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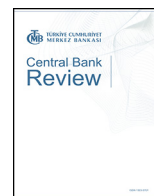
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Market-based monetary policy expectations for Turkey

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ABSTRACT

This study discusses various types of market-based instruments and tries to find which financial instrument is the best in predicting monetary policy expectations for different time horizons in Turkey. Consistent with the existing literature on this subject, we adopt an approach that comes from expectations theory of term structure of interest rates, which implies that short term forward interest rates reflect market expectations of short term rates in the future. By using this methodology, we treat upcoming monthly, 3-months, 6-months, 9-months, 12-months, and 24-months average of daily CBRT effective policy rates as alternative dependent variables; and market rates with corresponding maturities as independent variables. We aim to assess which market rate has the best predictive power for CBRT effective policy rates. We find that FX forward implied rates dominate all other instruments for 3, 6, 9, 12 and 24 months horizons while Borsa Istanbul overnight repo rate expectation from CBRT's Survey of Expectations is the best for 1-month horizon in forecasting future policy rates. We also note that CBRT's monetary policy predictability also changes with CBRT's choice of monetary policy implementation.

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1. Introduction

It is important to measure market expectations of monetary policy decisions for policy makers to predict market responses and understand whether they communicate market participants as desired. Market expectations play a vital role in the transmission mechanism of monetary policy to the real economy by affecting borrowing and lending interest rates of economic agents. This article provides an overview of all the available financial market instruments that can be used to infer Central Bank of the Republic of Turkey's (CBRT) policy rate expectations and evaluates them in terms of their ability to predict CBRT's effective policy rate at different future horizons.

The objective of the paper is two-fold. In the first part, assuming that the expectation hypothesis holds and market participants therefore assess the future path of short-term interest rates accurately, we construct a framework to compare a range of market instruments in Turkey. We try to compare their predictive power with regard to assessing monetary policy actions by simply focusing on explanatory powers in the regressions. In the second

part, we test the predictive power of various instruments for longer forecast horizons. We finally present the CBRT's survey information on policy rate expectations. Since the surveys do not include any credit, liquidity or term premia, they can provide clear information about policy rate expectations. However, the surveys are not available at high frequency like financial market indicators, and they are implemented over a period of several days rather than a specific date which could distort their predictive power. Moreover, surveys cannot cover all market participants and are open to misreporting by construction.

All financial market instruments provide noisy signal of expectations due to credit, liquidity risk etc., and it can be misleading to rely on these measures. It should also be noted that the CBRT's monetary policy predictability depends on its monetary policy choices and for different episodes different instruments may predict future interest rates better.

There exists a number of studies focusing on extracting monetary policy expectations from various asset prices. These studies try to extract policy rate expectations from financial market-based instruments such as swaps and futures. In this context, the choice of the financial asset to be used in measuring expectations is important. Money market rates have been extensively used to derive expectations since especially the short-term rates are affected by central bank's decisions to a large degree. There are many studies in the literature that use money market rates and

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prices of derivatives to measure expectations and high-frequency changes in these instruments to gauge the unexpected (surprise) component of monetary policy decisions. The studies on this subject started with Krueger and Kuttner (1996), Rudebusch (1998) and Brunner (2000). Kuttner (2001) and Faust et al. (2004) use the current-month federal funds futures (FFF) contract in their study while Bomfim (2003) and Poole and Rasche (2000) use the month-ahead FFFcontract. A widely cited paper Gürkaynak et al. (2007) compares the predictive power of term federal funds loans, federal funds futures, term Eurodollar deposits, Eurodollar futures, Treasury bills and commercial paper in capturing expectations of future course of monetary policy. They conclude that, federal funds futures dominate all other financial market instruments in forecasting monetary policy out to a 6-month horizon. Although FFFs serve as an important tool for gauging monetary policy expectations, they are US-specific and very few similar instruments are available for developing countries. Alp et al. (2010) implemented a similar methodology like Gürkaynak et al. (2007) for Turkey and compare the ability of different market instruments in predicting monetary policy decisions. They conclude that the one-week Turkish lira interbank bid rate (TRLIBID) is the best predictor of policy expectations among various indicators for the period September 2007–October 2009.

Since financial market data is available at high-frequency such as intraday, deriving expectations using these kind of data offer advantages over survey or model based measures.¹ Relatively recent studies incorporate intraday financial data and use high-frequency identification techniques with structural vector autoregression methods to estimate the effects of monetary policy shocks (See Stock and Watson, 2012; Mertens and Ravn, 2013). High-frequency data enable researchers to extract monetary policy surprises uninfluenced by other related news (See Gertler and Karadi, 2015).

In this paper, we aim to measure market expectations of monetary policy. For this purpose, we construct a framework for Turkey to compare a range of market instruments in terms of predictability power of the effective policy rate, and evaluate three specific episodes of monetary policy implementation in terms of predictability.

The remainder of this paper is organized as follows. Section 2 provides some brief information about CBRT's monetary policy framework in which three different episodes with specific characteristics emerge. Section 3 presents a detailed information about the financial market instruments that we use in our study. Section 4 describes the data and discusses our methodology. Section 5 presents our empirical results and a comparison of market-based instruments with related survey data. Section 6 concludes.

2. CBRT's monetary policy implementation: three episodes

CBRT's monetary policy framework has changed remarkably during the time horizon of our study (Fig. 1). Therefore, it is convenient to provide some brief information about the different phases of monetary policy implementation in Turkey. We split our time horizon into three phases; i) 2005–2010 H1: Excess Liquidity in the Banking System; ii) 2010 H2–2016 H1: Financial Stability and Inflation Targeting Episode, iii) 2016 H2–2018: Simplification of Monetary Policy. The first episode is generally associated with surplus liquidity of the banking system where CBRT sterilizes the excess funds through open market and deposit operations. The sterilization of excess liquidity is mainly conducted via overnight

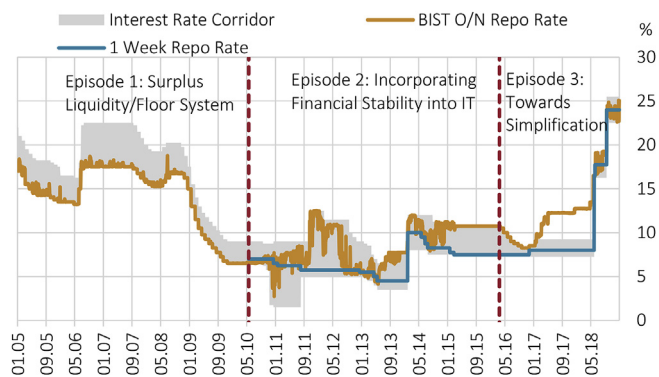


Fig. 1. Different episodes of monetary policy implementation.

operations, and therefore the overnight money market rates hover around CBRT's overnight borrowing rate. This episode resembles a floor system in which the sterilization rate of the CBRT (CBRT overnight deposit rate) stands as a lower bound for overnight interest rates. Global financial crisis has led to a reassessment of macroeconomic policy formulation especially for small open emerging economies like Turkey. As Küçük et al. (2016) state, the CBRT has changed the general framework of inflation targeting regime and developed new policy instruments as of the second half of 2010. Accordingly, the inflation targeting regime implemented since 2006 was modified to safeguard financial stability as well. Active use of the interest rate corridor and fixed rate repo auctions are among the main elements of the new system. Starting from May 20th, 2010, CBRT started to provide funding through 1 week repo auctions. These auctions are carried out by quantity method and the fixed rate used in these transactions is regarded as the policy rate. CBRT also used the interest rate corridor active to mitigate the pressure of capital flows on the exchange rate. CBRT could adjust the composition of its funding on a daily basis and adjust the short term money market rates accordingly. As can be seen from Fig. 1, overnight market rate exhibited larger fluctuations inside the corridor and moved far away from CBRT's policy rate. CBRT also diversified its policy instruments in this period and by using required reserves and the Reserve Options Mechanism, the Bank took steps towards to assure price stability and financial stability simultaneously. This period can be associated with increased uncertainty regarding CBRT's liquidity management and thus the level of short term money market rates.

CBRT took the first step towards simplification when it published a report titled, "Roadmap in the Normalization Process of Global Monetary Policies" in August 2015. During the March–September period of 2016, the CBRT gradually lowered the upper band of the corridor by 250 basis points in total. In October 2016, the CBRT suspended the rate cuts and raised the upper band of the corridor in accordance with the global economic developments. The CBRT did not change the interest rates in 2017 and used the late liquidity window (LLW) as the main policy instrument and hiked this rate throughout the year. CBRT used this non-traditional policy tool and provided most of its funding via LLW in 2017–June 2018 period. Starting from June 2018, the CBRT completed the simplification process of its operational framework and one-week repo rate became the policy rate. CBRT started to provide all of its funding via weekly repo actions except two episodes of increased market volatility (August 2018 and March 2019) and CBRT funding was carried out by overnight lending. In this episode, as the CBRT provided funding predominantly through a single channel, effectiveness and predictability in money markets significantly increased.

¹ Most of the model and survey based measures are available at monthly frequencies. See Lloyd (2017) for a combination of financial market and model based measures. For a combination of model and survey based measures, see Kim and Orphanides (2007).

3. Market measures of CBRT policy rate expectations

CBRT has changed its policy instrument during the time horizon of our study as explained above. In order to make each specific period comparable, our baseline models consider Weighted Average Funding Cost (WAFC) of CBRT as policy rate for the whole sample. WAFC indicates the volume weighted average interest rate of all CBRT's Turkish lira funding in a particular weekday. Unfortunately, market expectations of the future path of WAFC cannot be observed directly since there is no financial instrument tied to WAFC. As [Macaulay \(1938\)](#) first suggested in expectations theory of term structure of interest rates, long-term interest rates on a variety of financial market instruments can be used to infer market expectations of forward policy rate. If there were no credit, liquidity and term premium, these forward market interest rates would provide a measure of the implied market expectations of future policy rates at different future horizons.

[Binici et al. \(2019\)](#) show that WAFC and Borsa Istanbul (BIST) rates are both important elements in affecting bank interest rates such as deposits and loans. Therefore, both the BIST overnight repo rates and WAFC are likely to represent effective policy rates. Although our baseline models use the CBRT's WAFC as the dependent variable, WAFC may not fully reflect the monetary policy stance especially during times when CBRT used the interest rate corridor actively. During unconventional liquidity management practices, WAFC can diverge from the overnight rates in BIST repo market and the BIST repo rates start to represent the stance of the monetary policy more accurately than the WAFC. In order to address this issue, we also take the BIST overnight repo rate as an alternative measure of effective policy rate.

3.1. Government bonds

We use Government debt securities (GDS), which are borrowing instruments issued by the Turkish Treasury denominated in Turkish lira in the domestic market. During the maturity, government debt securities may be traded in secondary markets. All fixed income securities including the GDS are traded on the Outright Purchases and Sales Market within Borsa Istanbul, which is an organized and transparent secondary market. GDS with maturities up to 10 years are currently traded in the market. We use Turkish GDS yields as quoted in Bloomberg for the maturities 3, 6 months, 1-year, and 2 years.

3.2. Turkish lira reference interest rate (TRLIBOR and TRLIBID)

The Banks Association of Turkey determines and fixes the Turkish Lira Reference Interest Rate (TRLIBOR) since 2000 but the fixing has then been suspended due to the unfavourable economic and financial developments. In 2002, the project of determination and fixing of TRLIBOR has been resumed. The banks of which total assets is 1 billion USD according to the balance sheets issued as of December 31, 2001, and which agree to enter and process 1 million TL quotation in the procedure be allowed to participate the system. With the decision taken on the May 5, 2006, together with TRLIBOR, Turkish Lira Interbank Bid Rate (TRLIBID) is decided to be published daily from the July 3, 2006. Fixings are published at 11:15 every day, and deleted at 09:00 the next day. Participating banks enter a quotation by using the data providers' software between 10:30 and 11:15 and after 10:45 the Banks Association of Turkey randomly take the quotations 5 times, and remove the highest and lowest three quotations at each maturity, and publish the arithmetical average of the ask (offer) side of the remaining quotations for overnight, 1 week, 1 month, 2 month, 3 month, 6 month, 9 month and 12 month. The Association repeats the same procedure for the bid side. Execution of transactions at a certain maturity or formation of a certain minimum transaction volume is not

necessarily needed for fixing and publishing of reference interest rates as above. Banks participating the fixing will separately and mutually inform each other in writing of the transaction limits and the maximum maturity to be processed. The quotations can be used in transactions within banks so all the participating banks try to provide bid/ask rates that reflect money market conditions.

3.3. Interbank deposit rates

The annualized rate of interest that a bank will charge for lending or pay for borrowing Turkish lira for a specific maturity. This data provides us interbank deposit rates for maturities up to 1 year. We use interbank TL composite deposit rates as quoted in Bloomberg for the maturities 1,3,6,9 months and 1 year.

3.4. Deposit rates

We use banking sector's weighted average deposit interest rates which are calculated on the customer basis by relating the type of each deposit to the interest rate applied according to the maturity bracket. Time deposit maturities according to legislations are: up to 1 month (including 1 month), up to 3 months (including 3 months), up to 6 months (including 6 months), up to 1 year (including 1 year), 1 year and more. Weighted average deposit interest rates are calculated as compound interest rates since the customer accounts do not have standard maturities and then weighted averages are calculated by using deposit amounts and interest rates.

We use weekly weighted average deposit rates as provided by CBRT EVDS database for the maturities 1, 3, 6 months and 1 year. It should be noted that the maturities of the deposits do not cover exact time periods, for example 1 month time deposits are deposits up to 1 month. This characteristics of the data can be problematic since we compare the average of CBRT funding rate with different time horizons (1 month, 3 month, 1 year etc.) and the explanatory deposit variables do not necessarily have the same maturity with our independent variable. This is also reflected in lower R-squared for deposit rates in our simple model, as expected.

3.5. Foreign exchange forward implied yields

A currency forward or FX forward is an effective hedging instrument between two parties to exchange a certain amount of a currency for another currency at a fixed exchange rate on a fixed future date. Currency forwards are over-the-counter (OTC) instruments. Unlike standardized FX future, a FX forward can be tailored to a particular amount and delivery period. The "forward rate" or the price of an outright forward contract is based on the spot rate at the time the deal is booked, with an adjustment for "forward points" which represents the interest rate differential between the two currencies concerned.

In other words, the valuation of forward contracts are based on "covered interest parity" which refers to a theoretical condition in which the relationship between interest rates (domestic: r , foreign: r_f) and spot (S_0) and forward currency values (F) are in equilibrium for a specific time horizon (T).

$$F = S_0 e^{(r-r_f)T} \quad (1)$$

Equation (1) can be re-arranged for USDTRY forward rates to calculate implied TL yields for various maturities.

$$r = r_f + (1/T) \ln(F/S_0) \quad (2)$$

We use forward implied TL yields as quoted in Bloomberg for the maturities 1,3,6,9 months and 1,2 years.

3.6. Cross currency swap rates

Cross-currency swaps are an over-the-counter (OTC) derivative in a form of an agreement between two parties to exchange interest payments and principal denominated in two different currencies. In a cross-currency swap, interest payments and principal in one currency are exchanged for principal and interest payments in a different currency. Interest payments are exchanged at fixed intervals during the life of the agreement. Among types of swaps, the Bank for International Settlements (BIS) distinguishes “cross currency swaps” from “FX swaps.” Unlike in a cross currency swap, in an FX swap there are no exchanges of interest during the contract term and a differing amount of funds is exchanged at the end of the contract. Given the nature of each, FX swaps are commonly used to offset exchange rate risk, while cross currency swaps can be used to offset both exchange rate and interest rate risk. FX swaps are widely used by exporters, importers and institutional investors to hedge their positions by enabling them to raise foreign currencies.

Although the structure of cross-currency basis swaps differs from FX swaps, they both serve the same economic purpose, except for the exchange of floating rates during the term of the contract. Cross-currency swaps enable local banks and investors to convert funds in foreign currency obtained from foreign institutions to local currency. Turkish banks often borrow in foreign currency from international capital markets and then use cross-currency swaps to create Turkish lira funding. In recent years, the change in credit composition in favour of TL and depositors’ increased tendency towards FX deposits also drove banks to conduct cross-currency swaps against FX with non-residents. As of October 2018, the net TL funding that the Turkish banks raised by cross-currency swaps with non-residents was about 165 billion TL. Local banks can either use FX deposits or FX funds borrowed from international markets in these transactions. The high level of utilization of cross-currency swaps by the Turkish banking sector in recent years provides us an alternative instrument to extract CBRT policy rate expectations.

3.7. Interest rate swap rates

An interest rate swap is a contractual agreement between two counterparties to exchange cash flows on particular dates in the future. There are two types of legs (or series of cash flows). A fixed rate payer makes a series of fixed payments and at the outset of the swap, these cash flows are known. A floating rate payer makes a series of payments that depend on the future level of interest rates (a quoted index like LIBOR for example) and at the outset of the swap, most or all of these cash flows are not known. The most common and most liquid interest rate swaps are known as “vanilla” swaps, which exchange fixed-rate payments for floating-rate payments based on LIBOR (London Inter-Bank Offered Rate).

According to BRSA as of December 2018, 32 percent of derivative transactions in off-balance sheet items is from interest rate swaps while 49 percent from cross-currency swaps.

It should be noted that all of our financial instruments incorporate forward expectations for CBRT’s policy rate as well as expectations of LIBOR and market’s perception of other factors such as liquidity, supply and demand dynamics, the credit quality of the banks, and risk premium.

4. Data and methodology

We use weighted average interest rates of deposits (depos), Turkish lira reference bid rate (trlibid), Turkish lira reference offer rate (trlibor), cross currency swap rates (swap), interest rate swap rates (irs), foreign exchange forward implied yields (forward), interbank deposit rates (inter), and government bonds (treasury) for

maturities of 1 month, 3 months, 6 months, 9 months, 12 months, and 24 months to compare out of sample performance to predict CBRT’s effective policy rates (WAFB and BIST repo). Our data is daily and sample period is January 4th, 2005–December 31st, 2018. Our data sources are Bloomberg and Central Bank of Turkey database. We use the approach that comes from expectations theory of term structure of interest rates that Macaulay (1938) first introduced. Expectations theory of term structure of interest rates assumes that implied short term forward interest rates reflect market expectations of short term rates in the future. In other words, today’s long-term rates can be used to forecast what short-term rates will be in the future. By using this assumption, we treat upcoming monthly, 3-months, 6-months, 9-months, 12-months, and 24-months average of daily CBRT WAFB and BIST overnight repo rate as dependent variables and current market rates with corresponding maturities as independent variables. In this study, we aim to evaluate which market rate has the best predictive power for CBRT effective policy rates. We use R-squared values² as a proxy for out of sample predictive power measure of CBRT’s policy for regression below. The equations and discussions below take CBRT WAFB as the dependent variable. We also run the same regressions where we take the BIST overnight repo rate as the dependent variable.

$$\overline{WAFB}_{t,t+m} = \alpha + \beta r_{m,t}^s + \varepsilon_t \quad (3)$$

where $\overline{WAFB}_{t,t+m}$ is the mean of daily CBRT Weighted Average Funding Cost (WAFB) at time t over maturity m , and calculated as

$$\overline{WAFB}_{t,t+m} = \frac{\sum_{i=1}^m WAFB_{t,t+i}}{m} \quad (4)$$

and $r_{m,t}^s$ is market interest rate of financial security s at time t with maturity m .

Suppose that we want to measure predictability of 1-month cross currency swap as of July 15th, 2017; we take average of WAFB in the weekdays between July 15th, 2017 and August 15th, 2017 as dependent variable and 1-month cross currency swap rate in July 15th, 2017 as independent variable. We use R-squared value of this regression as the measure of predictive power of cross currency swap for 1-month maturity.

Different from the common practice, we did not de-trend our regression equation by subtracting the current level of policy rate from both sides because we are mainly interested in the long-run relationship. Existing studies focusing on the short-run relationship use de-trending (since the variables are integrated) because the coefficients will be dominated by the co-integrating vector otherwise. Since we primarily focus on the long-run relationship we use an equation without de-trending and compare the predictive power of various instruments with regard to assessing monetary policy actions. Since we are mainly interested in comparing the predictive power of various financial instruments rather than constructing a forecasting model of the policy rate, we do not discuss the findings of some studies on modelling and forecasting cointegrated variables.³

We compare the predictive power of the models for all time horizons by using Diebold-Mariano (DM) statistics. The test of predictive accuracy that was proposed by Diebold and Mariano, (1995) is widely regarded as an important test for comparing the predictive power of two models. Since our models provide close R-squared values, it is necessary whether if these models are

² We use Diebold-Mariano test to compare R-squared values statistically.

³ For further discussion See Christoffersen and Diebold (1998), Duy and Thoma (1998).

Table 1
Predictive power of market rates for future CBRT WAFC^a.

	1-month	3-months	6-months	9-months	12-months	24-months
Deposit	0.934	0.886	0.803	.	0.731	.
TRLIBID ^b	0.956	0.935	0.866	0.787	0.718	.
TRLIBOR	0.960	0.935	0.868	0.797	0.734	.
Cross Currency Swap ^c	0.926	0.909	0.780	0.818 ^d	0.790	0.585
Interest Rate Swap	0.957	0.936	0.861	0.800	0.753	0.532
Forward Implied Yield	0.955	0.944	0.894	0.844	0.792	0.586
Interbank Depo	0.945	0.922	0.837	0.768	0.711	.
Treasury Bond Yield	.	0.935	0.877	.	0.760	0.497
Max R-squared	0.960	0.944	0.894	0.844	0.792	0.586

^a January 15th, 2013–December 31st, 2018.

^b January 7th, 2005–December 31st, 2018.

^c Turkish Lira Interbank Bid Rate is available between October 26th, 2006 and December 31st, 2018.

^d All cross currency swap data is available between August 5th, 2008 and December 31st, 2018.

^e Currency swap data with maturity of 9 months is not available between June 30th, 2016 and December 17th, 2018. We exclude these dates in regression of cross currency swap with maturity of 9 months.

Table 2
Diebold-Mariano test for comparing the predictive accuracy of models.

	1-month	3-months	6-months	9-months	12-months	24-months
Forward Implied Yield (Model-1)
TRLIBID (Model-2)	4.73*** (0.00)	7.56*** (0.00)	2.39** (0.02)	−6.32*** (0.00)	−9.70*** (0.00)	.
TRLIBOR (Model-3)	4.96*** (0.00)	5.81*** (0.00)	4.10*** (0.00)	−2.36** (0.02)	−5.00*** (0.00)	.
Cross Currency Swap (Model-4)	−1.97** (0.05)	−3.11*** (0.00)	−8.88*** (0.00)	24.28*** (0.00)	8.75*** (0.00)	9.18*** (0.00)
Interest Rate Swap (Model-5)	0.35 (0.73)	10.76*** (0.00)	1.09 (0.28)	−4.86*** (0.00)	−1.00 (0.31)	−6.72*** (0.00)
Deposit (Model-6)	−7.79*** (0.00)	−10.51*** (0.00)	−9.44*** (0.00)	.	−6.52*** (0.00)	.
Interbank Depo (Model-7)	0.93 (0.35)	−1.45 (0.15)	−3.56*** (0.00)	−7.57*** (0.00)	−8.48*** (0.00)	.
Treasury Bond Yield (Model-8)	.	11.91*** (0.00)	0.43 (0.67)	.	−8.31*** (0.00)	−17.68*** (0.00)

*, **, *** Indicate significance at the 10%, 5% and 1% level.

statistically different in forecasting.

Diebold-Mariano test basically takes the residuals of two forecasts and then defines a loss-differential function. Let's consider we have two models and define the forecast errors as;

$$e_{it} = \hat{y}_{it} - y_t, \quad i = 1, 2 \quad (5)$$

The loss associated with forecast i is a function of the forecast error, e_{it} and denoted by $g(e_{it})$.

$g(\cdot)$ is a loss function and typically the square or the absolute value of e_{it} .

$$g(e_{it}) = e_{it}^2 \quad (6)$$

$$g(e_{it}) = |e_{it}| \quad (7)$$

Diebold-Mariano define a loss differential between these two forecasts, d_t and uses this series to construct a test statistic.

$$d_t = g(e_{1t}) - g(e_{2t}) \quad (8)$$

$$\bar{d} = \frac{1}{n} \sum_{t=1}^n d_t \quad \mu = E[d_t] \quad (9)$$

Under the assumption that $\mu = 0$ (the null hypothesis) DM follows a standard normal distribution:

$$DM \sim N(0,1) \quad (10)$$

Null hypothesis is $H_0: E(d_t) = 0$ is that the forecasts have the same accuracy and the alternative hypothesis is that the two forecasts have different levels of predictive power.

We use the simple average of daily CBRT WAFC in our regressions because our explanatory market-based variables are also

quoted in simple terms. However, the related literature generally prefers to use the compounded return of daily policy rates (rolling over overnight loans) consistent with standard asset pricing theory. We also implemented the same methodology and used compounded daily rates. The regression results which are presented in Appendix for robustness check do not change when we use compounded rates.

For rolling regressions, our rolling window length is 4 years, and we shifted the window by 1-month for each step. We replicate regressions with rolling window length of 2 years and 6 years for robustness as well which are also provided in Appendix. The window length only affects the smoothness of R-squared values but it does not change the relative predictability of financial instruments and their trend over time.

Finally, we present a comparison of the predictive power of market-based measures with CBRT's survey of expectations. CBRT's Survey of Expectations intends to monitor the expectations of decision-makers and experts in the financial and real sectors regarding various economic variables. We use all relevant survey data for our comparison. Firstly, we use the expectation of the Borsa Istanbul (BIST) Repo and Reverse Repo Market Overnight Interest Rate (end of current period) and compare this survey data with all available 1-month market indicators. Secondly, we use the expectation of annually compounded interest rate of TRY denominated Government Domestic Debt Securities with maturity of about three months. We calculate the simple yield of the survey data (end of current period) and compare all available 3-month maturity market indicators. In the fourth column of the table, we calculate the simple yield of the survey data and derive "3 month forward 3 month rates" of all available market indicators by using yields on 6-month and 3-month securities. In the last column of the table, we calculate the simple yield of the survey data and derive "6 month forward 3 month rates" of all available market indicators by using yields on 9-month and 6-month securities.

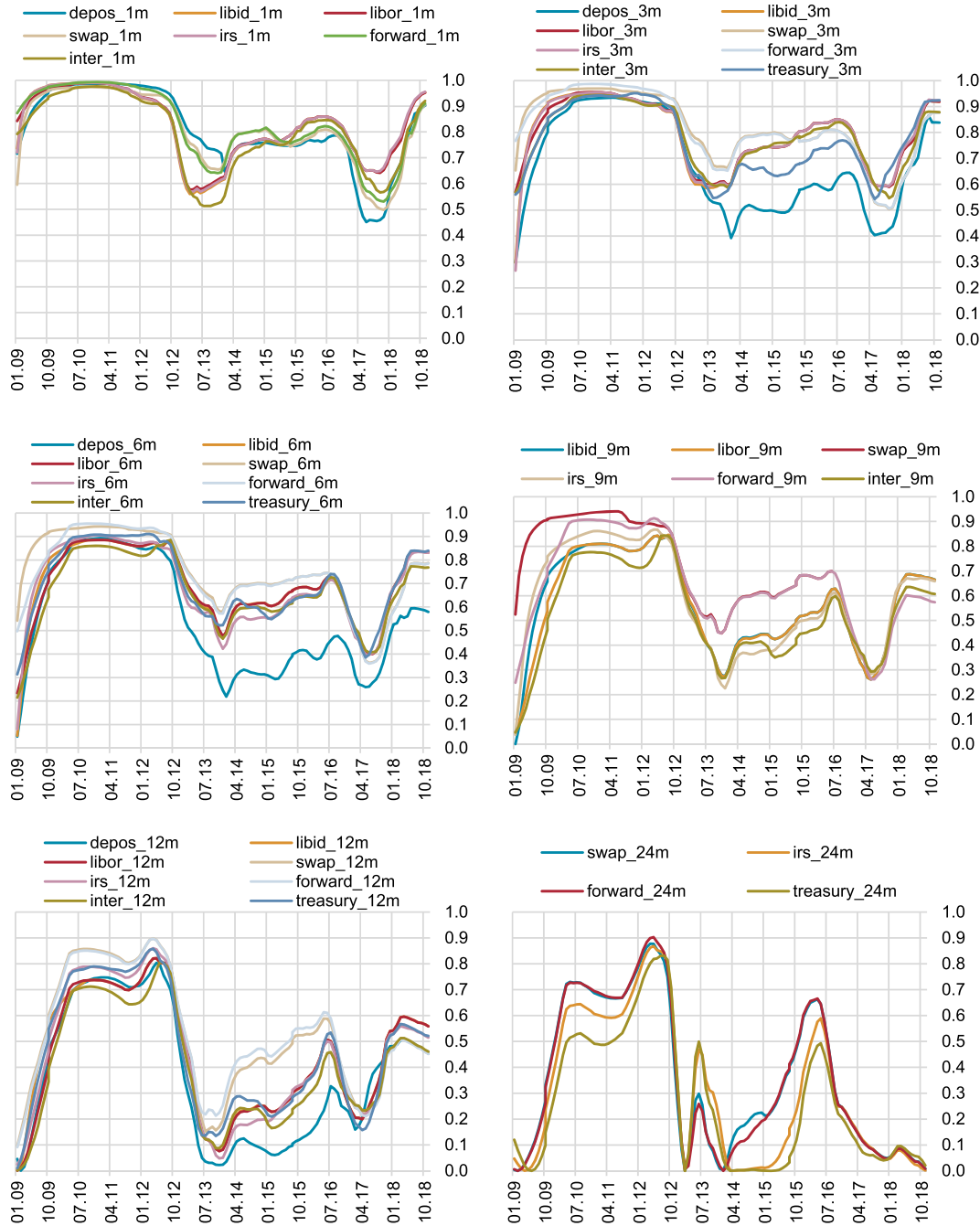


Fig. 2. Predictive power of market rates rolling over 4-years.

5. Empirical results

To assess out of sample predictive power of market rates, we regress arithmetic mean of future CBRT effective policy rates (WAF and BIST repo), over related maturity to market interest rates with relevant maturity. Firstly, we present and discuss the regression results for CBRT WAF and then for BIST repo. Since average effective policy rates over related maturity is co-integrated with market rates⁴ as expected, we report R-squared values in the OLS regression in levels in Table 1. As can be seen from Table 1, in our

⁴ We check whether residuals are stationary or not in levels regression, and we find that all residuals are stationary.

baseline models in which the CBRT WAF is the dependent variable, FX forward implied rates dominate all other instruments for 3, 6, 9, 12 and 24 months horizons while TRLIBOR is the best for 1-month horizon in forecasting future policy rate.

Table 2 presents DM test statistics with squared-error loss function and p-values (in parentheses) to test whether our base model provides forecasts that are significantly different from other models. We take the model (Model-1) that uses the forward implied yields as explanatory variable as our baseline model since it gives the highest R-squared values for most of the time horizons. It should be noted that the holdback period have 2326 observations covering January 4th, 2005–December 31st, 2013 and out-of-sample forecasts cover January 2nd, 2014–December 31st, 2018 period which has 1279 observations. According to DM test, we can

Table 3

Predictive Power of Market Rates vs. CBRT Survey.

	1-month ^a	3-month ^b	3-month after 3-months ^b	3-month after 6-months ^b
Deposit	0.944	0.8805	0.4621	
TRLIBID	0.962	0.9288	0.7639	0.5107
TRLIBOR	0.964	0.9281	0.7631	0.5097
Cross Currency Swap	0.941	0.9102	0.7109	
Interest Rate Swap	0.963	0.9338	0.7107	0.5163
Forward Implied Yield	0.966	0.9100	0.7088	0.5100
Interbank Depo	0.940	0.8951	0.5676	0.4977
Treasury Bond Yield		0.9475	0.7606	
CBRT Survey	0.973	0.9478	0.7238	0.4651
Max R-squared	0.973	0.9478	0.7639	0.5163

As can be seen from Table 4, our main findings do not change significantly in models which take the BIST repo rate as the dependent variable and FX forward implied rates continue to dominate all other instruments for 3, 6, 9, 12 and 24 months horizons while TRLIBID is the best for 1-month horizon in forecasting future policy rate.

^a January 7th, 2005–December 31st, 2018.

^b January 15th, 2013–December 31st, 2018.

Table 4Predictive power of market rates for future BIST repo rate^a.

	1-month	3-months	6-months	9-months	12-months	24-months
Deposit	0.884	0.824	0.742	.	0.625	.
TRLIBID ^b	0.975	0.928	0.821	0.713	0.604	.
TRLIBOR	0.974	0.927	0.830	0.737	0.643	.
Cross Currency Swap ^c	0.927	0.880	0.691	0.723 ^d	0.702	0.471
Interest Rate Swap	0.974	0.927	0.822	0.732	0.670	0.414
Forward Implied Yield	0.959	0.930	0.857	0.790	0.706	0.477
Interbank Depo	0.950	0.904	0.785	0.693	0.609	.
Treasury Bond Yield	.	0.906	0.830	.	0.69	0.373
Max R-squared	0.975	0.930	0.857	0.790	0.706	0.477

^a January 15th, 2013–December 31st, 2018.

^b January 7th, 2005–December 31st, 2018.

^c Turkish Lira Interbank Bid Rate is available between October 26th, 2006 and December 31st, 2018.

^d All cross currency swap data is available between August 5th, 2008 and December 31st, 2018.

^e Currency swap data with maturity of 9 months is not available between June 30th, 2016 and December 17th, 2018. We exclude these dates in regression of cross currency swap with maturity of 9 months.

conclude that the predictive power of market rates (as presented in Table 1) are significantly different. There are some exceptions for our conclusion; for 1-month horizon Model-1 and Model-5 & 7, for 3-months Model-1 and Model-7, for 6-months Model-1 and Model-5 & 8, and for 12-months Model-1 and Model-5 forecasts have statistically the same predictive power.

The predictive power of market instruments change through time which we mainly relate this to CBRT's choices of monetary policy implementation. Hence, the results of the rolling regressions are provided in Fig. 2 which reflect the time-varying property of the predictive power.⁵ As discussed in Section 2, the CBRT's monetary policy framework has changed remarkably during the time horizon of our study. Different episodes in terms of monetary policy implementation have a direct effect on CBRT's monetary policy predictability and hence the predictive power of market-based indicators. We observe that the most predictable episode over the last 14 years is the December 2006–December 2010 period. The predictability of market indicators decline sharply after the CBRT's use of unconventional monetary policy tools which increased uncertainty regarding CBRT's liquidity management. The predictive power of market rates increase in recent years with CBRT's simplification of monetary policy.

We present a comparison of the predictive power of market-based measures with CBRT's survey of expectations in Table 3.

As we expected, survey data have superior predictive power

over market rates for the short term because the survey data do not contain any credit, liquidity or risk premium like other market rates and only focus on genuine policy rate expectations. On the other hand, for longer time horizons market indicators predict policy rate changes better than the survey data. It should also be noted that the CBRT started to hold 8 MPC meetings per year since 2017 rather than monthly-scheduled meetings. This change will increase the predictive power of the survey for short term horizons and one should be cautious in interpreting the results for recent years.

It should be noted that surveys are not available at high frequency for those monitoring financial markets on a daily basis. There are also some other disadvantages with surveys, including the fact that respondents may take time to revise their views and the fact that some surveys are carried out over a period of several days rather than referring to a specific point in time. Another potential difficulty is that surveys may capture most likely policy rate to occur rather than the average expectation, which is implicitly priced in market rates.

The results of the rolling regressions for predicting the BIST repo rate are provided in Fig. 3 which resemble our findings for the baseline model and also show the time-varying property of the predictive power.

6. Conclusion

Market expectations play a vital role in the transmission mechanism of monetary policy to the real economy by affecting borrowing and lending interest rates of economic agents. This paper revisits market-based monetary policy expectations but this

⁵ Dates at the bottom of charts show the ending date of rolling time intervals in Fig. 2. For example, R-squared corresponding to date January 4, 2009 shows R-squared from regression between January 4, 2005 and January 4, 2009.

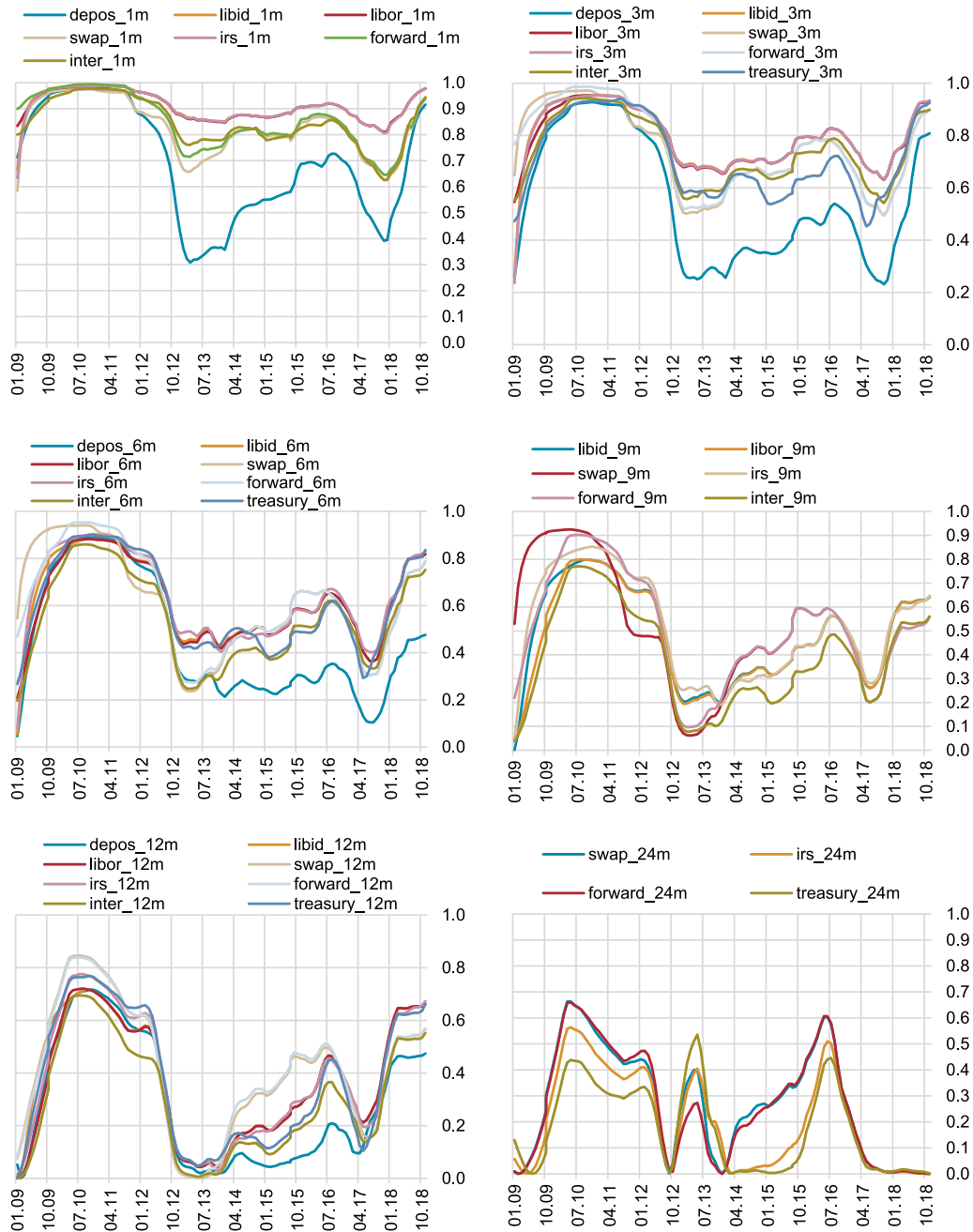


Fig. 3. Predictive power of market rates rolling over 4-years.

time for different future horizons and with a more comprehensive financial instrument set for Turkey. We implement an approach that comes from expectations theory of term structure of interest rates and try to compare their predictive power with regard to assessing monetary policy actions by simply focusing on explanatory powers in the regressions.

Our approach is different from the setup in [Alp et al. \(2010\)](#) which allows us to measure the predictive power of market rates in each weekday rather than measuring it only for MPC decision dates. In this regard, our approach is more flexible and enables us perform rolling regressions to see how the predictability of policy rate by market based indicators changes over time.

Although our baseline models use the CBRT WAFC as the dependent variable, WAFC may not fully reflect the monetary

policy stance especially during times when CBRT used the interest rate corridor actively. During unconventional liquidity management practices, WAFC can diverge from the overnight rates in BIST repo market and the BIST repo rates start to represent the stance of the monetary policy more accurately than the WAFC. In order to address this issue, we also run our regressions with BIST overnight repo rate as the dependent variable and present that our main findings do not change remarkably.

We find that FX forward implied rates dominate all other instruments for 3, 6, 9, 12 and 24 months horizons in predicting the CBRT effective policy rate while BIST overnight repo rate expectation from CBRT's Survey of Expectations is the best for 1-month horizon in forecasting future effective policy rate. We also note that CBRT's monetary policy predictability also changes with

CBRT's choice of monetary policy implementation. Based on the predictive power of market-based indicators, the most predictable episode over the last 14 years is the December 2006–December 2010 period. This period can be characterized as excess liquidity in banking sector and predictable conventional inflation targeting period. After the second half of 2010, CBRT implemented unconventional monetary policy, and its predictability by market-based indicators declined remarkably. CBRT's predictability has increased again since the second half of 2016 thanks to simplification of monetary policy framework.

Since every financial instrument has limitations in measuring policy rate expectations due to their particular credit, liquidity risk, term premia; new financial instruments such as Overnight Indexed Swap (OIS) and/or WAFC futures, a financial instrument tied to CBRT WAFC, may be helpful to measure market expectations of monetary policy in a more accurate and timely manner.

Appendix

Table 1
Robustness Check Predictive Power of Market Rates Using Compounded WAFC

	1-month	3-months	6-months	9-months	12-months	24-months
Deposit	0.9339	0.8853	0.8015	.	0.7300	.
TRLIBID	0.9564	0.9348	0.8644	0.7857	0.7174	.
TRLIBOR	0.9598	0.9348	0.8670	0.7959	0.7333	.
Cross Currency Swap	0.9262	0.9093	0.7768	0.8188	0.7887	0.5816
Interest Rate Swap	0.9569	0.9361	0.8600	0.7988	0.7522	0.5298
Forward Implied Yield	0.9552	0.9443	0.8931	0.8429	0.7909	0.5838
Interbank Depo	0.9449	0.9225	0.8360	0.7669	0.7098	.
Treasury Bond Yield	.	0.9350	0.8764	.	0.7598	0.4953
Max R-squared	0.9598	0.9443	0.8931	0.84429	0.7909	0.5838

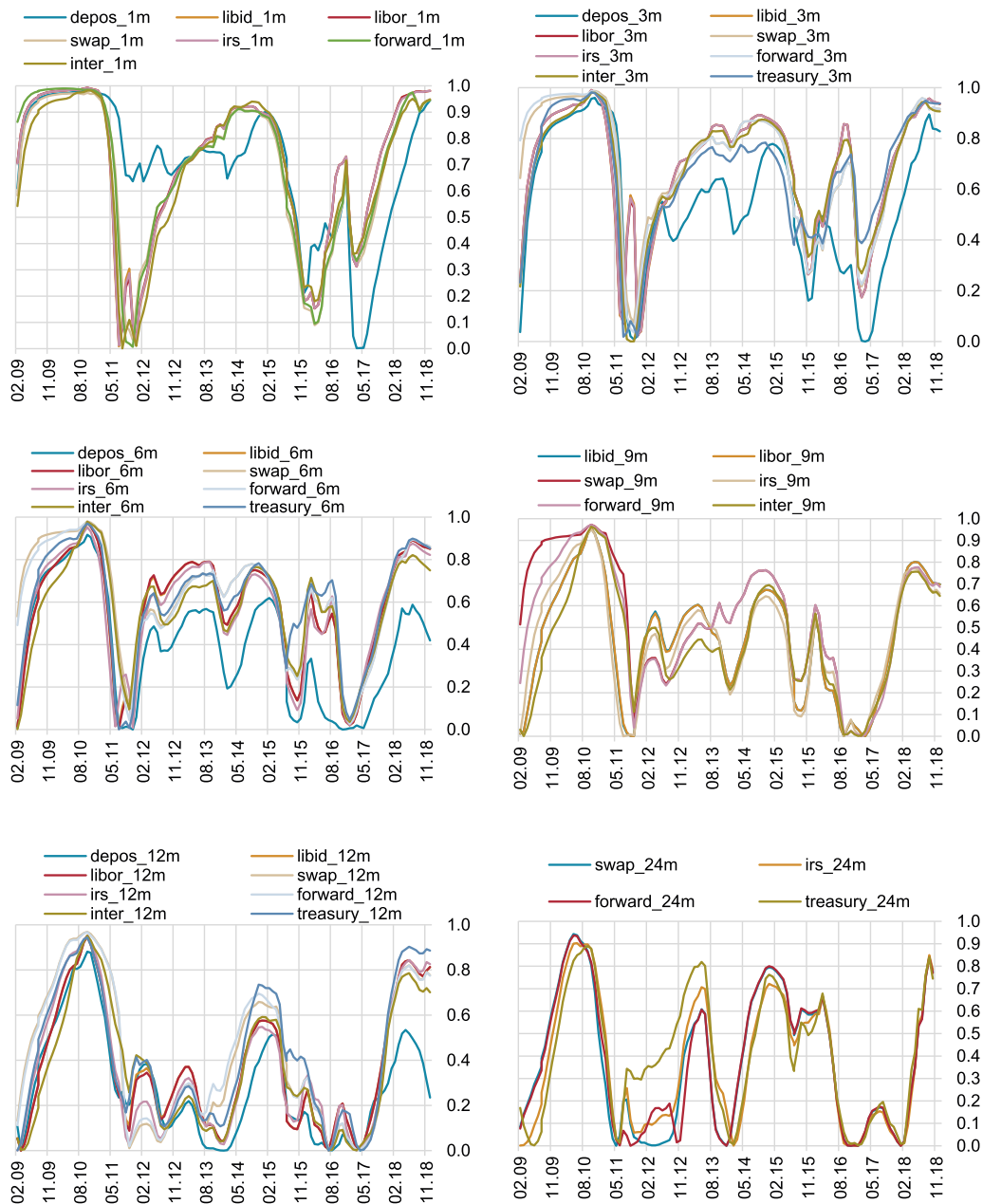


Fig. 1. Predictive Power of Market Rates Rolling Over 2-years.

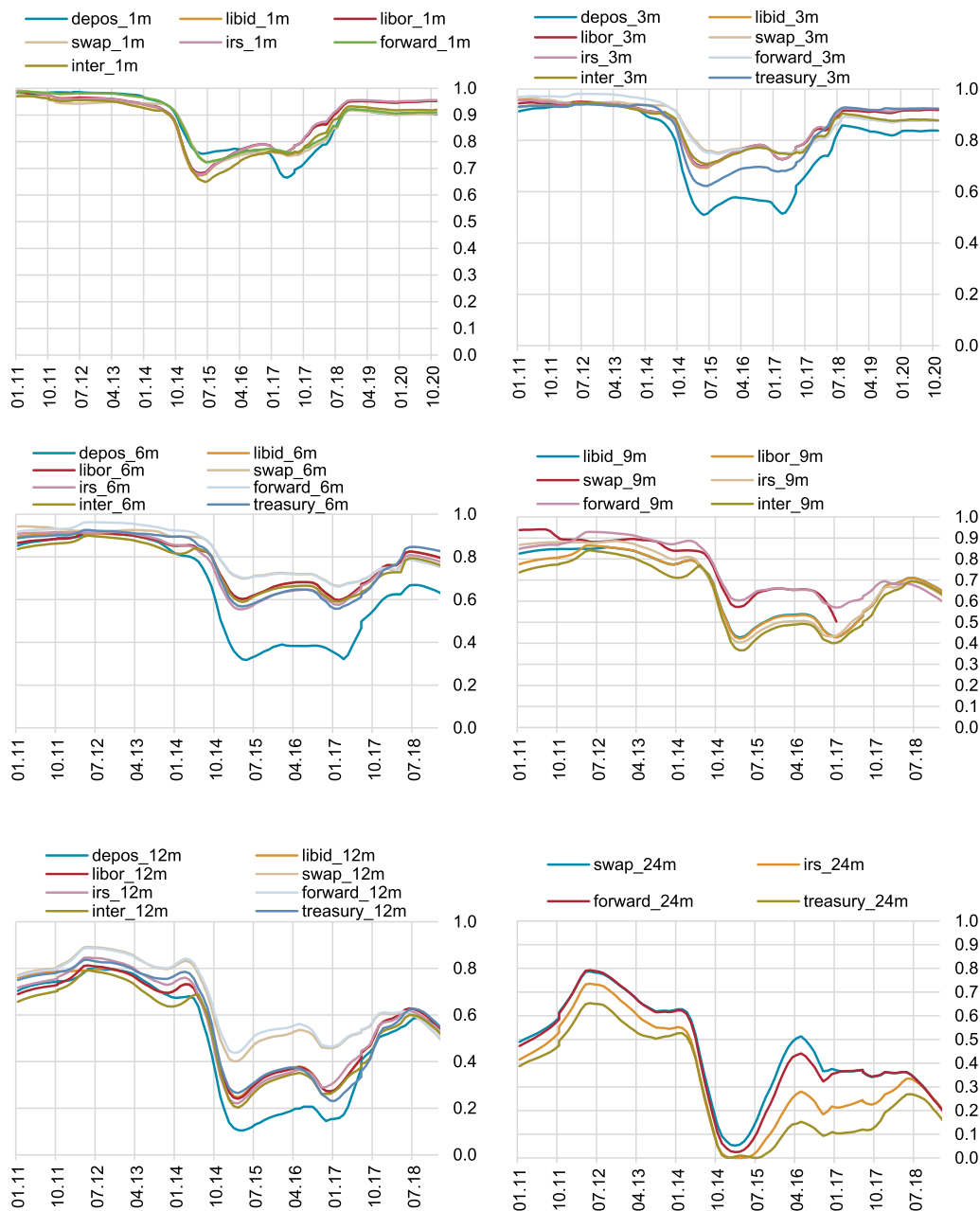


Fig. 2. Predictive Power of Market Rates Rolling Over 6-years.

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