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Determinants of Interest Rates in Turkey

The interest burden of borrowing has been the main concern of the Turkish Treasury since 1994. Beginning with the April 5th Stabilization Program—which owes its name the date it was announced, April 5, 1994—the budget has recorded a primary surplus. However, adding the interest payment figures to the budget deficit complicates the matter. The ratio of interest payments to the budget deficit was 1.05 in 1996 and 1.78 in 1997. In other words, the government has had a budget surplus when the interest payments are excluded. The ratio of interest payments to tax revenues was 48 percent in 1996 and 79 percent in 1997. In other words, interest payments have put immense pressure on the government budget.

The interest payment facet of domestic borrowing complicates the matter for a public sector whose borrowing requirement is high. Hence, the interest payment burden plays the role of impeding efforts to decrease inflation. Thus, it might well be said that understanding the behavior of the interest rates is important for the implementation of macroeconomic stabilization policies to suppress inflationary dynamics in Turkey.

In this paper, we analyze the behavior of treasury interest rates that are determined via auctions and then will show that interest rates are affected by both expected inflation and inflation risk. The analysis will take the Fisher hypothesis framework as the reference point.

The Fisher hypothesis suggests that anticipated inflation is the main determinant of interest rates: as the inflation rate increases by 1 percent, the rate of inter-

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est increases by 1 percent. This suggests that anticipated interest rates change in proportion to anticipated changes in inflation, or that anticipated real interest rates are invariant to the anticipated inflation. There are extensive studies testing the test of the positive relationship between the expected inflation rate and the interest rate and the constancy of the real interest rate (Mishkin and Simmons 1995, and references cited therein).

Tobin (1965), on the other hand, argues that the real interest rate decreases with inflation. In other words, the interest rate increases less than the increase in inflation. As reiterated in later studies for the Tobin effect, Fisher (1979), Darby (1975), Felstein (1976), and Stulz (1986) assumes that the real wealth is kept constant in the form of financial assets—money and capital stock. As the inflation rate increases, the opportunity cost of holding money will increase and money demand will decrease. This increases capital stock at a given level of the real financial wealth. If the production function exhibits decreasing returns to scale, then the marginal productivity of the capital stock decreases with higher capital stock and lowers the firm's profit maximizing interest rates.

Economic agents are concerned with the real return on their asset holdings. At any given time, agents know the nominal return on their asset holdings, but not the inflation for the current period. Though they do not know the real rate of interest, they form expectations for the current period and assess expected real interest rates to make their portfolio choices. If uncertainty is involved in the inflation level forecast, this uncertainty will also affect the agents' welfare. It is assumed that investors are risk-averse: They prefer to have a higher return for a given level of risk, or a lower risk for a given level of return. Therefore, risky assets should offer a higher return to investors as a compensation for assuming higher risk. As a result, higher inflation uncertainty must be associated with higher returns, since the investors are concerned about the variability of inflation over the period that they hold the assets (i.e., the conditional standard deviation). Chan (1994) and Evans (1998) discuss the possible positive effect of inflation uncertainty on interest rates.

Liquidity of the assets is another concern. Coleman, Gilesand, and Labadie (1992) recognize that monetary shocks induce a premium on short term interest rates relative to long term interest rates, while Strongin and Tarhan (1990) argue that the expected liquidity effect is the dominant factor in the behavior of short term interest rates up to three years. Hence, they assert that the liquidity effect dominates inflation considerations. These authors might be classified as defending the evidence of a positive relationship between maturity and interest rates (or returns). In contrast to the authors mentioned above, Missale and Blanchard (1994) argue that an optimizing government uses both return and debt maturity as instruments to decrease the interest burden of the budget. The result of this is that a negative relationship between maturity of debt and interest rates holds as the debt burden (i.e., the debt-to-GDP ratio) rises.

Table 1

Summary Indicators (percent)

	1991	1992	1993	1994	1995	1996	1997
Inflation	66.0	70.1	66.0	106.3	93.6	80.4	85.7
PSBR/GNP	10.2	10.6	12.0	7.9	5.4	9.4	9.5
Domestic debt/GNP	6.8	10.5	12.8	13.9	14.6	18.4	20.0
Interest rates	80.5	87.7	87.6	164.4	121.9	135.2	122.5
Maturity	211.0	211.0	257.0	119.0	206.0	195.0	341.0
Real interest rate	8.1	9.6	13.0	28.2	14.6	30.4	11.8

Source: State Planning Organization.

If we consider the Turkish case, we see that Turkey, especially after establishing the auction system in 1986, might be considered as an interesting laboratory for monitoring interest rate behavior. As seen from Table 1, the domestic debt burden of the treasury is on an escalating trend. In addition, due to high and volatile inflation rates, interest rates and maturity structure show an oscillating picture. It can also be seen that the government undertakes unsustainably high interest rates in order to preserve the maturity at a certain band. These efforts imply a high variance in interest rates, inflation, and the maturity of the debt. In such a setting, the lenders demand high positive risk premiums for shorter periods of maturity.

Aside from the preliminary facet and its implications on the government debt market in Turkey, we start with the focus on the inflation risk in Turkey. In order to assess the risk, we proxy the uncertainty of inflation with the conditional standard deviation of inflation. Recent advances in econometric methods allow us to estimate the conditional variability. Afterwards, we estimate the conditional variance of inflation using a Generalized Autoregressive Conditional Heteroscedasticity (GARCH, hereafter) model.

The main aim of this paper is to explain the behavior of interest rates as a function of expected inflation and of uncertainty associated with inflation. The empirical analyses indicate that inflation raises interest rates less than the increase in inflation—that is, anticipated real interest rates decrease with inflation. Moreover, inflation risk increased interest rates for Turkey during the period from November 1989 to June 1998. This finding has important implications for the effectiveness of a government's macroeconomic policies and the validity of Fisher hypothesis. If a government wants to decrease the burden of interest payments in the government deficit or increase the primary surplus, a reduction in the volatility of inflation could be a less costly measure compared to reducing the level of inflation. However, it should be noted that the level of debt burden, measurable in terms of the effective debt-to-GDP ratio, is vital in fully concluding the matter. This is important since the level of the debt burden affects the behavior of the lenders. As it rises, the agents perceive it as a risk of either monetization or depreciation. Hence, the market becomes sensitive about lending to the Treasury in a shorter horizon, or demands high risk premium before being persuaded to extend the maturity period.

After modeling the interest rate determination process by utilizing expected inflation and the uncertainty stemming from the inflationary process, this paper aims at drawing inferences concerning whether the interest rate determination process in Turkey conveys characteristics on a parallel with the "liquidity premium" approach or if it follows the guidelines of Missale and Blanchard (1994). Thus, in addition to modeling the interest rate determination process, the paper also searches for the maturity profile of the government debt in Turkey.

In the next section, we develop and outline the methodology used in this paper, and describe the data. The findings are reported in the third section. The last section summarizes the findings and concludes the paper.

Expectations, Risk, and GARCH Models

In this part, we will introduce the method for assessing the risk (conditional variance) and for incorporating that risk into the interest rate equation. The Rational Expectations school emphasizes the importance of the effect of expected and unexpected shocks to inflation on the macroeconomic performance. Most of the research has been performed with the aim of identifying these effects. Engle (1982) introduced his method for modeling the volatility of inflation. This was important because for the risk-averse agents, not only the anticipated level of macroeconomic variables, but also the assessed risk of the variable, was crucial to making informed decisions for investors' portfolio choices. Next, we introduce the method used to measure the anticipated inflation and the inflation risk, after which we incorporate these two variables into the interest rate equation. Lastly, we introduce the data.

Expected Inflation and Modelling of the Inflation Risk

Here, we model the inflation equation first and then model the variance of the inflation equation. We assume that inflation, π_t, follows an autoregressive process in order q:

$$\pi_t = i_0 + {}^{q}\sum_{j=1} i_j \pi_{t-j} + \varepsilon_t \qquad (1)$$

Here, i_j is the coefficient of the jth lag of inflation, and e_t is the discrete–time real valued stochastic process. The conditional variance of the unanticipated inflation,

e_t, with a given information set at time t–1 is h_t^2 with a mean of zero.

$$\varepsilon_t / \Omega_{t-1} \sim (0, h_t^2) \tag{2}$$

Here the information set at time $t-1$, Ω_{t-1}, includes all the information available to the agents at time $t-1$. Therefore, the conditional expectation of the inflation rate at time t with the given information set at time $t-1$ is:

$$E_t(\pi_t / \Omega_{t-1}) = i_o + \sum_{j=1}^{q} i_j \pi_{t-j} \tag{3}$$

The autoregressive Conditional Heteroscedasticity (ARCH) models introduced by Engle (1982) allow us to assess the risk of the inflation (i.e., conditional variance of inflation) at given time t. ARCH models assume that the conditional variance of the residual term can be explained by the lagged values of the squared residual terms of the inflation equation:

$$h_t^2 = d_o + \sum_{j=1}^{p} d_{lj} \varepsilon^2{}_{t-j} \tag{4}$$

Bollerslev (1986) extends the ARCH modeling by incorporating the lagged values of the conditional variance, and this is called Generalized ARCH or GARCH modeling. Hence, the GARCH model can be written as:

$$h_t^2 = d_o + \sum_{j=1}^{p} d_{lj} \varepsilon^2{}_{t-j} + \sum_{j=1}^{q} d_{2j} h_{t-j}^2 \tag{5}$$

As noted by Bollerslev, all the estimated coefficients need to be positive, and the sum of all d_{1j} and d_{2j} is to be less than "1" as sufficient conditions for non-negativity and non-explosiveness of the conditional variances.

Estimation

Fisher (1907) argues that nominal interest rates move with the expected inflation rate:

$$r_t = c_o + c_\pi \pi_t^e + \eta_t \tag{6}$$

Even if the nominal interest rates are known for the current period at time t inflation, the real interest rates are not known at time t. Lack of knowledge concerning the inflation rate for the current period contributes to the risk undertaken while holding assets. Risk-averse agents demand compensation for holding a risky asset in the form of additional returns.

The Fisher equation suggests that the nominal interest rate is affected by the expected inflation, π_t^e. In addition to the original form, we allow that interest rates are affected by the inflation risk, measured with the conditional standard deviation:

$$r_t = c_0 + c_\pi \pi_t^e + c_h h_t + \eta_t \tag{7}$$

Here we assume that the residual term of the interest rate equation has zero mean and constant variance. When equation (7) is estimated, expected inflation, p^e_t, and risk measure h_t need to have been calculated. One of the methods that we could use to assess the expected inflation and risk is to estimate equations (1) and (5) jointly for the full sample, then use their fitted values as a measure of the expected inflation and risk. Here, however, in order to calculate the expected inflation for any given period, we need to use full sample data for the estimation of the parameters that are not known at a mid-sample period. Hence, we estimate equations (1) and (5) with rolling regressions.[1]

Data and Sample

The data sample includes monthly observations from November 1989 to June 1998. We used the average interest rate for the treasury auctions and the average maturity dates for these auctions. In order to measure the inflation, we used the percentage changes of the seasonally adjusted wholesale price index.[2] It could be argued that since the treasury's actions are adjusted for a specific maturity, we need to include the forward behavior of the inflation for the corresponding period. However, Turkey has a developed secondary markets for these bills, which are traded heavily. Therefore, it is reasonable to assume that these bills are held for one month and that the real interest rates are realized at the end of that period.

Empirical Evidence and Discussion

In this section, we present the basic empirical evidence of the class of Fisher models. First, we present the evidence on Fisher equation. Then we model the inflation risk and incorporate the risk into the interest rate equation. In order to control the liquidity premium, we include the number of days to maturity as an explanatory variable. Last, we look at the determinants of the initial term to maturity.

Fisher Model

In order to assess the inflationary expectations, we have estimated the inflation equation as an autoregressive model. We model inflation as an AR(1) process.[3]

For the Fisher, equation the estimates are the following, where *t*-statistics are reported in parentheses below the corresponding coefficient estimates.[4]

$$r_t = \underset{(2.92)}{0.026} + \underset{(6.47)}{1.39}\, \pi_t^e \tag{8}$$

Here, the estimated coefficient of the expected inflation is greater than 1 (1.39), and is statistically significant.[5] This suggests that nominal interest rates increase more than expected inflation when the expected inflation is rising. In other words, the real interest rate increases an additional 0.39 percent. This finding suggests that inflation itself has an adverse effect on the economic performance, and may transfer income from lenders to borrowers.

Friedman (1977) and Holland (1993) argue that there is a positive relationship between inflation and inflation risk. Since those two variables move together, it might be considered that inflation proxies the inflation risk. Hence, here we include inflation risk as an additional explanatory variable in the regression analysis. In this way, we could observe the effect of expected inflation and inflation risk on interest rates. If the estimated coefficient of the inflation is less than one, then it suggests that the interest rate increases less than the inflation rate does, which implies that the real interest rate decreases with higher inflation. After considering various forms of ARCH specification, GARCH(1,1) was the appropriate presentation of the conditional variance presentation.[6]

We estimate the Fisher equation (equation 7) as:

$$r_t = \underset{(2.42)}{0.024} + \underset{(1.87)}{0.47}\, \pi_t^e + \underset{(3.65)}{1.91}\, h_t + \eta_t \tag{9}$$

This suggests that, parallel to Tobin and others, the rate of increase in the interest rates decreases as the level of inflation escalates. Moreover, inflation risk positively affects interest rates. The estimated coefficient of the expected inflation is less than one. These estimates reveal a striking difference for the model that does not incorporate the inflation risk. Higher expected inflation decreases the real interest rates, and lower real interest rates stimulates the economy. A one percent increase in expected inflation decreases real interest rates by 0.53 percent. Moreover, inflation uncertainty does increase interest rates. In other words, higher expected inflation stimulates the economy but inflation uncertainty suppresses the economy.

Apart from the risk and the expected inflation, maturity might work as a determinant of the interest rate formation process in Turkey. Although inflation and the risk associated with it contribute to interest rates positively, it would be interesting to test for the Turkish case if the liquidity premium view or the view defended by Missale and Blanchard (1994) hold. As discussed earlier, the maturity of borrowing may affect the interest rates; the lower the maturity of the borrowing, the higher the liquidity of the bond will be. Hence, we incorporate maturity of the borrowing into the interest rate equation. Our preliminary expectation is the existence of a positive relationship between interest rates and maturity considering that the treasury might be extending the maturity of the debt stock by allowing higher interest rates or the lenders might assign more weight to liquidity, hence demanding lower returns for shorter maturity.[7] When the maturity of borrowing is incorporated into the analysis, the estimates are as follows

$$r_t = \underset{(2.43)}{0.024} + \underset{(2.19)}{0.57}\, \pi^e_t + \underset{(2.97)}{1.68}\, h_t - \underset{(-1.65)}{0.00005}\, \text{Mat}_t + h_t \tag{10}$$

However, this specification, which comprises the maturity (Mat_t) releases contrary results to the idea of liquidity premium cited above. The negative relation, then, should be interpreted as the lenders demand higher returns for lower maturity. This result, in fact, proves that pricing in the Turkish government debt market operates parallel to the guidelines set in Missale and Blanchard (1994). In other words, the lenders, being cautious about the possibility of monetization or an unexpected depreciation prefer shorter periods of lending and it seems that as the burden of debt intensifies, the market favors higher-risk premiums for a shortened period of maturity. Another facet of this picture prevails in the behavior of the treasury where it uses the maturity as an additional tool to decrease the burden of the debt servicing since insistence on maturity elongation would cause the Treasury to undertake superb levels of resource transfer.

In searching for the plausibility of our original argument, we questioned whether the relationship between the interest rate and maturity is spurious. Both of these variables could be affected by a third variable. Inflation risk could be the third variable that affects both interest rates and maturity of borrowing. Hence, we test whether the maturity of borrowing is affected by the inflation risk. We model the maturity of the borrowing as an AR(1) process, as suggested by the Final Prediction Error criteria, and incorporated the effect of inflation risk into the Maturity equation.

$$\text{Mat}_t = \underset{(2.39)}{48.20} + \underset{(8.15)}{0.72}\, \text{Mat}_{t-1} - \underset{(-2.40)}{2214.07}\, h_t + \eta_t \tag{11}$$

The estimates suggest that inflation risk decreases the maturity of the government borrowings. This analysis may suggest that the treasury uses both the interest rate and debt maturity as policy tools, rather than using the interest rate as a tool and taking maturity as a constraint.

These findings confirm the work done by Missale and Blanchard (1994). As argued by the mentioned authors, in countries where the government debt burden is high, a sharp reduction of maturity is observed. This is done on the risk aversion instinct of the lenders since in this case the agents associate the increase in the debt burden with the risk of government's monetizing possibility of the debt (even with a default risk) or an unexpected depreciation of the local currency. Nevertheless, the lenders demand lower maturity with high rates of return in order to hedge themselves. In this perspective, in a setting where the debt burden of the government increases—in a possibly unsustainable manner—the effort of the Treasury in extending the maturity composition requires higher rates of risk premiums. Thus, the Treasury prefers to lower the maturity in order to reduce the debt servicing.

Conclusions

The Fisher hypothesis suggests that the main determinant of inflation is expected inflation. Moreover, it is suggested that there is one-to-one relationship between the nominal interest rate and expected inflation; hence the real interest rate is constant. This proposition has been challenged in various platforms. In order to understand the behavior of Turkish interest rates, we incorporate the inflation risk into the Fisher model. Since agents are concerned about the real return on their holdings, not the nominal returns, uncertainty in inflation or the real return may affect the interest that agents ask for holding risky assets.

A class of ARCH models is considered to model the inflation risk. GARCH (1,1) was the most appropriate specification for inflation risk. Once, the inflation risk is incorporated, then both expected inflation and inflation risk increase interest rates. However, the interest rate increases less than inflation; in other words, parallel with Tobin (1965), real interest rates decrease with higher inflation. We also look for a possible relationship between government's borrowing maturity and the interest rates. When this factor was included in the Fisher equation, maturity had a negative correlation with the interest rates. This is not what was expected. We also consider the effect of inflation risk on the maturity. The empirical evidence suggests that maturity decreases with higher inflation. Over all, this may suggest that the government uses both auction interest rates and maturity as a policy tool for decreasing the burden of government debt servicing since the lenders in Turkey prefer shorter maturity while demanding higher risk premiums.

Notes

1. Engle (1982) assumed that the errors have normal distributions. There are extensive studies showing that normality assumption is too restrictive. However, Nelson (1991) suggested using General Error Distribution, where normal distribution is a special case of the General Error Distribution.

2. We could control the seasonality with the dummy variables in the estimation process of the inflation equation. Doing this would increase the number of parameters to be estimated and possibly with longer lags. Hence, we prefer to use the seasonally

adjusted data. The empirical evidence was robust with the non-seasonally adjusted data after controlling the seasonality with dummy variables.

3. Lag order is determined by the Final Prediction Error Criteria (FPE) for the full sample. The choice of FPE is crucial because FPE sets the lag order such that it eliminates the autocorrelation problem. Cosimano and Jansen (1988) showed that autocorrelated errors of the mean equation (inflation equation here) indicate the presence of ARCH even if the ARCH effect is not present. CUSUM tests and CUSUMQ tests do not suggest a structural change in the inflation process.

4. Since we used generated regressors on the right hand side of the model, we used robust standard errors. In order to have a relationship between interest rate and expected inflation rate either these two series are stationary or both of them have a unit root and they are cointegrated. Hence, we performed Dickey and Fuller (DF), and Phillips and Perron (PP) unit root tests for both interest and inflation rates. For the interest rate, DF test statistics is –3.54 and PP test statistics is –3.38. For the expected inflation DF test statistics are –7.64 and PP test statistics is –7.54. All these four test statistics are less then –3.17 critical value at the 5 percent level of significance. Therefore, regressing the interest rate on the expected inflation is admissible.

5. The level of significance is 5 percent unless otherwise noted.

6. For the estimate of the Fisher equation, the inflation variability is estimated with the GARCH(1,1) specification for the full sample. Lagrangian Multiplier test indicated that additional lags are not necessary for the conditional variance of the inflation. Next we test for the specification of the inflation equation. We used Ljung–Box Q autocorrelation tests for 1, 6 and 12 lags. The presence of autocorrelation of the residuals or the standardized residuals (residuals/conditional standardized deviation of the residuals) indicates the misspecification of the inflation equation. The table below reports the p-values for the Ljung–Box Q autocorrelation tests for rolling regressions residuals in different lag orders. None of the p-values is less than the conventional 5 percent level. Hence, we cannot reject the inflation specification. We also divide the sample arbitrarily and perform Lagrangian multiplier tests for additional lag orders in the conditional variance specification. Lagrangian multiplier tests did not suggest additional lags for the conditional variance specification among arbitrarily chosen sub-samples. Last, we test for the presence of autocorrelation for the full sample estimates and different sub samples. The results do not indicate the presence of the autocorrelation.

	1 lag	6 lags	12 lags
Autocorrelation test of residuals	0.63	0.45	0.88
Autocorrelation test of standard residuals	0.84	0.99	0.99

7. One may argue that having both the risk measure (h_t) and maturity (Mat_t) on the right hand side in equation (10) may raise the simultaneity biased issue. Here, h is a deterministic function of the lagged values of the squared residual of the inflation equation as well as the lagged value of h; hence, h is a predetermined variable. On the other hand, the simultaneity issue can be raised in equation (10) for maturity. This equation does not show a behavioral relationship between the interest rate and maturity, but rather it is used to show the presence of a negative correlation between interest rate and maturity. This type of analysis has been performed between inflation and tax rate to show the positive relationship between these two variables before (see Mankiw 1987; Poterba and Rotemberg 1990).

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