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The relationship between output growth and inflation: Evidence from Turkey

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Abstract

In this study, a bi-variate Generalized Autoregressive Conditional Heteroscedasticty model is used in order to investigate the Granger causality relationships between output growth, inflation rate and their uncertainties. Our test results show that the existence of Granger-causality is observed from nominal uncertainty to inflation, from nominal uncertainty to real uncertainty, from output growth to real uncertainty, from output growth to nominal uncertainty and from inflation to nominal uncertainty. These findings prove that theoretical predictions of Cuikerman and Meltzer (1986), Okun (1971) and Friedman (1977) are valid for the period 1986:6-2007:1 for Turkey. On the other hand, 'Short-run Phillips Curve' and 'Taylor Effect' have proven empirically to be invalid for Turkey for this sample period. Moreover, we deduce that Turkish inflation is affected by the output growth through the nominal uncertainty channel.

JEL CODE: C22, E0
KEY WORDS: Inflation; output growth; uncertainty; Granger-causality; bi-variate GARCH

1. INTRODUCTION

High inflation rate is the major problem of Turkish Economy like all the other developing countries. In recent years, this prolonged high inflation rates are beginning to decrease where this phenomena leads to an improvement in the conditions of Turkish economy. From the Friedman (1977) paper, we know that increasing average inflation induces high levels of inflation uncertainty. Moreover, high inflation uncertainty is one of the important obstacles in making investment decisions for the private sector. Thus, decreasing investment results in low levels of output which shows declining levels of growth. Shortly, these inefficiencies, created by inflation uncertainties, can be summarized by deterioration of relative prices, additive risk primaries on long-run investment project by risk-averse investors and increasing interest rates. In order to cope with these inefficiencies, central banks implement contractionary monetary policies. For the Turkish case, covering the period 1986:6-2007:1 the Central Bank of the Republic of Turkey attempts to execute same kind of policies. In this period, Turkish monetary authority implemented several stabilization programs and monetary policies; from these attempts only the last stabilization program reached its goals which established a price stability in Turkey.

In this study, we use bi-variate Generalized Autoregressive Conditional Heteroscedasticty (GARCH) model and Granger causality test for analyzing the aforementioned issues. By using bi-variate GARCH model, we obtain inflation and output uncertainty which we will use them as separate variables in Granger causality test. Finally by using these 4 variables, we obtained 12 bidirectional causality relationships.

In section 2, we discuss the theoretical relationships and empirical researches about the links between these variables. In section 3, estimation and identification of bi-variate GARCH model and Granger causality test are given. Finally, Section 4 concludes.

2. THEORETICAL RELATIONSHIPS AND EMPIRICAL FINDINGS

In economics literature, we can find economic interpretation for the predicted bidirectional causality relationships between nominal (inflation) uncertainty, real (output growth) uncertainty, output growth, and inflation.

First discussion about the relationship between inflation and inflation uncertainty takes place in Okun (1971). According to Okun, monetary policy becomes unpredictable in high inflationary periods and this situation causes positive relationship between inflation and inflation uncertainty. Furthermore, Friedman (1977) argued that higher inflation leads to more uncertainty about inflation. According to Okun and Friedman, policy makers have pressure on themselves in order to decrease high levels of inflation rates[1]. Therefore, the high inflation rates are reduced by implementing contractionary monetary polices which induce recession to the economic system. Ball (1992) gives theoretical explanation to Okun's and Friedman's hypothesis as a part of theoretical model which uses asymmetric information game. Moreover, positive relationship between inflation and inflation uncertainty has been argued by Flemming (1976) as well. According to Flemming, as inflation rate increases governments tend to announce more unreliable stabilization programs. Nonetheless, there are also theoretical arguments about negative relationship between inflation and inflation uncertainty. Pourgerami and Moskus (1987) claim that economic agents undertake more investment to anticipate inflation in high inflationary periods and this aspiration leads to a reduction in nominal uncertainty. Theoretical model of this hypothesis has been studied by Ungar and Zilberfarb (1993).

Positive relationship between inflation and nominal uncertainty has been detected in empirical studies for Turkey. For instance, Nas and Perry (2000) find positive relationship between these variables for the three sub periods in between 1960-1998. While, Çetin (2004) finds a positive relationship for the period covering 1985-2003, Telatar (2003) finds a negative relationship for the period covering 1987-2001. Erdoğan and Bozkurt (2004) state that the consequence of high nominal uncertainty for the Turkish economy covering the period 1985-2003 is high due to the volatile inflation rates. Artan (2006) employ long-term co-integration and short-term error correction models for the period covering 1987-2003 for Turkey and he stated that the results of these analyses denote that there is a relationship between inflation and inflation uncertainty.

One of the theories that explain causality relationship from nominal uncertainty to inflation takes place in Cukierman and Meltzer (1986). Cukierman and Meltzer (1986) use the framework of Barro and Gordon's model. By using this model, Cuikerman and Meltzer (1986) denote that an increase in uncertainty about money supply growth and inflation will elevate the optimal average inflation rate because it supply an encouragement to the policymaker to generate an inflation surprise in order to stimulate output growth. Hence, we can conclude that Cukierman and Meltzers' (1986) analysis demonstrate the way, how higher nominal uncertainty leads to more inflation. Furthermore, Holland (1995) states that, if a central bank has a stabilization intention, an increase in inflation uncertainty will be responded by tight monetary policy. Thus, this stabilizing motive of central bank reduce the inflation rate, where this process minimize the real cost of nominal uncertainty. The causal relationship between nominal uncertainty and inflation is investigated empirically by Grier and Perry (1998), Wilson(2006), Fountas *et al.(*2002), and Fountas and Karanasos (2007). These studies record both positive and negative relationship between inflation uncertainty and inflation for different countries and different periods. For the Turkish, case Nas and Perry (2000) find negative relationship between nominal uncertainty and inflation except one of the sub-samples. Telatar (2003) and Çetin (2004) could not find any relationship between inflation uncertainty and inflation for the period that they analyze for Turkey.

In economics literature, it is difficult to find out relationship between output growth and real uncertainty quite frequently [Fountas and Karanasos (2006)]. This connection can be explained with two theoretical relationships: 'Short-term Phillips Curve' and 'Taylor's Effect'. With respect to Phillips Curve, increase in output level causes rise in inflation. According to Friedman's and Okun's hypothesis, this situation increases inflation uncertainty. Taylor (1979) argues that, increasing nominal uncertainty leads to a decrease in real uncertainty. Therefore, there occurs a trade off between inflation uncertainty and real uncertainty (the so-called Taylor Effect) which constitutes a positive relationship between output growth and real uncertainty. The causal relationship between output growth and real uncertainty is investigated empirically by Fountas *et al.* (2002), in which they find significant statistical positive relationship between output growth and real uncertainty for Japanese economy for the period covering 1961-1999, and Fountas and Karanasos (2006), in which they report negative relationship between output growth and real uncertainty for Germany and U.S. Furthermore, Çetin (2004) finds negative relationship for 1, 4, 8 and 16th lags and positive relation for only 12th lag for Turkey. As can be seen from the theoretical explanation, there is a negative causal relationship in between output growth and real uncertainty. In empirical studies such as Fountas *et al.* (2002), neither the causality from inflation uncertainty to real uncertainty nor real uncertainty to inflation uncertainty could be found for Japan with using data from 1961-1999 period. While, Çetin (2004) could not observe any meaningful causality from inflation uncertainty to real uncertainty for 1985:01-2003:11 period as well, but he found positive meaningful causality from real uncertainty to inflation uncertainty for 1, 4 and 8 lags covering this period.

Necessary theoretical relationships can be found in economics literature to explain the relationship between output growth and nominal uncertainty. Because of short-term Phillips Curve effect, rate of inflation will increase when output growth occurs (Briault 1995). According to Friedman's and Okun's hypothesis, rises in inflation rates will increase nominal uncertainties, which in turn will create a positive relationship between output growth and inflation uncertainty. Furthermore, if Pourgerami's and Moskus's hypothesis occur, negative relationship will arise between these variables. In empirical studies, Fountas *et al*. (2002) could not found any causality from output growth to inflation uncertainty with using data from 1961-1999 period for Japan. Çetin (2004) also could not found any relationship, like Fountas *et al.* (2002), between output growth and inflation uncertainty for the period 1985-2003 for Turkey.

3. EMPIRICAL STUDY AND THE MODEL

In this study VAR-GARCH (Vector Autoregressive-Autoregressive Conditional Heteroscedasticity) model is used. By using this model, conditional means and variances of inflation and real output growth and co-variances among each other are estimated simultaneously. After employing the lag test, we have found that VAR(5) model is suitable for our model:

$$y_t = \phi_{y0} + \sum_{i=1}^{5} \phi_{yy,i} y_{t-i} + \sum_{i=1}^{5} \phi_{y\pi,i} \pi_{t-i} + \varepsilon_{yt} \tag{1a}$$

$$\pi_t = \phi_{\pi 0} + \sum_{i=1}^{5} \phi_{\pi\pi,i} y_{t-i} + \sum_{i=1}^{5} \phi_{\pi y,i} \pi_{t-i} + \varepsilon_{\pi t} \tag{1b}$$

π_t and y_t denote the inflation rate and real output growth, respectively. Residual vectors can be showed as $\varepsilon_t = (\varepsilon_{\pi t}, \varepsilon_{yt})'$. It is assumed that ε_t is conditionally normal with mean vector 0 and covariance matrix H_t. That is $(\varepsilon_t / \Omega_{t-1}) \sim N(0, H_t)$, where Ω_{t-1} is the information set up time t-1. Following Bollerslev (1990), it is imposed that the constant correlation GARCH (1,1) structure on the conditional covariance matrix H_t.

$$h_{\pi t} = w_\pi + \beta_\pi h_{\pi,t-1} + a_\pi \varepsilon^2_{\pi,t-1} \ , \tag{2a}$$

$$h_{yt} = w_y + \beta_y h_{y,t-1} + a_y \varepsilon^2_{y,t-1} \ , \tag{2b}$$

$$h_{\pi y,t} = \rho \sqrt{h_{\pi t}} . \sqrt{h_{yt}} \tag{2c}$$

Where $h_{\pi t}, h_{yt}$ represent the conditional variances of the inflation rate and output growth, respectively. Furthermore, $h_{\pi y,t}$ is the conditional covariance between $\varepsilon_{\pi t}$ and ε_{yt}. And parameter restrictions are given as: $(w_i), a_i > 0$, $\beta_i \geq 0$, for $i = \pi, y$ and $-1 \leq \rho \leq 1$.

According to Bollerslev (1990), constant correlation model is computationally most useful model among rival models. Bollerslev (1990) stated that the correlation matrix can be determined by the log-likelihood function, resultant in a drop in the number of parameters to be optimized. Furthermore, it is quite easy to manage the parameters of the conditional variance equations during the optimization so that h_{it} is always positive. Another important thing that we must think is related with assumptions of VAR(5)-GARCH(1,1) model that is used according to the study of Bollersley (1990). In this direction, we estimate the systems of equation (1) and (2) using the Berndt *et al.* (1974) numerical optimization algorithm (BHHH) to obtain the maximum likelihood estimates of parameters and to estimate the asymptotic covariance matrix of the coefficient as consistent.

In our empirical study, in order to determine VAR process, optimal lag-length algorithm of the Akaike (AIC) and Bayesian (BIC) information criteria are used. Both information criteria choose VAR(5) model. Similarly, the chosen GARCH(1,1) model corresponds to the smallest estimated value of both information criteria. Nominal uncertainty and real uncertainty are obtained from estimated conditional variance of inflation and output growth equations. Totally four variables with two new variables obtained from here will be subject to 12 different Granger causality test.[2]

In this study, Consumer Price Index (CPI) and Industrial Production Index (IPI) represent price level and output (production amount), respectively. The data have monthly frequency and range from 1986:6-2007:1. Inflation is obtained by measuring the monthly difference of the log CPI:

$$y_t = \log\left(\frac{CPI_t}{CPI_{t-1}}\right)$$

Real output growth is measured by the monthly difference in the log of the IPI:

$$y_t = \log\left(\frac{IPI_t}{IPI_{t-1}}\right)$$

Unit root test of the inflation rate and the growth rate are performed by using ADF (Augmented Dickey -Fuller) and PP (Phillips-Perron) tests. The results of these tests are given in Table 1.

Table 1. Unit Root Tests

	ADF test statistic	*Phillips-Perron test staitstics*
Output growth	-7.499	-8.141
Inflation	-10.129	-34.870

* All test statistics at the % 1 significance level

As seen from Table 1, both inflation and growth rate do not imply any unit root; So, they are stationary.

AIC and SIC criteria are employed in order to identify VAR lag and the results are presented in Table 2.[3] As seen in Table 2, the lowest values are found for estimated VAR(5)-ccc-GARCH(1,1) by using AIC and BIC criteria.

Table 2. Model Selection Criteria

	AIC	*BIC*
VAR(5)-Univariate GARCH(1,1)	-3362.25	-2898.48
VAR(5)-ccc- GARCH(1,1)	-3378.25	-2942.59
VAR(5)-dvec-GARCH(1,1)	-3370.25	-2920.53
VAR(5)-Fv- GARCH(1,1)	-3266.25	-2633.84
VAR(5)-BEKK	-3338.25	-2832.32

* Constant Conditional Correlation (ccc) GARCH(1,1) is selected with the AIC and BIC criteria. Dvec represents for diagonal-vector, Fv represents full vector parameterization, BEKK represents positive definite parameterization (BEKK) that enforces a positive definite covariance matrix.

Therefore, the most appropriate structure selected for the study is VAR(5)-ccc-GARCH (1,1) model among other models.

Table 3 shows estimated coefficient of VAR(5)-GARCH(1,1) model. The conditional mean and variance equations for output growth are given in equation (1) and equation (2) respectively. The sum of estimated inflation coefficients is -0.042. Furthermore, the conditional mean and variance equations for inflation are given in equation (2) and equation (3) respectively. The sum of estimated output growth coefficients is 0.838. The ARCH parameter is calculated as 0.360 and 0.426 for output growth and inflation equation respectively.

Table 3 Estimates of the VAR-GARCH Model [4]

$$y_t = \underset{\substack{(0.001)\\ {[3.738]}}}{0.005} - \underset{\substack{(0.019)\\ {[0.802]}}}{0.015}\, y_{t-1} + \underset{\substack{(0.060)\\ {[2.208]}}}{0.132}\, y_{t-2} + \underset{\substack{(0.049)\\ {[0.194]}}}{0.009}\, y_{t-3} - \underset{\substack{(0.040)\\ {[3.509]}}}{0.143}\, y_{t-4} - \underset{\substack{(0.044)\\ {[2.414]}}}{0.108}\, y_{t-5}$$
$$- \underset{\substack{(0.035)\\ {[7.758]}}}{0.273}\, \pi_{t-1} + \underset{\substack{(0.031)\\ {[13.292]}}}{0.424}\, \pi_{t-2} - \underset{\substack{(0.025)\\ {[15.067]}}}{0.387}\, \pi_{t-3} + \underset{\substack{(0.049)\\ {[7.660]}}}{0.376}\, \pi_{t-4} - \underset{\substack{(0.037)\\ {[4.810]}}}{0.182}\, \pi_{t-5} + \varepsilon_{y_t} \quad (1)$$

$$h_{y_t} = \underset{\substack{(0.000)\\ {[7.587]}}}{0.010} + \underset{\substack{(0.087)\\ {[4.133]}}}{0.360}\, \varepsilon^2_{y,t-1} + \underset{\substack{(0.114)\\ {[2.052]}}}{0.234}\, h_{y,t-1} \quad (2)$$

$$\pi_t = \underset{\substack{(0.001)\\ {[5.368]}}}{0.005} + \underset{\substack{(0.011)\\ {[1.909]}}}{0.021}\, y_{t-1} - \underset{\substack{(0.026)\\ {[1.730]}}}{0.045}\, y_{t-2} - \underset{\substack{(0.029)\\ {[1.362]}}}{0.009}\, y_{t-3} - \underset{\substack{(0.023)\\ {[1.630]}}}{0.039}\, y_{t-4} - \underset{\substack{(0.023)\\ {[0.334]}}}{0.007}\, y_{t-5}$$
$$+ \underset{\substack{(0.049)\\ {[12.565]}}}{0.620}\, \pi_{t-1} - \underset{\substack{(0.020)\\ {[2.837]}}}{0.058}\, \pi_{t-2} + \underset{\substack{(0.046)\\ {[1.908]}}}{0.089}\, \pi_{t-3} - \underset{\substack{(0.027)\\ {[2.314]}}}{0.064}\, \pi_{t-4} + \underset{\substack{(0.026)\\ {[9.639]}}}{0.258}\, \pi_{t-5} + \varepsilon_{\pi_t} \quad (3)$$

$$h_{\pi_t} = \underset{\substack{(0.000)\\ {[5.606]}}}{0.0001} + \underset{\substack{(0.161)\\ {[2.636]}}}{0.426}\, \varepsilon^2_{\pi,t-1} + \underset{\substack{(0.051)\\ {[1.980]}}}{0.101}\, h_{\pi,t-1} \quad (4)$$

$$h_{y\pi,t} = \underset{\substack{(0.053)\\ {[2.301]}}}{0.122} \sqrt{h_{y_t}.h_{\pi_t}} \quad (5)$$

* While the values in the brackets that are under the estimated coefficients denote standard errors, square brackets show t statistics.

In output growth equation, value of GARCH parameter shows how long a shock affects volatility. GARCH parameter for output growth is 0.234 and less than 1. In this situation, long term effect of a shock on output growth will be small. In the same way, ARCH and GARCH parameters for inflation are found to be 0.426 and 0.101, respectively. Value of GARCH parameter that is being less than estimated in output growth equation means long term effect of a shock will be much lower. In both equations, ARCH parameters are greater than GARCH parameters which mean short term effect of both shocks are heavier than their long term effects. The sum of the ARCH and GARCH parameters for output growth and inflation are

0.594 and 0.527, respectively. That means that current information is not important for the forecast of the conditional variances for long horizons.

Table 4. Residual Diagnostics

	Inflation Equation	*Output Equation*	*Cross Equation*	*Critical Value* *(at %5 significance level)*
$Q(4)$	5.25	3.06	2.52	9.48
$Q(12)$	17.60	17.20	5.83	21.02
$Q^2(4)$	1.55	2.05		9.48
$Q^2(12)$	5.41	7.20		21.02

* Ljung-Box Test statistics are given in this table.

Ljung-Box Q statistics are calculated at 4 and 12 lags for the levels, squares, and cross-equation of the standardized residuals for the estimated VAR(5)-GARCH(1,1) model. The results are shown in Table 4. The conditional correlation is close to zero which means the residual covariance between equations is statistically significant. Briefly, we can say that serial correlation problem is corrected in the estimated GARCH(1,1) models and it's residuals.

After this stage, Granger-causality test can be applied to provide some statistical evidence on the nature of the relationship between average inflation, output growth, nominal uncertainty, and real uncertainty. Granger-causality test is applied for 1, 4, 8, and 12 lags. When the test statistic is statistically significant, sums of the lagged coefficient and sign of it is declared in the table.

Granger-causality test that is applied to four different variables for the period 1986:6-2007:1 is provided by Table 5.

Table 5. Granger-causality tests results between inflation, output growth, nominal and real uncertainties.

	1 Lag	4 Lag	8 Lag	12 Lag
Panel A: Causalities to Growth				
$\pi_t \rightarrow y_t$	1.944	1.727	1.107	0.642
$h_{y_t} \rightarrow y_t$	2.363	1.318	1.382	1.619
$h_{\pi_t} \rightarrow y_t$	2.334	0.431	0.750	1.248
Panel B: Causalities to Inflation				
$y_t \rightarrow \pi_t$	0.051	0.348	0.338	0.669
$h_{y_t} \rightarrow \pi_t$	1.429	0.936	1.136	0.954
$h_{\pi_t} \rightarrow \pi_t$	0.009	(+)2.068***	(+)2.144**	(+)1.727**
Panel C: Causalities to Real Uncertainty				
$y_t \rightarrow h_{y_t}$	(-)5.762**	(-)4.291*	(-)3.154*	(-)2.408*
$\pi_t \rightarrow h_{y_t}$	0.072	0.734	0.769	0.892
$h_{\pi_t} \rightarrow h_{y_t}$	0.243	0.199	0.427	(+)1.913**
Panel D: Causalities to Nominal Uncertainty				
$y_t \rightarrow h_{\pi_t}$	0.821	1.655	(-)2.498**	(-)1.930**
$\pi_t \rightarrow h_{\pi_t}$	(+)27.939*	(+)8.732*	(+)4.928*	4.025
$h_{y_t} \rightarrow h_{\pi_t}$	0.066	0.395	0.448	0.730

F statistics are reported *, ** and *** denote the significance level at the 0.01, 0.05 and 0.10 levels,
(+) indicates that the sum of the coefficients on related variable is positive,
(+) indicates that the sum of the coefficients on related variable is positive.
As an example ($\pi_t \rightarrow y_t$) means, inflation does not Granger-cause output growth.

Granger-causality to output growth, inflation, nominal uncertainty and real uncertainty are given in panel A, B, C, and D of Table 5, respectively. Granger-causality test is statistically significant from nominal uncertainty to inflation; from nominal uncertainty to real uncertainty; from output growth to real uncertainty; from output growth to nominal uncertainty and from inflation to nominal uncertainty. Theoretical relationships are given in section 2.

Panel B provides evidence that null hypothesis of inflation uncertainty does not Granger-cause inflation is rejected at the 5% level or better. The sum of the coefficients on lagged inflation uncertainty in the inflation equation is positive. Therefore, our key result is that inflation uncertainty significantly raises average inflation. Thus, we provide empirical support to Friedman's and Cuikerman and Meltzer's hypothesis, respectively.

Panel D provides evidence that null hypothesis of inflation does not Granger-cause inflation uncertainty is rejected at the 1% level. The sum of the coefficients on lagged inflation uncertainty in the inflation equation is positive. Therefore, our key result is that inflation significantly raises inflation uncertainty. Thus, we provide empirical support of Friedman's and Okun's hypothesis.

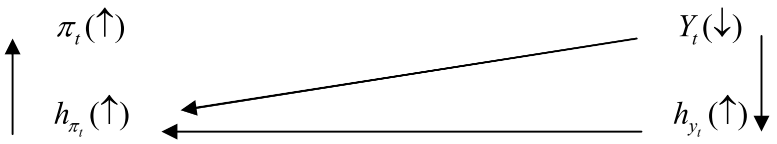
We find evidence that increased nominal uncertainty raises real uncertainty in Panel C. While a statistical meaningful relationship is found at 5% significance level at 12 lag, this relationship could not be found for remaining lags. The direction of the relationship obtained by the sum of the coefficients is positive. Hence, Taylor's hypothesis which is given as theoretical explanation for this relationship is not valid. Weak empirical findings contradict with theoretical explanation.

Panel D provides evidence that null hypothesis that output growth does not Granger-cause nominal uncertainty is rejected at the 5% level. The sum of the coefficients on lagged output growth in the nominal uncertainty equation is negative. Therefore, our key result is that output growth significantly lowers nominal uncertainty. One can find necessary theoretical background for the causal effect of output growth on nominal uncertainty. More output growth would be accompanied by more average inflation according to Short-run Phillips Curve (Briault, 1995). Furthermore, increasing inflation rates leads to more inflation uncertainty due to Friedman's and Okun's hypothesis. In summary, increasing output growth leads to more nominal uncertainty. Instead of Friedman's and Okun's hypothesis, Pourgerami and Moskus (1987) hypothesis can be influential in the second phase. In this situation, increasing output growth leads to less nominal uncertainty which we can conclude that causal effect of output growth on nominal uncertainty is negative. This theoretical reasoning is contradicted with the above arguments where we claim that Friedman's and Okun's hypothesis is valid. Hence, it is better to give a different theoretical explanation for this empirical result. In empirical literature, which deals with the bi-directional relationship between output growth and inflation, there is considerable amount of study which finds negative causal effect of output growth on inflation for Turkey (Kökocak and Arslan, 2006). Thus, with this new finding, we can construct a new theoretical reasoning for our empirical result. In this case, more output growth would be accompanied by more average inflation on the contrary to Short-run Phillips Curve. Furthermore, decreasing inflation rates leads to less inflation uncertainty due to Friedman's and Okun's hypothesis. In summary, increasing output growth leads to less nominal uncertainty which shows that Friedman's and Okun's hypothesis is still valid and is not contradicted with the above arguments. Thus, we find a negative relationship between output growth and nominal uncertainty by using Friedman's and Okun's hypothesis. Furthermore, for the transmission channel of this relationship Omay and Hasanov (2010) can be examined for Turkey.

Panel C provides evidence that null hypothesis that output growth does not Granger-cause real uncertainty is rejected at the 5% level or better. The sum of the coefficients on lagged output growth in the real uncertainty equation is negative. Therefore, our key result is that output growth significantly lowers real uncertainty. By using 'Phillips Curve' and 'Taylor Effect', Fountas and Karanasos (2006) explain the positive causal effect of growth on real uncertainty. In our situation, we have proven empirically that these hypotheses are not valid for Turkey. Moreover, both of the hypotheses provide counter effects between these variables. If we follow the method of Fountas and Karanasos (2006) for giving theoretical explanation for the causal effect of growth on real uncertainty, we will obtain negative causal effect of growth on real uncertainty, because of the mentioned reasons: More output growth would be accompanied by less average inflation on the contrary to Short-run Phillips Curve. On the one hand, decreasing inflation rates leads to more inflation uncertainty due to Friedman's and Okun's, hypothesis; on the other hand more inflation uncertainty leads to less real uncertainty which we provided the empirical reasoning above. In summary, increasing output growth leads to less real uncertainty, which indicates a negative causal effect of output growth on real uncertainty.

The below flow diagram shows the bidirectional causality relationships between nominal uncertainty, real uncertainty, output growth, and inflation:

Figure 1. Flow Diagram of Relationship



From this diagram, we can easily trace the direction and sign of the relationships. Furthermore, this diagram has proven the consistency of the relationships. Therefore, we can conclude from the diagram that the directions of the relationships are dominated[1] by the output growth. This conclusion needs some explanation. After 2001, we have seen that the Turkish inflation rate decrease gradually from %40 to under %10. Khan and Senhadji (2001) use an unbalanced panel method in order to determine threshold effects of inflation-growth nexus for a large sample of 140 countries. They find the thresholds to be around 10-11% for developing countries. On the other hand, they conclude that, the effects of inflation on growth to be statistically insignificant or positive on low inflation regimes, and statistically significant and negative on high inflation regimes. In order to have detailed information of this literature, Arin and Omay (2006) can be further read. From this conclusion, we can state that Turkey pass to low inflationary regime after 2001. Moreover after 2001, Turkish GDP grows in a high level which is induced by foreign capital. When we look at the flow diagram, we deduce that Turkish inflation is affected by the output growth by nominal uncertainty channel. Hence, this

[1] All of the variables are affected from output growth, but none of them effects the output growth. Output growth has a direct effect on uncertainties and indirect effect on inflation by using nominal uncertainty channel.

channel will be very important in the coming days, when we think about the Global Economic crises. This induced growth will decline and this decline will lead to high levels of inflation.

4. CONCLUSION

In this study, we have investigated bidirectional causality relationships between nominal uncertainty, real uncertainty, output growth, and inflation. Our test results show that existence of Granger-causality is observed from nominal uncertainty to inflation, from nominal uncertainty to real uncertainty, from output growth to real uncertainty, from output growth to nominal uncertainty and from inflation to nominal uncertainty. These findings prove that theoretical predictions of Cuikerman and Meltzer (1986), Okun (1971) and Friedman (1977) are valid for the period 1986:6-2007:1 for Turkey. Moreover, 'Short-run Phillips Curve' and 'Taylor Effect' have been proven empirically to be invalid for Turkey for this sample period. On the other hand, it is important to emphasize that these findings are not contradicting (do not contradict) with each other.

Moreover, we deduce that Turkish inflation is affected by the output growth by nominal uncertainty channel. Hence, this channel will be very important in the coming days, when we think about the Global Economic crises. High levels of growth which is induced by foreign capital will decline and this decline will lead to high levels of inflation. In order to solve this problem, the Central Bank of the Republic of Turkey has to resolve this structural problem of Turkey. Further avenues for research include applying the very same methodology to sub-samples for Turkey in order to check whether different periods have the same dynamics.

END NOTES

1. Policy makers avoid movements that are directed to decrease inflation, because they are aware of the fact that contractionary policies create recession.
2. In the study of Fountas *et al.* (2002), advantages of this model according to rival models are explained.
3. Results are available upon request.
4. For the 1994 crisis, we use dummy variable for the inflation equation, IPI index is seasonally filtered by X11.

5. In the bi-variate GARCH estimation inflation variable is significant for 5 lags in the first equation where output is dependent variable. But, in the Granger Causality test, we compute that inflation does not Granger Cause output, this results seem to be a contradiction when we think that the estimation and the variables are same kind. However in the bi-variate GARCH model, we are estimating the both equation simultaneously and modeled residual as a GARCH process. Hence, the estimated t values are belonging to expected inflation where we use the inflation variable it self in Granger Causality test. On the other hand, Granger Causality tests are the results of F-test, thereby it is not important to examine the t test unless we are dealing the direction of causality. In the estimation of Granger Causality test for the lag four, we have found that the first and the third lags are significant where the second and fourth lags are not. This is an evidence of the above mentioned arguments. In terms of these reason, the results are not a contradiction, they are the natural outcome.

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