6th. International Conference on Modern Research's in MANAGEMENT, ECONOMICS & ACCOUNTING

ششمین کنفرانس بین‌المللی پژوهش‌های نوین در مدیریت، اقتصاد و حسابداری

15th. Nov. 2016 London - UNITED KINGDOM

۲۵ آبان ماه ۱۳۹۵ لندن - انگلستان

UNCERTAINTY AND ECONOMIC GROWTH: The case of Turkey

Amirhossein Najafzade*
PhD Student, Department of Economics, Mofid University, Qom, Iran
ahnajafzade@gmail.com

Naser Elahi
Associate Professor, Department of Economics, Mofid University, Qom, Iran
elahi@mofidu.ac.ir

Mohamad Naghizade Aydenloo
PhD Student, Department of Economics, Islamic Azad University, Tabriz, Iran
M_aidenloo@yahoo.com

Hossein Khadivi
PhD Student, Department of Economics, Islamic Azad University, Urmia, Iran
Hosein.khadivi@gmail.com

Abstract

In this Research the empirical relationship between output growth and output growth uncertainty has been examined for Turkey by using quarterly data over the period 1960 – 2015. The econometric methodology employs GARCH models and Full Information Maximum Likelihood (FIML) method and proxies output uncertainty by the conditional variance of shocks to output growth. The results is in line with Imbs (2002) and Simpson's fallacy phenomenon is accepted.

Keywords: Output variability, Output growth, Economic growth, Volatility, GARCH Models

Introduction

In 18 and 19 centuries, economic growth was related to a small group of countries. But this problem has been extended to the rest of the world in next centuries and recently is one of the most important issues. Although the way of developing in several countries is unequal and lots of studies paid attention to the causes of these inequalities, in all the studies, economic growth has been the only powerful mechanism in long-run expansion of per capita income. Studying the causes and factors of growth was always considerable among economists and several growth models have been designed. The relationship between economic growth and its fluctuations is important for making economic policies. If any positive relation exists between these variables, economic policy, which tries to stabilize the business cycles, may threat potential and long-run growth. Also, if any, negative relation exists between growth and its fluctuations, economic policy, which is designed for reducing fluctuations of the business cycle, will lead to long-run economic growth. Therefore, determining the causality between these variables is important in macroeconomic researches and policy making areas of every country. Most of the empirical studies on economic growth mainly used linear regression over the 1990 century and before that. In most of these researches, the researchers have estimated average rate of growth of a group of explanatory variables for some selected countries and concentrated on parameters of one or more special variable. In other words, these studies have ignored important changes of other variables meaningfulness for the sake of partial changes in the explanatory variables inserted into the model. In fact, they have ignored model's uncertainty (Levine & Renelt, 1992). Of course, expecting a better result in this model is not sensible if potential explanatory variables could be inserted in the economic growth model.

The researcher must consider the principle of parsimony and select a simple model which has suitable explanatory power. In fact, it's not particularly that a model with several explanatory variables to be able to give better predictions out of the statistical sample (Ghaosh & Samanta, 2001). The researchers in the usual method of testing the growth explanatory variables can decide about parameters meaningfulness, by using some explanatory variables and their related coefficients. But in most cases, sample size is not as big as to allow the researchers to consider all the explanatory variables in the model which is discussed in growth literature. In this case, essays related to intercounty regressions are sensitive examples. In some cases, the some suggested explanatory variables were more than the some countries. Thus, a special regression model specification, which includes all the items, was not possible. Therefore, the usual methodology between empirical growth economists had inserted the most important variables on growth. Hence, the major problem in intercounty empirical growth literature is the model uncertainty which the researches encounter with. Researchers often use some form of a generalized autoregressive conditional heteroskedasticity (GARCH) modeling strategy to check the volatility in real GDP growth. Most such studies, however, assume a stable GARCH or exponential GARCH (EGARCH) process capturing the movement in volatility.

This paper reinvestigates the empirical relationship between output growth and output growth uncertainty with Turkish data. There are some different types of uncertainty in conventional econometrics analysis (see e.g. Wu, et al. 2003, for more discussion). However, we estimate growth uncertainty by using the conditional variance of growth. In this method, the generalized autoregressive conditional heteroscedasticity (GARCH) model is applied to estimate a time-varying conditional residual variance. The paper contributes to the literature in several respects: First, this paper employs quarterly Turkish data, a country that has experienced significant uncertainty in output and economic growth over the last three decades. Second, in order to determine stationarity properties of the series, we use several tests such as Augmented Dickey Fuller (ADF) and Philips-Perron (PP) tests. Third, we use three alternative GARCH models in dealing with the measurement of growth uncertainty. Forth, by using the last two aforementioned models to measure growth uncertainty, we will be able to examine the possibility of asymmetry in growth uncertainty. Six, we use three different specifications of the growth uncertainty measurement: the conditional variance, the conditional standard deviation, and the natural logarithm of the conditional variance. Our result shows that, there is a significant relationship between uncertainty and economic growth.

The rest of the paper is organized as follows: In section Theoretical issues, we introduce three schools of research related to ours. The methodology is presented in section Methodology. Section Data Analyzing and Model Usage, discusses the data and presents the estimations. And finally we conclude.

Theoretical issues

According to the direct effect of economic growth on social welfare, determination of effective factors on economic growth and its short-run fluctuations is one of the favorite topics between economists in research and policy making decisions. As Caporale and McKiernan (1996, 1998) and Fountas et al (2004) expresses, there is no consensus on a related point between economic growth and its fluctuations. Briefly on theoretical issues, three intellectual schools are distinguishable. The first school is related to Black (1987). According to the hypothesis of Black, there is a positive relationship between output growth and its fluctuations. In his opinion, investment and economic growth resulting from it will take place if returning expectation rate is enough high to amend the more risk. This theory is well-known in macroeconomic to Fisher business cycle. For testing this hypothesis, Grier and Tullock (1989) have studied the economic growth fluctuations in the economic growth of 113 countries by using pooled cross-section/time-series data. The findings show a positive impact of growth volatility on growth rate. In a study, Caporale and McKiernan (1996) perused the relationship between growth and its fluctuations in England by using quarterly data over the period 1948 – 1991. They used the GARCH-M model and concluded that there is a positive and significant relationship between growth and growth fluctuations. Also Caporale and McKiernan (1998) in a same study with ARCH-M method and by using annual data over the period 1871 – 1993, found that there is a positive and significant relationship between growth and growth fluctuations in the United States. In other research, Fountas and Karanasos (2006) have studied the relationship between economic growth and real uncertainty in the G3 for one and a half century. In this research they have used AR-GARCH-ML by QML estimation method and concluded that the volatility of growth rate has a positive effect on economic growth (except the United States).

The second school is related to Keynes. According to the hypothesis of Keynes, there is an inverse relationship between economic growth and growth fluctuations. In this theory, the main stress is about the expectations of entrepreneurs in making decisions to investment. According to the belief of the fans of this school, entrepreneurs consider the fluctuations of economic activities in making decisions about investment. Thus, if economic activities are in fluctuation, the risk of investment will increase and this problem will reduce the level of investment and output growth of its own. For testing this hypothesis, Zarnowitz and Moore (1986) studied the growth rate of real GDP, according to the standard deviation of output (as a criterion for measuring GDP fluctuations) in the United States and found that the growth rate of real GDP in periods with low standard deviation is approximately high. In a study Lensink et al (1999) investigated the uncertainty effect on economic growth of 138 developed and developing countries over the period 1970 – 1995 by using cross-sectional data. For this purpose they used econometric techniques and defined three different indexes of volatility. The results indicated that volatility has a negative effect on economic growth. Macri and Sinha (2000) examined economic growth uncertainty on industrial output (as replacement for GDP variable) of Australia since 1957 – 1999 by using quarterly data and ARCH-M method. According to their findings, Economic growth fluctuations significantly have an inverse relationship with industrial output growth. Aizenman and Marion (1993) explored links between policy uncertainty and growth for 46 developing countries over the 1970 – 1985 periods, and concluded that policy uncertainty is negatively correlated with both investment and growth. Henry and Olekalns (2002) have tested the effect of slump in the United States on the relationship between growth fluctuation and average economic growth rate and found that growth volatility has a negative effect on the output growth rate.

The third school is related to Friedman (1968). According to the hypothesis of Friedman, there is no reason for a relation between economic growth and its fluctuations. Friedman (1968) implies that output fluctuations and its growth are independent from each other. In his opinion, the output growth rate is determined by real factors such as skills of the labor force, technology and etc. For testing this hypothesis, Speight (1999) examined output fluctuations effect on its growth rate by using quarterly data of England since 1948 – 1994. They used ARMA-GARCH-M method and concluded that there is a positive relation but statistically not significant. Fang et al (2008) explored probable effects of output fluctuations on output growth and also output growth effect on its fluctuations in eight countries, including Germany, The united states, England, Italy, Japan and Canada by using quarterly data of GDP over the period 1957 – 2006. They found that in these countries except Japan, output volatility has no effect on growth. Yavuz and Guris (2004) have studied volatility on economic growth by considering the political and economic occurrences and also the big earthquake. According to their result, growth volatility has no effect on economic growth. Fountas et al (2004) examined the empirical relationship between output variability and output growth using quarterly data for the Japanese economy over the period 1961–2000 and as Speight (1999) concluded a similar result. Also similar to Hamori (2000) they found that there is no evidence of asymmetry between output variability and growth. Vale (2005) examined growth uncertainty by using quarterly data for Brazils' economy over the period 1975 – 2001. He used two variable GARCH model and concluded that growth volatility has no effect on economic growth.

As discussed before, several empirical studies could be found in one of three theoretical scenarios. In some cases the results of two separate studies are very different for a same country. While Caporale and McKiernan (1996), for instance, conclude a positive and significant relationship between output growth and its fluctuations by using quarterly data of England with GARCH-M method over the period 1991-1948, Speight (1999) concludes a positive relationship of output fluctuations effect on growth rate (statistically not significant) by applying partial changes in the model and data– that is, ARMA-GARCH-M method and the period 1994 – 1948. The studies of Fang et al (2008) confirm the results of Speight (1999) indicating that there is no significant relationship between these two variables for England. Beside the growth and sample, the existence of structural break in growth data and also growth uncertainty index affects the results of empirical researches. Fang et al (2008) did not find any relationship (In Japan case there was a negative relation) between output fluctuations and growth in the G7 (France excluded) by considering a structural break in data and its fluctuations. The Authors had neglected the existence of additive outlier and structural break in data. Fang and Miller (2009) used quarterly data over the period 1995 – 2008 and specified a parsimonious ARCH-M model. They, actually, adjusted the uncertainty evaluation criterion toward additive outlier existence in the model. According to their results, neither growth uncertainty affects growth nor does economic growth affect growth uncertainty. Briefly sample size (period in time series data) and cross-sectional data, the way of growth rate definition, structural break existence, an additive outlier in the data and its fluctuations can bias the results of these studies.

Methodology

During the recent years, several empirical and theoretical studies have been done in modeling and variability prediction, especially in the stock market, exchange rate, inflation and etc. variability is one of the important issues in economic and financial discussions. ARCH model gives a suitable framework for variability analysis in time series. But this model has restrictions and problems. Determination of q (that is, the number of lags which we must give to the remainder) is one of the problems. On the other hand, the non-negative hypothesis may be rejected and encounters the estimation of ARCH model with problem. For solving this problem we can use Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. In this model, conditional variance of the error term follows an ARMA process. GARCH (p, q) model can be written as below:

$$y_t = \beta_0 + \sum_{i=1}^{n} \beta_i y_{t-i} + \varphi x_t + \varepsilon_t \quad (1)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2 + \sum_{j=1}^{q} \alpha_j \varepsilon_{t-j}^2 \quad (2)$$

y_t is the growth rate of gross domestic product over t period, which is calculated by equation 3, x_t is a vector of explanatory variables[1], ω is constant parameter, ε_{t-j}^2 is square of previous error terms, quantities until the q lag, and σ_{t-i}^2 is lagged conditional variances until the p lag. For studying output growth volatility on economic growth rate, conditional variance of error terms is inserted into the growth model as dependent explanatory variable. This method is named as GARCH-M.

$$y_t = \beta_0 + \beta_1 y_{t-1} + \lambda\sigma_t^2 + \varepsilon_t \quad (3)$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad (4)$$

λ is the coefficient effect of conditional variance on y_t. If λ be significant then conditional variance of the error term, which is measuring the volatility, affects the growth. Otherwise, volatility does not affect the output growth. The important restriction of the GARCH-M model is being symmetric. Meaning that the absolute value of the changes is important and their signs, since the AR and MA are squared, are not important. So, a negative shock in future changes has the same effect of positive shock. In symmetric GARCH models, volatilities (that is, variances) are same for positive and negative shocks. For instance the effects of positive and negative shocks applied to yield of capital are considered symmetric. But there is no reason for the effects of these shocks to be symmetric. Thus, GARCH models have been expanded for considering the effects of positive and negative shocks as asymmetric. T-GARCH model (Glosten, Jaganathan and Runkle, 1993 and Zakoian, 1994) is obtained by adding a dummy variable, like D, to GARCH model. Specification of conditional variance in this model is:

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \gamma\varepsilon_{t-1}^2 D + \beta\sigma_{t-1}^2 \quad (5)$$

If $\varepsilon_{t-1} \geq 0$ then D = 0 and if $\varepsilon_{t-1} < 0$ then D = 1. Also, if $\gamma \neq 0$ then the effect of shocks is asymmetric and otherwise the effect of shocks is symmetric. Specification of higher ranks of T-GARCH model is:

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2 + \sum_{j=1}^{q} \alpha_j \varepsilon_{t-j}^2 + \sum_{k=1}^{s} \gamma_k \varepsilon_{t-k}^2 I_{t-k} \quad (6)$$

In this model, positive shocks (with:$\varepsilon_{t-j} > 0$) and negative shocks (with:$\varepsilon_{t-j} < 0$) will have different effects on conditional variance. Positive shocks apply the effect of α and negative shocks apply the effect of $\gamma + \alpha$ to the model. If $\gamma > 0$ then negative shocks increase fluctuations and leverage effect is concluded. For examining asymmetric shock effect, we can run null hypothesis ($H_0: \gamma = 0$) versus its alternative hypothesis ($H_1: \gamma \neq 0$). If the null hypothesis is rejected then we can conclude that there are asymmetric effects. TGARCH-M model obtains by substituting conditional variance, captured by equations 5 or 6, as an explanatory variable in the growth equation.

The dependence of the variance equation of GARCH model to the size of growth rate's shock, without considering a sign of shocks (positive or negative), is one of the problems of GARCH models in studying the relationship between economic growth rate and its volatility. Whereas, variance model will have a bias error if positive and negative shocks have asymmetric effects on growth volatility (Wilson, 2006). To solve this problem and by considering the significance of shocks in variance equation, Nelson (1991) suggests using exponential GARCH (EGARCH) model. Conditional variance specification in EGARCH model is written as equation 8:

$$\log \sigma_t^2 = \omega + \sum_{i=1}^{p} \beta_i \log(\sigma_{t-i}^2) + \sum_{j=1}^{q} \alpha_j \frac{|\varepsilon_{t-j}|}{\sigma_{t-j}} + \sum_{k=1}^{s} \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \quad (7)$$

1 - The control variables in the vector x are per capita, physical and human capital, and openness. These variables are relevant to economic growth.

EGARCH models have several benefits. First of all in this model, the dependent variable (that is, σ_t^2) is in logarithm mode. Thus, the parameters of variables in the right hand would be positive and negative. Anyhow, then σ_t^2 will be positive. Hence, there is no need to apply any positive restriction on parameters. Second, in this model, the effect of asymmetric shocks is considered. Because the coefficient of ε_{t-k} is γ and ε_{t-k} can be positive or negative. For instance, if σ_t^2 is considered as the yield of capital variability, γ illustrates the positive and negative shock effects, whereas α is a coefficient that only considers the absolute value of ε_{t-j}. If $\gamma = 0$, then the effects are symmetric and otherwise they are asymmetric. If $\gamma > 0$ then the effects of negative shocks will be more than positive shocks. In other words, γ is the effect of positive shocks and $\gamma + \alpha$ is the effect of negative shocks. If we let the error term follows t student or normal distribution, conditional variance specification in EGARCH model expressed by Nelson[2] can be written as below:

$$\log \sigma_t^2 = \omega + \sum_{i=1}^{p} \beta_i \log(\sigma_{t-i}^2) + \sum_{j=1}^{q} \alpha_j \left[\frac{\varepsilon_{t-j}}{\sigma_{t-j}} - E\left(\frac{\varepsilon_{t-j}}{\sigma_{t-j}}\right) \right] + \sum_{k=1}^{s} \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \tag{8}$$

Estimation of Eq.7 and Eq.8 causes to a same result and the only difference is ω. The difference depends on distribution assumptions and the order of q. for instance, in q = 1 with a normal distribution, the difference is only about $\beta_1\sqrt{2/\pi}$

Data Analyzing and Model Usage

In this research, we used GDP series of Bolt and Van Zanden (2014) to construct GDP quarterly data over the period 1950 – 2015. Equation 9 is used in order to calculate the growth rate of GDP.

$$y_t = (\ln GDP_t - \ln GDP_{t-1}) \times 400 \tag{9}$$

Jarque-Bera is a test statistic for testing whether the series is normally distributed. The test statistic measures the difference of the skewness and kurtosis of the series with those of the normal distribution. The statistic is computed as:

$$Jarque - Bera = \frac{N}{6}\left(S^2 + \frac{(K-3)^2}{4}\right) \tag{10}$$

Where S is the skewness and K is the kurtosis. Under the null hypothesis of a normal distribution, the Jarque-Bera statistic is distributed as χ^2 with 2 degrees of freedom. The reported Probability is the probability that a Jarque-Bera statistic exceeds (in absolute value) the observed value under the null hypothesis. A small probability value leads to the rejection of the null hypothesis of a normal distribution. According to table 1, large value of the Jarque-Bera statistic (with 0.0000 prob.) implies a deviation from normality. Thus, the hypothesis of normal distribution at the 5% level is rejected.

Table1- Descriptive Statistics of GDP Growth Rate

Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.
2.8228	2.8558	18.8764	-23.5444	5.5093	-1.0970	8.7892	388.0882	0.0000

Growth Rate Stationary Test

2 - Nelson (1991) assumes that the error term has generalized distribution with zero mean and unity variance. A suggested functional form by Nelson can be expressed as $f\left(\frac{\varepsilon_t}{\sigma_t}\right) = D\ exp\left[-(1/2)\left(\frac{\varepsilon_t}{\sigma_t^2}/\lambda\right)^D\right] \Big/ D\ exp\left[-(1/2)\left(\frac{\varepsilon_t}{\sigma_t^2}/\lambda\right)^D\right]$. Where $\boldsymbol{\Gamma}$ is the gamma distribution, D is a positive parameter determining the thickness of the tails, λ is a constant given by $\lambda = \left(2^{-(z/D)}\Gamma(1/D)/2^{-(z/D)}\Gamma(1/D)\right)^{1/2}$. If D=2 then the equation becomes the standard normal density. If D > 2 then the density has a thinner tail than the normal and if D < 2 then the density has thicker tails than the normal.

Phillips-Perron and Augmented Dickey-Fuller tests are used for testing growth rate stationary. According to Table 2, the unit root null hypothesis is rejected.

Table 2- Results of stationary test of economic growth rate

Included in test Equation	ADF	PP
With intercept and without trend	-4.75	-6.83
The MacKinnon critical values	-3.45 (1%), -2.87 (5%), -2.57 (10%)	
With intercept and trend	-4.64	-6.76
The MacKinnon critical values	-3.99 (1%), -3.42 (5%), -3.13 (10%)	
Without intercept and trend	-3.18	-7.60
The MacKinnon critical values	-2.57 (1%), -1.94 (5%), -1.61 (10%)	

Notes: ADF and PP are the Augmented Dickey-Fuller and Phillips-Perron unit root tests, respectively.

Model specification and its estimation

The best model for each country is chosen on the basis of correlogram graph and selected the following model according to Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) and also according to other standards such as an error term standard deviation, log likelihood and adjusted R square ($\bar{R}^2$). The information criterion selects an AR(3) for Turkey. Moreover, the GARCH (1,1) specification is chosen for the conditional variance. The results are presented in table 3.

Table 3- Model Estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
β_0	1.2018	0.4812	2.4974	0.0132
β_1	0.5661	0.0885	6.3933	0.0000
AR(3)	0.1953	0.0915	2.1335	0.0339
$\bar{R}^2 = 0.3146$	D.W= 1.9270	AIC = 5.8751	SC = 5.9187	HQC = 5.8926

Note: D.W is Durbin-Watson stat and HQC is Hannan-Quinn Criterion.

Goodness of Fit Test

Goodness of fit test of estimated model is being examined in below tests:

Serial Correlation Test

In the estimated models, Breusch – Godfrey serial correlation LM test is used in order to test the existence and nonexistence of correlation between error terms. The results are illustrated in table 4:

Table 4- LM Coefficient Test

F-statistic	0.7978	Probability	0.3726
LM test	0.8087	Probability	0.3685

According to table 4, there is no serial correlation between error terms.

Heteroskedasticity Test and ARCH Effect Existence Specification

As the existence of heteroskedasticity is a reason for the existence of ARCH effect, thus studying the heteroskedasticity among the remainders of the model becomes more important. LM test, suggested by Engel (1982), is used for specifying the heteroskedasticity. The result of this method is shown in table 5:

Table 5- LM Test for Specifying ARCH Effect

LM Test	6.3628	Probability	0.0117

According to table 5, assumption of hemoskedasticity between the error terms (Null hypothesis) is rejected. Thus, ARCH effect exists.

Structural Break Test

Structural break (change) phenomenon has been seen in other countries. For instance, Kim and Nelson (1999), McConnell and Perez-Quiros (2000), Blanchard and Simon (2001), have seen structural changes in GDP of the United States. Stock and Watson (2003), Bhar and Hamori (2003), Mills and Wang (2003) and Fang et al (2008) have documented such breaks in GDP growth rate of other G7 countries. In this research, Bai and Perron (2003) tests[3] are used for testing structural break on GDP growth rate and its fluctuations. To use Bai and Perron test, let consider structural stability in an equation which has only one explanatory variable (except constant term) in its regression equation. Also, according to section 3.3, serial correlation and heteroskedasticity are considered in this test. Furthermore, four endogenous structural breaks (without date determination) have been used in data. Table 6 presents the results.

Table 6- Bai and Perron (2003) Structural Break Test.

Tests	Est. Value	Critical Value			
		10%	5%	2.5%	1%
Sup $F_T(1)$	9.5661	8.2159	8.7067	11.1416	13.1368
Sup $F_T(2)$	5.0212	7.4740	7.3417	9.0261	9.7041
Sup $F_T(3)$	4.2618	6.1953	5.8751	8.9064	9.2069
Sup $F_T(4)$	4.4617	5.3146	6.0842	7.8523	8.9140
UD max	9.5661	7.4808	8.2707	9.3067	10.4131
WD max	9.5661	8.1953	10.6187	11.2049	12.6190
SupF(2|1)	3.5219	7.3146	7.7108	10.9064	11.4066
SupF (3|2)	3.1940	9.5375	10.0270	12.0248	13.5504
SupF (4|3)	0.0937	10.1208	12.0363	13.0149	15.0184

$SupF_T$, UD max and Sequential tests illustrate a structural break in data (5% significance level). According to the sequential test, this break is in 1990. Meanwhile, conditional SupF, WD max, BIC and LWZ tests do not show any significant break. According to Bai and Perron (2003) suggestion, [4] the existence of structural break in data is accepted. However, the results presented in table 4 indicate that the break is not so strong in mentioned dates and is rejected by 2.5% and 1% levels.

Specification and Estimation of AR-GARCH Model

Drawing the correlogram of squared errors captured from model is enough for specifying a suitable GARCH model. According to Box-Jenkins criterion, among the specified equations, AR-GARCH (1,1) is most suitable. The results of AR-GARCH (1,1) model are illustrated in table 7:

Table 7- AR-GARCH (1,1) model estimation

Average Equation				
Parameter	Coefficient	St.d Error	Z-Stat	Prob.
β_0	0.9617	0.3275	2.9363	0.0033
β_1	0.7285	0.0646	11.2630	0.0000
AR(3)	0.2938	0.0791	3.7131	0.0002
Variance Equation				
ω	4.3950	1.8001	2.4415	0.0146
ε_{t-1}^2	0.7339	0.2224	3.2989	0.0010
σ_{t-1}^2	0.1847	0.0689	2.6792	0.0074

According to table 7, all of the estimated coefficients are significant. Conditional variance of a model and measurement criteria of growth fluctuations is shown as σ_t^2. After estimating GARCH (1,1), we use

3 - Bai and Perron (2003) test is used in volatility literature by Fang et al (2008) and Fang and Miller (2009). Also, Heidari and Parvin (2008) used this test for determining the number of structural breaks in the quarterly data of Iran's inflation in order to specify a Time-Varying Bayesian Vector Autoregressive model.

4 - According to Bai and Perron (2003), sequential test acts better that others in determining the number and the date of break.

LM test for studying the existence of ARCH effect between remainders of the model. The results are illustrated in table 8:

Table 8- LM test for specifying ARCH effect

LM Test	Probability
0.0068	0.9341

According to the results, Null hypothesis (hemoskedasticity between error terms) is not rejected. Thus, ARCH effect does not exist.

AR-GARCH-M Model Estimation

According to the suggestion of Pagan and Ullah (1988), for studying the relationship between growth and growth volatility, we use Full Information Maximum Likelihood (FIML) to estimate the AR-GARCH-M model. Thus, we insert the conditional variance of the error term, in fact economic growth fluctuations, into the average equation and by estimating the coefficients and significance test would be able to study the effect of growth fluctuated on growth (Berument and Dincer, 2005). For specifying the implicit conditional variance function, the error term in average equation is used in three states $(\sigma_t^2, \sigma_t, ln\sigma_t^2)$. For instance, using conditional variance with logarithmic status in average equation would result a better performance in volatility estimation (Caporale and McKiernan, 1996). Whereas Pagan and Hong (1991) do not satisfy it:

- If conditional variance be smaller than unit and the specification of implicit function be negative in average equation then risk premium will be negative.
- If the conditional variance will to zero, then the logarithm of the conditional is very big. Thus, the relationship between conditional variance and growth rate is overstated.

According to the above reasons, Speight (1999) inserted a linear relationship between growth and conditional variance. Of course, Henry and Olekalns (2002) inserted standard error of conditional variance into the average equation too. Thus, for estimating any GARCH models and to show the robust results of estimation, in this research, we use conditional variance in three forms (including $ln\sigma_t^2, \sigma_t, \sigma_t^2$) in the average equation. The results are illustrated in table 9:

Table 9- Estimation of AR-GARCH-M

Parameters	σ_t^2	σ_t	$ln\sigma_t^2$
λ	0.7256 (0.0782) [0.0000]	0.2261 (0.0438) [0.0000]	0.3277 (0.1880) [0.0813]
ω	1.7702 (0.3991) [0.0000]	5.3647 (1.3531) [0.0001]	4.3276 (1.7856) [0.0154]
α	0.4234 (0.0790) [0.0000]	1.5148 (0.3366) [0.0000]	0.7751 (0.2340) [0.0009]
β	0.6017 (0.1149) [0.0000]	0.4760 (0.0935) [0.0000]	0.5196 (0.0987) [0.0000]

Note: The numbers in parentheses and brackets are standard deviation and probability, respectively.

According to table 9, λ coefficient is not significant in logarithm mode, but in two statuses (σ_t^2, σ_t). According to the results, growth fluctuations have a positive effect on economic growth. This result is similar to the results captured by Caporale and McKiernan (1996), Caporale and McKiernan (1998) and Fountas and Karanasos (2006) and is another empirical confirmation for the hypothesis of Black.

AR-TGARCH-M Model Estimation

Asymmetric models are used in order to study the effect of positive and negative shocks of economic growth, with same size, on volatility. The results of AR-TGARCH-M estimation[5] are illustrated in table 10:

Table 10- AR-TGARCH-M model estimation

Parameters	σ_t^2	σ_t	$ln\sigma_t^2$
λ	4.3976 (1.2762) [0.0006]	3.2860 (0.9602) [0.0006]	2.2909 (0.3649) [0.0000]
ω	7.2935 (1.7492) [0.0000]	7.0943 (0.4710) [0.0000]	5.6138 (0.4908) [0.0000]
α	0.5102 (0.0710) [0.0000]	0.6139 (0.0264) [0.0000]	0.4818 (0.0353) [0.0000]
γ	-0.0866 (0.0181) [0.0000]	-0.0888 (0.0225) [0.0001]	-0.0714 (0.0087) [0.0000]
β	-0.1338 (0.0461) [0.0037]	-0.2119 (0.0538) [0.0001]	-0.4022 (0.0367) [0.0000]

Note: The numbers in parentheses and brackets are standard deviation and probability, respectively.

According to table 10, all of the coefficients are significant. The significance of γ (the coefficient of $D\varepsilon_{t-1}^2$) indicates that the positive and negative shocks of growth with a same size have different effects on its fluctuations. Thus, the effects of different growth shocks on its fluctuations will be asymmetric. For examining asymmetric shock effect, we can run null hypothesis ($H_0: \gamma = 0$) versus its alternative hypothesis ($H_1: \gamma \neq 0$) by using Wald test.

Table 11- Asymmetric test of shock effect

Wald Test	Probability
1.8952	0.1699

According to table 11, the shocks have asymmetric effects on growth volatility in 5% level of significance.

AR-EGARCH-M Model Estimation

The results of the EGARCH - M model are illustrated in table 12:

Table 12- AR-EGARCH-M model estimation

Parameters	σ_t^2	σ_t	$ln\sigma_t^2$
λ	0.0106 (0.0115) [0.3554]	0.5622 (0.1646) [0.0006]	1.8516 (0.3297) [0.0000]
ω	-0.1125 (0.1130) [0.3196]	2.4688 (0.3293) [0.0000]	2.3444 (0.2655) [0.0000]
α	0.8929 (0.0449) [0.0000]	1.0990 (0.0930) [0.0000]	1.2316 (0.1445) [0.0000]
γ	-0.0962 (0.0338) [0.0045]	-0.0951 (0.0250) [0.0001]	0.1749 (0.0701) [0.0127]
β	-0.1397	-0.1078	-0.0960

5 - According to AIC and SBC, for estimating equation 17, the best Threshold rank is 1.

	(0.1517) [0.3570]	(0.0814) [0.1854]	(0.0492) [0.0513]

Note: The numbers in parentheses and brackets are standard deviation and probability, respectively.

According to the results, all of the coefficients are significant except β coefficient in three statuses (σ_t^2, σ_t and$ln\sigma_t^2$), λ and ω coefficients in σ_t^2 column. The γ coefficient is significant. Thus, the model is asymmetric. The negativity of γ implies that positive shocks on growth will have larger effects on growth volatility than negative shocks. And also the positivity of α coefficient implies that an increase in this variable causes for an increase in growth volatility.

Conclusion

According to three hypothesizes of growth and growth volatility and also empirical heterogeneous results, this research has studied the relationship between these two variables as its importance in macroeconomic policy making decisions. For this, we used GARCH models, including: AR-GARCH-M, AR-TGARCH-M, AR-EGARCH-M, with GDP quarterly data for Turkey. For estimating these models Full Information Maximum Likelihood (FIML) method was used. According to the results, obtained by AR-GARCH-M, Black hypothesis is accepted. Also, according to the results captured by AR-TGARCH-M and AR-EGARCH-M models, Keynes hypothesis is not rejected. This result is similar to the results captured by Lensink et al (1999), Zarnowitz and Moore (1986), Aizenman and Marion (1993) and Macri and Sinha (2000). Meanwhile, the effects of positive and negative shocks on the growing volatility show that negative shocks affect growth volatility, less than positive shocks; therefore, there are asymmetric effects in the GDP shocks. The results show a Simpson's fallacy phenamenon and this conclusion is in line with Imbs (2002).

References

Aizenman, J. and Marion, N. 1993. Policy Uncertainty, Persistence and Growth. Review of International Economics. 1(2), 145-163.

Bia, J. and Perron, P. 2003. Computation and analysis of multiple structural change models. Journal of Applied Econometrics, Vol. 18, pp 1-22.

Bhar, R. and Hamori, S. 2003. Alternative characterization of volatility in the growth rate of real GDP. Japan and World Economy, Vol. 15, Pp 223-231.

Black, F. (1987). Business cycles and equilibrium. New York: Basil Blackwell.

Blanchard, O. and Simon, J. 2001. The Long and Large Decline in U.S. Output Volatility. Brookings Papers on Economic Activity, Vol 32, Pp 135-174.

Bolt, J. and van Zanden, J. L. (2014). The Maddison Project: collaborative research on historical national accounts. The Economic History Review, 67 (3): 627–651.

Caporale, T. and McKiernan, B. 1996. The relationship between output variability and growth: evidence from post war UK data. Scottish Journal of Political Economy, Vol.43, Pp 229-36.

Caporale, T. and McKiernan, B. 1998. The Fischer black hypothesis: some time series evidence. Southern Economic Journal, Vol. 64, Pp 765 – 71.

Chatterjee, P. and M. Shukayev. 2006. Are average growth rate and volatility related? Bank of Canada. Working Paper 2006-24.

Engel, R. 1982. Autoregressive conditional heteroskedasticity with estimates of the variance of UK inflation. Econometrica, Vol. 50, 987-1007.

Fang, W.; S., Miller, and C. Lee 2008. Cross-Country evidence on output growth volatility: Nonstationary variance and GARCH models. Scottish Journal of Political Economy, Vol. 55, Pp 509-541.

Fang, W. S. and S.M. Miller. 2009. Modeling the volatility of real GDP growth: The case of Japan revisited. Japan and the World Economy, Vol.21, Pp 312-324.

Fountas, S., Karanasos, M.; and A., Mendoza. 2004. Output variability and economic growth: the Japanese case. Bulletin of Economic Research, Vol.56, Pp 353-363.

Fountas, S., and M., Karanasos., 2006. The relationship between economic growth and real uncertainty in the G3. Economic Modelling. Vol. 23, Pp 638-647.

Friedman. M. (1968). The role of monetary policy. American Economic Review, Vol 58, Pp 1-17.

Ghaosh, J.K. & T. Samanta. 2001. Model Selection- An-Overview. Indian Statistical Institute.

Glosten, Lawrence R., Jagannathan, Ravi., Runkle, David E., 1993. On the relation between the expected value and the volatility of the nominal excess return on stocks. Journal of Finance, Vol. 48, Pp 1779-1801.

Grier, K. and Tullock, G. 1989. An Empirical Analysis of Cross-national Economic Growth. Journal of Monetary Economics, Vol.24, Pp 259-276.

Hamori, S. 2000. "Volatility of real GDP: some evidence from the United States, the United Kingdom and Japan. Japan and World Economy, Vol. 12, Pp 143-152.

Heidari, H and Bashiri, S. 2011. Revisiting the Effects of Growth Uncertainty on Inflation in Iran: An Application of GARCH-in-Mean Models. International Journal of Business and Development Studies, Vol. 3, Pp 123-140.

Heidari, H. and Parvin, S. 2008. Modeling and Forecasting Iranian Inflation with Time Varying BVAR Models. Quarterly Iranian Economic Research, Vol. 36, Pp 63-92.

Henry, O. and N. Olekalns. 2002. The effect of recessions on the relationship between output variability and growth. Southern Economic Journal, Vol. 68, Pp 683- 692.

Imbs, J. 2002. Why the link between volatility and growth is both positive and negative. CNE WP11. Center for the Network Economy.

James H. Stock & Mark W. Watson. 2005. Understanding Changes in International Business Cycle Dynamics, Journal of the European Economic Association, vol. 3(5), pages 968-1006, 09.

Kim, Chang-Jin. and Nelson Charles R. 1999. Has the U.S. Economy Become More Stable? A Bayesian Approach Based on a Markov-Switching Model of the Business Cycle. The Review of Economics and Statistics, Vol. 81, 608-616.

Lensink, R.; Hong Bo; and E. Sterken. 1999. Does uncertainty affect economic growth? An empirical analysis. Weltwirtschaftliches Archiv, Vol 135, Pp 379-396.

Levine, R. E. & D. Renelt. 1992. A Sensitivity Analysis of Cross- Country Growth Regressions. American Economic Review, 82(4):942- 963.

Lucas, R. J. 1988. On the Mechanics of Economic Development. Journal of Monetary Economics. 22(1), Pp.3-42.

Macri, J. and Sinha, D. 2000. Output variability and economic growth: the case of Australia. Journal of Economics and Finance. Vol. 24, Pp 275-282.

McConnell, Margaret M., and Gabriel Perez-Quiros. 2000. Output Fluctuations in the United States: What Has Changed since the Early 1980's?. American Economic Review, 90(5): 1464-1476.

Mills, Terence C. and Wang, P. 2003. Have Output Growth Rates Stabilised? Evidence From the G7 Economies. Scottish Journal of Political Economy, Vol 50, Pp 232-246.

Nelson, B. 1991. Conditional heteroskedasticity in asset returns: A new approach. Econometrica, Vol 59, Pp 347-370.

Pagan, A. and Hong, Y.S. 1991. Nonparametric estimation and the risk premium, in Barnett, W. A., Powell, J. and Tauchen, G. (eds.), Nonparametric and Semiparametric Methods in Econometrics and Statistics, Cambridge: Camberidge Univercity Press, Pp 51-75

Pagan, A. and Ullah, A. 1988. The econometric analysis of models with risk terms. Journal of Applied Econometrics, Vol.3, Pp 87-105.

Speight, A. 1999. UK output variability and growth: some further evidence. Scottish Journal of Political Economy, Vol. 46, Pp 175-84.

Vale, S. 2005. Inflation, Growth and Real and Nominal Uncertainty: Some Bivariate GARCH-in-Mean Evidence for Brazil. RBE, Vol. 59, Pp 127-145.

Wilson, B. 2006. The link between inflation, inflation uncertainty and output growth: New time series evidence from Japan. Journal of Macroeconomics, Vol. 28, Pp 609-620.

Yavuz, N. and B. Guris 2004. Volatility in the growth rate of real GNP: Evidence from Turkey. Kocaeli Universitesi Sosyal Bilimler Enstitusu Dergisi, Vol. 7, Pp 93- 103.

Zakoian, Jean-Michel, 1994. "Threshold heteroskedastic models," Journal of Economic Dynamics and Control, Elsevier, Vol. 18(5), Pp 931-955

Zarnowitz, V. and Moore, G. 1986. Major changes in cyclical behavior. In The American Business Cycle: Continuity and Change, edited by Robert J. Gordon. Chicago: University of Chicago Press.