Money Multiplier under Reserve Option Mechanism

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Abstract

This paper introduces a generalized money (M2) multiplier formula to the literature for a monetary system with Reserve Option Mechanism (ROM). Various features of the proposed multiplier are then explored using monthly Turkish data during the decade 2005 to 2015. We report a step increase in the magnitude and a slight upward adjustment in the long-run trend of the multiplier with the adoption of ROM. We provide evidence for substantial change in the seasonal pattern of the multiplier, cash ratio, required and excess reserves under ROM. We show that money (M2) multiplier is less volatile in a monetary system with ROM and discuss the subsequent stabilizing influence of more predictable multiplier on the foreign exchange market.

Keywords: Money multiplier, macroprudential policy, reserve option mechanism, reserve requirements, financial stability

JEL Classification: E51; E52; E58; F31

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I. Introduction

Capital flows, measured by percentage share of GDP, to emerging markets and majority of developing economies have increased more than twofold on average during the five years preceding global financial crisis of 2007-08 (Gallagher & Tian, 2014). Soaring volatility and sudden stops are considered as two fundamental elements of capital flows to emerging markets during and aftermath of global financial crisis. Surges in international capital flows and financial stability concerns led many emerging market central banks to adopt alternative macroprudential policy instruments like reserve requirements and capital requirements.

Reserve requirement ratios have been important monetary policy instruments for many central banks. Federico, Vegh, and Vuletin 2014 reports around two thirds of developing economies have used reserve requirement policies for macroeconomic stabilization purposes in comparison to none industrialized country since 2004. In this research, we focus on Reserve Option Mechanism which we consider as a modern version of reserve requirement policies.

With macroeconomic and financial stability in mind, the Central Bank of the Republic of Turkey (CBRT) developed Reserve Option Mechanism (ROM) an unconventional reserve requirement policy aiming to reduce adverse effects of short term capital flows and exchange rate volatility aftermath of global financial crisis of 2007-08. ROM is a mechanism that allows commercial banks to keep a certain percentage of their Turkish lira required reserves in foreign currencies: USD and Euro, and gold[1]. ROM is considered acting as an automatic stabilizer in the face of external

[1] Foreign currencies that can be maintained for Turkish lira required reserves have been limited to USD only as of August 2014.

imbalances and hence it promises to be a potentially useful reserve requirement policy instrument for macroeconomic and financial stability (Alper, Kara, & Yorukoglu, 2013).

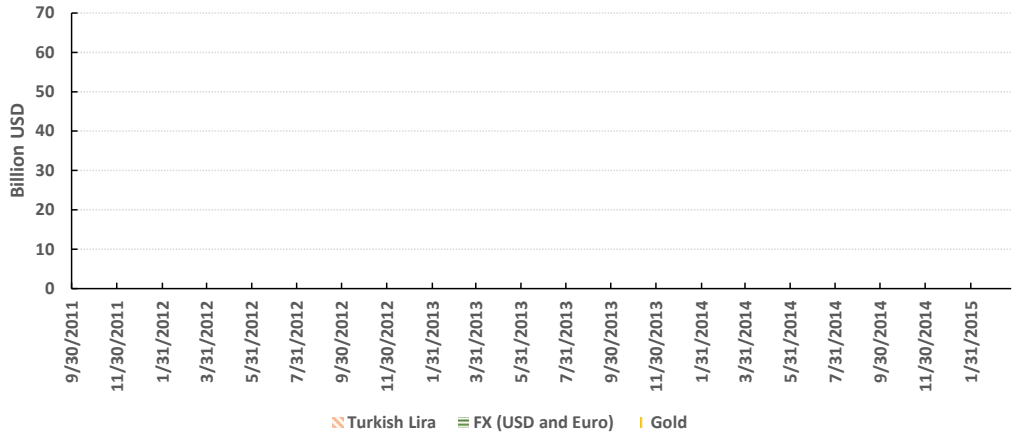
In this paper, we study the behavior of money multiplier in a monetary system where Reserve Option Mechanism is effectively used as a policy instrument. To this end, we analytically derive a generalized money (M2) multiplier formulae and assess the impact of Reserve Option Mechanism on the multiplier and its components. Using Turkish data, we show that money (M2) multiplier increased in a stepwise fashion due to introduction of ROM. We discuss how the rise in the value of the multiplier reinforces the role of ROM as an automatic stabilizing policy tool. In addition, we study seasonal patterns and stability of money (M2) multiplier and its components. We report that seasonal patterns of money (M2) multiplier has changed and money (M2) multiplier became significantly less volatile with the inception of ROM facility to the monetary system.

Figure 1. FX Reserve Option Mechanism Utilization Rates

Notes: Data has biweekly frequency (per-maintenance period) covering the period from 9/30/2011 to 3/27/2015. The diagram shows the FX Reserve Option Mechanism utilization rates for the banking sector.
Source: Electronic Data Delivery System (EDDS) of the Central Bank of Republic of Turkey.

Reserve Option Mechanism (ROM) consists two principal elements: reserve option ratio (ROR) and reserve option coefficients (ROCs) which are both set by the central bank. The upper limit for the proportion of domestic currency required reserves that is allowed to be held in foreign currency (FX) and gold is governed by reserve option ratio (ROR). The amount of FX and gold that can be held against per domestic currency required reserves is called the reserve option coefficient (ROC). Our focus in this research is on FX option of ROM due to the fact that Turkish banking sector has been utilizing FX option under ROM intensively as depicted by Figure 1. Due to Turkish banking sector's approach to FX option, the composition of required reserves held at the central bank has changed dramatically as shown by Figure 2.

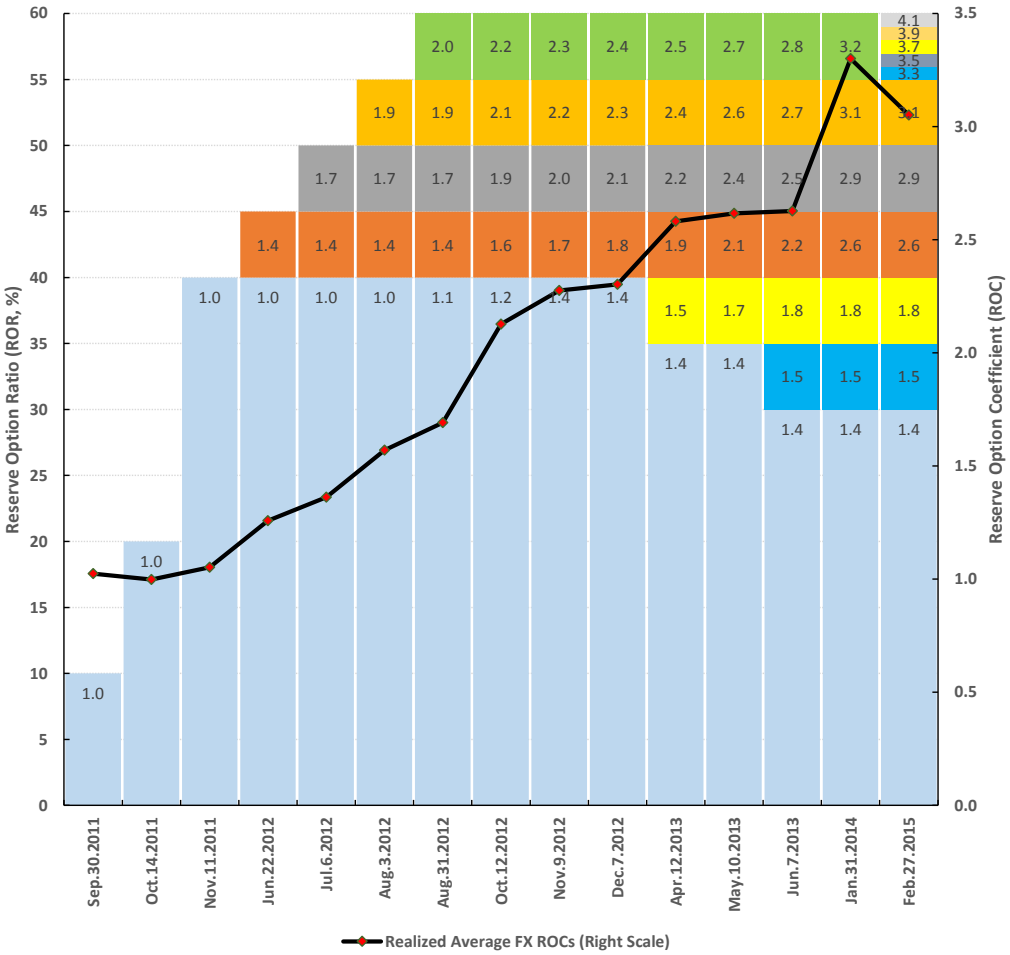
Figure 2. Required Reserves to be maintained for TL Liabilities under ROM



Notes: Data has biweekly frequency (per-maintenance period) covering the period from 9/30/2011 to 3/27/2015.
Source: Electronic Data Delivery System (EDDS) of the Central Bank of Republic of Turkey.

The Turkish central bank has been employing ROM as an alternative macroprudential monetary policy tool quite actively. Figure 3 presents reserve option ratios and the corresponding FX reserve option coefficients since the introduction of ROM in Sept. 2011. The diagram shows that there has been constant amendments in both reserve option ratios and the corresponding FX reserve option coefficients until Mar. 2015.

Figure 3. Evolution of Reserve Option Ratios (ROR) and corresponding FX Reserve Option Coefficients (ROCs)



Notes: Data has biweekly frequency (per required reserves maintenance period) covering the period from 9/30/2011 to 3/27/2015. The figures inside the stacked bar chart show effective foreign exchange (FX) Reserve Option Coefficients (ROCs) and the corresponding tranches as of the given dates (required reserves maintenance periods) on the horizontal axis. For instance, effective FX ROCs as of Aug.31.2012 are 1.1, 1.4, 1.7, 1.9, and 2.0 for the corresponding tranches of 0-30, 30-35, 35-40, 40-45, 45-50, 50-55, and 55-60 percent. The ROCs 3.30, 3.50, 3.70, 3.90, and 4.10 located at the top right corner of the diagram correspond the tranches of 55-56, 56-57, 57-58, 58-59, and 59-60 percent, respectively. The solid black line is obtained by connecting fifteen realized average FX ROC data points for the banking sector for the corresponding fifteen dates (required reserves maintenance periods) on the horizontal axis. Realized average FX ROCs are obtained by taking the ratio of required reserves kept in FX to total required reserves multiplied by the percentage use of FX ROM facility.
Source: Electronic Data Delivery System (EDDS) of the Central Bank of Republic of Turkey.

II. Literature Review

There is a long and established literature on money multiplier that links reserve money to supply of broad money. In this tradition, monetary base is viewed as an important monetary policy instrument through which central banks control the money supply. In modern economics, though, the use official interest rates is considered as the main

policy instrument rather than reserve requirements. Having said that, monetary authorities in emerging economies still use reserve requirements extensively as an accompanying monetary policy instrument.

In contrast to several work on money multiplier, studies on Reserve Option Mechanism (ROM) are not much while the number of studies are on the rise. Alper et al., 2013 introduce Reserve Option Mechanism and explain the way this mechanism function through banks' decision making on reserves. Küçüksaraç and Özel, 2012 compute optimal Reserve Option Coefficients (ROCs), important elements of ROM facility, where they provide evidence for high sensitivity of breakeven ROCs to funds denominated in foreign currency. Değerli and Fendoğlu, 2015 study the impact of ROM in reducing the volatility of foreign exchange expectations. Oduncu, Akçelik, and Ermişoğlu, 2013 show that ROM is an effective policy tool in reducing volatility of Turkish lira.

This paper touches upon two lines of work on money multiplier and Reserve Option Mechanism. There are two recent and closely related studies to current research on ROM. Aslaner, Çıplak, Kara, and Küçüksaraç, 2014 use bank level data where they show variations in banks' ROM utilization rates are mainly explained by variations in short term domestic interest rates. Hence, they argue, counter active policy responses to capital flows, higher/lower interest rates during outflows/inflows, undermine automatic stabilizing feature of the ROM facility. This paper shows that domestic short term interest rates automatically re-adjust upward/downward to some extent during capital outflows/inflows via changes in money (M2) multiplier which in turn depends on banks' utilization rate of the ROM facility. Hence, excessive counter active interest rate policy responses may reduce automatic stabilizing ability of the ROM facility rather than the conduct of interest rate policy itself in response to capital flows.

Unlike Jayaratne and Morgan's, 2000 finding on limited bank lending channel of monetary policy, Alper, Binici, Demiralp, Kara, and Özlü, 2014 find banks' lending behavior respond significantly to reserve requirement induced monetary policy. Alper et al., 2014 produce cost based effective reserve requirement ratio which negatively depends on the banks' utilization rate of ROM facility as long as banks find FX borrowing is less costly than that of in domestic currency. They argue short term borrowing from the central bank is not a close substitute for deposits for banks. Therefore, banks' lending behavior respond significantly to reserve requirements and the introduction of ROM facility. Our research shows that, since reserve requirements under ROM influence banks' lending behavior, broad money supply must be linked to reserve requirements via a modified money multiplier under ROM.

III. Data description and preliminary empirics

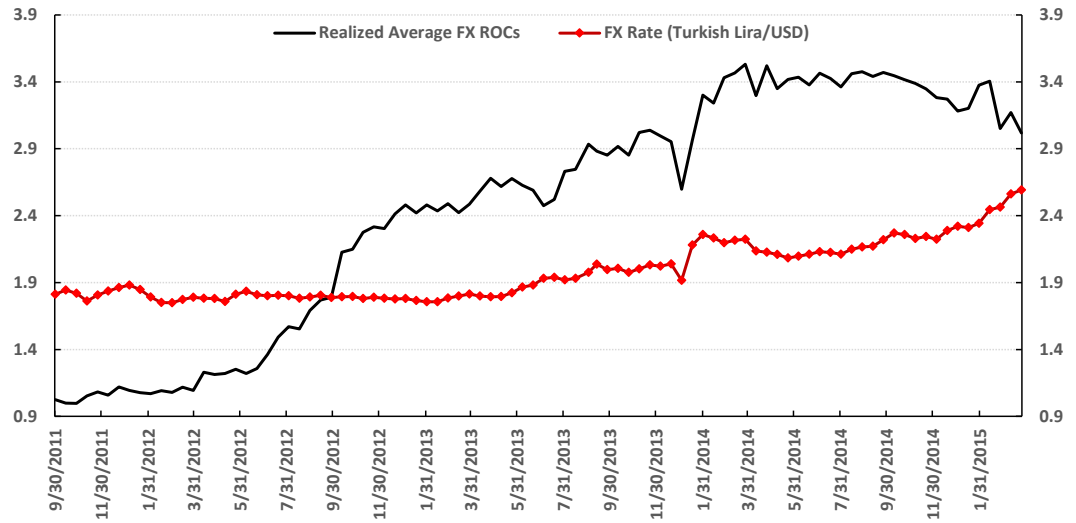
This study uses monthly frequency data from Turkey covering the period of December 2005 to February 2015[2]. All data is secondary and gathered from Electronic Data Delivery System (EDDS) of the Central Bank of Republic of Turkey. Data table in Appendix I reports raw data used to produce diagrams, obtain summary statistics and estimates, and conduct various statistical tests.

We adopt IMF definition of reserve money (monetary base MB) where MB equals to the sum of currency in circulation C, total domestic currency reserves R, and demand deposits of banks held at the Central Bank. In the data table in Appendix I, there is negligible amount of discrepancy between the monetary base MB and the sum of currency in circulation C and total domestic currency reserves R is due to deposits of banks held at the Central Bank. Following the standard definition, money supply (M2)

[2] Unless it is stated otherwise underneath figures, tables etc. given in the text.

is a broad money measure comprising domestic currency in circulation, checkable and time deposits (excluding foreign currency deposits) held by the public at commercial banks and other depository institutions. Time deposits TD consists of one-month, three-months, six-months, one-year and longer deposits. Common reserve requirement ratios $rr_1$and rr_2 applies to domestic currency checkable deposits and time deposits, respectively until January 6, 2011[3]. Time deposits reserve requirement ratio rr_2 is the weighted average of the required ratios for one-month, three-months, six-months, one-year and longer deposits. Monthly interbank money market rates r_t are calculated by taking simple average of the daily weighted averages of interbank overnight (O/N) rates.

Figure 4. Realized Average FX ROCs and FX Rates



Notes: Data has biweekly frequency (per required reserves maintenance period) covering the period from 9/30/2011 to 3/27/2015. The black and red lines show realized average FX ROCs for the entire banking sector and 14-day simple average FX rates (Turkish lira per USD). Realized average FX ROCs are obtained by taking the ratio of required reserves kept in FX to total required reserves multiplied by the percentage use of FX ROM facility.
Source: Electronic Data Delivery System (EDDS) of the Central Bank of Republic of Turkey.

[3] In Press Release No. 2010-41 of Dec. 17, 2010, the CBRT announced the Turkish lira required reserve ratio would be differentiated according to the maturity structure of deposits starting January 2011.

The model in Section IV shows that threshold reserve options coefficients depend on spot exchange rates. To configure these relationship, we use daily nominal spot exchange rate e_t (domestic currency per USD) to obtain 14-day simple averages and monthly rates[4]. The correlation coefficient between realized average FX reserve option coefficients (ROCs) and nominal spot exchange rates is about +0.75 as illustrated by Figure 4.

IV. The model

The existing literature links money supply MS to monetary base MB through money multiplier m. This relationship is usually depicted as following.

$$MS_t = m_t \times MB_t \quad (1)$$

The total amount of reserves R in the banking system equals to the sum of total required reserves RR and excess reserves ER i.e. $R_t = \sum_{i=1}^{i=N} RR_t^i + \sum_{i=1}^{i=N} ER_t^i$ where RR_t^i and ER_t^i stand for required and excess reserves held by bank i at time period t. According to this formulation N banks operate in the banking sector.

Assume reserve requirement ratio on domestic currency checkable deposits D_t^i is $rr_1$and on time deposits TD_t^i is rr_2 where $rr_2 < rr_1 < 1$. Note that how much domestic currency checkable vs. time deposits to be held by public at commercial banks and other depository institutions would depend on market interest rate r. We assume the public hold a fraction of its domestic currency checkable deposits as time deposits i.e. $\sum_{i=1}^{i=N} TD_t^i = \rho(r) \sum_{i=1}^{i=N} D_t^i$ and the public tend to utilize domestic currency time deposits more as market interest rises i.e. $\rho'(r) > 0$. Hence, in a monetary system without

[4] The liabilities subject to reserve requirements are calculated on Friday every two weeks in Turkish banking sector i.e. biweekly required reserves maintenance period applies.

Reserve Options Mechanism (ROM), total required reserves (in terms of domestic currency) in the banking system equals to

$$RR_t = \sum_{i=1}^{i=N} rr_1 \times D_t^i + \sum_{i=1}^{i=N} rr_2 \times TD_t^i = [rr_1 + \rho(r) rr_2] \sum_{i=1}^{i=N} D_t^i \quad (2)$$

Suppose banks hold $k_1(r)$ portion of checkable deposits and $k_2(r)$ portion of time deposits as excess reserves. We assume precautionary demand for excess reserves for checkable deposits is greater than that of time deposits i.e. $k_2(r) < k_1(r)$. Since excess reserves don't earn any interest, excess reserve demand for any given level of checkable and time deposits is negatively related to market interest rates $k_1'(r) < 0$, $k_2'(r) < 0$. Hence, the total excess reserves in the banking system is given by

$$ER_t = k_1(r) \sum_{i=1}^{i=N} D_t^i + k_2(r) \sum_{i=1}^{i=N} TD_t^i = [k_1(r) + \rho(r) k_2(r)] \sum_{i=1}^{i=N} D_t^i \quad (3)$$

Putting equations (2) and (3) give total reserves R (in domestic currency equivalent units) in the banking system as described in equation 4 below.

$$R_t = \{rr_1 + \rho(r) rr_2 + k_1(r) + \rho(r) k_2(r)\} \sum_{i=1}^{i=N} D_t^i \quad (4)$$

In a monetary system with Reserve Option Mechanism the banks are allowed to keep up to reserve option ratio (ROR) of their domestic currency required reserves in foreign exchange (FX) and/or gold. Hence, total required reserves held by the banks wishing to utilize the ROM facility can be written as

$$RR_t = [rr_1 + \rho(r) rr_2] \sum_{i=1}^{i=K} D_t^i \times \left(1 - ROR_t^i\right) + [rr_1 + \rho(r) rr_2] \sum_{i=1}^{i=K} D_t^i \times ROR_t^i \times ROC(ROR_t^i) \quad (5)$$

In equation 5, the first term stands for the total required reserves held in domestic currency whereas the second term shows the total foreign currency or gold held by the banks against domestic currency required reserves (in domestic currency

equivalent units). According to this formulation ROR_t^i stands for utilization rate of ROM by bank i at time period t, and $ROC\left(ROR_t^i\right)$ is the corresponding reserve option coefficient as set by the Central Bank. Any bank i deciding on ROR_t^i at any time period t automatically determines which trench of ROC it must use. This formulation assumes $K \leq N$ banks utilize ROM facility in the banking sector.

Using equation 5 along with equations 3 and 4 give us total reserves at time period t in a monetary system with ROM as described by equation 6.

$$R_t = \left([rr_1 + \rho(r) rr_2] \sum_{i=1}^{i=K} D_t^i \times \left(1 - ROR_t^i\right) + [rr_1 + \rho(r) rr_2] \sum_{i=K+1}^{i=N} D_t^i + [k_1(r) + \rho(r) k_2(r)] \sum_{i=1}^{i=N} D_t^i \right) + \left\{ [rr_1 + \rho(r) rr_2] \sum_{i=1}^{i=K} D_t^i \times ROR_t^i \times ROC(ROR_t^i) \right\} \quad (6)$$

In equation 6, the first term inside large parentheses and the second term inside large curly bracket stand for reserves held in domestic currency and reserves held in foreign currency (in domestic currency equivalent units). According to equation 6, K banks utilize ROM facility whereas $N - K$ banks don't. Because the monetary base MB equals to the sum of total domestic currency reserves and currency in circulation C, we generate equation 7 linking the monetary base to checkable deposits and currency in circulation by dropping the term inside large curly bracket in equation 6 to obtain:

$$MB_t = [rr_1 + \rho(r) rr_2] \sum_{i=1}^{i=K} D_t^i \times \left(1 - ROR_t^i\right) + [rr_1 + \rho(r) rr_2] \sum_{i=K+1}^{i=N} D_t^i + [k_1(r) + \rho(r) k_2(r) + c_t] \sum_{i=1}^{i=N} D_t^i \quad (7)$$

where we assume non-bank public holds fraction c of the total amount of checkable deposits as currency i.e. $C_t = c_t \times \sum_{i=1}^{i=N} D_t^i$.

Inserting equation 7 into equation 1 yields equation 8 linking money supply MS to checkable deposits via money (M2) multiplier m^{ROM} in a monetary system where ROM facility is in use.

$$MS_t = m_{2,t}^{ROM} \times \left[[rr_1 + \rho(r) rr_2] \sum_{i=1}^{i=K} D_t^i \times \left(1 - ROR_t^i\right) + [rr_1 + \rho(r) rr_2] \sum_{i=K+1}^{i=N} D_t^i + [k_1(r) + \rho(r) k_2(r) + c_t] \sum_{i=1}^{i=N} D_t^i \right] \tag{8}$$

Following the standard definition, money supply (M2) is a broad money measure comprising domestic currency in circulation, checkable and time deposits (excluding foreign currency deposits) held by the public at commercial banks and other depository institutions. According to this definition money (M2) supply can be written as following.

$$MS_t = \sum_{i=1}^{i=N} D_t^i + \sum_{i=1}^{i=N} TD_t^i + c_t \sum_{i=1}^{i=N} D_t^i = [1 + \rho(r) + c_t] \sum_{i=1}^{i=N} D_t^i \tag{9}$$

Inserting equation 9 into 8 and solving for $m_{2,t}^{ROM}$ produces money (M2) multiplier under ROM as summarized by equation 10.

$$m_{2,t}^{ROM} = \frac{1 + \rho(r) + c_t}{[rr_1 + rr_2 \rho(r)] \left\{ 1 - \frac{\sum_{i=1}^{i=K} D_t^i \times ROR_t^i}{\sum_{i=1}^{i=N} D_t^i} \right\} + [k_1(r) + k_2(r)\rho(r)] + c_t} \tag{10}$$

According to equation 10, money (M2) multiplier under ROM is a function of the currency ratio c and $\rho(r)$ chosen by depositors, the excess reserve ratio $k_1(r) + k_2(r)\rho(r)$, the number of banks K utilizing ROM, and the utilization rate of reserve

option mechanism ROR_t^i optimized by the banks, and, finally, the required reserve ratios rr_1 and rr_2 set by the monetary authority[5]. Note that money (M2) multiplier under ROM turns into a standard money (M2) multiplier m_2 as in Goodfriend, 1982 given in equation 11 in the absence of ROM facility (i.e. $ROR_t^i = 0 \; \forall \; i$) and/or when no bank utilizes ROM facility (i.e. $K = 0$).

$$m_{2,t} = \frac{1 + \rho(r) + c_t}{rr_1 + rr_2\rho(r) + [k_1(r) + k_2(r)\rho(r)] + c_t} \tag{11}$$

It is straightforward to show that money (M2) multiplier under ROM $m_{2,t}^{ROM}$ is at least as large as the standard money multiplier $m_{2,t}$ in the absence of ROM facility due to the fact that $\sum_{i=1}^{i=K} D_t^i \times ROR_t^i \geq 0, rr_1 >, rr_2 > 0$ and $\rho(r) > 0$.

According to equation 10, calculating M2 multiplier requires ROM facility utilization rates at bank level. Since banks' may consider ROM utilization rates as commercial secret, such bank level data is not publically available. However, this doesn't mean the formulae in equation 10 can't be evaluated. Suppose there is at least a bank utilizing the ROM facility (i.e. $K > 0$), and the utilization rate of ROM by banks is common at any time period t (i.e. $ROR_t^i = ROR_t > 0 \; \forall \; i = 1, 2, \ldots K$). Then, the M2 multiplier under ROM turns into formulae as in equation 12.

$$m_{2,t}^{ROM} = \frac{1 + \rho(r) + c_t}{[rr_1 + rr_2\rho(r)]\{1 - ROR_t \times \theta_t\} + [k_1(r) + k_2(r)\rho(r)] + c_t} \tag{12}$$

where θ_t is the share of total domestic currency checkable deposits at the banks utilizing the ROM facility at time period t i.e. $\theta_t = \frac{\sum_{i=1}^{i=K} D_t^i}{\sum_{i=1}^{i=N} D_t^i}$. According to this

[5] Note that banks' use of reserve option mechanism ROR^i must lie within the limits as set by monetary authority.

formulation, ceteris paribus, the higher the share of domestic currency checkable deposits (or required reserves to be maintained) at the banks utilizing the ROM facility (higher θ), the larger the M2 multiplier.

Each bank's utilization rate of the ROM facility depends on the relative cost of acquiring domestic currency and/or FX funding and other bank specific factors. Suppose all banks have the same level of ability obtaining domestic currency funding and/or FX funding i.e. there is not any credit constraint and no bank specific factors exist. When bank i decides to fulfill domestic currency required reserves without utilizing the ROM facility, the total cost of acquiring domestic currency funding at time period t equals to $\left[rr_1 \times D_t^i + rr_2 \times TD_t^i\right] \times r_t$. When bank i decides to fulfill domestic currency required reserves utilizing ROM facility at a rate of ROR_t^i, the total cost of acquiring funding at time period t equals to the cost of domestic currency funding $(1 - ROR_t^i)\left[rr_1 \times D_t^i + rr_2 \times TD_t^i\right] \times r_t$ plus the cost of acquiring FX funding $ROR_t^i \times ROC(ROR_t^i) \times \left[rr_1 \times D_t^i + rr_2 \times TD_t^i\right] \times r_t^* \times \frac{E_t[e_{t+1}]}{e_t}$ where r_t is domestic market interest rate, r_t^* is foreign market interest rate, e_t is nominal spot exchange rate (domestic currency per USD) at time period t, and E_t is the expectation operator conditional on the information observed through time period t. The term $ROC\left(ROR_t^i\right)$ stands for the corresponding trench of reserve options coefficient based on banks' choice of utilization rate of the ROM facility at time period t. The bank optimizes the utilization rate ROR_t^i at any time period t where the associated costs for utilization and non-utilization of the ROM facility are equal. Hence, the threshold reserve options coefficient at any time period t ROC_t^{tr} can be expressed as following

$$ROC_t^{tr} = \frac{r_t}{r_t^* \times \frac{E_t[e_{t+1}]}{e_t}} \tag{13}$$

Note that each bank's threshold reserve options coefficient may differ due to each bank's utilization rate of the ROM facility ROR^i which in turn is determined by solving each bank's profit maximization problem considering the relative cost of domestic and FX funding as described in equation (13) plus credit constraints and other bank specific factors. Our focus in this paper is not on banks' individual profit maximization behavior towards the use of ROM facility.

Comparative statics for M2 multiplier under ROM:

i. *Changes in the required reserve ratios rr_1 and/or rr_2:* When required reserve ratios rr_1 and/or rr_2 rise/fall, $m_{2,t}^{ROM}$ falls/rises i.e. rr_1 and/or rr_2 and $m_{2,t}^{ROM}$ are negatively related.

$$\frac{\partial m_{2,t}^{ROM}}{\partial rr_1} < 0; \qquad \frac{\partial m_{2,t}^{ROM}}{\partial rr_2} < 0$$

ii. *Changes in the currency deposits ratio c:* When currency deposits ratio c_t rises/falls, $m_{2,t}^{ROM}$ falls/rises i.e. c_t and $m_{2,t}^{ROM}$ are negatively related.

$$\frac{\partial m_{2,t}^{ROM}}{\partial c_t} < 0$$

iii. *Changes in elements of excess reserve ratio $k_1(r)$ and/or $k_2(r)$*: When $k_1(r)$ and/or $k_2(r)$ rise/fall, $m_{2,t}^{ROM}$ falls/rises i.e. $k_1(r)$ and/or $k_2(r)$and $m_{2,t}^{ROM}$ are negatively related.

$$\frac{\partial m_{2,t}^{ROM}}{\partial k_1} < 0; \qquad \frac{\partial m_{2,t}^{ROM}}{\partial k_2} < 0$$

iv. *Changes in the number of banks utilizing the ROM facility K*: When the number of banks K utilizing the ROM facility rises/falls, $m_{2,t}^{ROM}$ rises/falls i.e. K and $m_{2,t}^{ROM}$ are positively related.

$$\frac{\partial m_{2,t}^{ROM}}{\partial K} > 0$$

v. *Changes in the banks' utilization rate of the reserve options mechanism*: When the banks' utilization rate ROR_i of the ROM facility rises/falls, $m_{2,t}^{ROM}$ rises/falls i.e. ROR_i and $m_{2,t}^{ROM}$ are positively related.

$$\frac{\partial m_{2,t}^{ROM}}{\partial ROR^i} > 0$$

vi. Changes in the domestic money market interest rates r: When money market interest rates rises/falls, $m_{2,t}^{ROM}$ rises/falls i.e. r and $m_{2,t}^{ROM}$ are positively related. Using M2 multiplier formulae in equations 10, 11, and 12, partial derivatives described by equations A1, A2, and A3 in Appendix II prove that

$$\frac{\partial m_{2,t}^{ROM}}{\partial r} > 0$$

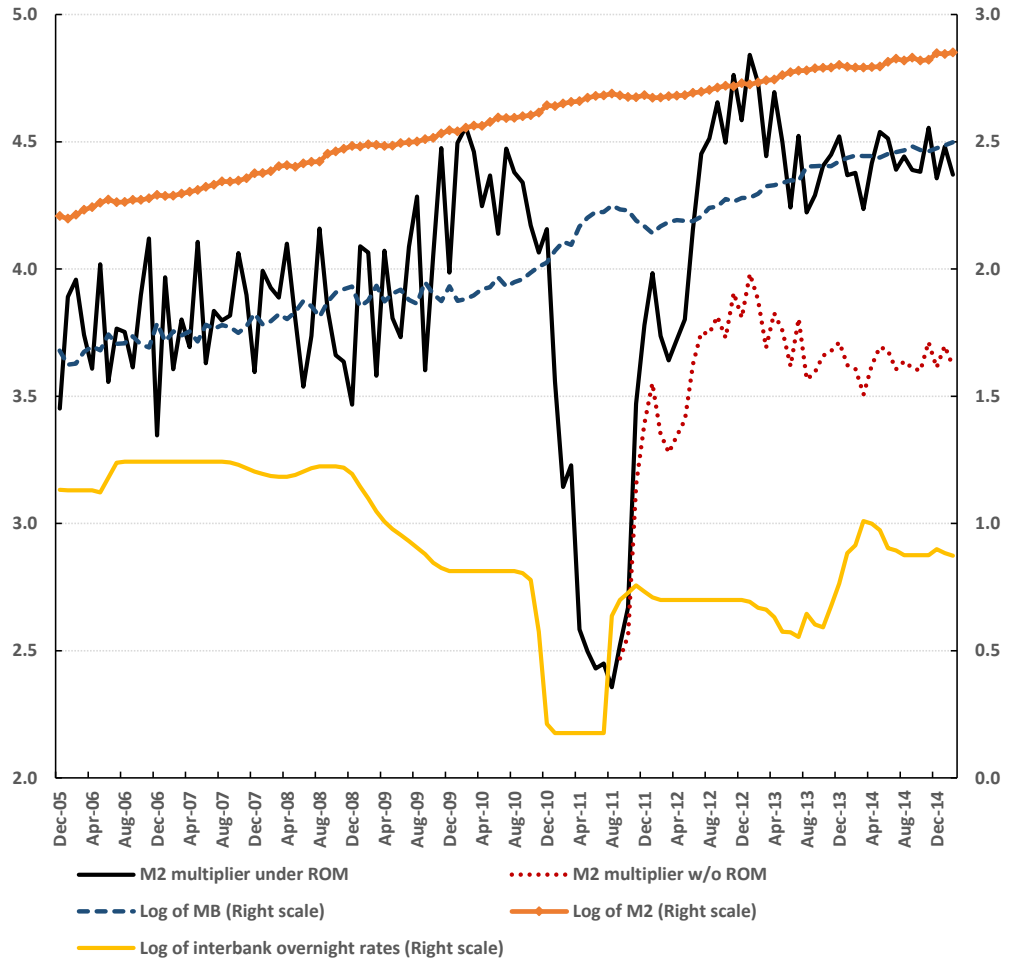
The rationale behind this finding is simple. When r rises it is more costly to find domestic currency funding than FX funding and therefore banks start utilizing the ROM facility more intensely (given that the bank is not already utilizing the ROM facility fully) i.e. ROR_t^i rises when r rises and this would lead to an increase in threshold reserve option coefficient ROC_t^{tr} and finally the utilization rate rises since reserve option ratio and reserve option coefficient are positively related.

According to equations 10 and 11, money (M2) multiplier in a monetary system with ROM is more sensitive to the domestic market interest rate changes as shown by equations A4 and A4 in Appendix II.

V. Empirical analysis and results

We first calculate M2 multiplier using Turkish data from Dec. 2005 to Feb. 2015 and illustrate our computations. Figure 5 plots M2 multiplier under and w/o ROM against the log of monetary aggregates: monetary base and M2 along with market interest rates. The figure reveals three key features. First, there is a

Figure 5. Money (M2) multiplier, Monetary aggregates and interest rates

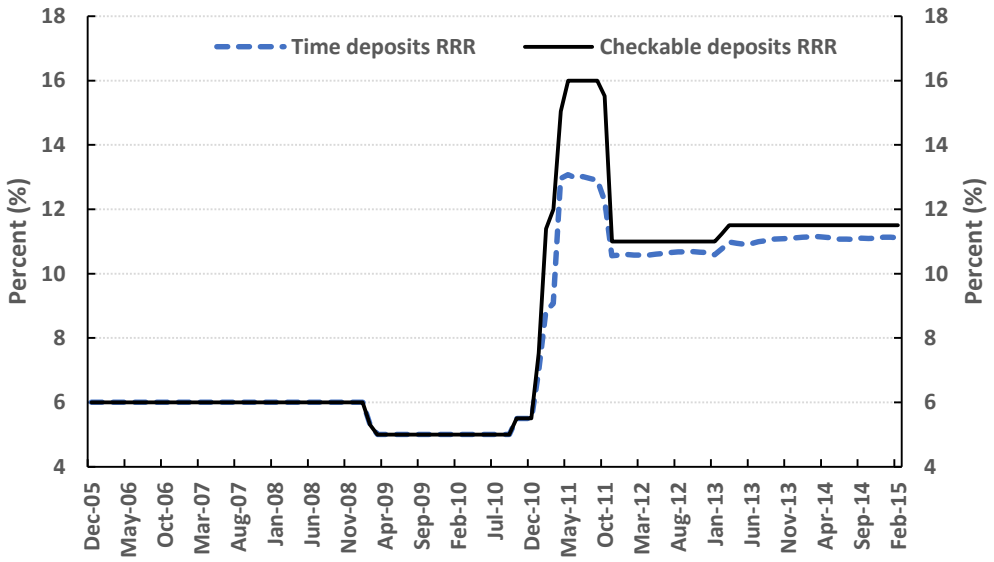


Notes: Data has monthly frequency covering the period from December 2005 to February 2015. M2 multiplier under ROM is calculated assuming $\theta = 0.90$ due to Aslaner et al., 2014 which reports that the share of total domestic currency checkable deposits (or reserve requirements to be maintained) at the banks utilizing the ROM facility constitutes 91% of the banking sector. M2 multiplier w/o ROM is calculated by setting $\theta = 0$.

sharp drop and a subsequent significant rise in M2 multiplier during 2011. Second, M2 multiplier under ROM is significantly larger. Third, a decisive upward trend in M2

multiplier become evident with the inception of ROM to the monetary system. The sharp drop and the subsequent rise in M2 multiplier during Dec. 2010 to Sept. 2011 seem to reflect changes in required reserve ratios rather than changes in other components of M2 multiplier. In Dec. 17, 2010, the CBRT announced Turkish lira required reserve ratio would be differentiated according to the maturity structure of deposits starting Jan. 2011. In addition, significant increases were introduced in the required reserves ratios. From Dec. 2010 to Sept. 2011, common reserve requirement ratio sharply rose from 5.5 to 16 and about 13 percent on checkable and time deposits, respectively. The rates were re-adjusted again in Oct. 2011 where required reserves ratios were set to about 11 percent. Figure 6 shows the time path of required reserve ratios on checkable and time deposits.

Figure 6. Reserve requirement ratios



Notes: Data has monthly frequency covering the period from December 2005 to February 2015. Time deposits reserve requirement ratio (RRR) is the weighted average of the required ratios for one-month, three-months, six-months, one-year and longer deposits since 2011.

The sharp drop in M2 multiplier during Dec. 2010 to Sept. 2011 is mainly reflected by step increase in the reserve requirement ratios as indicated in Figure 6. Subsequently,

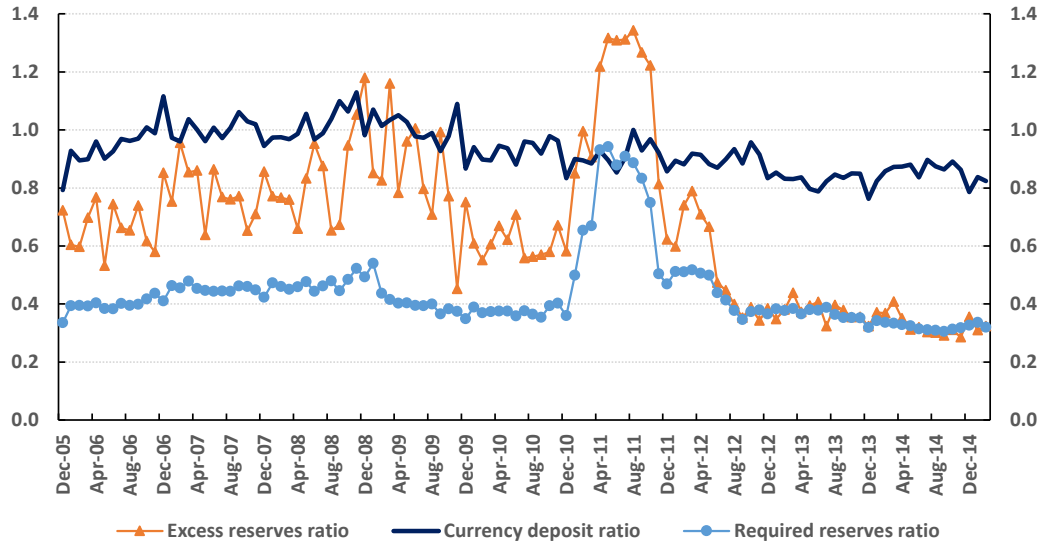
when the Central Bank set required reserves ratios back to about 11 percent, M2 multiplier picked back up from a bottom of 2.5 to 3.5 as indicated in Figure 5.

According to Figure 5, average M2 multiplier under and w/o ROM is about 4.3 vs. 3.6 during Sept. 2011 to Feb. 2015, respectively. The p-value associated with Student's paired t-test with one tailed distribution is 0.0000 indicating significantly larger M2 multiplier under ROM. There is a definite upward trend in M2 multiplier along with monetary base and M2. Average slope of upward trend in M2 multiplier under ROM equals to 0.24 whereas 0.17 for that of w/o ROM. The rise in the size and altered trend behavior of M2 multiplier seem to reflect the introduction of ROM facility to the monetary system and the changes it triggered in the components of M2 multiplier.

Figure 7 gives a visual summary of the underlying components of M2 multiplier under ROM and how they change over time. There is steady long-run declining trend in required reserves ratio (as described by $[rr_1 + rr_2\rho(r)]\{1 - ROR_t \times \theta_t\}$), excess reserves ratio, and currency deposit ratio c from Dec. 2008 and onwards except for the period of Apr. 2011 to Oct. 2011, the period with sharp drop and a subsequent rise in M2 multiplier. The declining trend in required and excess reserves ratios seem to be reinforced by the introduction of ROM around Sept. 2011. Comparative statistics ii, iii, and v predict negative relationship between M2 multiplier and currency deposit ratio, excess reserves ratio, and ROM utilization rate. The data suggests that the slight upward trend found in M2 multiplier around Dec. 2008 to Aug. 2010 is due to slight declining trend in currency deposit ratio, excess reserves and required reserves ratios (as described by $[rr_1 + rr_2\rho(r)]$) w/o ROM. M2 multiplier rises even further due to large decreases in excess and required reserves ratios around Sept. 2011, the date for inception of ROM to the monetary system, and onwards. Required reserves ratio refers to $[rr_1 + rr_2\rho(r)]\{1 - ROR_t \times \theta_t\}$ aftermath of Sept. 2011 by the introduction of

ROM. Hence, the decrease in required reserves ratio could be due to changes in $[rr_1 + rr_2\rho(r)]$ and/or changes in ROM utilization rate i.e. in $\{1 - ROR_t \times \theta_t\}$. We find about 60 percent of the increase in the multiplier is due to the inception of ROM facility and its utilization by banks.

Figure 7. Money (M2) multiplier components



Notes: Data has monthly frequency covering the period from December 2005 to February 2015. Excess reserves and currency deposit ratios refers to total excess reserves divided by total checkable deposits and currency in circulation divided by total checkable deposits, respectively. Required reserves ratio refers to $[rr_1 + rr_2\rho(r)]\{1 - ROR_t \times \theta_t\}$.

Table 1 gives estimated long-run trends in M2 multiplier under ROM and its components. The estimates provide evidence for significant shifts in the long-behavior of M2 multiplier, required and excess reserves with the introduction of ROM to the monetary system. Trend estimates for M2 multiplier rise from 0.13 to 0.61 percent when the period of estimation is narrowed from full sample of 2005m12-2015m2 to 2011m9-2015m2 in which ROM is in effective use. Abrupt decline in M2 multiplier during Dec. 2010 to Oct. 2011 is due to significant upward shifts in excess and required reserves as shown in Figure 6. Significant rise in excess reserves seem to reflect cost efficiency as indicated by significant drops in market interest rates depicted in Figure 5.

Abrupt changes in required reserves, on the other hand, reflect pure updates in the reserve requirement ratios as discussed above.

The evolution of required and excess reserves series can be characterized by two distinct phases. Trend estimate for required reserves rises from -0.14 to 1.61, whereas excess reserves ratios decreases from -0.80 to -2.40 percent when the period of estimation is narrowed from 2005m12-2015m2 to 2011m9-2015m2. The percentage change is trend estimate for currency in circulation is about 20 percent, a relatively small drop in c from -0.17 to -0.20 percent when entire period of 2005m12-2015m2 is narrowed to 2011m9-2015m2. Theoretically, decreases in required reserves and currency in circulation ratios increases M2 multiplier whereas rise in excess reserves decreases the multiplier.

Table 1. Estimated long-run trend in M2 multiplier and its components

Period & Variable (X)	Trend per-month	t-statistics	p-value	Adjusted R-squared
2005m12 – 2015m2				
M2 multiplier	0.13%	3.09	0.00	0.017
Currency in circulation ratio	-0.17%	-10.38	0.00	0.535
Required reserves ratio	-0.14%	-1.98	0.00	-0.050
Excess reserves ratio	-0.80%	-8.08	0.00	0.347
Time-Checkable deposits ratio	-0.24%	-8.10	0.00	0.368
2005m12 – 2011m8				
M2 multiplier	-0.15%	-1.73	0.00	-0.055
Currency in circulation ratio	-0.07%	-2.00	0.05	0.128
Required reserves ratio	0.46%	3.31	0.00	0.047
Excess reserves ratio	0.32%	2.23	0.03	0.004
Time-Checkable deposits ratio	0.00%	1.53	0.13	-0.010
2011m9 – 2015m2				
M2 multiplier	0.61%	3.92	0.00	0.180
Currency in circulation ratio	-0.20%	-4.17	0.00	0.458
Required reserves ratio	-1.61%	-9.52	0.00	0.673
Excess reserves ratio	-2.40%	-7.74	0.00	0.577
Time-Checkable deposits ratio	-0.71%	-17.02	0.00	0.884

Notes: Trend is estimated from an OLS regression where log of X is regressed on an intercept, a linear time trend and eleven monthly seasonal dummies.

Hence, the data suggests that the rise in M2 multiplier mainly come from the changes in banks' behavior with respect to required reserves which in turn are influenced by introduction of the ROM facility the monetary system.

Taking log and first differencing equation 1 of the model yields month-to-month percentage growth in M2 that can be decomposed into two factors: percentage growth in monetary base and M2 multiplier. Table 2 reports summary statistics for M2, monetary base MB, and the M2 multiplier over the full period from Dec. 2005 to Feb. 2015 as well as for two sub-periods with and w/o ROM.

Table 2. The stability of M2 multiplier

	Average monthly growth rates			Average monthly variance and covariance			
	$\widehat{M2}$	$\widehat{MB}$	$\hat{m}_2$	$Var(M2)$	$Var(MB)$	$Var(m_2)$	$Cov(m_2, MB)$
2005m12-2015m2	1.34%	1.71%	0.21%	0.1951	0.3734	0.0223	0.0182
2005m12-2011m8	1.62%	1.92%	-0.56%	0.1080	0.1130	0.0204	-0.0267
2011m9-2015m2	0.88%	1.36%	1.47%	0.0177	0.0679	0.0179	0.0163

Notes: ^ refers to month-to-month percentage change as calculated by taking the first log difference of the variables.

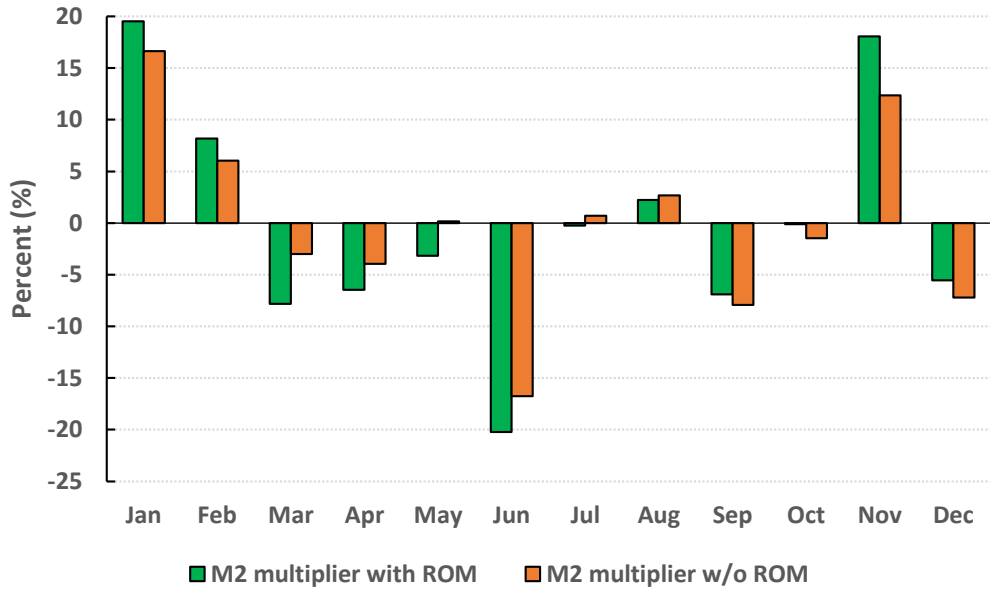
Confirming the graphical evidence indicated in Figure 5, Table 2 reports that monthly average growth rates in monetary aggregates of M2 and MB, and M2 multiplier under ROM are positive over the entire period of Dec. 2005 to Feb. 2015. When the full sample is split into two sub-periods based on availability of ROM facility, the average growth rate in the multiplier changes from -0.56 to 1.47, respectively. Average monthly growth rate of M2 multiplier changes to from -0.56 to 0.28 even when the period of Jan. 2011 to Aug. 2011 with large swings is dropped from the period of Dec. 2005 to Aug. 2011. This finding confirms M2 multiplier under ROM has a larger trend component than that of w/o ROM.

The right hand panel in Table 2 give variance and covariance estimates to study short-run dynamics in monetary aggregates and the M2 multiplier. First, no matter the size of the sample, the variance of M2 is lower than that of MB indicating M2 being

more stable than is monetary base in the short-run. According to Table 2, the variance on M2 multiplier is reduced from 0.02 to 0.01 when the full sample is narrowed to Sept. 2011 to Feb. 2015. This finding suggest that the volatility in M2 multiplier decreases with the introduction of ROM to the monetary system.

Figures 8A and 8B report strong seasonal pattern in M2 multiplier under and w/o ROM, required and excess reserves ratios, and relatively weaker seasonal pattern in currency in circulation ratio. According to Figure 8A, seasonal pattern is influenced by the introduction of ROM facility to the monetary system. Seasonal behavior during the first half of the year seem to become stronger with the introduction of ROM whereas the opposite is true for the second half of the year with the exception of November. M2 multiplier rises significantly in January, drop abruptly in June and rebounds by the end of the year. During other months, with the exception of July and October, there don't seem to be a distinct seasonal pattern in M2 multiplier.

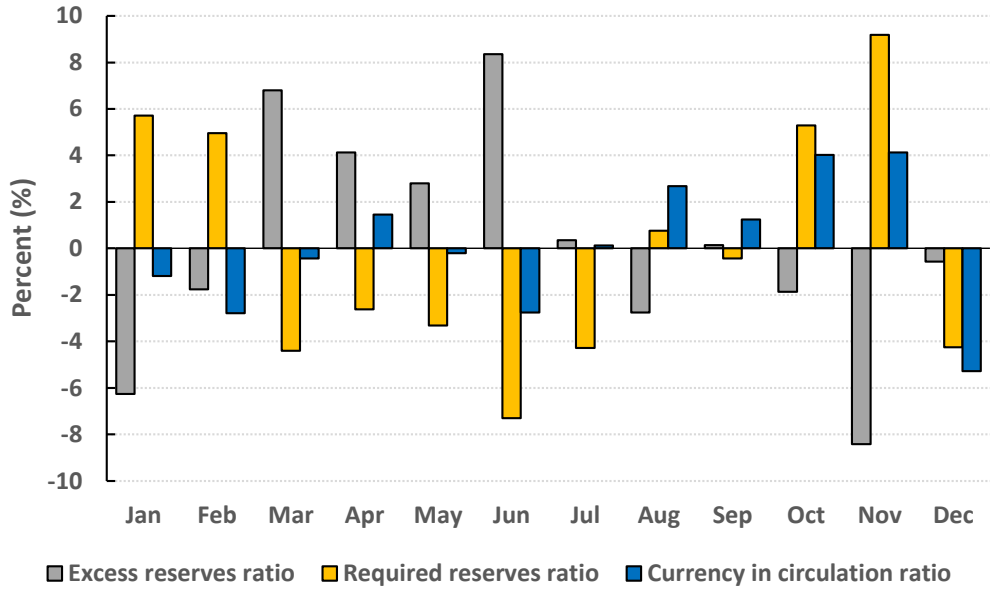
Figure 8A. Seasonal patterns in M2 multiplier



Notes: Data has monthly frequency covering the period from December 2005 to February 2015. The figures show average monthly deviations from mean.

Currency in circulation ratio falls sharply in February, June, and December while it rises significantly in August, October, and November as indicated in Figure 8B. The substantial increase in cash holdings relative to deposits in August seem to reflects crop purchases and harvest season. Required reserves ratio rise significantly in January and February and towards the end of the year while it drops abruptly during the March-July period. A closer look at the seasonal behavior of M2 multiplier in Figure 8A and that of required reserves in Figure 8B reveals significant seasonal comovement between the two series. In contrast, Figure 8B provide evidence that excess reserves ratio behave with strong opposite seasonal pattern compared to required reserves ratio.

Figure 8B. Seasonal patterns in RR, ER, and CC ratios



Notes: Data has monthly frequency covering the period from December 2005 to February 2015. The figures show average monthly deviations from mean. Required reserves (RR) ratio, Excess reserves ratio (ER) and Currency in circulation (CC) ratio are found by dividing these figures with total amount of checkable deposits.

Now, we turn our attention onto the stabilizing role of money multiplier under ROM under substantial capital outflows and inflows. First, consider a hypothetical situation where an economy experiences substantial capital outflows. Capital outflows place depreciation pressure on domestic currency. We argue depreciation pressure on

domestic currency is reduced/softened via two channels: a direct and an indirect channels. The direct channel is due to changes in banks' behavior in use of ROM facility which alters the supply of foreign exchange at the FX market via changes in currently held international reserves of the monetary authority as explained in Alper et al., 2013. Periods with capital outflows are usually characterized by increase in FX funding cost relative to domestic currency and tightening of external borrowing constraints. Increases in foreign exchange relative to domestic currency funding costs induce banks to use ROM facility less intensely. Lower utilization of ROM would release some of the required reserves kept in FX at the Central bank to the FX market which would reduce the depreciation pressure on domestic currency. The second and indirect channel is due to changes in the money multiplier stimulated by banks' decision on the utilization of the ROM facility. Lower utilization of the ROM facility reduces money (M2) multiplier as proved in comparative statics v[6]. If the monetary authority allows private market forces to determine the domestic interest rate i.e. if the monetary authority remain passive and does not engage in domestic open market operations, domestic interest rate rise. The stimulated increase in domestic interest rate would contain capital outflows limiting depreciation pressure on domestic currency. This finding provide basis for Aslaner et al., 2014 where the authors argue active interest rate policy responses to capital flows undermine automatic stabilizing feature of the ROM facility.

Capital inflows, on the other hand, induce banks to utilize ROM facility more intensely which contains appreciation pressure on domestic currency as discussed in

[6] Since bank use domestic currency more intensely to satisfy reserve requirements, lower utilization of the ROM facility reduces domestic money supply directly, as well.

Alper et al., 2013. Moreover, higher utilization of ROM increases money (M2) multiplier as proved in comparative statics v. If the monetary authority allows private market forces to determine the domestic interest rate, domestic interest rate fall. The fall in domestic interest rate would slow down capital inflows reducing appreciation pressure on domestic currency.

VI. Conclusion

In this paper, our objective was to study Reserve Option Mechanism (ROM), a recently introduced macroprudential monetary policy instrument, and its impact on the behavior of money multiplier. To this end, we analytically derive a generalized money (M2) multiplier under ROM and assess size, stability and seasonal properties quantitatively. Our case study is Turkish economy where we use monthly data during the decade 2005 to 2015. We report one time significant rise in the size of money multiplier and slight upward adjustment in the long run trend component of the multiplier due to adoption of ROM. Moreover, empirical evidence suggests substantial change in the seasonal behavior of the multiplier, cash ratio, required and excess reserves with ROM. We report money multiplier is strongly seasonal along with significant readjustment within year movements in the multiplier under a monetary system with ROM. Strong seasonal movements in required and excess reserves, the components of money multiplier, prove to be the underlying forces behind strong seasonal behavioral changes in the money multiplier. We show that money multiplier is substantially less volatile in a monetary system with ROM. We discuss the stabilizing impact of Reserve Option Mechanism in the foreign exchange market via adjustments in money multiplier responding to banks' managerial decisions over required reserves. The actual mechanism through which the introduced money multiplier under ROM reduces the size of variations in the foreign exchange market remain an open question for future studies.

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VIII. Appendix

Appendix I: Data

				Currency in circulation	Required reserves	Excess reserves	Checkable deposits	Time deposits	Interbank overnight O/N rates	Reserve requirement ratios		Reserve Option Ratio
Date	MB	$M1$	$M2$	C	RR	ER	D	TD	r	rr_1	rr_2	ROR
				(in billions of Turkish lira)						(percent, %)		
Dec-05	47.78	45.31	161.44	20.03	9.40	18.26	25.28	116.13	13.57	6.00	6.00	
Jan-06	42.04	40.52	157.45	19.50	9.82	12.70	21.02	116.93	13.50	6.00	6.00	
Feb-06	42.44	41.39	163.10	19.55	9.82	13.05	21.85	121.70	13.50	6.00	6.00	
Mar-06	47.16	43.61	170.85	20.65	10.48	16.01	22.96	127.24	13.50	6.00	6.00	
Apr-06	49.64	44.56	174.86	21.83	10.34	17.45	22.74	130.29	13.49	6.00	6.00	
May-06	47.84	47.38	181.93	22.45	12.12	13.25	24.93	134.54	13.25	6.00	6.00	
Jun-06	55.23	49.38	187.13	23.75	12.40	19.07	25.63	137.75	15.11	6.00	6.00	
Jul-06	50.81	47.08	183.01	23.18	11.76	15.83	23.91	135.93	17.33	6.00	6.00	
Aug-06	51.08	47.68	183.30	23.38	11.81	15.88	24.30	135.62	17.50	6.00	6.00	
Sep-06	54.38	48.35	186.94	23.81	12.41	18.15	24.54	138.59	17.50	6.00	6.00	
Oct-06	50.59	47.13	186.80	23.66	12.43	14.47	23.46	139.68	17.50	6.00	6.00	
Nov-06	49.18	45.64	189.54	22.68	13.16	13.31	22.96	143.90	17.50	6.00	6.00	
Dec-06	61.23	51.90	195.20	27.37	12.86	20.89	24.52	143.30	17.50	6.00	6.00	
Jan-07	51.90	44.01	193.67	21.70	13.38	16.80	22.31	149.66	17.50	6.00	6.00	
Feb-07	56.82	44.49	193.99	21.80	13.35	21.67	22.69	149.50	17.50	6.00	6.00	
Mar-07	54.76	44.70	197.59	22.76	13.26	18.73	21.94	152.90	17.50	6.00	6.00	
Apr-07	56.87	47.03	200.89	23.53	13.10	20.22	23.50	153.86	17.50	6.00	6.00	
May-07	51.92	47.65	204.10	23.35	13.04	15.50	24.29	156.45	17.50	6.00	6.00	
Jun-07	60.35	50.27	210.35	25.23	13.48	21.62	25.03	160.08	17.50	6.00	6.00	
Jul-07	58.23	50.42	214.28	24.85	13.71	19.65	25.57	163.86	17.50	6.00	6.00	
Aug-07	60.23	52.73	220.57	26.46	13.78	19.97	26.27	167.84	17.50	6.00	6.00	
Sep-07	59.11	51.90	220.48	26.72	12.97	19.42	25.18	168.59	17.36	6.00	6.00	

Oct-07	56.03	51.81	222.10	26.27	13.09	16.66	25.54	170.30	17.01	6.00	6.00
Nov-07	59.47	54.01	227.00	27.27	13.20	18.99	26.75	172.99	16.48	6.00	6.00
Dec-07	66.77	57.81	237.65	28.08	13.13	25.45	29.73	179.84	15.99	6.00	6.00
Jan-08	60.50	53.11	238.23	26.20	13.53	20.74	26.91	185.12	15.64	6.00	6.00
Feb-08	62.37	55.30	242.06	27.30	13.58	21.47	28.00	186.76	15.37	6.00	6.00
Mar-08	66.51	58.88	253.28	28.96	14.79	22.73	29.91	194.40	15.25	6.00	6.00
Apr-08	63.51	58.78	255.27	29.19	14.79	19.51	29.59	196.48	15.25	6.00	6.00
May-08	67.63	57.57	252.03	29.56	14.72	23.34	28.01	194.46	15.49	6.00	6.00
Jun-08	74.82	61.17	259.94	30.07	15.11	29.63	31.10	198.77	15.99	6.00	6.00
Jul-08	71.47	60.27	263.48	29.96	14.93	26.54	30.31	203.21	16.47	6.00	6.00
Aug-08	64.82	59.62	264.13	30.36	15.32	19.13	29.26	204.51	16.75	6.00	6.00
Sep-08	74.39	69.78	283.14	36.54	15.46	22.38	33.24	213.36	16.75	6.00	6.00
Oct-08	80.73	65.41	289.40	33.71	17.00	29.99	31.70	223.99	16.75	6.00	6.00
Nov-08	83.37	64.14	296.13	34.02	17.63	31.71	30.12	231.99	16.58	6.00	6.00
Dec-08	85.23	65.52	304.22	32.46	13.64	38.99	33.06	238.70	15.66	6.00	6.00
Jan-09	71.18	62.31	302.79	32.21	13.34	25.61	30.10	240.48	13.95	6.00	6.00
Feb-09	75.12	67.15	308.50	33.80	13.77	27.53	33.34	241.35	12.55	5.00	5.00
Mar-09	85.89	66.89	307.16	34.01	13.75	38.13	32.89	240.27	11.14	5.00	5.00
Apr-09	74.51	68.48	304.04	35.09	13.25	26.15	33.39	235.56	10.18	5.00	5.00
May-09	80.02	67.97	305.24	34.44	13.36	32.20	33.53	237.28	9.49	5.00	5.00
Jun-09	82.91	69.62	312.27	34.42	13.12	35.36	35.20	242.65	9.02	5.00	5.00
Jul-09	75.68	70.17	314.51	34.61	12.72	28.34	35.57	244.33	8.51	5.00	5.00
Aug-09	73.08	70.01	316.27	34.82	13.32	24.92	35.19	246.26	8.04	5.00	5.00
Sep-09	88.89	75.78	323.56	36.45	13.40	39.02	39.33	247.78	7.58	5.00	5.00
Oct-09	79.82	74.94	327.37	37.06	13.55	29.21	37.88	252.43	7.01	5.00	5.00
Nov-09	74.80	82.92	340.32	43.23	13.60	17.96	39.69	257.40	6.68	5.00	5.00
Dec-09	85.43	83.42	350.22	38.73	13.07	33.57	44.69	266.80	6.50	5.00	5.00
Jan-10	75.00	77.29	346.95	37.47	13.28	24.24	39.82	269.66	6.50	5.00	5.00
Feb-10	76.22	82.11	358.61	38.85	13.52	23.84	43.26	276.50	6.50	5.00	5.00
Mar-10	78.76	82.87	365.60	39.13	13.12	26.50	43.74	282.73	6.50	5.00	5.00
Apr-10	83.29	83.88	364.32	40.77	13.67	28.83	43.11	280.44	6.50	5.00	5.00
May-10	84.78	86.69	378.08	41.94	15.01	27.83	44.76	291.39	6.50	5.00	5.00
Jun-10	92.63	91.90	393.73	43.02	14.99	34.60	48.88	301.83	6.50	5.00	5.00

Jul-10	85.39	90.50	391.13	44.34	15.27	25.77	46.16	300.64	6.50	5.00	5.00	
Aug-10	88.71	93.11	392.70	45.50	16.39	26.80	47.61	299.59	6.50	5.00	5.00	
Sep-10	91.12	95.44	397.66	45.69	17.09	28.33	49.75	302.22	6.38	5.00	5.00	
Oct-10	96.69	97.73	402.13	48.34	19.73	28.61	49.39	304.40	6.00	6.00	6.00	
Nov-10	102.11	97.55	411.31	47.86	20.90	33.33	49.69	313.76	3.75	6.00	6.00	
Dec-10	105.94	109.22	439.53	49.66	21.51	34.64	59.56	330.31	1.63	6.00	6.00	
Jan-11	118.02	103.72	436.65	49.12	22.49	46.39	54.59	332.94	1.50	8.00	7.00	
Feb-11	127.87	105.94	447.03	50.05	22.20	55.62	55.89	341.09	1.50	11.00	9.00	
Mar-11	124.46	107.64	453.47	50.50	22.18	51.77	57.13	345.83	1.50	12.00	9.00	
Apr-11	146.75	110.76	456.62	53.31	23.45	69.98	57.46	345.86	1.50	15.00	13.00	
May-11	158.84	113.22	470.17	53.49	26.73	78.60	59.72	356.96	1.50	16.00	13.00	
Jun-11	167.29	119.93	478.11	55.21	27.41	84.66	64.72	358.19	1.50	16.00	13.00	
Jul-11	167.38	119.63	480.80	56.81	28.17	82.39	62.82	361.16	1.50	16.00	13.00	
Aug-11	177.41	128.36	488.35	64.18	27.04	86.18	64.18	359.99	4.33	16.00	13.00	
Sep-11	171.54	121.37	480.49	58.46	33.35	79.72	62.91	359.12	5.00	16.00	13.00	8.00
Oct-11	169.92	118.93	473.93	58.50	37.58	73.83	60.43	355.00	5.33	16.00	12.00	16.00
Nov-11	154.87	116.86	472.55	56.04	49.32	49.49	60.82	355.69	5.71	11.00	11.00	34.00
Dec-11	147.36	121.39	481.10	56.02	50.62	40.66	65.37	359.71	5.39	11.00	11.00	36.00
Jan-12	138.18	111.56	470.18	52.65	50.28	35.25	58.91	358.62	5.12	11.00	11.00	36.00
Feb-12	147.02	111.34	471.57	52.16	51.05	43.81	59.18	360.23	5.00	11.00	11.00	36.00
Mar-12	152.85	113.01	477.10	54.08	52.28	46.48	58.92	364.09	5.00	11.00	11.00	36.00
Apr-12	155.69	115.96	479.86	55.38	57.35	42.94	60.58	363.90	5.00	11.00	11.00	36.00
May-12	154.59	116.47	481.82	54.60	58.73	41.25	61.87	365.35	5.00	11.00	11.00	36.00
Jun-12	154.17	124.31	492.12	57.82	64.88	31.47	66.49	367.81	5.00	11.00	11.00	41.00
Jul-12	160.36	120.57	497.12	57.08	74.90	28.37	63.49	376.55	5.00	11.00	11.00	49.00
Aug-12	173.97	126.58	505.40	61.13	86.67	26.16	65.46	378.81	5.00	11.00	11.00	54.00
Sep-12	176.06	131.87	515.65	61.87	89.50	24.69	70.00	383.79	5.00	11.00	11.00	56.00
Oct-12	188.40	132.84	524.53	64.96	97.04	26.39	67.88	391.69	5.00	11.00	11.00	54.00
Nov-12	183.98	128.30	522.27	61.33	99.67	22.97	66.97	393.97	5.00	11.00	11.00	54.00
Dec-12	190.25	135.40	536.23	61.57	100.19	28.43	73.83	400.83	5.00	11.00	11.00	52.00
Jan-13	190.31	128.31	530.91	59.06	107.17	24.07	69.25	402.60	4.92	11.00	11.00	52.00
Feb-13	197.44	131.77	541.09	59.84	110.16	27.43	71.93	409.32	4.66	11.00	11.00	53.00
Mar-13	211.38	137.23	550.55	62.27	116.20	32.89	74.96	413.32	4.59	12.00	11.00	52.00

Apr-13	213.33	137.78	554.66	62.75	122.64	27.93	75.03	416.88	4.29	12.00	11.00	55.00
May-13	218.15	146.68	577.03	65.02	120.90	32.22	81.66	430.35	3.75	12.00	11.00	50.00
Jun-13	223.12	158.87	593.10	70.02	116.87	36.22	88.85	434.23	3.74	12.00	11.00	46.00
Jul-13	221.76	157.68	600.45	71.17	122.57	28.00	86.51	442.76	3.58	12.00	11.00	47.00
Aug-13	252.88	163.99	601.95	75.15	142.53	35.19	88.84	437.96	4.42	12.00	11.00	50.00
Sep-13	253.44	167.83	614.63	76.34	142.41	34.68	91.49	446.80	4.01	12.00	11.00	51.00
Oct-13	254.50	166.17	616.44	76.37	146.23	31.88	89.80	450.27	3.91	12.00	11.00	53.00
Nov-13	253.51	165.24	618.83	75.87	145.83	31.80	89.37	453.59	4.74	12.00	11.00	54.00
Dec-13	264.73	175.70	632.86	76.04	156.38	32.21	99.66	457.16	5.80	12.00	11.00	54.00
Jan-14	273.06	169.26	623.20	76.48	162.16	34.41	92.78	453.94	7.64	12.00	11.00	53.00
Feb-14	278.80	168.05	618.68	77.61	167.86	33.32	90.44	450.63	8.20	12.00	11.00	55.00
Mar-14	278.01	169.50	618.83	78.97	162.08	36.96	90.54	449.33	10.21	12.00	11.00	56.00
Apr-14	277.50	169.94	621.66	79.22	166.48	31.79	90.71	451.72	9.97	12.00	11.00	57.00
May-14	273.88	170.50	624.03	79.81	165.77	28.29	90.69	453.54	9.41	12.00	11.00	57.00
Jun-14	283.17	180.35	651.40	82.13	169.61	31.43	98.22	471.05	8.00	12.00	11.00	57.00
Jul-14	287.76	191.57	669.91	90.56	166.35	30.65	101.01	478.34	7.83	12.00	11.00	57.00
Aug-14	292.37	187.37	658.98	87.41	174.67	30.07	99.96	471.61	7.50	12.00	11.00	57.00
Sep-14	303.20	196.97	676.90	91.26	180.93	30.75	105.70	479.93	7.50	12.00	11.00	56.00
Oct-14	293.18	187.83	659.53	88.50	173.51	30.91	99.33	471.71	7.50	12.00	11.00	57.00
Nov-14	289.90	185.03	663.38	85.68	175.50	28.42	99.34	478.35	7.50	12.00	11.00	57.00
Dec-14	298.28	196.66	703.89	86.55	172.33	39.14	110.11	507.23	7.91	12.00	11.00	53.00
Jan-15	306.15	193.28	699.17	88.09	185.06	32.62	105.19	505.90	7.64	12.00	11.00	54.00
Feb-15	314.77	201.72	709.22	91.10	187.51	35.77	110.62	507.50	7.46	12.00	11.00	54.00

Notes: There is a discrepancy between the sum of reserves RR plus ER and currency in circulation C since IMF definition for monetary base MB is adopted where MB is the sum of reserves, currency in circulation and banks' demand deposits at the Central Bank. Reserve requirement ratio rr2 is the weighted average of the required ratios for One-Month, Three-Months, Six-Months, One-Year and Longer Deposits. Reserve option ratios are realized average ratios for the banking sector.
Source: Electronic Data Delivery System (EDDS) of the Central Bank of Republic of Turkey.

Appendix II: The Model

Using standard M2 multiplier formulae (equation 11) it is straightforward to show that:

$$\frac{\partial m_{2,t}}{\partial r} = \rho'(r)\left\{(rr_1 - rr_2) + [k_1(r) - k_2(r)] + c_t[1 - rr_2 - k_2(r)]\right\} - [1 + \rho(r) + c_t]\left\{k'_1(r) + k'_2(r)\rho(r)\right\} > 0 \quad \text{(A1)}$$

since $\rho'(r) > 0;\ \ rr_1 - rr_2 > 0;\ \ k_1(r) - k_2(r) > 0;\ \ k'_1(r) < 0;\ \ k'_2(r) < 0$ holds.

Similarly, taking partial derivative of equation 12 reveals that:

$$\frac{\partial m_{2,t}^{ROM}}{\partial r} = \rho'(r)\left\{[rr_1 - rr_2(1 - ROR_t \times \theta_t)] + [k_1(r) - k_2(r)] + c_t[1 - rr_2(1 - ROR_t \times \theta_t) - k_2(r)]\right\} - [1 + \rho(r) + c_t]\left\{k'_1(r) + k'_2(r)\rho(r) + (1 - ROR_t \times \theta_t)'[rr_1 + rr_2\rho(r)]\right\} > 0 \quad \text{(A2)}$$

In addition, taking partial derivative of equation 10 shows that:

$$\frac{\partial m_{2,t}^{ROM}}{\partial r} = \rho'(r)\left\{\left[rr_1 - rr_2\left(1 - \frac{\sum_{i=1}^{i=K} D_t^i \times ROR_t^i}{\sum_{i=1}^{i=N} D_t^i}\right)\right] + [k_1(r) - k_2(r)] + c_t\left[1 - rr_2\left(1 - \frac{\sum_{i=1}^{i=K} D_t^i \times ROR_t^i}{\sum_{i=1}^{i=N} D_t^i}\right) - k_2(r)\right]\right\} - [1 + \rho(r) + c_t]\left\{k'_1(r) + k'_2(r)\rho(r) + \frac{\partial\left(1 - \frac{\sum_{i=1}^{i=K} D_t^i \times ROR_t^i}{\sum_{i=1}^{i=N} D_t^i}\right)}{\partial r}[rr_1 + rr_2\rho(r)]\right\} > 0 \quad \text{(A3)}$$

since $\rho'(r) > 0;\ rr_1 - rr_2\left(1 - \frac{\sum_{i=1}^{i=K} D_t^i \times ROR_t^i}{\sum_{i=1}^{i=N} D_t^i}\right) > 0;\ \ k_1(r) - k_2(r) > 0;\ \ k'_1(r) < 0;\ \ k'_2(r) < 0;\ \ \frac{\partial\left(1 - \frac{\sum_{i=1}^{i=K} D_t^i \times ROR_t^i}{\sum_{i=1}^{i=N} D_t^i}\right)}{\partial r} < 0.$

Note that equation A2 and A3 differs from equation A1 by the blue colored terms due to inception of ROM facility to the monetary system.

According to equations 10 and 11, M2 multiplier in a monetary system with ROM facility is more sensitive to the domestic market interest rate changes i.e.

$$\frac{\partial m_{2,t}^{ROM}}{\partial r} - \frac{\partial m_{2,t}}{\partial r} = \rho'(r)\left[rr_2 \times \frac{\sum_{i=1}^{i=K} D_t^i \times ROR_t^i}{\sum_{i=1}^{i=N} D_t^i}(1+c_t)\right] - [1+\rho(r)+c_t]\left\{\frac{\partial\left(1-\frac{\sum_{i=1}^{i=K} D_t^i \times ROR_t^i}{\sum_{i=1}^{i=N} D_t^i}\right)}{\partial r}[rr_1 + rr_2\rho(r)]\right\} > 0 \quad \text{(A4)}$$

and/or

$$\frac{\partial m_{2,t}^{ROM}}{\partial r} - \frac{\partial m_{2,t}}{\partial r} = \rho'(r)\left[rr_2 \times ROR_t \times \theta_t(1+c_t)\right] - [1+\rho(r)+c_t]\left\{(1-ROR_t \times \theta_t)'[rr_1 + rr_2\rho(r)]\right\} > 0 \quad \text{(A5)}$$