

# Istanbul as a Global Financial Center



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Edited by

Melike Bildirci, Cemal Zehir,  
Fazıl Kayıkçı, Murat Karagöz  
and Tahsin Bakırtaş

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**SECTION 1:**  
**MONETARY POLICY, FINANCE**  
**AND BANKING**



# **CHAPTER 1**

## **POLICIES**



# AN ANALYSIS OF UNCONVENTIONAL MONETARY POLICY APPLICATIONS USING THE MS-GARCH METHOD

MELIKE E. BILDIRICI<sup>1</sup> AND CEREN TURKMEN<sup>2</sup>

## Abstract

The GARCH model is one of the most widely-applied econometric models in finance, but the results gleaned are rarely tested for structural breaks. This study's main aim is to explain the monetary policy strategies held by CBRT and the historical change of monetary policy tools used within these strategies, as well as to analyze liquidity management after the 2008 crisis under MS-GARCH, MS-PGARCH and MS-APGARCH methods. In order to test the effects of CBRT's new wave of policies we created an O/N interbank rate and a two-sided transaction volume series by taking natural logarithms. We distinguish three different regimes in our study. According to our results, the volatility shocks caused by the liquidity arrangements of CBRT show persistence. Additionally, according to the power coefficient (which is close to 2) shocks caused by monetary authorities prevail for a longer period in financial markets.

**Keywords:** Monetary policy, liquidity management, MS-GARCH, MS-PGARCH, MS-APGARCH

## 1. Introduction

Economics has a large catalogue of literature in terms of publications attempting to anticipate crises and examine whether they are permanent or not. The main reason is that crises can have a spillover effect on different

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economies through various channels, and that can negatively affect the global economy. The majority of these studies ascribe important roles to monetary policy authorities for the prevention of crises, and ensuring the stability of both financial markets and prices.

In this context, the majority of the world's central banks are trying to ensure their main objective of price stability is achieved, under assumptions of reliability, accountability and transparency. For this purpose, liquidity management is an important tool<sup>3</sup>.

The variables used in traditional studies which aim to measure liquidity usually have a monetary base. Recent studies conducted to measure market liquidity used data from the bond/bill secondary market, secondary stock market, TL / USD spot market, the futures market at VOB, etc. Unlike in previous articles, we used the O/N, overnight, interbank market in this study. The main reasons for using this data can be explained as follows: first of all, this market is not directed by CBRT, the Turkish monetary policy authority. Secondly, this market can reflect the response of financial markets against central bank monetary policy measures. Lastly, and most importantly, this variable affects the entire economy due to its pass-through to the real sector. The variables used in previous studies show a delayed response, and the financial markets are not fully explained. The validity of traditional definitions of money, especially in today's conditions, has become controversial. Indeed, in the study by Mah and Lim (2008), global liquidity has been described as an inverted pyramid; the traditional definition of money is mostly 1% of the total share of global liquidity. Considering these circumstances, in order to best analyze these structures in Turkish conditions, the O/N interbank market was selected. Another important variable that can be used is intra-day interbank market data. However, this study concentrates only on O/N data.

This study's main aim is to explain the monetary policy strategies held by CBRT and the historical change of monetary policy tools within these

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<sup>3</sup> Monetary liquidity and funding liquidity, which are intimately associated with market liquidity, emerge as a sub-definition of the concept of liquidity. Monetary liquidity is related to money supply; any increase in money supply will lead to an overall increase in the general level of financial market activities, and thus it may increase market liquidity. On the other hand, funding liquidity is important for the financial sector units exposed to an asset-liability maturity mismatch. Any liquidity crunch will lead to a confidence crisis so that market liquidity will be adversely affected. As stated in Taner (2008), liquidity management for central banks is managing the conditions affecting the supply and demand for money, consistent with their monetary policy objectives.

strategies, as well as to analyze liquidity management after the 2008 crisis using MS-GARCH, MS-PGARCH and MS-APGARCH methods.

The study is comprised of five sections. Following the introduction, the second part is a literature survey regarding central bank liquidity measures following the global crisis. In the third part we attempt to describe the evolution of monetary policy tools implemented by the Central Bank in Turkey. In later sections, liquidity values will be analyzed with the data obtained from CBRT by the use of the MS-GARCH, MS-PGARCH and MS-APGARCH methods. In other words, this part defines the conceptual framework that supports the theoretical propositions. In the last section, our results will be analyzed in comparison with empirical results in the related literature.

## **2. Economic Background**

Lim et al. (2011) examined the effects of macro-prudential policy measures on financial stability for the period 2000-2010, covering 49 countries, and found that using these policies is effective at reducing systemic risk, independent of the size of the country being considered.

Kristen and Kugler (2010) examined the monetary applications of the BOE, ECB, FED and the Swiss National Bank in the period between 2007 and 2009 to reach an international assessment relating to liquidity measures. According to this study, central banks have responded to crises both in terms of amount and price of liquidity, although different liquidity tools have been used as a substitute.

According to the study by Ait-Sahalia et al. (2009) investigating the effects of additional liquidity announcements by the BoJ, BOE and FED, the announcement of additional liquidity in the UK and Euro areas reduced the spread.

Other studies examining the change in Central Bank monetary policies can be listed, but are not limited to Basci and Kara (2011), Kara (2012), Dogru et al. (2012), Demirhan (2013), Kartal (2013), Oktar et al. (2013), and Kati and Ozkeskin (2012). The Basci and Kara (2011) and Kara (2012) studies are published by the CBRT and demonstrate the stance of both the CBRT and policy makers when facing a crisis. Hence, they can be accepted as the core of other papers in an examination of Turkey's macro-prudential policy mix. These studies are trying to assess the new monetary policy mix designed to limit the macro financial risks caused by short-term capital inflows, current account balance deterioration and credit expansion.

Changes in monetary policy are analyzed in Kartal (2013) by changes in the CBRT balance sheet and money supply between 2007 and 2011.

The diffusion channels of the global crisis and CBRT anti-crisis measures are examined in Kati and Ozkeskin (2012) by using selected macroeconomic data.

### **3. Development of Monetary Policy in Turkey**

Global markets and the Turkish economy faced considerable local and global crises in the 1990s. There are numerous research works aiming to predict and/or eliminate the negative impact on countries' economies and the global economy. The majority of these studies attribute an important role to the monetary authorities such as crisis prevention and ensuring price and financial stability under the assumptions of reliability, accountability and transparency. For this purpose, liquidity management is an important tool.

In this context, the CBRT's monetary policy strategy and the changing use of monetary policy instruments within the framework of this strategy will be summarized below.

The policies implemented during the period 1970 -1980 basically aimed to reduce foreign exchange shortages and reduce inflation. They were constructed on Central Bank monetary aggregates. During this period, the limiting of treasury funding from the Central Bank was attempted. The period 1988-1993 was a period of general deterioration in macroeconomic stability. Therefore, attempts were made to resolve liquidity-induced imbalances by controlling the money supply.

In 1990, the Central Bank declared its first monetary program, targeting the size of selected balance sheet items. In that period, monetary policy tried to control both exchange rate volatility and excess liquidity, but the program was not successful, and ended in 1994 with a crisis. The measures taken after the crisis, known as the April 5 decisions, targeted incremental gains in foreign exchange reserves as well as stability in monetary and fiscal policies.

An inflation targeting regime has been applied in countries with inflation problems since the 1990s. The success of inflation targeting regimes in countries with a high debt load history such as Turkey, depends on the success of monetary and fiscal policies both individually and combined. According to Article 4 of Central Bank Law No. 1211 dated 25 April 2001, the Central Bank's main objective is to maintain price stability.

For this purpose, the bank was granted the right to determine, amongst other things, the implementation of monetary policy and monetary policy instruments, ensuring the credibility of monetary policy, during the period



2001-2004. When general opinion agreed that the necessary preconditions for transition to the explicit inflation targeting regime had occurred, the year 2005 was announced as this transition period. In this year, implicit inflation targeting continued as in the previous three years under the floating exchange rate regime, and it was intended to increase the efficiency of the interest rate policy by taking monetary aggregates into account, despite the fact that the nominal anchor of the program was monetary-based.

As can be seen in Figure 1, in January 2006, the Central Bank started an explicit inflation targeting regime, whose basic element is the floating exchange rate regime. Only inflation targets are considered in interest rate decisions, which is the main policy tool in this exchange rate regime. In the inflation targeting regime, short-term interest rates are used as the operational target and expected inflation is used as a medium-term target. (Gobakan Onder, 2008: 29)

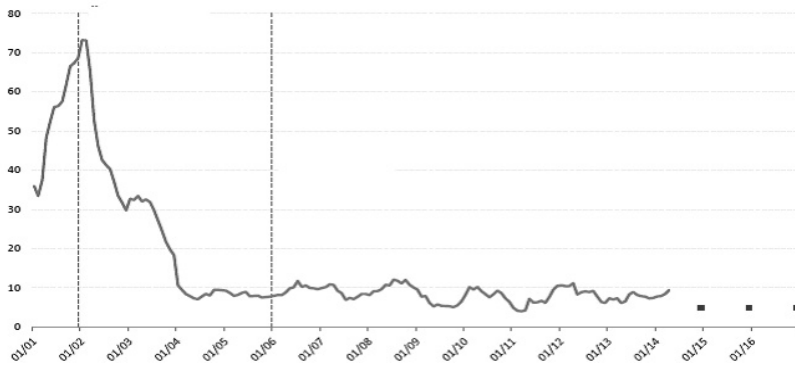


Figure 1: Inflation Rate (%) (2001-2014) (Central Bank, June 2014)

A sudden drop in housing prices in the USA led to collateral and repayment problems in residential mortgage loans. Especially, unreturned "sub-prime" loans caused banks to encounter resource problems. This financial liquidity shortage caused the financial sector to end up at a standstill, more so than the real economy.

Following the global financial crisis which began in 2008, monetary policy applications have shown a great change both in Turkey and around the world. Central banks, who had used Taylor-like short-term interest rate based policies in order to achieve their primary objective of price stability since the 1990s, started to abandon traditional monetary policy applications because of the deepening crisis, the sudden stoppage of the

real economy and the impossibility of further decreases in interest rates. Central banks have shifted to different monetary policy tools to ensure economic recovery. These tools can be summarized under five main headings: Quantitative Easing (QE), Credit Easing (CE), Interest Commitment Policy, Required Reserve Ratio and Interest Rate Corridor.

Quantitative easing is an asset purchase policy aimed to increase market liquidity when interest rate policy can no longer work. This policy has been applied by the FED, ECB and the BoJ due to the impossibility of further interest rate cuts. However, it leads to increased economic volatility in developing countries. Capital investment mobility to developing countries with high risk and return leads to appreciation of national currency, causing negative pressure on exports and inflation. In this context, countries like China, Brazil and Korea have argued that QE implemented by the FED caused monetary and trade wars.

Credit easing policy is the process of exchanging commercial securities in the market with treasury bills having the same maturity. While this process does not affect the central bank balance sheet size or maturity, it affects the risk premium since a more liquid and less risky instrument is presented to the market.

Interest rate commitment policy is an implicit or explicit way of committing to a low interest rate for a certain period of time for market players, policy-based expectation management depends on central bank reliability.

Since reserve requirement policies directly affect banking sector liquidity, they are not frequently used. In the post crisis period, in addition to Turkey's, the central banks of Argentina, Bulgaria, Peru, Uruguay, Romania, Indonesia, China, Croatia, and Colombia used reserve requirement ratios in the context of macro-prudential policy measures. (Lim et al., 2010)

There is a triple interest rate corridor system where the band between the overnight borrowing and lending and policy rates can be considered as approximately the mid-point of the band policy. In the full-corridor system, there is an attempt to control exchange rates by widening/narrowing the interest rate band, rather than just responding directly to interest rates and doing so without any usage of open market operations.

While this system was used by Canada, Great Britain, Japan, the ECB, Norway, Australia, Sweden and New Zealand before the global crisis, it was also used by countries such as Indonesia, Poland, Romania, Hungary, Serbia, Turkey and Iceland. (Vural, 2013)

The Central Bank of Turkey was one of the early adopters of "easing the process", by reducing interest rates in November 2008. Turkey's recent crisis experiences may have affected that swift movement.

On 18 January 2011, CBRT former President Durmus Yilmaz in his speech in Vienna, titled; "The Emerging Friendly Policy Mix Seeking: Global Financial Crisis" mentioned the changing economic environment of central banks as the "new normal" and emphasized that policies applied against crises should be country-specific and "creative". In this context, he also stated that an effective policy mix with a high required reserve ratio, low policy interest rates and a broader interest rate corridor is thought to be effective against macro imbalances due to short-term capital inflows (Yilmaz, 2011). In line with this statement, the CBRT has gradually reduced the borrowing rate to 6.50% in order to reduce interest rate volatility, and it has also narrowed the interest rate corridor. Additionally, they funded the markets during the day and sterilized excess liquidity with O/N transactions. Alternative policy mix has been developed in order to control the increased debt ratios and current account imbalances caused by the global capital inflows in the pre-crisis period.

Within this framework, starting from 24 October 2008, the CBRT decided to inject foreign exchange liquidity into the market through foreign exchange auction sales under the basic principles of the floating exchange rate regime, to avoid any decrease in liquidity in the banking sector. Through the foreign exchange deposit operations which resumed in October 2008, both the banks' foreign exchange deposit market transaction limits and maturities were gradually extended. The TL required reserve ratio was reduced. Moreover, with the amendments to the Communiqué on the Required Reserves dated 10/2010, financial institutions were allowed to hold an announced portion of the reserves as gold or foreign currency (FX) with the mechanism known as ROM. Via this application, both the banks' liquidity management options and also the CBRT's gross foreign exchange reserves increased.

To sum up; the CBRT included alternative strategies such as interest rate corridor, reserve requirement, and the ROM-ROK mechanism along with traditional interest rate policies within the framework of effective crisis management. In this way, the effectiveness of CBRT policies has been increased.

## **4. Data and Methodology**

### **4.1. Data**

In order to test the effects of the CBRT's new wave of policies we wanted to select a single variable that could react to any policy change both immediately and independently from the CBRT's direct control, and

also be different from traditional instruments such as repo, etc. O/N interbank rates (weighted arithmetic mean of actual two-sided transactions) and two-sided transaction volume data from between 25.09.1990 and 03.04.2014 (workdays) was obtained from the CBRT's electronic data distribution system (EVDS), corresponding to 5893 observations. To obtain the series, natural logarithms are taken as follows:

$$y_t = \ln(i_t / i_{t-1})$$

## 4.2. Methodology

### MS-GARCH Models

The GARCH model was introduced by Engle (1982) and Bollerslev (1986) where conditional volatility is a linear function of lagged squared residuals and lagged conditional volatility. Markov Switching-GARCH (hereinafter referred to as MS-GARCH) is the extension of the basic GARCH model by allowing structural breaks in its parameters over time. Expressing the GARCH model with the hidden Markov chain, which allows each regime to show different behavior, extends the main model's dynamic nature and increases the ability to adopt more complex structures. However, a significant drawback of the models constructed in this way is that volatility estimation under regime change requires information for the entire process. In order to overcome this problem, Cai (1994) and Hamilton and Susmel (1994) proposed the MS-ARCH model, to capture the effects of sudden shifts in the conditional variance. The Hamilton and Susmel model assumes three regimes explaining low, moderate and high volatility.

On the other hand, Gray (1996), Dueker (1997), Klaassen (2002) and Haas et al. (2004) proposed different versions of the MS-GARCH model. Gray suggests integrating out the unobserved regime path in the GARCH term by using the conditional expectation of the past variance. In other words, in Gray's model, conditional variance in any regime depends on its expected value in the previous period rather than its actual value. Klaassen (2002) extended Gray's model by allowing the expected value of conditional variance in the previous period to depend on the current regime and observations. He developed the conditions for stationarity of the model for the special cases of the two regimes.

As stated in Bildirici and Ersin (2014), the MS-ARMA-GARCH model, where regime switching behavior is governed by a Markov Chain, can be defined as follows:

$$y_t = c_{(s_t)} + \sum_{i=1}^r \theta_{i,(s_t)} y_{t-i} + \varepsilon_{t,(s_t)} + \sum_{j=1}^m \varphi_{j,(s_t)} \varepsilon_{t-j,(s_t)}$$

$$\sigma_{t,(s_t)}^2 = w_{(s_t)} + \sum_{i=1}^p \alpha_{i,(s_t)} \varepsilon_{t-i,(s_t)}^2 + \sum_{j=1}^q \beta_{(s_t)} \sigma_{t-j,(s_t)}$$

where,

$$\varepsilon_{t-i-1,(s_{t-i})} = E \left[ \varepsilon_{t-i-1,(s_{t-i-1})} \mid s_{t-i}, Y_{t-i-1} \right] \text{ and}$$

$$\sigma_{t-i-1,(s_{t-i})} = E \left[ \varepsilon_{t-i-1,(s_{t-i-1})} \mid s_{t-i}, Y_{t-i-1} \right]$$

$s_t$  determines the regimes:

$$L = \prod_{t=1}^T f(y_t \mid s_t = i, Y_{t-1}) \Pr[s_t = i \mid Y_{t-1}]$$

and the probability  $\Pr[s_t = i \mid Y_{t-1}]$  is calculated through iteration,

$$\begin{aligned} \pi_{jt} &= \Pr[s_t = j \mid Y_{t-1}] \\ &= \sum_{i=0}^1 \Pr[s_t = j \mid s_{t-1} = i] \Pr[s_t = j \mid Y_{t-1}] \sum_{i=0}^1 \eta_{ji} \pi_{it}^* \end{aligned}$$

Consequently, the Henneke et al. (2009) and Francq and Zakoian (2002) models diversify through the definitions of  $\varepsilon_{t-1}^2$  and  $\sigma_{t-1}$ . In the next part, the derived model will be extended by adding asymmetric power terms and fractional integration.

### MS-ARMA-APGARCH Model

Liu (2007) proposes a generalization of the MS-ARMA-GARCH model, allowing a nonlinear relationship among past shocks and future volatility in stock markets. Haas (2008) extended Liu's study with an easier model of representation to obtain unconditional moments as well as the dynamic autocorrelation structure of the power-transformed absolute error terms which can also be taken as a measure of volatility.

According to the model by Haas (2008), it is assumed that the time series  $\{\varepsilon_t, t \in \mathbf{Z}\}$  follows a  $k$  regime MS-APGARCH process, such that;

$$\varepsilon_t = \eta_t \sigma_{\Delta_t, t} \quad t \in \mathbf{Z}, \quad \text{where } \{\eta_t, t \in \mathbf{Z}\} \text{ is the i.i.d. sequence and } \{\Delta_t, t \in \mathbf{Z}\} \text{ is a Markov chain with finite state space } S = \{1, \dots, k\} \text{ and } P \text{ is}$$

the irreducible and aperiodic transition matrix with typical element  $p_{ij} = p(\Delta_t = j | \Delta_{t-1} = i)$  so that

$$P = [p_{ij}] = [p(\Delta_t = j | \Delta_{t-1} = i)], \quad i, j = 1, \dots, k.$$

$$\sigma_{jt}^\delta = w_j + \alpha_{1j} |\varepsilon_{t-1}^+|^\delta + \alpha_{2j} |\varepsilon_{t-1}^-|^\delta + \beta_j \sigma_{j,t-1}^\delta, \quad \delta > 0,$$

Conditional variance  $\sigma_{jt}^2$  of the  $j^{\text{th}}$  regime follows a univariate APGARCH process, as stated in Liu (2007), where,  $w_j > 0, \alpha_{1j}, \alpha_{2j}, \beta_j \geq 0, j = 1, \dots, k$ . For the power term  $\delta = 2$  and for  $\alpha_{1j} = \alpha_{2j}$ , the model reduces to the MS-GARCH model.

Haas investigated an MS-GARCH model. The Haas (2008) model is similar to Liu's (2007) approach which is explained above. A finite state-space Markov chain is assumed to govern the ARCH parameters in his model, while the autoregressive process is followed by the conditional variance, which is subject to the assumption that past conditional variances are in the same regime.

In the Haas model the asymmetry terms have a differentiated form as,

$$\sigma_{jt}^\delta = w_j + \alpha_j (|\varepsilon_{t-1}| - \gamma_j \varepsilon_{t-1})^\delta + \beta_j \sigma_{j,t-1}^\delta, \quad \delta > 0, \quad \text{where } 0 < w_j, \alpha_j, \beta_j \geq 0, \gamma_j \in [-1, 1] \text{ with regimes } j = 1, \dots, k.$$

If  $\alpha_{1j} = \alpha_j (1 - \gamma_j)^\delta$  and  $\beta_j = \alpha_j (1 + \gamma_j)^\delta$  the MS-APGARCH model of Haas (2008) reduces to Liu's (2007) MS-APGARCH specification.

The model specification in this study assumes that the conditional mean follows an MS-ARMA process. In addition to this, conditional variance follows regime switching behavior as in GARCH-type models. Accordingly, the MS-ARMA-APGARCH model is derived from the MS-ARMA process in the conditional mean and the MS-APGARCH ( $l, m$ ) conditional variance process as follows,

$$\sigma_{t,(s_t)}^{\delta(s_t)} = w_{(s_t)} + \sum_{l=1}^r \alpha_{l,(s_t)} (|\varepsilon_{t-l}| - \gamma_{l,(s_t)} \varepsilon_{t-l})^{\delta(s_t)} + \sum_{m=1}^q \beta_{m,(s_t)} \sigma_{t-m,(s_t)}^{\delta(s_t)}, \quad \delta_{(s_t)} > 0$$

where  $(s_t)$  governs the regime switches and the parameters are restricted as  $w_{(s_t)} > 0, \alpha_{l,(s_t)}, \beta_{m,(s_t)} \geq 0$  with  $\gamma_{l,(s_t)} \in (-1, 1), l = 1, \dots, r$ . As shown above, MS-ARMA-APGARCH models allow the power

parameters to vary across regimes. The model can be reduced to the Haas (2008) model if the restrictions  $l=1, j=1, \delta_{(s)} = \delta$  are applied.

A fractional integration property of the financial time series due to possessing a long memory will be introduced to the MS-ARMA-APGARCH model given above.

## 5. Results

At the first stage, GARCH and APGARCH models are estimated to be treated as baseline models for evaluation purposes.

**Table 1. Baseline Volatility Models**

BASELINE GARCH MODELS, SINGLE REGIME						
<b>GARCH</b>	<b>ARCH</b>	<b>GARCH</b>			<b>C</b>	<b>Log L</b>
	.10762535 (.0023957)	.8218867 (.00135)			.0013448 (0.00156)	-2538.518
<b>P GARCH</b>	<b>ARCH</b>	<b>GARCH</b>	<b>POWER</b>			<b>Log L</b>
	.0690949 (.0024461)	.9279289 (.0020859)	1.973593 (.0786873)		.0012824 (.0001218)	-2040.31
<b>APGARCH H</b>	<b>APARCH</b>	<b>APARCH_E</b>	<b>PGARCH</b>	<b>POWER</b>	<b>C</b>	<b>Log L</b>
	.0114318 (.002812)	.9288347 (.0274917)	.8320446 (.0016728)	1.96139 (.0701984)	.0014204 (0.000567)	-1989.48

According to the baseline model results, which do not take regime switching into consideration, all ARCH and GARCH parameters are positive and their sum is smaller than 1. Hence, the stability condition is met. The GARCH effect dominates the ARCH effect in all models. High GARCH impact indicates that the conditional variance was influenced more by the previous variance compared to the previous periods. Low GARCH impact refers to the fact that information entering the market has less impact on the volatility compared to the previous periods.

In this context, the volatility shocks caused by liquidity arrangements of the CBRT show persistence. Moreover, power coefficients are 1.96139 and 1.97 in the PGARCH and APGARCH models.

Details of this asymmetry term reveal that the estimated coefficient was negative and very significant for each market. Although the magnitude of the asymmetric response to past shocks seems to vary from one market to another, the inclusion of the power term proves useful in all cases.

Despite the additional flexibility brought about by estimation of the power, it can be observed that the obtained level of volatility persistence is very high with the PGARCH(1,1) model and comparable to the results obtained with the classical GARCH(1,1) and APGARCH(1,1) models. An interesting result is the proximity to the GARCH coefficients of the GARCH(1,1) and PGARCH(1,1) models.

The existence of a high persistence level could be the result of structural breaks caused by the change of CBRT policy. The Ljung-Box statistics determine that neither the GARCH nor the APGARCH single-regime models are rich enough to suppress all symptoms of heteroskedasticity in high-order transformations of the standardized residuals.

According to the log-likelihood statistic, the APGARCH model performs better as it shows a better fit.



Table 2. Nonlinear Models

	GARCH	Power	ARCH	Constant	P_{1 1}	P_{2 2}	P_{3 3}	LogL	LR	
<b>MS-GARCH</b>			0.0686 (.00228)	0.0012 (.00004)						
	<b>Reg 1.</b>	0.8276 (0.001305)								
	<b>Reg 2.</b>	0.845 (0.013415)		0.01192(.00420)						
<b>Reg 3.</b>	0.8128 (0.00129)		0.0684 (.00227)	0.00126 (.00004)	.8213	.866	.919	1878.8152	4700.1427	
<b>MS-PGARCH</b>		<b>Power</b>	<b>ARCH</b>	<b>Constant</b>	<b>P_{1 1}</b>	<b>P_{2 2}</b>	<b>P_{3 3}</b>	<b>LogL</b>	<b>LR</b>	
	<b>Reg 1.</b>	82.10025 (.0238611)	0.4582 (.01009)	.849862 (.0835933)						
	<b>Reg 2.</b>	40.88517 (.0017772)	.306423 (.00303)	.278129 (.00276)						
	<b>Reg 3.</b>	81.79289 (.0020859)	1.973593 (.078687)	.0559095 (.00245)	.001282(.00012)	.8780	.9011	.9200	1745.6604	4413.0403
		<b>GARCH</b>	<b>Power</b>	<b>ARCH</b>	<b>Constant</b>	<b>P_{1 1}</b>	<b>P_{2 2}</b>	<b>P_{3 3}</b>	<b>LogL</b>	<b>LR</b>
	<b>Reg 1.</b>	0.82218 (0.00206)	1.960 (0.0768)	0.0693 (.00236)	0.00129 (.00013)					
<b>Reg 2.</b>	0.8145 (0.0134)	1 (0.000198)	0.0294 (.0063)	0.0119 (.0042)						
<b>Reg 3.</b>	0.8008 (0.00204)	1.941 (0.0767)	0.0691 (.00235)	0.00131 (.000123)	.8480	.8748	.9236	1823.9379	4508.9703	

\*standard errors are in parentheses.

Three regimes are taken into consideration. According to the estimation results, MS-GARCH model transition probability results are calculated as 0.8213, 0.866 and 0.919, showing persistence in regimes. All three model results exhibit persistence such that while diagonal transition matrix values are between 0.80 and 0.95, regime switching values are lower in other dimensions. According to the estimation results of the MS-PGARARCH model, regime 1 lasts approximately 8.19 months, regime 2 lasts 10.11 months and regime 3 lasts 12.49 months. In the same way, in the MS-APGARARCH model regime 1 lasts approximately 6.58 months, regime 2 lasts 7.99 months and regime 3 lasts 13.09 months. The null hypothesis of no GARCH effects is rejected according to residual tests at a 1% significance level. In the MS-PGARARCH model, regime 2, the value of the persistence parameter decreases.

Statistical inference regarding the empirical validity of the regime switching process was carried out by using nonstandard LR tests. The LR is an approximate chi-square distributed statistic, comparing two nested models. Likelihood Ratio statistics are used for testing a linear specification versus the Markov switching model. The nonstandard LR test is statistically significant and this suggests that linearity is rejected.

The MS-APGARARCH model provides such an asymmetric term through the parameter which is allowed to vary from one regime to another. The significant asymmetric effect is present in both regimes. The level of asymmetry changes according to the regime.

Market participants can differentiate less between good and bad news when they are in an extremely volatile period. Our MS-APGARARCH model also relies on direct estimation of the power parameter for each regime as proposed by Ane and Ureche-Rangau (2006).

In Table 2, the level of persistence within regimes was dramatically reduced and in the MS-APGARARCH model, the persistence of previous shocks represents an important source of volatility persistence that comes in addition to the high persistence of both regimes.

## 6. Conclusion

This study used the MS GARCH-APGARARCH method in order to analyze the effects of CBRT monetary policy strategies applied in the post 2008 crisis period over liquidity.

In order to test the effects of the CBRT's new wave of policies, we created the O/N interbank rate and two-sided transaction volume series by taking natural logarithms. Three regimes were considered. Based on the series of our empirical results it is suggested that the volatility shocks

caused by the liquidity arrangements of the CBRT show regime persistence. Along with regime persistence, the persistence of previous shocks is also an important source of volatility persistence. According to the power coefficient (which is close to 2) market participants can differentiate less between good and bad news when they are in an extremely volatile period.

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