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EFFECT OF EXCESSIVE MACROECONOMIC VOLATILITY ON MONETARY POLICY PREFERENCES IN TURKEY

This article analyses the influence of excessive macroeconomic volatility on central bank preferences from the endogenous perspective in Turkey. Central bank preferences are obtained from the underlying macroeconomic structure by utilizing the simultaneous equations model framework. Excessive volatility in the exchange rate and the inflation rate has significant impact on monetary preferences. The interest rate smoothing parameter is increased and the target inflation rate is decreased in the second subsample period over 2001-2009. Exchange rate stabilization on the sound equilibrium level should significantly contribute to the achievement of stabilization in the monetary policy variables. The analysis illuminates that excessive volatility enforces the need for rule-based policy decisions.

Keywords: *central bank policy; GARCH; simultaneous equations model.*

JEL Classification: *E58, C50.*

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ВПЛИВ НАДМІРНОЇ МАКРОЕКОНОМІЧНОЇ ВОЛАТИЛЬНОСТІ НА ЗМІНИ МОНЕТАРНОЇ ПОЛІТИКИ ТУРЕЧЧИНИ

У статті проаналізировано вплив надмірної макроекономічної волатильності на зміни в монетарній політиці центрального банку Туреччини. Поведінку банку змодельовано з використанням відповідної макроекономічної структури на основі моделі одночасних рівнянь. Підвищена волатильність обмінних курсів і рівня інфляції значно впливає на монетарну політику. В період 2001-2009 рр. збільшився згладжуючий параметр ставок по кредитах і збільшився рівень цільової інфляції. Стабілізація обмінних курсів на певному збалансованому рівні має істотний вплив на стабілізацію монетарної політики. Аналіз показав, що підвищена волатильність викликає необхідність вживання жорстких заходів з боку центрального банку.

Ключові слова: *політика центрального банку, GARCH, модель одночасних рівнянь.*

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ВЛИЯНИЕ ЧРЕЗМЕРНОЙ МАКРОЭКОНОМИЧЕСКОЙ ВОЛАТИЛЬНОСТИ НА ИЗМЕНЕНИЯ В МОНЕТАРНОЙ ПОЛИТИКЕ ТУРЦИИ

В статье проанализировано влияние чрезмерной макроэкономической волатильности на изменения в монетарной политике центрального банка Турции. Поведение банка смоделировано с использованием соответствующей макроэкономической структуры на основе модели одновременных уравнений. Повышенная волатильность обменных курсов и уровня инфляции значительно влияет на монетарную политику. В период 2001-2009 гг. поднялся сглаживающий параметр ставок по кредитам и увеличился уровень целевой инфляции. Стабилизация обменных курсов на определенном сбалансированном уровне оказывает существенное влияние на стабилизацию монетарной политики. Анализ показал, что повышенная волатильность вызывает необходимость применения жестких мер со стороны центрального банка.

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Ключевые слова: *политика центрального банка, GARCH, модель одновременных уравнений.*

1. Introduction. Turkish economy suffered from hyper-inflation in the 1980—1990s and the first years after the millennium. The excessive inflation phenomenon determined the proper working of Turkish economy during those years (Fig. 1). This macroeconomic basis constituted a great challenge for Turkey's monetary policy and its smooth functioning.

After assigning the IMF stand-by agreement at the end of 1999, the Central Bank of Republic of Turkey (CBRT) announced its monetary policy principles. A proactive role was assigned to the monetary policy based on the reduced exchange rate depreciation in line with the targeted rate of inflation[3], thus providing a nominal anchor for inflationary expectations. The CBRT explicitly stated that it would stand ready to intervene at the market to smooth out excessive short-run exchange rate volatility[4]. This exchange rate commitment was supported by strong fiscal adjustments and consistent income policies in the public sector[5]. Telli et al. (2008) regard the CBRT's stability principles as a twin-targeting policy that relies on two pillars: (1) fiscal austerity targeting a primary budget surplus of 6.5% GDP and (2) price stability via inflation targeting.

Despite the IMF stand-by agreement, the great financial crisis aroused in 2001, accounting for the negative GDP growth of about -9,4% and the 28,2% decline in the volume of real credit growth. This painful experience provoked the constitution of a new structural program for the economy, especially the financial sector. The structural reformation program compassed several issues: financial sector restructuring, increasing transparency in the public sector and the strengthening of public finance, enhancing the competitiveness and efficiency of the economy, and strengthening social solidarity. This research paper empirically shows the extent to which the central bank's major concerns of macroeconomic development are reflected in the monetary preferences of the CBRT. Hereby, the introduced model attempts to describe the macroeconomic structural change from the perspective of endogenous policy preferences. The analysis reveals the effects of excessive volatility by using two decisive key variables, the exchange rate (USD/TL) and the inflation rate, on the central bank's monetary preferences. The central bank's deep preferences are determined from the underlying macroeconomic structure based on a loss function using a Taylor (1993) rule style with flexible inflation targeting[6]. The methodology follows the approach applied by Rudebusch and Svensson (1998). They describe the Taylor rule as an outcome of an intertemporal optimization problem and estimate the preferences under macroeconomic demand and supply function. Similarly, Cecchetti et al. (2002), Favero and Rovelli (2002) and Dennis (2004) examine the relative importance of output and inflation variability in policymakers' objective functions under

[3] As Basci and Kara (2011) state, the CBRT used short-term interest rates to implement inflation targeting in the post-crisis era after 2001.
[4] See Akinci et al. (2007) for details.
[5] See Ozutku (2004) for details.
[6] One reason why the Taylor rule has been preferred is its simplicity in formulation and accountability, as Kydland and Prescott (1977, p.487) mention.

distinguishing periods in the USA. The remainder of the article is organized in 3 sections. In section 2 the model utilizes a GMM-estimated simultaneous equations model (SEM) framework to determine the monetary policy preferences expressed in the Taylor rule style. A further step is the value at risk approach (VaR) used to endogenously determine excessive volatility in the relevant macroeconomic variables. In Section 3 the obtained results are presented. Section 4 concludes and discusses the results.

2. Econometric Methodology. To test the hypothesis of interest rate smoothing and the effect on output stabilization in our model, we choose flexible inflation targeting. The data sample spans from 1987 to 2009 using monthly intervals. The data is splitted into two subsamples ranging from 1987 to 2000 and from 2001 to 2009. The subsample division aims to present the potential change of the monetary parameters after the fundamental crisis in 2001 in Turkish economy.

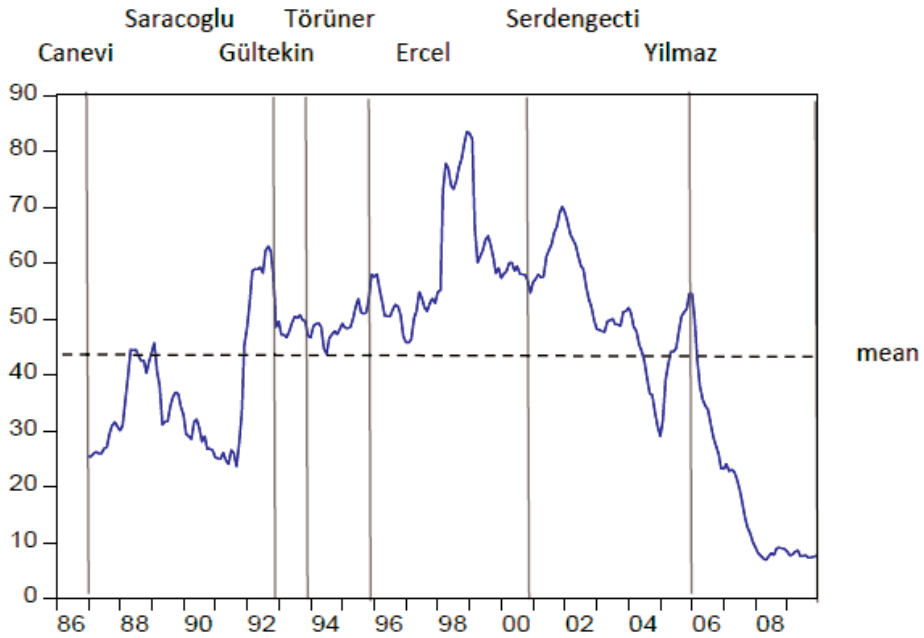

Figure 1. **Inflation rate under the incumbent central bank governors**

Endogenous monetary preferences. The central bank preferences are described by the intertemporal loss function[7]:

$$E_t \sum_{i=0}^{\infty} \delta^i L_{t+1} \tag{1}$$

and

$$L = \frac{1}{2}\left[(\pi_t - \pi^*) + \lambda x_t^2 + \mu(i_t - i_{t-1})^2\right] \tag{2}$$

[7] See Rudebusch and Svensson (1998).

The equations contain the following variables: δ, intertemporal discount determined as 0.95; π, inflation rate; π^*, target inflation rate; λ, the weight attached to the output stabilization; and μ, the weight on interest rate smoothing.

The loss function Eq. (2) represents the central bank's reaction function in *Taylor-style*, which characterizes the central bank's policy preferences and objectives in the context of monetary policy rules. The solution of the model is provided by an intertemporal optimization of the loss function subject to the aggregate demand and aggregate supply function. The small macroeconomic model is constructed by determining the specific lag order, which is the result of the vector autoregressive model (VAR)[8]. Once the VAR model is applied and insignificant lags for each variable are omitted, the supply and demand function is stylized by

$$\begin{aligned} x_t &= a_1 x_{t-1} + a_2 (i_{t-1} - \pi_{t-1}) + u_t^d \\ \pi_t &= a_3 \pi_{t-1} + a_4 x_{t-1} + a_5 x_{t-2} + u_t^s \end{aligned} \tag{3}$$

Similar to Favero and Rovelli (2002), we apply the Euler equation to solve the (first order) optimization problem. The Euler equation captures the dynamics of intertemporal optimization under identified constraints:

$$\begin{aligned} x_t &= a_1 x_{t-1} + a_2 x_{t-2} + a_3 x_{t-3} + a_4 (i_{t-2} - \overline{\pi}_{t-2}) + u_t^d \\ \pi_t &= \alpha_5 + \alpha_6 \pi_{t-1} + (1-\alpha_6)\pi_{t-2} + \alpha_8 x_{t-3} + \alpha_9 (i_{t-1} - \overline{\pi}_{t-1}) + a_{15} \Delta lcimf_{t-1} + u_t^s \\ (i_{t+1} - i_t)\delta\mu &= (i_t - i_{t-1})\mu + \delta^3 \alpha_9 \alpha_4 E_{t-1} \left[(\pi_{t+3} - \pi^*) + \delta(\pi_{t+4} - \pi^*) \right] \\ &\quad + \lambda\delta^2 a_4 E_{t-1} [x_{t+2} + \delta a_1 x_{t+3} + \delta(a_1^2 + a_2 a_1) x_{t+4}] + u_t^m \end{aligned} \tag{4}$$

The model variables are given as x_t, the relative gap between the actual and the potential industrial output with applied Hodrick-Prescott filter in %; π_t, annual inflation in the GDP chain-weighted price index (in percentage points); i_t-$\overline{\pi_t}$, short-term real interest rate; and Δ*lcimf*, IMF commodity price index to account for the international price level. The third equation in Eq. (4) is the optimization outcome of the model. It can be considered as the monetary authorities' policy rule. The data is implemented in logarithmic returns.

Endogenous determination of excessive volatility. The endogenous determination procedure is conducted through the GARCH-estimated value at risk (VaR) framework that examines excessive volatility in the exchange rate and the inflation rate.

$$\begin{aligned} Y_t &= c_0 + c_1 Y_{t-1} + \varepsilon_t \\ \sigma_t^2 &= \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \\ VaR_\alpha(X) &= \inf\{x \in R : P(X > x) \le 1-\alpha\}, \alpha = 99.8\% \end{aligned} \tag{5}$$

[8] For the discussion of the VAR model, we refer to Christiano et al. (1998), who give a detailed illustration and interpretation of VAR models in monetary policy.

Table 1. **GARCH estimation results from VaR Model for key macroeconomic variables**

	Exchange rate		Inflation rate	
Mean Equation				
C	0.00210	(0.165)	0.0189	(0.000)
AR(1)	0.255	(0.000)	0.739	(0.000)
Variance Equation				
ω	0.000115	(0.0847)	0.000000553	(0.263)
α	0.353	(0.0603)	0.0808	(0.0229)
β	0.657	(0.000)	0.905	(0.000)
Decision Criteria				
AIC	-4.430		-5.25	
SIC	-4.353		-5.182	
Q(20)	18.212	(0.508)	53.902	(0.000)
ARCH-LM	(0.949)		(0.745)	
Log likelihood	639.554		760.675	

Note: The GARCH estimation results and decision criteria are illustrated for the VaR model in Eq.(5). The numbers in parentheses are *p*-values.

The GARCH specification is selected as a rudimentary AR(1)-GARCH(1,1) model, which fulfils the criteria for the stationary process and accounts for heteroskedasticity.

For each excessive volatility date, obtained in the VaR-framework, one dummy variable is matched. Subsequently, the obtained exception periods are used to constitute a time series of dummy variables, which takes the value *'1'* for (positive or negative) volatility excess and *'0'* otherwise. The constructed dummy series are introduced into the supply and demand functions in Eq. (4). The results for the GARCH-model specifications are given in Table 1.

3. Empirical Results. The initial model is estimated according to the model described in Eq. (4). In Table 2, it can be observed that the weight of output stabilization is significantly positive at approximately 0.024. The target inflation is approximately 44.78% and positive. The weight on interest rate smoothing, μ, is negative and significant, indicating that almost no interest rate policy rule by the CBRT can be observed for the sample period. Although the estimated parameter for interest rate smoothing is very small, it would not be correct to assume that it is irrelevant. It describes a high degree of discretion to reach its policy goals.

Table 2. **Estimated results for selected parameters**

Model specification	π *	λ	μ	σ (u^d)	σ (u^s)	*J statistic*
Sample 1987-2009, No excess, total sample	44.78 (0.00)	0.024 (0.027)	-0.0000032 (0.05)	8.97	2.66	0.19
Subsample 1987-2000 No excess, subsample 1	48.79 (0.00)	-0.0026 (0.066)	-0.0000012 (0.00)	9.094	2.87	0.23
Subsample 2001-2009 No excess, subsample 2	39.22 (0.00)	-0.013 (0.00)	0.000048 (0.00)	6.72	1.58	0.25

Note: Model specifications are described according the Model in Eq.(4). The numbers in parentheses are *p*-values. The *J*-statistic measures the validity of the model and whether the moment conditions are well matched to the data. Standard deviations for the supply and demand functions are given as $\sigma(u^s)$ and $\sigma(u^d)$, respectively.

Further, in Table 2 the sample period is divided into two subsample periods 1987:09-2000:05 and 2001:6-2008:12. The weight on output stabilization, λ, is negative in both subsamples.

The parameter on interest rate smoothing, μ, increases from $-1.2 \cdot 10^{-6}$ to $4.8 \cdot 10^{-5}$. This gives some indication that the interest rate decisions signal the lower level of discretion in the second period. Another key issue in Table 2 is that the implicit inflation target decreases significantly from 48,8% to 39,2%. The standard deviation of supply and demand shocks decrease both in the period from 2001 to 2009, by 45% and 26% and vice versa. Beside cyclical macroeconomic effects, it can be argued that the effectiveness of monetary policy for the second period has been improved. In the next subsections, the model results are presented for the case, when endogenously determined dummy variable are included. The negative exchange rate dummy variable gives rise to a slightly higher target inflation value and a higher μ-value. A more significant impact on μ compared to the initial solutions prevails in the positive exchange rate dummy model. Both excess types coincide with increased values in the relevant variables. However, the simultaneous inclusion of positive and negative dummies induces an insignificant value for output stabilization, λ. The positive dummy variable coefficient is positive, approximately 1.03, at a high significance level and negative, approximately -0.85, for the negative excess variable (see Table 3). The coefficients of both dummy variables are negative in the case of simultaneous inclusion.

The model results with included excessive inflation rate volatility dummies are presented in Table 3. Regarding negative inflation rate dummy variables, μ, is insignificant, and λ is increased in size, by approximately 0.031 compared to the initial results. The introduction of the positive inflation rate dummy makes λ lower by approximately 0.021 compared to the initial model, and μ becomes slightly positive, approximately 0.0000121[9]. When including positive and negative dummies simultaneously, μ turns out to be insignificant, whereas λ is placed near the equilibrium rate, as in the initial results.

Table 3. **Estimated results for the selected parameters under excessive volatility**

Model specification by inclusion of dummy variables	π^*	λ	μ	$\sigma(u^d)$	$\sigma(u^s)$	*J statistic*
Negative excess in exchange rate	45.01 (0.00)	0.025 (0.028)	0.00000453 (0.047)	9.01	2.70	0.19
Positive excess in exchange rate	45.31 (0.00)	0.029 (0.034)	0.0000694 (0.0061)	8.68	2.91	0.18
All excesses in exchange rate	46.49 (0.00)	0.052 (0.30)	0.000108 (0.13)	8.74	3.11	0.26
Negative excess in inflation rate	44.78 (0.00)	0.031 (0.042)	0.0000242 (0.17)	8.96	2.82	0.22
Positive excess in inflation rate	44.75 (0.00)	0.021 (0.044)	0.0000121 (0.053)	9.00	2.69	0.19
All excesses in inflation rate	44.56 (0.00)	0.0284 (0.042)	0.0000397 (0.25)	9.04	2.90	0.22

Note: See Table 2. The simultaneous inclusion of positive and negative excess dummy variables weakens the significance of the results in general.

[9] These results are supported by Ozlale (2003), who finds that interest rate smoothing plays a more important role than output stabilization in the case of the Federal Reserve.

The coefficients for almost all corresponding dummy variables are negative in Table 4. In the case of separate inclusion, the dummy variable coefficients are significant in almost all the variables. This shows that the relevant variables are effective in influencing the macroeconomic demand and supply function, namely initiating a shift in the functions. The simultaneous inclusion of positive and negative excess dummy variables weakens the significance of the results in general.

Table 4. **Estimated coefficients for excessive dummy variables**

Model specification by inclusion of dummy variables	neg. excess dummy	pos. excess dummy	neg. excess dummy	pos. excess dummy
Negative excess in the exchange rate	-0.85 (0.055)			
Positive excess in the exchange rate		1.02 (0.0003)		
All excesses in the exchange rate			-3.43 (0.016)	-1.57 (0.078)
Negative excess in the inflation rate	-1.04 (0.029)			
Positive excess in the inflation rate		-1.13 (0.056)		
All excesses in the inflation rate			-1.11 (0.11)	-1.19 (0.01)

Note: Model specifications are described according to the inclusion of excessive volatility variables into the Model in Eq.(4). The numbers in parentheses denote *p*-values.

4. Conclusion. Following the financial and monetary restructuring program, the macroeconomic developments have shown evident improvements in the inflation rate and a profound restructuring in the financial sector. Nonetheless, the output growth has been continuing to be disputable in the context of high real interest rates. The criticism has put the focus on (speculative) foreign capital inflows that were attracted by high interest rates. As it is argued regularly, such a growth model is not capable to create sources for new employment[10]. We obtain the results in line with the criticism, concerning the value for the output stabilization parameter, which is negative for two subsamples, nevertheless, positive for the initial sample period. This controversy reflects the structural development over the entire sample period rather than the effectiveness of the monetary transmission process. After turmoil in social and political stance under the governance of influential cumbersome bureaucratic authorities, Turkish economy began to pass through the metamorphose towards an open economy with dynamic economic activities, accounting for more or less robust growth in the recent years.

The SEM framework results indicate that the CBRT's preferences change significantly upon the excessive impact of macroeconomic variables. This finding shows that the relevant variables are effective in influencing the macroeconomic demand and supply function, initiating a shift in the functions. Positive and negative excesses in the exchange rate denote currency depreciation and appreciation. Thus, it can be suggested that exchange rate stabilization on a sound equilibrium level should significantly contribute to the achievement of stabilization in the monetary policy variables. The change of the μ-parameter indicates that excessive volatility initiates the

[10] See Ay and Karacor (2007) for an elaborate illustration for the post restructuring economic stance in Turkey.

need for a higher level of rule-based monetary policy decisions rather than a higher level of discretion. Rodrik (2009) acknowledges that the CBRT should intervene with a clear statement of preference, favouring the prevention of overvaluation to exploit potential growth[11].

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[11] See Rodrik (2009) for details.