TÜRKİYE CUMHURİYET MERKEZ BANKASI

CBT RESEARCH NOTES IN ECONOMICS

Which Money Market Instrument is Better at Representing Market Expectations on Short-Term Rates?*

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Özet: Bu not iki amaca odaklanmaktadır. İlk olarak, çeşitli finansal enstrümanların kısa vadeli para piyasası faizine dair piyasa beklentilerini temsil yetenekleri incelenmektedir. İkinci olarak ise, analize dahil edilen getirilerin içerdikleri vade priminin elde edilmesine yönelik alternatif bir yöntem sunulmaktadır. Sonuçlar ABD doları/Türk lirası (TL) vadeli döviz sözleşmelerinden elde edilen TL getirilerinin gecelik para piyasası faizini tahmin gücünün diğer getiri çeşitlerinin üzerinde olduğunu; bu getiri çeşidini ABD doları/TL kur takası sözleşmelerinden elde edilen TL getirisinin ve TL Bankalararası Alış Oranının (TRLIBID) takip ettiğini ortaya koymaktadır. Buna ek olarak, söz konusu getiri çeşitlerinin içerdikleri vade priminin, diğer getirilere kıyasla daha düşük ve istikrarlı oldukları sonucuna ulaşılmıştır. Ne var ki, Türkiye Cumhuriyet Merkez Bankası'nın, gecelik para piyasasında "kontrollü belirsizliği" bir araç olarak kullanmaya başladığı yeni para politikası çerçevesiyle birlikte getirilerin tahmin güçleri belirgin biçimde azalmaktadır. Söz konusu dönemde TL Bankalararası Alış ve Satış Oranları (TRLIBID ve TRLIBOR) kısa vadede piyasa beklentilerini temsil gücü en yüksek getiri çeşitleri olarak ön plana çıkmaktadır.

Abstract: This note aims to serve two purposes. First, it evaluates the ability of various financial market instruments to capture market expectations on short-term rate. Second, it utilizes an alternative approach to obtain estimates of term premium inherent in alternative returns. Empirical results reveal that Turkish lira (TRY) returns implied by USD/TRY forward rates dominate all other return types for predicting the overnight interbank repo rate, followed closely by TRY returns in USD/TRY swap agreements and TRY interbank bid rate. Moreover, these return types are found to contain the lowest and least volatile term premium. However, forecasting ability of returns declines significantly with the introduction of the new policy framework by the Central Bank of Turkey, which utilizes "controlled degree of uncertainty" in o/n rates as an additional tool. In the recent period TRY interbank bid and ask rates stand out as returns with the highest ability to represent market expectations at short horizon.

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1. Introduction:

In this note I aim to serve two purposes. First, I evaluate the ability of various financial market returns which are considered to be closely related to short-term money market rate, to capture market expectations on the future course of the short-term rate and hence monetary policy. To this end, I estimate alternative returns' success in predicting the weighted average of Turkish lira (TRY) overnight (o/n) repo rate in the period between January 2007 and July 2012 for various horizons up to six months.[1] Those returns having the highest predictive power are taken to be the best measures of market expectations. Additionally, I focus on the impact of the new monetary policy framework in which the Central Bank of Turkey (CBT) has adopted the degree of policy predictability and uncertainty in o/n money market rate as an additional tool.

I also use an alternative method to obtain estimates for term premium inherent in alternative returns. These estimates serve as an additional measure for the convenience of returns for mesuring market expectations. Arguably more importantly, premiums are measured in such a way that they can be used for practical purposes as these estimates could be incorporated in the construction of the curve for market expectations on the course of the o/n rate, although construction of the curve is out of the scope of this note. For this, distributions of differences between calculated forward rates are obtained for periods in which policy rate is unanimously expected to remain unchanged. Returns included in the analysis are TRY interbank bid (Trylibid) and ask rates (Trylibor), TRY depo ask (Depoask), bid (Depobid) and last rates (Depolast) quoted in Bloomberg by financial institutions, TRY rates quoted for USD/TRY currency swaps (Tryswap) and USD/TRY forward contracts (Tryforw). These returns are expected to be closely linked to the o/n rate as they are either close substitutes or functions of the o/n repo rate.

Results reveal that Tryforw dominates all other returns for predicting the o/n repo rate at horizons out to six months, except the one-month horizon; closely followed by Trylibid and Tryswap. Prediction performance declines for longer horizons for all return types. Moreover, Tryforw and Tryswap are found to contain the lowest and least volatile term premia together with Trylibid. All these findings bring Tryforw to the fore as being the most convenient return for the derivation of market expectations for the period examined, together with Trylibid and Tryswap.

However, estimations for the period in which the CBT has adopted a new policy framework depict a partially contrasting picture with the previous one. In this period, forecasting power of all types of returns diminishes to a significant extent, even vanishing at some subperiods. This is in line with our expectations as the CBT has intended to incorporate uncertainty by creating high level of volatility in the ISE repo market via gauging the amount of liquidity in the interbank

[1] By focusing on the weighted average of Turkish lira (TRY) overnight (o/n) repo rate, I assume that the investors are able to invest in o/n market at the weighted average return.

market. Trylibid and Trylibor stand out as having "relatively" high forecasting power at the one-week horizon through the recent period[2].

2. Empirical Specification:

Rational market participants are expected to use all available information to make the best forecasts. For this reason, in this paper I take the ability of alternative financial returns to predict the TRY o/n repo rate in ISE money market for various horizons as an indicator of how convenient they are for measuring market expectations. In this contenxt, I refer to the "weak form of expectation hypothesis" (WFEH), which is a common assumption in literature. According to this hypothesis, due to the ability of investors to substitute between different financial market instruments, a long-term return must be equal to the expected rate of return from an investment strategy of rolling over o/n rates through the term of the long-term return, plus a risk premium which covers premia required for risks associated with investing for longer terms. In this framework, I test the forecasting power of various financial returns by estimating equation (1), which is a modification of the standart interest rate forecasting regression used in the literature, Mankiw and Jeffrey (1986), Rudebusch (2002) and Gürkaynak (2007) being three of the papers using various forms of this equation:

$$i_t^p = \alpha + \beta\left(\left(\left(\prod_{k=t}^{t+p-1}\left(1+\frac{on_k}{36000}\right)\right)-1\right)\left(\frac{36000}{p}\right)\right) + \varepsilon_t \qquad (1)$$

In the equation above, i_t^p is the rate of return on a p-term market instrument at day t and on_k denotes the o/n rate at day k. The expression in the outmost parenthesis presents the compounded return to the strategy of rolling over o/n rate and α incorporates the average level of risk premium. To avoid the problem of autocorrelation, horizons of long-term returns in the sample should not overlap. In other words, the sample should be comprised of observations at time t, t+p, t+2p...

According to WFEH, under the no-arbitrage condition, β should be equal to 1, α to be equal to a constant including a term premium together with all other premia imposed by the structure of the financial instrument and ε_t to cover deviations of term premium from its long-term average, plus all other factors contributing to the deviation of the return from compounded o/n rate. Although WFEH assumes term premium to be constant over time, I do not require this assumption for this paper, since I am interested in the forecasting performance of regression (1) rather than structural estimates of β. To the extent that the risk premium varies over time, it will deteriorate the forecasting performance of the financial return and lead us to favor against it. I am

[2] See Kanlı (2012) for a detailed explanation of the methodology and discussion of findings.

interested in particular in the R^2 of the regression as a measure of the usefullness of returns for forecasting the o/n rate, as exercised in Rudebusch (2002), Alp (2010) and Gürkaynak (2007).

The dependent and independent variables in equation (1) have unit roots and they tend to move in a cointegrated way, hence in that case the estimated coefficients represent the long-run relationship between variables. Since I am primarily interested in the ability of market rates to predict the o/n at the horizon up to six months, I follow the common practice in literature and "stochastically detrend" equation (1) by subtracting off the current level of o/n rate from both sides of the equation:

$$i_t^p - on_t = \alpha + \beta\left(\left(\left(\prod_{k=t}^{t+p-1}\left(1+\frac{on_k}{36000}\right)\right)\left(\frac{36000}{p}\right)\right) - on_t\right) + \varepsilon_t \qquad (2)$$

3. Results:

Estimation results of equation (2) for alternative returns and horizons of 1, 2, 3 and 6 months are reported in Table 1 and R^2 values are plotted in Figure 1 as a function of the horizon[3]. As seen in Figure 1, there exists no pronounced pattern for the R^2 values with the forecast horizon up to three months. However, forecasting power of all types of returns diminishes sharply at the six-month horizon. Results indicate that Tryforw dominates all other return types in predicting o/n rates at all horizons except one-month horizon, followed by Trylibid and Tryswap. At the horizon of one month, Trylibid and Trylibor have high forecasting power, a result consistent with Alp et al (2010), which concludes that Trylibid has the highest forecasting power at the horizon of one week. On the other hand, Kanlı (2012) shows that forecasting power improves significantly for all return types once the forecasting horizon is restricted to the period until July 2011.

The estimated average risk premium, which is denoted by α in equation (2) is quite large and increasing with the horizon for returns except Tryforw and Tryswap. It may in part reflect the compensation for higher counterparty risk for longer horizons. However consecutive reduction in policy rates by amounts larger than market anticipated in the period between November 2008 and Novermber 2009 may well have boosted the estimated risk premia. On the other hand, estimated risk premium is fairly low or even statistically insignificant at some horizons for Tryforw and Tryswap as these returns do not incorporate any significant counterparty risk since both forward and swap agreements comprise an exchange instead of a loan. Finally, though it is not the primary concern of this note, we cannot reject the hypothesis that β=1 at 95% confidence level for horizons up to three months for all return types. Here, I should emphasize that the sample size used in estimations is limited especially for the six-month horizon due to the unavailability of data

[3] Limited size of the sample restrains me from estimating the forecasting power of returns at longer horizons.

prior to the period analyzed and necessity for non-overlapping horizons. This requires a cautious approach in the assesment of results for longer horizons.

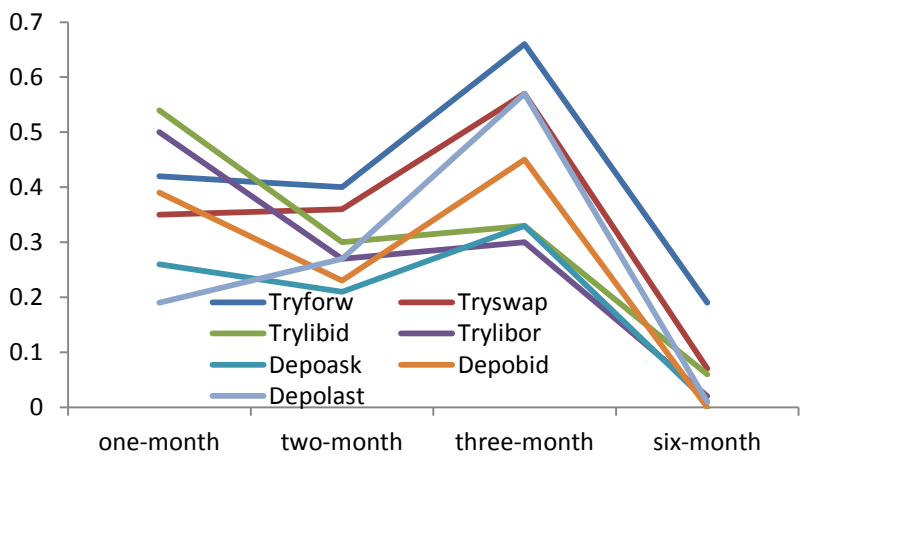
Table 1: Monthly Regression Results of Equation (2) for the period between January 2007 and July 2012

	α	Standard errors	β	Standard errors	R^2	*p-value* H_0:β=1
Tryforw						
one-month	-0.15	0.10	0.84***	0.12	0.42	0.19
two-month	-0.24	0.15	0.73***	0.16	0.40	0.10
three-month	-0.03	0.15	0.82***	0.13	0.66	0.19
six-month	0.19	0.37	0.43	0.24	0.19	0.04
Tryswap						
one-month	-0.01	0.11	0.80***	0.13	0.35	0.14
two-month	-0.20	0.15	0.67***	0.16	0.36	0.05
three-month	0.02	0.16	0.75***	0.14	0.57	0.10
six-month	0.23	0.39	0.26	0.31	0.07	0.04
Trylibor						
one-month	1.09***	0.08	0.81***	0.10	0.50	0.07
two-month	1.17***	0.14	0.52***	0.15	0.27	0.00
three-month	1.42***	0.22	0.59***	0.20	0.30	0.06
six-month	1.82***	0.24	-0.09	0.19	0.02	0.00
Trylibid						
one-month	0.43***	0.08	0.85***	0.10	0.54	0.12
two-month	0.50***	0.14	0.55***	0.15	0.30	0.01
three-month	0.74***	0.22	0.62***	0.20	0.33	0.07
six-month	1.54***	0.33	0.14	0.21	0.06	0.00
Depoask						
one-month	1.65***	0.13	0.78***	0.17	0.26	0.19
two-month	1.75***	0.20	0.60***	0.21	0.21	0.06
three-month	1.92***	0.22	0.63***	0.20	0.33	0.08
six-month	2.56***	0.39	-0.08	0.25	0.01	0.00
Depobid						
one-month	-0.05	0.10	0.81***	0.13	0.39	0.13
two-month	-0.07	0.18	0.57***	0.19	0.23	0.03

three-month	0.07	0.18	0.67***	0.17	0.45	0.06
six-month	0.37	0.46	-0.02	0.37	0.00	0.02
Depolast						
one-month	0.65***	0.16	0.74***	0.19	0.19	0.18
two-month	0.74***	0.16	0.56***	0.16	0.27	0.01
three-month	1.01***	0.14	0.67***	0.13	0.57	0.02
six-month	1.75***	0.30	-0.04	0.19	0.01	0.00

*10% significance level; ** 5% significance level; *** 1% significance level

Figure 1: R^2 of Regressions for Alternative Returns



4. The New Framework For Monetary Policy: Controlled Uncertainty

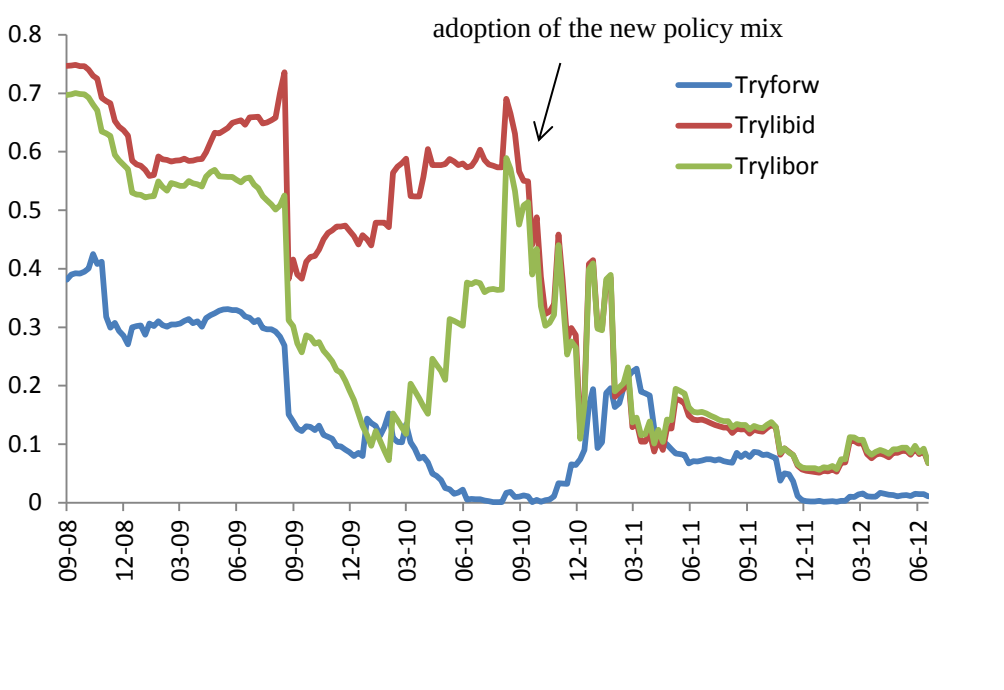
In order to cope with the challanges brought by the post-crisis period, the CBT modified its existing framework in the end of 2010 to bring the economy to a soft landing and to rebalance the composition of growth, without hampering the price stability objective. Accordingly, the CBT has adopted a new policy mix by using alternative policy tools, namely the required reserve ratios and the interest rate corridor in addition to short-term interest rates.

One of the motivations for adopting interest rate corridor as an additonal instrument was to introduce “controlled uncertainty” in short-term rates, thus discourage short-term speculative inflows by reducing the expected return-to-risk ratios from carry trades and reinforce the effectiveness of required reserve ratios. The induced volatility in short-term rates has been accompanied by less policy guidance regarding the path of future policy rates to further bolster

the impact of the interest rate risk channel. By other words, The CBT started using the degree of policy predictability and uncertainty in o/n rate as an additional tool.[4]

The new policy framework has taken its toll on the ability of various returns to forecast the future course of o/n rate, as intended. I estimated equation (2) for the period between July 2007 and July 2012, however this time taking the forecast horizon as one week and by rolling regressions of 60 observations. Though not compatible with the previous section, one-week forecast horizon enabled me to have enough observations to conduct regressions for the recent period, and rolling regressions to trace changes in forecasting ability of returns through time. Figure 2 depicts rolling R^2 values of regressions for the whole-sample best forecasters. Unsurprisingly, forecasting powers of returns decline in the recent period, albeit to surprisingly low levels. The R^2 values follow a volatile course through the period, sometimes even touching the "almost zero" bound. In this period, Trylibor and Trylibid step ahead as returns with higher forecasting ability and hence better in capturing market expectations. On the other hand, term premia estimated for Tryforw and Tryswap are significantly higher than the premia obtained previously, while difference is not noteworthy for other return types.

Figure 2: R^2 of Roling Regressions with Weekly Data between July 2007 and July 2012



[4] See Başçı and Kara (2011) for a detailed exposition of the new policy framework.

5. An Alternative Approach for the Term Premium

Estimated values of average term premia, which is denoted by α in equation (2), are not of my primary interest in the previous section as I focus on measuring the ability of various returns to forecast the o/n rate. However, in practical use, the usability of a return type for obtaining expectations depends also on whether a reasonably stable and small term premium could be assigned to that return. Otherwise uncertainty as to whether the difference between forward rates reflects the term premium or expectations of o/n rate change could lead to wrong inferences. Equation (3) below presents the relationship between spot and forward rates. Market expectations curve, which reflects the expectations of market participants on short rate at different horizons, could be constructed using forward rates calculated with this equation, though it is out of the scope of this note:

$$(1 + i_{t,t+N})^N = (1 + i_{t,t+p})^p \times (1 + f_{t+p,t+N})^{N-p} \tag{3}$$

In the equation above, $i_{t,t+N}$ and $i_{t,t+p}$ denote spot rates at time t with terms of N and p months, respectively. $f_{t+p,t+N}$ represents the (t+p)x(t+N) forward rate at time t, that is the forward return at time t for the period of length (N-p) months between time (t+p) and (t+N). Forward curve can be constructed by applying equation (3) recursively using spot rates. More precisely, forward rates for the first three months of the curve, tx(t+1), (t+1)x(t+2) and (t+2)x(t+3) forward rates, are calculated as follows:

$$f_{t,t+1} = i_{t,t+1} \tag{4}$$

$$f_{t+1,t+2} = ((i_{t,t+2} + 1)^2/(i_{t,t+1} + 1)) - 1 \tag{5}$$

$$f_{t+2,t+3} = ((i_{t,t+3} + 1)^3/(i_{t,t+2} + 1)^2) - 1 \tag{6}$$

Forward rates calculated as above are comprised of two components according to WFEH: Compounded rate of expected o/n rates through the period forward rate covers and a term premium. In this respect there must be a term premium between forward rates with consequent value dates such as $f_{t+1,t+2}$ and $f_{t+2,t+3}$. For this reason, it is crucial to assess whether the difference between $f_{t+1,t+2}$ and $f_{t+2,t+3}$ is a reflection of expectations of a change in the o/n rate from the period of (t+1,t+2) to (t+2,t+3) or just the term premium.

Estimates of α in equation (2) in section two contain information regarding the term premia in alternative returns for different terms. However, the limited sample size used in estimations and the dominance of downsided shocks to policy rate in the sample period requires caution in using these estimated values of term premia both as a measure of convenience of returns for obtaining market expectations. Additionally, α also includes premium for the structural differences between investing in alternative financial instruments and o/n repo market in ISE such as taxation, transaction costs etc.

In this context, an alternative approach to have an indicator of the term premium incorporated in alternative returns is to analyze the differences between forward rates with different value dates for the periods in which there exists a complete consensus on constant o/n rate through the horizon of three months[5]. Expectations of no change in o/n rate imply that differences between forward rates shown below will mostly reflect term premia.

$$d_{t,t+1} = f_{t,t+1} - on_t \tag{7}$$

$$d_{t+1,t+2} = f_{t+1,t+2} - f_{t,t+1} \tag{8}$$

$$d_{t+2,t+3} = f_{t+2,t+3} - f_{t+1,t+2} \tag{9}$$

$d_{t,t+1}$, $d_{t+1,t+2}$ and $d_{t+2,t+3}$ can be taken as proxies for term premia between forward rates[6]. Descriptive statistics for these differences for the periods of 15.12.2009 - 15.03.2010 and 01.07.2010 - 30.11.2010 in which market participant are in complete agreement in favor of o/n rate to be constant through the three month horizon are reported in Table.

Table 2: Descriptive statistics of $d_{t,t+1}$, $d_{t+1,t+2}$ and $d_{t+2,t+3}$ for the periods of 15.12.2009 - 15.03.2010 and 01.07.2010 - 30.11.2010

	$d_{t,t+1}$			$d_{t+1,t+2}$			$d_{t+2,t+3}$		
	Mean	**Median**	**St. Dev.**	**Mean**	**Median**	**St. Dev.**	**Mean**	**Median**	**St. Dev.**
Tryforw	0.16	0.12	0.25	0.00	0.01	0.13	0.09	0.08	0.10
Tryswap	-	-	-	0.06	0.08	0.09	0.09	0.05	0.13
Trylibid	0.08	0.08	0.12	0.23	0.20	0.10	0.35	0.35	0.10
Trylibor	0.21	0.21	0.01	0.23	0.20	0.10	0.38	0.38	0.11
Depobid	0.11	0.09	0.33	-0.09	0.04	0.37	-0.13	0.08	1.02
Depoask	1.26	1.37	0.60	0.50	0.16	0.96	1.45	1.05	1.81
Depolast	0.63	0.63	0.43	0.26	0.12	0.41	0.63	0.57	0.59

Results reveal that premia for Tryforw and Tryswap are distributed symmetrically around zero, $d_{t,t+1}$, $d_{t+1,t+2}$ and $d_{t+2,t+3}$ having median values of 12, 1 and 8 basis points for Tryforw and $d_{t+1,t+2}$ and $d_{t+2,t+3}$ having median values of 9 and 5 basis points for Tryswap respectively[7]. These figures are consistent with the findings in section two and what we expected as these

[5] The CBT's Survey of Expectations reports expectations for o/n rate only up to three-months horizon, rendering calculations impossible for horizons longer than three months.

[6] There are two reasons for calculating differences between forward rates and using them as proxies of term premia in the construction of the expectations curve: First, an mentioned previously, forward rates, which are calculated recursively from spot rates, are used to measure expectations on the course of the o/n rate. In this respect, inferences regarding expectations are made by evaluating these differences between consequetive forward returns. Second, this methodology prevents the volatility in o/n term returns of various financial instruments passing through to term premium calculations.

[7] $d_{t,t+1}$ can not be calculated for Tryswap as there exists no o/n Tryswap.

instruments include an exchange rather than lending. Trylibid, which is another good predictor of o/n rates especially for shorter horizons, is found to contain term stable term premium. Overall, term premia for alternative returns are tended to increase with horizon, which is a natural consequence of the proportionality of risk premium, unceratinty and the horizon. Findings in this section underpin the results of the previous section in the sense that Fxforw and Fxswap are the two types of returns with lowest and stable term premia, Trylibid accompanying them in terms of the stability of premia. On the other hand, term premia obtained by two different methods in the two sections of this paper are found to be closely correlated.

6. Conclusions

This paper aims to serve two purposes. First, it evaluates the ability of various financial market instruments to capture market expectations on the future course of short-term rate and hence monetary policy. Second, it uses an alternative method to obtain estimates for term premia inherent in alternative returns which serves as an additional measure in the comparison of the convenience of financial returns for deriving market expectations and also can be used in the detection of expectations based changes in forward rates.

Results for the period until July 2012 reveal that TRY returns on USD/TRY forward rate agreements dominates all other returns for predicting the o/n repo rate at all horizons except one-month horizon, followed closely by TRY interbank bid rate and TRY returns on USD/TRY swap agreements. Predicting performance declines for longer horizons for all return types. Moreover, these return types are found to contain the lowest and least volatile term premia.

However, forecasting ability of returns declines significantly with the introduction of the new policy framework by the CBT, which utilizes “controlled degree of uncertainty” in o/n rates as an additional tool in the recent period. In the recent period TRY interbank bid and ask rates stand out in terms of the ability to capture market expectations at short horizons.

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