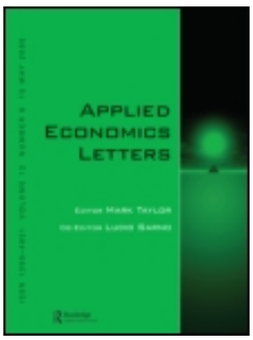

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The relationship between inflation and different sources of inflation uncertainty in Turkey

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The relationship between inflation and different sources of inflation uncertainty is investigated in Turkey during the period of 1995:3–2000:12. A time-varying parameter model of inflation with heteroscedastic disturbances is used to generate different sources of inflation uncertainty and then Granger methods are employed to test for causality between inflation and different sources of inflation uncertainty. The findings show that there is a causative influence of inflation on its uncertainty arising due to time-varying parameters of the inflation model. No evidence is found on the correlation between inflation and inflation uncertainty arising due to heteroscedasticity in the disturbance terms.

I. INTRODUCTION

Theoretical and empirical research on the relationship between the level of inflation and inflation uncertainty have not yet reached a consensus on the direction of causality. On the theoretical basis, Friedman (1977) and Ball (1992), for example, argued that uncertainty about inflation increases when inflation rises, while Cukierman and Meltzer (1986) and Cukierman (1992) suggested that an increase in inflation uncertainty leads to higher average inflation. Existing empirical research, also, provides conflicting evidence about the relationship between the rate of inflation and its uncertainty. For example, Ball and Cecchetti (1990), Evans (1991) and Fountas (2001) reported evidence in favour of a positive relationship, while Engle (1983) and Cosimano and Jansen (1988) offered no supporting evidence. Grier and Perry (1998) examined the direction of causality between the level of inflation and its uncertainty for G7 countries and presents mixed results. As Evans and Wachtel (1993) pointed out that these conflicting results might have arised from differences in measures and models of uncertainty.

The issue of decomposing inflation uncertainty into different parts that comes from different sources has not explored in the existing empirical literature. Nevertheless, the results on the the direction of causality might differ when the fact that the uncertainty in the inflation process might come from different sources is considered. This article developes a reduced form of the structural model of the inflation process that can be used to derive measures of different sources of inflation uncertainty for the Turkish economy. The model assumes that there are two types of uncertainty within a regression context: uncertainty that arises due to time-varying regression coefficients and uncertainty that arises due to heterocedasticity in the disturbance terms. First generate two different types of uncertainty were generated by estimating the structural model of inflation and then use them to examine the direction of causality between inflation and inflation uncertainty for Turkey during the period of 1995–2000.[1] Study of the causality relationship between the rate of inflation and its uncertainty for Turkish economy is particularly interesting, since over more than two decades its economic experience has included high and volatile inflation, and various structural changes.[2]

[1]Grier and Perry (1998) examined the direction of causality between inflation and inflation uncertainty for G7 Countries.
[2]See, Agenor *et al.* (1997) and Nas and Perry (2000) for details about Turkish Economy.

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This article, using Kalman filter techniques, finds that high inflation leads to greater inflation uncertainty coming from time-varying parameters of the model. No evidence on the causality in neither direction between inflation and its uncertainty coming from heteroscedastic disturbances of the model is found.

Section II presents the modelling strategy for inflation uncertainty and give estimation results for the Turkish economy. Section III concludes.

II. MODELLING INFLATION UNCERTAINTY FOR TURKEY

An overview of some important features of the Turkish economy

Turkey is an interesting case with both its political and economic structures. After all, it is a developing country, and therefore the relations between the government and the bodies in charge of implementing economic policies vary from those in the developed countries. The Central Bank of the Republic of Turkey (CBRT) is directly or indirectly controlled by the governments, and from time to time may be forced to act in line with the choices and decisions of the then government. However, the institutions in charge of fiscal policies, for example the Ministry of Finance and Treasury, are currently under direct control of the government. Therefore, the relationships between the government and political authorities in Turkey ensure that monetary and fiscal policies directly reflect governmental decisions.

Political instability has also contributed to the economic instability in Turkey. Experiencing six governmental changes over the period of 1995–2000 not only made the country a unique case but also caused the monetary and fiscal policies to change frequently, that is, to be unstable.

Turkey is a developing country, it has fought with rising inflation for over 25 years. Despite many stabilization programmes having been initiated to overcome this problem, all of them failed in reducing the inflation rate to an acceptable level. Six unsuccessful International Monetary Fund-supported programmes had been implemented over the 1970–2000 period.

In light of these features of the Turkish economy, it is reasonable to assume that the regression coefficients of the inflation process are time varying. In other words, a time-varying parameter model is thought to reflect the political instability and consequently unstable monetary and fiscal policies, in addition to the frequent implementation of unsuccessful stabilization programmes.

There is one more aspect that adds a novel dimension to the economic instability of Turkey. Capital account liberalization, began in August 1989, has left the country more exposed and sensitive to the foreign shocks. Table 1 shows the capital flows and portfolio accounts for Turkey over the period 1995–2000.

Table 1. *Capital Accounts for Turkey (Billion $)*

Year	Capital flows (excluded reserves)	Portfolio investments (net)
1995	4.6	0.2
1996	5.6	0.6
1997	7.1	1.6
1998	− 0.8	− 6.7
1999	4.7	3.4
2000	9.4	1.0

Source: Central Bank of Turkey.

During the sample period, the average yearly capital flows and portfolio investments are 5.1 and 0.01 with standard deviations of 3.4 and 3.4, respectively. In particular, notice that there is a sizeable amount of capital outflow from the country in 1998 due to Russian Crisis. The fact that the country is sensitive to the external shocks is incorporated in the model by assuming Markov-switching heteroscedasticity in the disturbance terms.

Model and estimation results

The following time-varying parameter model was considered with Markov-switching heteroscedasticity and was then used the conditional variance of the inflation forecast error as a measure of inflation uncertainty[3]

$$\pi_t = \beta_{0t} + \beta_{1t}\pi_{t-1} + \beta_{2t}\Delta i_{t-1} + \beta_{3t}\log m_{t-1} + \beta_{4t}\Delta \log w_{t-1} + \beta_{5t}\log r_{t-1} + u_t \quad (1)$$

$$\beta_{it} = \beta_{it-1} + v_{it}$$

$$u_t \sim N(0, h_t)$$

$$v_i \sim N(0, \sigma^2_{v_i}), \quad i = 1, 2, \ldots, 5$$

$$h_t = \sigma_0^2 + (\sigma_1^2 - \sigma_0^2)S_t, \quad \sigma_1^2 > \sigma_0^2$$

$$S_t = 0 \text{ or } 1$$

or in vector notationz

$$\pi_t = X_{t-1}\beta_t + e_t \quad (1')$$

$$\beta_t = \beta_{t-1} + \upsilon_t$$

$$\upsilon_t \sim N(0, Q)$$

[3]For details on estimation of the model, see Kim (1993).

Table 2. *Models of Turkish Inflation Rate*

A. *Least squares estimation* dependent variable: inflation rate (π_t)		
Independent variables	Coefficient estimations	Standard errors
Constant	1.738643	0.479092
π_{t-1}	0.533784	0.098741
Δi_{t-1}	0.419487	0.190904
$\Delta \log m_{t-1}$	0.048657	0.017417
$\Delta \log w_{t-1}$	0.033325	0.026548
$\Delta \log r_{t-1}$	0.094161	0.054443
Adjusted $R^2 = 0.39$	CHOW Test	
$F = 10.33$	1996:6 = 14.39	
Breusch–Godfrey LM = 22.48	1998:1 = 13.40	
LM ARCH(1 lag) = 0.09	1999:1 = 14.14	
LM ARCH(12 lags) = 14.39	1999:6 = 15.53	
B. *Time-varying parameter model with heteroscedastic disturbances*		
Parameters	Estimations	Standard Errors
σ_{v_0}	0.000027	0.108410
σ_{v_1}	0.000058	0.015641
σ_{v_2}	0.008315	0.002320
σ_{v_3}	0.009385	0.000143
σ_{v_4}	0.187897	0.010070
σ_{v_5}	0.102573	0.000000
σ_{u0}	1.042910	0.047778
σ_{u1}	1.126050	0.041930
p_{00}	0.921276	0.017188
p_{11}	0.831240	0.019965
H_0: $\sigma_{v1} = \sigma_{v2} = \sigma_{v3} = \sigma_{v4} = \sigma_{v5} = 0$; H_1: otherwise.		
Unrestricted log likelihood = −127.42562.		
Restricted log likelihood = −134.5545		

$$e_t \sim N(0, h_t)$$

$$h_t = \sigma_0^2 + (\sigma_1^2 - \sigma_0^2)S_t, \quad t = 1, 2, \ldots, T$$

where X_{t-1} is a 1×5 vector of independent variables; β_t is a 5×1 vector of time-varying coefficients; Q is a positive definite matrix; and π_t, Δi_{t-1}, $\Delta \log m_{t-1}$, $\Delta \log w_{t-1}$ and $\Delta \log r_{t-1}$ stand for Turkish monthly inflation rate figures as measured by CPI, changes in the interest rate as measured by the interbank rate, growth rate of M1 money supply, growth rate of wages measured by the average of public and private sector and growth rate of import price index, respectively.[4] The sample period is 1995:3–2000:12. S_t is an unobserved state variable whose process is determined probabilistically as in Hamilton (1988, 1989):

$$\Pr[S_t = 1 | S_{t-1} = 1] = p_{11} \tag{3}$$

$$\Pr[S_t = 0 | S_{t-1} = 1] = 1 - p_{11}$$

$$\Pr[S_t = 1 | S_{t-1} = 0] = 1 - p_{00}$$

$$\Pr[S_t = 0 | S_{t-1} = 0] = p_{00}$$

Panel A of Table 2 shows the estimation results obtained by least squares estimation. As seen from the table, Chow stability test results demonstrated that there are at least four structural break-points in the process of inflation. Panel B of Table 2 reports the maximum likelihood estimation of the inflation process. A likelihood ratio test is performed to test the null hypothesis of stable regression coefficients, which is rejected at 0.01 significant level. Using the results in panel A and panel B of Table 2, One calculates Theil inequality coefficients to measure the relative goodness of fit of the models. The coefficients are calculated as 0.208 for the constant-parameter-linear model and 0.085 for the time-varying model. Overall, the test results suggest that the time-varying model with heteroscedastic disturbances provides a better explanation for the process of inflation in comparison with the constant parameter model.

Decomposing inflation uncertainty

This model setting allows us to decompose the inflation uncertainty into two distinct parts.[5] Within Kalman filter

[4]The choice of regressors in the inflation equation considered in this article is motivated by Fama (1981), Engle (1983) and Lee and Ni (1996), and specific features of the inflation process in Turkey.

[5]Kim's (1993) study was followed in carrying out decomposition process.

framework, the conditional variance of the forecast errors obtained from Equation 1 is given by:

$$\tilde{H}_t = \tilde{H}_{1t} + \tilde{H}_{2t} \tag{4}$$

$$\tilde{H}_{1t} = X_{t-1}\tilde{R}_{t|t-1}X'_{t-1} \tag{5}$$

and

$$\tilde{H}_{2t} = \sum_{j=0}^{1} \Pr\left[S_t = j|\psi_{t-1}\right]\sigma_j^2 \tag{6}$$

where

$$\tilde{R}_{t|t-1} = \sum_{i=0}^{1} \Pr[S_{t-1} = i|\psi_{t-1}] \times \left\{ R^i_{t|t-1} + \left(\tilde{\beta}_{t|t-1} - \beta^i_{t|t-1}\right) \cdot \times \left(\tilde{\beta}_{t|t-1} - \beta^i_{t|t-1}\right)' \right\}$$

where $\beta^i_{t|t-1}$ is the estimate of β_t based on the information up to $t-1$, given $S_{t-1} = i$; $R^i_{t|t-1}$ is the covariance matrix of $\beta^i_{t|t-1}$; $\tilde{\beta}_{t|t-1} = \sum_{i=0}^{1} \Pr[S_{t-1} = i|\psi_{t-1}]\beta^i_{t|t-1}$.

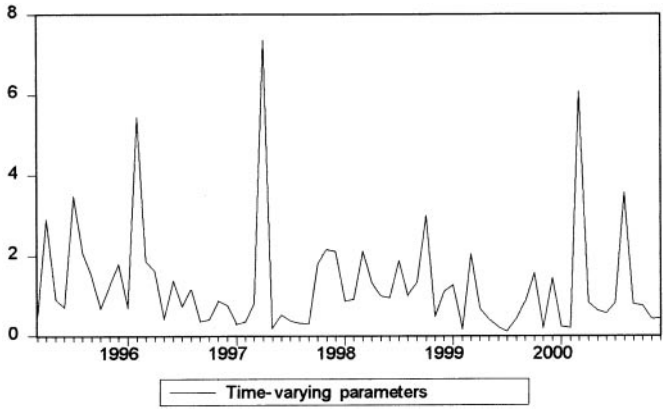

Fig. 1. *Inflation uncertainty due to time-varying parameters*

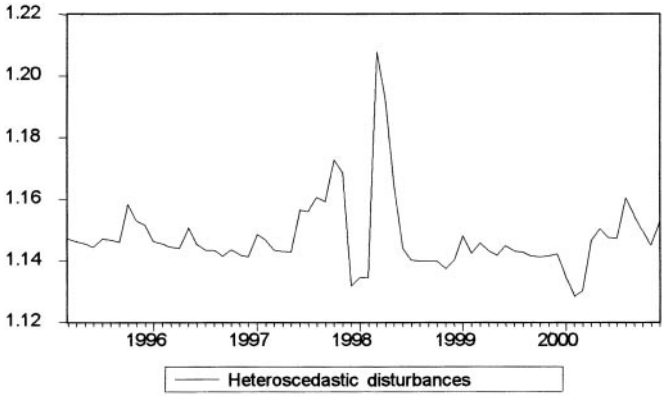

Fig. 2. *Inflation uncertainty due to heteroscedastic disturbances*

The conditional variance of the forecast errors ($\tilde{H}_t$) in Equation 1 consists of two distinct terms: the conditional variance due to changing regression coefficients ($\tilde{H}_{1t}$) and the conditional variance due to the heteroscedasticity in the disturbance terms ($\tilde{H}_{2t}$). Figs. 1 and 2 depict the decomposed uncertainties $\tilde{H}_{1t}$ and $\tilde{H}_{2t}$ estimated from the model.

The average levels of the conditional variance due to changing regression coefficients and the conditional variance due to the heteroscedasticity in the disturbance terms are 1.26 and 1.14 with standard deviations of 1.33 and 0.012, respectively. This indicates that time-varying part of the uncertainty is the dominant factor in determining inflation uncertainty compared to the other part coming from heteroscedastic disturbances in the case of Turkey. The mapping of the time-varying part of uncertainty in Fig. 1 shows that frequent government changes occurred in October 1995, March 1996, June 1996, June 1997, January 1999 and May 1999 raised the uncertainty. This finding is consistent with Fisher and Modigliani's (1978) view that governments tend to declare unrealistic stabilization programmes as the rate of inflation increases, resulting in an increased instability in the future path of prices.

The estimated uncertainty, partly due to heteroscedasticity in the disturbance terms, depicted in Fig. 2 captures he fact that there has been a sizeable amount of capital outflow from Turkey in 1998. Therefore, the capital account liberalization might be thought of as one of the factors that explains the dynamics of the uncertainty due to this part of uncertainty. Overall, this model gives us a quite well explanation of the dynamics of the forecast error variance of the inflation process in Turkey.

Granger causality tests

This section uses different parts of inflation uncertainty to examine the direction of the causality relationship between inflation and its uncertainty using Granger-causality tests. Panel A of Table 3 uses inflation uncertainty due to the time-varying regression coefficients and shows that the null hypothesis that inflation does not Granger-cause inflation

Table 3. *Ranger-causality tests for inflation and inflation uncertainty in Turkey*

	H_0: Inflation does not Granger-cause inflation uncertainty	H_0: Inflation uncertainty does not Granger-cause inflation
Panel A	2.72[a] (Four Lags)[b]	0.42 (Four Lags)
Panel B	0.36 (Four Lags)	0.38 (Four Lags)

Notes: [a]indicates significance at 0.05 levels; [b]indicates the sum of the coefficients on the lagged inflation is positive and significant.

uncertainty is rejected at 0.05 level using four lags. Since the sum of the coefficients on the lagged inflation is positive, our results provide evidence in support of Friedman–Ball hypothesis for the case of Turkey.

Panel B of Table 3 uses inflation uncertainty due to the heteroscedasticity of the disturbance terms and reports that there is no Granger-causality in either directions. This finding is consistent with Engle (1983), who found that high inflation levels are not correlated with unpredictable inflation.

III. CONCLUSION

This article used a reduced form of the structural and time-varying parameter model with Markov-switching heteroscedastic disturbances to derive measures of monthly inflation uncertainty in Turkey over the sample period 1995–2000. The modelling strategy enables decompostion of inflation uncertainty into two distinct parts in terms of source: the uncertainty due to changing regression coeffiients and the uncertainty due to the heteroscedasticity in the disturbance terms. The model gives a quite reasonable explanation of the dynamics of the inflation process and its uncertainty for the Turkish economy. For example, the part of uncertainty due to heteroscedastic disturbances captures the fact that the capital account liberalization that started in August 1989 might be thought of as one of the factors explaining the uncertainty, and the other part due to time-varying parameters of the inflation process shows that the instability in monetary and fiscal policies induced by political instability as well as unsuccessful stabilization programs might have contributed to the uncertainty.

If then investigated the relationship between inflation and inflation uncertainty using Granger-causality tests. Finding evidence on the causative influence of inflation on its uncertainty arising from time-varying parameters of the inflation model. No evidence was found on the correlation between inflation and its uncertainty due to heteroscedasticity in the disturbance terms.

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