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ESTIMATING THE VOLATILITY OF DEPOSIT BANKS' CREDIT STOCK WITH A SWARCH MODEL

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Abstract

In this study, the volatility of deposit banks' credit stock in Turkey is investigated by using weekly data from June 2000 through June 2007. To determine the high and low volatility states, two state switching autoregressive conditional heteroscedasticity (SWARCH) models are estimated. The economic and political events that resulted in high volatility in credit stock volume are also analyzed. Results show that volatility of credit stock volume in Turkey is sensitive to domestic government bonds' interest rate and foreign portfolio investments. The volatility of credit stock volume is also affected by political events.

Key Words *: Credit Stock Volume, Volatility, SWARCH*

Özet

Bu çalışmada Haziran 2000 – Haziran 2007 tarihlerini kapsayan haftalık veriler aracılığıyla Türkiye'deki mevduat bankalarının kredi hacmindeki volatilitesi incelenmiştir. Yüksek ve düşük volatilite durumlarını belirlemek için iki aşamalı switching otoregresif koşullu heteroskedastisite (SWARCH) modeliyle tahmin yapılmıştır. Ayrıca kredi hacminde yüksek volatiliteye neden olan ekonomik ve politik olaylar da analiz edilmiştir. Sonuçlar, Türkiye'de kredi hacmindeki volatilitenin yurtiçi devlet kağıtlarının faiz oranına ve yabancı portföy yatırımlarına duyarlı olduğunu göstermiştir. Kredi hacmindeki volatilite politik olaylardan da etkilenmektedir.

Anahtar Kelimeler: *Kredi Hacmi, Volatilite, SWARCH*

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1. Introduction

Many papers concerning volatility have evaluated events in the international financial markets. Especially after the 1970s, in conjunction with the collapse of the Bretton Woods System, the liberalization of capital movement and implementation of a flexible exchange rate system have created volatility in some areas of economies. Exchange in deposit banks' credit stock is affected by financial liberalization, which is an explanatory factor in the international arena. In the national arena, economic factors are important, although political factors also have a significant effect.

Deposit banks' credit stock has a place among some important indicators in economics. The aim of this study is to determine the periods of time which have had high volatility in deposit banks' weekly credit stock in Turkey between 2000-2007, in order to determine the reasons for that volatility and to determine the relationship between volatility in consumer credit and macroeconomic variables.

The second part of the study investigates the extant literature related to deposit banks' consumer credit. The third part of the study discusses the basic features of the data set used in this study. In the fourth part, the SWARCH Model is chosen and explained as a volatility model. In the fifth part, deposit banks' consumer credit stock volatility in Turkey is estimated with the SWARCH model, results are reported, and an explanation is provided for the volatility, using national and international events.

The main contribution of this study is that it is the first study to examine the volatility of consumer credit in Turkey and the first to use a SWARCH Model econometrically.

2. Literature

The topics that are focused on consumer credit have been amply debated in the literature. Brady's (2006) study investigated whether there was a structural break in consumer credit between 1959 and 2005 and found a structural break in the 1990s. D. He etal.'s (2005) study examined the development of consumer credit after the Asian Crisis in 1997 and came to the conclusion that, after the crisis, there was a sharp increase in consumer credit and credit cards. Studies in this area to date have largely focused on precautions that the financial credit institutions must take against increased credit demand by taking risk factors into account, and arrangements that the government must make regarding the infrastructure of the financial sector. Corudego and Meullebauer (2005) investigated the change in consumer credit conditions from 1975 to 2001 in the United Kingdom and empirically determined that the use of the Consumer Credit Index1 began to be widespread in 1980. Hillebrand and Koray (2006) analyzed the relationship between the number of home mortgage loans and mortgage interest rates for 1971 through 2001 and found that there is a positive relationship between these two variables because, in times of high interest volatility, households disinvest in government securities and invest in real assets, increasing the number of mortgage loans. Galindo and Micco (2005) investigated

[1] Credit Condition Index is used in consumption literature and is needed to measure credit appropriateness.

the relationship between creditor protection and credit cycle in 139 countries between 1990 and 2003 and found support for the argument that better legal protections significantly reduce the impact of exogenous shocks on credit. Therefore, Galindo and Micco (2005) stressed that legal and institutional arrangements were extremely important for credit markets. Hale, Razin and Tong (2007) used data for 40 countries from 1984 to 2004 to study how creditor protection affects the volatility of stock market prices and found support for the hypothesis that institutions that help reduce the probability of oscillation between binding and non-binding states of the credit constraint also reduce asset price volatility. Mendicino (2007) investigated the role of credit market size as a determinant of business cycle fluctuations in OECD countries and found a reduction in productivity-driven output volatility implied by the established size of the credit market observed in OECD data.

Deposit banks' credit stock volatility has not been investigated directly, so the current study can fill an important deficiency in the literature. The most important constraint is that the paper deals only with Turkey, but it also investigates the effects of political and economic developments on credit stock volatility.

3. Data

The data for this study is weekly data of deposit banks' consumer credit stock volume from June 2, 2000, to June 29, 2007, so there are 370 observations in the sampling period. The data are taken from the Electronic Data Delivery System of Central Bank of the Republic of Turkey (TCMB). Logarithmic change of credit stock volume, GCREDITt, is calculated as follows:

$$GCREDIT_t = 100 \times (\ln CREDIT_t - \ln CREDIT_{t-1}) \qquad (1)$$

where CREDITt, is total credit stock volume at time t. Figure 1 shows these series, and some statistical properties of data are presented in Table 1. According to the ADF test results shown in Table 2, logarithmic change of credit stock volume has no unit root. Thus, it can be concluded that the GCREDITt series is stationary.

Figure 1: Total Credit Stock and Total Credit Stock Logarithmic Change Series (Weekly Data)

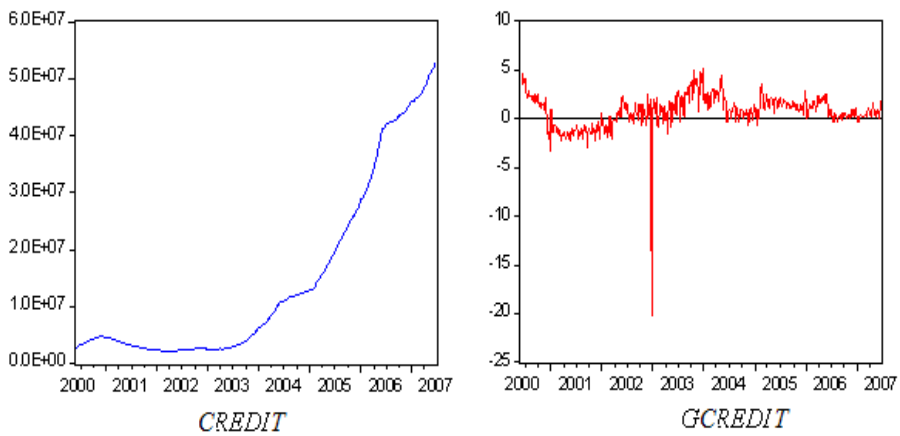


Table 1: Summary Statistics of Variables

	$CREDIT_t$	$GCREDIT_t$
Observation	370	369
Mean	14795463	0.8137
Minimum	2064935	-20.293
Maximum	53582046	5.169
Standard Deviation	15810250	1.845
Skewness	1.112	-3.982
Kurtosis	2.758	47.836

Table 2: Unit Root Test for Logarithmic Change of Credit Stock Volume

	Augmented Dickey-Fuller			Phillips-Perron		
	N	C	C&T	N	C	C&T
Test	-2.948*	-3.245**	-3.625**	-13.762*	-15.395*	-15.307*
AR(1)	-0.146*	-0.187*	-0.219*	-0.459*	-0.546*	-0.571*
Constant		0.123	-0.099		0.434*	0.054
Trend			0.001			0.002*

*significant at 0.010 ** significant at 0.05 N: No constant or trend C: Constant C&T: Constant and trend

4. Switching Arch Model (SWARCH)

The Auto Regressive Conditional Heteroscedasticity (ARCH) Model, which was developed by Engel (1982), is used particularly in financial time-series modeling, although estimations of ARCH parameters are affected by structural changes (Lamoreux and Lastrapes, 1990). Switching to the ARCH (SWARCH) Model, which was developed by Hamilton and Susmel (1994), enables us to work in a framework so that ARCH parameters can vary in different states. The most important advantage of this model is that it allows estimation of unobservable state variables with other parameters. The SWARCH Model used in this study is represented as follows:

$$GCREDIT_t = c + e_t \quad (2)$$

$$e_t = u_t \sqrt{g(s_t)} \quad (3)$$

$$u_t = h_t^{1/2} \varepsilon_t \qquad \varepsilon_t \sim N(0,1) \quad (4)$$

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i u_{t-i}^2 \quad (5)$$

where $GCREDIT_t$ represents the logarithmic change of credit stock volume and C is the conditional mean. e_t is the serially uncorrelated deviation term which represents the deviation of logarithmic change of credit stock volume from its conditional expectation and follows the ARCH process with h_t, conditional variance. ε_t is a Gaussian white noise series with mean zero and constant variance. h_t, the conditional variance, depends on squared lag values of u_t. s_t is the unobserved state variable, $s_t = 1, 2, 3, \ldots, K$, which indexes the volatility regime. $g(s_t)$ is a constant variance factor that scales the ARCH process. Equations (2), (3) (4), and (5) describe a SWARCH (K,q) model. In the case of a two-state Markov process, state transition probabilities can be shown by using equation (6):

$$\begin{aligned} &P(s_t = 1 \mid s_{t-1} = 1) = p_{11} \\ &P(s_t = 2 \mid s_{t-1} = 1) = 1 - p_{11} \\ &P(s_t = 2 \mid s_{t-1} = 2) = p_{22} \\ &P(s_t = 1 \mid s_{t-1} = 2) = 1 - p_{22} \end{aligned} \quad (6)$$

where, p_{ij} is the probability that state i, is followed by state j.

The main assumption in switching models is that the change of distribution results in rapid changes in the variables. Unobserved state variables, st, show which distribution generates the sample. The aim is to determine the probability that observations come from a particular distribution.

5. Estimation Results

The SWARCH Models shown by using equations (2), (3) (4), and (5) are estimated by the maximum likelihood estimation method. The results are presented in Table 3. All parameters of the SWARCH(2,1) model are statistically significant, but parameter α_2 in the SWARCH(2,2) model is not statistically significant2. However, the estimations of transition probabilities are the same in both models. To compare the models, both SWARCH(2,1) and SWARCH(2,2) estimation results are presented in Table 3. From the estimates, the expected duration of each volatility state can be calculated as $(1/1-p_{ij})$. In

[2] We include additional lags in conditional variance equations but we cannot estimate statistically significant parameters.

this study, the expected duration of the low-volatility state is 63 weeks, while the duration of the high-volatility state is 30 weeks. The g_2 variance factor is statistically significant and estimated as 12.922, which means that the high-volatility state is 12.922 times more volatile than the low-volatility state.

Table 3: Estimation Results of SWARCH Models

Parameters	SWARCH(2,1)	SWARCH(2,2)
C	0.968(0.056)	0.966(0.057)
α_0	0.680(0.094)	0.676(0.097)
α_1	0.121(0.074)	0.126(0.075)
α_2	-	0.0005(0.042)
g_2	12.922(1.781)	12.992(1.871)
p_{11}	0.984	0.984
p_{22}	0,967	0.967
L	-642.668	-642.647
Persistence	0.121	0.1265

* L shows maximum likelihood functions. Volatility persistence is calculated by adding coefficients of squared lag variables in conditional variance equations. ** Standard errors are in parenthesis.

Figure 2 shows the probability of a high-volatility state for the SWARCH(2,1) model, and Figure 3 shows both the probability of high-volatility states and the logarithmic credit stock volume change for SWARCH(2,1). The weeks in which the credit stock volume change volatility is high can be detected by investigating the probability series. The high-volatility periods are reported in Table 4.

Figure 2: Probability of High Volatility States for SWARCH (2,1) Model

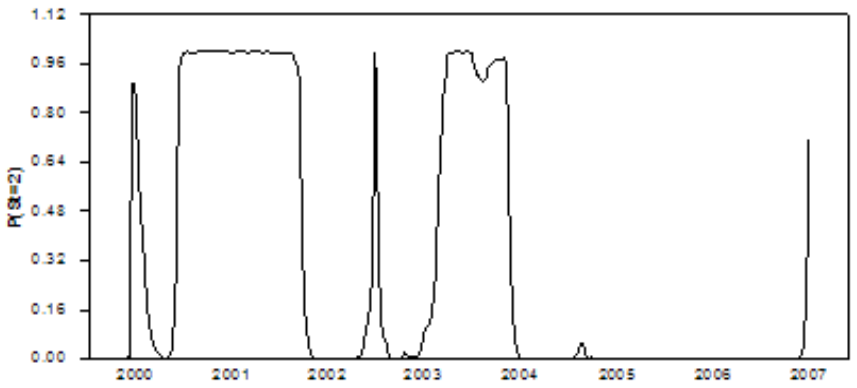


Figure 3: Credit Stock Logarithmic Change and Probability of High Volatility States for SWARCH (2,1) Model

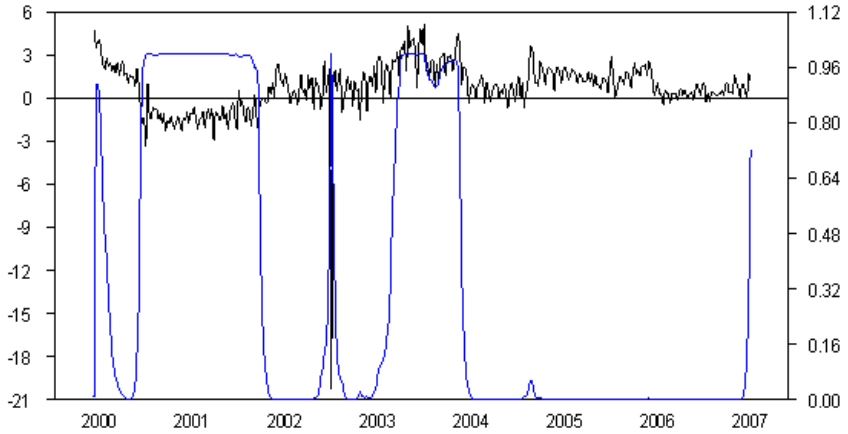


Table 4: High Volatility Periods

Period	Week numbers
06.16.2000-07.14.2000	5
12.08.2000-03.22.2002	68
12.20.2002-01.03.2003	3
08.22.2003-05.14.2004	39
06.29.2007	1

The main advantage of switching models is that it reveals the volatility state (high or low) of the variable over time so political and economic events can be related to volatility (Bautista, 2003:315).

Table 4 shows that there were 116 high-volatility weeks in the 370 weeks between 2000 and 2007. These 116 weeks can be separated into 5 different integrated periods; Table 4 sets the start and end dates of these periods in order. The high volatility in these periods can be explained by national and international influences.

One of the most important variables that affect the deposit banks' credit stock is interest rate. Interest rate is one of the fastest indicators that reflect market developments, so it can be used to explain volatility. The interest rates obtained from the Ministry of Treasury reveal that the credit stock volatility becomes high or low after a sharp increase or decrease in interest rates. (Interest rates are affected internationally from international capital movements and nationally from economic and politic events.) Figure 4 shows the movement of domestic government bonds' interest rate (INT) and holdings of foreign investor stock (CAP).

Figure 4: Domestic Government Bonds' Interest Rates and Holding of Foreign Investor Stock

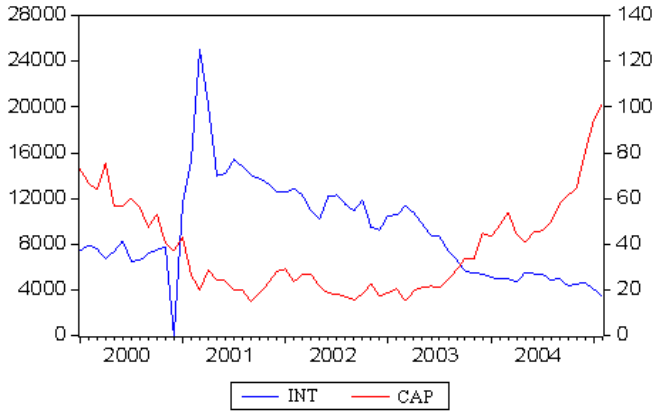
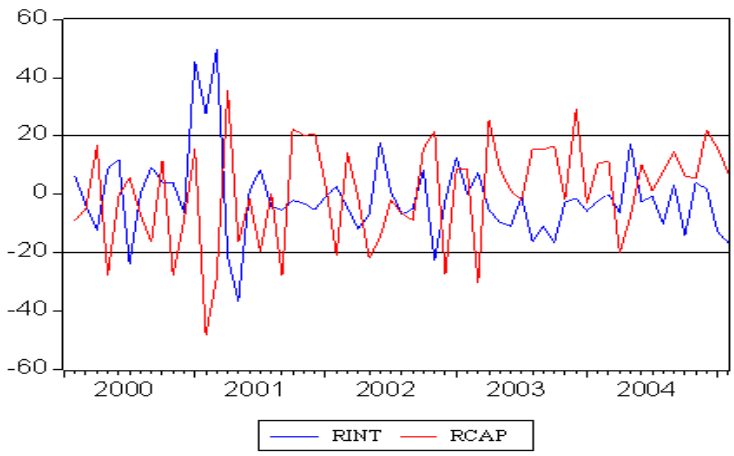


Figure 5 shows that volatility remained at a high level for 5 weeks, from June 16, 2000, to July 14, 2000, and, in this period, domestic government bonds' interest rate increased from 36.8% to 41.5%. A month later, it had decreased to 32.7%. Figure 5 shows the change in interest rate and capital movement. The change in the interest rate was very high, and capital outflow was also high during this period. At the same time, there was a coalition government, with 3 parties, in Turkey, so volatility continued high because of the tension in the coalition government3. (One of the parties' leaders was to be judged at High Court4.)

Figure 5: Logarithmic Change in Domestic Government Bonds' Interest Rates and Holding of Foreign Investor Stock



[3] Radikal Daily Newspaper, May 26 and 3–24 June 2000, http://www.radikal.com.tr

[4] Radikal Daily Newspaper, June 3 2000, http://www.radikal.com.tr/2000/06/03/politika/mhp.shtml

Volatility was also at a high level for 68 weeks from December 8, 2000, to March 22, 2002. At that time, there was a crisis as a result of capital flight in the Turkish banking sector because of a liquidity crisis that increased interest rates to 2000%, deviating the economic programs from their targets and causing a loss of confidence in the markets thorough the end of November 20005. Solutions that were tried to end the crisis were not effective so, in February 2001, the Turkish economy entered a crisis which continued for a very long time, and the effect of this crisis on deposits banks' credit stock was continued high volatility until March 2002. In this period, except for two months that had very high interest rates, the interest rate of domestic government bonds fluctuated between 70% and 61.4%. After March 2002, the interest rate decreased sharply to 54% and high volatility ceased.

The reasons of for high volatility in the 3 weeks between December 20, 2002, and March 3, 2003, were that there were two parties in the Congress after the November 3, 2002, 6 elections, one of which had a high Islamic component. At the same time, the Copenhagen Summit of 11-12 December 2002, was to discuss full membership for Turkey in the European Union7, there was a deadlock in the Cyprus problem8, and there was the possibility of a U.S. attack on Iraq which was accompanied by debates about permitting the U.S. to send its military to Iraq from Turkey9. For a long period, the interest rate of domestic government bonds had leveled off at about 40%, but in this period it increased to 55% and then fell again down to its old level. Figure 5 shows a sharp change in capital outflow and a fluctuation in capital movement and interest rate during this period.

Another long high-volatility period lasted for 39 weeks from August 22, 2003, to May 14, 2004. The reasons for this period of high volatility were unexpectedly high tax revenues because of the peace tax, consolidation of loans from 2004-2005 to 2006 by the IMF, and a reduction in the inflation rate10. Optimistic events in the economy reflected on the domestic government bonds' interest rate, which decreased from 45% to 23.4%, then went up again after May 2004. There was also an increase in foreign portfolio investments: Capital outflow was $5 billion after the 2001 February crisis and continued at the same level until August 2003, which was the date high-volatility began; after that, it increased to $11 billion in 7 months. A sharp increase in capital inflow ended the period of high volatility.

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[5] Net Domestic Assets of TCMB were declined about 3.8 quadrillion TL between 17 November and 1 December 2000. Yeldan, Erinç (2004). Türkiye Ekonomisi, Anadolu University Press, Press No: 1579, p. 223

[6] Radikal Daily Newspaper, November 4 2002, http://www.radikal.com.tr/index.php?tarih=04/11/2002

[7] Radikal Daily Newspaper, December 13, 2002, http://www.radikal.com.tr/index.php?tarih=13/12/2002

[8] Radikal Daily Newspaper, December 1, 2002 – April 17, 2003

[9] Radikal Daily Newspaper, November 1, 2002 – March 2, 2003

[10] Radikal Daily Newspaper, August 4, 2003, http://www.radikal.com.tr/index.php?tarih=04/08/2003 and http://www.radikal.com.tr/haber.php?haberno=83922

6. Conclusion

Deposit bank's credit stock in Turkey between 2000-2007 experienced five periods of high volatility covering 116 weeks out of 370 weeks in the period. The duration of the high-volatility period was low in three of the five periods—the first period lasted 5 weeks, the 3rd period lasted 3 weeks, and the 5th period lasted 1 week—and the duration of the high-volatility period was long in two: the 2nd period, at 68 weeks, and the 4th period, at 39 weeks.

Explanatory factors for the periods of high volatility terms in Turkey were political as well as economic. The first period of high volatility occurred with the break in the coalition government and the possibility of the subversion of the government. Instability in the political arena caused interest rates to rise and brought about high volatility in credit stocks. National and international factors affected the second high-volatility period, when a liquidity crisis in the Turkish banking sector and an economic crisis created the longest period of high volatility. The 2002 elections and the threat of Turkey's not having full partnership in the European Union caused the third period of high volatility, when the reaction of the markets was a sharp increase in interest rate. The fourth high-volatility period appeared as a result of positive developments in the economy: high and permanent direct or indirect capital inflow, consolidation of 2004-2005 loans to 2006 by the IMF, a decrease in the interest rate and a decrease in the inflation rate. The last high-volatility period began on 29 June, 2007.

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