Preliminary and incomplete, please do not quote.

REQUIRED RESERVES, LIQUIDITY RISK, AND CREDIT GROWTH

Koray Alper*, Mahir Binici*, Selva Demiralp†, Hakan Kara*, and Pınar Özlü*

*Central Bank of Turkey
†Koç University

Abstract

Following the global financial crisis, central banks in many emerging economies incorporated financial stability into their policy objectives. Reserve requirement ratios (RR) have been one of the most popular unconventional monetary policy instruments in these countries. In this paper, we utilize a simple model and provide empirical evidence in understanding the transmission channels of RR. Our analysis allows us to identify a new channel that we name as the "liquidity channel". The channel works through a decline in bank liquidity and loan supply due to an increase in reserve requirements.

Keywords: Monetary transmission mechanism; liquidity risk; bank lending channel; Turkey.

JEL Classifications: E44; E51; E52

May 2014

I. Introduction

Following the global financial crisis of 2007-2009, the size and the volatility of capital flows into emerging market economies have increased substantially. The new environment created financial and macroeconomic stability challenges such as excessive volatility in exchange rates and credit growth. In response, central banks in many emerging economies incorporated financial stability concerns into standard inflation-targeting frameworks and adopted new monetary policy tools to deal with multiple objectives.

The standard reaction of many emerging economies to surging capital inflows was to keep policy rates at low levels in order to avoid excessive appreciation of domestic currencies, while at the same time engaging in some form of macro prudential tightening to curb the rapid credit growth. As of this writing, it is still an open question as to whether the unconventional policies pursued by the emerging economies are going to be specific to the post-crisis conditions or if they will stay as permanent tools in the tool box. To address this question from a normative point of view, empirical as well as theoretical research regarding the transmission mechanisms of these new instruments is needed. Our study aims to contribute to the efforts in filling this gap by investigating the transmission of quantitative tightening policies, especially through reserve requirements. We exploit the Turkish economy as a laboratory to unveil the transmission mechanism on the bank lending behavior.

Reserve requirement ratios (RR) have been one of the most popular tools among unconventional monetary policy instruments utilized by the central banks in emerging economies. They have been extensively used by both inflation targeting (IT) and non-IT emerging market economies as a supplementary monetary policy tool to ease the trade-off between financial stability and price stability. Especially after the global financial crisis, emerging economies such as Brazil, Turkey, Colombia, and Peru have actively used reserve requirement ratios to address the policy dilemmas caused by strong and volatile capital

inflows (see Medina and Roldós, 2014). The experiences of Latin American economies in general suggest that adjustments in reserve requirements may have helped to stabilize market rates in a way that moderated capital flows (Montoro and Moreno, 2011). They may also have helped to smooth credit growth during the expansionary and contractionary phases of the economic and financial cycle (see Tovar et al., 2012).

Despite the increasing reliance on RR as a policy tool to contain excessive credit growth, the effectiveness of RR and the transmission channels in general have not been studied in detail. The exact transmission mechanism through which RR interacts with bank lending behavior still remains to be explored. In this paper, we look inside the black box through a simple model and provide empirical evidence that could be useful in understanding the transmission channels of RR. Our analysis allows us to identify an additional channel which we call the "liquidity channel". This channel works through a decline in bank liquidity and loan supply due to an increase in reserve requirements.

Most of the studies in the literature focus on the "cost channel" of the RR where an increase in reserve requirements affects financial intermediation through an implicit tax on the banking system. Fama (1980) proposed that RR are taxes on the return on deposits. Prada (2008), Glocker and Towbin (2012), and Carrera and Vega (2012) illustrate that an exogenous increase in RR has similar effects to those of a tax on deposits, which makes funding through deposits more expensive. However, as long as central bank credit and deposits are close substitutes as alternative sources of bank funding, higher RR generally produces a fall in deposit interest rates, leaving lending rates unchanged. In such a setup, the eventual impact of RR on credit and economic activity is broadly neutral. Meanwhile, empirical evidence on emerging markets provided by Reinhart and Reinhart (1999) suggests that an increase in RR raises the spread between lending and deposit rates where the impact varies across countries.

The authors note that the structure of the deposit and loan markets is crucial in determining the share of additional intermediation costs among borrowers and depositors.

In a floating exchange rate regime with short term interest rates as the operating target, the liquidity impact of using reserve requirements may be negligible because the central bank meets the liquidity needs to maintain its interest rate target. In line with this reasoning, Di Giorgio (1999) argues that as the short-term interest rate becomes the standard operating target for monetary policy, RR becomes less relevant as a policy tool. This view assumes that the central bank's provision of liquidity is a perfect substitute for deposits. In other words, a bank faced with a liquidity shock due to a RR hike can easily compensate the diminished funds by borrowing from the central bank. In this scenario, reserve requirement changes are completely neutral from a loanable funds perspective.

In this paper we argue the presence of a liquidity channel which implies imperfect substitution between deposits and central bank funding. We show that a policy -induced change in the liquidity position of the banking system, such as a shift in liquid assets or liabilities, can alter the bank lending behavior. Because central bank funding is collateralized, the swap of deposits with central bank borrowing depletes the liquid assets of the bank, which implies that central bank funding and bank deposits are not close substitutes. Our empirical findings support this hypothesis. Using data on open market operations, we show that increases in central bank credit, driven by reserve requirement decisions and foreign exchange operations, lead to significant rise in bank deposit rates. These findings suggest the existence of balance sheet effects of reserve requirements in addition to the cost channel that is traditionally conveyed in the earlier literature.

Throughout the paper, we provide evidence on the liquidity channel on several dimensions. We document that the impact of changes in reserve requirements on loan rates, deposit rates and their spreads depends on banks' liquidity buffers. Reserve requirements and

other liquidity policies of the central bank are the main drivers of banks' liquid assets, which in turn have a significant effect on bank lending behavior. Overall, our results lend support to the view that liquidity policies can be used as a separate tool to tighten bank lending conditions. Thus, reserve requirements have the potential to be an additional tool for the central banks in emerging economies to relieve the policy trade-offs faced by the volatility of capital flows. These findings are also in line with the arguments that using RR as a policy tool to stabilize the lending behavior may be particularly relevant for emerging markets where the financial markets are less developed and the transmission from the policy rate to market rates is weaker (see, e.g. Montoro and Moreno, 2011).

To our knowledge, this is the first paper in the literature that attempts to unveil the transmission of central bank liquidity policies from an emerging market perspective. There are a few studies which refer to some sort of a balance sheet mechanism through bank reserves. These papers usually explain the transmission of reserve requirements from a "loanable funds" perspective and in an "advanced economy" set up. For example, in a seminal paper, Bernanke and Blinder (1988) implicitly talk about the balance sheet readjustment of banks following a monetary shock. Later on, Bernanke and Gertler (1995) define the "balance sheet channel" as the mechanism that highlights the effects of monetary policy on borrowers' balance sheets, while the "bank lending channel" is the mechanism that works through the effects of monetary policy on loan supply. However, neither these frontier papers on the credit channel nor their followers link the analysis to reserve requirement policies. Nor do they provide direct empirical evidence on the transmission of the balance sheet effects of the RR.

One recent study related to our paper is Gadanecz et al. (2014), which documents evidence on the role of banks' liquid assets in driving credit across emerging markets during the post-crisis period. Nevertheless, the paper does not mention the role for reserve

requirements and it does not provide any explicit analysis on the transmission mechanism. Recently, De Groot (2014) characterized the impact of monetary policy on bank balance sheets with a DSGE model but his focus is on the incentives created by the systematic policy reaction of the central bank, rather than credit growth or bank lending. Our approach is more micro oriented relative to the existing studies on reserve requirements, emphasizing the role of liquidity from an optimizing bank perspective.

Our results also contribute to the more general literature on the monetary transmission mechanism as well. The traditional literature evolves around interest rates as the operating instrument of monetary policy. Hence, most of the sub-channels of the monetary transmission mechanism investigate the effects of a change in interest rates or bank reserves on credit and output. By highlighting reserve requirements as an additional tool for the policy makers, we compare the dynamics of the consequent cost and liquidity channels with respect to the traditional channels of the monetary transmission mechanism. Different from the conventional bank lending view (see e.g. Bernanke and Gertler, 1995; Kashyap and Stein, 2000; Kishan and Opiela, 2000), we highlight the role of bank balance sheets and the buffer of liquid assets rather than traditional "loanable funds" argument.

The rest of the paper is organized as follows: The next section introduces a simple model to motivate the main idea and elaborates on the monetary transmission mechanism. The third section describes the Turkish monetary-financial framework, which is important for setting up the empirical model and interpreting the results. The fourth section presents the empirical findings and last section concludes.

II. Liquidity, Reserve Requirements and Bank Behavior: Implications of A Simple Model

In this section, we analyze the bank behavior through the lens of a standard model. Although our model is highly simplified, it is nevertheless useful for motivating the main idea

and deriving testable implications. We first sketch the impact of a change in reserve requirements on bank balance sheets. This exercise demonstrates how a shift in the balance sheet composition of the banks, induced by a change in reserve requirements, may affect the lending behavior.

The impact of reserve requirement on bank liquidity: A balance sheet view

We start with a simplified hypothetical balance sheet of the banking system where banks' assets are composed of loans, securities, and reserves, while liabilities are customer deposits and short-term funding (either from the Central Bank or money markets). Banks are required to pledge collateral against their borrowings from the Central Bank. When a security is pledged as collateral, it cannot be used during the term of the debt. Hence, we make a distinction between the banks' unencumbered (free) securities, which are available for use, and encumbered securities, which are pledged as collateral. We assume that banks do not hold any excess reserves. This is a realistic assumption in the Turkish context, because excess reserves are not remunerated and their demand is negligible.

In this example and throughout the paper, we use the ratio of unencumbered (free) government securities as a fraction of total liabilities as the measure for bank liquidity. Unencumbered government securities constitute the most important portion of liquid assets which can be used against possible liquidity shocks.

Table 1: A Hike in Reserve Requirement Ratio and Bank Balance Sheet

a) Before a hike in RR

Assets		Liabilities	
Loan:	90	Deposit:	100
Unenc. Sec.:	10	Repo:	0
Enc. Sec.:	0		
Reserves:	0		

b) After a hike in RR

Assets		Liabilities	
Loan:	90	Deposit:	100
Unenc. Sec.:	5	Repo:	5
Enc. Sec.	5		
Reserves:	5		

Suppose that the bank initially has 100 units of assets which consists of 90 units of loans and 10 units of government securities. Therefore, our measure of liquidity

(unencumbered securities / total liabilities) is 10 percent. Table 1 shows how a 5 percentage point hike in RR alters the bank balance sheets. Because the bank cannot cut down its loan commitments immediately, 5 units of foregone deposits have to be compensated by borrowing from the Central Bank, which requires pledging collateral. Hence, the bank's unencumbered securities decline by 5 units, bringing the liquidity ratio from 10 percent to approximately 5 percent (=5/105). That is, the banking system's liquidity position deteriorates. According to the liquidity channel that we envision in this paper, the in the liquidity ratios prompts some banks to tighten loan supply due to liquidity concerns. [1]

Figure 1 below depicts the first stage of the transmission of the liquidity channel that we envision. As the figure shows, the immediate response of banks to a hike in reserve requirements is to increase their borrowing from the central bank by a similar amount. Because the central bank funding is collateralized, it depletes the liquid assets of the bank, consistent with the balance sheet movements shown in Table 1.

[1] Using alternative definitions for bank liquidity may change this conclusion. For example, if reserves are included in the definition of liquidity (as in the current regulatory liquidity ratio in Turkey), the impact of the increase in RR on the official liquidity indicator would be much smaller. Nevertheless, from the perspective of loan issuance, it is plausible to exclude (at least partially) the required bank reserves from the definition of liquidity, especially from the perspective of loan issuance. See Orr and Mellon (1961) for a discussion of this idea.

Figure 1.
Reserve Requirements and Short-Term Funding from the CBRT (percent)

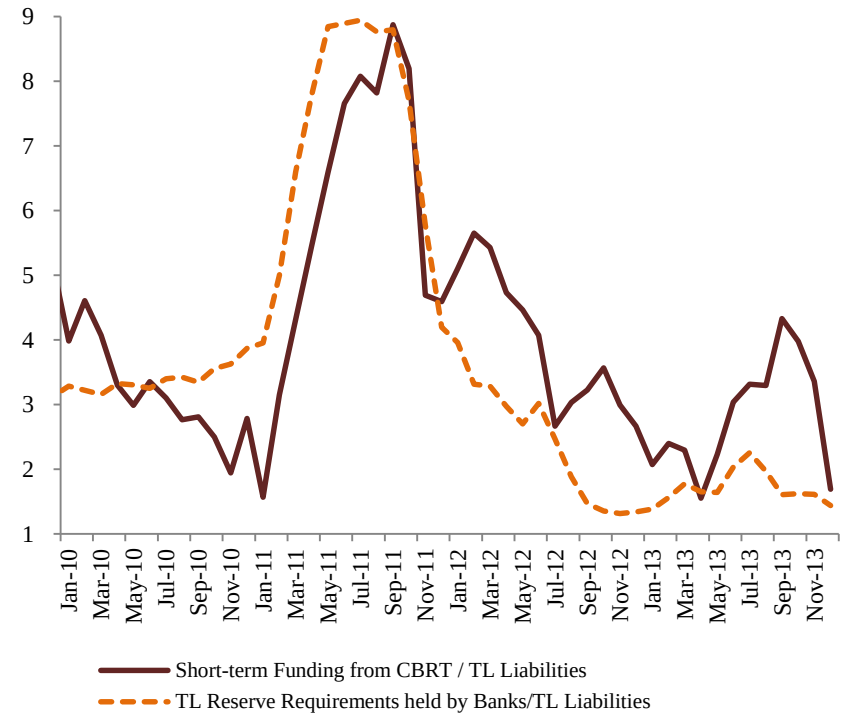
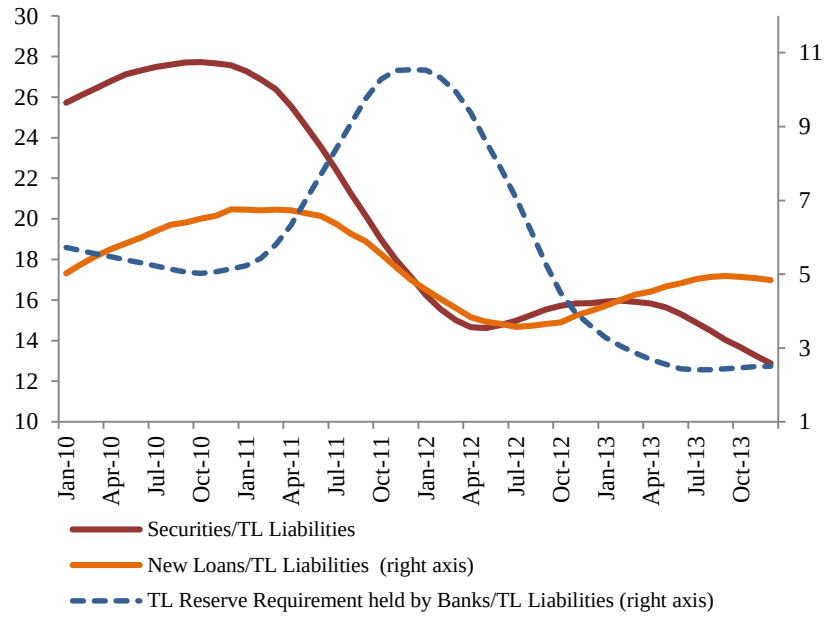


Figure 2 confirms that an increase in reserve requirements is associated with a decline in bank liquidity and hence a decline in bank loans. It is also interesting to note that at the early stages of the quantitative tightening cycle, the decline in bank liquidity is associated with relatively stable bank loans. This observation is consistent with the scenario depicted in Bernanke and Blinder (1992) who argue that due to the contractual nature of bank loans they are slower to adjust. Hence, banks reduce their liquid assets to finance their loans before they adjust their loan books.

Figure 2.
Liquid Assets, Reserve Requirements and New Loans



*All series are drawn as12-months moving average.

Bernanke and Blinder (1992) further note that in the long run banks reduce their loans while bringing their liquidity back to its optimal level. The figure above is broadly consistent with this view where banks prefer to keep a certain buffer of liquid assets in order to avoid a substantial increase in their marginal costs in the case of market stress. Banks prefer not to resort to central bank funding or interbank funding at a large scale. This is especially relevant for emerging economies where almost all interbank funding is collateralized and government bonds are the main source of collateral. Thus, banks with low liquidity buffers may run into collateral constraints rather easily which is particularly undesirable during turbulent times. Combined with possible reputational costs, we argue that liquidity positions may matter for the bank lending behavior even during normal times.

Although the main focus of our paper is the transmission of reserve requirement policies, another important quantitative tool that directly affects the banks' liquidity is the

foreign currency (FX) sales/purchases by the central bank. FX sales drain local currency from the banking system, which has to be injected back by the central bank through open market operations. Even if the FX sales are fully sterilized, net borrowing of the banks from the central bank would still increase increase. Because open market purchases require pledging liquid assets as collateral, the liquidity of the banking system deteriorates. Hence, the overall liquidity impact of foreign currency sales would be similar to a hike in RR.

Reserve Requirements, Liquidity and Bank Lending: A Simple Model

The set up is an augmented version of Monti-Klein type banking model. We modify the standard model to account for reserve requirements and bank liquidity to analyze the interaction between reserve requirements, liquidity and bank lending behavior.[2]

The main agent is a representative bank which can raise funds through customer deposits (*D*) and short-term funding from the Central Bank in the form of repurchase agreements (*R*). The bank has three types of assets: loans, (*L*), bonds (*B*), and reserves (*Res*) held at the Central Bank. We assume that reserves are not remunerated and the market rates are not too low (as in emerging economies) so that profit maximizing banks do not hold any excess reserves beyond their legal requirements (*rr*D*).

Loans, deposits, and collateralized borrowing are endogenous in the model as well as the loan rate (i^L) and the deposit rate (i^D) which are determined by the profit maximizing bank. Reserve requirement ratio (*RR*) and the policy rate (i^{CB}) are exogenous policy variables. In line with the discussion above, securities pledged as collateral (B^{IL}) cease to be liquid assets during the term of borrowing. The model variables can be illustrated as below:

[2] See for example, Xavier and Rochet (2008) for a Monti-Klein model altered for liquidity risk. For a very similiar way of modelling expected liquidity costs see Orr and Mellon (1961).

Assets	Liabilities
Loan (L)	Deposit (D)
Unencumbered Securities (B^L)	Repo (R)
Encumbered Securities (B^{IL})	
Reserves (Res):	

Under this setting, the balance sheet identity implies:

$$L + B + rrD = D + R \quad (1)$$

Without loss of generality, total bond holdings of the bank, B, are assumed to be fixed in the short-run. Thus, the sum of encumbered (B^{IL}) and unencumbered bonds (B^L) is constant:

$$\bar{B} = B^{IL} + B^L \quad (2)$$

Because borrowing through repurchase agreements necessitates pledging collateral, the volume of the repos, R, is equal to encumbered bonds:

$$B^{IL} = R \quad (3)$$

Finally, we assume that there is monopolistic competition in both loan and deposit markets and the volume of loans, L, and deposits, D, are functions of loan rate, i^L, and deposit rate, i^D, respectively:

$$L=L(i^L) \quad (4)$$

$$D=D(i^D) \quad (5)$$

At the end of the period, the bank receives the principal and the interest payment of the loan as well as the reserves held at the Central Bank. Meanwhile, the bank pays back the principal and interest rate expenses to its depositors and the amount borrowed from Central Bank, $[L + \bar{B} - D(1 - rr)]$.

Hence, the one period profit function of the bank can be stated as follows:

$$\Pi = L(1 + i^L) + rrD + \bar{B}(1 + i^B) - D(1 + i^D) \quad (6)$$
$$- [L + \bar{B} - D(1 - rr)](1 + i^{CB}) - C(B^L)$$

The last term in the profit function, $C(B^L)$, is the expected cost of running into a liquidity shortage; i.e. the cost of resorting to uncollateralized borrowing when liquid assets are inadequate to cushion an adverse liquidity shock.

The lower is the ratio of unencumbered securities (or liquid assets), the higher is the probability of resorting to uncollateralized borrowing. Meanwhile, the higher is the rate of uncollateralized borrowing, the higher is the expected cost of a liquidity shortage ($C' < 0$).[3] The function denoting the expected cost of a liquidity shortage is specified as follows:

$$C(B^L) = i^P \int_{B^L}^{D} (x - B^L) f(x) dx \qquad (7)$$

where "*x"* is the magnitude of the random liquidity shock, $f(x)$ is the probability distribution of that random variable, B^L is the volume of unencumbered securities, and *D* is the volume of deposits. i^P is the penalty rate, which is the rate for unsecuritized borrowing. Banks incur a higher cost for uncollateralized borrowing which can be perceived as the wedge over the costs of collateralized borrowing. Implicit in the penalty rate is the reputational costs of uncollateralized borrowing as well.

The balance sheet constraint implies that the total stock of liquid assets is equal to the volume of deposits less reserves and loans:

$$\mathrm{B^L} = (\mathrm{D}(1 - \mathrm{RR}) - \mathrm{L}) \qquad (8)$$

As shown in equation (8), there is an inverse relationship between reserve requirements and liquid assets.

Taking the policy rate, reserve requirements, and the initial bond holdings as given, the bank tries to maximize its expected profits by setting loan and deposit rates. The first order conditions (FOC) for the profit maximization problem can be expressed as follows:

[3] In emerging economies, money market transactions are largely conducted in the form of collateralized repurchase agreements. Hence, it is reasonable to assume that the expected cost of a liquidity shortage can be quite high compared to the deposit or repo funding.

FOC 1: **Loan rate**

$$L'(1+i^{L})+L-L'(1+i^{CB})+C'L'=0 \tag{9}$$

In the absence of the liquidity channel (when $C=0$), the loan rate implied from the FOC is simply:

$$\widehat{i^{L}}=\frac{i^{CB}}{\left(1-\frac{1}{\varepsilon_{L}}\right)} \tag{10}$$

where $\varepsilon_{L}$is the interest elasticity of loan demand defined as $\frac{L'}{L}i^{L}$.

Equation (10) implies that the bank determines the loan rate by exerting a mark-up over the marginal cost of borrowing, where the mark-up is determined by the interest elasticity of loan demand. Note that, in this case reserve requirements have no impact on the bank's loan rate setting.

In contrast, when we allow for the bank to internalize the risk of liquidity shocks and its costs, the loan rate would be:

$$\widehat{i^{L}}=\frac{i^{CB}-C'}{\left(1-\frac{1}{\varepsilon_{L}}\right)} \tag{11}$$

where the derivative of the cost function, $C'(.)$, which is related to liquidity risk, is given as:

$$C'=-i^{P}\int_{B^{L}}^{D}f(x)dx<0 \tag{12}$$

An increase in RR decreases B^{L} as shown in equation (8) and depending on the shape of the distribution function of the liquidity shock, *x*, this could increase the optimal lending rate. For a reasonable distribution function we expect:

$$\frac{dC'}{d(RR)}\geq 0 \tag{13}$$

Note that once the liquidity channel becomes operative, central bank funding and deposits become imperfect substitutes and thus the RR affects loan rates. According to equation (11), the more elastic the demand is, the less interest rates would respond to reserve requirements.

For example, in the case of perfect competition (infinite elasticity) the loan rate would not respond at all.[4]

Going back to the profit maximization problem illustrated in equation (6), the FOC for the deposit rate can be expressed as follows:

FOC 2: **Deposit rate**

$$-D'i^D - D + D'(1-rr)i^{CB} - C'(1-rr)D' = 0 \qquad (14)$$

If we start with the simple case of no liquidity shock and no liquidity channel (or perfect substitution between deposits and central bank funding), equation (14) can be re-arranged as follows:

$$i^D = \frac{(1-rr)i^{CB}}{\left(1+\frac{1}{\varepsilon_D}\right)} \qquad (15)$$

where $\varepsilon_D$is the interest elasticity of deposit demand defined as $\frac{D'}{D}i^D$.

Equation (15), together with equation (10), reveals that, when deposits and central bank funds are perfect substitutes, the bank passes all the direct intermediation costs imposed by RR to deposit rates and keeps the lending rate constant, as implied by the cost channel. To be more specific, a 100 basis point increase in RR decreases the deposit rate by $\frac{i^{CB}}{\left(1+\frac{1}{\varepsilon_D}\right)}$ basis points. In other words, the cost of a RR hike is reflected onto deposit rates, the extent of which is determined by the demand elasticity.

[4] In equation (7), the cost of uncollateralized borrowing is assumed to be independent of the borrowed amount. However, a more realistic assumption would be to think of the cost of uncollateralized borrowing as an increasing function of the amount of borrowing. Under this assumption, the relationship between the loan rate and RR gets stronger. In that case, the expected cost of resorting to uncollateralized borrowing takes the following form:

$$C(B^L) = \int_{B^L}^{D} g(x-B^L)(x-B^L)\,f(x)dx$$

where $g(x-B^L)$ reflects the penalty cost of unsecuritized borrowing as a function of the amount borrowed where $g'(.)>0$ and $g''(.)>0$.

In the presence of the liquidity channel, the FOC expressed in equation (14) boils down to:

$$i^D = \frac{(1-RR)i^{CB} - (1-RR)C'}{\left(1+\frac{1}{\varepsilon_D}\right)} \tag{16}$$

According to equation (16), the optimal deposit rate is a function of the cost of marginal borrowing, the liquidity risk, interest rate elasticity of deposit demand, and reserve requirements. The expression reveals that there are two opposing effects of RR on the deposit rate. On the one hand, higher reserve requirements lower the deposit rates through direct intermediation cost, which can be expressed as $(RR)i^{CB}$ (the cost channel). On the other hand, higher reserve requirements lead to an increase in the deposit rate through the liquidity channel, i.e., through the additional cost of a deterioration in the liquidity position of the bank, expressed as $(RR)C'$ (the liquidity channel). Therefore, the net impact of the RR on the deposit rates depends on how large the central bank funding rate is compared to the expected cost of a liquidity shortage. Note that because the latter is a decreasing function of liquidity, RR would certainly have a positive impact on the deposit rate if the liquid falls to a certain threshold level.

Using equations (11) and (16), the spread between the loan rate and the deposit rate, (*S*), can be obtained as:

$$S = (i^{CB} - C')\left[\frac{1}{\left(1-\frac{1}{\varepsilon_L}\right)} - \frac{(1-RR)}{\left(1+\frac{1}{\varepsilon_D}\right)}\right] \tag{17}$$

According to equation (17), the effect of RR on the spread depends on the interest rate elasticities of loan and deposits. Higher RR implies higher spreads. Under the assumption of

perfectly competitive markets for both loan and deposits5 and no liquidity risk, the spread would be RR $*$ i^{CB}.

Interest rate versus quantity adjustment

Our simple model does not directly address the implications of RR for the volume of loans. Yet it is possible to extend the intuition to the case of quantity adjustments under certain assumptions. Suppose that the lending market is quite competitive such that it is very costly for the bank to adjust the loan rate in the face of a liquidity shock. In this case, if the liquidity channel is operative, the bank would bring its liquidity risk down to more acceptable levels by decreasing its loans and/or replacing them with more liquid assets.

In order to demonstrate the loan volume adjustment in our simple model, the loan rate, i^L should be taken as the given parameter and the loan volume, L, should become the choice variable in the profit maximization problem.

The resulting FOC is provided below:

$$\frac{d\pi}{dL} = (i^L - i^{CB}) - C' = 0 \qquad (18)$$

In equation (18), the bank reduces its loans down to the point where the return on marginal lending $(i^L - i^{CB})$ is equal to the additional increase in expected cost of a liquidity shortage (C').

Following a liquidity shock, if the bank cannot adjust its loan rates for some reason (e.g. competitive loan market or high degree of demand sensitivity to interest rates), then the adjustment is made through the quantity of loans. This argument implies that the impact of reserve requirements on loan growth would be higher for those loans with higher demand elasticity of interest rates.

[5] Elasticities would be ∞ in the perfectly competitive markets.

A Summary of the Transmission Mechanism of Reserve Requirements

The degree of substitution between deposits and central bank credit as sources of bank funding is a critical parameter for the transmission mechanism of RR. If the two sources of funding are imperfect substitutes, a rise in RR will not be fully replaced with central bank credit. Thus, both the supply of bank loans and the demand for deposits will be affected, together with lending and deposit rates.

In practice, there are reasons why deposits and central bank funding may not be close substitutes. Because the maturity of central bank credit is typically shorter than the maturity of deposits, central bank credit and deposits may be imperfect substitutes for risk-averse banks. In that case, a larger reliance on central bank credit adds to interest rate risk (see Betancourt and Vargas, 2008, Herrera et al., 2010). Meanwhile, the interest rate risk would be reduced to the extent that the average maturity of bank deposits is short and the interest rate policies of central banks are predictable. Despite these theoretical expositions, the previous literature does not provide any empirical support for the existence of a significant interest rate risk channel.

While we do not rule out the existence of an interest rate risk channel, we argue that there may be alternative explanations as to why deposits and central bank funding are not close substitutes. In practice, switching bank deposits with central bank credit after a reserve requirement hike leads to a deterioration in the liquidity position of the banks. As we have shown in the previous section, a change in RR induces a shift in the composition of the bank balance sheets. When faced with a tightening in reserve requirements, banks initially resort to central bank funding to fulfill their precommitted loan contracts. However, because central bank funding is collateralized, banks are left with less liquidity buffers to use against unexpected liquidity shocks. The marginal cost of borrowing from the central bank thus increases as the banks take into account the additional liquidity risk, which, in turn, leads to

higher lending rates and/or a reduction in the pace of credit growth. We call this as the "liquidity channel".

Our discussions on the monetary transmission mechanism can be summarized along the following lines; Assuming that central bank funding and bank deposits are *perfect substitutes* as loanable funds, and the central bank does not pay interest on reserves (or interest on reserves is lower than market rates), the transmission mechanism can be depicted with the traditional cost channel:

- **Cost channel:** RR ↑ , Cost of deposit funding ↑, deposit rate↓ , deposits↓ , central bank funding ↑ , loan rate (unchanged), loans (unchanged).

Instead, if the central bank pays interest on bank reserves at market rates, the above channel would not exist because the increased cost of deposit funding would be compensated by the higher interest payments on reserves. However, even if bank reserves are fully remunerated, the reserves requirements may still affect bank behavior through interest rate risk or liquidity channels. As explained earlier, the existence of such channels implies *imperfect substitution* of deposits with central bank funding. In that case, the transmission channels can be described as follows:

- **Interest rate risk channel:** RR ↑ , interest rate risk ↑ , deposit rate ↑ , loan rate ↑ , loans ↓
- **Liquidity channel:** RR ↑ , Bank liquidity ↓ , Deposit rate ↑, Loan rate ↑ , loans ↓

The above illustration of the monetary transmission mechanism implies challenges for the empirical analysis. It is almost impossible to identify the individual impact of some of the channels described above. For example, the cost channel may interact with the interest rate and liquidity channels as the share of direct intermediation costs may depend on the liquidity and interest rate risks. Moreover, as described above, the impact of interest rate risk and liquidity channels on deposit rates and loans are observationally equivalent. Nevertheless,

there are still testable implications that would allow us assess the effects of reserve requirements on bank behavior. For example, if the deposit and lending rates go up significantly in response to a tightening in reserve requirements, this would suggest strong balance sheet effects due to liquidity and interest rate risk channels. In section IV, we empirically investigate the existence of these channels as well as the hypothesis of perfect substitutability between deposit and central bank funding.

The relationship between the liquidity of a bank's portfolio and its loan issuance is not a new topic. Nevertheless, the previous literature either focused on bank liquidity as a factor that weakens the effectiveness of the traditional bank lending channel (see e.g. Kashyap and Stein, 2000, Kishan and Opiela, 2000) or as a factor that enhances loan issuance (see Cornett et al., 2011). What we emphasize in this paper is the change in banks' liquidity positions due to central bank's quantitative policy actions (such as reserve requirements), independent of the central bank's interest rate policy. We argue that even if the central bank keeps the short term money market interest rates at the same level, it can still have an impact on loan supply through quantitative policies by affecting the balance sheet composition of banks.

How does the liquidity channel that we propose in this paper compare to the traditional channels of monetary transmission mechanism? The traditional channel that is closest to the liquidity channel is the bank lending channel. In the case of the bank lending channel, contractionary monetary policy is represented by a decrease in bank reserves, which leads to a reduction in bank deposits and a decline in bank loans. Bank loans decrease because deposits and external funding are not perfect substitutes as sources of funds. That is, banks cannot completely replace the decline in deposits by generating external funding. In the case of the liquidity channel, contractionary monetary policy is represented by an increase in required reserves, which leads to a decline in deposits and a decline in bank loans. Unlike the bank lending channel, the reason for the decline in deposits is not open market operations but an

increase in the opportunity cost of raising deposits. This time, bank loans decrease because deposits and central bank funding are not perfect substitutes as sources of funds. That is, banks cannot completely replace the decline in deposits by borrowing from the central bank or interbank markets because doing so depletes their stock of liquid assets.

III. Monetary Policy, Banking System, and the use of Reserve Requirements in Turkey

Banking System and the Composition of Loans

Turkish financial system is dominated by commercial banks where bank lending is mainly financed by deposits. As of the end of 2013, loan to deposit ratio was around 110 percent. About 90 percent of deposits and lending is extended by the largest 19 banks we consider in our analysis. Loans to nonfinancial companies are issued both in Turkish liras (TL) and in foreign currencies. Consumer loans, on the other hand, are almost fully in TL since banks are not allowed to lend to consumers directly in foreign currencies.

Central Bank of the Republic of Turkey (CBRT) mainly used the reserve requirements for Turkish lira denominated liabilities for countercyclical purposes in the past few years. Liabilities in foreign currencies are also subject to reserve requirements but they have been mostly used for prudential purposes rather than countercyclical credit policy. Therefore, in this study we focus on the movements in the reserve requirements for TL liabilities and their interaction with the bank lending behavior.

We investigate the consumer and corporate loans separately to shed light on the differences in their transmission mechanisms. Slightly more than half of the TL lending is extended to non-financial companies as commercial loans. Commercial loans have relatively short maturity with re-adjustable interest rates. The other half of TL lending is consumer loans, which have longer maturity (averaging about 5 years) and fixed interest rates. Typically, the demand for consumer loans is more sensitive to interest rate changes while

corporate loans—especially those used for working capital—are less sensitive to interest rates. Moreover, the demand for corporate loans is also less sensitive to interest rate differentials across banks (see Alper et. al. 2011).[6] We come back to this point during the interpretation of our empirical findings.

Monetary policy framework since 2010

Before 2010, monetary policy framework could be characterized as a conventional inflation targeting regime where short term interest rate was the main instrument. After the global crisis, heightened volatility in capital flows and uncertainties regarding the global economy prompted the CBRT to adopt an alternative approach to monetary policy. The new framework can be described as an augmented version of inflation targeting where the central bank explicitly acknowledges the need to respond to macroeconomic financial risks by using multiple instruments. There is enhanced emphasis on avoiding excessive credit growth and exchange rate misalignments. To this end, reserve requirements, liquidity policy, interest rate corridor, and reserve option mechanism are used after 2010 to supplement the new framework. Although our focus is mainly on the reserve requirements and the liquidity policy of the CBRT, we provide brief descriptions of the other main instruments as well, because they are interrelated and complementary and thus can be helpful in interpreting our results.

Reserve Requirements

Reserve requirements are applied to the stock of bank liabilities, which predominantly consist of deposits. RR was used in Turkey as a policy tool during the 2008-2009 global crisis mostly for crisis management and not necessarily for counter-cyclical policy purposes. In fact, the CBRT paid interest (remuneration) to reserve requirements until 2010, where the interest

[6] The insensivity of commercial loan demand to loan rates can be explained by the relationship banking in the literature (see Boot, 2000)**.** Banks form relationship with firms over time to diminish the effects of information asymmetries. Most firms, especially small and medium sized firms establish these relationships with banks. Banks may gain from their relationships with these firms such that they can then use the informational advantages to maintain bank lending during a monetary contraction at low risk and low cost to themselves. Firms also prefer to work with the banks they establish relationship and thus changes in interest rates may not motivate them to change the bank they get used to work.

rate hovered around 80 percent of the central bank's policy rate. Therefore, the cost channel of RR was negligible by construction. After 2010, the CBRT used the required reserves more actively in various dimensions. There have been several changes to the RR during the sample period. First, the remuneration was terminated to increase the effectiveness of RR as a monetary policy tool. Second, the coverage of reserve requirements was expanded. Third, in order to encourage the lengthening of the maturities in deposits and other stable funding sources, the required reserves ratio was differentiated across maturities. Fourth, the weighted average reserve requirements ratio for the banking sector was raised by about 10 percentage points in several steps. Finally, the CBRT introduced a new scheme called the Reserve Options Mechanism, where the banks are allowed to hold a certain fraction of their reserve requirements for TL denominated liabilities in foreign exchange. All these measures led to substantial variations in the reserve holdings of the banking system, both across banks and through time, which is not common in central banking practice.[7] Such variation is critical in helping us identify the different channels of the transmission mechanism empirically.

Reserve Option Mechanism

At the end of 2011, the CBRT introduced the Reserve Option Mechanism (ROM) to smooth out the impact of capital flows on credit growth and exchange rates. The idea was to absorb the massive inflows triggered by the quantitative easing policies of advanced economies and accumulate foreign exchange reserves without excessive sterilization costs.

The ROM is a mechanism that allows banks to voluntarily hold a certain portion of their TL reserve requirements in foreign exchange and/or gold. The amount of foreign exchange or gold that can be held per unit of TL is called the reserve option coefficient (ROC). For example, if the ROC is 2, banks must hold 2 TL worth of foreign currency or gold

[7] In the construction of the RR, we take the weighted average of RR across maturities of liabilities subject to reserve requirements. RR varies across maturities of bank liabilities or from one maintenance period to another. Thus, RR has both cross sectional and time variation in our sample.

per 1 TL reserve requirement if they wish to utilize the ROM facility. The CBRT adjusted the ROC to change the relative cost of using the reserve option mechanism.[8]

A simple example may help understand the mechanism. Suppose that banks have to hold 100 TL reserve requirements in total for their TL liabilities. Let us assume that the ROM allows the banks to hold up to 90 percent of their TL reserve requirements in foreign currency and that the Reserve option coefficient (ROC) is equal to 1. Let us further assume that the USD/TL exchange rate is 1.8. In this case, if the bank prefers to use the facility fully in USD, it has to hold the 90 TL equivalent of USD, which is 90/1.8 = 50 USD. If this is the case, banks will hold 50 USD (90 TL) plus 10 TL, to fulfill their 100 TL of total reserve requirements. If the ROC is set at 2 instead of 1, the banks will have to hold the 2 TL equivalent of FX per 1 TL. In this case, if the banks wish to utilize the facility fully, they will hold 90×2=180 TL equivalent of foreign currency for their 90 TL reserve requirements, which will be 180/1.8=100 USD.

Given that ROM uses reserve requirements as a natural base to operate, any study exploring the impact of reserve requirements in Turkey has to take ROM into account. One advantage of this mechanism from the perspective of this study is the rich cross sectional and time series variation it provides for empirical analysis. The parameters of the reserve option mechanism have been changed many times during our sample period, which leads to substantial variation in the data and helps us better identify the channels of the transmission mechanism.

Computation of Cost Effective Reserve Requirements

In order to conduct empirical analysis on the transmission of reserve requirements, it is critical to decide on which metric to use as a measure for reserve requirements. One possible option is to use the officially announced average reserve requirements weighted across

[8] See Alper, Kara, and Yörükoğlu (2013) for a detailed exposition of the reserve option mechanism.

liabilities for different maturities. However, this may not be an appropriate strategy in Turkey where there have been several changes to the reserve requirement scheme, including remuneration and the introduction of the reserve option mechanism explained above. In order to capture all these changes in one variable, we develop and use a single metric throughout the study. Because reserve requirements introduce additional intermediation costs for the banks, it is informative to develop a variable to represent the cost-effective reserve requirements which encompasses various schemes.

Let us start with the simple case with no remuneration and no ROM. If there are no reserve requirements, the direct cost of collecting one unit of loanable fund is the interest rate paid for one unit of deposit, i^d. When the bank has to hold a fraction (RR) of deposits at the central bank in the form of unremunerated reserve requirements, effective cost of one unit of useable fund to the bank would increase to $i^d/(1\text{-}RR)$. If the central bank pays interest, $i_{rr,}$ for the required reserves, then the cost of using one unit of loanable funds would be $\frac{i_d - RR * i_{rr}}{1-RR}$. Because the CBRT stopped remunerating reserves in October 2010, which introduces a break in our series, we wish to develop a metric to transform the officially announced RR to cost-effective RR. This can be achieved by finding the RR^c that would satisfy the following equivalence:

$$\frac{i_d}{1-RR} = \frac{i_d - RR * i_{rr}}{1-RR^C}$$

Solving for RR^c in the above equation yields the following cost-based effective reserve requirement ratio:

$$RR^C = 1 - \frac{(1-RR)}{1 - RR * \frac{i_{rr}}{i_d}} \qquad (19)$$

Note that when i_{rr} =0, $RR^c = RR$, which corresponds to the period after October 2010 in our sample during when bank reserves were not remunerated.

How would one calculate the intermediation cost introduced by reserve requirements once the ROM is in place? In the absence of the ROM, the extra cost of fulfilling one unit of RR for TL liabilities for each individual bank is the cost of TL funding would be proportional to the TL deposit funding rate (i_d). When ROM is introduced, banks may prefer to hold a certain fraction of their requirements in foreign exchange or gold. Therefore, the banks' cost of funding reserve requirements now can be expressed as a linear combination of TL funding cost (i_d), foreign exchange borrowing cost (i_{FX}), and the cost of borrowing gold. For simplicity we assume that the cost of borrowing gold is close to the cost of borrowing foreign exchange.

Suppose a bank prefers to hold *x* percent of its reserve requirements in TL and (*1-x*) percent in foreign exchange and gold, and that the effective weighted average reserve option coefficient for foreign exchange and gold is *ROC.* In this case, the cost of funding one unit of reserve requirement is approximately equal to $x * i_d + (1 - x) * ROC * i_{FX}$ compared to the unit cost of i_d incurred in the absence the ROM. Therefore, we scale our cost-based reserve requirements measure shown in equation (21) by $[x * i_d + (1 - x) * ROC * i_{FX}] / i_d$ to find the effective cost of reserve requirements under ROM. Accordingly, our cost-based effective reserve requirement is:

$$RR^c = \left(1 - \frac{(1-RR)}{1-RR*\frac{i_{rr}}{i_d}}\right) * [x * i_d + (1 - x) * ROC^{FX} * i_{FX})] / i_d \quad (20)$$

where, RR is the officially announced average reserve requirements for TL liabilities. Thus, introducing the ROM lowers the direct intermediation cost of the effective reserve requirement as long as interest rate on foreign liabilities multiplied by ROC is lower than the borrowing cost in domestic currency.

Figure 3.
Average RR and Cost-Based Effective RR for TL Liabilities

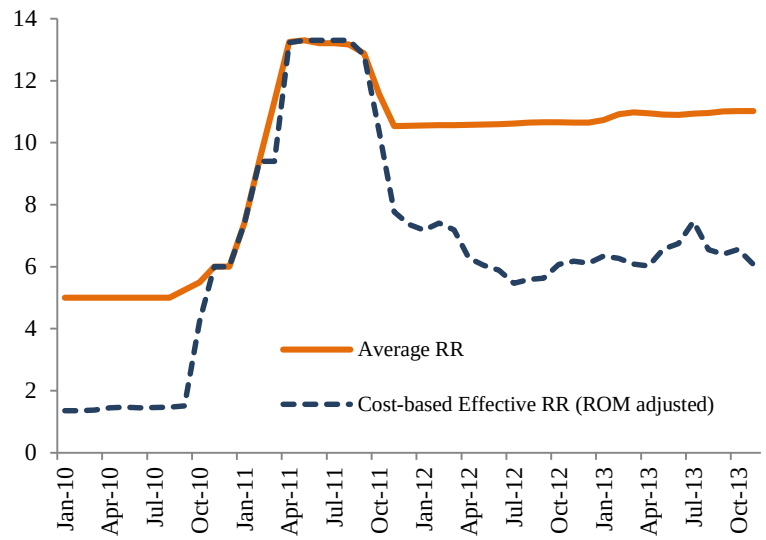


Figure (3) depicts the officially announced reserve requirements and our metric for cost-effective reserve requirements. Because the CBRT paid interest on reserves until October 2010, the cost-based effective RR during this period is lower than the average RR. Notice that the two ratios were very close from November 2010 to October 2011 when bank reserves were not remunerated. During this period, the time variation in the RR was driven by several hikes in RR with cross sectional variation due to the change in the maturity of liabilities subject to RR. After the CBRT introduced the ROM at the end of 2011, our cost-based effective RR measure once again departs from the average RR. The cost-based effective RR was consistently lower than the aggregate RR after October 2011 as borrowing costs in FX were lower than the costs in domestic currency. The parameters of the ROM were changed several times during this period which provided variation in both time series and cross sectional dimensions.

Interest Rate Corridor

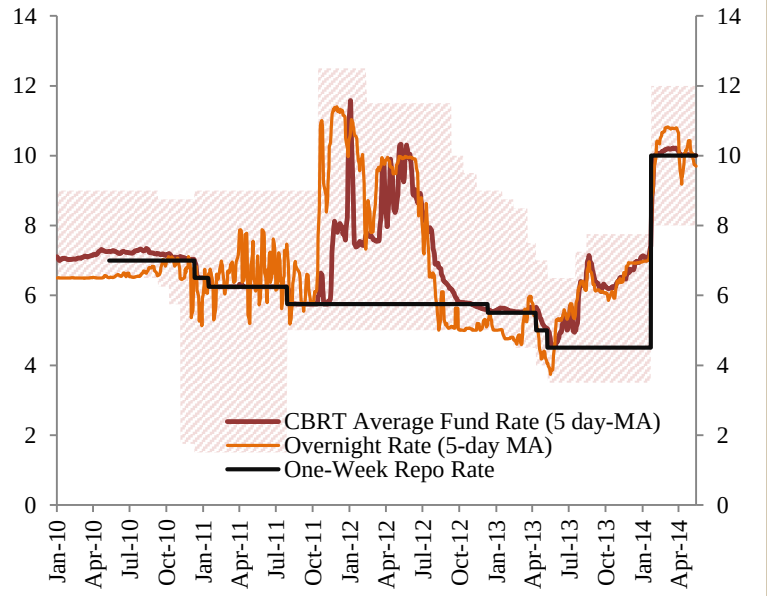
Another important feature of the Turkish monetary policy framework, which may be important in evaluating our empirical results, is the asymmetric interest rate corridor system. The asymmetric interest rate corridor is a new tool developed by the CBRT to increase the flexibility of monetary policy. It provides the ability to adjust short term interest rates promptly in response to external finance or risk sentiment shocks. Through the active management of daily open market operations, the overnight rate is allowed to fluctuate substantially within the corridor, when needed.

In order to understand how the mechanism works, we briefly review the operational framework. The CBRT, like many other central banks, uses a corridor system. The central bank has various instruments at its disposal to affect the amount of liquidity and interest rates in the interbank money market. In principle, the CBRT can provide daily, weekly, or monthly funding to the banks that are short of liquidity, and borrow at the O/N borrowing rate from those that have an excess of it. Because funding is provided mainly through weekly repo transactions, the average cost of funding by the CBRT is close to the one-week repo funding rate. The spread between the O/N borrowing and lending rates is called the "interest rate corridor"

What makes the Turkish case unique is the use of the width of the corridor as a policy instrument. In the conventional structure, the interest rate corridor is defined as a symmetric and generally unchanged narrow band around the policy rate, which is used as a two-sided buffer to prevent market rates from deviating significantly from the policy rate. The interest rate corridor assumes a passive role in this set up. In contrast, the CBRT used the interest rate corridor as an active instrument during most of our sample period by adjusting the width of the interest rate corridor possibly in an asymmetric way. The liquidity policy was used actively to deliver a faster and more flexible reaction to the volatility in short-term capital

movements. This behavior contrasts with the conventional corridor system where interest rates are fixed between two monetary policy committee meetings. To the contrary, interbank market rates and the weighted average cost of central bank funding were changed on a daily or weekly frequency, when necessary, by adjusting the quantity and the composition of funds provided through one-week repo auctions as shown in Figure 4. By changing the various parameters of the corridor, it is possible to have separate effects on exchange rate and credit growth, which would help ease the policy trade-offs faced by capital flows.[9]

Figure 4.
Implementation of Interest Rate Corridor



The use of the interest rate corridor and liquidity policies in an active way has implications for the empirical results and the interaction between reserve requirement and interest rate policies. As noted in the previous section, one of the transmission channels of RR mentioned in the literature is the interest rate risk channel (Betancourt and Vargas, 2008). In practice, however, we argue that the extra interest rate risk incurred by the bank through a hike in reserve requirements should be limited due to two reasons: (i) central banks fix short

[9] See Kara (2013) for the details on the use of interest rate corridor to affect credit and exchange rate channels seperately. Binici, Erol, Kara, Özlü and Ünalmış (2013) show how credit-deposit interest rate spread responds to various policy instruments.

term interest rates between two monetary monetary policy meetings, (ii) the maturity of bank deposits are short, especially in emerging markets. For example, average weighted average maturity of deposits is 55 days in the Turkish case. When deposits are of short term nature, interest rate risk incurred from the central bank funding is relatively low, especially under a typical IT framework where short term interest rates are fixed within two MPC meetings.

It can be argued that the active use of the interest rate corridor in Turkey might have increased the uncertainty of short term interest rates within the month, which could have made the interest rate risk more relevant for banks. As we show in the empirical section, commercial loan rates in Turkey are sensitive to the upper bound of the interest rate corridor, which may indicate the importance of the interest rate risk for the bank loan pricing. On the other hand, consumer loans, which have much longer maturity with fixed interest rates should be priced according to longer term expectations regarding the cost of central bank funding. Provided that interbank rate is a good proxy for marginal cost of funding or future expected cost of funding, consumer loans should respond to them. All these assessments are important in formulating our empirical models for different loan types as well as deposits. The bottom line is that the CBRT adopted a "multiple policy rates" approach during most of our sample period. Therefore, as shown in the following section, our proxy for policy rate differs across empirical models.

IV. Empirical Analysis

In this section, we investigate how the key variables such as bank loan and deposit rates, as well as credit growth respond to changes in reserve requirements and other liquidity policies of the central bank.

Data

We use flow data on deposit and loan variables, which enables us to document the timely impact of policy decisions on bank behavior as well as the interaction of banks' liquidity positions with their lending. The flow data for loans consists of newly granted loans while the flow data for deposits reflect newly collected deposit within a month.[10] The sample period expands from June 2010 through December 2013.

Our data set includes 19 major deposit banks. The original frequency of our loan and deposit data is weekly. However, in order to filter out the noise in the erratic behavior of commercial loan rates we use monthly averages. The monthly frequency is also dictated by some of the macroeconomic variables such as the inflation rate or other balance sheet items that are only available at the monthly frequency.

Commercial loans in Turkey typically have short-term maturity with less than one year. Anecdotal evidence further suggests that a large fraction of these loans consists of very short-term loans with less than 3-months maturity that are frequently rolled over. In order to avoid double-counting in the presence of frequent roll-overs, we take the average loan volumes within a given month. In contrast, consumer loans have longer maturity, and they are not rolled over as frequently. Therefore, we take the sum of weekly consumer loans within a month.

Turning to the liabilities side, one of the stylized facts about the sources of funds in Turkey is that around 90 percent of customer deposits have durations that are less than three months. Therefore, we only consider these deposits with maturities up to three months in our analysis.[11] When we calculate the net interest rate margin, we consider comparable maturities and only construct the spread for commercial loans that typically have shorter durations.

[10] Changes in the stock data for total loans do not necessarily reflect new loans because the stock data can change due to expiring loans as well. Similarly, it is hard to detect roll overs in high frequency stock loans.
[11] Deposits consist of all household and institutional deposits, excluding interbank deposits.

Other bank level control variables that are used in the analysis include non-performing loan (NPL) ratio that is constructed as the volume of non-performing loans as a percentage of total loans. Non-performing loans are stock data; however, we take the first difference of NPL to proxy for flow data.

Liquidity ratio is the key variable for our analysis. In the empirical analysis, we construct the liquidity ratio as total securities held by each bank as a fraction of its total TL liabilities. Securities consist of total sovereign debt held by commercial banks in their trading portfolio. These securities can be used as collateral when banks need to borrow in the interbank market or they can be sold to meet any sudden liquidity needs that may arise due to policy shocks, deposit runs, or any other regulatory changes.

Empirical Results on Interest Rates

Our main focus is the impact of liquid asset holdings on bank behavior and its interaction with central bank liquidity policies. We start with a simple specification on the relationship between reserve requirements and bank lending rates:

$$ir_{it} = \beta_0 + \mu_i + \beta_1 ir_{i,t-1} + \beta_2 O/N_t + \beta_3 NPL_{it} + \beta_4 RR^c_{it} + \beta_6 X_t + \varepsilon_{it} \qquad (21)$$

Here ir_{it} interchangeably denotes interest rates on commercial loans, consumer loans, or deposits. O/N is the overnight interest rate. We use central bank overnight lending rate (upper bound of the interest rate corridor) and/or overnight interbank rates depending on the specification. RR^c_{it} is the cost-based effective required reserve ratio as described in the preceding section, NPL_{it} denotes non-performing loans ratio. X_t represents a vector of control variables such as the inflation rate, which is constructed as the year-over-year percentage change in the consumer price index; and the exchange rate, which is the 3-month percentage change in USD/TL exchange rate, calculated as the monthly average of daily rates. μ_i are bank-specific fixed effects. The errors, $\varepsilon_{i,t}$, are clustered at the bank level to address potential serial correlation.

In order to capture the dynamic adjustment and the persistency in interest rates, the lagged value of the dependent variable is included as the right hand side variable. To remove the inconsistency in parameter estimates, we use generalized method of moments (GMM) of Arellano and Bond (1991) as the estimation method. Given the endogeneity problem introduced by the lagged dependent variable, further lags of the dependent variable are used as instruments.

Table 2: Interest Rate on Commercial Loans

		(1)	(2)	(3)
1.	$i_{i,t-1}^{\text{commercial loan}}$	0.78***	0.78***	0.79***
		(0.02)	(0.02)	(0.02)
2.	CB O/N Lending Rate $_t$	0.19***	0.18***	0.15***
		(0.02)	(0.02)	(0.04)
3.	Nonperforming Loan Ratio $_{i,t}$	0.22**	0.19*	0.24**
		(0.11)	(0.11)	(0.11)
4.	Inflation rate$_t$	0.09***	0.08***	0.08**
		(0.03)	(0.03)	(0.03)
5.	Δ USD/TL $_t$	0.04***	0.03***	0.04***
		(0.01)	(0.01)	(0.01)
6.	RR^c $_{i,t}$	0.07***		0.07***
		(0.02)		(0.02)
7.	RR^c $_{i,t-1}$		0.08***	
			(0.02)	
8.	Interbank O/N Rate $_t$			0.06
				(0.06)
9.	Constant	-0.53**	-0.27	-0.42
		(0.26)	(0.24)	(0.25)
10.	Observations	817	817	817
11.	Number of id	19	19	19

Sample Period: June 2010 – December 2013. Standard errors are given in parenthesis and adjusted for heteroskedasticity. *** p<0.01, ** p<0.05, * p<0.1. Dynamic panel model is estimated with one stage GMM (Arellano and Bond, 1991).

Table 1 illustrates the regression results for commercial loan rates. We observe that the commercial loan rate is positively related to the upper bound of the corridor (row 2), while interbank rates are not significant in explaning the variations in the commercial loan rate (row 8), consistent with the earlier studies (see Binici et al.2013). This is an interesting result suggesting that banks, in setting their commercial loan rates, fully price the interest rate risk posed by the active use of the interest rate corridor.

The results in Table 2 suggest that an increase in non-performing loans prompts the banks to tighten their lending through higher rates (row 3). Furthermore, loan rates are positively correlated with the inflation rate, consistent with the Fisher hypothesis (row 4).

If reserve requirements play a significant role in the monetary transmission mechanism, we should expect a positive relationship between RR_{it}^{c} and loan rates so long as central bank funding and deposits are imperfect substitutes (β_4>0). Looking at the relationship between the loan rate and RR, we note that the coefficient on the required reserves ratio is positive and highly significant either contemporaneously (row6) or with a lag (row 7). Based on the depiction of the monetary transmission mechanism in section 2, a significant and positive coefficient associated with RR, after controlling for the policy rate implies that interest rate risk channel or the liquidity price channel may be operational in moving the loan rates.

Looking at the size of the β_4 coefficient in rows 6 and 7, and taking into account the long run impact implied by the coefficient on lagged dependent variable (β_1) in row 1, we note that a 1 percent increase in the RR is associated with an increase of about 35 basis points in commercial loan rates. A significant and positive coefficient on the loan rate is at odds with the previous literature on RR (e.g. Glocker and Towbin, 2012) where central bank funding and bank deposits are argued to be close substitutes. Reinhart and Reinhart (1999) state that, the way the tax burden of RR is split between lenders and deposit holders depends on the degree of access to alternative sources of funding by banks. But even if we assume that banks' have no access to external funding and thus they reflect the intermediation cost fully to lending rates, the size of the β_4 coefficient is still much higher than the levels that can be explained by plain intermediation costs.[12]

[12] As shown in the previous section, the additional direct intermediation cost incurred by increasing the reserve requirement ratio by 1 percentage point would be close to the deposit rate. Because the average deposit rates during our sample period is around 8 percent, increasing reserve requirements by one percentage point would, on average, increase the direct intermediation costs of the banks by about 8 basis points.

As explained in section 2, reserve requirements decisions would have a stronger impact on the bank lending behavior when deposits and central bank funding are not close substitutes. Whether central bank borrowing is a perfect substitute for deposits for bank funding is an empirical question that can be tested in our framework. One way to test this hypothesis is to look at the relationship between deposit rates and the policy induced shifts in the liquidity need of the banking system (changes in net central bank funding).

In order to perform these additional tests, we decompose the liquidity need of the banking system as follows:

(i) *Changes in the liquidity need of the banks driven by central bank operations.*

These operations mainly consist of reserve requirement decisions and foreign exchange sale/purchase operations. The elevated liquidity needs that arise from a RR hike or an FX sale are initially met by more short term central bank credit provided through open market purchases. Because central bank funding depletes unencumbered assets, it heightens the liquidity risk incurred by the banking system. Going back to section 2, if central bank funds and deposits are not perfect substitutes, then, when there is an increase in central bank's net funding to the system, banks would increase their deposits rates to attract more deposits. Because deposits are more valuable than central bank funding from a liquidity and interest rate risk perspective, an increase in borrowing needs prompts banks to increase their deposit rates to attract more deposits. Therefore we expect a positive coefficient on the liquidity need arising due to both reserve requirement decisions and foreign exchange sale/purchase operations.

(ii) *Changes in the liquidity need of the banks mostly due to endogenous movements* such as shifts in the money demand. We do not necessarily expect a significant response from deposit rates to the endogenous shifts in the liquidity needs of the banking system because several common factors may explain both the liquidity and the changes in the deposit rates.

The sign may be positive or negative depending on the type of factors shifting the liquidity demand of the banking system. In what follows, we do not interpret the coefficient of this component because our main focus is central bank induced movements in the banks' liquidity needs.

The hypothesis to be tested is whether the change in the net liquidity need of the banking system driven by central bank operations (the first term discussed above) are neutral for deposit rates when other factors are controlled. If central bank funds and deposits are close substitutes, then the banks would not need to raise their deposit rates when faced with a liquidity shock. We run the following regression:

$$ir_{it}^{d} = \beta_0 + \mu_i + \beta_1 ir_{it-1}^{d} + \beta_2 afr_{it} + \beta_3 RR_t^L + \beta_4 FX_t^L + \beta_5 OFN_t + \beta_6 RR_{it}^c + \beta_7 X_t + \varepsilon_{it} \quad (22)$$

where ir_{it}^{d} is the deposit rate and afr_{it} is the average funding rate, which is calculated as the weighted average interest rate for the outstanding stock of funding by the CBRT via interbank money market (deposit lending) and open market operations (BIST, primary dealer, one-week and one-month repo operations). Because the original frequency of these series is daily, we take the arithmetic average to construct monthly series. RR_t^L denotes the liquidity withdrawn from (or injected to) the system through reserve requirements, while FX_t^L is liquidity withdrawn (or injected) via foreign exchange operations. These variables are constructed so that an increase in reserve requirements or a foreign exchange sale operation would result in higher funding needs. OFN_t represents other funding needs of the banking system calculated as open market operations net of reserve requirements and FX related liquidity operations, which is the second component of the liquidity need discussed above. All funding variables are scaled by total TL liabilities that are subject to required reserves. In the regression we also control for the direct intermediation cost of the reserve requirements, RR_{it}^c. Finally, the vector *X* stands for the other macroeconomic variables such as inflation rate and currency depreciation.

Table 3: Deposit Rates with Liquidity Components

		(1)
1.	$\dot{I}_{i,t-1}^{deposit}$	0.64***
		(0.03)
2.	Average Funding Rate $_t$	0.26***
		(0.03)
3.	Funding need due to RR (RR_t^L)	0.03***
		(0.01)
4.	Funding need due to FX Operations$_t$ (FX_t^L)	0.11***
		(0.01)
5.	Other Funding Need $_t$ (OFN_t)	-0.02
		(0.01)
6.	Direct Cost of RR ($RR_{i,t}^c$)	0.06***
		(0.01)
7.	Inflation $_t$	0.08***
		(0.01)
8.	Δ USD Dollar/TL $_t$	0.01***
		(0.001)
9.	Constant	0.91***
		(0.19)
10.	Observations	817
	Number of id	19

Sample Period: June 2010 – December 2013. Standard errors are given in parenthesis and adjusted for heteroskedasticity. *** p<0.01, ** p<0.05, * p<0.1. Dynamic panel model is estimated with one stage GMM (Arellano and Bond, 1991).

Table 3 shows the regression results. Our main focus is on the coefficients of the central bank funding components that are driven by central bank operations. Therefore, we are interested in the estimated coefficients for β_3 and β_4, which are shown in rows 3 and 4. The estimates are significant and positive for both of the coefficients, as expected. There is a significant increase in the deposit rates when the funding need of the system rises with central bank policy actions such as higher reserve requirements or foreign exchange sales. These results further strenghten our intuition that central bank funding and deposits are not strong substitutes. The implication is that there may be additional channels through which RR interacts with bank behavior such as interest rate risk and liquidity channels, both of which would imply imperfect substitution of deposits with central bank funds. This finding also complements the results in Table 2 which showed that the size of the reserve requirement's impact on the bank loan rate is higher than that implied by direct intermediation costs.

Up to this point we have provided indirect evidence on the existence of the liquidity channel. Next, we take the analysis one step further and directly test the liquidity impact on bank loan and deposit rates. To that end, we add our measure for bank liquidity to equation (21) such that:

$$ir_{it} = B_i + \beta_1 ir_{i,t-1} + \beta_2 O/N_t + \beta_3 NPL_{it} + \beta_4 RR^c_{it} + \beta_5 X_t + \beta_6 LR_{it} + \beta_7 RR^c_{it} \times LR_{it} + \varepsilon_{it} \quad (23)$$

where LR_{it} is the liquidity ratio. We also add an interaction term $RR^c_{it} \times LR_{it}$ to capture the relationship between reserve requirements and bank liquidity. If the liquidity channel is effective, then the positive relationship between interest rates and RR should be amplified for those banks with less liquid portfolios. Put it differently, having more liquidity buffers should weaken the impact of RR on interest rates, implying β_7<0.

Table 4 shows the estimation results of equation (23). The first column adds the liquidity ratio to the specification in Table 2 and finds that the LR is negatively related to the commercial loan rate (row 8). Better liquidity implies lower rates because banks are more comfortable in issuing new loans, as implied by the theory. This finding is consistent with the liquidity channel of reserve requirements, given that RR policy is a major driver of bank liquidity as discussed in the context of Figure 2.

Table 4: Interest Rate on Commercial Loans

	(1)	(2)	(3)	(4)	(5)
1.$\dot{I}_{i,t-1}$ commercial loan	0.78***	0.77***	0.78***	0.78***	0.78***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
2.O/N Lending Rate $_t$	0.25***	0.19***	0.21***	0.23***	0.19***
	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
3.Nonperforming Loan Ratio $_{i,t}$	0.19*	0.17*	0.21**	0.20**	0.17*
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
4.Inflation $_t$	0.02	0.06**	0.04	0.02	-0.01
	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)
5.Δ USD Dollar/TL $_t$	0.05***	0.03***	0.02*	0.02*	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
6.RR^c $_{i,t}$			0.06***	0.08***	
			(0.02)	(0.02)	
7.RR^c $_{i,t-1}$		0.07***			0.09***
		(0.02)			(0.02)
8.Liquidity Ratio$_{i,t-1}$	-0.03***	-0.019***			

	(0.01)	(0.01)			
9. $\widehat{Liquidity\ Ratio}_{i,t-1}$			-0.11***	-0.10***	
			(0.03)	(0.03)	
10. $\widehat{Liquidity\ Ratio}_{i,t-1}$					-0.16***
					(0.03)
11.$RR^c_{i,t}$×Liquidity Ratio $_{i,t}$				-0.002**	
				(0.001)	
12.$RR^c_{i,t}$×Liquidity Ratio $_{i,t-1}$					-0.002**
					(0.001)
Constant	0.40	0.081	1.05	1.13	2.33***
	(0.31)	(0.29)	(0.69)	(0.69)	(0.53)
Observations	817	817	817	817	817
Number of id	19	19	19	19	19

Sample Period: June 2010 – December 2013. Standard errors are given in parenthesis and adjusted for heteroskedasticity. *** p<0.01, ** p<0.05, * p<0.1. Dynamic panel model is estimated with one stage GMM (Arellano and Bond, 1991). Liquidity $Ratio_{i,t-1}$ is instrumented by the change in net TL injection implied by the central bank through foreign exchange operations. $\widehat{Liquidity\ Ratio}_{i,t-1}$ denotes the fitted value obtained from regressing liquidity variable on FX_t^L.

If changes in reserve requirements directly affect bank liquidity, the liquidity ratio would be correlated with RR. Hence it may not be clear whether the significance of the LR in column (1) is due to pure liquidity effects or the interaction of the cost channel of RR with liquidity effects. To address this issue, we add our cost based required reserves measure together with the liquidity ratio in column two and show that the liquidity ratio is still significant when required reserves are included in the specification. The coefficient associated with the liquidity ratio in column 2 indicates that even after we control for the effects of RR^c on the loan rate, there may be still additional impact due to changes in bank liquidity.

As another robustness check, we address the potential endogeneity between bank loans and the liquidity ratio. The decision to alter the fraction of liquid assets might be an endogenous choice by each bank, especially at the high frequency that we consider. Bank's lending decisions directly feed into its liquidity while the liquidity of its portfolio directly affects the bank's lending. Moreover, these two variables might move simultaneously by the bank's decisions to allocate its portfolio between more liquid vs. less liquid assets in response to various shocks. For example, if one bank decides to increase its share in the loan market,

the first response would be to cut the loan rates and increase the loan supply, which may lead to a negative relationship between liquidity ratios and loan rates. Thus, a reduced form OLS regression of the loan rate on bank liquidity would tend to underestimate the true relationship. The previous literature on the liquidity effects typically focuses on the crisis times when bank liquidity was subject to exogenous fluctuations arising from changes in the market risk sentiment. Hence, their treatment of the liquidity as an exogenous variable is justifiable. In contrast, our focus is on the use of reserve requirements during relatively more tranquil times when the banks did not face an acute liquidity risk. Under such circumstances, changes in the bank's portfolio decisions would largely reflect simultaneous changes in bank lending and liquid assets.

Because bank liquidity ratios are affected virtually from all the developments related to balance sheets, treating bank liquidity as an endogenous variable and finding the right instrument is a main challenge. Our solution is to instrument for bank liquidity with the liquidity withdrawn/injected through central bank's FX operations. In emerging economies, many central banks resort to FX operations as an additional tool to smooth the volatility of exchange rates posed by frequent fluctuations in capital flows. The CBRT used foreign exchange rate operations intensively since 2011 as well. In the case of sterilized operations, the domestic currency funds injected to the financial system through FX purchases is withdrawn through open market operations. Because central bank funding is collateralized, this means the liquid assets and thus the liquidity ratios of the banking system are directly affected by the foreign exchange operations. Thus, even though foreign exchange operations directly affect bank liquidity by inducing a change in the net TL funding need of the system, they are conducted independent of bank loans because their main motivation is to smooth exchange rate volatility. Hence, the amount of net TL funding through FX operations can be used as an instrument for bank liquidity.

Accordingly, in order to address the endogeneity in the liquidity ratio, we run the following auxiliary regression to obtain the fitted value of LR as a first stage:

$$LR_{it} = \beta_i + \beta_1 FX_t + \varepsilon_{it} \quad (24)$$

where LR_{it} is the liquidity ratio of bank *i* and FX_t is the total Turkish lira funds withdrawn through net foreign exchange sales in month *t*. At the next step, we use the fitted value from equation (24) to replace LR_{it} in equation (23). Columns 3-4 in Table 4 display the results from these specifications. We note that once we correct for the endogeneity bias, the coefficient associated with the liquidity ratio more than triples in absolute value, indicating that the endogenous shifts in the bank lending behavior which tend to imply a *positive* contemporenous correlation may lead to an underestimation of the true impact of liquidity on bank behavior.

One way to test whether the liquidity channel is significant is to see if the negative relationship between RR and loan rates is weaker for those banks with higher levels of liquidity. Recall that the liquidity channel argues that an increase in RR leads to a decline in bank liquidity, which puts upward pressure on loan rates and a decline in bank loans. Accordingly, if there is a significant liquidity channel, then the impact of RR on loan rates should be more pronounced for those banks that have less liquid balance sheets. In order to test this argument formally, we interact the RR with bank liquidity.[13] Rows 11 and 12 in Table 4 illustrate that the coefficients associated with the interaction terms are significant and negative as expected, suggesting the presence of a liquidity channel.

[13] The OLS estimator for the endogenous interaction term is shown to be consistent. See Bun and Harrison (2014), Aghion et al.(2005), Rajan and Zingales (1998).

Table 5: Estimates for Interest Rates on Commercial and Consumer Loans, Deposit and Spread

		Commercial	Consumer	Deposit	Spread
		(1)	(2)	(3)	**(4)**
1.	$i_{i,t-1}$	0.77***	0.82***	0.64***	0.78***
		(0.02)	(0.01)	(0.02)	(0.02)
2.	CBT O/N Lending Rate $_t$	0.19***			
		(0.02)			
3.	Average Funding Rate$_t$		0.37***	0.33***	
			(0.05)	(0.02)	
4.	Spread $_{i,t-1}$				0.22***
					(0.04)
5.	Nonperforming Loan Ratio $_{i,t}$	0.17*	0.46**		0.22**
		(0.10)	(0.21)		(0.09)
6.	Inflation $_t$	-0.01	0.12**	0.07***	
		(0.04)	(0.04)	(0.02)	
7.	Δ USD Dollar/TL $_t$	0.01	0.02	0.01***	0.02**
		(0.01)	(0.02)	(0.002)	(0.01)
8.	RR^c $_{i,t}$	0.08***	0.17***	0.05***	0.04*
		(0.02)	(0.05)	(0.01)	(0.02)
9.	$\widehat{Liquidity\ Ratio}_{t,t-1}$	-0.16***	-0.13**	-0.07***	-0.03
		(0.03)	(0.06)	(0.01)	(0.03)
10.	RR^c $_{i,t}$×Liquidity Ratio $_{i,\,t-1}$	-0.002**	0.001	0.00	-0.002
		(0.001)	(0.002)	(0.00)	(0.001)
11.	Constant	2.33***	-0.02	0.59***	0.39
		(0.53)	(1.27)	(0.19)	(0.35)
12.	Observations	817	817	817	817
13.	Number of id	19	19	19	19

Sample Period: June 2010 – December 2013. Standard errors are given in parenthesis and adjusted for heteroskedasticity. *** p<0.01, ** p<0.05, * p<0.1. Dynamic panel model is estimated with one stage GMM (Arellano and Bond, 1991). Liquidity Ratio$_{i,t-1}$ is instrumented by the change in net TL injection implied by central bank foreign exchange operations. $\widehat{Liquidity\ Ratio}_{t,t-1}$ denotes the fitted value obtained from regressing liquidity variable on FX_t^L.

Table 5 extends the analysis to a wider range of interest rates. The first column in Table 5 replicates the last column in Table 4 for comparison purposes. The rest of the columns show the estimation results for the interest rates on consumer loans, deposit rates, and the spread between the commercial loan rate and the deposit rate. We observe that the liquidity ratio has a negative relationship with consumer loans and deposit rates as well.

It is interesting to note that the significance of the interaction of bank liquidity with the impact of reserve requirements cannot be generalized to consumer loan rates (row 10, column 2). In other words, liquidity does not seem to play a significant role in the reaction of

consumer loan rates to changes in reserve requirements. One way to interpret this finding is to note that consumer loans in Turkey have higher demand elasticity of interest rates compared to commercial loans (see the discussion in the next section). Therefore, one can argue that the banks might be less flexible in changing their rates for consumer loans relative to commercial loans when they are faced with idiosyncratic liquidity shocks.

These findings provide compelling evidence that liquidity position of the banks matter for bank lending behavior. Provided that the liquidity ratios of the banks can be affected by central bank quantitative policies such as reserve requirements, these results imply that monetary policy has an alternative channel distinct from short term interest rate policies. In section 2, using a balance sheet approach we illustrated how a change in the reserve requirement decision of the banks is translated into a change in the liquidity ratios. Figure 2 also confirms this intuition by exhibiting a close relationship between the TL reserves held at the central bank and the liquid government bond holding of commercial banks. Therefore, even when the central bank purely "sterilizes" the impact of its own decisions through open market operations, the actions of the central bank may not be neutral because the open market operations have consequences on the banks' liquidity positions.

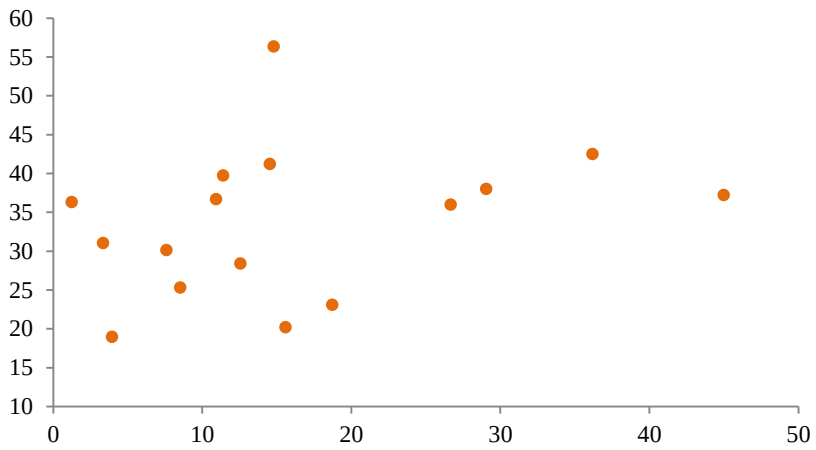
Our empirical results provide ample evidence on the existence of balance sheet effects of central bank liquidity policies such as reserve requirements and/or FX operations. These policies may induce a shift in the balance sheet composition of banks, which in turn may have an impact on loan and deposit rates.

Empirical Results: Loan Growth

Before proceeding with the analysis on loan growth and liquidity, it is informative to have a cursory look at the data. When the CBRT started implementing unconventional policies at the end of 2010, most banks had sizeable initial amounts of liquidity buffers in the form of government securities. The figure below (Figure 5) provides a scatterplot between

the initial liquidity levels of banks and their consequent loan growth. The figure suggests that banks with higher initial liquidity buffers could afford higher credit growth during the period when the CBRT hiked reserve requirements aggressively. This observation strengthens our intituion that the liquidity position may be an important component of bank lending behavior.

Figure 5.
Initial Government Bond Holdings and Cumulative Loan Growth



* Y-axis denotes credit growth (% Δ between November 2010-December 2011) while X-axis denotes Securities /TL Liabilities (September-November 2010 Average).

In the previous subsection, we documented that liquidity has a stronger impact on commercial loan rates relative to consumer loans. At first sight, this result may look puzzling, because the consumer loans in Turkey are of longer term and fixed rate, while commercial loans have much shorter maturity with adjustable interest rates. The longer duration of consumer loans makes them less liquid relative to commercial loans, which would imply a stronger response of consumer loans to the changes in the liquidity positions. A potential explanation for the stronger evidence on the liquidity channel for commercial loans can be attributed to their relatively lower demand elasticities to interest rates compared to consumer loans. Table 6, which is reproduced here using the survey evidence from Alper et al.(2010), shows that consumer loans, especially mortgages, have the highest degree of sensitivity to interest rates among all loan types, suggesting that banks might be more hesitant to adjust the rates on such loans in the face of moderate fluctuations in bank liquidity. In other words, the

sticky pricing behavior might limit the response of consumer loan rates to liquidity movements, notwithstanding the less liquid nature of consumer loans relative to commercial loans.

Table 6: Degree of Loan Price Elasticity*

	Liquidity of the loan type	Elasticity of the loan demand to banks' interest rate differential	Interest Rate Elasticity of the loan demand
Firm Loans	+++	++	+
Consumer Loans	+	+++	++
Housing		++++	+++
Other	+	++	+
Automobile	+	+++	++

Given the *rigidity* in the prices of consumer loans, one should be able to see the impact of liquidity developments on the *quantity* of loans, if the liquidity channel we describe is valid. In order to assess this conjecture, we complement our analysis by investigating whether the direct impact of liquidity on the quantity of new loans differs across loan types.

In order to check the existence of the transmission channels on loan volumes, we estimate the following equation for bank loans:

$$\Delta \log(Loans)_{it} = B_i + \beta_1(\Delta Capital\,Inflows)_t + \beta_2 \Delta LR_{i,t-1} + \beta_3 \Delta RR_{i,t-1} + \beta_4 \Delta RR_{i,t-1} \times LR_{i,t-1} \quad (25)$$
$$+ \beta_5 \Delta O/N_{t-1} + \beta_6 \Delta \log(Core\,Deposits)_{i,t-1} + \beta_7 \Delta \log(Non-Core\,Deposits)_{i,t-1}$$
$$+ \beta_8 (LeverageRatio)_{i,t-1} + \beta_9 \Delta CI_{t-1} + \varepsilon_{i,t}$$

The dependent variable in equation (25) is the growth rate of newly issued bank loans. We estimate the equation for consumer loans and commercial loans separately as in the rate regressions. The loan data is seasonally adjusted using Census X-12 technique. In emerging economies, capital flows have a strong relationship with credit growth. Therefore, we add capital inflows into the regression as an explanatory variable. We use the share of foreign participation in the government bond market as a proxy for capital inflows. The growth rate of bank loans is expected to be positively related to capital inflows (β_1 >0). Due to the endogenous relationship between capital flows and bank loans, we estimate equation (25) via Two-Stage Least Squares, using the changes in country Credit Default Swap (CDS) spreads

as an instrument for capital inflows. One can argue that changes in the country CDS are directly related to capital flows but not directly related to the volume of individual bank loans. Hence, it should be a relevant instrument. Our tests regarding the validity and the relevance of the instrument verify this intuition.

A liquid portfolio is expected to encourage the issuance of bank loans (see e.g. Cornett et al.,2011). This implies that β_2>0. Meanwhile, it is also feasible to think of a scenario where the bank reduces its liquid assets to issue new loans temporarily in the face of an exogenous shock (β_2<0). Bernanke and Blinder (1992) note that banks may reduce their liquidity to maintain their existing loans until they adjust their loans and re-establish their optimal liquidity level. In the presence of these offsetting effects, the net sign of β_2 is indeterminate. Consistent with the previous section, we use the two step procedure to address the endogeneity problem in the LR by using the fitted value from equation (24).

An increase in RR is expected to reduce the growth rate of new loans (β_3 <0). Nevertheless, the significance of this variable alone cannot allow us to identify whether it is driven by the cost channel, the interest rate risk channel, or the liquidity channel. In order to identify the presence of a liquidity channel, we interact RR with the liquidity ratio as in the previous section. If banks have higher liquidity ratios, then they should not be as adversely affected from the hike in RR (β_4 >0).

The rest of the control variables are as follows: in order to control for the monetary channel, we include overnight rates as the policy rate. An increase in the policy rate is expected to reduce the growth rate of bank loans consistent with tight monetary policy (β_5 <0). We use the same loan growth equation for consumer and commercial loans except for the variables that capture the policy rate and the economic activity. As the policy variable, we use the upper bound of the interest rate corridor for the commercial loans, and interbank rates for consumer loans. To capture the impact of the economic activity on loan demand, we use

business confidence index (RCI) for commercial loans and consumer confidence index (CCI) for consumer loans. A higher level of confidence in the economy is expected to increase the demand for bank loans (β_9>0). As for the funding opportunities, core and non-core liabilities are expected to increase the bank's issuance of loans (β_6, β_7>0). We use lagged values for all the variables, as it takes time for the quantity of loans to adjust to changes in the policy variables. In contrast, in our loan rate specifications we used contamperaneous variables, because interest rates—especially commercial loan rates—adjust very quickly to policy changes.

Estimation results

The first stage equations (not shown) regress the change in capital inflows onto the regressors from the loan equations as well as the instrument for capital inflows, which is the change in CDS. The regression results for both consumer loans as well as commercial loans indicate that CDS is highly significant as an instrument for capital inflows and the F-test of excluded instruments is rejected, indicating that capital inflows are identified by the proposed instrument after partialing out the linear projection of other regressors.

Table 7 shows the results for the loan growth equation. The Kleibergen-Paap rk LM statistics (row 12) suggests that we reject the null hypothesis that the equations are under-identified. This suggests that the excluded regressors are relevant and correlated with the endogenous regressors. In our application, this finding reassures us that the change in CDS is a relevant instrument.

Looking at the first column for consumer loans, we observe that capital inflows are positively and significantly related to loan growth. In order to capture the lagged adjustment process between changes in bank liquidity and loans, we include the lagged value of the changes in the liquidity ratio. Consistent with the previous literature, we find a positive relationship between consumer loans and liquidity. Changes in reserve requirements are

negatively and significantly related to both types of loans, consistent with the previous section. That suggests the existence of the additional channels of monetary transmission mechanism triggered by reserve requirements.

Table 7: Loan Growth

		(Consumer)	(Commercial)
1.	$\Delta(\text{Capital Flows})_t$	5.49**	3.18
		(2.56)	(6.49)
2.	$\Delta \widehat{Liquidity\ Ratio}_{i,t-1}$	172.21*	24.66
		(98.33)	(109.06)
3.	ΔReserve Requirement Ratio$^{C}_{i,t-1}$ ($RR^{C}_{i,t-1}$)	-4.90***	-2.26**
		(0.92)	(1.09)
4.	$\Delta RR^{C}_{i,t} \times$ Liquidity Ratio$_{i,t-1}$	14.78**	1.68
		(6.54)	(6.33)
5.	ΔO/N BIST Rate $_{t-1}$	-4.72***	
		(0.90)	
6.	ΔO/N Lending Rate $_{t-1}$		-4.81**
			(2.12)
7.	Δ log (Core Deposits) $_{i, t-1}$	-0.02	0.30*
		(0.15)	(0.18)
8.	Δ log (Non-Core Deposits) $_{i, t-1}$	-0.01	0.01
		(0.02)	(0.01)
9.	Δ CCI $_{t-1}$	2.85***	
		(0.49)	
10.	Δ RCI $_{t-1}$		1.06**
			(0.5)
11.	Leverage Ratio $_{i,t-1}$	-1.26	-1.21
		(0.96)	(0.8)
12.	Under-identification test	LM=13.66	LM=13.46
	(Kleibergen-Paap rk LM statistic)	Chi-sq(1) P-value=0.00	Chi-sq(1) P-value=0.00

Sample Period: June 2010 – December 2013. Standard errors are given in parenthesis and adjusted for heteroskedasticity. *** p<0.01, ** p<0.05, * p<0.1. GMM Continuously Updated Estimator (CUE) is utilized. Dependent variable: $\Delta \log(Loans)_{it}$

When we interact the reserve requirements with the bank liquidity ratio (row 4), we observe that its coefficient is positive and significant for consumer loans, suggesting that banks with higher liquidity ratios are not as influenced by the negative impact of the liquidity squeeze that is induced by RR. This finding suggests that there is evidence of a liquidity channel for consumer loans.

Even though we do not find a significant impact of the liquidity variables on the quantity of commercial loans, this does not necessarily imply the inexistence of the liquidity

channel. Our findings can be reconciled with the intution that we had laid out in the previous section. In the case of commercial loans, the liquidity channel manifests itself through loan *prices* (interest rates), while for the consumer loans the liquidity impact is mostly evident through the adjustments in the *quantity*. We attribute these findings to the specific structure of the loan market in the Turkish banking system: high interest rate elasticity of consumer loan demand limits the reaction of consumer loan rates while banks have more freedom in adjusting their commercial loan rates.

Looking at the additional control variables, we observe that the policy rate is negatively related to bank loans consistent with a tight monetary policy action. Deposits are only marginally significant for commercial loans. Meanwhile, the confidence index is positively related to both types of loans.

V. Concluding Remarks

In this study, we explored the interaction between central bank liquidity policies, bank balance sheets, and bank lending behavior in the context of Turkey. We show that quantitative policies of the central bank affect the funding needs and the liquidity position of the banking system. The consequent changes in bank liquidity, in turn, have a significant impact on bank lending behavior. We define and highlight the role of the liquidity channel in driving these results. Our findings are also related to a broader theme which is recently discussed intensively among central bankers and academics: Can quantitative policy be used as an additional tool apart from the conventional interest rate policy? Friedman and Kuttner (2010) found evidence that during the 2007-2009 financial crises, the policy interest rate and the balance sheet of the Federal Reserve operated as independent instruments. In the Federal Reserve's experience, balance sheet policies were in the form of assets purchases (quantitative easing) under the zero lower bound. Emerging economies, on the other hand, resorted to quantitative tightening mostly in the form of reserve requirements, where capital inflows and financial stability

concerns imposed an upper limit on interest rates. Our results lend support to the view that reserve requirements can be used as an additional tool to affect bank lending behavior and ease the trade-off between price stability and financial stability.

References

Aghion, P., Howitt, P. and D. Foulkes, "The Effect of Financial Development on Convergence: Theory and Evidence", *The Quarterly Journal of Economics*, February 2005.

Alper, K., H. Kara, M. Yörükoğlu (2013), "Reserve Options Mechanism", *Central Bank Review*, 13 (1), 1-14.

Alper, K., Mutluer, D. Kurul and R. Karasahin (2011), "Arzın Merkezine Seyahat: Bankacılarla Yapılan Görüşmelerden Elde Edilen Bilgilerle Türk Bankacılık Sektörünün Davranışı", *CBRT Working Paper*, 1124.

Arellano, M. ve S. Bond (1991), "Some Tests of Specification for Panel Data: Monte Carlo Evidence and An Application to Employment Equations", *Review of Economic Studies*, 58, 277-297.

Bernanke, B. S. and A. S. Blinder (1988), "Credit, Money and Aggregate Demand" *American Economic Review*, Vol: 78(2), 435-39.

Bernanke, B. and A. Blinder (1992), "The Federal Funds Rate and the Channels of Monetary Transmission", *American Economic Review*, 82(4): 901-921.

Bernanke, B. and M. Gertler (1995), "Inside the Black Box: The Credit Channel of Monetary Policy Transmission", *Journal of Economic Perspectives*, 9, 27-48.

Betancourt, Y R and H. Vargas (2008): "Encajes Bancarios y la Estrategia de Inflación Objetivo", Borradores de Economía, no 533, Banco de la República. (in Spanish)

Binici, M., Erol, H., Kara, H., Özlü, P. and D. Ünalmis (2013), "Interest Rate Corridor: A New Macroprudential Tool?," *CBRT Research Notes in Economics*, 1320.

Boot, A. (2000), "Relationship Banking: What do We Know?", *Journal of Financial Intermediation*, 9(1), 7-25.

Bun, M. and T. Harrison (2014), "OLS and IV Estimation of Regression Models Including Endogenous Interaction Terms", Discussion Paper, 2014/02, Amsterdam School of Economics.

Cordella, T., Federico, P., Vegh, C. and G. Vuletin (2014), "Reserve Requirements in the Brave New Macroprudential World", *World Bank Policy Research Working Paper*, 6793.

Cornett, M. M., Macnutt, J., Strahan, P. and H. Tehranian (2011), "Liquidity Risk Management and Credit Supply in the Financial Crisis", *Journal of Financial Economics*, 101, 297–312.

Coval, J. and A. Thakor (2005),"Financial Intermediation as a Beliefs-bridge between Optimists and Pessimists", *Journal of Financial Economics*, 75, 535-569.

DeGroot, O. (2014),"The Risk Channel of Monetary Policy", *Finance and Economics Discussion Series*, Federal Reserve Board.

Di Giorgio, G. (1999), "Financial Development and Reserve Requirements", *Journal of Banking & Finance*, 23 (7), 1031-1041.

Fama, E. F. (1980), "Banking in the theory of finance", *Journal of Monetary Economics*, 6(1), 39-57.

Freixas, X. and J. Rochet (2008), "Microeconomics of Banking", The MIT Press.

Friedman, M. and K. Kuttner (2010), "Implementation of Monetary Policy: How Do Central Banks Set Interest Rates?," *Handbook of Monetary Economics, in: Benjamin M. Friedman & Michael Woodford (ed.)*, edition 1, volume 3, chapter 24, pages 1345-1438 Elsevier.

Glocker, C. and P. Towbin (2012), "The Macroeconomic Effects of Reserve Requirements", International Journal of Central Banking, *International Journal of Central Banking*, vol. 8(1), pp 65-114.

Gadanecz, B., A. Mehrotra and M. Mohanty (2014), "Foreign Exchange Inervention and the Banking System Balance Sheet in Emerging Market Economies",*BIS Working Papers*, No: 445.

Herrera, H.V., Betancourt, Y.R., Varela, C. and N. Rodrigues (2010), "Effects of Reserve Requirements in an Inflation Targeting Regime: The Case of Columbia", *BIS Papers* No: 54

Hoover, K. D (1988), "The New Classical Macroeconomics", *Blackwell Publishers*.

Kara, A. (2013), "Monetary Policy after the Global Crisis," *Atlantic Economic Journal*, International Atlantic Economic Society, vol. 41(1), pages 51-74, March

Kashyap, A. and J. Stein (2000), "What do a Million Observations on Banks Say about the Transmission of Monetary Policy? *American Economic Review*, 90, 407-428.

Kishan, R. and T. Opiela (2000), "Bank Size, Bank Capital, and the Bank Lending Channel", *Journal of Money, Credit and Banking*, 32, 122-141.

Medina, J. P. and J. Roldós (2014),"Monetary and Macroprudential Policies to Manage Capital Flows", *IMF WP/14/30*.

Montoro, C. and R. Moreno (2011), "The Use of Reserve Requirements as a Policy Instrument in Latin America," *BIS Quarterly Review*, March.

Orr, D. and W.G. Mellon, "Stochastic Reserve Losses and Expansion of Bank Credit", *American Economic Review*, Sept. 1961, 51, 6l4-23.

Prada, J. (2008), "Financial Intermediation and Monetary Policy in a Small Open Economy", *Borradores de Economia 531*, Banco de la Republica de Colombia (in Spanish).

Rajan, R. G. and L. Zingales (1998),"Financial Dependence and Growth", *American Economic Review*, 88 (3), 559-586.

Reinhart, C. and V. Reinhart (1999): "On the Use of Reserve Requirements in Dealing with Capital Flow Problems", *International Journal of Finance and Economics*, vol 4, no 1, pp 27–54.

Schaffer, M.E. (2010), "XTIVREG2: Stata module to perform extended IV/2SLS, GMM and AC/HAC, LIML and k-class regression for panel data models", http://ideas.repec.org/c/boc/bocode/s456501.html

Stiglitz, J. and A. Weiss (1981), "Credit Rationing in Markets with Imperfect Information," *American Economic Review*, 71, 393-410.

Tovar, C. E., Garcia-Escribano, M and M. V. Martin (2012), "Credit Growth and the Effectiveness of Reserve Requirements and Other Macroprudential Instruments in Latin America", *IMF WP/12/142*.