The Term Structure of Interest Rate as a Predictor of Inflation and Real Economic Activity: Nonlinear Evidence from Turkey

Omay, Tolga

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Tolga Omay

Çankaya University Department of Economics
Ogretmenler Cad. No:14, YY., Balgat, Ankara,
E-mail: omayt@cankaya.edu.tr
(90) 312 284 45 00 -154

Abstract

This study investigates whether the term structure of interest rates contains useful information about future real economic activity and inflation in Turkey during the 1991:7-2004:3 periods. In order to analyze these relationships, we have employed the Generalized Impulse Response (GIRF) analysis to the Logistic Smooth Transition Vector Autoregressive (LSTVAR) model. We have determined that the results of a GIRF analysis are consistent with the recursive Chow test and parameter stability tests. Besides, we have found out that the relationships between spread-real economic activity and spread-inflation are negative. These negative relationships have also been examined by GIRF analysis; because of a negative reverse relationship between Expectation Hypothesis and Interest Transmission Channel, a negative correlation between real economic activity and spread has occurred.

JEL Classification: E00, C15, C22, C32, C53, E37, E43

Keywords: Term Structure of Interest Rates; Monetary Policy; LSTVAR; GIRF; Real Economic Activity; Inflation

1. Introduction

Policymakers may use the information provided by financial indicators as a complementary to the information provided by monetary aggregates to make monetary policy decisions. Therefore, it is crucial for policymakers to know whether these financial indicators can predict future real economic activity and inflation (i.e. Estrella 1997). There are numerous studies, for instance, on whether the interest rate spread (i.e. the difference the between long-term interest rate and the short-term interest rate) can predict future economic activity (Harvey, 1988; Chen, 1991; Estrella and Hardouvelis, 1991; Plosser and Rouwenhorst, 1994; Haubrich and Dombrosky, 1996; Estrella, 1997; Dotsey, 1998; Moody & Taylor 2000; Hamilton and Kim, 2001). However, most of the previous literature applied a linear approach to tackle the problem. More recently, Venetis *et.al* (2003) has suggested that Smooth Transition Regression (STR) models are better suited to investigate spread-output relationships as they can contain regime-switching type behavior and time-varying parameters. On the other hand, there are numerous studies on whether the interest rate spread can predict future inflation (Mishkin, (1990 a, b); Mishkin, 1991; Frankel and Lown, 1994; Estrella and Mishkin, 1997). More recently, Telatar, Telatar and Ratti (2003) has also suggested that nonlinear models (Markov Switching) are useful and better suited to investigate spread-inflation relationship as they can accommodate to regime switching type behavior and time-varying parameters.

In addition to the bivariate single equation investigations of the predictability of term structure, there are also some “equation system” studies in order to identify the predictability relationship. In the equation system approach class, we see that the most influential study is Estrella’s 1997 paper. In this paper, he has derived reduced form relationships of output growth and spread, inflation and spread and finally, interest rate and spread from a simple structural model of the economy. Estrella (1997) has found that empirical relationships are not structural, and alternative monetary policy regimes could lead to very different outcomes. Estrella’s approach in this study is a unification of the theories which uses the term structure of interest rates for predicting different important economic variables. In the empirical part of his paper, he has employed a theoretical impulse response analysis to this unified model and found out that it can imitate a real economic system. Moreover, Jardet (2004) has used this methodology in order to analyze US and Canadian economies and employed a VAR-VECM model. She has found out that the predictability of the term structure of interest rate is reduced by the structural breaks, related to monetary policy changes. Furthermore, Estrella has also found similar results for the US economy in his 2004 research.

In this paper, we have applied a nonlinear approach to an emerging market, Turkey, concerning a particular period a period that was influenced by high inflation, high budget deficits and political instability. Besides these handicaps, Turkey has been encompassed by other disadvantages of testing the predictability issue like not having wide and deep financial markets for the same periods[1]. Because of these features, all possible methods must be applied only very carefully to the Turkish economy. In particular, linear models are not sufficient to analyze these types of economies. For example, for predictability of inflation, Mishkin (1990) has stated that “when the

[1] For the detailed information about the Turkish economy, Telatar, Telatar and Ratti (2003) can be used.

relationship between the term structure and inflation is unstable, it would not be possible to provide correct information about the inflationary pressures in the economy by using the estimated parameters of the linear model", and therefore the term structure of interest rates are no longer a guide for future monetary policies aiming at ensuring price stability. Following this advice and other reasons, we have employed a non-linear model. Unfortunately, all papers mentioned above have investigated the stability issue with a structural breaks analysis, in linear bivariate single equation models except Venetis *et.al* (2003) to investigate spread-output relationships and Telatar, Telatar and Ratti (2003) for spread-inflation relationship. In our analysis, we have employed STR type non-linearity to both of the relationship like Venetis *et.al* (2003), but our analysis is the generalization of their analysis applied in multivariate case. By using this analysis, the stability and the causes of the predictability issue among these nexus will further be investigated. For this purpose, we are employing a LSTVAR (Logistic Smooth Transition Vector Autoregressive) model too obtain the GIRF (Generalized Impulse Response Function). GIRF analysis has several advantages over the traditional counterparts in analyzing these kinds of systems. TIRF (Traditional Impulse Response Function) analysis has its limitations and confines researchers to give one impulse response for one specific situation in the estimation period. For example giving an impulse to interest rate variable has one response by inflation variable during the estimation period in a linear VAR model. But in a LSTVAR model, one can apply an impulse response to specific histories (events) in the estimation period. This feature enables researchers to employ impulse response analysis to specific variables both before and after an important event. Therefore, we have incorporated these advantages in to our research to investigate the highlighted issues in our study. We are also investigating, the Expectation Theory, Interest Transmission Channel and Fisher Effect with assistance of the GIRF for Turkey through the estimation period. This analysis sheds light on the theoretical connections of predictability of term structure for Turkey.

The remainder of the paper is organized as follows: Section 2 reviews the previous literature and model. Section 3 discusses the data and methodology used. Section 4 presents the empirical results. Finally, Section 5 offers conclusions drawn from the study undertaken.

2. Previous Literature and Model

Harvey (1988) is the pioneer study that investigates the relationship between real economic activity and spread. Harvey (1988) shows that there is useful information in the real yield spread about future consumption growth. Estrella and Hardouvelis (1991) argue that the nominal spread is a useful predictor of future growth in output, consumption and investment. Plosser and Rouwenhorst; (1994) study shows that the term structure has a significant predictive power for long-term economic growth. Haubrich and Dombrosky (1996) contend that the yield spread is an excellent predictor of four quarter economic growth but its predictive content has changed over time. Dotsey (1998) has thoroughly investigated the forecasting properties of the yield spread for economic activity. To our knowledge the only other study that has investigated the yield spread-future economic activity relationship in an emerging market is by Kanagasabapathy and Goyal (2002). Their results show that the term structure of interest rates has significant power in forecasting Indian real economic activity.

Mishkin (1990a) is the first study that has investigated the relationship between inflation and spread. In his study, he uses the difference between an n-months interest rate and an m-months interest rate to predict the difference between average inflation rates over n-months and m-months concerning the future, where n, m ≤ 12. He has examined the spread for US Treasury bills. Although, he has found that for maturities of six months or less, the term structure of nominal interest rates have provided so little information about the future path of inflation, he has concluded, nevertheless, that for longer maturities of nine and twelve months, the spread of nominal interest rates indeed provides information about the future path of inflation. Mishkin (1990b) obtains even better results with longer maturities, i.e. from one to five years. In both of these papers, the researchers have developed the theoretical background from the application of both the Fisher equation and the Expectations Hypothesis of the term structure of interest rates. On the other hand Mishkin (1991) has also examined data obtained from ten OECD countries and has found out that shorter maturities have provided almost no information about the future path of inflation. Estrella and Mishkins (1997) study shows that the term structure has a significant predictive power for subsequent economic activities and the inflation rate by using Europe and the US data. Finally, Frankel and Lown; (1994) study shows that a different measure of spread has a better predictive power by using US data.

All of these empirical studies above use linear models, which have limitations as they cannot control the possibility of asymmetric effects or structural shifts. Moreover, it is common knowledge that a number of economic variables exhibit a non-linear behavior. Following this common knowledge, a limited number of studies that has motivate employ non-linear approaches like Venetis *et.al*. (2003), Omay (2006) and Telatar *et al.* (2003). Venetis *et.al*. (2003) uses a TV-STAR model in order to investigate the relationship between real economic activity and the spread, for three developed countries. Omay (2006) uses a MR-STAR model in order to investigate the relationship between real economic activity and the spread, for Turkey. Telatar *et al.* (2003) uses a time-varying parameter model with Markov-switching heteroskedastic disturbances in order to investigate the relationship between inflation and the spread for Turkey. Besides Telatar, *et al.* (2003), there are two other studies that have investigated the Turkish economy, namely Şahinbeyoğlu and Yalçın (2000), and Akyıldız (2003), which have employed linear models to test the predictability relationship between inflation and term structure of interest rate. Şahinbeyoğlu and Yalçın (2000) have concluded that the term structure and inflation have a negative relationship between each other. They claimed that the high volatility of real interest rates relative to expected inflation, as well as the negative correlation between these two variables, has produced significant and negative term structure coefficients as mentioned in Mishkin (1990a) and Mishkin (1991).

Hence, we aim to contribute to the existing literature on this issue by employing a LSTVAR model to an emerging market and investigating the sources of the negative relationship between these nexus.

In this paper we have used the model which is given below. This model was developed by Estrella (1997):

I) Phillips Curve: $\pi_{t+1} = \pi_t + a y_t + \varepsilon_{t+1}$

II) IS Curve : $y_{t+1} = b_1 y_t - b_2 \rho_t + \eta_{t+1}$

III) Monetary Pol. Reac. Fun.: $r_{t+1} = g_1 r_t + g_2 \pi_{t+1} + g_3 y_{t+1} + (1 - g_1 - g_2) z_{t+1}$

IV) Monetary Shock: $z_{t+1} = z_t + v_{t+1}$

V) Fisher Equation: $R_t = \rho_t + \frac{1}{2}\left(E_t \pi_{t+1} + E_t \pi_{t+2}\right)$

VI) Expectation Hypothesis: $R_t = \frac{1}{2}\left(r_t + E_t r_{t+1}\right)$

Parameter restrictions in the equation system:
$0 \prec a \prec 1$, $0 \prec b_1 \prec 1$, $0 \leq b_2 \leq 1$, $0 \leq g_1 \leq 1$, $g_2, g_3 \geq 0$

where π_t is the inflation rate in period t, y_t is the output gap in period t, r_t is the short term (1 period) nominal interest rate, R_t is the long-term (2 period) nominal interest rate in period t, ρ_t is the long-term (2 period) real interest rate in period t, z_t is the inflation target in period t, E_t is the rational expectations operator based on period t information and $\varepsilon_t, v_t, \eta_t$: i.i.d. random variables

Estrella (1997) derives reduced form equation for the relationship between inflation, changes in real output, and the spread with a simple structural model of an economy given as above. Estrella's model is based on the model used by Fuhrer and Moore (1995) for empirical purposes. But, Estrella (1997) has found a theoretical, implicit solution for this model. The advantage of Estrella's model is the flexible choice of a monetary policy reaction function. The monetary policy reaction function can be simplified by the choice of parameters to either the Taylor (1993) reaction function ($g_1 = 0$) or Fuhrer-Moore ($g_1 = 1$) version of the Taylor rule.

Estrella (1997, 2004) researches derived the reduced forms of this model by forward and backward methods and show that the coefficient linking expected future output, inflation and short term interest rates to the spread, depending on the parameters in the monetary reaction function. For example, if the central bank only reacts to output deviations where $g_2 = 0$, the coefficient linking expected future output and spread in the reduced form is given as ($2/g_3$). As a conclusion of Estrella's (1997) work, monetary policy is a key determinant of the precise relationship between the term structure of interest rates and macroeconomic variables such as real output and inflation. With respect to Estrella's (1997) rational expectation's model, he notes that with alternative monetary policy rules, one or more of the following can occur: the term structure spread is the optimal predictor of real output; the term structure spread is the optimal predictor of changes in inflation; the short-term nominal rate is the best predictor of real output; the short-term nominal rate is perfectly correlated with the long-term real rate; interest rates are not informative with regard to future output and inflation. However, Estrella (1997) has found that the term structure of interest rates has at least some predictive power for both real output and inflation under almost all circumstances.

3. Data and Methodology

3.1. Data

For the paper, we are using industrial production index and the CPI (consumer price index) downloaded from the website of the Republic of Turkey's Central Bank. In order to calculate the term structure of interest rate (spread), 1 month and 3 month government security interest rates are taken from the secondary market. These data are extracted from the Istanbul Stock Exchange (ISE) monthly journal[2]. Therefore, the spread variable sp is obtained by subtracting 1 month interest rate from 3 month interest rate.

3.2 Basic Regression of Predictability: Real Economic Activity and Inflation

In the paper, we consider the annual growth rate of the monthly industrial production index as "cumulative", whereas some other papers use marginal growth rates:

$$\Delta^k y_t = \frac{12}{k}(y_t - y_{t-k}) \qquad (3.2.1)$$

where y_t is the logarithm of the industrial production index at time t. We compute the slope of the nominal yield curve as the difference between the long-term bond yield LR i_t and the short-term yield SR i_t as (LR i_t -SR i_t) at time t.

The following basic regression is a way to describe the relationship between the spread and future activity:

$$\Delta^3 y_t = \zeta + \beta sp_{t-1} + \varepsilon_t \qquad (3.2.2)$$

where k is the forecast horizon and ε_t forecast error. Depending on the previous literature, the best forecasting horizon is three-month period for Turkey. Therefore, we only consider the forecast horizon of three months in this study. Moreover, Turkey is a high inflationary country thus, a long horizon can be at most three months with regard to long term economic decision. The fact that we are working with monthly data creates some temporal correlation between the successive error terms. In order to remedy this serial correlation problem, we have used Newey and West (1987) for standard error terms (see Jardet 2004). The estimated equation is given as below:

$$\Delta^3 y_t = \underset{(0.039)}{0.018} - \underset{(0.0001)}{0.0004} sp_{t-1} + \varepsilon_t$$

r-square = 0.006, $\hat{\sigma}_e$ = 0.337, SK=0.313 (0.197), EK=-0.043 (0.930), JB= 1.715 (0.424) (3.2.3)
DW=1.254, ARCH(1)= 3.284 (0.069)

[2] The daily interest rates obtained from ISE are weighted with the transaction volumes to calculate the interest rates for one-month and three-month maturities. The one-month interest rate is defined to have a maturity in the range of 20-40 days and the three-month interest rate is defined to have a maturity in the range of 80-100 days

where heteroscedasticity consistent (hcc) standard errors are given in the parentheses below the parameter estimates, ε_t denotes the regression residual at time t, $\hat{\sigma}_e$ is the residual standard deviation, SK is skewness, EK excess kurtosis, JB the Jarque-Bera test of normality of the residuals, and ARCH is the LM test of no Autoregressive Conditional Heteroscedasticity (ARCH). Normality of residual is not rejected with Jarque-Bera test. SK and EK are also rejected. But, Durbin-Watson test shows that there is a significant autocorrelation problem. Moreover, the LM test for ARCH has significant value which can be the indication of neglected nonlinearity (see van Dijk 1999). This final conjecture is investigated further by applying the LM-type linearity test of Luukkonen *et al*. (1988). From the equation (3.2.3), we can observe that the relationship between real economic activity and the spread is significant and negative like the previous findings. This linear model suggests that the spread has information content about real economic activity for Turkey, but, this relationship is negative where as the relationship has been found to be positive in developed countries. This issue has one of the main questions posed in this paper, and will be analyzed further in section four. On the other hand, the other main question is the stability of this relationship. For investigating the stability issue, we have employed two different approaches; one of them is a recursive Chow structural break test with which we can date the structural breaks; and the other one is parameter stability test which is developed by Lin and Terasvirta (1994). A recursive Chow structural test for equation (3.2.3) shows three consecutive structural change points between 1999 and 2000. These structural points are 1999:3 = 2.901(0.038), 1999:4= 2.885(0.039) and 1995:5= 2.930(0.037). The first value is Chow test and the probabilities are given in parenthesis. The parameter stability test LM= 2.283(0.081) suggests that the equation can be modeled by a TV-STAR model which shows that the parameter of the model is not constant. Hence, stability issue is not satisfied for the Turkish case by using linear model.

For the inflation case, we consider the marginal growth rate of monthly inflation rate as:

$$\Delta^k \pi_t = (\pi_t - \pi_{t-k}) \tag{3.2.4}$$

where π_t is the logarithm of the inflation rate which is obtained by the CPI at time t.

The following basic regression shows the relationship between spread and future activity:

$$\Delta^k \pi_t = \zeta + \beta sp_{t-1} + \varepsilon_t \tag{3.2.5}$$

where k is the forecast horizon and ε_t forecast error. In this study we are only dealing with the forecast horizon of three months, because we are not dealing with the best predictability horizon. On the other hand, other papers, dealing with the predictability issue, have found that the best forecasting horizon is three-month period for Turkey (see Omay (2006)). This is theoretically sensible as well, because Turkey is a high inflationary country and a long horizon can be at most three months to decide to make sound long term investments.

$$\Delta^3 \pi_t = \underset{(31.173)}{-40.063} \underset{(0.905)}{-6.870} sp_{t-1} + e_t$$

$$\text{r-square}= 0.580 \; \hat{\sigma}_e = 0.054 \;\; SK= 0.001\ (0.197) \;\; EK=-0.564\ (0.930) \;\; JB= 1.529\ (0.424) \;\; DW=0.707 \;\; ARCH(1)= 60.096(0.000) \quad (3.2.6)$$

All the misspecification test results and their explanations are the same. However, this time linear model has better information content than the real economic activity case which we can be decided as looking at the R-square criteria[3]. Again we have investigated the stability issue; we employed two different approaches, which mentioned above. The recursive Chow structural test for equation (3.2.2) shows that there are many structural breaks at 1% significance level, starting from 96:3= 5.815(0.000) until the end of the sample period. The most significant one is 99:8= 29.771(0.000). The parameter stability test suggests that the equation can be modeled by a TV-STAR model which shows that the parameter of the model is not constant and the test statistics here LM= 6.835 (0.000). From these analyses, we have seen that the parameters of the linear models are not constant and the stability issues are not satisfied with the Turkish data.

3.3 Specification of Smooth Transition Vector Autoregressive Model and Linearity Tests

The specification and estimation of multivariate STAR models are discussed in further details in van Dijk (1999, Chapter 5). In the specification of a smooth transition vector auto-regression model (STVAR) we follow van Dijk (1999). Let $x_t = (x_{1t}, ... x_{kt})'$ be a (k x 1) vector time series. We have $x_t = \left(y_t, p_t, i_t, sp_t\right)'$ where y_t is the log of industrial production index, i_t the log of nominal interest, p_t the log of the consumer price index, and sp_t the log of spread values. A k-dimensional smooth transition vector auto-regression model (STVAR) then can be formulated as

$$\Delta x_t = \left\{ \phi_1 + \sum_{i=1}^{p-1} \varphi_{1i} \Delta x_{t-i} \right\} . \left(1 - F(s_t;\gamma,c)\right) + \left\{ \phi_2 + \sum_{i=1}^{p-1} \varphi_{2i} \Delta x_{t-i} \right\} . \left(F(s_t;\gamma,c)\right) + \varepsilon_t \qquad (3.3.1)$$

where ϕ_j j=1,2 are (k x 1) vectors, $\varphi_{j,i}$, j=1,2, I=1,…,p-1 are (k x k) matrices, and $\varepsilon_t = (\varepsilon_{1t}, ..., \varepsilon_{kt})$ is a k-dimensional vector white-noise process with mean zero and (k x k) covariance matrix Σ . The transition function $F(s_t;\gamma,c)$ is assumed to be a continuous function between zero and one, with parameters γ and c determining the smoothness and location of the change in the value of $F(s_t;\gamma,c)$, respectively. Here we have the following form logistic function

$$F(s_t;\gamma,c) = \frac{1}{1+\exp\left\{-\gamma\left[s_t - c\right]\right\}} \;, \quad \gamma > 0 \qquad (3.3.2)$$

[3] In both of the regression equations, we are using different dependent variables; hence, there is no direct comparison of r squares.

The specific-to-general approach for specifying univariate STAR models put forward by Teräsvirta (1994) can be adapted to the multivariate case. This procedure starts with specifying a vector autoregressive model for $x_t = \left(y_t, p_t, i_t, sp_t\right)^{'}$, that is,

$$\Delta x_t = \phi_1 + \sum_{i=1}^{p-1} \varphi_i \Delta x_{t-i} . \varepsilon_t \tag{3.3.3}$$

where the order p should be such that residuals $\hat{\varepsilon}_t$ have zero autocorrelations at all lags. The choice of p is based on applying both the SIC and AIC in a linear VAR model for x_t with a deterministic linear trend. Both information criteria select p = 1 as the appropriate lag order.

The next step of the specification procedure is testing linearity against STAR-type nonlinearity as given in (3.2.1), with (3.2.2). However, the testing problem is complicated by the presence of unidentified nuisance parameters under the null hypothesis. This can be understood by noting that the null hypothesis can be expressed in multiple ways, either as $H_0 : \phi_1 = \phi_2$ and $\varphi_{1,i} = \varphi_{2,i}$ for I=1,…,p-1 or as $H_0^{'} : \gamma = 0$. In order to overcome this problem, following the approach of Luukkonen *et al.* (1988), we replace the transition function $F(s_t; \gamma, c)$ with a suitable Taylor approximation. For example, a first-order Taylor approximation of the transition function results in the following auxiliary regression

$$\Delta x_t = A_0 + \sum_{i=1}^{p-1} B_i \Delta x_{t-i} + A_1 s_t + \sum_{i=1}^{p-1} B_{1,i} \Delta x_{t-i} s_t + e_t \tag{3.3.4}$$

where e_t comprises the original shocks ε_t as well as the error arising from the Taylor approximation. In (3.3.4) it is assumed that the transition variable s_t is not one of the elements of $\Delta x_{t-i}, i = 1, ..., p-1$ or their linear combination. If this is not the case, the term $A_1 s_t$ must be dropped from the auxiliary regression. The parameters in A_j and $B_{j,i}$ j=0,1, I=1,…,p-1, are functions of the parameters in the original STVAR. In this case the null hypothesis of linearity can be expressed as $H_0^{"} : A_1 = B_{1,i} = 0$, I=1,…,p-1, that is, the parameters associated with the auxiliary regressors are all zeros. This null hypothesis can be tested by a standard variable addition test in a straightforward manner. The test statistics, to be denoted as LM_1, have an asymptotic χ^2 distribution with $k(q+1) + (p-1)k^2$ degrees of freedom under the null of linearity. Since the LM_1 statistic does not test the original null hypothesis $H_0^{'} : \gamma = 0$ but rather the auxiliary null hypothesis $H_0^{"} : A_1 = B_{1,i} = 0$, this statistic is usually referred to as an LM-type statistic.

As noted by Luukkonen *et al.* (1988), the LM_1 statistic has no power in situations where only the intercept in the VAR varies across regimes, that is, when $\phi_1 = \phi_2$ but $\varphi_{1,i} = \varphi_{2,i}$ for I=0,1,…,p-1, in STVAR given in (1). Luukkonen *et al.* (1988) suggest to remedy this problem by replacing the transition function $F(s_t;\gamma,c)$ by a third-order Taylor approximation, which results in the auxiliary regression (4) with , s_t^j and $\Delta x_{t-i}s_t^i$,j=2,3, i=1,…,p-1 as additional auxiliary regressors. The test statistic computed from the augmented auxiliary regression is LM_2 statistic. Since only the parameters corresponding to s_t^2 and s_t^3 are functions of ϕ_1 and ϕ_2, a parsimonious, or "economy" version of the LM_2 statistic can be obtained by augmenting (3.3.4) with additional regressors s_t^2 and s_t^3. The resultant statistic is the LM_3 statistic.

To identify an appropriate transition variable s_t, the LM-type statistic can be computed for several candidates, and the one for which the associated p-value of the test statistic is smallest, can be selected. In this paper, we consider 54 different candidate transition variables; lagged growth rates in output (Δy_{t-i}), lagged growth rates in interest (Δi_{t-i}), lagged inflation rates (Δp_{t-i}), and lagged rate of change of the spread rates (Δsp_{t-i}).By being a linear combination of real and monetary variables, such a transition variable can capture both nominal and real rigidities. Since monthly time series exhibit considerable short-run fluctuations which do not necessarily represent changes in regimes, we also consider quarterly changes in the above-mentioned variables (i.e. $\Delta_3\theta_{t-i} = \theta_{t-i} - \theta_{t-i-3}$ where θ_t is one of the elements in the time series vector x_t) We set i=1,…, 12 in all cases.

The results of the linearity tests are shown in Table 3.3.1, which reports only the candidate transition variables for which the null of linearity of the output equation is rejected.

Table 3.3.1 LM Type Test Against Linearity

Candidate transition variables	Equation				System-wide test
	Δp_t	Δi_t	Δy_t	sp_t	
Δp_{t-6}	3.880	1.135	1.809	2.415	65.664
	(0.000)	(0.344)	(0.089)	(0.022)	(0.000)
$\Delta^3 p_{t-6}$	1.937	0.519	1.316	1.803	67.824
	(0.067)	(0.818)	(0.246)	(0.091)	(0.000)
Δy_{t-1}	3.014	0.569	4.373	3.573	104.128
	(0.005)	(0.779)	(0.000)	(0.001)	(0.000)
Δy_{t-6}	0.898	0.613	0.473	3.217	87.663
	(0.509)	(0.744)	(0.852)	(0.003)	(0.000)
sp_{t-1}	6.205	4.385	4.585	23.774	110.094
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δsp_{t-1}	5.143	1.537	2.947	17.922	101.927
	(0.000)	(0.159)	(0.006)	(0.000)	(0.000)
Δi_{t-2}	3.760	1.463	2.218	2.164	49.827
	(0.000)	(0.184)	(0.036)	(0.040)	(0.006)
Δi_{t-2}	1.430	0.745	1.602	0.762	47.709
	(0.197)	(0.634)	(0.139)	(0.619)	(0.011)
t	6.412	3.650	3.287	3.285	42.891
	(0.000)	(0.001)	(0.002)	(0.002)	(0.035)

The most suitable candidate variables are given .Besides, the other test statistics are available upon request

The results of both system-wide linearity tests as well as a test of linearity of the output equation suggest Δp_{t-i}, Δy_{t-i}, Δi_{t-i} and the spread as appropriate transition variables. Since the null of linearity is rejected more strongly for Δsp_{t-1}, in price, output and short run interest rate equations, we use this variable as the system-wide transition variable in estimation of the STVAR.

Given the choice of the transition variable s_t, estimation of the parameters in the STVAR (1) is a relatively straightforward application of nonlinear least squares, which is equivalent to quasi maximum likelihood based on a normal distribution. Under certain (weak) regularity conditions, which are discussed by White and Domowitz (1984), and Pötscher and Prucha (1997), among others, the NLS estimates are consistent and asymptotically normal.

The estimation can be performed using any conventional nonlinear optimization procedure. The burden on the optimization algorithm can be alleviated by using good starting values. For fixed values of the parameters in the transition function, γ and c, the STVAR model is linear in the parameters ϕ_j, $\varphi_{j,i}$, j=1,2, I= 1,…,p-1, and therefore, can be estimated by OLS. Hence, a convenient way to obtain sensible starting values for the nonlinear optimization algorithm is to perform a two-dimensional grid search over γ and c. Furthermore, the objective function (the log of the determinant of the residual covariance matrix) can be concentrated with respect to ϕ_j, $\varphi_{j,i}$, j=1,2, I= 1,…,p-1. This considerably reduces the dimensionality of the NLS estimation problem, as the objective function needs to be minimized with respect to the two parameters γ and *c* only. Parameter estimates of LSTVAR model are given in table 3.2.2:

Table 3.2.2 Estimation Results of LSTVAR

Parameters	**DCPI**	**DGSMH**	**SP**	**DSRI**
Constant	-0.059	0.194	-2.345	-2.352
	(0.017)	(0.056)	(32.931)	(0.475)
$L-\Delta p_{t-1}$	0.983	0.072	-9.827	-1.519
	(0.015)	(0.049)	(28.813)	(0.424)
$L-\Delta y_{t-1}$	-0.057	0.585	-60.994	-1.271
	(0.024)	(0.077)	(45.551)	(0.651)
$L-sp_{t-1}$	-0.0002	0.0002	0.174	-0.003
	(0.000)	(0.000)	(0.068)	(0.000)
$L-\Delta i_{t-1}$	0.015	-0.051	0.731	0.751
	(0.005)	(0.016)	(9.430)	(0.138)
$U-\Delta p_{t-1}$	0.002	-0.015	-5.310	0.145
	(0.001)	(0.005)	(3.070)	(0.044)
$U-\Delta y_{t-1}$	0.081	0.062	14.422	-1.701
	(0.042)	(0.136)	(79.991)	(1.1436)
$U-sp_{t-1}$	0.0002	-0.0004	1.407	-0.006
	(0.000)	(0.000)	(0.139)	(0.001)
$U-\Delta i_{t-1}$	-0.005	0.030	13.072	-0.236
	(0.004)	(0.013)	(7.713)	(0.111)
R^2	0.985	0.521	0.634	0.487
γ		5.119		
		(8.550)		
C		10.736		
		(0.394)		

After estimating the LSTVAR model, we test whether the estimated model adequately captures the nonlinear features of the time series under examination. Specifically, we test the model for remaining nonlinearity and for parameter constancy. The testing procedure is outlined in Appendix D in Anderson and Vahid (1998), who generalize the procedure developed by Eitrheim and Teräsvirta (1996) to the multivariate context. In addition to the candidate transition variables used for testing linearity of the baseline model, we also use semi-annual changes in the same variables.

Table 3.3.3. Test Against Multiple Regime LSTVAR

Candidate transition variables	Additive	Multiplicative	Additive and multiplicative together
Δp_{t-6}	57.106 (0.172)	56.313 (0.191)	34.420 (0.999)
$\Delta^3 p_{t-6}$	28.056 (0.990)	46.493 (0.534)	30.028 (0.999)
Δy_{t-1}	29.912 (0.981)	40.417 (0.773)	26.116 (1.000)
Δy_{t-6}	27.175 (0.993)	36.434 (0.889)	19.379 (1.000)
sp_{t-1}	49.731 (0.404)	51.182 (0.349)	39.359 (0.999)
Δsp_{t-1}	30.595 (0.976)	40.728 (0.762)	37.753 (0.999)
Δi_{t-2}	38.831 (0.824)	51.920 (0.323)	36.046 (0.999)
Δi_{t-4}	40.525 (0.769)	38.643 (0.830)	26.623 (1.000)
t	40.366 (0.775)	47.586 (0.489)	33.781 (0.999)

* Table contains the smallest p value test statistics. Other test statistics are available upon request

4. Investigations of Expectation Theory Interest Transmission Mechanism Fisher Effect and Stability of Predictability: Generalized Impulse Response Analysis (GIRF)

In this section, we have employed the generalised impulse response analysis in order to detect the effects of structural changes and crises in predicting future output and inflation for Turkey. From this analysis, we will detect whether the predictability relationship variables mentioned are stable in the estimation period or not. Generalised Impulse Response Functions have advantages on their linear counter parts per Koop, Pesaran and Potter (1996). Hence, we use GIRF as an indicator tool for visualizing the effects of structural changes and crises.

The Traditional Impulse Response Function (TRIF) has characteristic properties in case the model is linear. First, the TRIF then is symmetric. In the sense that a shock of $-\delta$ has exactly the opposite effect as a shock of size $+\delta$. Furthermore, it might be called linear, as the impulse response is proportional to the size of shock. Finally, the impulse response is history independent as it does not depend on the particular history w_{t-1} van Dick (1999). These properties do not carry over to nonlinear models. In non-linear models, the impact of a shock depends on the sign and the size of the shock, as well as on the history of the process. The Generalized Impulse Response Function (GRIF), introduced by Koop *et al.* (1996) provides a natural solution to the problems involved in defining impulse responses in non-linear models. The GIRF is a function of δ (shock) and w_{t-1} (history), which are the realisations of the random variables ε_t and Ω_{t-1}. Koop *et al.* (1996) stress this; hence the GIRF is a realization of a random variable. Using this interpretation of the GIRF as a random variable, various conditional versions can be defined, which are of potential interest. In our case, for analyze the stability and source of relationship; we are giving shock to estimated model for every specific year in the sample period.

During this analysis, we have considered whether "Expectations Theory" and "Interest Transmission Mechanism" opereate simultaneously in the same direction or not, in order to investigate the source of the predictability relationship between spread and real economic activity. In almost all empirical studies, these mechanisms are assumed to be the theoretical structure of real economic activity and the spread relationship. For example, if the Central Bank decides to exercise an expansionary monetary policy, the first effect of this policy will be a fall in the interest rate of all maturities. According to the Expectations Theory of the interest rate's term structure, long-term interest rates will less than short-term interest rates. The simultaneously falling interest rates result in an increase in investment and, successively, an increase in real economic activity, whereas the higher fall in short-term interest rates relative to long-term interest rates causes an increase in the spread. As it can be seen from the above discussion, the mechanism is very simple. The spread and real economic activity move in the same direction with expansionary monetary policy. The move in the same direction can be demonstrated as the theoretical reason why the spread is an indicator of future real economic activity. On the other hand, Expectation Theory with Fisher Hypothesis is the key theoretical underpinning for the predictability of inflation. Moreover, there are two important assumptions; rational expectation and constancy of ex-ante real rates must be satisfied. Hence, we are also inspecting the spread and inflation relationships with a GIRF analysis. The second important relationship for the predictability of inflation, Fisher Hypothesis is analyzed by dynamic correlation analysis which is obtained by also GIRF analysis. High volatility of the real interest rates relative to expected inflation, as well as the negative correlation between these two variables, produce significant and negative term structure coefficients as mentioned in Mishkin (1990a) and Mishkin (1991). Both of these arguments are revealed the predictability relationship of inflation for Turkey while we are investigating the relationship.

Among many authors who have investigated the relationship between monetary policy and the spread are Cook and Hahn (1989). Cook and Hahn (1989), first firmly established the positive empirical relationships between target rates and long-term rates, and interpret their findings as supportive of the Expectations Theory of the term structure. The expectations theory suggested that a long-term interest rate should be equal to the sum of short-term interest rates over the same period of time plus a term premium; thus an increase in the first couple of short-term rates should drive up the long-term rate too, but by less. However, Romer (1996) produced the opposite results to Cook and Hahn (1989). To them, positive movement in the long-term rate is inconsistent with standard monetary theory; this is, in short, a puzzle. According to received theory, they claim, an increase in short-term rates should reduce inflation, and hence reduce the level of long-term rates sufficiently. Romer suggests that the puzzle can be resolved if the central bank has access to private information about economic fundamentals, but they do not develop their argument formally. In short, we can say that some authors argue that long-term rates should increase as monetary policy is tightened, mainly via the expectations hypothesis of the term structure. Others support the hypothesis that a monetary tightening should increase short rates but decrease long-term rates, as inflation expectations fall.

Ellingsen and Söderström (2004) expand Romer's idea. According to Ellingsen and Söderström, if monetary policy reveals information about economic developments interest rates of all maturities move in the same direction in response to policy innovation as if monetary policy reveals the central bank's policy preferences interest rates short-term and long-term rates move in the opposite direction. So the first proposition of Ellingsen and Söderström supports the Expectation Hypothesis and they called this type of "policy endogenous". For both of the theoretical explanations, an increase in short-term interest rate (tight monetary policy) leads to a decrease in the spread variable. From Ellingsen and Söderström's argument, we can derive a new relationship which is revealing the Expectation Hypothesis; if the short-term rate increases (decreases) then the spread will decrease (increase) because short-term rates should drive up the long rate too, but by less; when monetary policy reveals the central bank's policy preferences then short rate and long rate move in opposite direction which again leads to a decrease. Therefore, we can deduce Expectation Hypothesis by analyzing impulse response between the short term interest rate (which can be the monetary policy tool), and the spread variable; giving positive one standard shock to the short-term interest rate leads to a negative response of the spread variable in impulse response analysis, which indicates that the Expectation Hypothesis is valid for that period for any type of theoretical explanation. In an opposite case, we will conclude that the Expectation Hypothesis is not valid.

We have given GIRF to nine different periods covering the sample period. From the impulse response given to extract the relationship of short-term interest rates and the spread, we have found out that six of them are negative, which indicates that the Expectation Hypothesis is valid for those periods. Besides, we have found two significant positive relationships covering the periods through 1998:5 to 2000:8 and one insignificant positive relationship covering the period through 2000:5 to 2001:8. These periods are important for the Turkish economy, which experienced heavy banking crises. The structural break analysis which is applied to univaried predictability equations shows the same dates as significant structural breaks. From these results, we can conclude that the GIRF findings are consistent with the earlier research in this study. The results of GIRF analysis can be seen from the figure 1 given in below.

[Figure1]

The relationships between monetary policy (or the short-term interest rate) and real economic activity can also be analyzed employing impulse response analysis in the estimation period. This analysis shows us whether the interest rate transmission channel of Turkey is working or not. When an increase (decrease) occurred in the short-term interest rate, this causes a decrease (increase) in real economic activity, e.g. by stimulated investments; this mechanism is called as "Interest Rate Transmission Mechanism" (see Mishkin 1995). Hence, we can analyze this Transmission Channel by giving positive one standard impulse to short-term rates and tracing the response of this impulse on real economic activity. From the above argument, the short-term interest rate has to have a negative relationship with real economic activity; hence when we observe a positive response interms of real economic activity, which indicates that the Transmission Channel is not working for that period.

We have given a GIRF to nine different periods covering the sample period. From the impulse response given to extract the relationships of short-term interest rate and real economic activity, we have found that six of them were positive, which indicates that the Interest Rate Transmission Channel was not working for these periods. Besides, we have found two significant negative relationships which cover the period through 1998:5 to 2000:8; one insignificant negative relationship which covers the period through 2000:5 to 2001:8. These periods are important periods in which Turkish economy experienced banking crises, and which we mentioned about for the Expectation hypothesis. In the sample period, Turkey has a very high real interest rate which prevents domestic investors from making investments in real sector. Hence, this evidence shows the main obstacle of the Interest Transmission Channel to work properly for the sample period[4]. From figure one; we can trace the GIRF analysis of Interest Transmission Channel through the sample period.

One can easily recognize that generalized impulse response analysis shows an asymmetric relationship between Expectation Hypothesis and Interest Transmission Channel. When the Expectation Hypothesis is valid for Turkey, the Interest Rate Transmission Channel is not working and vice versa, along the sample period. On the other hand, this systematic and reverse symmetric movement explains the negative relationships between the spread and real economic activity. This systematic reverse (symmetric) movement explains why the spread predicts real economic activity negatively. For example, again if the Central Bank decides to exercise an expansionary monetary policy, the first effect of this policy will be a fall in the interest rate of all maturities. According to the Expectations Theory of the term structure interest rates, long-term interest rates will fall less than short-term interest rates. Unfortunately, the simultaneously falling of these two variable; interest rates do not result in an increase in investment and, successively, an increase in real economic activity, because of high real interest rates. As can be seen from this discussion, the mechanism does not lead to a move in the same direction between spread and real economic activity. Thus, we have obtained a negative predictability relationship between these variables. Alternatively, this result can be obtained by discussing the opposite argument.

From the linear bivarite single equation analysis of inflation and real economic activity, we have found significant structural breaks with the recursive Chow test. From the GIRF analysis, we have found the same pattern in these relationships. As we have stated before, the GIRF analysis has its own advantages while analyzing data. Hence, we use these advantages in order to deduce stability relationship from the estimated model. Both generalized impulse responses of the spread to inflation and also real economic activity have significant and negative impacts. For the spread to inflation GIRF, the periods 94:5 to 95:8, 95:5 to 96:8, 96:5 to 97:8, 97:5 to 98:8, 2001:5 to 2002:8 and 2002:5 to 2003:8 have a significant negative impact of between -0.005 and -0.01, whereas for periods 98:5 to 99:8 and 2000:5 to 2001:8 there is a significant negative impact of around -0.01. For the period 99:5 to 2000:8 there is a significant negative impact greater than -0.01. These impulse response results are consistent with the recursive Chow test results. Again the most significant Chow test result date is the biggest impact period for the GIRF analysis.

[4] Conversely, during the crises the Interest Transmission Channel worked. What could be the cause of this abrupt phenomenon? This question is a subject of a further study.

GIRF analysis shows us a more detailed picture of the structural break points without losing any degree of freedom. Moreover, we can follow the conditions of the relationships at every point of sample. For the spread to real economic activity GIRF, the periods 94:5 to 95:8, 95:5 to 96:8, 96:5 to 97:8, 97:5 to 98:8, 2001:5 to 2002:8 and 2002:5 to 2003:8 have a significant negative impact of between -0.006 and -0.008, whereas for the periods 98:5 to 99:8 and 2000:5 to 2001:8 there was a significant negative impact of around -0.01 and for period 99:5 to 2000:8 there was a significant negative impact greater than -0.01. These impulse response results are consistent with the recursive Chow test results. Again the most significant Chow test result date is the biggest impact period for the GIRF analysis. From these results, we can conclude that the GIRF analysis can be used as a helpful tool for finding the break points of relationship. On the other hand there are numerous structural break points in the sample period, which can not be analyzed by linear models, because of dividing them into sub periods. Most probably, sub-periods have a very small sample size that can not be analyzed by conventional statistical techniques. Especially, there are consecutive break points in the inflation predictability equation which leads to only one observation point for each sub sample. Therefore, analyzing the changing structure of predictability can only be done by the GIRF method, which we have suggested in the beginning of this section.

[Figure 2]

From the GIRF analysis, we have recognized that the negative predictability power increases in the periods of crises, when the Transmission Channel is working, providing that the Expectation Theory is not valid. In our opinion, this point needs further investigation. From this analysis we can conclude that the Interest Rate Transmission Channel has more influential effects than the Expectation Hypothesis on predictability of the real economic activity. This point indicates that the information content of spread is more derived from monetary policy than Expectation Theory, which are the rival theories in the predictability literature. In a sense, then, this result supports Estrella's (1997) conclusions, which we will analyze in the next section in order to prove our assessment[5].

[Figure 3]

6. Concluding Remarks

This study investigates whether the term structure of interest rates contains useful information about future real economic activity and inflation for Turkey covering the period 1991-2004. We employ a recursive Chow Structural Break Test to the linear models and from this recursive test procedure; we have seen that the spread-real economic activity and spread-inflation relationships are not stable. This conclusion is also re-affirmed by the linearity test against STR non-linearity which is given as a parameter stability test. On the other hand, we have employed GIRF analysis to LSTVAR model in order to understand the source of the negative relationship between these variables. This analysis shows us that the negative relationship between spread and real economic activity has occurred because of the negative symmetric relationship between Expectation Hypothesis and Interest Rate Transmission Channel. And, also this analysis shows us that the

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[5] For Turkish economy Omay and Hasanov (2006) and Hasanov and Omay (2008) have estimated nonlinear monetary policy reaction function. They have concluded that the monetary reaction function has continuously changing structure with respect to TVSTR test.

negative relationship between spread and inflation has occurred because of the negative Expectation Hypothesis and Fisher Effect. Furthermore, we have employed a GIRF analysis in order to see whether the predictability relationships are stable for Turkey. This analysis shows us that the stability relationship of these variables is not established for the period that we have analyzed. From this analysis, we have seen that the GIRF analysis is consistent with the recursive Chow test and parameter stability test at the same time. The GIRF analysis has its own advantages for analyzing the data which we have mentioned before. Especially, we have seen that the predictability power of these relationships can be analyzed by the GIRF without loosing any degrees of freedom which, otherwise, can not be obtained by linear bivariate equation estimation of sub-samples as we have pointed out in section 4. Finally, use of GIRF enables us to make a computation about the Expectation Hypothesis, Interest Rate Transmission Channel and Fisher Effect which can not be obtained by TIRF analysis.

From the GIRF analysis, we have recognized that the negative predictability power is increased during periods of crisis, when the Interest Rate Transmission Channel is working, whereas the Expectation Theory is not valid. In order to further investigate this issue, we have estimated the policy reaction function of Turkey, covering the estimation period of the LSTVAR analysis. We have found out that the policy reaction function has multiple structural breaks that can prevent sound conclusions on the above issues. Hence Estrella's (1997) theoretical prediction, "empirical relationships are not structural, and alternative monetary policy regimes could lead to very different outcomes", can not be proven by the Turkish data.

Appendix A.

Generalized Impulse Response Functions are obtained by making bootstrapping. Hence we have to construct their confidence band again by designing a bootstrapping instead of Monte-Carlo design. For GIRF, we handle 2 hundred of impulse responses in order to get one specific histories' impulse response. We have obtained these 2 hundred impulse responses in order to average the effect of intermediate shocks. For their confidence band again we design a bootstrap and handle the confidence band from this computation. For this purpose, we run 1000 impulse responses which are the averaged from 200 impulse responses and create %10 confidence band for every histories impulse response.

Appendix B. Figures

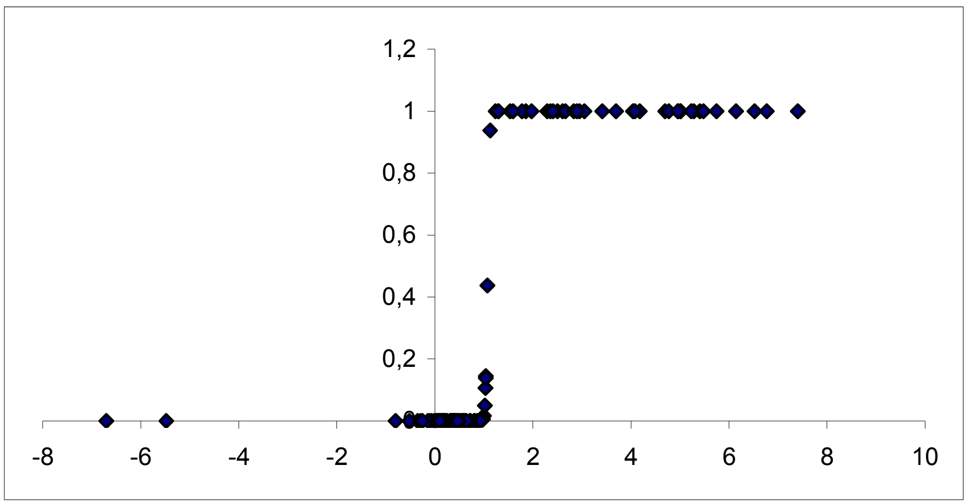


Figure 6. Transition Function

References

Akyıldız, K., (2003), " Getiri Farkı Ekonomik Aktivitenin Tahmininde Öncü Gösterge İşlevi Görebilir Mi? Türkiye Örneği" *Hazine Dergisi,* Sayı:16, 1-20.

Anderson, M., H., and Vahid, F. (1998), "Testing multiple equation systems for common nonlinear component" *Journal of Econometric,s* Volume 84, Issue 1, May 1998, Pages 1-36

Berüment H. ve Malatyalı K., (2000), "The implicit reaction function of the Central Bank of Republic of Turkey", *Applied Economics Letters*, 7, 425-430.

Chen, N. (1991), "Financial Investment Opportunities and the Macroeconomy," *Journal of Finance* 46, 529-554.

Chow, G. C. (1960) "Test of Equality between Sets of Coefficients in Two Linear Regressions." *Econometrica,* 25, 591-605.

Clarida, R., J. Gali ve M. Gertler, (2000), "Monetary Policy Rules and Macroeconomic stability: Evidence and Some Theory", *Quarterly Journal of Economics*, 115, 147-180

Cook, T. and Hahn, T., (1989), "The effect of changes in the federal funds rate target on market interest rates in the 1970's" *Journal of Monetary Economics* ,19, 31-72.

Dotsey, M. (1998), "The Predictive Content of Interest Rate Term Spread for Future Economic Growth." *Federal Reserve Bank of Richmond Economic Quarterly*, 84, Summer 31-51.

Eitrheim, Q. ve T. Terasvirta (1996), "Testing the Adequacy of STAR Models." *Journal of Econometrics, 74, 59-76.*

Ellingsen, T. and U., Söderström "Why are Long Rates Sensitive to Monetary Policy?" Riksbank Working Paper No:5

Estrella, A. ve G. A. Hardouvelis. (1991),"The Term Structure as a Predictor of Real Economic Activity." *Journal of Finance*, 46, 555-576.

Estrella, A. and F. S. Mishkin. (1995), "The Term Structure of Interest Rates and Its Role in Monetary Policy for the European Central Bank." *National Bureau of Economic Research Working Paper*, 5279.

Estrella, A. and F. S. Mishkin. (1996a), "Predicting U.S. Recessions: Financial Variables as leading Indicators." *Federal Reserve Bank of New York*, *Research Paper*, 9609.

Estrella, A. (1997), "Why Do Interest Rates Predict Macro Outcomes? A Unified Theory of Inflation, Output, Interest, and Policy," *Federal Reserve Bank of New York Research Paper* No. 9717.

Estrella, A. (1998a), "A New Measure of Fit for Equations with Dichotomous Dependent Variables," *Journal of Business and Economic Statistics* 16, 198-205. 24.

Estrella, A. (1998b), "Monetary Policy and predictive Power of the Term Structure of Interest Rates," *Federal Reserve Bank of New York.*

Estrella, A., and A. P. Rodriguez (1998), "Consistent Covariance Matrix Estimation in Probit Models with Autocorrelated Errors," *Federal Reserve Bank of New York Staff Report* No. 39.

Estrella, A., A. P. Rodriguez and S. Schichs (2000), "How Stable Is the Predictive Power of Yield Curve? Evidence from Germany and the United State." Discussion Paper. *Federal Reserve Bank of New York Research Paper 9717.*

Frankel, J. A. ve C. S. Lown (1994), "An Indicator of Future Inflation Extracted from the Steepness of the Interest Rate Yield Curve Along its Entire Length." *The Quarterly Journal of Economics*, 517-530.

Fuhrer, J.C. and G.R. Moore (1995) "Monetary Policy Trade offs and the Correlation Between nominal interest rates and real output", *American Economic Review* 85, 219-239.

Galbraith, B. and G.Tkacz (2000) "Testing for Asymmetry in the Link between the Yield Spread and Output in the G7 Countries." *Journal of International Money and Finance*, 19, 657-672.

Granger, C. W. J. and T. Terasvirta (1993), *Modeling Nonlinear Economic Relationships*. Advanced Texts in Econometrics, Oxford University Press.

Hamilton, J. D. and D. H. Kim. (2002), "A Re-examination of the Predictability of Economic Activity Using the Spread." *Journal of Money, Credit, and Banking,* 34, 2-10.

Harvey, C. R. (1988) "The Real Term Structure and Consumption Growth." *Journal of Financial Economics*, 22, 305-333.

Harvey, C. (1989), "Forecast of Economic Growth from the Bond and Stock Market." *Financial Analysts Journal,* 38-45.

Hasanov, M. and Omay, T. (2008), "Monetary Policy Rules in Practice: Re-examining the Case for Turkey. *Physica A Statistical Mechanics and Its Applications.* 387(17), p. 4309-4318

Haubrich, J. G. and A. M. Dombrosky. (1996), "Predicting Real Growth Using the Yield Curve." *Federal Reserve Bank of Cleveland*, *Economic Review*, 32, 26-35.

Jardet, C., (2004), "Why Did the Term Structure of Interest Rates Lose its Predictive Power?" *Economic Modeling*. 21: 509-524.

Kalkan, M., Kipici, A. ve Peker, A., (1997), "Monetary policy and leading indicators of inflation in Turkey", *Irvin Fisher Committee Bulletin*, 1.

Kim K. A. ve P. Limpaphayom (1997), “The Effect of Economic Regimes on the Relation between the Term Structure and Real Activity in Japan” *Journal of Economics and Business*, 49, 379-392.

Koop, G., M.H. Pesaran and S.,M., Porter (1996) “Impulse response analysis in nonlinear multivariate models”, *Journal of Econometrics*, 74, 1 119-147.

Lin, H. and T. Terasvirta (1994), “Testing the Constancy of Regression Parameters against Continuous Structure Change” *Journal of Econometrics*, 62, 211-228.

Luukkonnen, R. P. Saikkonen and T. Terasvirta (1988), “Testing Linearity against STAR Models.” *Biometrika*, 75, 491-499.

Mishkin, F. (1990a),“What Does the Term Structure Tell Us about Future Inflation?” *Journal of Monetary Economics*, 25, 77-95.

Mishkin, F. (1990b), “The Information in the Longer Maturity Term Structure About Inflation.” *Quarterly Journal of Economics*, 55, 815-828.

Mishkin, F. (1991), “A Multi-Country Study of the Information in the Shorter Term Structure About Future Inflation.” *Journal of International Money and Finance*, 10, 2-22.

Mishkin, F. (1995), “Symposium on the Monetary Transmission Mechanism.” *Journal of Economic Perspective*, 9, 3-10.

Mody, A. ve M.P. Taylor (2000), “The High Yield Spread as a Predictor of real economic Activity: Evidence of a Financial Accelerator for United States.” *IMF Stuff Paper.*

Newey, W. ve K. West (1987), “A Simple Positive Definite Heteroskedasticty and Autocorrelation Consistent Variance Matrix” *Econometrica*, 55, 703-708.

Omay T. and Hasanov M. (2006) “Türkiye için Reaksiyon Fonksiyonunun Doğrusal Olmayan Modelle Tahmin Edilmesi” MPRA Paper 20154.

Omay T. (2006) Türkiye’de Fazin Vade Yapısı ile Reel Ekonomik Aktivite Arasındaki İlişki. İktisadi Araştırmalar Vakfı Yayınları.

Romer, D. (1996) Advance Macroeconomics, 3rd ed., McGraw-Hill, New York

Peel, D. A. ve C. Ioannidis (2003), “Empirical Evidence on the Relationships Between the Term Structure of Interest and Future Real Output Changes When There are Changes in Policy Regime.*”* *Economic Letters*, 78, 147-152.

Peel, D. A. ve M. P. *Taylor* (1998), “The Slope of the Yield Curve and Real Economic Activity: Tracing the Transmission Mechanism.” *Economics Letters,* 59, 353-360.

Plosser, C. ve K. G. Rounwenhorst. (1994), "International Term Structure and Real Economic Growth." *Journal of Monetary Economics*, 33, 133-155.

Pötscher, B.M. and Prucha, I.V. (1997) Dynamic Nonlinear Econometric Models – Asymptotic Theory, Berlin, Springer-Verlag

Şahinbeyoğlu, G. ve C. Yalçın (2000), "The Term Structure of Interest Rates: Does it tell about inflation?" *TCMB Discussion Paper* 2000:2.

Telatar, E., F.Telatar and R.A.Ratti (2003), "On the Predictive Power of the Term Structure of Interest Rates for Future Inflation Changes in the Presence of Political Instability: The Turkish Economy." *Journal of Policy Modeling*, 25, 931-946.

Terasvirta, T. (1994), "Specification, Estimation and Evaluation of STAR Models." *Journal of American Statistical Association*, 89, 208-218.

Terasvirta, T. and H. M. Anderson (1992), Characterizing Nonlinearities in Business Cycles Using STAR Models." *Journal of Applied Econometrics*, 7, 119-136.

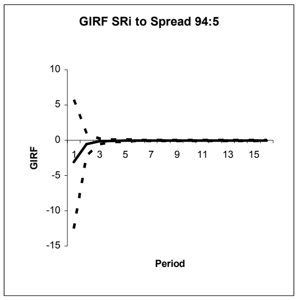
Tkacz, G. (2001), "Neural Network Forecasting of Canadian GDP Growth." *International Journal of Forecasting,* 17, 57-69.

van Dijk D., Terasvirta T. and P.H. Franses (2000), "STAR Models: A survey of recent developments." *SSE/EFI Working Paper Series in Economics and Finance* no. 380.

van Dijk D. (1999), *STR Models Extensions and Outlier Robust Inference*. Tinbergen Institute Research Series no. 200.

Venetis, I. A., I. Paya and D. A. Peel (2003), "Reexamination of the Predictability of Economic Activity Using the Yield Spread: A nonlinear approach" *International Review of Economics and Finance,* 2, 187-206.

White, H. and Domowitz, I. (1984) "Nonlinear regression with dependent observations", Econometrica, 52, pp. 143-161.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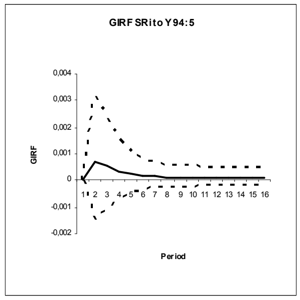
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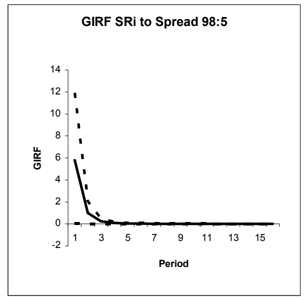
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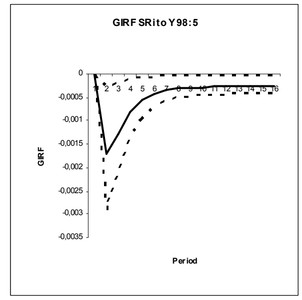
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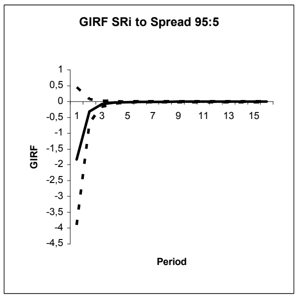
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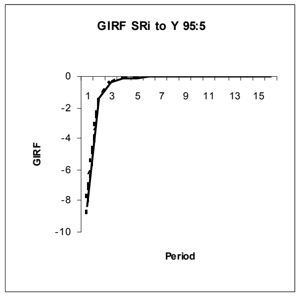
Period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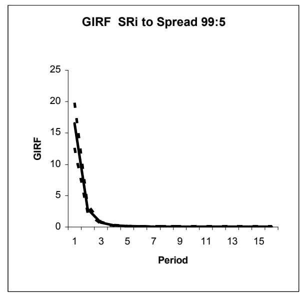
Period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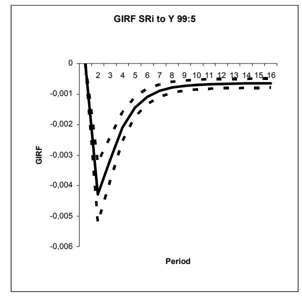
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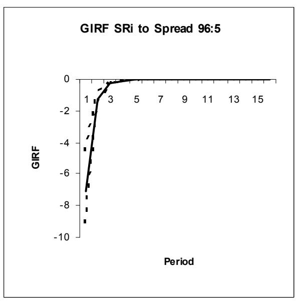
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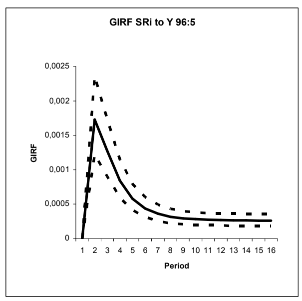
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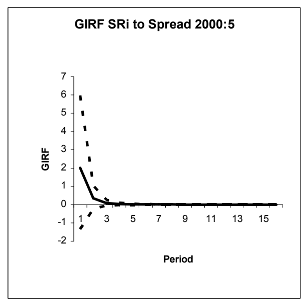
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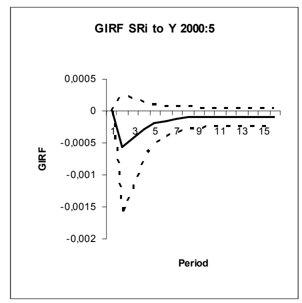
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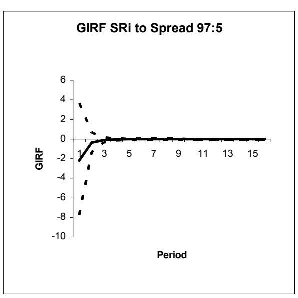
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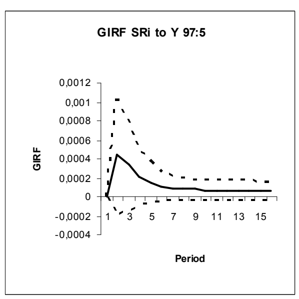
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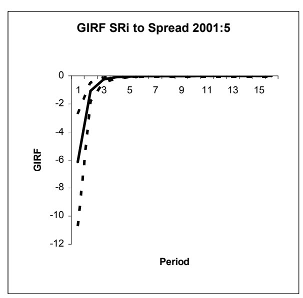
Period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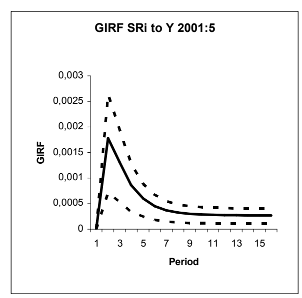
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Period

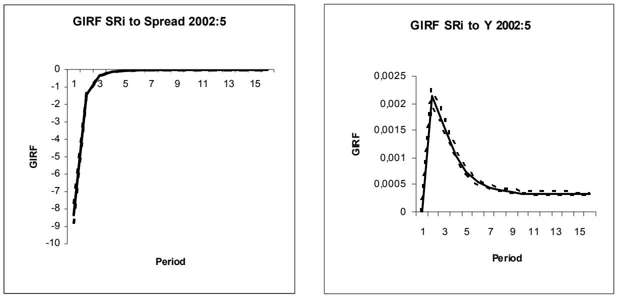

Figure 1. Investigation of Expectation Theory and Transmission Channel: GIRF analysis

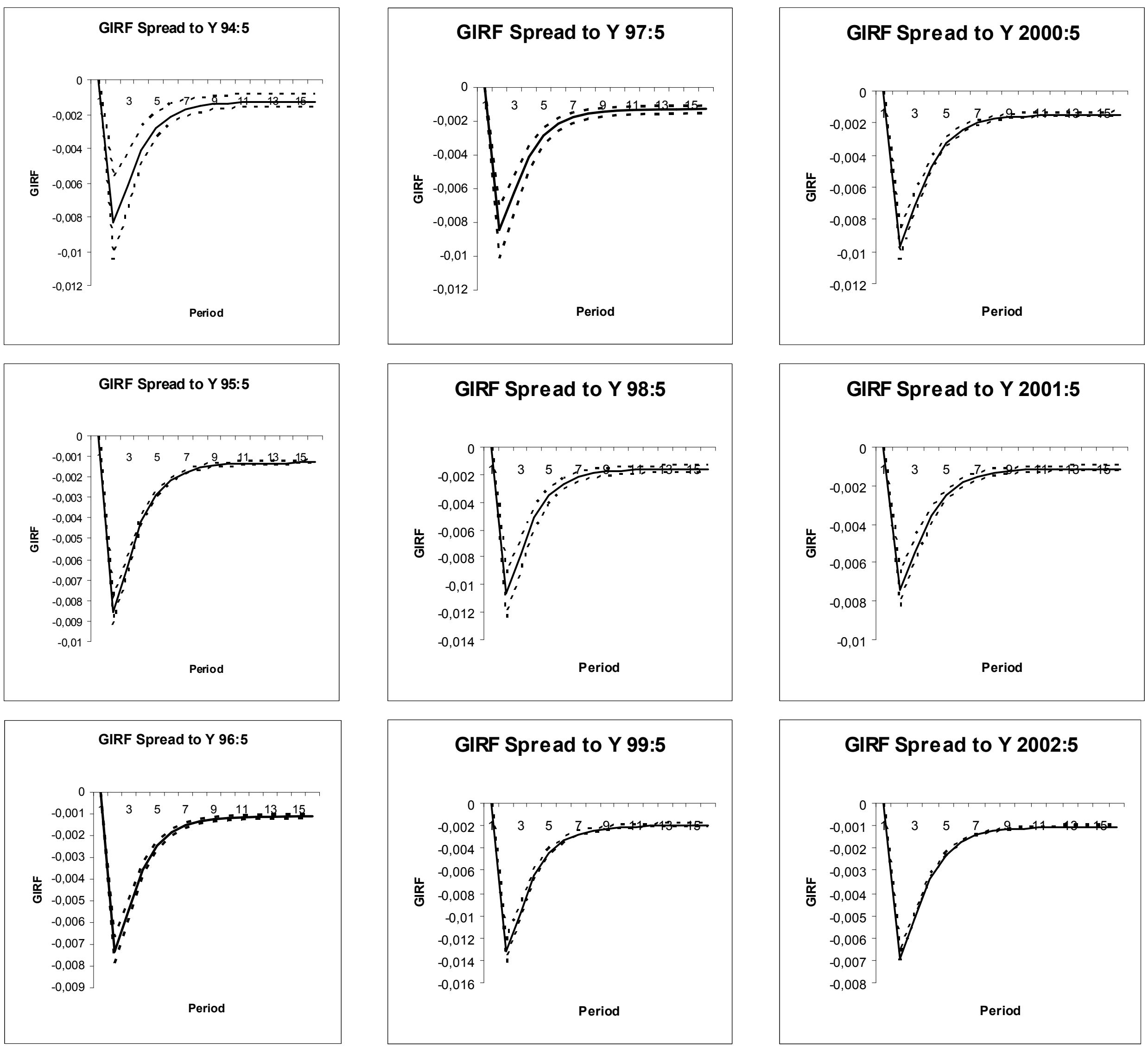

Figure 2. Stability Analysis of Real Economic Activity Predictability: GIRF Analysis

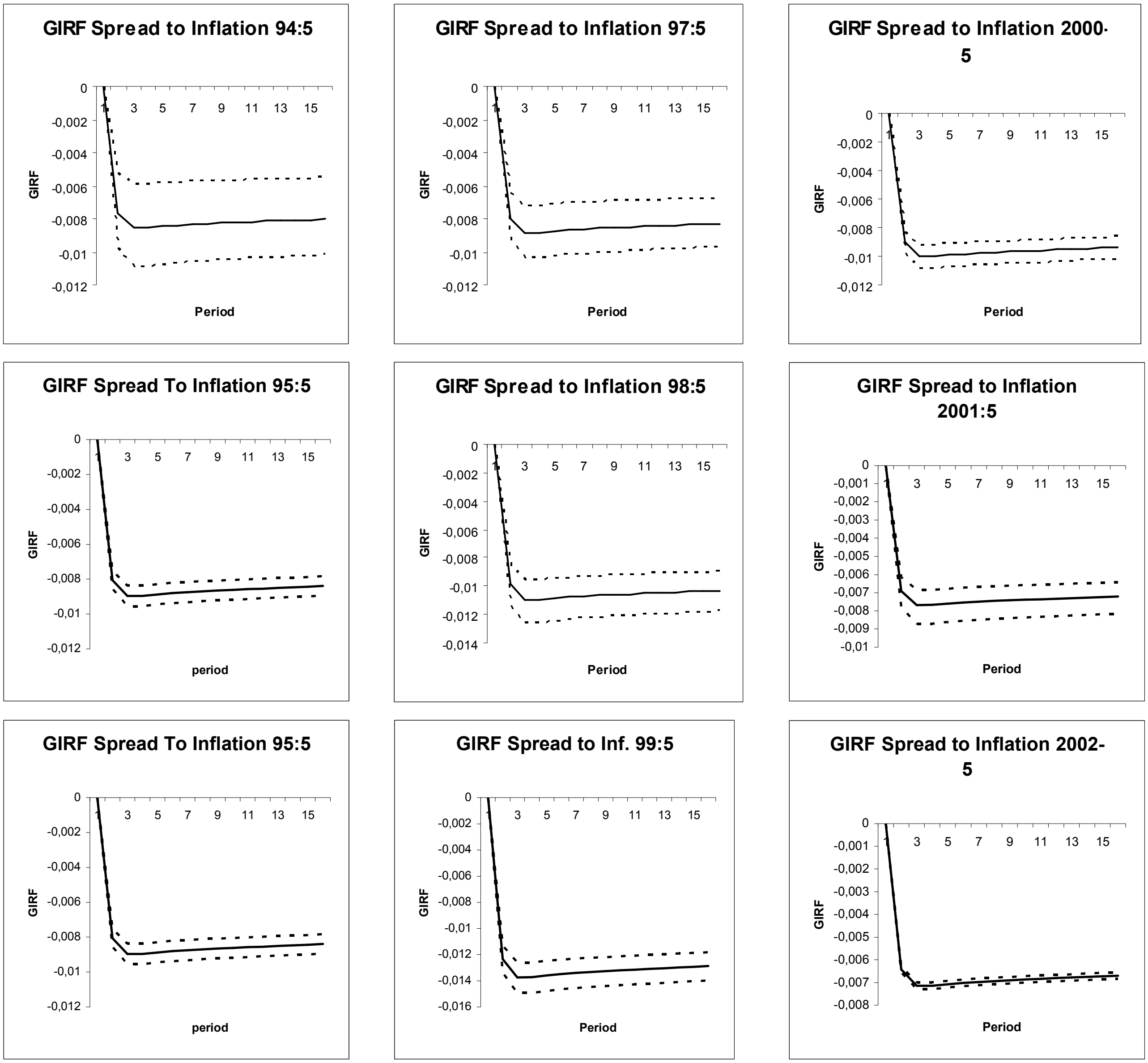

Figure 4. Stability Analysis of Inflation Predictability: GIRF Analysis