DETERMINANTS OF INTEREST RATES IN TURKEY

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THE CENTRAL BANK OF THE REPUBLIC OF TURKEY
Research Department
Discussion Paper: 9902

ANKARA
February 1999

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* The corresponding author. Opinions expressed in this paper are not necessarily shared by the Central Bank of the Republic of Turkey, State Planning Organization or other members of staff. We like to thank to Fatih Özatay for his valuable comments, and Anita Akkas for her editorial assistance.

ABSTRACT

This paper analyzes the Turkish Treasury interest rate behaviour within the Fisher hypothesis framework for the period from 1988:11 to 1998:6. Consistent with the hypothesis, empirical evidence indicates that the interest rates increase with expected inflation. After the risk is controlled, the paper suggests that interest rates increase less than expected inflation; that is, real interest rates decrease with higher inflation. Moreover, inflation risk increases interest rates and decreases the maturity of government debt: This is evidence that lenders prefer shorter maturity in order to hedge themselves in a setting where the debt burden on the budget is on the rise. This may also indicate that both the interest rates and maturity of the debt are used as policy tools by the Treasury rather than as state variables.

JEL codes: E31 & E43

Key words: Inflation Risk, Interest Rates and GARCH models.

1. INTRODUCTION

The interest burden of borrowing has been the main concern of the Turkish Treasury since 1994. Beginning with the April 5th Program — which owes its name the date it was announced, April 5th, 1994 — the Budget has recorded primary surplus. However, adding the interest payment figures to the Budget Deficit complicates the matter. The ratio of the interest payments to a budget deficit is 1497.4: 1238.1 in 1996 and 2279,9:2240 in 1997. In other words, the government has a budget surplus when the interest payments are excluded. The ratio of the interest payments to tax revenues was 1479.4:2244.1 in 1996 and 2277.9: 4745.5 in 1997. In other words, interest payments put immense pressure on the government budget.

As is easily seen, 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 the efforts to decrease inflation. So, 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 show that interest rates are affected by both expected inflation and inflation risk. The analysis takes the Fisher Hypothesis framework as the reference point.

The Fisher hypothesis suggests that (expected) inflation is the main determinant of interest rates: as the inflation rate increases by one per cent, the rate of interest increases by one percent. This suggests that the (expected) interest rates change in proportion to the changing (expected) inflation, or the (expected) real interest rates are invariant to the (expected) inflation. There is a field of extensive studies on the test of the positive relationship between the expected inflation rate and the interest rate and the constancy of the real interest rate (see Mishkin and Simmons, 1995 and references cited in).

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 iterated in later studies for the Tobin effect, Fisher (1979), Darby (1975), Felstein (1976) and Stulz (1986) assume 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. At a given level of the real financial wealth, this increases the capital stock. If the production function exhibits decreasing returns to scale, then the marginal productivity of the capital stock decreases with higher capital stock and lowers interest rates.

Economic agents are concerned with the real return on their 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 their expectations for the current period and observe expected real interest rates to make their portfolio choices. If there is uncertainty 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. Chen (1991) and Evans (1998) briefly discuss the possible positive effect of inflation uncertainty on interest rates.

Liquidity of the assets is another concern. Coleman et al (1992) recognize that monetary shocks induce a premium on short term interest rates relative to long term interest rates while Strongin and Tarhan (1990) defend that the expected liquidity effect is the dominant factor in the behavior of the short term interest rates up to three years. Hence, they argue 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). Contrary to the authors mentioned above, Missale and Blanchard (1994) argue that an optimizing government uses both the return and the debt maturity as instruments to decrease the interest burden of the budget. As a result they found out that as the debt burden (i.e. debt/gdp ratio) rises, a negative relationship between maturity of debt and interest rates holds.

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 the interest rate behaviour. As seen from the table below, the domestic debt burden of the Treasury is in an escalating trend. In addition, due to high and volatile inflation rates, interest rates and maturity structure show an oscillating picture. On the other hand, it is easily 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 premia for shorter periods of maturity.

TABLE
SUMMARY INDICATORS
(%)

	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 (cmp.)	80.5	87.7	87.6	164.4	121.9	135.2	122.5
Maturity	211	211	257	119	206	195	341
Real Interest Rate	8.1	9.6	13.0	28.2	14.6	30.4	11.8

Source: State Planning Organization.

Aside from the preliminary facet and its implications of the government debt market in Turkey, we start with the focus on the inflation risk in Turkey. In order to asses the inflation risk in Turkey, 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 the 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 — (expected) real interest rate decreases with inflation. Moreover, inflation risk increased the interest rates for Turkey during the period from 1988:11 to 1998:6. This finding has important implications for effectiveness of governments' 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/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 convinced to extend the maturity period.

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

The plan of the paper is as follows: The next section develops and outlines the methodology used in this paper and describes the data. The findings are reported in Section 3. The last section summarizes the findings and concludes the paper.

2. EXPECTATIONS, RISK AND GARCH MODELS

In this part, we will introduce the methodology for assessing the risk (conditional variance) and for incorporating that risk into the interest rate equation. The importance of the effect of expected and unexpected shocks to inflation on the macroeconomic performance was emphasized by the Rational Expectations school. Most of the research was performed with the aim of identifying these effects. Engle (1982) introduced his methodology on modeling the variability 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 their portfolio choices. Next, we will introduce the method used to measure the anticipated inflation and the inflation risk. Section 2.2 will incorporate these two variables into the interest rate equation. Lastly, we will introduce the data.

2.1. 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, $ð_t$, follows an autoregressive process in order q:

$$(1) \qquad p_t = i_0 + \sum_{j=1}^{q} i_j p_{t-j} + e_t$$

Here, i_t is the coefficient of the i^{th} lag of inflation and $å_t$ is the discrete-time real valued stochastic process. The conditional variance of the unanticipated inflation, ε_t, with a given information set at time *t-1* is $h_t^{\,2}$ with a mean of zero.

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

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

(3) $$E_t(\pi_t \,/\, \Omega_{t-1}) = i_0 + \sum_{j=1}^{q} i_j \pi_{t-j}$$

Autoregressive Conditional Heteroscedasticity (ARCH) models are introduced by Engle (1982) allows to forecast the riskiness of the inflation (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:

(4) $$h_t^2 = d_0 + \sum_{j=1}^{p} d_{1j} \varepsilon^2_{t-j}$$

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

(5) $$h_t^2 = d_0 + \sum_{j=1}^{p} d_{1j}\,\varepsilon^2_{t-j} + \sum_{j=1}^{q} d_{2j}\,h_{t-j}^{2}$$

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

2.2. Estimation

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

(6) $$r_t = c_0 + c_\pi \pi_t^{e} + \eta_t$$

Even if the nominal interest rates are known for the current period at time *t,* inflation, hence the real interest rates, is not known at time *t*. Not knowing the inflation rate for the current period contributes to the risk undertaken while holding the asset. Risk averse agents demand compensation for holding a risky asset in the form of additional returns. Therefore, there should be a positive correlation between inflation risk and nominal interest rates. In order to observe the expected inflation and inflation risk, Equations 3 and 5 are estimated jointly by using the Quasi Maximum Likelihood Estimation method of Bollerslev and Wooldridge[1].

1 Engle (1982) assumes that the errors have a normal distribution. There is a field of extensive studies showing that normality assumption is too restrictive. Bolllerslev and Wooldridge (1992) suggested Quasi Maximum Likelihood estimates to parameters of

Then, we use these two equations to observe the effect of expected inflation and inflation uncertainty on interest rates within the Fisher hypothesis framework. The Fisher equation suggests that the nominal interest rate is to be affected by the expected inflation, $ð^e_t$. In addition to the original form, we allow that interest rates are affected by the inflation risk, measured with the conditional standard deviation .

(7) $$r_t = c_0 + c_p p_t^e + c_h h_t + h_t$$

Here we assume that the residual term of the interest rate equation have zero mean and constant variance, f_0. We also assume that the covariance of the residual terms of inflation and interest rate equations is time independent, e_0:

(8) $$\begin{bmatrix} e_t \\ h_t \end{bmatrix} \sim \left[\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} h_t^2 & e_0 \\ e_0 & f_0 \end{bmatrix} \right]$$

It is important to note that h_t^2 in equation 6 is a generated regressor. Pagan (1984) argues that using regressors generated by a stochastic model can result in biased estimates of parameters' standard errors. As a solution to this problem, Hoffman (1987) suggests using a method that estimates all the parameters together[l]. Hence, the Quasi Maximum Likelihood estimation technique is used to estimate the parameters of interest.

concern which gives consistent estimates under non-normal distribution of the error terms.

2.3. Data And Sample

The data sample includes monthly observations from 1988:11 to 1998:6. 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 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 the real interest rates are realized at the end of that period.

3. EMPIRICAL EVIDENCE AND DISCUSSION

In this section, we will present the basic empirical evidence of the class of Fisher models. First, we present the evidence on Fisher equation and 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. Lastly, we look at the determinants of the initial term to maturity.

3.1 Fisher Model

In order to asses the inflationary expectations, we estimated the inflation equation as an autoregressive model. We model inflation as an AR(1)[3] process. For the Fisher equation, the estimates are the following,

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2 We could control the seasonality with the dummy varaibles 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. The choice of FPE is

where t-statistics are reported in parentheses below the corresponding coefficient estimates[4].

$$r_t = 0.020 + 1.36\pi_t^{\,e}$$

(0.85) (2.45)

Here, the estimated coefficient of the expected inflation is greater than “1” (1.36) and is statistically significant. 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 0.36 percent when the expected inflation increases by 1 percent after addressing heteroscedasticity in the error process with GARCH specification. This finding suggests that inflation itself has an adverse effect on the economic performance and may transfer income from borrowers to lenders.

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. Thus, here we include inflation risk as an additional explanatory variable in the regression analysis. In this way, we can observe the effect

crucial because FPE sets the lag order such that it eliminates the autocorrelation problem. Cosimano and Dennis (1988) show that autocorrelated errors of the mean equation – inflation equation indicates the presence of ARCH even if the ARCH effect is not present.

4 For the estimate of the Fisher equation, the inflation variabiliity is estimated with the GARCH(1,1) specification. The LM test indicated that additional lags are not necessary for the conditional variance of the inflation equation. In order to find the specification of the inflation equation, we test the autocorrelations of the residual terms and the standardized residual terms. The values are :

	1 lag	6 lags	12 lags
Autocorrelation Test of Residuals	0.91	0.59	0.88
Autocorrelation Test of Standandarized Residuals	0.79	0.82	0.96

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)[5] was the appropriate presentation of the conditional variance presentation[6].

We estimate the Fisher equation (equation 7) as [7];

$$r_t = 0.032 + 0.55 \text{ p}_t^{e} + 0.94\, h_t + \text{h}_t$$

(4.18) *(2.26)* *(2.46)*

This suggests that, parallel with Tobin and others, the rate of increase in the interest rates decrease as the level of inflation escalates. Moreover, inflation risk positively affects the interest rates. The estimated coefficient of the expected inflation is less than one. This is a striking difference for the model that does not incorporate the inflation risk. Expected inflation decreases the real interest rates and stimulates the economy. A 1 percent increase in expected inflation decreases real

5 Additional lags were included in the GARCH specification till those added lags were statistically significant. We also tested normality of the standardized residuals of the inflation equation for robustness.

6 In order to test the implication of the hypotheses, the quasi maximum likelihood estimation of equations 3, 5 and 6 is performed. The sufficient conditions are satisfied for the GARCH presentation.

7 In order to find the specifications of the inflation equation, we test the autocorrelations of the residual terms and the standardized residual terms. The values are :

	1 lag	6 lags	12 lags
Autocorrelation Test of Residuals	0.70	0.59	0.89
Autocorrelated Test of Standandarized Residuals	0.88	0.87	0.97

interest rates by 0.45 percent (or increases the real rate by only 0.55 percent). However, inflation uncertainty does increase interest rates. In other words, a higher expected inflation stimulates the economy but the 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 this 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 composition may affect the interest rates; the lower the maturity of the debt, the higher the liquidity of the bond will be. Hence, we incorporate maturity of the debt 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, thus demanding lower returns for shorter maturity.

$$r_t = 0.028 + 0.67\,\pi_t + 0.80\,h_t - 0.00013\,Mat_t + \eta_t$$

(3.23) *(2.59)* *(2.96)* *(-3.75)*

However, the specification which comprises maturity by the name of 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 against 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 favours higher risk premia for a shortened period of maturity. Another facet of this picture prevails in the behaviour 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 greater levels of resource transfer[8].

In searching for the plausability of our original argument, we posed the question of whether the relationship we apply is spurious in the sense that these two variables are affected by a third variable. Hence, we performed a Granger causality test between maturity and interest rates (the results are not reported here). The test results suggest that neither the maturity nor the interest rate has a Granger causal effect on the other.

In addition to our quest for the confirmation of the model, we tested whether the debt to maturity is affected by the inflation risk, where the inflation risk is the third variable that affects both interest rates and debt maturity. We model the maturity of the debt as an AR(1) process as suggested by the Final Prediction Error criteria and incorporated the effect of inflation risk into the Maturity equation.

8 In order to find the specifications of the inflation equation, we test the autocorrelations of the residual terms and the standardized residual terms. The values are :

	1 lag	6 lags	12 lags
Autocorrelation Test of Residuals	0.54	0.54	0.83
Autocorrlation Test of Standarized Residuals	0.58	0.57	0.79

$$Mat_t = 83.94 + 0.107\, Mat_{t-1} - 923.94\, h_t$$

(4.75) (9.25) (-2.41)

This suggests[9] that inflation risk decreases the maturity of the government debt maturity profile. This analysis may suggest that the Treasury uses both the interest rate and debt maturity as policy tools rather than use the interest rate as a tool and obey some maturity 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 in maturity is come across. 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 possible monetizitation of the debt (even with a default risk) or an unexpected depreciation of the local currency. In any case, 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 premia. Thus, the Treasury prefers to lower the maturity in order to reduce the debt servicing.

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9 In order to find the specifications of the inflation equation, we test the autocorrelations of the residual terms and the standardized residual terms. The values are :

	1 lag	6 lags	12 lags
Autocorrelation Test of Residuals	0.93	0.99	1.00
Autocorrelation Test of Standandarized Residuals	0.15	0.13	0.31

4. CONCLUSIONS

The Fisher hypothesis suggests that the main determinant of inflation is the expected inflation. Moreover, it is suggested that there is a one-to-one relationship between the nominal interest rate and expected inflation, causing the real interest rate to be constant. This proposition has been challenged in various platforms. In order to understand the behavior of the 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 on the real return or inflation 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 the interest rates. However, the interest rate increases less than inflation. In other words, in concurrance with Tobin (1965), real interest rates decrease with higher inflation. We also allow that debt to maturity might affect the interest rates. When this factor is included in the Fisher equation, debt to maturity has a negative correlation with interest rates. This is not what is expected. We also consider the effect of inflation risk on the debt-to-maturity. The empirical evidence suggests that debt-to maturity decreases with higher inflation. Overall, this may suggest that the government uses debt-to-maturity as well as the auctioned interest rates as policy tools to decrease the burden of government debt servicing since the lenders in Turkey prefer shorter maturities while demanding higher risk premia.

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