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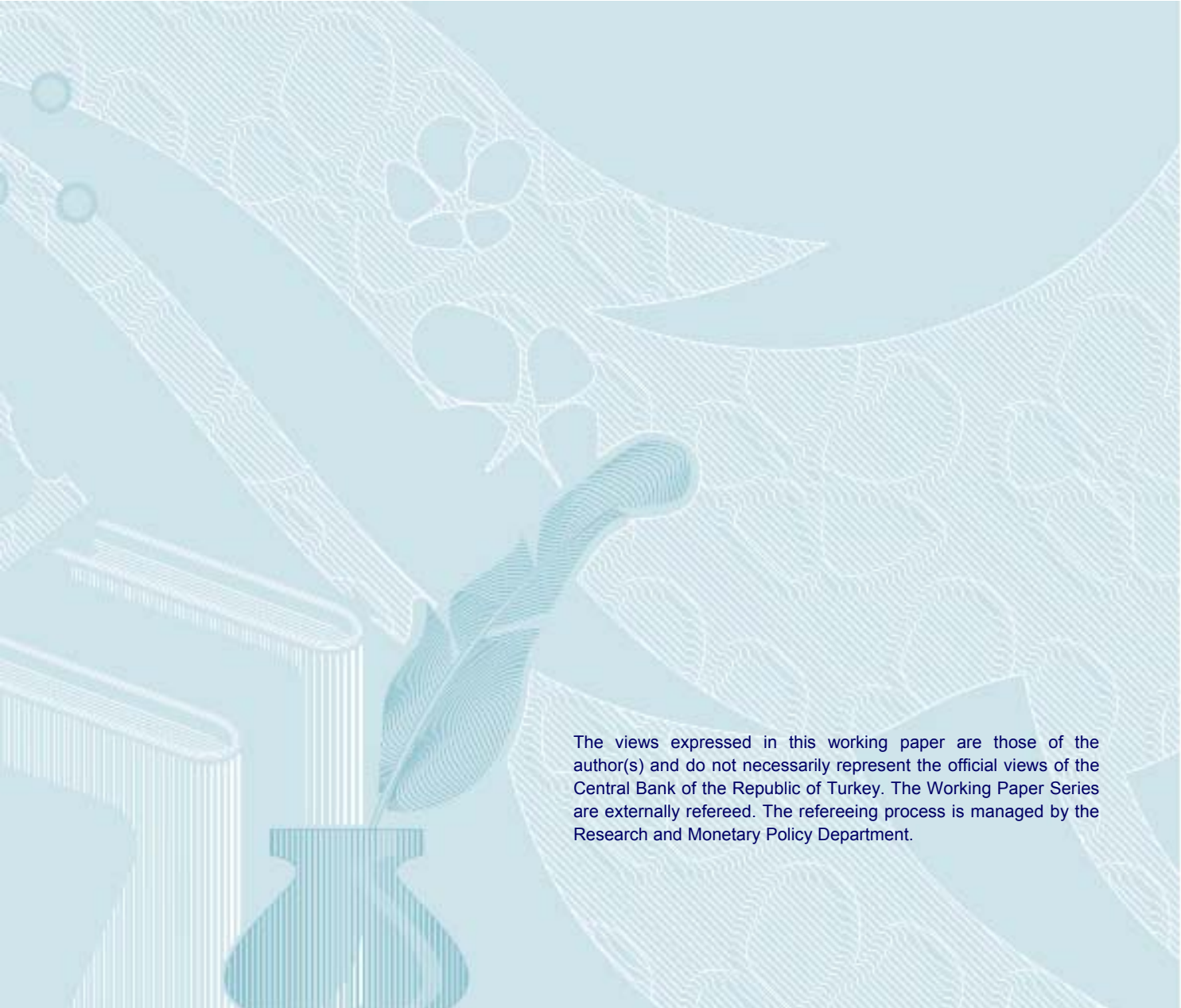
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Interest Rate Corridor, Liquidity Management and the Overnight Spread¹

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Abstract

Recently, massive global liquidity has compelled many emerging market economies to change their monetary policy frameworks in order to address the financial stability challenges posed by volatile capital flows. In this respect, as of the second half of 2010, the Central Bank of the Republic of Turkey (CBRT) has developed additional policy instruments to support the adoption of financial stability as a complementary objective to price stability. Liquidity management has actively been used in conjunction with a wide interest rate corridor to smooth excessive volatility in short-term capital inflows. As a result, the spread between the Borsa Istanbul overnight repo interest rate and the CBRT average funding rate (overnight spread) has become wider and more volatile. We analyze the determinants of the overnight spread using data from both the traditional and the new monetary policy episodes and empirically document that this spread has recently been influenced by various factors which are directly or closely related to the liquidity policy of the CBRT.

Keywords: Overnight interest rate; liquidity policy; monetary policy; operational framework

JEL Classification: E43; E52; C22

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1. Introduction

The aftermath of the recent global crisis is characterized by expansionary monetary policies of advanced economies, which have led to excessive liquidity in global markets and rapid changes in global risk perception. Beginning from the first half of 2009, monetary easing in advanced economies has led to a surge in capital inflows toward emerging economies including Turkey. An outcome of this development was the potential macroeconomic instabilities faced by emerging countries. A major concern has been that unfettered inflows can lead to problems in these countries such as exchange rate appreciation, excessive credit growth and/or asset price bubbles. Hence, many emerging markets had to amend their monetary policy frameworks and take macroprudential measures in order to address the financial stability challenges posed by volatile capital flows.² This paper focuses on the experience of Turkey, where the monetary policy framework has been extensively modified in the aftermath of the global financial crisis.

As of the second half of 2010, the Central Bank of the Republic of Turkey (CBRT) has changed the general framework of the inflation targeting regime and developed new policy instruments to support financial stability as a complementary objective to price stability. The new framework largely aims at containing the effects of capital flows on the domestic economy, especially on credit growth and current account deficit, without prejudice to the price stability objective.

In this respect, the CBRT increasingly emphasized credit growth and exchange rate as key channels in monetary policy transmission and stressed the need to have a separate control on these two variables, which in turn requires the use of multiple instruments.³ A conventional inflation targeting framework with a single instrument might lead to difficult policy trade-offs when large external shocks dominate. For example, raising the policy rate in order to prevent overheating and excessive credit growth during a capital inflow surge might pull even higher capital inflows, leading to overvaluation in domestic currency and a larger buildup of external imbalances. On the other hand, cutting the policy rate to prevent further capital inflows and currency

² Pradhan et al. (2011) and Ostry et al. (2010) review the policy responses of emerging markets to capital flows in the aftermath of the global financial crisis.

³ Kara (2013) explains in detail various policy instruments introduced in the new policy framework and discusses how exchange rate and credit channels are affected by the new policy instruments of the CBRT.

appreciation might feed into a larger boom and have adverse consequences for inflation.

The new policy mix of the CBRT entailed the joint use of the interest rate corridor between overnight borrowing and lending rates (asymmetric interest rate corridor)⁴, liquidity policy and required reserves in addition to the policy rate.⁵ We should note here that, since multiple liquidity instruments have been used under the new monetary policy framework, policy stance is represented by the average funding cost of CBRT (named as “CBRT average funding rate” or “effective policy rate”) instead of the policy rate (one-week repo rate).^{6,7} In this paper, we focus on the interest rate corridor and liquidity management, and analyze the effect of these policies on the overnight market rate, which is represented by the Borsa Istanbul (BIST) overnight repo interest rate.

The corridor system is employed by many central banks around the world to set interest rates.⁸ In this system, overnight market rate is generally kept close to the policy rate. After the global crisis, many central banks including the CBRT have abandoned this practice due to the introduction of unconventional policies.⁹ In the new policy framework adopted by the CBRT, overnight market rate (represented by the Borsa Istanbul overnight repo interest rate) can exhibit larger fluctuations inside the corridor and can move far away from the average funding rate (Figure 1).

[Figure 1]

The average cost of CBRT funding provided to banks and the overnight market rate can be determined at different values within the corridor according to the

⁴ In the new setup of the interest rate corridor system, the CBRT is able to adjust the distance of the policy rate vis-a-vis the overnight borrowing and lending rates in an asymmetrical manner.

⁵ See Başçı and Kara (2011), Kara (2012) and Kara (2013) for detailed descriptions of the policy framework implemented by the CBRT in the post crisis period.

⁶ In order to represent the funding cost of the banks more accurately, we calculate a weighted average of all types of interest rates used by CBRT in funding the banking system. We name this as the “CBRT average funding rate” or the “effective policy rate”, which is the weighted average cost of outstanding funding by the CBRT via Interbank Money Market (overnight lending facility) and Open Market Operations (BIST repo, primary dealer repo, one-week repo via quantity auction, one-week repo via traditional auction and one-month repo). Simple interest rates are used in calculation.

⁷ One-week repo rate acted as the main policy rate between May 2010 and December 2013. Since the start of 2014, this interest rate is referred to as “stable funding rate-1”. See CBRT (2013).

⁸ The Federal Reserve, the European Central Bank, the Reserve Bank of Australia, the Bank of Japan, the Bank of Canada and the Bank of England are few examples. In fact, although many countries adopt the corridor system, there can be differences in its implementation. See Berentsen and Monnet (2008) and Whitesell (2006) for the details of the interest rate corridor system.

⁹ See Bech and Monnet (2013) for an analysis on selected developed countries.

intended monetary policy stance. This is made possible by the presence of liquidity instruments with different maturities (daily, weekly, monthly) which allows the CBRT to change its funding terms on a daily basis by adjusting the amount of funding provided through each instrument. With this framework, the CBRT aims to facilitate a fast and flexible reaction to the volatility in short term capital movements together with controlling credit growth at the same time (CBRT, 2012).¹⁰

This setup implies that the overnight market rate can deviate visibly from the average cost of funding provided by the CBRT. In fact, in the period following the adoption of the new framework, the spread between the overnight rate and the CBRT average funding rate (overnight spread) has become wider and more volatile compared to the conventional policy episode (Table 1, Figure 2).

[Table 1]

[Figure 2]

In this paper, we analyze the determinants of the overnight spread providing evidence from both the conventional and the new monetary policy episodes in Turkey. We focus on the interest rate corridor and liquidity management policies, and try to find out to what extent the non-standard monetary policy measures affect the overnight spread. This analysis is important to shed light on the changing nature of the monetary transmission since the adoption of the new policy framework in 2010.

Our paper is related to a burgeoning literature that aims to understand the determinants of the overnight spread. Linzert and Schmidt (2011) and Beirne (2012) analyze the determinants of the EONIA spread, i.e. the spread between the Euro Overnight Index Average (EONIA) and the main policy rate of the European Central Bank (ECB). Linzert and Schmidt (2011) aim to explain the widening of the EONIA spread from mid-2004 to mid-2006 by linking it to the change in the operational framework of monetary policy at ECB in March 2004. They find an important role for the liquidity deficit as well as the tightness of liquidity conditions in accounting for the widening in the spread. Beirne (2012), on the other hand, examines the determinants of the EONIA spread during the crisis and non-crisis times, relating the spread to the liquidity policies of the ECB in addition to liquidity and credit risk. Similarly, Nautz and Offermanns (2007) examine how the EONIA rate (overnight

¹⁰ See Binici et al. (2013) for the use of interest rate corridor as a macroprudential tool in Turkey.

market rate) adjusts to the policy rate of the ECB and they find a strong role for the change in the operational framework of ECB. Though the spread between policy rate and overnight market rate has risen because of the change in the implementation of the repo auctions, the study argues that this change did not lead to a loss of control over the EONIA. Recently, Bech and Monnet (2013) study the impact of unconventional policies on the overnight interbank market of six developed countries in the aftermath of the financial crisis. They emphasize the role of excess reserves in driving the overnight rate to the floor of the corridor. In overall, empirical studies provide mixed evidence on the determinants of the overnight spread. One common finding is that liquidity policy is an important factor in affecting the spread.

A related strand of the literature analyzes the effects of unconventional policy measures on various other short-term money market rates and spreads mainly using event-study methodologies. Examples include Krishnamurthy and Vissing-Jorgensen (2011) for the U.S., Joyce et al. (2011) for the U.K. and Brunetti et al. (2011) and Szczerbowicz (2011 and 2012) for the euro area, which find mixed evidence on the effectiveness of unconventional policies in reducing money market spreads widened following the global financial crisis.

To the best of our knowledge, this is the first paper which investigates the determinants of the overnight spread in Turkey. Moreover, this is one of the few papers in the literature that analyze the effects of nontraditional policy instruments on the overnight spread.¹¹ Our paper contributes to the understanding of the interest rate corridor and liquidity policy in an unconventional setup using the case of Turkey as an example. We use an OLS framework to regress the overnight spread on a range of variables related to the liquidity policy of the CBRT and other policy instruments, the liquidity need of banks, interest rate expectations and uncertainty. We find that the liquidity policy of the CBRT is an important determinant of the money market spread in the unconventional monetary policy episode, while it did not play an important role in the earlier episode of conventional inflation targeting where policy rate was the single instrument of monetary policy. Hence, we argue that the rise in the short-term

¹¹ One major difference of our approach from the literature mentioned above is that money market spread that we are analyzing does not incorporate any counterparty risk as both types of borrowing are subject to similar types of collateral. Thus, in our case the widening in spread is due to a change in the operational framework of monetary policy instead of a rise in counterparty risk or credit risk following the financial crisis.

money market spread in the new episode is a natural consequence of pursuing a monetary policy with multiple instruments.

The rest of the paper is organized as follows. Section 2 explains the details of the liquidity management of the CBRT. The explanatory variables and the regression methodology are outlined in Section 3 and estimation results are reported in Section 4. Finally, Section 5 concludes.

2. CBRT's Liquidity Management Framework

The CBRT can provide liquidity at daily, weekly or monthly maturities using different types of liquidity instruments. Since May 2010, weekly repo auctions that are conducted as quantity auctions have been the main liquidity instrument with the one-week repo rate serving as the policy rate.¹² The one-week repo rate lies between the overnight borrowing and lending rates of the CBRT. The one-week repo rate and overnight borrowing and lending rates are revised monthly in Monetary Policy Committee (MPC) meetings. See Figure 3 for a visual description of the daily liquidity management framework of the CBRT.¹³

[Figure 3]

Figure 4 presents the time frame for the operational steps in the CBRT's liquidity supply auctions and some stylized facts regarding the market structure. The timeline of the CBRT's standard operations and opening/closing times for various markets are also provided in Figure 4. As mentioned above, CBRT conducts fixed-rate tenders with one-week maturity on a daily basis, and announces the auction results at around 11:15 am. Then, benchmark overnight market rates are set at 2.00 pm at the overnight repo/reverse repo market at BIST, which is the most active market for overnight funding across banks and other intermediaries.¹⁴ Banks can also use standing facilities of the CBRT at overnight maturity at the upper and lower bounds of the prevailing interest rate corridor at 4.00 pm. The Late Overnight Window (LON) facility by which the CBRT fulfills its lender-of-last-resort function operates between 4.00 pm and 5.00 pm at more discouraging interest rates for the banks. Finally, for the

¹² In the quantity auction, the total amount for the auction is determined and announced by the CBRT before the auction takes place.

¹³ The numbers in Figure 3 are just for illustrative purposes and do not necessarily represent the current situation.

¹⁴ Since the BIST Repo/Reverse Repo Market is the largest organized repo market in Turkey, the overnight rate for the repo transactions in this market acts as the "benchmark overnight market rate" for the money markets in Turkey.

last day of the reserve maintenance period, in order to enhance the flexibility of bank's liquidity management, the use of LON facility is extended until 5:15 pm.

[Figure 4]

As part of the new monetary policy framework, the CBRT can induce additional monetary tightening when deemed necessary by lowering the amount of funding provided at the policy rate via one-week quantity auctions. On these days, the CBRT may conduct one-week repo auctions via traditional method.¹⁵ Financial institutions cover their liquidity needs at a significantly higher cost using the BIST Overnight Repo/Reverse Repo Market, the CBRT Overnight Lending Facility or the Primary Dealer (PD) Repo Facility (See Figure 5, for the time frame on days of additional monetary tightening). This leads to a significant rise in both the average funding cost and the overnight money market rate, bringing both rates close to the upper bound of the corridor.¹⁶

[Figure 5]

During the days of additional monetary tightening, the CBRT signals the market players about its tight stance by not announcing one-week quantity auctions at 10:00 am. The Bank may provide one-week repo funding via the traditional method in which financial institutions bid competitively and intra-day auctions can be opened anytime during the trading day.¹⁷ Banks are forced to meet their funding requirements through other sources at higher interest rates within the corridor. PD banks can also obtain repo funding from the CBRT within their limits at a rate that is slightly lower than the upper bound of the corridor.¹⁸ These other sources of funding provided by the CBRT increase the average cost of funding, and cause money market interest rates to come close to the upper bound of the corridor. One last facility that should be mentioned is the Intra-day Limit Facility that banks can use during the trading hours to meet their temporary liquidity needs by paying a certain commission.

¹⁵ In the traditional repo auction, all the bids are ranked from highest to lowest rate and the amount announced for the auction is allocated according to this ranking. In other words, the rates on successful bids determine the repo rate.

¹⁶ See CBRT (2012) for the details of the implementation.

¹⁷ By definition, central banks open intra-day repo auctions in order to offset the adverse effects of unexpected liquidity shocks or central banks' liquidity forecast errors. In Turkey, CBRT had used intra-day repo auctions on additional monetary tightening days from 2011 until mid-2012. On these days, CBRT did not provide repo funding via quantity auctions at the policy rate and instead it opened one-week intra-day auctions via the traditional method. CBRT has not used intra-day repo auctions since June 4, 2012.

¹⁸ PD banks refer to selected banks that lead the market.

3. Explanatory Variables and Methodology

3.1. The Determinants of the BIST Spread

Liquidity conditions in the money market determined by the interaction of the liquidity supply and demand factors stand as natural candidates to explain the behavior of the overnight spread. The explanatory variables given below are considered in two subgroups, namely: “liquidity supply and monetary policy” and “liquidity demand and other liquidity conditions”.¹⁹ The full list of the explanatory variables and the expected signs of their estimated coefficients are given in Table 2.

[Table 2]

3.1.a. Liquidity supply and monetary policy

As described above, the CBRT provides liquidity through various instruments. These consist of the overnight lending facility at the Interbank Money Market and open market operations including one-week and one-month repo as well as daily BIST repo and PD repo.

Each morning on a business day, the amount of liquidity provided to banks through weekly and monthly open market operations is determined. CBRT announces the allotment amount at 10:00 am and carry out the auction afterwards. By 11:15 am, financial institutions figure out how much funds they can obtain via CBRT one-week repo (and also via one-month repo conducted on each Friday²⁰) auctions. Having received this information, the banks that could not cover their liquidity needs through these auctions have to rely on the overnight repo market with a higher cost, that is, BIST repo market and PD repo facility. The funds provided through overnight repo transactions constitute an important indicator, representing the overnight liquidity shortage, i.e., the deficit that could not be covered in open market repo auctions at the beginning of the day. Hence, as a general indicator of daily aggregate liquidity conditions, we use *net liquidity deficit* calculated as the sum of CBRT's net overnight funding at BIST repo market and PD repo usage (Figure 6). This indicator is directly related to the overnight spread. In the empirical analysis, net liquidity deficit is represented as a ratio by dividing the deficit to the total Turkish lira (TL) reserve requirements of the banks in the current maintenance period. In other words, this variable measures banks' overnight liquidity deficits relative to their short term

¹⁹ The appendix of this study provides details of the liquidity supply/demand factors.

²⁰ Since November 2013, the CBRT ceased funding through one-month repo auctions.

liquidity needs. Higher net liquidity deficit is associated with tight liquidity conditions and is expected to drive the overnight spread upwards. However, when the BIST overnight repo rate is nearby the lower (upper) bound of the corridor, even a sizable net BIST liquidity surplus (deficit) may not cause a visible change in the BIST overnight repo rate as it has no place to move further. Therefore, in analyzing the effect of the net liquidity deficit on the overnight repo rate we use a dummy variable to select the days when BIST overnight repo rate hovers inside the corridor. This dummy variable eliminates the days when upper and lower bounds of the corridor are binding.

[Figure 6]

Another variable on the liquidity supply side is the *CBRT funding at one-week and longer term maturity*, which is represented as a ratio of the total TL reserve requirement liabilities of the banking system. This variable is expected to affect the spread negatively as a higher CBRT funding would ease liquidity conditions. To control for the maturity effect, we construct the variable *maturity structure of the CBRT funding*. We calculate the ratio of one-week repo in total funding (at one-week and longer maturity) provided by the CBRT. An increase in this explanatory variable means that a higher share of liquidity is provided at shorter maturity. This can be interpreted as tight liquidity conditions since providing funds at longer maturity reduces uncertainties associated with banks' liquidity management. Hence, we expect to see an increase in the BIST spread whenever this variable goes up.

We also consider CBRT overnight borrowing and lending rates as determinants of the BIST spread. These rates which constitute the lower and upper bound of the interest rate corridor are set at each MPC meeting along with the policy rate. The banking system in Turkey had liquidity surplus until the first half of 2010. Hence, the overnight rate hovered around the lower bound of the corridor. The CBRT lowered the borrowing rate at the end of 2010 to prevent huge capital inflows due to the overheating concerns in the economy. Coupled with the gradual rise in the reserve requirement ratios, the liquidity surplus has lessened and then turned into a deficit. We observe a further rise in the liquidity deficit of the banking system during the European debt crisis. In this period, the Central Bank has raised both the lower and the upper bounds of the corridor. An increase in the overnight lending rate is predicted

to create an upward pressure on the overnight rate and thus the spread.²¹ When the banking system is in need of liquidity, the funding uncertainty gets higher which makes the upper bound an important cost indicator for the banking system. On the contrary, since the overnight borrowing rate is an important indicator for the short-term capital inflows, the overnight rate is expected to be negatively related to the borrowing rate. A raise in the overnight borrowing rate might bring in short term capital inflows and ease liquidity conditions in the overnight money market, putting a downward pressure on the overnight rate. For example, on August 5, 2011 the CBRT raised the lower bound by 350 basis points to avoid a decrease in capital inflows due to deepening of the European debt crisis. When the borrowing rate increased, the overnight rate decreased sizably at the same time (see also Figure 1).

3.1.b. Liquidity demand and other liquidity conditions

Reserve requirements of banks constitute the main source of the liquidity demand of financial institutions. Liquidity demand is also related to expectations and uncertainty. When determining the quantity announced at each repo auction, the CBRT takes into account both reserve requirements and forecasts of autonomous factors such as changes in Treasury accounts and currency in circulation.

To measure banks' liquidity demand due to reserve requirements; we use the variable cumulated average reserve fulfillments since the beginning of the maintenance period calculated as a ratio of the average reserve requirement. We take cumulated averages because the reserve averaging mechanism allows banks to smooth their reserve fulfillments within the maintenance period of 14 days. In the analysis we include this variable as a ratio of the average reserve requirements to derive a relative figure. This variable is named as the *cumulative reserve position*. If reserve fulfillment of the banking system has been high on average at a specific day of the maintenance period, the pressure coming from reserve requirements would be low in the following day, driving the spread downward. Thus, we expect this variable to affect the BIST spread in the opposite direction.

The bidding behavior in open market repo auctions is another important factor in determining the liquidity situation in the system. Therefore, we introduce some

²¹ Average funding rate is a weighted average of different funding rates some of which are determined only once a month at the MPC meetings. Thus, changes in the average funding rate are expected to be less pronounced than the changes in the overnight rate and the spread is usually led by the overnight rate.

variables that may influence the bidding behavior such as bid-to-cover ratio, liquidity uncertainty, interest rate expectations, maturity structure of the CBRT funding and banks' heterogeneity in terms of liquidity position.

The *bid-to-cover ratio* is defined as the ratio of total bid volume to the amount covered by CBRT in the open market repo operations. This variable reflects the amount of liquidity demand by banks which has been met by the CBRT. We expect this variable to affect the BIST spread positively. A high bid-to-cover ratio shows that demand for central bank funding has only been satisfied to a low degree which leads banks to rely more on alternative funding opportunities at higher costs such as the interbank money market. This in turn would drive the spread upwards. To measure the effect of this variable correctly, we have to take into account changes in the way the repo auctions are conducted. Since May 20, 2010, one-week repo auctions have been conducted via quantity auction method and each institution could bid up to the announced auction amount. In this set-up, all bids are allocated to the full amount if the total amount of bids is less than or equal to the announced auction amount.²² As of August 5, 2011, some amendments were made in order to enhance the efficiency of liquidity management and facilitate a more balanced distribution of central bank liquidity across the financial system (CBRT, 2011). Accordingly, each institution's bid for the repo auction was limited by 20 percent of the announced auction amount. This upper limit was increased to 30 percent to be effective from January 2, 2013. Hence, we introduce interaction dummies for these amendments related to the open market repo auctions.

Funding uncertainty is an important factor for banks' bidding strategies. Whenever daily funding need of banking system is high and there is uncertainty regarding to what extent this need would be covered by the CBRT or the market, banks may settle for higher funding costs. Moreover increased aggregate liquidity uncertainty may lead banks to bid at higher rates due to the risk of not obtaining the desired liquidity. This would lead overnight rates to increase, and consequently drive the spread upwards. Therefore we expect to find a positive relation between funding uncertainty and the BIST spread. CBRT announces aggregate required reserve

²² If the total amount of bids is higher than announced auction amount, the auction amount is distributed to the institutions via multiplying each institution's bid amount with the ratio of auction amount to total bid amount.

balances and market opening reserves at 10:00 a.m. each morning.²³ Banks take this information into account when deciding how much to bid in OMO tenders because the difference between market opening reserves and required reserve balances at the beginning of the day is a proxy for intra-day cash flows. Therefore, the ratio of the expected intra-day cash flows to the amount of reserve balances at the beginning of the day contains information on funding uncertainty.²⁴

Liquidity distribution among banks is another factor that possibly affects the bidding behavior of banks. In the BIST repo-reverse repo market, there are two sub-markets: the interbank repo-reverse repo market (IRM) and the general repo-reverse repo market. IRM was established to facilitate the repo transactions in organized market conditions, without having to meet the reserve requirement of the CBRT.²⁵ Different from IRM, in general repo-reverse repo market, investment funds can also operate in addition to banks. To represent the liquidity distribution among banks, we use the ratio of the volume of overnight repo transactions in IRM to the total volume of overnight transactions in the BIST repo-reserve repo markets. If this ratio is high, then the transaction volume in IRM is high which points to a heterogeneous distribution of funds among banks. In other words, this means that while some banks have liquidity shortage, some others have liquidity surplus. A bank faces higher uncertainty when it has to borrow from each other than borrowing from CBRT. For instance, the bank in need of funds cannot foresee the lending conditions of the bank with liquidity surplus, that is, how much the latter is willing to provide and at what price. As opposed to the CBRT, banks operate by profit maximization motive and hence banks with liquidity surplus may demand high interest rates in this oligopolistic market structure. According to anecdotal information, it is known that whenever the

²³ Market opening reserves are the total liquidity of the banking system at the beginning of a trading day which consists of free deposits of banks and expected net cash flows for that day. The reserves can be taken as a “buffer liquidity” of the banking system which can be used in case of unexpected liquidity shocks which may arise during the trading day. This variable is available at CBRT web site on a daily frequency since 2007.

²⁴ To ease the interpretation of the mentioned funding uncertainty variable, we use it after multiplying by -1. This way, when there are cash outflows (on tax payment days for instance) we observe a rise in funding uncertainty.

²⁵ Since January 2011, banks obtaining funds from non-bank financial establishments (such as investment funds) at the BIST Repo/Reverse Repo Market are liable for holding required reserves. On the other hand, Interbank Repo Market (IRM) is established for repo transactions among banks and these transactions are not subject to reserve requirements. The difference between these two repo markets is reflected on the average overnight repo interest rates, where the rates in IRM tends to be higher than the rates in the BIST repo market (bank to non-bank transactions) since the rates in IRM include the reserve requirement holding cost.

transaction volume in IRM increases banks have a tendency to bid in CBRT repo auctions although they are not in need of funds. Through this way, they try to make profits by lending to those banks short of liquidity. This supports our claim that an increase in repo transactions among IRM would lead the overnight interest rates and BIST spread to increase. In the analysis we use the lag of this variable in order to rule out concerns about endogeneity.

Interest rate expectations of banks also affect their bidding behavior. Similar to Linzert and Schmidt (2011), we use swap rates as an indicator for policy rate expectations. Accordingly, we use the difference between overnight swap rates and CBRT average funding rate to capture the expectations of the system regarding the changes in short term interest rates. When banks expect an increase in interest rates within the maintenance period they would tend to bid at higher rates since refinancing would become relatively costly in the future. As a consequence, we expect a positive relationship between the swap spread and the overnight spread.²⁶

3.1.c. Dummy variables

To capture some autonomous factors and stylized facts, we introduce several dummy variables in our regression model. Banks have a tendency to hold large amounts of reserves at the beginning of each reserve maintenance period. This may lead them to over-bid in open market repo auctions and rely more on BIST repo market driving the BIST spread upwards. Hence we use a *first day dummy* to capture this effect. Similarly on the last day of a reserve maintenance period, banks may have a different bidding behavior. On the last day of a maintenance period, most of the banks have fulfilled the bulk of their reserve requirements and their demand for liquidity tends to be low. That's why we introduce a *last day dummy* to take this behavioral phenomenon among banks.

Relying on the observation that banks demand higher liquidity on *tax payment days* and *quarterly balance sheet reporting periods*, we also use dummy variables for these periods in our regression model. We predict these variables to put upward pressure on the BIST spread.

²⁶ Swap rates are announced early in the morning each day.

3.2. Methodology

Our estimation methodology is based on Linzert and Schmidt (2011) who estimate OLS regression on daily data to explain the EONIA spread. We analyze the determinants of the BIST spread by the following equation:

$$\begin{aligned}
 s_t = & c + \rho_1 s_{t-1} + \rho_2 s_{t-10} + \alpha_1 cbt_t^{funds} + \alpha_2 L_t + \alpha_3 maturity_t + \alpha_4 RP_{t-1} \\
 & + \alpha_5 \Delta(bid/cover)_t + \alpha_6 H_t + \alpha_7 \Delta(ub)_t + \alpha_8 \Delta(lb)_t + \alpha_9 i_t^E \\
 & + \alpha_{10} uncertainty_t + \alpha_{11} D_t^{first\ day} + \alpha_{12} D_t^{last\ day} + \alpha_{13} D_t^{tax} \\
 & + \alpha_{14} D_t^{balance\ sheet} + \alpha_{15} D_t^{auctionamendments} + \varepsilon_t
 \end{aligned}$$

In the equation above, the variables used (in the same order as above) are the overnight spread (s_t), funding at weekly and longer maturity (cbt_t^{funds}), liquidity deficit (L_t), maturity of the funding ($maturity_t$), cumulative reserve position of the banks (RP_t), change in the bid/cover ratio ($\Delta bid/cover$), liquidity heterogeneity among banks (H_t), change in the upper bound of the corridor (overnight lending rate of CBRT) (Δub_t), change in the lower bound of the corridor (overnight borrowing rate of CBRT) (Δlb_t), interest rate expectations (i_t^E), funding uncertainty ($uncertainty_t$), dummy for the first day of the maintenance period ($D_t^{first\ day}$), dummy for the last day of the maintenance period ($D_t^{last\ day}$), dummy for the tax payment periods (D_t^{tax}), dummy for the balance sheet periods ($D_t^{balance\ sheet}$) and an interaction dummy for the auction amendments ($D_t^{auctionamendments}$). Table 2 presents the explanation for each variable outlined above and the expected signs of their estimated coefficients in affecting the spread.

4. Empirical Findings

Tables 3 and 4 represent the estimation results of the new framework period (May 2010-May 2013). We also present the results of estimated model for the conventional policy episode (Tables 5 and 6).

4.1 Unconventional Policy Episode

As Table 3 suggests, explanatory variables that are directly or closely related to CBRT policies have statistically significant effects on the BIST spread.

The net liquidity deficit has the intended effect on the BIST spread. A higher net liquidity deficit leads the spread to increase as this puts upward pressure on the

overnight market rates. However, we should note that it is effective only when the BIST overnight rate hovers within the interest rate corridor. This is due to the fact that, when the corridor is binding, the net liquidity deficit does not affect the BIST rate as this rate has no place to move further. Thus, in the empirical analysis, we eliminate the days when the BIST rate is stuck at the lower/upper bound of the interest rate corridor. Similarly, CBRT weekly and longer term funding has a significant impact on the spread. The spread tends to fall when the CBRT funding increases which indicates an easing in the banks' liquidity conditions. The variable that captures the effect of maturity structure of central bank funding is also found to be significant in explaining the spread. This implies that as the average maturity of CBRT funding falls, the overnight rate (and the spread) tends to increase.

We included changes in the interest rate corridor into our analysis as CBRT began to use it as an active tool in the new framework period. As expected, a change in the upper bound of the corridor is found to affect the spread in the same direction. In fact, during the period of the analysis, the banking system generally has liquidity deficit. This situation leads the central bank to resort to the upper bound of the corridor as a policy tool more frequently compared to the lower bound. We also observe that the lower bound has affected the spread in the opposite direction as expected (despite with a lower coefficient in magnitude than the upper bound).

Most of the variables, except the average cumulative reserve position of banks, which are related to the liquidity need of the system, are found to be statistically significant (Table 3). As our predictions suggest, the *change in the bid-to-cover ratio* has a significant positive effect on the spread. The estimated sign of *funding uncertainty* is also in line with our expectations; where a rise in uncertainty puts upward pressure on the spread.

The estimation results suggest that *short-term interest rate expectations* affect the spread in the same direction. This is plausible because banks may backdate part of their liquidity demand when they expect a rise in the interest rate. The *liquidity distribution among banks* is found to impact the spread positively. The more heterogeneous the liquidity distribution among banks is, the more the spread tends to move upward.

Estimating the cumulative reserve position correctly is difficult for the banks since reserve requirement mechanism in Turkey complicates this calculation.²⁷ That is why banks may not be able to use this variable as an input in their bidding decisions which makes *cumulative reserve position of banks* insignificant in our analysis.

[Table 3]

Finally all dummy variables are found to be significant in explaining the BIST spread. The bidding behavior of banks change in the first (last) day of the maintenance period and this puts upward (downward) pressure on the spread. Moreover dummy variable for balance sheet reporting period has a positive sign indicating that, banks tend to increase their liquid assets around these days. As predicted, the tax-paying days are associated with a rise in the spread as banks' demand for liquidity increases. The dummy variable that captures the effect of the amendment to repo auctions in 2011 is also significant which has led to a structural change in bidding behavior of banks.

Many studies in the literature document that the liquidity conditions are very important in determining the overnight spread. Thus, among other conditions, in order to see the relative strength of the liquidity policy we carry out a standardized regression. When we standardize the variables, it is possible to compare the coefficients for each variable. The standardized estimation results for the new monetary policy episode are documented in Table 4. These results show that, among the policy variables, net liquidity deficit has the highest coefficient and thus it is the most important determinant of the overnight spread. Maturity structure is also crucial in explaining the deviations in the overnight spread. Among other factors, short-term interest rate expectations have the highest standardized coefficient. Bid/cover ratio and liquidity distribution also have sizable standardized coefficients.

[Table 4]

²⁷ In Turkey, not only deposits but most major balance sheet items are subject to reserve requirement and the reserve requirement ratios also change depending on the maturity structure. As of the end of 2011, reserve option mechanism (ROM) has been added to the monetary policy mix. ROM allows banks to voluntarily hold a certain proportion of their Turkish lira (TL) reserve requirements in foreign exchange (FX) and/or gold. Under the ROM, it is difficult to gauge the currency composition of other banks' reserve holdings.

4.2 Conventional Policy Episode

Most of the variables we use in the analysis above are associated with the new policy framework. Therefore we use a limited set of variables when running the regression for the conventional policy episode.

Table 5 presents the estimation results. The lags of the spread, bid-to-cover ratio and first day dummy continue to have statistically significant effect on the spread. Remaining variables lose their significance in this period. We see that policy variables lose explanatory power in this period as there was a permanent liquidity surplus in the system. Moreover the spread itself was too small (Figure 1).

[Table 5]

The standardized estimation results for the conventional policy episode are documented in Table 6. The standardized coefficients of the significant explanatory variables (bid/cover ratio, interest rate expectations and the first day dummy) are very close in magnitude, suggesting that there is no single variable that dominates in explaining the deviations in the BIST spread.

[Table 6]

5. Conclusion

Overnight market is the primary link in the interest rate channel of the monetary policy transmission. Since unconventional policies adopted by both developed and emerging market economies after the global crisis have complicated this transmission channel, many studies flourished recently in order to understand how this channel is modified. In this respect, our study tries to shed light on the changing nature of the monetary transmission in Turkey since the adoption of the new policy framework in 2010.

The Central Bank of the Republic of Turkey (CBRT) has significantly changed its monetary policy strategy as of the second half of 2010 in order to address the financial stability challenges posed by volatile capital flows. Accordingly, giving more weight to the financial stability, the new monetary policy framework was tailored to meet the specific challenges of the new era. Thus, to offer a diverse, flexible and non-standard policy approach, the CBRT has started using a policy mix

of 1-week repo auction rates (policy rate), the interest rate corridor between O/N borrowing and lending rates, liquidity policy and required reserve system.

Under the new monetary policy framework, the spread between the Borsa Istanbul overnight repo interest rate and the CBRT average funding rate (the overnight spread) has become wider and more volatile compared to the conventional policy episode. This study analyzes the determinants of the overnight spread providing evidence from both the traditional and the new monetary policy episodes in Turkey. Our results show that, among the policy variables, net liquidity deficit is one of the most important determinants of the overnight spread in the new monetary policy episode. We conclude that the widening in the spread is a natural consequence of a monetary policy framework with multiple instruments and objectives, whereby the overnight market rate can be affected by liquidity policies in addition to the policy rate.

Appendix

Liquidity Supply and Demand Factors

We present the basic supply and demand factors of liquidity by focusing on a simplified version of CBRT's balance sheet. Table A1 provides a stylized version of the CBRT's balance sheet, and it contains all relevant information to understand CBRT's current liquidity management without presenting any numerical figures.

[Table A1]

In addition to CBRT's standard refinancing operations that are conducted as auctions and standing facilities such as deposit/lending facilities, open market operations of the CBRT include PD repo and BIST overnight repo/reverse repo operations which are both conducted on the initiative of counterparties. The PD banks can obtain overnight funding from the CBRT within their pre-determined limits at a slightly lower cost than CBRT's overnight lending facility. The CBRT's transactions at BIST Repo/Reverse Repo market acts as standing facilities (2.3.2a and 2.3.2b in Table A1) and assures that the repo interest rates in this market lie within the interest rate corridor set by the CBRT.

The autonomous factors are not related to central bank's transactions but they have liquidity-providing or liquidity-absorbing effects, therefore they have to be taken into account in central bank's liquidity management.²⁸

Reserves held by the banks consist of two parts: the first one is due to the reserve requirement system in which banks hold reserves over a 14-day maintenance period; the second one is the balances that are above the reserve requirements which banks may hold for precautionary motives. The sum of these two figures - reserves held by banks- can be treated as a residual position. Similarly, Bindseil and Seitz (2001) claim that reserve holdings of the banking system balances the central bank's balance sheet since all operations of a central bank ultimately affect the banks' reserve accounts. By using the simplified CBRT balance sheet, we can derive this residual component using the following equation:

$$\begin{aligned}
 \text{Reserves held by banks} &= \text{Open Market Operations} + \text{Use of Standing Facilities} + \text{Autonomous Factors} \quad (1) \\
 &= (\text{One-week repo} + \text{One-month repo} + \text{PD Repo}) + (\text{CBRT O/N lending} + \\
 &\quad \text{BIST O/N repo} - \text{CBRT O/N deposit} - \text{BIST O/N reverse repo}) + (\text{Net Foreign} \\
 &\quad \text{Assets} + \text{Other autonomous factors} - \text{Currency in circulation} - \text{Government} \\
 &\quad \text{Deposits})
 \end{aligned}$$

Reserves held by the banking system proxy the demand side of liquidity while the right hand side of the equation mainly consists of liquidity supply factors. By using the equation above, one can state that by taking into account the net effects of autonomous factors the CBRT provides liquidity through open market operations in such a way that the financial institutions can fulfill their reserve requirements throughout the maintenance period. A loose liquidity management of the CBRT increases the use of liquidity draining standing facilities such as CBRT O/N deposit and BIST O/N reverse repo. On the other hand, the use of liquidity providing standing facilities such as (CBRT PD repo, CBRT O/N lending and BIST O/N repo facilities increase if the CBRT's monetary policy stance is tight.

²⁸ The autonomous factors in our study include Net Foreign Assets, Currency in Circulation, Liabilities to Government and Other Autonomous Factors.

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Table 1. Descriptive Statistics of the Overnight Spread*

	Time period	Mean	Standard deviation
Complete sample	January 2005- May 2013	0.024	0.856
Old framework	January 2005- May 2010	-0.087	0.377
New framework	May 2010- May 2013	0.226	1.318

* BIST overnight rate *minus* CBRT average funding rate.

Table 2. Explanatory Variables and Expected Signs

Explanatory Variable and Its Notation	Explanation	Expected Sign
CBRT Weekly and Longer Term Funding (cbt_t^{funds})	Weekly and longer term maturity funding by the CBRT as a ratio of the total TL reserve requirements of the banks	-
Net Liquidity Deficit (L_t)	CBRT's net overnight funding at BIST repo market + PD repo usage as a ratio of the total reserve requirements of the banks (when upper and lower bounds of the corridor are not binding)	+
Maturity structure of CBRT Funding ($maturity_t$)	The ratio of weekly CBRT funding to the total of weekly and longer term maturity CBRT funding	+
Δ Upper Bound of Corridor (Δub_t)	Change in CBRT's overnight lending rate	+
Δ Lower Bound of Corridor (Δlb_t)	Change in CBRT's overnight borrowing rate	-
Δ Bid-to-cover Ratio ($\Delta bid/cover$)	The bid-to-cover ratio in the open market repo auctions conducted by CBRT	+
Funding Uncertainty ($uncertainty_t$)	Ratio of the expected intra-day cash outflow/inflow to the amount of reserve balances at the beginning of the day	+
Liquidity Distribution Among Banks (H_t)	Ratio of the volume of overnight repo transactions among banks in BIST IRM to the total volume of overnight transactions in the two BIST repo-reserve repo markets	+
Interest Rate Expectations (i_t^E)	The difference between the overnight swap rate and the CBRT's funding rate	+
Cumulative Reserve Position of Banks (RP _t)	Cumulated average reserve fulfillment since the beginning of the maintenance period as a ratio of the average reserve requirement	-
Dummy: First Day ($D_t^{first\ day}$)	Dummy for the first day of the maintenance period	+
Dummy: Last Day ($D_t^{last\ day}$)	Dummy for the last day of the maintenance period	-
Dummy: Balance sheet ($D_t^{balance\ sheet}$)	Dummy for the last working day of the quarter-end	+
Dummy: Tax Payments (D_t^{tax})	Dummy for the days of high tax payments by the banks	+
Dummy: Auction Amendments ($D_t^{auction\ amendments}$)	Dummy for the period after August 2011 (limits are imposed on the total bids by the banks)	-

**Table 3. Estimation Results for the Unconventional Policy Period
(May 20, 2010 - May 6, 2013)**

Dependent variable: BIST spread	Coefficient	Standard Error
Dependent Variable (-1)	0.64***	0.06
Dependent Variable (-10)	0.05	0.03
<i>Policy Variables</i>		
CBRT Weekly and Longer Term Funding	-0.13 ***	0.05
Net Liquidity Deficit (inside the corridor)	2.07**	0.91
Maturity structure of CBRT funding	0.59***	0.19
Δ Upper Bound of Corridor	0.55***	0.12
Δ Lower Bound of Corridor	-0.31**	0.13
<i>Liquidity Demand and Conditions</i>		
Δ Bid/Cover Ratio	0.13***	0.04
Funding uncertainty	0.28***	0.11
Liquidity Distribution Among Banks	0.55***	0.21
Interest Rate Expectations	0.20***	0.04
Cumulative Reserve Position of Banks (-1)	0.46	0.44
Dummy: First Day	0.20***	0.07
Dummy: Last Day	-0.22***	0.08
Dummy: Balance Sheet	1.16***	0.31
Dummy: Tax	0.27***	0.09
Dummy: Auction Amendments	-0.08*	0.05
Constant	-0.81	0.51
R ² (Adjusted R ²)	0,85 (0,85)	

Notes: ***, ** and * denote 1,5 and 10 percent significance level. Standard errors in parenthesis are adjusted for autocorrelation and heteroskedasticity.

**Table 4. Standardized Estimation Results for the Unconventional Policy Period
(May 20, 2010 - May 6, 2013)**

Dependent variable: BIST spread	Coefficient	Standard Error
Dependent Variable (-1)	0.64***	0.06
Dependent Variable (-10)	0.05	0.03
<i>Policy Variables</i>		
CBRT Weekly and Longer Term Funding	-0.05***	0.02
Net Liquidity Deficit (inside the corridor)	0.20**	0.09
Maturity structure of CBRT funding	0.11***	0.03
Δ Upper Bound of Corridor	0.06***	0.01
Δ Lower Bound of Corridor	-0.05**	0.02
<i>Liquidity Demand and Conditions</i>		
Δ Bid/Cover Ratio	0.09***	0.02
Funding uncertainty	0.05**	0.02
Liquidity Distribution Among Banks	0.09***	0.04
Interest Rate Expectations	0.21***	0.04
Cumulative Reserve Position of Banks (-1)	0.02	0.02
Dummy: First Day	0.15***	0.05
Dummy: Last Day	-0.17***	0.06
Dummy: Balance Sheet	0.88***	0.23
Dummy: Tax	0.20***	0.06
Dummy: Auction Amendments	-0.06*	0.03
Constant	-0.02	0.02
R ² (Adjusted R ²)	0,85 (0,85)	

Notes: ***, ** and * denote 1,5 and 10 percent significance level. Standard errors in parenthesis are adjusted for autocorrelation and heteroskedasticity.

Table 5. Estimation Results for the Conventional Policy Period**(Nov 29, 2007- May 18, 2010)**

Dependent variable: BIST spread	Coefficient	Standard Error
Dependent Variable (-1)	0.79***	0.04
Dependent Variable (-10)	0.08***	0.03
<i>Policy Variables</i>		
CBRT Weekly and Longer Term Funding	-0.04	0.03
Net Liquidity Deficit (inside the corridor)	0.44	0.45
<i>Liquidity Demand and Conditions</i>		
Δ Bid/Cover Ratio	0.02**	0.01
Interest Rate Expectations	0.02**	0.01
Cumulative Reserve Position of Banks (-1)	0.08	0.08
Dummy: First Day	0.07**	0.03
Dummy: Last Day	0.01	0.01
Dummy: Balance Sheet	0.15	0.12
Dummy: Tax	0.01	0.05
Constant	-0.11	0.09
R ² (Adjusted R ²)	0,81 (0,81)	

Notes: ***, ** and * denote 1,5 and 10 percent significance level. Standard errors in parenthesis are adjusted for autocorrelation and heteroskedasticity.

**Table 6. Standardized Estimation Results for the Conventional Policy Period
(Nov 29, 2007- May 18, 2010)**

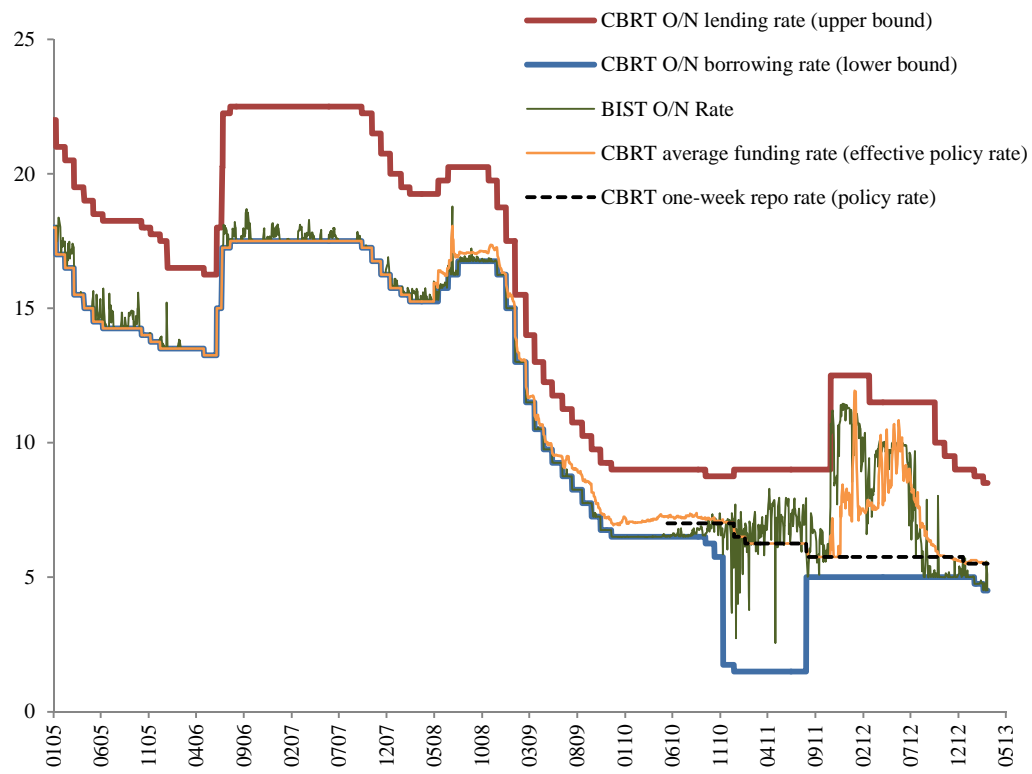
Dependent variable: BIST spread	Coefficient	Standard Error
Dependent Variable (-1)	0.79***	0.04
Dependent Variable (-10)	0.08***	0.03
<i>Policy Variables</i>		
CBRT Weekly and Longer Term Funding	-0.04	0.03
Net Liquidity Deficit (inside the corridor)	0.02	0.02
<i>Liquidity Demand and Conditions</i>		
Δ Bid/Cover Ratio	0.05**	0.02
Interest Rate Expectations	0.05**	0.02
Cumulative Reserve Position of Banks (-1)	0.02	0.02
Dummy: First Day	0.06**	0.03
Dummy: Last Day	0.01	0.01
Dummy: Balance Sheet	0.06	0.05
Dummy: Tax	0.01	0.04
Constant	-0.01	0.02
R ² (Adjusted R ²)	0,81 (0,81)	

Notes: ***, ** and * denote 1,5 and 10 percent significance level. Standard errors in parenthesis are adjusted for autocorrelation and heteroskedasticity.

Table A1. Simplified Version of CBRT's Balance Sheet

Assets	Liabilities
1. Net foreign assets	5. Currency in circulation
2. Open market operations	6. Liabilities to government (Gov. Accounts)
2.1. One-week Refinancing Operations	7. Reserves held by the banking system
2.2. One-month Refinancing Operations	7.1. Required reserve balances
2.3. Overnight refinancing operations	7.2. Excess reserve balances
2.3.1 Primary dealer repo	
2.3.2a. BIST O/N repo	2.3.2b. BIST O/N reverse repo
3a. CBRT O/N lending facility	3b. CBRT O/N deposit facility
4. Other autonomous factors	

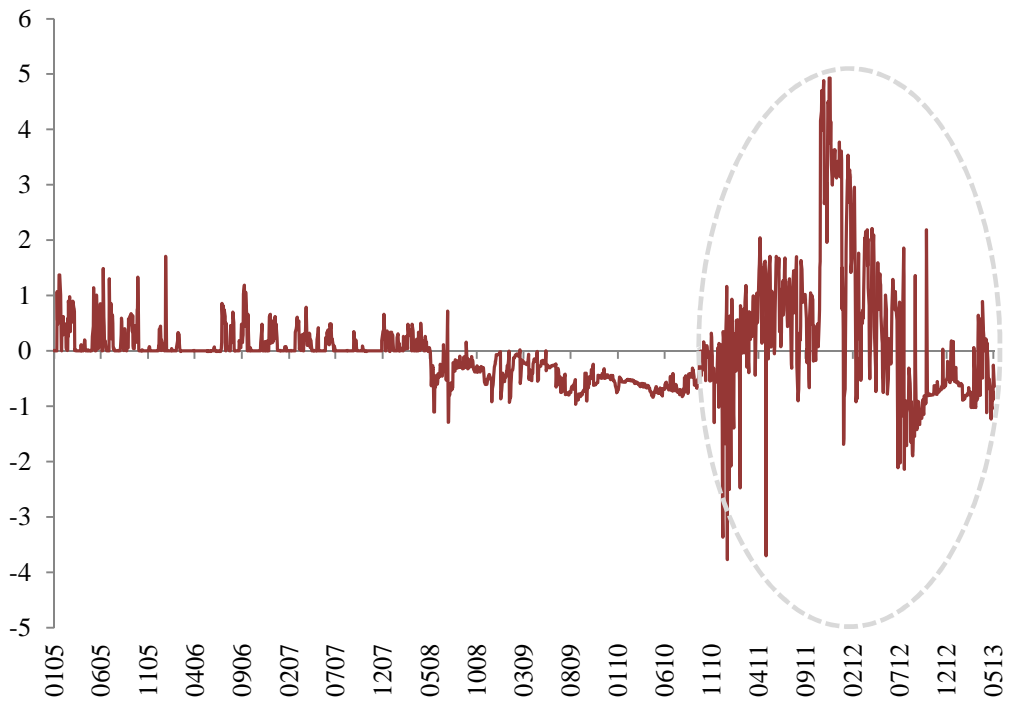
Figure 1. Interest Rate Corridor and Short-term Interest Rates



Source: BIST, CBRT.

Figure 2. Overnight Spread

(BIST Overnight Rate *minus* CBRT Average Funding Rate)



Source: BIST, CBRT.

Figure 4. Time Frame for Standard OMO Operations

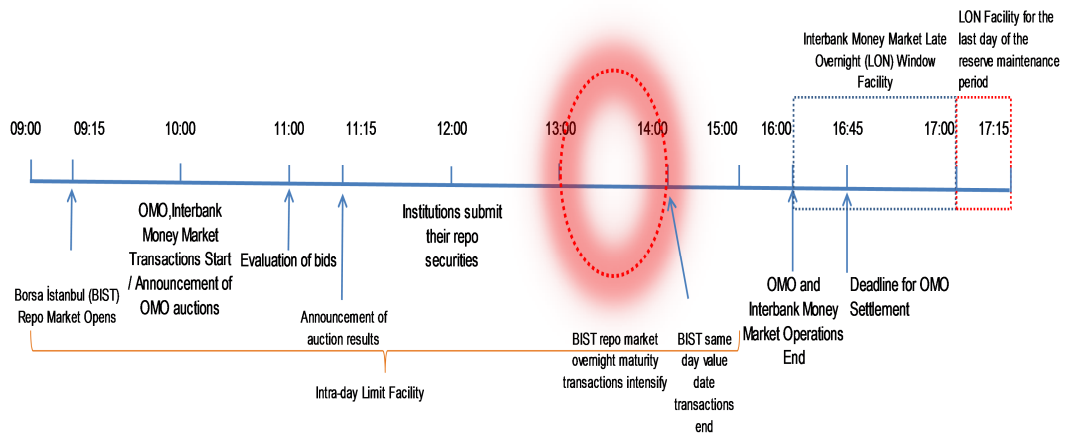


Figure 5. Time Frame for OMO Operations during Days of Additional Monetary Tightening

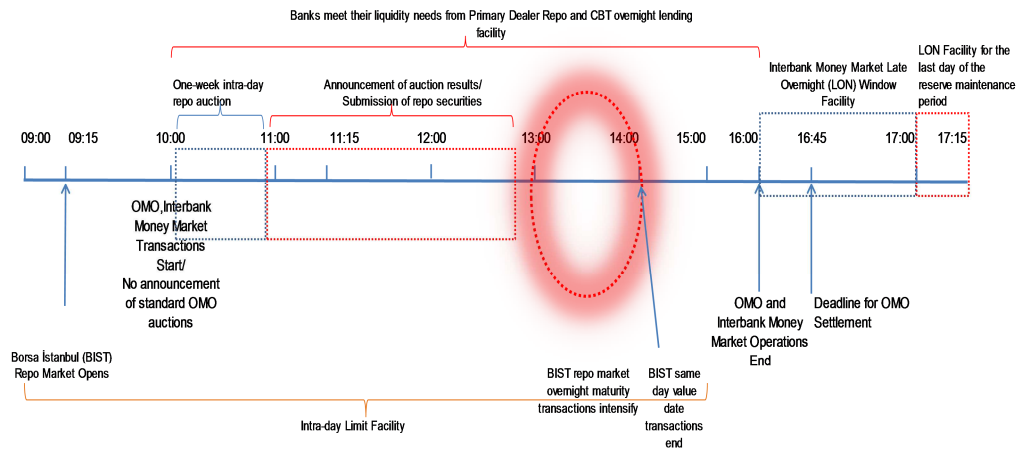
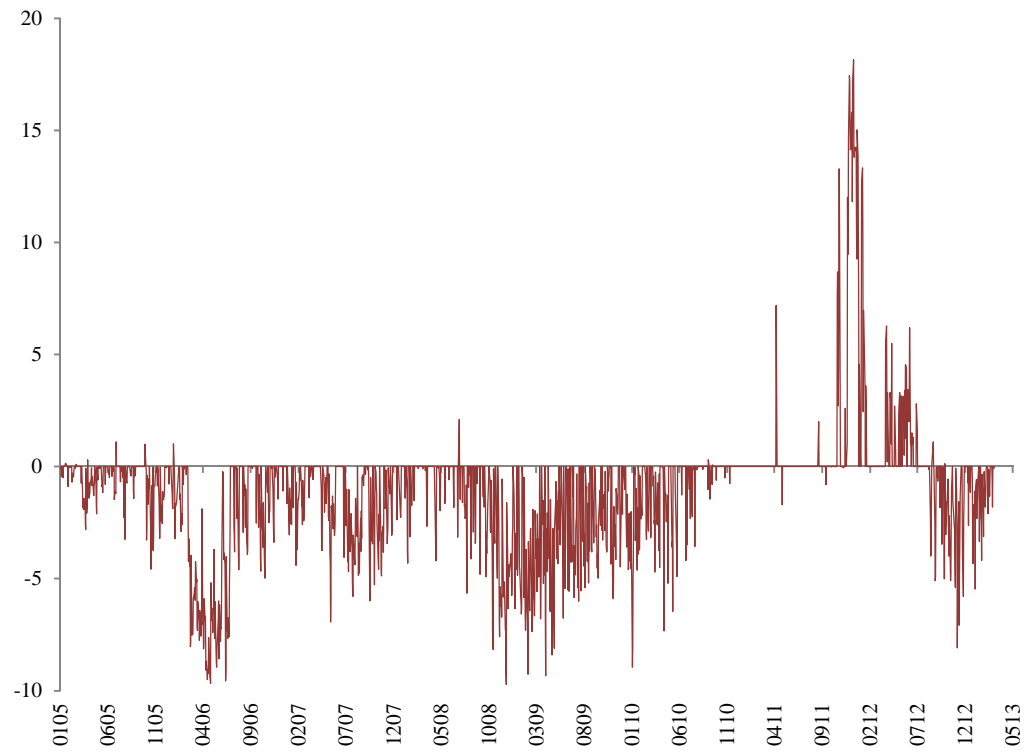


Figure 6. Net Liquidity Deficit (Billion TL)



Source: CBRT and authors' calculations.

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