The Impacts of Macroeconomic Uncertainty and Interest Rates on the Investment Spending: ARDL Co-integration Approach

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Abstract

The purpose of this study is to test the effects of macroeconomic uncertainty and interest rates on investment spending for Turkish economy. We have used quarterly data for the period of 2003-2016. The study uses three important econometric steps. In the first step, the macroeconomic uncertainty index is formed based on the Atta-Mensah (2004) approach. For this aim, moving standard deviation technique is used to calculate the volatilities of the stock market, general price level, economic activity and exchange rate. In the second step, macroeconomic uncertainty index is produced. In the third step, the long-run dynamic relationships are analyzed among macroeconomic uncertainty index, interest rates and investment spending and the effects of uncertainty index and interest rates on investment spending are tested using the ARDL co-integration test.

Keywords: *Macroeconomic Uncertainty, Investment Spending, ARDL.*

Makroekonomik Belirsizlik ve Faiz Oranlarının Yatırım Harcamaları Üzerindeki Etkileri: ARDL Eşbütünleşim Yaklaşımı

Öz

Bu çalışmanın amacı Türkiye ekonomisi için makroekonomik belirsizlik ve faiz oranlarının yatırım harcamaları üzerindeki etkilerini test etmektir. Çalışma üçer aylık 2003-2016 dönemini kapsamaktadır. Çalışmada üç önemli ekonometrik aşama kullanılmaktadır. İlk aşamada, Atta-Mensah (2014) yaklaşımı temel alınarak makroekonomik belirsizlik endeksi oluşturulmuştur. Bu amaçla borsa endeksi, fiyatlar genel düzeyi, ekonomik aktivite ve dolar kuru oynaklıkları hareketli standart sapma yöntemi ile elde edilmiştir. İkinci aşamada, makroekonomik belirsizlik endeksi üretilmiştir. Üçüncü aşamada, makroekonomik belirsizlik endeksi ve faiz oranları ile yatırım harcamaları arasındaki uzun dönemli dinamik ilişkiler analiz edilmiştir. Bu çalışmada, endeksin ve faiz oranlarının yatırım harcamaları üzerindeki etkileri ARDL ko-entegrasyon testi kullanılarak test edilmiştir.

Anahtar Kelimeler: *Makroekonomik Belirsizlik, Yatırım Harcamaları, ARDL.*

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1. Introduction

The theoretical and empirical macroeconomic literature studies the effects of uncertainty and interest rates on investment spending. Investment decisions in all economies require forecasting what will happen in the future. However, no one can predict exactly the future. There will always be some uncertainty about it. The effect of uncertainty and interest rates on investment spending has been analysed using theoretical models through different channels. In the related theory, the effect of the uncertainty on investment spending can be positive or negative. The result is related to assumptions about adjustment costs and risk aversion. For example, Ferderer (1993) found that uncertainty affects investment negatively but the result was statistically insignificant. According to Serven (1998) and Byrne and Davis (2005), the relationship between uncertainty and private investment is significantly negative for developing countries. According to their results, uncertainty affects investment negatively. The effect of government spending and uncertainty on private fixed investment in services sector was analyzed by Ahman and Qayyum (2008). In their studies, the results also show that macroeconomic uncertainty affects private investment negatively. Recently, Gilchrist et al. (2014) investigated how the interaction of uncertainty and credit spreads affects investment dynamics. They used micro-level data set to document the tight link between corporate bond credit spreads and uncertainty. The result of their study indicates that uncertainty shocks affect aggregate investment, negatively. As can be seen from above, the link between uncertainty and investment spending relationship has attracted a great deal of theoretical attention in recent years. However, they do not make a consensus about how to calculate macroeconomic uncertainty as an index. For example, F*erderer (1993), Serven (1998), Goel and Ram (2001), Byrne and Davis (2005), Bredin and Fountas (2005), Kumo (2006), Cronin et al. (2011), Guglielminetti (2013)* described macroeconomic uncertainty as the individual uncertainty of the macroeconomic variables such as exchange rate uncertainty, money growth uncertainty, stock index uncertainty, inflation uncertainty. However, there are studies that describe and estimate uncertainty as an index such as *Atta-Mensah (2004), Gan (2013) and Baker et al. (2015).*

Atta-Mensah (2004) determined macroeconomic variables that cause to an economic uncertainty in Canada economy. In his study, a macroeconomic uncertainty index was produced. *Erdem and Yamak (2016)* obtained an uncertainty series by using Atta-Mensah's approach. *Gan (2013), Erdem and Yamak (2016)* described the macroeconomic uncertainty index in the loss function of Central Bank. *Baker et al. (2015)* developed a new index of economic policy uncertainty. Their index bases the frequency of newspaper references to economic policy uncertainty, the number of federal tax code provisions set to expire, and the extent of forecaster disagreement over future inflation and government purchases.

Within this framework, the objective of this paper is to address two empirical questions. First, do macroeconomic uncertainty and interest rates have any impact on investment spending for Turkish economy? "Second, could a macroeconomic uncertainty index be produced by using a simpler and more effective approach?"

The study uses three important econometric steps. Firstly, moving standard deviation technique is used to estimate the volatilities of the stock market, general price level, economic activity, and exchange rate. Secondly, macroeconomic uncertainty index is calculated. Thirdly, the impacts of macroeconomic uncertainty index and interest rates on investment spending are examined. In section 2, we provide the literature review and in section 3 data and methodology. In section 4, we present empirical findings, and section 5 gives concluding remarks.

2. Literature Review

The impact of uncertainty and interest rates on investment spending has recently attracted a great deal of attention in the theoretical and empirical literature. For example, *Rittenberg (1991)* investigated the effect of interest rate policy on investment spending in Turkey. The data of the study covered the years of both financial repression and liberalization. According to *Rittenber (1991)*, there is a positive relationship between investment and interest rates for the years of both financial repression and liberalization.

The study of *Ferderer (1993)* is one of basic papers about the uncertainty-investment link. He tested the empirical relationship between uncertainty and investment spending, by using regression analysis. In his study, the risk premium was used as an uncertainty variable. According to his study, uncertainty had a negative impact on investment spending. However, uncertainty statistically did not have any effect on investment spending. *Leahy and Whited (1995)* used a panel of U.S manufacturing firms data and found that there was a negative impact of uncertainty on irreversible investment. In 1998, Serven re-examined empirically the investment-uncertainty link employing a large macroeconomic data set for developing countries, including 94 developing countries for the period of 1970-1995. Instead of the sample variability of individual macroeconomic variables, he used the dispersion of the innovations to the selected macroeconomic variables to construct the measures of uncertainty. By estimating an empirical investment equation under panel data econometric methods, *Serven (1998)* found a significant negative effect of measures of macroeconomic uncertainty on investment. In the study, another finding is that private investment is negatively affected by real interest rate.

Using micro-level panel data on three countries, Argentina, Mexico and Turkey that are argued to appear as a trio where financial liberalization program were first tested at full scale, *Demir (2009)* investigated the importance of macroeconomic uncertainty and country risk on real investment. In order to measure macroeconomic uncertainty and instability, he used bi-annual average standard deviatons of monthly variables and bi-annual average standard deviations based on AR(1) and GARCH(1,1) and based on micro-level company panel data for 1990-2003. His results indicate that there is a direct link between macroeconomic uncertainty and private investment spending in these three developing countries.

In addition, *Ghosal and Loungali (2000)* tested the impact of profit uncertainty on investment. They found that the relationship between investment and uncertainty was negative. *Holland et al. (2000)* indicated that aggregate uncertainty had a crucial role in investment decision making in terms of option-based investment models, by using regression analysis. They tested the relationship between uncertainty and investment spending. For this aim, they used aggregate data that were quarterly and covered the periods of 1972-1992. They found a statistically significant short-term negative relationship between aggregate uncertainty and the rate of investment. *Bekoe and Adom (2013)* used Ghanaian time series for the period of 1975 to 2008 in order to examine empirically the link between investments and uncertainty. In their empirical analysis, they employed GARCH(1,1) approach. They used five key macroeconomic variables (inflation, the relative price of capital goods, the growth of output, the real exchange rate and the terms of trade) to measure proxies for uncertainty. They constructed uncertainty indicators for the five macroeconomic variables. After producing uncertainty variables, they used fully modified OLS, their findings reveal a significant negative effect of all five macroeconomic uncertainty indicator variables on private investment. In their study, it was also found that real interest rate has a significant effect on private investment.

3. Data and Methodology

The data used in the current study cover the period of 2003:01-2016:02 (quarterly) for Turkish economy. All data are obtained from the Electronic Data Delivery System of the Central Bank of the Republic of Turkey. All data were seasonally adjusted by using the Census X12 method. Table 1 presents the summary of variables.

Table 1. The Summary of Variables

EX	*External Shocks (The Bilateral Exchange Rate between Turkey and the United States)*
EXVOL	*Volatility of the External Shocks*
BIST	*Stock Market (BIST Index)*
BISTVOL	*Volatility of the Stock Market*
CPI	*Consumer Price Index*
CPIVOL	*Volatility of the Consumer Price Index*
GDP	*Economic Activity*
GDPVOL	*Volatility of the Economic Activity*
R	*Interest Rates*
I	*Real Investment Spending (Gross Fixed Capital Formation)*
EUI	*Economic Uncertainty Index*

This study uses three important econometric steps:

• *Firstly,* the macroeconomic uncertainty index is formed based on the Atta-Mensah (2004) approach. Before starting the analysis, moving standard deviation technique is applied to get the volatilities of the stock market, consumer price index, economic activity, and exchange rate.

• *Secondly,* the macroeconomic uncertainty index is calculated by using Atta-Mensah (2004) approach as follows:

$$EUI = \sum_i^n \omega_i \left(\frac{vol_i - \overline{vol_i}}{\sigma_{vol}}\right) \qquad (1)$$

where *EUI* is the macroeconomic uncertainty index, vol_i is the volatility of the factor i $\overline{vol_i}$ is the average volatility, σ_{vol} is the standard deviation of volatility, and ω_i is the weight attached to each factor.

• *Thirdly,* the effects of macroeconomic uncertainty index and interest rates on investment spending are examined by using the ARDL cointegration approach[1].

4. Empirical Results

Table 2 presents the descriptive statistics of all series. As seen in Table 2, mean values of volatilities of the stock market, consumer price index, economic activity, and exchange rate are 0.119, 0.025, 0.022, 1.723, respectively. Also, the standard deviations of volatilities of the stock market, consumer price index, economic activity, and exchange rate are found as 0.06, 0.005, 0.01, 0.172, 0.47, respectively.

1 *Pesaran and Shin (1999).*

Table 2. Descriptive Statistics

	BISTVOL	***CPIVOL***	***GDPVOL***	***EXVOL***
Mean	***0.1199***	***0.0259***	***0.0227***	***1.7231***
Median	0.1015	0.0257	0.0197	1.5352
Maximum	0.3018	0.0379	0.0594	2.9464
Minimum	0.0262	0.0133	0.0033	1.1880
Std. Dev.	***0.0684***	***0.0058***	***0.0127***	***0.4760***
Skewness	0.8840	-0.0595	0.7880	1.3056
Kurtosis	2.9153	2.6518	3.1349	3.7858

Figure 1. Uncertainty Index of Turkish Economy

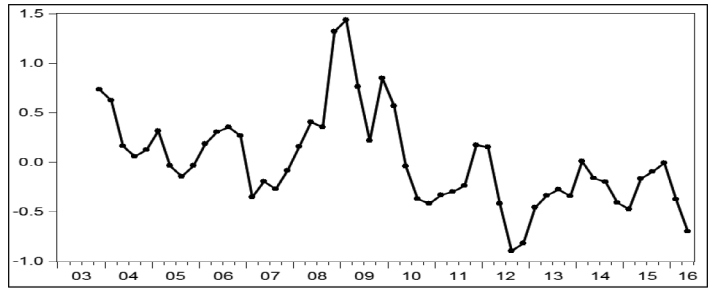


Table 3. The Results of ADF Unit-Root Test

Variables	***Level***		***First Difference***	
	Constant	***Constant+Trend***	***Constant***	***Constant+Trend***
I	-2.1928	-3.3739*	-4.1353***	-4.1535***
R	-6.6586***	-5.5679***	-5.2335***	-5.6597***
EUI	-2.5471	-3.6500**	-6.3502***	-6.2517***

*Note:*** is significance level of 1%, ** is significance level of 5% and * is significance level of 10%.*

Macroeconomic uncertainty index is obtained as weighted average of the estimated volatilities. The macroeconomic uncertainty index is constructed as follows:

$$EUI = \sum_{i}^{n} \omega_i \left(\frac{vol_i - \overline{vol_i}}{\sigma_{vol}}\right)$$

Economic uncertainty index of Turkish economy is shown in Figure 1. The figure reveals that economic uncertainty takes on its highest value at the first period of 2009 and on its lowest value at the second period of 2012.

After getting the uncertainty index, the impacts of macroeconomic uncertainty index and interest rates on investment spending are examined by using the ARDL co-integration approach. To apply ARDL approach, we must determine the order of integration for R, EUI, and I. For this aim, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP)[2] unit root tests were applied for the level and first difference of R, EUI, and I. Tables 3 and 4 present the results of the ADF and PP test statistics.

2 Dickey and Fuller (1979), Phillips and Perron (1988).

Table 4. The Results of PP Unit-Root Test

Variables	*Level*		*First Difference*	
	Constant	*Constant+Trend*	*Constant*	*Constant+Trend*
I	-2.1445	-2.6041	-4.1581***	-4.1966***
R	-6.4412***	-5.4444***	-5.1135***	-5.5737***
EUI	-2.5998*	-2.9896	-8.5579***	-8.5091***

*Note: *** is significance level of 1%, ** is significance level of 5% and * is significance level of 10%.*

The ADF and PP unit root test results indicate that the variables I and EUI were found to be stationary in their first differences at 1% significance level. However, the variable R was found to be stationary in its level at 1% significance level. Therefore, in this study, the ARDL approach is used to investigate the possible long-run relationship between investment, uncertainty and interest rates. Firstly, we must determine the presence of long-run relationship between the variables. For this aim, bounds test is applied. The ARDL bound test is based on Wald-test (F-statistic). The asymptotic distribution of the Wald test is non-standard. The null hypothesis of Wald test indicates that there is no co-integration among the variables. Pesaran et al. (2001) suggests two critical values for the co-integration test. Table 5 indicates that the results of the bounds test. As seen in Table 5, the F-statistics is 8.36 and the value of this statistics is greater than the upper critical value bounds. Therefore, there is long-run relationship between the variables. According to the results of Table 5, in a common long-run equilibrium, uncertainty, interest rates, and investment spending are co-integrated. In addition, in Table 5, the short run and long run coefficients of ARDL are given.

Table 5. ARDL Bounds Test Results-Short and Long Run Coefficients

Test Statistic			**Value**	**k**
F-statistic			8.3628***	2
Critical Value Bounds				
Significance			**I0 Bound**	**I1 Bound**
10%			2.63	3.35
5%			3.1	3.87
2.5%			3.55	4.38
1%			4.13	5
Short Run Coefficients				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	
ΔI_{t-1}	0.293	0.10	2.923***	
ΔEUI	-0.036	0.015	-2.439821**	
ΔR	0.0012	0.003	0.4	
Long Run Coefficients				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	
I_{t-1}	-0.223	0.04	-5.37***	
EUI_{t-1}	-0.056	0.015	-3.86***	
R_{t-1}	-0.004	0.001	-3.604***	

*Note: **, *** indicate significance at the 5% level and 1% level, respectively. Akaike information criterion was used for the lag length selection criteria. In the model, maximum lag length is 4, optimal lag length is 1 for each variable.*

Table 6. ARDL Long Run Coefficient

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
R	-0.0189	0.0047	-3.9582	0.0003
EUI	-0.2519	0.0520	-4.8357	0.0000
C	15.9582	0.0682	237.43	0.0000

Breusch-Godfrey Serial Correlation LM Test			
Obs*R-squared	1.5913	**Prob. Chi-Square(1)**	0.2071

Heteroskedasticity Test: ARCH			
Obs*R-squared	1.0818	**Prob. Chi-Square(1)**	0.2983

Table 6 shows that the results of long run coefficients. Since in the investment equation the dependent variable is in logarithm form and the independent variables are in level (or original) form, the estimated regression is in Log-Linear functional form. As seen from Table 6, the estimated long-run coefficients of R and EUI are -0.0189 and -0.2519, respectively. The coefficients are statistically significant at 1% level. As expected, only coefficient of constant term is positive. In the long-run investment equation, the estimated long-run elasticity coefficient of uncertainty is calculated as -0.0026 (-0.2519*0.0104). The elasticity coefficient of uncertainty implies that investment spending increases (decreases) by 0.02 percent if uncertainty index decreases (increases) by 10 percent. Similarly, the coefficient of interest rate is -0.0189. The coefficient is statistically significant. This coefficient also implies that investment spending increases (decreases) by 2.8 percent if interest rates decrease (increases) by 10 percent. Because, the estimated long-run elasticity coefficient is -0.28 (-0.0189*14.8164). Table 6 shows the results of diagnostic tests such as serial correlation and heteroscedasticity. As seen as Table 6, there are no autocorrelation and heteroscedasticity problems.

Table 7 shows cointegrating form. The cointegrating form is Error Correction Model (ECM) and ECM bases on the model that was given in Table 5. As seen from Table 7, in the short run, macroeconomic uncertainty index has a strong impact on investment spending. The index affects private investment spending as negative. It also negatively affects private investment spending in long run. However, there is no statistically significant relationship between interest rates and investment spending in the short run. In other words, real investment spending is not sensitive to interest rates in the short run.

Based on this test and regression model, the decision of ECM model estimation should be made

Table 7. Cointegrating Form

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Δ(I(-1))	0.2922	0.0915	3.1922	0.0026
Δ(R)	0.0011	0.0025	0.4707	0.6402
Δ(EUI)	-0.0356	0.0129	-2.7463	0.0088
CointEq(-1)	***-0.2224***	0.0371	-5.9820	***0.0000***

Figure 2: CUSUM

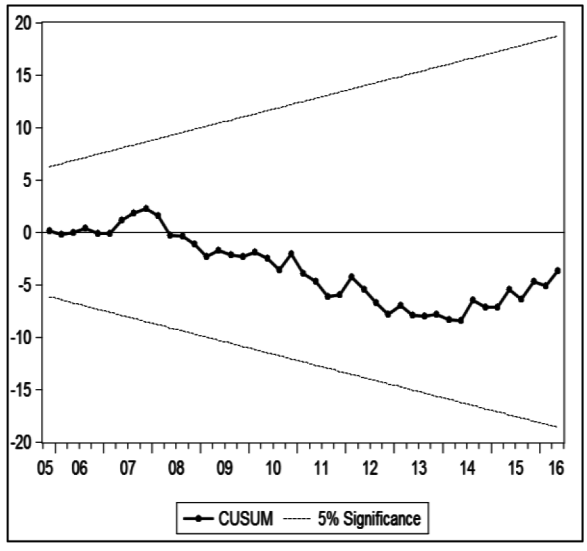
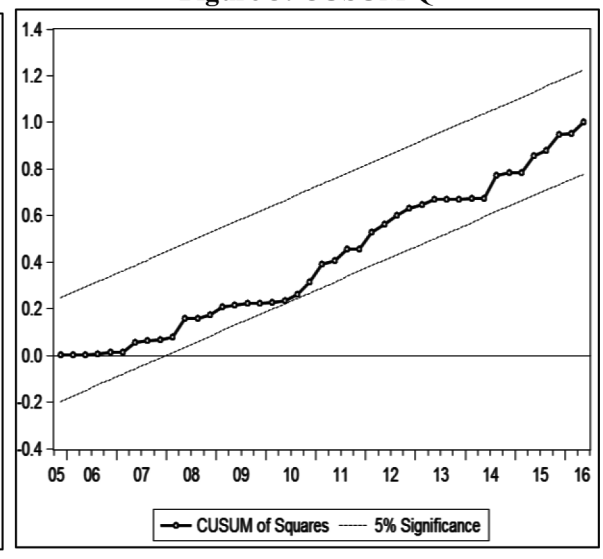


Figure 3: CUSUM Q



Figures 2-3 present CUSUM and CUSUM Q of the estimated ARDL model. We can see in Figures 2-3, all estimated coefficients are stable.

5. Conclusions

In this study, the impacts of macroeconomic uncertainty and interest rates on investment spending were investigated. The data used in this study cover the period of 2003-2016 for Turkish economy. In this study, the macroeconomic uncertainty index was formed based on the Atta-Mensah (2004) approach. Then, the long-run dynamic relationships were analyzed among macroeconomic uncertainty index, interest rates and investment spending. For this aim, ARDL co-integration test was used.

According to findings of this study, macroeconomic uncertainty takes on its highest value at the first period of 2009 and on its lowest value at the second period of 2012 in Turkish Economy. When real investment spending was used to be dependent variable, the relationship among investment spending, uncertainty and interest rates was found to be co-integrated. It means that real investment spending, macroeconomic uncertainty and interest rates were linked in a common long-term equilibrium. According to the findings of the estimated ARDL model, real investment spending is sensitive to macroeconomic uncertainty both in short and long run. However, interest rates affect negatively real investment spending only in long run. For short run, investment is not sensitive to interest rates. Real investment spending increases (decreases) by 0.02 percent if uncertainty index decreases (increases) by 10 percent. When interest rates decrease (increase) by 10 percent, investment spending increases (decreases) by 2.8 percent.

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