We are IntechOpen, the world's leading publisher of Open Access books
Built by scientists, for scientists

6,900
Open access books available

185,000
International authors and editors

200M
Downloads

Our authors are among the

154
Countries delivered to

TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities

CLARIVATE ANALYTICS
BOOK CITATION INDEX
INDEXED

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Effects of Inflation Uncertainty on Economic Policies: Inflation-Targeting Regime

Mehmet Kenan Terzioğlu

Additional information is available at the end of the chapter

Abstract

Inflation uncertainty maintains its importance in emerging economies as well as in others. Increases in the level of inflation uncertainty constitute an important risk factor by affecting macroeconomic variables in the markets that are sensitive to price changes. The stabilization programs implemented in Turkey during 1980–2003 could not reduce the sensitivity of economic structure to inflationary shocks. Between 2003 and 2015, changes occurred, switching from high inflation to the single-digit inflation rates, in Turkey with transition to the inflation-targeting regime. Within the scope of this study, the effect of inflation uncertainty on inflation, economic growth and selected monetary-fiscal policy variables was examined using multivariate generalized autoregressive conditional heteroscedasticity (MGARCH) models. The dynamic conditional covariance model is designed to reflect the strong time-dependent correlation structure. While the inflation-targeting regime studies in developing countries focus on either the adoption or nonadoption of such a regime and its feasibility, this study evaluates the success of the regime in Turkey as an emerging economy.

Keywords: inflation uncertainty, inflation targeting, monetary policy, fiscal policy, MGARCH models

1. Introduction

The phenomenon of high inflation arising from the 1970s oil crisis and the collapse of Bretton Woods's system has brought price stability to the base of the monetary policy. While inflation, growth, exchange rate and interest rate should be in harmony in order to prevent financial-based crises, to eliminate income distribution imbalances and to increase prosperity, the implicit relationship between monetary and fiscal policies should not be ignored in developing countries that are subject to the inflation-targeting regime.

Inflation uncertainty has an effect not only on monetary and fiscal policy variables but also on economic growth and indirectly on the real sector by affecting both real net revenues and price system efficiency in resource allocation. In emerging markets economies, interest rate and exchange rate, which are indicative variables, have a decisive influence on the real and nominal sectors for sustainable development and a stable economy. Changes in interest rates and exchange rates affect domestic and foreign investment decisions and consumer behaviors. High interest rates increase risk perception as they cause inflationary expectations. Moreover, volatility that may be experienced at interest rates creates exchange rate uncertainties. Thus, the exchange rate instability affects the real sector and it causes economic instability. In open economies, exchange rates are controlled through interest rates (usually short term) when it is necessary.

Tax revenues follow a fluctuating structure in emerging economies where the economies are not fully managed due to the influence of political structure. Tax revenues can be seen as a means of development by the direct or indirect effect of resource allocation in developing countries. Macroeconomic balances are realized at a lower cost in the shorter term as the tax revenues are directed toward the financing of the growth. The longer the average collection period of taxes, the greater the magnitude of the corrosive effect on tax revenues is related with inflation. Depending on inflation, inflation rate increases by increased risk premiums due to economic uncertainty and instability. Funds used in the financing of the growth by excluding investments shift to nontaxable areas. The economic contraction due to the diminishing of investments reduces the taxable potential.

Tax revenues create economic conditions for stability and growth by reducing the debt burden of the public sector and alleviate the pressure on interest and inflation. Therefore, public expenditures also have an effect on the relation between inflation and tax revenues. The change in public expenditure activates the multiplier mechanism and causes a change in income, consumption and tax revenues. The high public debt burden may affect inflation expectations and can constitute difficulties to meet the inflation target. Government revenues increase as total savings, and taxable potential increases in moderate inflation periods.

Imbalances between government revenues/expenditures, elimination of existing debts by borrowing, problems in banking system, deficiencies in risk management processes, monetary and fiscal policy approaches which are far from rationality and the environment where short-term capital movements for speculative purposes are widespread due to increasing globalization and economic liberalization movements make an inflation spiral in emerging economies as well as in Turkey.

The effectiveness of inflexible monetary policies has disappeared because of the fluctuations in the variables used as main or intermediate target. High inflation, floating growth rates, high public deficits and a dollarized economy emerged between 1989 and 2001 in Turkey because of not only the short-term capital movements started to be effective in the economic structure but also unrealizable financial and structural reforms. In this period, monetary policy approaches that target interest rate, foreign currency exchange rate and monetary aggregates had been used in the economic system. Interest-exchange rate targeting has been abandoned because of the changes in shocks in the economic structure and high-floating inflationary periods that make interest targeting difficult. The increase in capital movements and the decrease

in flexibility against global shocks made the use of the exchange rate ineffective. Monetary aggregates could not be applied as intermediate targets owing to the structural changes and financial liberalization, and programs had resulted in disappearance of stability in the currency speed of money, the emergence of new financial instruments and the destabilization of the money demand caused by fast-growing financial sector. The exchange rate policy has been changed to the floating exchange rate regime because of the anticipation that it could be effective in closing the current account deficit and the monetary policy gained independence. Inflation had been adversely affected because the foreign exchange rate, which is sensitive to external shocks, exhibited a volatile structure and the perception that the interventions made on the interest rate were considered as interventions to the exchange rates.

In order to achieve price stability in the Turkish economic structure, it has been decided to implement the inflation-targeting regime, a monetary policy approach that targets directly inflation without using any intermediate targets. In Turkey, due to domestic debt stock and high interest rates, the transition to the inflation-targeting regime could not be possible immediately. With the transition to the inflation-targeting regime, which had been implemented in 2003, inflation and the level of dollarization had started to decrease. With the transition to the inflation-targeting regime in 2006, inflation reached single digits and the aim changed as price stabilization. Due to the difficulty of keeping inflation under control in emerging economies and the delayed/prolonged effects of the monetary-fiscal policy instruments on inflation, the long-term internal and external shocks experienced in Turkey between 2002 and 2009 created disruptions in the operation of the regime.

Since the relationship between uncertainty and macroeconomic variables is sensitive to various factors such as sampling period, model classification and uncertainty identifications, different results have been determined in studies among inflation, output growth, interest rate and inflation uncertainty. Almost none of the studies have been found within the scope of the developed economies or the developing economies on the interactions of inflation uncertainty with real effective exchange rate, tax revenues and government expenditures.

Cukierman et al., Azariadis et al., Friedman and Deveraux [1–4] argue that there is a positive relationship between inflation and inflation uncertainty. Baillie et al. [5] conclude that the Cukierman-Meltzer hypothesis is valid only in high inflationary countries. Pourgerami et al., Ungar et al. and Grier et al. [6–8] argue that there is an inverse relationship between inflation uncertainty and inflation rate. Bhar et al. [9] have concluded that inflation uncertainty has diminished inflation after inflation targeting. Holland [10] argues that higher inflation uncertainty may be associated with lower average inflation. While Dotsey and Sarte [15] find that inflation uncertainty has a positive effect on growth, Friedman, Pindyck, Beaudry et al.,Tommasi and Fountas et al. [1, 11–14] determine an inverse relationship between inflation uncertainty and output growth. Bhar et al. [9] point out that inflation uncertainty reduces the growth rate after inflation targeting. Chan [16] suggests that uncertainty reduces output growth by reducing consumption and investment spending with interest rates when there is a positive relationship between inflation uncertainty and interest rates. Berument et al. [17] show that inflation uncertainty increases 3-month deposit interest. Omay et al. [18] show that the effect of the inflation risk on the interest rates is regime dependent.

In case of uncertainty, determining the interaction of real and nominal economic variables with inflation uncertainty is important in shaping economic policies of countries experiencing problems with inflation. In this study, it is investigated whether the inflation-targeting regime causes a structural change in the economic system exposed to high- and low-inflation periods. It is aimed to contribute to the literature by focusing on the effect of inflation uncertainty on inflation, output growth and selected monetary-fiscal policy instruments under the inflation-targeting regime. Within the scope of the study, inflation-targeting period was accepted between 2003 and 2015 and preinflation-targeting period was between 1987 and 2003. The effect of inflation uncertainty on real and nominal economic indicators is examined using multivariate generalized autoregressive conditional heteroscedasticity (MGARCH) model. Because volatility is a quantitative measure of the risk that individual investors and financial institutions face, it is one of the noteworthy features of financial data. Because of the fact that financial changes move together over time, the ability to envision and forecast the dependency of second-degree moments of return is important in financial econometrics. The multivariate GARCH models, which are developed based on the fact that financial asset volatilities move together over time, provide efficiency gains. In order to handle all the possible interactions in a system equation, solutions are obtained by using full-information maximum-likelihood method.

In this way, with the help of an equations system that is stated in a multivariate structure, all the possible interactions are tackled together and solutions are obtained based on complete information. In addition, with the help of a slope dummy variable, which was defined to differentiate the periods before and after 2003, the effects of inflation and output uncertainty have been assessed for both high and low inflation periods. The study first takes a general look at the related literature about inflation uncertainty. It then moves on to defining the model and obtaining empirical findings which were established over the model. The study concludes with an assessment section in which the empirical findings obtained are evaluated.

2. Model structure

The generalized autoregressive conditional heteroscedasticity (GARCH) approach includes the time dependencies between conditional variances and covariances between various markets and assets. Although multivariate GARCH (MGARCH) models fundamentally resemble univariate GARCH models, the significant difference between the two is the definitions of the equations that show how the covariances of multivariate models move over time. To elicit these changes, performing analysis within the framework of multivariate modeling allows the researcher to obtain results that are more realistic. From the financial perspective, it facilitates taking better risk management decisions.

Expansion from the univariate GARCH model to a model with n variables requires that random variables (ε_t) with n dimensions and a zero average are dependent on elements in the information set of the conditional variance–covariance matrix. If H_t with respect to $\mathcal{F}_{t-1}'$ (information set) can be measured, then the multivariate GARCH model is expressed as $\varepsilon_t \mid \mathcal{F}_{t-1} \sim N(0, H_t)$. Because H_t is a variance matrix, positive definiteness should be satisfied. MGARCH

models allow the researcher to solve multivariate financial models requiring the variances, and covariances to be dependent on the vector ARMA-type information set require modeling the variances and covariances. To explain time dependency, Bollerslev et al. [19] expanded univariate ARCH/GARCH models with multivariate models under VEC parameterization. Because the VEC-GARCH model requires the estimation of too many parameters, and the positive definiteness of the covariance matrix cannot be satisfied always, it has some inherent applicability problems. Moreover, developing MGARCH models attempt to solve the dimension problem in financial modeling. Since it is difficult to secure the positive definiteness of H_t in VEC representation without bringing serious restrictions on parameters, it is focused on alternative MGARCH model constructions. From the perspective of applicability, structures in the form of factor or diagonal parameter matrix can be incorporated into the model.

This model class makes the theoretical structure of unconditional moment, ergodicity and stationarity conditions easier (He and Terasvirta, [20]). Since it is difficult to secure H_t's positive definiteness in VEC representation without bringing serious restrictions on parameters, the Baba-Engle-Kraft-Kroner (BEKK) model, which is a restricting version of the VEC-GARCH model, is used (Engle and Kroner, [21]). As in the VEC model, the parameters of the BEKK model do not show a direct effect of the different lag terms of H_t's elements. Structurally, the conditional covariance matrices of the BEKK-GARCH model satisfy positive definiteness. When C_0^*, A_{ik}^* and B_{ik}^* denote n x n parameter matrices, C_0^* denotes a triangle, C_{1k}^* denotes J x n parameter matrices and K determines generalization of summation limit process:

$$H_t = C_0^{*'} C_0^* + \sum_{k=1}^{K} C_{1k}^{*'} x_t x_t^{'} C_{1k}^* + \sum_{k=1}^{K}\sum_{i=1}^{q} A_{ik}^{*'} \mathcal{E}_{t-i} \mathcal{E}_{t-i}^{'} A_{ik}^* + \sum_{k=1}^{K}\sum_{i=1}^{p} B_{ik}^{*'} H_{t-i} B_{ik}^* \qquad (1)$$

can be written as BEKK (1,1,K) model. Eq. (1) is positive definite under weak conditions. In addition, because the model contains all positive-definite diagonal representations and almost all positive-definite VEC representations, it is adequately general. The BEKK model directly concentrates on the model structure, notably as A and B matrices. The main advantage of this is that because there is no constraint requirement necessitating H_t to be positive definite, parameters can be easily estimated. One disadvantage, on the other hand, is that because parameters enter the model in the form of matrices, and are transposed, effects on H_t can easily be interpreted. While matrix A measures the ARCH effect in the model, each element of the matrix B (b_{ij}) represents continuity in conditional variance from the variable "i" to the variable "j".

Using conditional variance and correlation in direct modeling of conditional covariances is a relatively new approach. Conditional correlation models are much more convenient alternatives in the estimation and interpretation of parameters. These models, which are nonlinear combinations of univariate GARCH models, allow for separate determination of individual conditional variances on the one hand, and of a conditional correlation matrix between the individual series on the other, or of another dependency criterion. Time-dependent correlations are usually calculated by the cross product of returns and by multivariate GARCH models that are linear in their squares. The dynamic conditional correlation (DCC) model takes the change of conditional correlation over time into account. The multivariate models

that are called DCC have the flexibility of parsimonious parametric models and relevant univariate GARCH models for correlations. In other words, the DCC estimators have the flexibility of univarate GARCH; however, they refrain from the complexity of multivariate GARCH. Despite being nonlinear, they can be calculated by two-step methods or single-variable methods that are based on probability function. These models, which directly parameterize the conditional correlations, can be estimated in two steps: the first being a series of univariate GARCH estimations and the second being correlation estimation. It is observed that under many circumstances they function well and provide reasonable empirical results.

When $\varepsilon_t = D_t^{-1} r_t$ and $D_t = \text{diag}\{\sqrt{h_{i,t}}\}$, $R = E_{t-1}(\varepsilon_t \varepsilon_t') = D_t^{-1} H_t D_t^{-1}$ represents a correlation matrix containing conditional correlations:

$$H_t = D_t R D_t \tag{2}$$

The dynamic conditional correlation model, which is a generalized form of the constant conditional correlation (CCC) estimator, is shown as follows:

$$H_t = D_t R_t D_t \tag{3}$$

The only difference in the dynamic conditional correlation model is that R changes over time (Engle, [22]). Parameterization of R requires that conditional variances are in integrity, and it has the same requirements as H.

The possible simplest and best method is exponential smoothing, which is expressed as a geometrical weighted average of normalized residuals. Another alternative is obtained using the GARCH (1,1) model. When the equation is written as

$$q_{i,j,t} = \bar{\rho}_{i,j} + \alpha\left(\varepsilon_{i,t-1} \varepsilon_{j,t-1} - \bar{\rho}_{i,j}\right) + \beta\left(q_{i,j,t-1} - \bar{\rho}_{i,j}\right) \tag{4}$$

the below equation

$$q_{i,j,t} = \bar{\rho}_{i,j}\left(\frac{1-\alpha-\beta}{1-\beta}\right) + \alpha \sum_{s=1,\infty} \beta^s \varepsilon_{i,t-s} \varepsilon_{j,t-s} \tag{5}$$

is obtained. Assuming that the unconditional expectation of the cross product is $\bar{\rho}$, variances are $\bar{\rho}_{i,j} = 1$. Because the $Q_t = |q_{i,j,t}|$ covariance matrix is positive definite and the weighted average of the positive semi-definite matrix, the correlation estimator $\rho_{i,j,t} = \frac{q_{i,j,t}}{\sqrt{q_{i,i,t} q_{j,j,t}}}$ is positive definite.

When S is an unconditional correlation matrix of epsilons, the matrix forms of these estimators are written as

$$Q_t = (1-\lambda)\left(\varepsilon_{t-1} \varepsilon_{t-1}'\right) + \lambda Q_{t-1} \tag{6}$$

$$Q_t = S(I - \alpha - \beta) + \alpha\left(\varepsilon_{t-1} \varepsilon_{t-1}'\right) + \beta Q_{t-1} \tag{7}$$

As long as unconditional moments are adapted to a simple correlation matrix, in order to parameterize the correlations, more complex positive-definite multivariate GARCH models can be used.

3. Effects of inflation uncertainty on economic policies

Quarterly data (1987:Q1–2015: Q3) were used to examine the effect of inflation uncertainty for Turkey on the variables of consumer price index, real gross domestic product, real effective exchange rate, 12-month deposit interest rate, government expenditures and tax revenues. The data set was taken from the Central Bank of the Republic of Turkey (CBRT) electronic data distribution system (EVDS). Different term dates for different base years are organized according to the 1987 base year. The seasonal structure in the real gross national product, government expenditures and tax revenue variables is eliminated by using the Tramo/Seat method. The government expenditures and tax revenues series are divided by the seasonally adjusted nominal gross national product and multiplied by 100. Growth measures expressed as percentage changes are obtained by taking the logarithmic first-order differences, multiplying by 100, of the consumer price index, real gross domestic product, 12-month deposit interest rate and real effective exchange rate.

MGARCH model structure by using inflation (π_t), output growth (b_t), exchange rate change (d_t), interest rate change (f_t), government expenditures (kh_t), tax revenues (vg_t), dummy variable (D_k) and inflation uncertainty (h_{π_t})

$$\pi_t = a_0 + a_1 D_k + \sum_{i=1}^{p} a_{2i}\pi_{t-i} + \sum_{i=1}^{p} a_{3i}b_{t-i} + \sum_{i=1}^{p} a_{4i}d_{t-i} + \sum_{i=1}^{p} a_{5i}f_{t-i} + \sum_{i=1}^{p} a_{6i}kh_{t-i} + \sum_{i=1}^{p} a_{7i}vg_{t-i} + \delta_1\sqrt{h_{\pi_t}} + \gamma_1 D_k\sqrt{h_{\pi_t}} + \varepsilon_{1t} \quad (8)$$

$$b_t = b_0 + b_1 D_k + \sum_{i=1}^{p} b_{2i}\pi_{t-i} + \sum_{i=1}^{p} b_{3i}b_{t-i} + \sum_{i=1}^{p} b_{4i}d_{t-i} + \sum_{i=1}^{p} b_{5i}f_{t-i} + \sum_{i=1}^{p} b_{6i}kh_{t-i} + \sum_{i=1}^{p} b_{7i}vg_{t-i} + \delta_2\sqrt{h_{\pi_t}} + \gamma_2 D_k\sqrt{h_{\pi_t}} + \varepsilon_{2t} \quad (9)$$

$$d_t = d_0 + d_1 D_k + \sum_{i=1}^{p} d_{2i}\pi_{t-i} + \sum_{i=1}^{p} d_{3i}b_{t-i} + \sum_{i=1}^{p} d_{4i}d_{t-i} + \sum_{i=1}^{p} d_{5i}f_{t-i} + \sum_{i=1}^{p} d_{6i}kh_{t-i} + \sum_{i=1}^{p} d_{7i}vg_{t-i} + \delta_3\sqrt{h_{\pi_t}} + \gamma_3 D_k\sqrt{h_{\pi_t}} + \varepsilon_{3t} \quad (10)$$

$$f_t = f_0 + f_1 D_k + \sum_{i=1}^{p} f_{2i}\pi_{t-i} + \sum_{i=1}^{p} f_{3i}b_{t-i} + \sum_{i=1}^{p} f_{4i}d_{t-i} + \sum_{i=1}^{p} f_{5i}f_{t-i} + \sum_{i=1}^{p} f_{6i}kh_{t-i} + \sum_{i=1}^{p} f_{7i}vg_{t-i} + \delta_4\sqrt{h_{\pi_t}} + \gamma_4 D_k\sqrt{h_{\pi_t}} + \varepsilon_{4t} \quad (11)$$

$$kh_t = k_0 + k_1 D_k + \sum_{i=1}^{p} k_{2i}\pi_{t-i} + \sum_{i=1}^{p} k_{3i}b_{t-i} + \sum_{i=1}^{p} k_{4i}d_{t-i} + \sum_{i=1}^{p} k_{5i}f_{t-i} + \sum_{i=1}^{p} k_{6i}kh_{t-i} + \sum_{i=1}^{p} k_{7i}vg_{t-i} + \delta_5\sqrt{h_{\pi_t}} + \gamma_5 D_k\sqrt{h_{\pi_t}} + \varepsilon_{5t} \quad (12)$$

$$vg_t = v_0 + v_1 D_k + \sum_{i=1}^{p} v_{2i}\pi_{t-i} + \sum_{i=1}^{p} v_{3i}b_{t-i} + \sum_{i=1}^{p} v_{4i}d_{t-i} + \sum_{i=1}^{p} v_{5i}f_{t-i} + \sum_{i=1}^{p} v_{6i}kh_{t-i} + \sum_{i=1}^{p} v_{7i}vg_{t-i} + \delta_6\sqrt{h_{\pi_t}} + \gamma_6 D_k\sqrt{h_{\pi_t}} + \varepsilon_{6t} \quad (13)$$

$$\varepsilon_{1t} = \sqrt{h_{\pi_t}} * z_t \quad (14)$$

is performed. The mean-model structure consists of Eqs. (8)–(13). Agumented Dickey-Fuller (ADF), Kwiatkowski-Phillips-Schmidt-Shin (KPSS) and Phillips-Perron (PP) unit root tests were applied in **Table 1** to set out the stationarity of the variables. It is decided that all variables are stationary, generally, when the ADF, KPSS and PP stationarity test results are evaluated for all variables.

Figure 1 shows the tendencies of the series used in the model construction with respect to time. When the inflation series is examined, it is observed that there has been a fluctuation in the period of 2003 with the transition to the inflation-targeting regime. A dummy variable has been added to the model structure to reveal the effects of this period. Dummy variable(D_k) used in the model construction is defined as 1 for the quarter of 2003–2015 and 0 for the other periods.

In the one-dimensional case, the mean equation for the model should be decided. In addition, the first condition that must be satisfied before dealing with the general structure of the variance equation in the multivariate GARCH model is that the series should be a white noise vector process. Residuals should be serially uncorrelated to each other, as well as have zero correlation with the lags of other components. It is suggested to use low-order VAR models to get rid of nested autocorrelation structure. **Table 2** shows the optimal lag length calculated for the model structure.

Detection of autocorrelation in residuals and/or squared residuals within the framework of established VAR (1) model leads to the use of MGARCH models. A preliminary multivariate ARCH effect test was performed in order to question the existence of the ARCH effect on the model constructed. In **Table 3**, it is shown that the absence of the ARCH effect is strictly rejected. Since the null hypothesis, constant and all other lagged parameters are equal to zero and are rejected, it can be said that there is no constant correlation and a dynamic structure can be mentioned with strong time-dependency correlation between the selected variables.
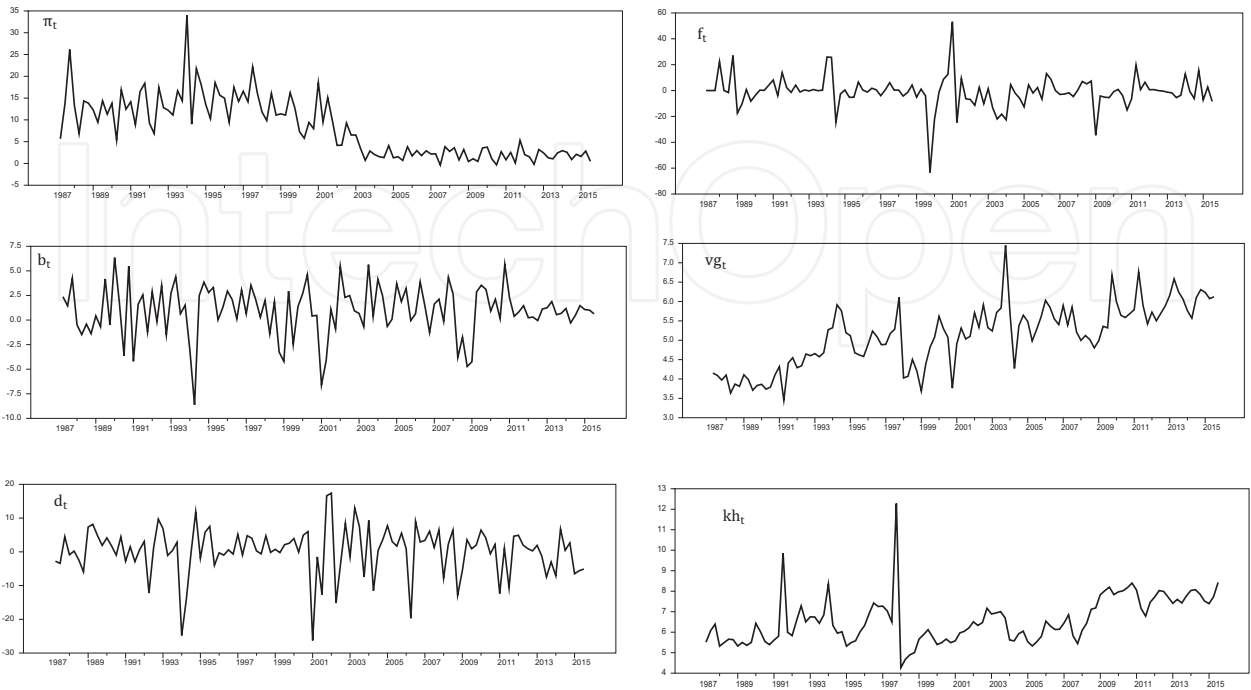

Figure 1. Graphical representation of the tendency of the series used in model construction over time.

		ADF test statistics	KPSS test statistics	PP test statistics
π_t	Level	−2.199	0.159***	−9.539**
b_t	Level	−7.599**	0.087**	−12.743**
d_t	Level	−10.836**	0.141**	−12.830**
f_t	Level	−9.754**	0.095**	−9.717**
vg_t	Level	−6.332**	0.081**	−6.332**
kh_t	Level	−7.304**	0.157***	−7.654**

***0.01, **0.05 and *0.10 test critical values.

Table 1. Unit root test results.

	Lag length	SC	HQ	AIC	FPE
Model C	0	30.7841788	30.6922946	30.6311298	808155.7
	1	30.4943727*	29.8511831*	29.4757366*	239794.0
	2	31.3253894	30.1308945	29.5447431	219511.0*
	3	32.3555313	30.6097310	29.9389591	247924.9
	4	33.3434204	31.0463148	30.4465451	272942.8
	5	34.4803294	31.6319184	31.2983202	356934.9
	6	35.7085147	32.3087984	32.4907265	527368.6
	7	36.9301733	32.9791516	34.0022509	805829.9
	8	37.5814766	33.0791495	35.3800101	733320.2
	9	37.9362941	32.8826617	37.0656734	530976.8
	10	38.1716960	32.5667583	39.5027360	373253.0
	11	38.5220873	32.3658442	43.3755930	332466.6
	12	38.9348464	32.2272979	49.4561719	374125.8

*minimum value on each information criteria for model order selection.

Table 2. Lag-length selection for model structure.

Multidimensional ARCH effect test statistic	Significance level
1898.86	0.000

***0.01, **0.05 and *0.10 significance level is not statistically significant.

Table 3. The presence of a priori ARCH effect.

Panel A: Model parameter tahminleri

π_t		b_t		d_t		f_t		kh_t		vg_t	
Constant	4.10*	Constant	0.65*	Constant	−0.750	Constant	−1.013*	Constant	2.001*	Constant	−1.327*
π_{t-1}	0.630*	π_{t-1}	−0.026	π_{t-1}	0.120	π_{t-1}	0.105*	π_{t-1}	−0.101	π_{t-1}	0.242
b_{t-1}	0.126	b_{t-1}	−0.042	b_{t-1}	0.114	b_{t-1}	0.526*	b_{t-1}	0.522	b_{t-1}	0.982**
d_{t-1}	−0.567	d_{t-1}	0.043*	d_{t-1}	0.092	d_{t-1}	−0.308**	d_{t-1}	0.092*	d_{t-1}	0.443*
f_{t-1}	0.033**	f_{t-1}	−0.028*	f_{t-1}	0.083*	f_{t-1}	0.190*	f_{t-1}	0.874*	f_{t-1}	−0.323*
kh_{t-1}	0.001	kh_{t-1}	−0.021	kh_{t-1}	0.314	kh_{t-1}	0.093*	kh_{t-1}	0.021	kh_{t-1}	0.084
Vg_{t-1}	0.074	Vg_{t-1}	0.013	Vg_{t-1}	0.053*	Vg_{t-1}	0.042	Vg_{t-1}	0.092*	Vg_{t-1}	0.463*
D_k	−0.48*	D_k	−0.095*	D_k	0.995	D_k	0.689*	D_k	−1.000*	D_k	0.154*
h_t	0.479*	h_t	0.155**	h_t	0.045	h_t	−0.093*	h_t	0.679**	h_t	−0.18*
$D_k^*h_t$	−0.12*	$D_k^*h_t$	−0.362*	$D_k^*h_t$	0.023	$D_k^*h_t$	0.102*	$D_k^*h_t$	−0.878*	$D_k^*h_t$	0.247*

Panel B: GARCH parameter estimates

C(1)	3.019***	C(4)	4.620***	A(1)	0.546*	A(4)	0.409**	B(1)	0.245***	B(4)	0.480***
C(2)	2.009*	C(5)	8.372***	A(2)	0.365	A(5)	0.352***	B(2)	0.514***	B(5)	0.583***
C(3)	5.267**	C(6)	9.157***	A(3)	0.709***	A(6)	0.222***	B(3)	0.235*	B(6)	0.534

Panel A: Model parameter tahminleri

π_t	b_t	d_t	f_t	kh_t	vg_t

Panel C: Correlation parameter estimates

DCC(1)	0.120***		DCC(2)	0.672***	
Multivariate Q (10) statistic		390.851*			
Multivariate ARCH statistic		3416.55**			

***0.01, **0.05 and *0.10 test critical values.

Table 4. DCC model parameter estimation results.

Within the scope of the study, the model structure is examined as a dynamic conditional correlation model to determine the effect of inflation uncertainty on economic variables. For this reason, the volatilities of the involved variables are restricted within the DCC framework. The DCC model established in the study states that there are unstable interactions of the series concerned with conditional correlation and that this correlation affects the correlations with a one lag-period. The DCC model estimation results are shown in **Table 4**. According to the result of the multivariate Q statistic in **Table 4**, no residuals were found to be serially correlated, and the ARCH effect was no more observed in the model. It is found that there is no autocorrelation problem when considering the autocorrelation function of residuals and its squares. When these results are taken into consideration, the effect of uncertainty in the inflation can be evaluated using the DCC model. The DCC model provides more precisely the dynamic structure of the correlation between inflation uncertainty and macroeconomic variables.

The dummy variable used for inflation targeting was found to be statistically insignificant for exchange rate changes, while statistically significant for inflation, output growth, interest rate change, governmet expenditure and tax revenues. This result indicates the effect of inflation uncertainty on selected variables differs pre-2003 and post-2003 periods. In other words, the effects of inflation uncertainty on real and nominal economic indicators are not the same in high and low inflationary periods. Inflation uncertainty had a positive and statistically significant effect on inflation, a positive and statistically significant effect on output gowth, a positive and statistically insignificant effect on exchange rate change, a negative and statistically significant effect on interest rate change, a positive and statistically significant effect on government expenditures and negative and statistically significant effect on tax revenues pre-2003 period. In the post-2003, inflation uncertainty affects inflation positively and statistically, output growth negatively and statistically significant, exchange rate change positively and statistically insignificant, interest rate change positively and statistically significant, government expenditures negatively and statistically significant, and tax revenues positively and statistically significant.

4. Findings and remarks

As unexpected inflation increases with rising inflation uncertainty, the more inflation uncertainty increases inflation for the pre-2003 and post-2003. It is noteworthy that increases in the period after 2003 are less than the previous period. In the period before 2003, the more inflation uncertainty is an increasing effect on economic growth. In this period, as consumption expenditures were made for saving, the increase in inflation uncertainty has led to a shift in commodity markets. Since consumption expenditures are not made for saving, more inflation uncertainty makes the reducing effect on economic growth in the post-2003 period.

Inflation uncertainty increases domestic prices, and so nominal exchange rate is also increased for both of the periods. While an exchange rate regime system was based on the "devaluation as much as inflation" idea in the period before 2003 (excluding the period between December 1999 and February 2001), flexible exchange rate system was implemented under implicit and explicit inflation-targeting regime in the post-2003 period. Due to the fact that the adequate

adjustment is provided in nominal exchange rate, inflation uncertainty has no effect on the reel exchange rates for the pre-2003 and post-2003 periods.

The increase in inflation uncertainty reduces the nominal interest rate in the period before 2003. Although the reduction of the nominal interest rate as inflation uncertainty increases, or the negative impact of inflation uncertainty on the nominal interest rate, seems contradictory at first glance, this result describes the features of the period before 2003. A severe increase in government borrowing needs is the basic phenomena that determine market interest rate for the pre-2003 period. In case that the state borrowing to repay the debt is a key factor in determining the market interest rates. The banks become main actors in financing the government. Given that deposits be a source of funding for banks, the decreasing effect of more inflation uncertainty on deposit interest rates is a reflection of the behavior of the banks' increasing profit margin, because bank is shrouded in a structure that they collect the deposits to the state as a debt in the period before 2003.

The increase in nominal interest rate as an impact of more inflation uncertainty is an expected result in the period after 2003. The most capital inflow to Turkey was experienced in the post-2003 period. It is a period in which it becomes very important that interior interest rates are too sensitive to outside interest rates and foreign interest rate is extremely high in the determination of domestic interest rates in Turkey. The supply of funds in the financial markets is largely shaped by a capital flow to Turkey. Capital flows to Turkey largely consist of hot money flows. In this sense, nominal interest rates are increasing due to the reduction in hot money flows as inflation uncertainty increases.

In addition, the inflation uncertainty and nominal interest rate relationship obtained from the study findings support the findings of inflation uncertainty and growth relationship. Consumption spending has become sensitive to interest rates due to the increase in financing consumption spending with credits (the most common example of a credit card) in the post-2003 period. If our findings are being analyzed, in the period after 2003, inflation uncertainty has an impact on nominal interest rate increase.

The fiscal policies implemented before the 2003 period and the conjunctural situation of the country caused the inflation rates to be considerably higher than the developed countries especially. Inflation uncertainty has led to the realization of the Tanzi effect, known as inflation cause to erode the real value of the tax revenues, in the pre-2003 period. In the same period, there was no inverse Tanzi effect, which means a decrease in the real value of public expenditures due to high inflation. When the post-2003 period was passed, the opposite effect was observed.

Author details

Mehmet Kenan Terzioğlu

Address all correspondence to: kenanterzioglu@trakya.edu.tr

Econometrics Department, Faculty of Economics & Administrative Sciences, Trakya University, Edirne, Turkey

References

[1] Friedman M. Nobel lecture: inflation and unemployment. The Journal of Political Economy. 1977;**85**:451-472

[2] Cukierman A, Meltzer AHA. Theory of ambiguity, credibility, and inflation under discretion and asymmetric information. Econometrica: Journal of the Econometric Society. 1986;**54**:1099-1128

[3] Azariadis C, Smith BD. Private information, money, and growth: Indeterminacy, fluctuations, and the Mundell-Tobin effect. Journal of Economic Growth. 1996;**1**(3):309-332

[4] Deveraux M. A positive theory of inflation and inflation variance. Economic Inquiry. 1989;**27**: 105-116

[5] Baillie RT, Chung CF, Tieslau MA. Analysing inflation by the fractionally integrated ARFIMA-GARCH model. Journal of Applied Econometrics. 1996;**11**(1):23-40

[6] Pourgerami A, Maskus KE. The effects of inflation on the predictability of price changes in Latin America: Some estimates and policy implications. World Development. 1987;**15**(2): 287-290

[7] Ungar M, Zilberfarb BZ. Inflation and its unpredictability—theory and empirical evidence. Journal of Money, Credit and Banking. 1993;**25**(4):709-720

[8] Grier KB, Henry ÓT, Olekalns N, Shields K. The asymmetric effects of uncertainty on inflation and output growth. Journal of Applied Econometrics. 2004;**19**(5):551-565

[9] Bhar R, Mallik G. Inflation uncertainty, growth uncertainty, oil prices, and output growth in the UK. Empirical Economics. 2013;**45**(3):1333-1350

[10] Holland S. Inflation and uncertainty: Tests for temporal ordering. Journal of Money, Credit, and Banking. 1995;**27**:827837

[11] Pindyck RS. Irreversibility, uncertainty, and investment. Journal of Economic Literature. 1990;**29**:1110-1148

[12] Beaudry P, Caglayan M, Schiantarelli F. Monetary instability, the predictability of prices, and the allocation of investment: An empirical investigation using UK panel data. University of British Columbia Discussion. 1996;**4**

[13] Tommasi M. The consequences of price instability on search markets: Toward understanding the effects of inflation. The American Economic Review. 1994;**84**:1385-1396

[14] Fountas S, Karanasos M, Kim J. Inflation and output growth uncertainty and their relationship with inflation and output growth. Economics Letters. 2002;**75**(3):293-301

[15] Dotsey M, Sarte PD. Inflation uncertainty and growth in cash-in-advance economy. Journal of Monetary Economics. 2000;**45**(3):631-655

[16] Chan LK. Consumption, inflation risk, and real interest rates: An empirical analysis. Journal of Business. 1994;**67**:69-96

[17] Berument H, Güner N. Interest rates, inflation and variability of of inflation: A case study for Turkey. METU studies in. Development. 1997;**24**:319-327

[18] Omay T, Hasanov M. The effects of inflation uncertainty on interest rates: A nonlinear approach. Applied Economics. 2010;**42**(23):2941-2955

[19] Bollerslev T, Engle RF, Wooldridge JM. A capital asset pricing model with time-varying covariances. J Polit Econ. 1988;**96**:116-131

[20] He C, Teräsvirta T. An application of the analogy between vector ARCH and vector random coefficient autoregressive models. SSE/EFI Working Paper Series in Economics and Finance. 2002;(516)

[21] Engle RF, Kroner KF. Multivariate simultaneous generalized ARCH. Economet Theor. 1995;**11**:122-150

[22] Engle RF. Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. Journal of Business and Economic Statistics. 2002;**20**:339-350