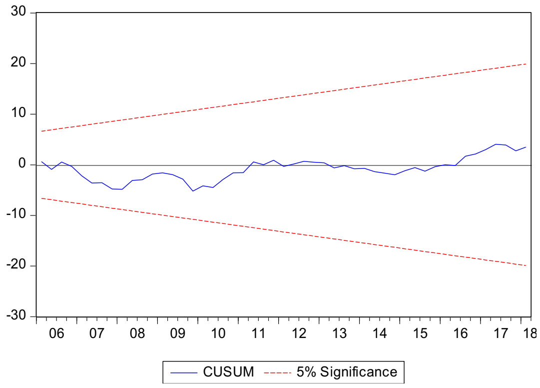


Model 1 EUR_UNC

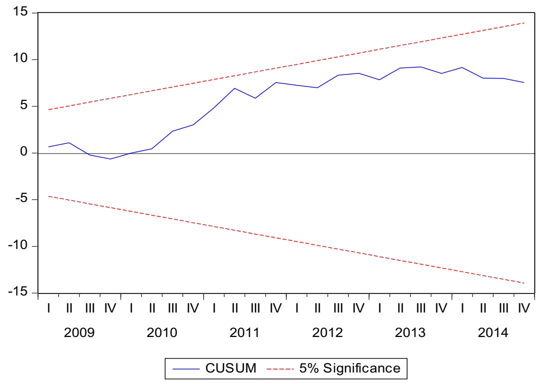


Model 2 EUR_UNC

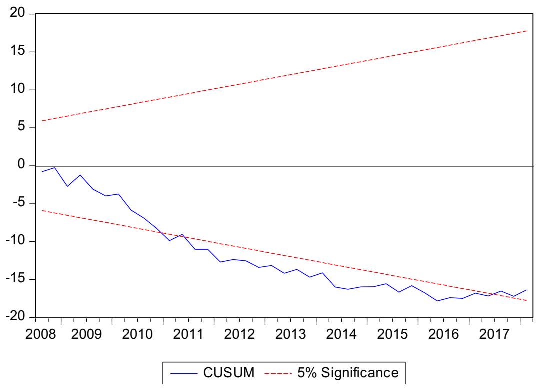
[3] We do not report the ARDL-ECM models for Model 3 and for Model 4.



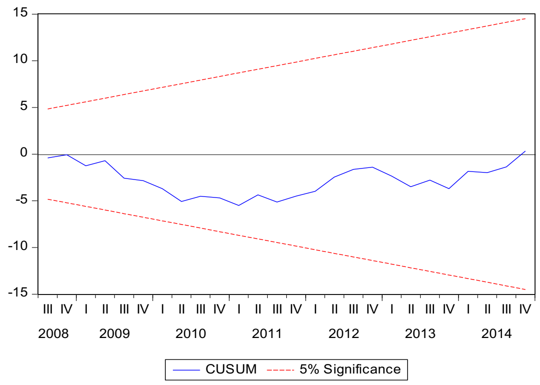
Model 1 USD_UNC



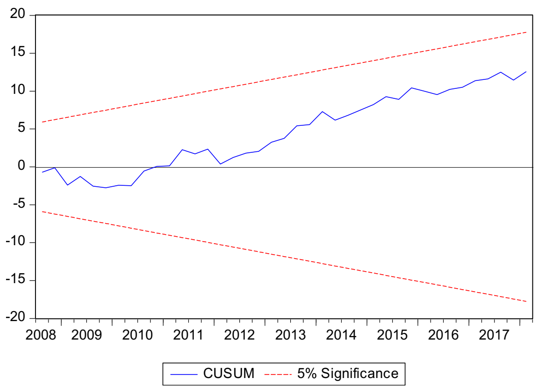
Model 2 USD_UNC



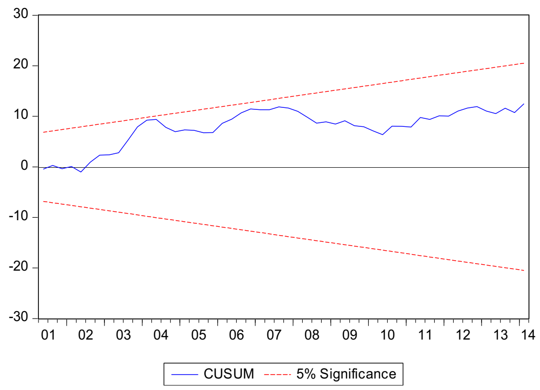
Model 1 GRW_UNC



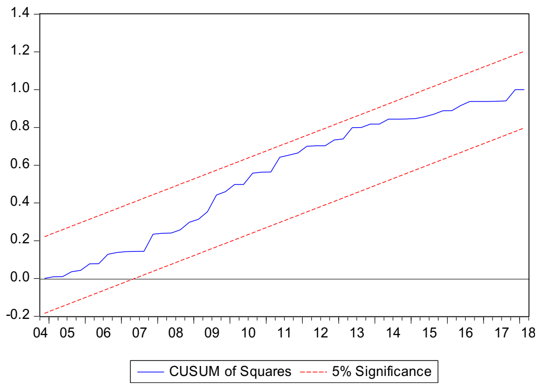
Model 2 GRW_UNC



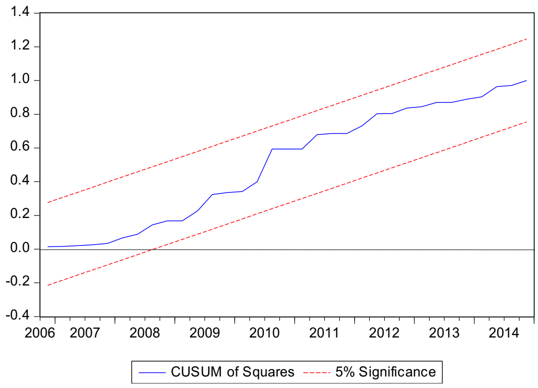
Model 1 INF_UNC



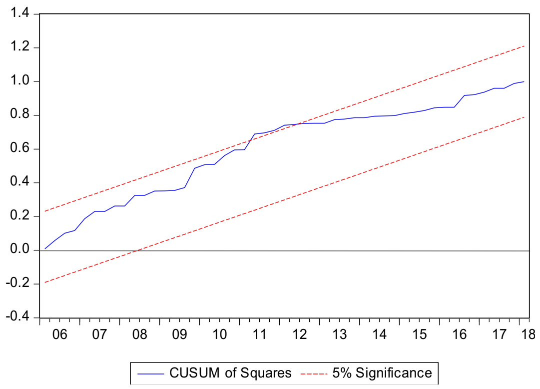
Model 2 INF_UNC



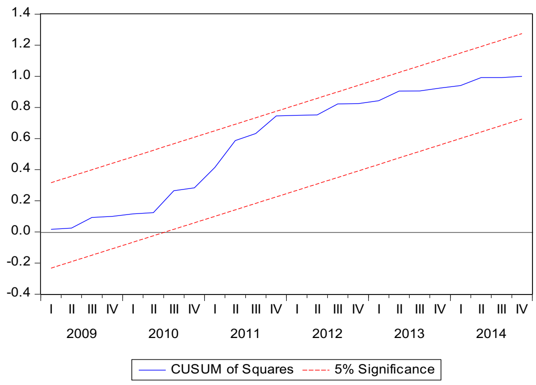
Model 1 EU_UNC



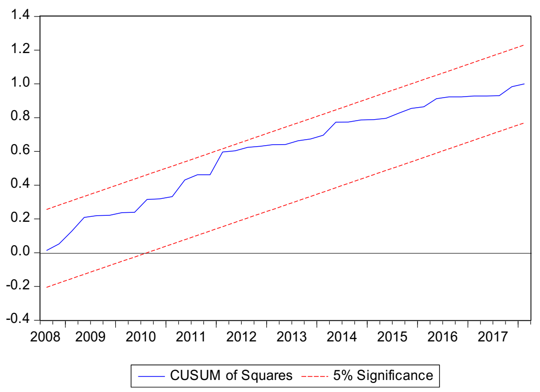
Model 2 EU_UNC



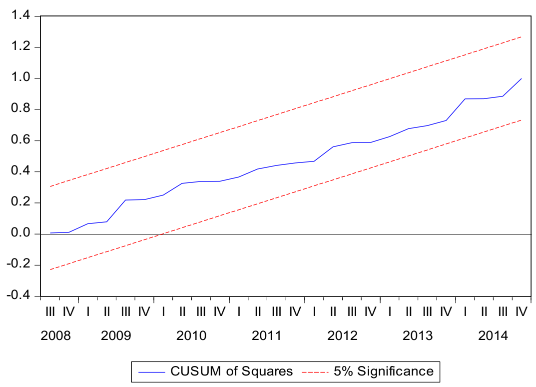
Model 1 USD_UNC



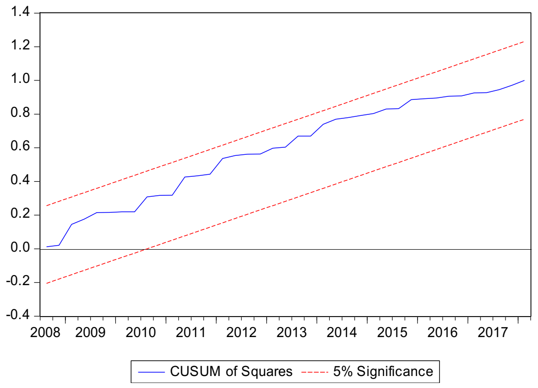
Model 2 USD_UNC



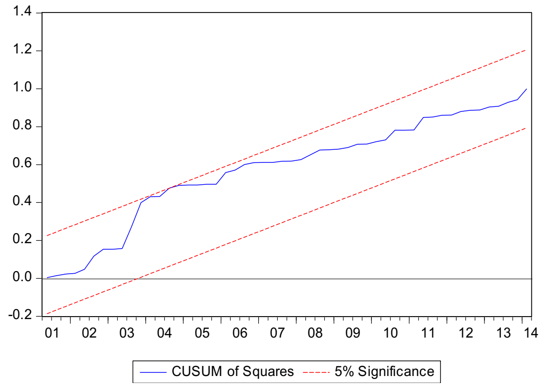
Model 1 GRW_UNC



Model 2 GRW_UNC



Model 1 INF_UNC



Model 2 INF_UNC

7. 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. It is 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 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/TL 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 effect of exchange rate uncertainty on investments. On the other hand, Turkish economy suffered from high and volatile inflation over the past three decades. In this respect, 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 main purpose of the central banks is to ensure price stability, while some argue that central banks should target economic growth. According to this approach, low interest rates leads 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 public became an important 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 the 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 nonlinear effect of uncertainty on investment for developing countries.

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