THE RELATIONSHIPS BETWEEN TERM STRUCTURE OF INTEREST RATE AND ECONOMIC ACTIVITY

An Application to Turkish Economy

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VADE FARKLARI İLE EKONOMİK AKTİVİTELER ARASINDAKİ İLİŞKİ

Türkiye Ekonomisi İçin Bir Uygulama

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ABSTRACT

The main purpose of this thesis is to investigate the relationship between term structure of interest rate and real economic activity, which measured by growth of industrial production index, during the period of April 1991-November 2006 in Turkey by considering in detail the observed relationship of term structure of interest rate and economic activity. To examine the associated relationship the Autoregressive Distributed Lag (ARDL) approach is used. We found that while ARDL bond test results indicate high degree of cointegating relationship between term structure of interest rate and growth of industrial production index, the long-run coefficient of all yield spreads are insignificant. On the other hand, when the inverse relationship is examined we found that, there is significant long-run relationship between growth of industrial production index and yield spreads. In addition to this, it is also analyzed the relationship between short term interest rate and growth of industrial production index. Using ARDL approach it is found a significant and negative long-run relationship between short term interest rate and growth of industrial production index as expected. Short run effects of short term interest rate on change in growth of production index are also investigated with error correction mechanism. The results indicate that any short-run deviations from equilibrium die out in the long-run and the system come to equilibrium by fluctuating. It is expected that, deepening of the financial market and achieving success in structural transformations in economy will lead to get better results from future term structure research.

ÖZET

Bu tez, Türkiye'de Nisan 1991-Kasım 2006 döneminde vade yapıları ile sanayi üretim endeksinin büyümesi arasındaki ilişkiyi araştırmaktadır. Bu ilişkinin mahiyetini araştırmak amacıyla gecikmesi dağıtılmış otoregresif model (autoregressive distributed lag ARDL) kullanılmıştır. ARDL sınır testi sonuçları vade farkları ile sanayi üretim endeksinin büyümesi arasında uzun dönemli eşbütünleşme (cointegration) ilişkisi olduğu gösterirken,statik uzun dönem çözümleri vade farklarının uzun dönemli ilişki katsayılarının anlamlı olmadığını göstermektedir. Diğer yandan, yine ARDL yaklaşımı kullanılarak ilişkinin diğer yönü de araştırılmış, üretim endeksi büyümesi ile vade farkları arasında uzun dönemli negatif ve istatistiki olarak anlamlı bir ilişkinin olduğu bulunmuştur. Vade farklarının reel ekonomi hakkındaki bilgi dağarcığı araştırıldıktan sonra, Türkiye'de kısa dönemli faiz oranları ile sanayi üretim endeksi büyümesi arasındaki ilişki analiz edilmiştir. Uzun dönemde kısa dönem faiz oranları ile üretim endeksi büyümesi arasında istatisiki olarak anlamlı ve negatif bir ilişki olduğu bulunmuştur. Kısa dönemli faiz oranları ile üretim endeksi büyümesi arasındaki kısa dönemli ilişki bir hata düzeltme modeli ile incelenmiş ve kısa dönemli denge sapmalarının uzun dönemde dalgalanarak dengeye geldiği tespit edilmiştir. Ulaşılan bu sonuçlar, daha önce Türkiye'de vade farkları ile ilgili yapılan çalışma sonuçlarını desteklemektedir. Finansal piyasaların derinleşmesi ve ekonomide yaşanan yapısal dönüşümlerin başarıya ulaşması gelecek dönemlerde yapılacak analizlerden daha sağlıklı sonuçların elde edilmesine katkı sağlayacaktır.

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1. INTRODUCTION

The term structure of interest rate, i.e. yield spread, has long been interest of macroeconomics and financial economics. As financial economists look at the theory of term structure of interest rate, macroeconomist look at the relationship between term structures of interest rate and economic activity in particular inflation and output growth.

Multiple theories have been proposed to explain the shape of the term structure, but research to date has not definitively explained which of the theories provides the best explanation for the term structure shape (Philips, 2003). There are four major theories of term structure of interest rate in the literature which are expectation hypothesis, segmented market theory, preferred habitat theory and liquidity premium theory.

The expectations hypothesis of the term structure of interest rates is one of the oldest and simplest analytical frameworks that simplify the rational behavior in the financial markets. According to the expectations hypothesis, the long-term interest rates should reflect future short-term changes. Specifically, long-term interest rates would be the average of future expected short rates (Esteve, 2006). On the other hand liquidity premium theory, advanced by Hicks (1946), is a modified type of expectation hypothesis asserts that long term interest rate is equal to average of expected short term interest rate plus a positive risk premium because of that investors are usually risk averse so any investor demand long instead of short must be paid by a positive premium.

Segmented markets theory, introduced by Cullberston (1957), explain term structure of interest rate by stressing existence of different demand and supply conditions for different maturities, and non-existence of substitution among securities with different maturities. Under the segmented markets theory, participants in one segment would be indifferent to supply-demand forces in adjacent maturity segments. A variant of the segmented markets theory, the preferred habitat theory, allows for segment participants to be induced to leave their preferred habitat when there are sufficient incentives; i.e., higher yields. Actually preferred habitat, introduced by Modigliani and Sutch (1966), and is a theory of combination of all three theories. Preferred habitat theory states that long term interest rate is equal to average of expected short term interest rate that occur during life time of the security plus a premium which reflects supply and demand conditions for that security. Therefore, spread depends primarily on expectation of long run changes but it also depends on supply and demand conditions.

On the other hand macroeconomists, policymakers and market analyst whish to investigate whether term structure of interest rate contain significant information about future economic activity. As expectation hypothesis suggest it is possible to extract expectation of economic actor about future economic activity by taking account to term structure of interest rate. On this basis, firstly Harvey (1988) showed that the term structure of ex ante real rates of interest contains information about future real consumption and economic growth. On the other hand Fama (1990) showed that term structure of interest rate has significant information about future path of inflation rate.

Especially the Mishkin (1990) by using Fisher equation and taking differences of two different periods of inflation, introduced term structure of interest rate as an information container about inflation. After Mishkin (1990) model, papers which are devoted to the investigation of the relationship between yield curve and inflation started to published. Folowing Mishkin (1990), Jurion and Mishkin (1991) find the similar results for European economies. Tzavalis and Wickens (1996), Gamber (1996), Ivanova at al (2000), Sahinbeyoğlu and Yalçın (2000), Nagayasu (2002), Telatar at al (2003),Estrella at al (2003) and Trackz (2004) are all investigate the information content of term structure about future economic activity. Except Sahinbeyoğlu and Yalçın (2000), and Telatar at al (2003) all conclude that slope of yield curve is a good informative about the future inflation changes.

Sahinbeyoğlu and Yalçın (2000) applied the Mishkin's (1990) model to Turkish economy and they, interestingly, found that term structure of nominal interest rates have a significant but, as a contrary to theoretical framework and previous studies, negative effects on future inflation path. They argued that the result may due to the immature financial market and lack of long maturities. Telatar at al (2003) visited the relationship between yield curve and inflation in Turkish economy by considering period which investigated is, 1990–2000, a period of high inflation, high budget deficits, and political instability. By using a time-varying-parameter model with Markov-switching heteroskedastic disturbance, they found, contrary to Sahinbeyoğlu and Yalçın (2000), positive relationship between slope of yield curve and inflation but information content of yield curve about future inflation is limited.

Harvey (1988), tried to find the relationship between expected real term structure and expected consumption growth by following the claim of consumption based asset pricing model and he found that real term structure has more information and more predictive power than lagged consumption growth and lagged stock return. Therefore these findings declared the existence of a new and strong variable that can be used for predicting future real economic activity. After Harvey, Estrella and Hordauvelis (1991) found that term structure has more information and predictive power than lagged output growth, lagged inflation, leading indicator index and level of real short term interest rate. Also Friedman and Kutner (1991), look at the relationship between spread between 6 month commercial paper rate and 3 month T-bill rate. They found that spread not only has explanatory power but also spread widens in business cycles period and narrow in recovery period. Following years, Plosser (1994), Bonser at al (1997), Estrella and Mishkin (1998), Peel and Taylor (1998), Estrella at al (2003), Bordo and Haunrich (2004), Giacomini and Rossi (2005) look at linear relationship between term structure of interest rate and output growth and they all found strong predictive relationship between term structure of interest rate and future real economic activity.

Estrella and Mishkin (1998), Esrella at al (2003) use also probit model to predict recession by using term structure of interest rate. They found term structure of interest rate has prediction power for recession. Chauvet and Potter (2000) use more general form of probit model and they reach the same conclusion.

On the other hand Galbraith and Tkacsz (2000), found the existence of asymmetries in the link between yield spread and output. Paya at al (2004) analyzed standard linear and nonlinear behavior of the information content and asymmetry in the spread for future real economic activity. It is found that both linear and nonlinear (threshold autoregression) models has significant predictive power over nine and four different industrial production sectors in the US and UK. Nakaota (2005) took into account of relationship between yield curve and real economic activity in Japan. He argued that the nature of relation may change over time after it cannot be found such relationship with standard linear model. By adding dummy variable to standard linear model he found that yield spread forecast real GDP growth. Ang at al (2006) construct a dynamic model of yield curve and found yield spread has predictive power but short interest rate dominates yield spread in forecasting GDP growth.

While the relationship between term structure of interest rate and real economic activity is powered by model, it is also investigated policy effects on this relationship. Gamber (1996) investigates that whether forecasting ability of term structure is solely due to its relationship to monetary policy or whether it contains independent information about change in future inflation and output. Results showed that terms structure of interest rate has independent predictive power only when FED does not react to change in that variable. Kim and Limpaphayom (1997) use bivariate term structure model to emphasize policy effects on predictive power of term structure of interest rate and found that policies toward economy highly affect the predictive power of term structure of interest rate.

Peer and Ioannidis (2003) test the structural stability of the forecasting output growth and reached the result that the anti-inflation policy reduces the predicative ability of term structure of the interest rate. Bordo and Haubrich (2004) found that when credibility is low, inflation persistence is high, predictive power of term structure is also high. Giacomin and Rossi (2005), found that structural breakdown linked to monetary policy changes in FED's preference parameters. Estrella (2005) concluded that the extent to which the yield curve is a good predictor depends on the form of the monetary policy reaction function, which in turn may depend on explicit policy objectives. Thus, the predictive relationships, though robust, are not structural.

While information content of term structure is deeply examined especially the cases of developed economies, there are not satisfactory studies of yield spread in Turkey. The unstable characteristic of Turkish economy, and immature structure of financial market lead to terms structure of interest rate being uninformative about inflation and real economic activity (Sahinbeyoğlu and Yalçın , 2000; Telatar at al 2003, Eraslan, 2005).

To determine the nature of relations between term structure of interest rate and growth of industrial production index the ARDL bound test approach applied. ARDL bound test approach allow us to investigate the long-run relationship of yield spread and growth of industrial production index irrespective of whether all variables are integrated same order or not.

The data are monthly and range from April 1991 to November 2006. Monthly industrial production index is obtained from IMF's International Financial Statistics 2006 CD Room. Treasury bond interest rates (thanks to Prof. Dr. Burak Saltoğlu for giving his data) of term 30, 60, 90, 120, 180, 270 and 360 days taken from Istanbul Stock Exchange database as a daily interest rate and obtained with interpolation method. All possible term structures are used. Mainly because of the lack of deep financial market and high risk in Turkey, term length not being much long.

Although the bound test results indicate that there are strong long-run relationship between yield spreads and growth of industrial production index, static long-run solutions show that long-run coefficients of term structure of interest rates are not significant. On the other hand, when the inverse relationship is analyzed and we found that, there is significant long-run relationship between growth of industrial production index and yield spreads. The long-run coefficient of growth of industrial production index is negative and significant and very high especially for the models that dependent variable is *s_360_30* and *s_270_30* and *s_180_30*. Thus associated results indicated that in the long-run any increase in y cause a decrease in s. As discussed in the literature; nonexistence information content of yield spreads about economic activity may because of the lack of deep financial market, lack of long term yield spread data that reflects long run expectations, unstable macroeconomic conditions such as high inflation, volatile growth and high risk factors in Turkey. Also level effects and time variation may play important role. Also getting long-run cointegrationg relationship and significant long-run reverse relationship may indicate that variables are affected by common factors, such as capital movements, political risk etc.

When we cannot reach usual conclusion, it is examined the relationship between short term interest rate and growth of industrial production index by following the findings of Ang et al (2006) stating that short interest rate predict future real economic activity better than yield spread. Using ARDL approach it is found that there is significant and negative long-run relationship between short term interest rate and growth of industrial production index. Also by using error correction mechanism the short run effects of short term interest rate on change in growth of production index is analyzed. It is found that any short-run deviations from equilibrium are cleaned up in the long-run.

The following study consists of six parts. In the first part the theories of yield curve are discussed. Second and third part consists of detailed literature survey about the relationship between term structure of interest rate and inflation, and real economic activity. In the fourth part the effects of policies on predicting power of term structure is discussed. In the fifth part it is conducted an empirical investigation of term structure and real economic activity for Turkey. The last part includes the concluding remarks and directions to the future research.

2. THE TERM STRUCTURE OF INTEREST RATE

As risk structure of interest rate (default risk, liquidity, income tax etc.) play important role for level of interest rate, length of time to maturity also do. At a given time, all other things being equal, the existing relationship between interest rate on and terms to maturity of different securities is known as term structure of interest rate or yield curve.

Figure 1: Positively sloped yield curve

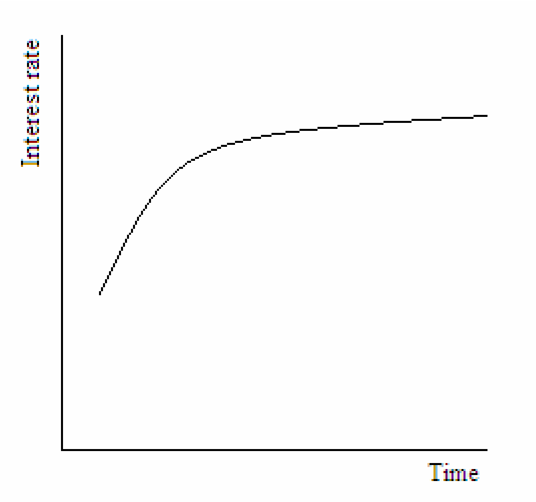
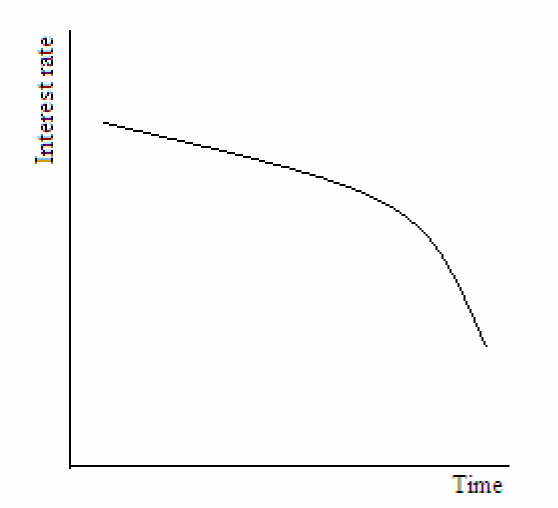


Figure 2: Negatively sloped yield curve



Yield curve can be classified into three different shapes: upward sloping, flat and downward sloping which is usually referred as inverted yield curve. It is upward sloping when short term interest rate of security is lower than long-term of the same security and it is inverted when the reverse is true. Yield curve takes flat shape when level of interest rate of security does not vary with time to maturity. Also a yield curve can have more complicated shapes such as firstly upward then inverted or vice versa.

Four theories in term structure history have tried to explain the shapes of yield curve have taken. Market Expectation (pure expectation) Hypothesis which usually referred as expectation hypothesis, Segmented Market Theory (Culbertson, 1957), Preferred Habitat Theory (Modigliani and Sutch, 1966) and Liquidity Premium Theory which advanced by Hicks (1946) are all theories of term structure of interest rate. However, explaining term structure of interest rate, Expectation Hypothesis and Liquidity Premium are primarily investigated, it appears, theories in many financial texts.

2.1. Expectation Hypothesis

Expectation hypothesis does not belong to any one individual. As its routes goes to Irving Fisher (1986), most of underlying part of theory was not developed before late 1930's, mainly developed by Hicks (1939) and Lutz(1940) (Cox, at al, 1981:774).

Expectation hypothesis simply posits that, long term return of a security is purely determined by expected return of short term return of that security (Cuthberston, 1996: 578). In its most purified version, expectation hypothesis states that long term interest rate is average of expected short term interest rate that expected to be realized in securities life time.

It means that expectations about future interest rate truly carried on yield curve so if expectation about future interest rates changes the slope of yield curve also changes. For example, if it is expected that interest rate will increase in the future, then there will be an increase in slope of yield curve. This is partly because, such expectations cause an increase in demand of short term securities and decrease in supply of short term securities due to avoid getting low yield from long term securities and paying high interest rate in the future after an increase in interest rate (Harrison and Pierce, 1996: 45).

Expectation theory also explains a historical fact that is interest rates on securities with different time to maturity move together over time. A rise in short-term interest rate raises expectations of future short-term rates, because of the rising expected short term interest rates long-term interest rates rise also. Thus short term and long term interest rates move together (Mishkin, 1998:156).

One of the most important assumption lies under expectation hypothesis is that financial securities with different maturity date are perfect substitutes. So the only criterion of preference over a security is its expected return.

As it can be seen expectation hypothesis brings a simple explanation for behaviors of term structure. Because of this attractiveness characteristic, it has been subject to many texts in literature. For example, Cox, Ingersoll and Ross (1981), Attfied and Duck (1982), Jones and Roley (1983), Fama (1984), Mankiw and Miron (1986), Kugler and Brutta (1993), Cuthberston (1996), Longstaff (2000), Kozicki and Tinsley (2005) are some of them.

2.2. Segmented Market Theory

Segmented matket theory developed by Culberston (1957). He argued that the expectation hypothesis developed by Hicks (1939) and Lutz (1941), is theoretically unsatisfactory and inconsistent with postwar area and, tried to find a theory which satisfactorily explains the behaviors of term structure in both during 1920s and 1930s experiences by emphasizing the interconnection between debt markets, liquidity differences among securities with different maturities and changes in maturity structures (Culberston, 1957: 488).

According to this theory, securities with different maturities are not substitutes. There are four factors that lead to markets of securities with different maturity being segmented. Firstly, short term debts are more liquid than long term ones, and lenders who prefer more liquid asset choose short term depts. As there are limitations for borrowers to finance their dept in short term, this will cause lower yield and in the market preferences matched. The behavior of most lenders and borrowers are not governed by future expectation because of different planning period, characteristic of timing activity, unstable prices, existence of speculators, lack of perfect foresight and etc in market. Hence there exists particular market for particular time period. Thirdly, maturity structure of demand for funds changes over the time. Changing behaviors of maturity structure of demand for funds, makes maturity structure of lenders more important thus mobility of funds among securities disappear and this is a factor that effects the maturity structure of interest rate. Also such changes affect the liquidity premium and marginal cost of lending and they changed the effects of market on speculative actions. Finally but weakly, cost of acquiring, evaluating, liquidating and administrating of debt with different maturities may affects the rate of return (Culberston, 1957).

Segmented market theory explain term structure of interest rate by stressing existence of different demand and supply conditions for different maturities, and non-existence of substantiality among securities with different maturities. Empirical evidence generally supports the market segmentation theory at the short end of the yield curve (Park and Switzer, 1997, Simon, 1991, and Taylor, 1992), and researches remained scarce for longer dated debt. Also according to this theory, a yield curve generally should be upward sloping, because in general short term securities preferred to long term by lenders. This will lead to, a decrease in short term interest rate and increase in long term interest rate. However, this theory has important deficiencies. It cannot explain the historical fact that short term and long term interest rate move together and also there is, as it examined in paper, many evidence that short term and long term interest rate have relations and different maturities shows substitutable character (Mishkin, 1998).

2.3. Liquidity Premium Theory

Liquidity premium theory (LPT) advanced by Hicks (1946), is a modified type of expectation hypothesis. LPT states that investors are usually risk averse so any investor demand long instead of short must be paid by a positive premium. Because of this risk aversion investors usually prefer to hold short term securities and thus to supply funds for long term they must be paid by a positive amount of time varying or risk premium. More generally theory declares that, long term interest rate is equal to average of expected short term interest rate plus a positive risk premium which carried on long term securities that long term yield more sensitive to interest rate than short term i.e. long term are more riskier. Because of this premium, forward rate is higher than one period short rate (Paleaz, 1997). Hicks made all these into three arguments. Firstly he argued that borrowers strongly prefer to borrow long to hedge themselves. Secondly in lender point of view, it is convenient to lend short for avoiding uncertainty and finally speculators fix this “constitutional weakness” by borrowing short and lending long but they must get positive premium for taken such risk during this process (Cox, at al, 1981:784).

LPT assumes that securities with different time to maturity substitute’s bun not perfect substitutes. According to this theory forward rate is a poor predictor of future spot rate because of the expected spot rate and risk premium. It explains the movement of short term and long term interest rate and also it brings very simple explanation for why yield curve usually upward sloping (Miskin, 1998).

2.4. Preferred Habitat Theory

In their paper Modigliani and Sutch (1966) states that all above three models have some deficiencies. They introduced a new theory which is preferred habitat theory by combining all three. The new theory states that long term interest rate is equal to average of expected short term interest rate that occur during life time of the security plus a premium which reflects supply and demand conditions for that security. Hence spread depends primarily on expectation of long run changes but it also depends on supply and demand conditions.

It shares the notion of liquidity premium but has one fundamental difference. As liquidity premium states that because of the uncertainty carry long term securities, risk premium must be positive to make expected return equal; PHT posits that premium can be positive or negative. Modigliani and Sutch states that result of LPT correct only when the assumption of every lender prefer to turn their assets cash in the short run, which means they have short habitats. In reality as market segmentation theory states, different players can have different habitats. As someone needs his funds n period later i.e. he has n habitats, by staying short will cause uncertainty and until n period every period he faces with extra transaction cost. On the other hand by taking n period bond, and considering risk aversion possibilities, he can destroy uncertainty and extra transaction costs. Therefore a transactor stay his habitat and hedge himself, unless other maturities offers an expected premium compensate risk and cost of staying different habitats (Modigliani and Sutch, 1966 :182-185).

Preferred habitat theory stands on the assumption that different maturities are substitutable like liquidity premium and expectation theory. Investors have preferences over maturity, they have habitats, but also expected return is considered by these investors. PHT can explain easily the accompany movement of short term and long term interest rate, by the help of risk aversion argument it also explain why usually yield curve upward sloping (Miskin, 1998: 158-159, Harrison and Pierce, 1996: 46)

3. THE OBSERVED RELATIONS BETWEEN TERM STRUCTURE OF INTEREST RATE AND INFLATION

Predicting inflation play an important role in wide range of economic decision including investment decision, monetary policy decision, wage negotiation etc. (Kozicki, 1998). Especially, with the popularity of inflation targeting as a monetary policy, forecasting inflation gain extra importance.

One of the financial market indicators used by monetary policy makers to extract information on future interest rate and inflation developments are yield curves or term structures of interest rates. Since 90's predicting inflation by using term structure of interest rate started to gain more attention. Especially the model of Mishkin (1990) becomes a guide for analyst and academicians. While the extent and sophistication of the uses of yield curves to extract information vary across central banks and over time, the forward looking nature of underlying bond prices has meant that monetary policy makers monitor the slope of yield curves as a general rule. Often, the information content of the term structure about inflation is defined as the ability of the slope of the term structure to predict changes in inflation rates. Specifically, if real interest rates and term premium are constant over time, the difference between short-term and long-term interest rates should be a linear function of expected inflation changes (Schich, 1999).

In Table 1, there are models that in literature trying to construct and discover the relations between terms structure of interest rate and inflation. It is depicted to models with used estimation techniques and the results.

Table 3: Literature on analysing relations between term structure and inflation

Author Name	Model	Estimation technique	Results
Fama, F.E., (1990)	$\pi_{t+T+1}-\pi_{t+T}=\alpha_1+\alpha_2[r(5:t)-r(t)]+\varepsilon_{t+T+1}$ π_{t+1} one year inflation rate $r(5:t)$ five-year bond rate $r(t)$ one year bond rate	**OLS**	Term structure show persistence forecast power for changes in inflation rate. R^2 is reached the most highest value when two and three years changes in inflation rates.
Mishkin, F.S. (1990)	$\pi_t^m-\pi_t^n=\alpha_{m,n}+\beta_{m,n}(i_t^m-i_t^n)+\varepsilon_t^{m,n}$ where π inflation rate i nominal interest rate m,n show periods	**OLS**	Term structure of very short interest rates (six or less months) includes almost no information about inflation. However term structure of long maturities (9 and 12 month) have significant predictive power for inflation rate**.**
Jorion, P., and Mishkin, F.S., (1991)	$\pi_t^m-\pi_t^n=\alpha_{m,n}+\beta_{m,n}(i_t^m-i_t^n)+\varepsilon_t^{m,n}$ where π inflation rate i nominal interest rate m,n show periods	**OLS**	In addition to U.S, previous model is applied, Germany, Britain and Switzerland's data. It is found that especially for longer maturities, term structure of interest rate has significant ability to forecast changes in inflation rates.

Table 1: Litereture on analysing relations between term structure and inflation (*Continue*)

Tzavalis, E. and Wickens, M.R (1996)	$\pi_t^m - \pi_t^n = \alpha_0 + \alpha_1 d_t + B(i_t^m - i_t^n) + \varepsilon_t^m$ (1) $\Delta\pi_t^m = \alpha_0 + \alpha_1 d_t + \gamma_1(L)\Delta\pi_t + \gamma_2(L)\Delta s_t$ $+\gamma_3(L)\Delta i_t + \sum_{m,n} \delta_{1,mn}(i_t^m - i_t^n) + \delta_2(r_{t-1} - \pi_t) + \omega_m^t$ (2) π inflation rate i interest rate r real interest rate m,n show periods d_t monetary regime dummy	**OLS (1)** **NLLS(2)**	1-) Results shows that term structure of interest rate contain almost no information about inflation. Exception of (*m,n*)=(12,3) and (12,6), estimates of β are not significantly different than zero and R^2 still is very small. 2-) By using NLLS estimation technique, it is reached improved fit and better out of sample forecasting. As a result, however, it is found that real interest rate contain far more information than slope of yield curve about future inflation
Gamber, E.N., (1996)	$L(6)\pi = \alpha_0 + \alpha_1 L(6)S_t + \varepsilon_t$ (1) $L(6)\pi = \alpha_0 + \alpha_1 L(6)S_t + \alpha_2 FF_t + \varepsilon_t$ (2) $L(6)\pi = \alpha_0 + \alpha_1 L(6)FF_t + \alpha_2 S_t + \varepsilon_t$ (3) $S_t = i_{10t} - i_{3t}$ S_t: slope of yield curve i_{10t}: yield on 10 years goverment security i_{3t}: yield on 3 months goverment security π : inflation FF : federal funds rate	**Gragner Causality Test**	Slope of yield curve includes independent information about inflation only when Federal Reserves do not react to changes in that variable. It is also found that FF is consistently estimates the inflation.

Table 1: Litereture on analysing relations between term structure and inflation (*Continue*)

Estrella, A. and Mishkin, F. S. (1997)	$\pi_{t,t+k} = \beta_0 + \beta_1 S_t + \beta_2 \pi_{t,t-k} + \omega_t$ (2) π: inflation rate $S_t = \alpha_0 + \sum_{i=0}^{6} \alpha_1 CB_{t-i} + \sum_{i=0}^{6} \alpha_2 Bill_{t-i} + \sum_{i=0}^{6} \alpha_3 Bond_{t-i} + \varepsilon_t$ (1) $S_t = Bond - Bill$ $Bond$:10 years goverment security rate $Bill$:3 months goverment security rate CB :central bank rate	**OLS**	In addition to U.S, for four major European economies (Germany, Italy, French, U.K,), it is found that term structure of interest rate is a good predictor of future inflation rate. Especially lead time of three and five years show better predicting performance.
Ivanova, D., Lahiri, K. and Seitz, F. (2000)	First order Markow process $P(S_t = j / S_{t-1} = i, S_{t-2} = k....)$ $= P(S_t = j / S_{t-1} = i) = p_{ij}$ EM algorithm $P(y_1, y_2, ...y_T : \lambda, y_0)$ $= \sum_{S_1=1}^{2} .... \sum_{S_T=1}^{2} P(y_1, y_2, ...y_T, S_1, ...S_T : \lambda, y_0)$ estimated parameters:$\lambda(\mu_1, \mu_2, \sigma_1^2, \sigma_2^2, p_{11}, p_{22})$ p_{ij} transition probabilty S_t: unobservable state which is 1 or 0 y_t: underlying spread, to be leading indicator of the inflation	**EM algorithm**	Turning point of inflation is truly estimated by all term spreads (Public TS, Bank TS, Call TS and Lombard TS). Downswings and upswings in inflation are anticipated average lead of 2.5 and 4 years respectively. Hence it seems long leads make term structure a good candidate for leading inflation.

Table 1: Litereture on analysing relations between term structure and inflation (*Continue*)

Şahinbeyoğlu, G. and Yalçın, C. (2000)	$\pi_t^m - \pi_t^n = \alpha_{m,n} + \beta_{m,n}(i_t^m - i_t^n) + \varepsilon_t^{m,n}$ where π inflation rate i nominal interest rate m,n show periods	**OLS**	The model of Mishkin (1990) applied to Turkish data. Because of the immature financial market, achievable longest period was 12 months. At the end it is found that term structure of nominal interest rates have a significant but, as a contrary to theoretical framework and previous studies, negative effects on future inflation path.
Estrella, A., Rodrigues, A. P. and Schich, S. (2003)	$P(\Delta\overline{\pi}_t^{m,n} i_t = 1) = F(\alpha + \beta(i_t^m - i_t^n))$ *where* $\Delta\overline{\pi}_t^{m,n} = \begin{cases} 1\ for\ \ \pi_t^m - \pi_t^n > 0 \\ 0\ for\ \ \pi_t^m - \pi_t^n \leq 0 \end{cases}$ π_t :inflation rate i_t:nominal interest rate	**ML**	Model applied to both German and U.S data. The result for German data show that the slope of yield curve is informative about the direction of future inflation changes and maximum pseudo- *R square* of .43 is obtained for the maturity combination of 6-3 years. For U.S, the information content of the term structure about the direction of future inflation changes are somewhat mixed. It is not clear as in German case and for many maturity combination pseudo- *R square* is very low and some times negative.

Table 1: Litereture on analysing relations between term structure and inflation (*Continue*)

Nagayasu, J. (2002)	$\pi_t^m - \pi_t^n = \alpha_{m,n} + \beta_{m,n}(i_t^m - i_t^n) + \theta_{m,n}\Delta M_t + \xi y_t + \varepsilon_t^{m,n}$ where π inflation rate that both WPI and CPI data differently is used i nominal interest rate ΔM real money growth y_t industrial production growth m,n show periods where m=2,3 and n=1	**GMM**	Model support that there is relationship between term structure and change in inflation. Longer end of term structure predicts inflation path better than short end. Also it is found that CPI is more useful than WPI. Model estimated firstly without money growth and production growth. Then it is added to the model first money growth and then production growth. Adding money growth cause improvement in prediction but same is not true for production growth.
Telatar, E., Telatar, F. and Ratti, R. A. (2003)	$\pi_t^m - \pi_t^n = X_t^{'}\xi_t + \varepsilon_t$ (1) where $\xi_t = \xi_{t-1} + \omega_t$ $\omega_t t \sim N(0, Q)$ (2) $\varepsilon_t \sim N(0,\ ht)$ $h_t = \sigma_0^2 + (\sigma_1^2 - \sigma_2^2)S_t$ with $X_t^{'} = [1(i_t^m - i_t^n)], \xi_t = [\alpha_t, \beta_t]$ π inflation rate i nominal interest rate m,n show periods	**ML**	Model applied to Turkish data which is generated from second hand market. The results show that there is limited information in term structure of interest rate, especially at longer horizons, about Turkish inflation path. Except one-three months range, it is also found that the intercept coefficient in the relationship between change in inflation and term structure of interest rates is time-varying.

Table 1: Literetune on analysing relations between term structure and inflation (*Continue*)

Tkacz, G. (2004)	$\pi_t^m - \pi_t^n = \alpha_{m,n}^2 + \beta_{m,n}^2 (i_t^m - i_t^n) + \delta_{m,n} d_t + \gamma_{m,n} d(i_t^m - i_t^n) + \varepsilon_t^{m,n}$ where $d = \begin{cases} 1 \text{ for } (i_t^m - i_t^n) \le \tau \\ 0 \text{ for } (i_t^m - i_t^n) > \tau \end{cases}$ $\alpha_{m,n}^2 = \delta_{m,n} + \alpha_{m,n}^1$ and $\beta_{m,n}^2 = \gamma_{m,n} + \beta_{m,n}^1$ π inflation rate i interest rate m,n show periods	**ML**	Spreads which jointly incorporate information from both short and long ends of the interest rate yield curve contain the most explanatory power for future inflation. Also it is found that significant thresholds emerge when the yield curve is relatively flat or inverted. For policy relevant horizon, relationship between long–short yield spreads and inflation changes is more pronounced when the spread is below some threshold, usually below 0.00.

Fama (1990) found that term structure of interest rate show persistence predicting power to change in inflation rate. Main aim of Fama is to reach the motive behind the behavior of term-structure forecasts of the one-year spot rate observed in Fama and Bliss (1987). He argued that this can be explained in terms of forecasts of the one-year inflation rate, the real return on one-year bonds, or both because of the spot rate is the sum of an expected inflation rate and an expected real return. He used log of Consumer Price Index as one year inflation rate and take the difference between 5 and 1 year government bond rate. Fama surprisingly reached that the yield spread shows more consistent power to forecast changes in the one-year inflation rate than changes in the spot rate.

The most influential model that aims to establish relations between term structure of interest rate and inflation rate was introduced by Mishkin. Mishkin (1990) established his famous model by using Fisher equation and show the causality of the relations between term structure of interest rate and inflation rate. The methodology of Mishkin is following;

$$E_t \pi_t^m = i_t^m - rr_t^m \qquad (Fisher\ equation) \tag{1}$$

where

E_t = expectation at time t

π_t^m = inflation rate from t to t+m

$i_t^m = m - period$ nominal interest rate at time t

$rr_t^m = m - period$ real interest rate at time t

By some manipulation we get known equation of Fisher which is

$$\pi_t^m = i_t^m - rr_t^m + \varepsilon_t^m \quad \text{where } \varepsilon_t^m = \pi_t^m - E_t \pi_t^m \text{ is forecast error.} \tag{2}$$

If *n*-period inflation is subtracted from equation 2 it can be examined the information in term structure about future inflation.

$$\pi_t^m - \pi_t^n = i_t^m - i_t^n - rr_t^m + rr_t^n + \varepsilon_t^m - \varepsilon_t^n \quad \text{where } m > n \tag{3}$$

This equation can be written in following form

$$\pi_t^m - \pi_t^n = \alpha_{m,n} + \beta_{m,n}(i_t^m - i_t^n) + \eta_t^{m,n} \qquad (4)$$

where

$\alpha_{m,n} = rr_t^n - rr_t^m$

$\beta_{m,n} = 1$

$\eta_t^{m,n} = \varepsilon_t^m - \varepsilon_t^n - (\upsilon_t^m - \upsilon_t^n)$

Because as expectations is rationale $(\varepsilon_t^m - \varepsilon_t^n)$ is orthogonal to right hand side of regression and as terms structure of real rates are constant over time, $(\upsilon_t^m - \upsilon_t^n)$ disappear. If it is expected that expectations are rational and real interest rates remain constant over time the slope of equation can be consistently estimated by OLS.

As a result rejection of $\beta_{m,n} = 0$ implies that term structure include information about future inflation rate and term structure of real rates and nominal rates do not move one for one to each other. On the other hand refection of $\beta_{m,n} = 1$ implies that slope of real term structure is not constant over time, and nominal term structure provide information about real term structure (Mishkin, 1990).

As an application Mishkin used U.S T-bill and government bond rate and he found that although term structure of short interest rates (six or less months) includes almost no information about future path of inflation, term structure of long maturities (9 and 12 month) have significant predictive power for inflation rate**.** He also argued that there is no evidence for changing in amount of information carried on term structure about future inflation as monetary regime change. Jorion and Mishkin (1991) the application of same methodology to some European economies and they reached familiar results. Estrella and Mishkin (1997) examine the relationship of term structure of interest rate to inflation, monetary policy and real economic activity. In examination to inflation Mishkin's methodology is used. They conclude that term structure of interest rate has significant predictive power on both inflation and real activity and they also conclude that monetary policy is a determinant of term structure spread buy only determinant. Hence terms structure of interest rate is appropriate guide for conducting monetary policy.

Tzavalis and Wickens (1996) tried to forecast inflation using difference between m and n period long run Fisher equation as Mishkin (1990, 1991) did before. Model shows that term structure of interest rate has no predictive power on inflation. They argued that the usefulness of the term structure in forecasting inflation depends to a large extent on the information it contains about the error term in first model which is affected by the real interest rate, inflation innovations and a time varying term premium. To extract information in the term structure Tzavalis and Wickens construct an error correction model based on Johansen-type estimation of the variables that appear in the long-run Fisher equation. Findings show that the real interest rate seems to contain more information about future inflation than the slope of the yield curve may due to the sticky prices cause monetary shocks to have real effects in the short term, and nominal effects in the long term. The results also show that there is no support for that the longer the time horizon the more information the term spread contains about future inflation.

Gamber (1996), use combination of federal funds rate, terms structure of interest rate and output growth to exploit information about inflation. For four different time horizons which are determined based on monetary policy regimes, Gamber conduct six regression that each regression includes a constant, 6 lagged dependent variables and 6 lags of each of the other variables. He found that term structure of interest rate contains independent information about the inflation rate after Fed's announced policy change in 1979 and then the lagged yield curve slope failed to predict inflation. It is also found that the fed funds rate is a consistent and better significant predictor of inflation.

Ivanova at al (2000) studied the comparative performance of a number of interest rate spreads as predictors of the German inflation and business cycle in the post-Bretton Woods era. They used the two-regime Markov-switch model that regarded as a nonlinear filter which allows the dynamic behavior of the economy to vary between expansions and recessions in terms of duration and volatility. The results show that turning point of inflation can truly estimated by all term spreads. Especially long leads make term structure a good candidate for leading inflation.

Sahinbeyoğlu and Yalçın (2000) and Telatar at al (2003) try to extract information about inflation in Turkish economy by using term structure. Şahinbeyoğlu and Yalçın (2000) used exactly the same methodology of Mishkin. They found that found that term structure of nominal interest rates have a significant but, as a contrary to theoretical framework and previous studies, negative effects on future inflation path. They argued that the result may due to the immature financial market and lack of long maturities. On the other hand Taletar at al (2003) argued that because of the considered period is,1990–2000, a period of high inflation, high budget deficits, and political instability in Turkey, herewith the relationship between term structure of interest rate and inflation can be explained by using a time-varying-parameter model with Markov-switching heteroskedastic disturbances. The result of time varying model shows that there is limited information in term structure of interest rate, especially at longer horizons, about Turkish inflation path. It is also found that the intercept coefficient in the relationship between change in inflation and term structure of interest rates is time-varying.

Nagayasu (2003) add money growth and industrial production to Mishkin model to get improvement in prediction of Japanese inflation. He found that adding monetary growth cause improving in prediction but industrial production does not. On the other hand Trackz (2004) try to investigate threshold effect in relationship between inflation changes and terms structure of interest rate by relying on the foundation of Fisher equation. He used two-regime threshold model and found that significant thresholds emerge when the yield curve is relatively flat or inverted, and the relation between term structure and inflation is more obvious when spread below some threshold level.

Estrella at al (2003) use a binary response model to estimate relationship between term structure and inflation rate. They apply model to both German and USA economy. The result for German data show that the slope of yield curve is informative about the direction of future inflation changes for U.S, the information content of the term structure about the direction of future inflation changes are somewhat mixed.

4. THE OBSERVED RELATIONS BETWEEN TERM STRUCTURE OF INTEREST RATE AND REAL ECONOMIC ACTIVITY

It is very important to have information about future economic activity for all economic actors to make optimal investment plan and accurate policy. Many interested parties have searched for the variables that can help to get information about the future economic conditions. Recent research, some of them detailed in the following part, under the light of expectation hypothesis have shown that the term structure of interest rate helps to predict future real economic activity (Nakaota, 2005).

There are two main explanations for this empirical relationship. First explanation indicate that, term structure of interest rate reflect the aspect of monetary policy. When monetary policy tight, this leads to increase in short term interest rate. As expectation hypothesis state increase in short term interest rate causes the increase in long-term interest rate. However, because of the thinking tight monetary policy is relaxed in future, the long-run interest rates increase less than short-run. Thereof yield spreads narrows even become negative. High interest rate reduces the investment in economy especially in interest rate sensitive sectors and then it is experienced economic slowdown. In consequence, negative or small yield spread associated with economic slowdown in the future. The other explanation takes into account the expectations. It is stated that, yield spread reflects the market expectation about future economic growth. When it is expected to future economic growth this means that the real income increase. To take advantage of future economic growth businesses make investment by borrowing and issuing more bonds. Since investments are longer term issued bonds will also be longer term. Therefore, supply of long term bond increase and this leads to decrease in price of this bonds. As price of bonds and yields negatively related, long term yields increase. Because of this, yield spread increase and yield curve become steeper. Consequently, steeper yield curve or broader yield spread associated with future economic growth (Bonser and Morley, 1997).

On this basis, many papers are devastated to examine the predictive power of term structure on future real economic activity. In Table 2, there are some models, with used estimation techniques and the results, that in literature trying to construct and discover the relations between terms structure of interest rate and future economic growth.

Table 2: Litereture on analysing relations between term structure and real economic activity

Author Name	**Model**	**Estimation technique**	**Results**
Harvey, C.R. (1988)	$\Delta c_{t+1:t+j} = \alpha_0 + \alpha_1 S_j + \alpha_2 r_t + \varepsilon_{t,t+j}$ Δc : per capita growth in real consumption S_j : spread between j maturity and one maturity expected real yields r_t : expected real interest rate	**OLS**	The results showed that term structure of real interest rate contain information about consumption growth. Also term structure is a better predictor of consumption growth than lagged consumption growth and lagged stock return both in out sample and in sample tests.
Estrella, A. and Hardauvelis, A. G. (1991)	$y_{t,t+k} = \alpha_0 + \alpha_1 S_t + \sum_i^N \beta_i X_t + \varepsilon_t$ $y_{t,t+k}$: Percentage change of GNP from t to $t+k$ S_t : Spread between 10 year gov. bond and 3 month T-bill X_t: Other information variables	**OLS**	It is found that term structure can predict cumulative change of GNP up to 4 and marginal changes of GNP up to 1.5 years. It also has extra predictive power over to lagged output growth, lagged inflation, leading indicators index and level of real short term interest rate which all included in model by variable X personally. Term structure shows success both in sample and out sample forecast. Results also direct that predictive power of it improves with parallel to forecasting horizon.

Table 2: Literetture on analysing relations between term structure and real economic activity (*Contiune*)

Friedman, B. M. & Kuttner, K. N. (1991)	$\Delta Y_t = \alpha + \sum_{i=1}^{4} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{4} \delta_i \Delta P_{t-i} + \sum_{i=1}^{4} \lambda_i \Delta Z_{t-i} + \varepsilon_t$ Y_t : Natural logarithm of real GDP P_t : Natural logarithm of price deflator Z_t : First difference between 6 month commercial paper rate and 180 day T-bill rate	**OLS**	Results show that term structure of interest rate has significant relations with fluctuations in real output. There is not only significant explanatory power of the spread in equation for real output movements but also there is, at forecast horizons relevant in business cycle context, significant ability of the spread to account for the variance of real output.
Plosser, C.I. and Rouwenhorst, K.G. (1994)	$y(t,k) = \alpha + \beta S + \varepsilon$ (1) $y(t,k)$: Annualized growth rate of nominal and real consumption, and GNP one quarter to 1,2 and 3 years ahead S: Spread between long term gov.bond (≥ 10) and 3 months T-bill $y(t,k) = \alpha_0 + \alpha_1[i^k(t) - i^1(t)] + \alpha_2 i^1(t) + \alpha_3[i_w^k(t) - i_w^1(t)] + \alpha_4 i_w^1(t) + \varepsilon(k)$ (2) $y(t,k)$: Annualized growth rate of industrial production i^k = Domestic interest rate with k quarter i_w^k = World interest rate with k quarter	**OLS**	**(1)**Term structure contains significant information about output growth in U.S. It is usually found that term structure predict real variables better than these corresponding real variables in U.K, Canada, U.S and Germany. **(2)**World variables contribute to prediction.. It only makes go down the predictive power of model in Germany case. At the end it is also reached that economic activity of countries with lower and more stable inflation better predicted by term structure than who has high and volatile ones.

Table 2: Litereture on analysing relations between term structure and real economic activity (*Contiune*)

Gamber, E.N., (1996)	$L(6)Y_t = \alpha_0 + \alpha_1 L(6)S_t + \varepsilon_t$ (1) $L(6)Y_t = \alpha_0 + \alpha_1 L(6)S_t + \alpha_2 FF_t + \pi_t + \varepsilon_t$ (2) $L(6)Y_t = \alpha_0 + \alpha_1 L(6)FF_t + \alpha_2 S_t + \varepsilon_t$ (3) Y_t: Growth rate of industrial production $S_t = i_{10t} - i_{3t}$ S_t: slope of yield curve i_{10t}: yield on 10 years goverment security i_{3t}: yield on 3 months goverment security π : inflation FF : federal funds rate	**Gragner Causality Test**	Term structure of interest rate has predictive power of production growth. When FF is added to the model it is seen that predictive power of slope of yield curve diminishes. It is also reached that slope of yield curve has more predictive power of production growth than FF.
Bonser,C., Morley.R.N. and Morley.R.T(1997)	$\Delta y_{t:t+k} = \alpha + \beta S_t + \varepsilon$ (1) $\Delta y_{t:t+k} = \alpha_0 + \alpha_1 \Delta y_{t:t+k-1} + \beta S_t + + \varepsilon$ (2) Δy : percentage change in GDP S_j : spread between (usually)10 year gov. bond 3 months T-bill	**OLS**	Model (1) and (2) is applied to 11 industrialized countries. The result shows that term structure predict future change in real economic activity significantly for all 11 countries. For out of sample test term structure predict future change in growth better than legged GDP growth. And also it is found that when spread horizon rise, predictive power of yield curve also does.

Table 2: Litereture on analysing relations between term structure and real economic activity (*Contiune*)

Estrella, A. and Mishkin, F. S. (1997)	$y_t^k = \alpha + \beta S_t + + \varepsilon_t$ y: annualized growth in GDP $S_t = \alpha_0 + \sum_{i=0}^{6} \alpha_1 CB_{t-i} + \sum_{i=0}^{6} \alpha_2 Bill_{t-i} + \sum_{i=0}^{6} \alpha_3 Bond_{t-i} + \varepsilon_t$ $S_t = Bond - Bill$ $Bond$:10 years goverment security rate $Bill$:3 months goverment security rate CB :central bank rate	**OLS**	Model is applied to four major European economies (Germany, Italy, French, U.K,).Results show that term structure of interest rate predicts change in GDP significantly and except Italy, especially for horizon of 4 to 8 it seem to be highly significant.
Estrella, A. and Mishkin, F. S.(1998)	$y_{t+k} = \beta x_t + \varepsilon_t$ (1) $R_t = \begin{cases} 1, if\ y_t > 0 \\ 0,\ otherwise \end{cases}$ (2) *Estimated equatin is* $P(R_{t+k} = 1) = F(\beta' x_t)$ (3) y_t: occurance of recession at time t x_t: x_t: vector that include constant and independent variables such as interest rates spread, interest rate, stock price index monatary aggregates, GDP, CPI, and such individual macroeconomic indicators and index of leading indicator R_t is observable recession indicator	**ML**	The analyses focus on out of sample performance. Results show that in estimating future recession, stock prices are useful variables especially with one-to-three quarter horizons; however term structure of interest rates (10-year gov. bond minus 3-month T-bill) emerges as the clear individual choice and typically performs better by itself out of sample than in conjunction with other variables. As to specific conclusions, the yield curve spread and stock price index seem as the most useful simple financial indicator.

Table 2: Litereture on analysing relations between term structure and real economic activity (*Contiune*)

Peel,D. A. and Taylor, M P. (1998)	$\Delta y_{t+k} = \alpha + \beta S_t + \eta_{t+k}$ y_t : logarithm of real GDP at time t S_t : difference between 10 year gov. bond and 3 months T-bill η_{t+k}: forecast error that has a moving avarage representation of order k-1	**OLS**	It is found that term structure of interest rates has significantly predicted the future change in cumulative GDP growth. Especially for five and six quarter horizon predictive power of term structure is greatest where %28 percent of variation in cumulative GDP is explained by term structure.
Ivanova, D., Lahiri, K. and Seitz, F. (2000)	First order Markow process $P(S_t = j / S_{t-1} = i, S_{t-2} = k....)$ $= P(S_t = j / S_{t-1} = i) = p_{ij}$ EM algorithm $P(y_1, y_2, ... y_T : \lambda, y_0)$ $= \sum_{S_1=1}^{2} .... \sum_{S_T=1}^{2} P(y_1, y_2, ... y_T, S_1, ...S_T : \lambda, y_0)$ estimated parameters:$\lambda(\mu_1, \mu_2, \sigma_1^2, \sigma_2^2, p_{11}, p_{22})$ p_{ij} transition probabilty S_t: unobservable state which is 1 or 0 y_t: underlying spread, to be leading indicator of the business cycle	**EM Algorithm**	Results show that except bank-public spread all others based on the call rate predict all recessions with a comfortable lead, although they lagged some of the recoveries by a few months. On the other hand although bank-public spread detect the last two recoveries with an average lead of nearly 12 months, it generates a series of false signals.

Table 2: Literetures on analysing relations between term structure and real economic activity (*Contiune*)

Galbraith, J.W., and Tkacz, G. **(2000)**	$\Delta y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + \sum_{j=0}^{k} \lambda_j \Delta g_{t-j} + \lambda \omega_{t-1} + \nu \varpi_{t-1} + \varepsilon_t$ y_t : the logarithm of real GDP g_t : logarithm of real government expenditure ω_t : function of the spread where $\mathrm{I}[\omega_{t-1} \le \tau] = \begin{cases} 0, \text{ for } \omega_{t-1} > \tau \\ 1, \text{ for } \omega_{t-1} \le \tau \end{cases}$ where τ is the threshold parameter ϖ_t : treshold variable that is $\varpi_{t-1} = \omega_{t-1}\mathrm{I}[\omega_{t-1} \le \tau]$	**ML**	Model is applied to the G-7 countries data. It is concluded that term structure of interest rate predict change in output in all G-7 countries except Japan.
Gertler, M. and Lown, C. S. (2000)	$Y_t = \alpha + \beta_1 Y_{t-4} + \beta_1 S_{t-4} + \varepsilon_t$ Y_t : output gap S_t : spread between high yield gov. bond and corresponding rate of highest quality firms	**VAR**	Predictive power of spread between high yield gov. bond and corresponding rate of highest quality firms, compared with spread between commercial paper rate and T-bill, term spread, oil prices, M2 growth and Federal funds rate by adding all variables four lagged to the VAR model. It is reached that, high yield spread has had significant explanatory power for the business cycle and also since mid 1980 the high yield spread outperforms the term spread, the paper-bill spread and the Federal Funds rate.

Table 2: Litereture on analysing relations between term structure and real economic activity (*Contiune*)

Chauvet,M. and Potter, S. (2002)	$Y_{t+k} = \alpha + \beta S_{t-K} + \sigma(t)\varepsilon_t$ (1) *where* $\sigma_n = \sigma(t)$ if $t_{n-1} < t < t_n$ Hitting probabilities $\pi(t,k) = \Phi_n[\alpha + \beta S_{t-K+k}]\prod_{s=1}^{k-1}\{1 - \Phi_n[\alpha + \beta S_{t-K+k}]\}$ (2) *where* $\Phi_n[\alpha + \beta S_t] = \Phi_n[(\alpha + \beta S_t)/\sigma_n]$ Y_t : represents the state of the economy S_t : spread between the 10-year and 3-month T-Bill rates Φ is the cumulative distribution function of the standard normal distribution	**ML**	It is established more general specification of standard probit model. It is found that this more general form has a much better in sample fit than the original probit model of EM. As in all specifications, yield curve is signaling weak future economic activity in 2000-2001, it changes from model to model the strength of the recession signals.
Estrella, A., Rodrigues, A. P. and Schich, S. (2003)	Model Linear $y_t^{(j,k)} = \alpha + \beta(i_t^q - i_t^n) + \varepsilon$ (1) y_t : cumulative growth, marginal growth i_t : nominal yield Probit Model $P(R_{t+k}^j = 1) = F(\alpha + \beta(i_t^q - i_t^n))$ (2) R is recession indicator	**OLS** **ML**	Linear model significantly predict the both marginal and cumulative growth for both Germany and U.S. It is also concluded that marginal results diminishes as forecast horizon increase but cumulative result become better as horizon lengthen. Probit model, although the results change for Germany and U.S, and marginal result cumulative result, predict recession significantly. One of the main conclusions is that there is no evidence of instability at any horizon, for any maturity combination, for either country.

Table 2: Litereture on analysing relations between term structure and real economic activity (*Contiune*)

Paya, I., Venetis, I. A. and Peel, D. A. (2004)	$\Delta y_t = \alpha_0 + \beta_0 s_{t-1} + (\alpha_1 + \beta_1 s_{t-1})(1+\exp[-\gamma(s_{t-d} - c)/\sigma_{st\text{-}d}])^{-1} + \varepsilon_t$ y_t : log of seasonally adjusted real GDP s_t : spread between 10-year gov. bond and 3-month T-bill γ : slope parameter c : location parameter σ_{st} : standart deviation	**NLS**	Threshold effects exist for a number of forecasting horizons affecting the power of the spread as a leading indicator while linear or nonlinear specifications are not free of parameter time-variation. It is observed that when the spread was above the threshold, its effects on output growth are significantly lower and for medium run forecasting horizons it is insignificant.
Jardet, C. (2004)	$\Delta^k y_t = \alpha + \beta(r_{t-k-1} - i_{t-k-1}) + \eta_t$ y_t : logarithm of the level of real monthly GDP at time t r_t : long term bond yield i_t : short term interest rate k is forecast horizon	**OLS**	The slope coefficient is strongly significant for all horizons. In addition, according to the R square criteria, the largest predictive power is at the 1 year forecast horizon, where, 33% of the variation in the annual growth rate of GDP is explained by the slope of the yield curve. But after determining a break (securitization process) and dividing sample into two after break and before break, model reached different conclusion. Before break slope coefficient significant for all horizon, but after break slope coefficient not significant for all horizon anymore that highest R square observed is %16.

Table 2: Litereture on analysing relations between term structure and real economic activity (*Contiune*)

Bordo, M. D. and Haubrich, J. G. (2004)	$\Delta Y_{t+4} = \alpha + \beta S_t + \gamma(L)\Delta Y_t$ Y_t : annual growth rate of real GNP at a quarterly frequency S_t : spread between corporate bonds and commercial paper $\gamma(L)$ is a lag polynomial	**ML**	As a first, equation is estimated on the entire sample (1875-1997), and then it is divided into sub sample and estimated. It is found that spread is well predictor of output growth and improves predictive ability of regression in sample results. However it does not show the same impressive performance for out of sample results.
Giacomini, R. and Rossi, B. (2005)	$Y_{t+k} = \alpha + \beta S_t + +\varepsilon_{t+k}$ Y_t : Changes in industrial production S_t : spread between long-term and short-term bonds	**ML**	It is considered various maturities, namely 5 and 3 years for the long rate and 1, 3 and 6 months for the short term rate. They found that terms structure of interest rate predict output changes but predictability vary over time.
Nakaota, H. (2005)	$y_t^k = \alpha_0 + \alpha_1 d_t + \alpha_2 S_t + \alpha_3 Sd_t + \varepsilon_t$ y_t : the annualized industrial production growth over the next k months d_t : dummy variables on constants S_t: difference between 5-year government bond rate and the 1-month bond and debenture rate Sd_t: dummy variables on spread	**OLS**	Without structural break there seems no relation between term structure and future economic activity. With dummies, it is observed that the term structure of interest rate is helpful for forecasting real GDP growth up to 2 years ahead.

Table 2: Litereture on analysing relations between term structure and real economic activity (*Contiune*)

Ang, A., Piazzesi,M. and Wei, M. **(2006)**	$X_t = \mu + \Phi X_t + \sum \varepsilon_t$ $where\ X = (y_t^m, (y_t^n - y_t^m), g_t)$ y_t^m : *yield* on securities with maturity m quarter g_t : quarterly GDP growth	**VAR** **GMM**	Model constructed under the assumption of no arbitrage. It is reached that model can easily estimate the GDP growth and show better performance than standard term structure models. Also imposing no arbitrage leads to predict GDP growth out of sample better than OLS. As it is found before, long maturity differences predict GDP growth best. However short interest rate dominates the slope of the yield curve in and out of sample in forecasting GDP growth.

Harvey (1988), tried to find the relationship between expected real term structure and expected consumption growth by following the claim of consumption based asset pricing model which assert that there is linear relationship between expected returns and expected consumption growth**.** Harvey divided estimation period into two sub period and he found that real term structure has more information and more predictive power than lagged consumption growth and lagged stock return which are most used variables in both period but evidence is strong for 1970s and 1980s.

Estrella and Hardauvelis (1991), Friedman and Kutner (1991), Plosser (1994), Bonser at al (1997), Estrella and Mishkin (1998), Peel and Taylor (1998), Estrella at al (2003), Bordo and Haunrich (2004), Giacomini and Rossi (2005) look at linear relationship between term structure of interest rate and output growth.

Estrella Hordauvelis (1991) found that term structure has more information and predictive power than lagged output growth, lagged inflation, leading indicator index and level of real short term interest rate. Plosser (1994) applied his model to U.S, U.K, Canada, and Germany. He found that term structure contain significant information about output growth especially for U.S. Plosser also add term structure of world interest rate to his model as a explanatory variable. He concluded that world variables contribute to prediction. He also reached that term structure predict economic activities better in the countries with stable and lower inflation rate.

Friedman and Kutner (1991), look at the relationship between spread between 6 month commercial paper rate and 3 month T-bill rate. They found that spread not only has explanatory power but also spread widens in business cycles period and narrow in recovery period.

Bonser at al (1997) applied linear model to 11 industrialized countries and they found that term structure significantly predict future change in output growth in all 11 countries. Estrella and Mishkin (1997) applied the linear model to four EU countries which are Germany, Italy, French and U.K. They also found that term structure of interest rates predict change in GDP significantly for all countries except Italy and relationship was broken in U.S in 1979.

Bordo and Haunrich (2004) aim to bring historical evidence that yield curve predict future inflation. They use spread of two risky asset corporate bonds and commercial paper under the assumption of that the differences in risk between the two securities do not dominate the term spread, instead of riskless assets government bond and T-bill because of the unavailable data. They found that as spread between corporate bond and commercial paper predict future output growth in period of 1875 and 1997 in U.S. Additionally they reached that predictability varies over time and predictability is better in period of the regime of low credibility i.e. high persistence of inflation.

Estrella and Mishkin (1998) use probit model to examine the information contained by term structure of interest rate about recession. Estralla at al (2003) applied to probit model for both U.S and Germany data.

Estrella and Mishkin (1998) examine out of sample performance of term structure of interest rate, stock prices and monetary aggregates as predictor of recessions in U.S economy. As it is known in probit model the variable which is predicted take only two values. Model is defined in reference to a theoretical linear relationship in the form of $y_{t+k} = \beta x_t + \varepsilon_t$ where y_{t+k} is unobservable determinant of recession at time *t* with *k* forecast horizon. Estrella and Mishkin take into account 27 different variables as explanatory variable x_t which include spread between 10 year government bond and 3 month T-bill, commercial paper rate, stock prices, monetary aggregates, indexes of leading indicator and individual macro indicator such as growth in real GDP, inflation rate, consumer expectation etc. They found that term structure of interest rate and stock prices did their job very well. They argued that over fitting very serious problem in macroeconomic predictions and when using a few variables in prediction adding another single variable or lagged variable reduce the prediction power of the model. Additionally in out of sample term structure of interest rate show best performance except one quarter forecast horizon.

The other paper belongs to Estrella at al (2002) in which used both linear and probit model for the main aim of testing stability of predictive power of yield curve. By using probit model they found that term structure of interest rate has prediction power for recession. In addition to this they argued that probit model show better performance than continuous one both in prediction and stability performances.

Chauvet and Potter (2000) used standard Gibbs sampling method to evaluate hidden properties of probit model with the same structure as Estrella and Mishkin (1998) used which implicitly implies that spread variable capture dependencies in the latent variable. They aim to estimate the effects of structural breaks on the probability of recession from probit models. They found that this more general form of probit model shows better performance than original one. On the other hand they concluded that there is uncertainty over the value of recession probabilities that may due to the different character of business cycles.

Galbraith and Tkacsz (2000), examined the link between yield spread and output, and tested, in the form of threshold effect, to possible existence of asymmetries. They test whether impact of the yield spread on the conditional expectation of output growth is greater on one side of the threshold than on the other or not. Therefore existence of asymmetry in here implied that the information content of the spread cannot be fully exploited in a linear model. They use G-7 countries data. As it usual they found that term structure of interest rate has predictive power on output changes in G-7 countries except Japan (Nakatoa (2005) had found yield spread-output link for Japan). However, results show that there is not enough evidence of asymmetric effects of yield spread outside U.S and Canada.

Paya at al (2004) analyzed standard linear and nonlinear behavior of the information content and asymmetry in the spread for future real economic activity. It is found that both linear and nonlinear (threshold autoregression) models has significant predictive power over nine and four different industrial production sectors in the US and UK. Results showed that there is a significant superior performance of nonlinear model for U.S. Empirical evidence indicated that the relationship between term structure and real economic activity exhibits asymmetries that allow for different predictive power of the spread when past spread values were above or below some threshold value.

Nakaota (2005), examined the relationship between term structure of interest rate and real economic activity in Japan. Under the assumption of information content of term structure is time invariant, Nakaota can not reach any relationship between spread and economic activity. Taking into account of considered relationship may change over time, Nakaota added dummy variable (which take zero value until the time structural change took place) to the standard linear model and he found that yield spread forecast real GDP growth up to 2 years ahead.

Ang at al (2006) construct a dynamic model for GDP and yield curve for forecasting GDP growth under the assumption of no arbitrage. They set the model in discrete time and select and collect number of factors to summarize information carried on whole yield curve in a vector which follows Gaussian Vector Autoregression. After estimating parameter firstly with standard SUR and then GMM, they jointly modeled the yield curve factors and output growth. Firstly they found that maximal maturity difference is the best measure of slope. Secondly, the nominal short interest rate dominates the slope of the yield curve in and out of sample in forecasting GDP growth. Finally, imposing no-arbitrage restrictions allow predicting GDP out-of-sample better than OLS.

5. THE POLICY EFFECTS ON PREDICTIVE POWER OF TERM STRUCTURE OF INTEREST RATE

Gamber (1996) investigates that whether forecasting ability of term structure is solely due to its relationship to monetary policy or whether it contains independent information about change in future inflation and output. He firstly use Gragner causality test to see whether information contained in variables (including yield curve, federal fund rate, lagged output growth) change systematically with monetary regimes. Secondly by using Fed reaction function he tried to information content of yield curve under different monetary regimes. Gamber investigate 3 different monetary regime period and at the and conclude that terms structure of interest rate has independent predictive power only when FED does not react to change in that variable.

Kim and Limpaphayom (1997) used bivariate term structure model that

$$\Delta GDP_{t+k} = \alpha + \beta S_t + \varepsilon_{t+k}$$

where

ΔGDP_{t+k} : cumulative quarterly Gross Domestic Product growth k quarters ahead

S_t : spread between long-term and short-term bonds

Model applied to two different periods for Japanese economy to emphasize policy effects on predictive power of term structure of interest rate. Sub-periods constructed by considering the considerable policy changes during Japanese economy that in first period authorities tightly regulated the all aspects of the financial system by controlling interest rates and restricting financial market activities, and in second sub-period, that is more market driven period, liberalization policies present and interest rate deregulated

Kim and Limpaphayom (1997) found that in first period term structure of interest rate contains almost no information about future output growth but in second sub period it predicted the future output growth significantly. Hence policies toward economy highly affect the predictive power of term structure of interest rate.

Peer and Ioannidis (2003), test the structural stability of the forecasting output growth by using terms structure as a regressor. Following the logic of Estrella, they estimated the equation of

$Y_t = \alpha + DY_{t-1} + \beta S_{t-1} + DS_{t-1} + \varepsilon_t$

where Y_t is changes in real output, S_t is Spread between long-term and short-term bonds

and D= $\begin{cases} 1 \text{ when anti-iflation regime is on} \\ 0 \text{ otherwise} \end{cases}$

Model is estimated by ARCH(1) and OLS. The result supports the theoretical prediction that, as the anti-inflation policy is on, predicative ability of term structure of the interest rate decreases.

Bordo and Haubrich (2004), after detecting the relationship between term structure of interest rate and output growth by using data since 1875, look at the effects of inflation persistence (i.e. monetary regime) on predictive power of term structure. They look at the correlation between term structure and persistence, and regress the spread against measures of persistence. At the end it is found that when credibility is low, inflation persistence is high, predictive power of term structure is also high. Theoretically when persistence is high, both short and long rate increase with inflation but if the reverse is present long rate does not increase as short rate does.

Estrella at al (2003), test the stability of predictive models which are explained before. It is used GMM in testing stability of both binary and linear model for both country U.S and Canada. The results of stability test of equation for predicting inflation differs between models used to predict. It is found that there is evidence of instability and further there is more evidence of instability in the case of the continuous variable than in the case of the binary variable. In stability test of equation for predicting real activity, it is detected instability also but was less than equation for inflation. It is also found that binary model is more stable than continuous one again. It is concluded that the changes in predictive power of model may be because of the different monetary policy regimes.

Estrella (2005) states that "If monetary policy is essentially reactive to deviations of inflation from target and of output from potential, the predictive relationships for output and inflation depend primarily on the magnitudes of the reaction parameters. If the monetary authority optimizes systematically to achieve certain goals with regard to inflation and output variability, the predictive power of the yield curve is more directly dependent on the structure of the macro economy."

Estrella's model consist of five known structural equation which are Philips curve, IS curve, Monetary Policy Reaction Function, Fisher Equation and Expectation Hypothesis.

$$\pi_{t+1} = \pi_t + \alpha y_t + \varepsilon_{t+1} \qquad (\textit{Philips curve})$$
$$y_{t+1} = b_1 y_t - b_2 \rho_t + \eta_{t+1} \qquad (\textit{IS curve})$$
$$r_{t+1} = g_r r_t + g_\pi \pi_{t+1} + g_y y_{t+1} + (1 - g_1 - g_2)\pi^* \qquad (\textit{Monetary Policy } \mathrm{Re}\textit{action Function})$$
$$R_t = \rho_t + 0.5(E_t \pi_{t+1} + E_t \pi_{t+2}) \qquad (\textit{Fisher Equation})$$
$$R_t = 0.5(r_t + E_{t+1} r_{t+1}) \qquad (\textit{Expectations Hypothesis})$$

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*, π^* is the inflation target in period *t*, E_t is the rational expectations operator based on period *t* information and ε_t, η_{t+1} are i.i.d. random variables.

Estrella derived from those five equations following reduced form of equations

$$E_t y_{t+1} = \frac{2}{g_y}(R_t - r_t) + \frac{1 - g_r}{g_y}(r_t - \pi^*) + \frac{g_\pi}{g_y}(\pi^* - \pi_t - a y_t) \qquad (5)$$

$$\frac{1}{2} E_t \Delta \pi_{t+2} = \frac{a}{g_y}(R_t - r_t) + \frac{a(1 - g_r)}{g_y}(r_t - \pi^*) + \frac{a g_\pi}{2 g_y}(\pi^* - \pi_t - a y_t) \qquad (6)$$

And

$$E_t y_{t+1} = \frac{2 b_2 (R_t - r_t) + b_1 y_t}{a b_2 + 2(1 + 2b_1)(1 - \mu) + 2 b_1 \mu_y} \qquad (7)$$

When the Central bank is only concerned with output deviations ($g_\pi = 0$) the coefficient linking expected future output and the spread in the reduced form is given by ($2/g_y$). On the other hand when the Central Bank only targets deviations of inflation from target ($g_y = 0$) the coefficient on the spread in the reduced form is zero. Intuitively, from the Phillips curve expected changes in inflation will be zero if the Central Bank concern only with inflation targeting because expected inflation will equal target inflation. Hence the spread has no predictive power for future changes in inflation and in the model no predictive content for future changes in real output.

Conclusion is that the extent to which the yield curve is a good predictor depends on the form of the monetary policy reaction function, which in turn may depend on explicit policy objectives. Thus, the predictive relationships, though robust, are not structural. For instance, when the monetary authority reacts only to output fluctuations and focuses on the change in the interest rate, rather than its level, the yield curve is the optimal predictor of future output. At the other extreme, if the policy reactions to both inflation and output deviations approach infinity, the predictive power of the yield curve disappears.

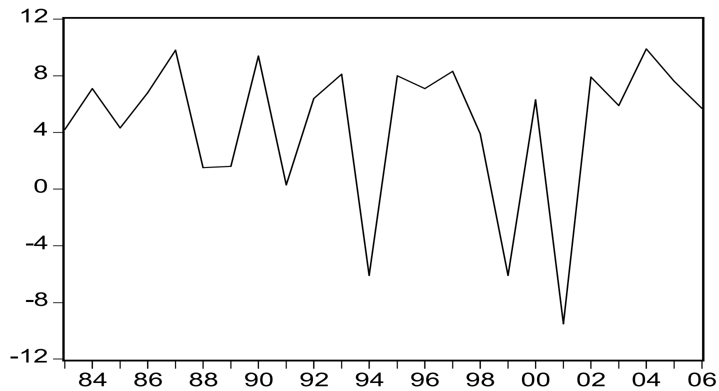
Empirical estimates using annual US data confirm the implications of the model and shed some light on changes in monetary policy regime. In particular, the period since 1987 seems to be consistent empirically with the implications of strict inflation targeting in the theoretical model.

Giacomin and Rossi (2005) aims to find whether there was breakdowns in forecasting ability of the term structure of interest rate in predicting output changes in U.S. They considered various maturities, namely 5 and 3 years for the long rate and 1, 3 and 6 months for the short term rate. By using Elliott and M. Üller’s (2003) J-test, they found that there is structural break in the predictive relationship between the yield curve and output growth especially in 1970s and 1980s. They also found that structural breakdown linked to monetary policy changes in Fed’s preference parameters.

6. DOES TERM STRUCTURE OF INTEREST RATE INCLUDE INFORMATION ABOUT REAL ECONOMIC ACTIVITY IN TURKEY

It is very interesting to examining the relationship between term structure of interest rate and real economic activity in Turkish economy because of the structure of financial market, and unstable economic history of Turkey. Although last two decade it is experienced widespread liberalization process, financial markets has not reached adequate deepness yet and the Turkish economy has been experienced high and persistent inflation until 2000's (Sahinbeyoğlu and Yalçın, 2000 ; Telatar at al, 2003). After 1983, the volatility of annual GDP growth rates increased substantially. Events such as the 1990–1991 Persian Gulf crisis, the 1994 Turkish financial crisis, the 1998 Russian and Asian crisis, two earthquakes in 1999, the 2000–2001 financial and banking crisis and 2000-2002 disinflation and economic restructuring program which failed in early 2001 contributed to rising output volatility in the economy (Dibooglu and Kibritcioglu, 2004).

Figure 3: Annual growth rate of GNP in Turkey during 1983-2006



Sources: Turkish Statistical Institute

Figure 4: Annual inflation rate in Turkey during 1983-2006

Sources: Turkish Statistical Institute

As we introduced before most of the studies for term structure of interest rate conducted for developed economies and deep financial markets such as U.S.A, U.K, Canada, Germany, Japanese. In the literature there are two term structure studies for Turkish economy and both of them examine the information content of term structure about inflation. There is also an unpublished master thesis of Eraslan (2005) examined the information content of term structure of interest rate about recession by using standard probit model. In this study it is found that term structure of interest rate has little information for recession and the information content change according to the periods which is determined by monetary policy.

6.1 Autoregressive Distributed Lag Model (ARDL)

Cointegration techniques, developed by Engle and Gragner (1987), Johansen and Joselius (1990), employed previous studies require that all variables are integrated in same order. However autoregressive distributed lag model (ARDL) bound test approach to cointegration (Pesaran et al., 2001) does not require that all variables are integrated same order (Kollias et al 2006; Karaca 2005).

ARDL is the major workhorse in dynamic single-equation regressions. The ARDL modeling approach is popularized by, Pesaran and Smith (1998), Pesaran and Shin (1999), and Pesaran *et al.* (2001). The main advantage of this approach lies in the fact that it can be applied irrespective of whether the variables are I(0) or I(1). Another advantage of this approach is that the model takes sufficient numbers of lags to capture the data generating process in a general-to-specific modeling framework. Moreover, a dynamic error correction model (ECM) can be derived from ARDL through a simple linear transformation. The ECM integrates the short-run dynamics with the long-run equilibrium without losing long-run information. It is also argued that using the ARDL approach avoids problems resulting from non-stationary time series data (Shrestha, 2005).

To illustrate ARDL modeling approach, let consider the simple model as follows:

$y_t = \alpha + +\beta_1 x_t + \varepsilon_t$ where y_t and x_t are two different time series and ε_t is error term.

ARDL (*p,q*) model without trend for this simple model is :

$$\Delta y_t = \alpha + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \sum_{i=0}^{q} \delta_i \Delta x_{t-i} + \lambda_1 y_{t-1} + \lambda_2 x_{t-1} + \upsilon_t$$

Where α is drift component and υ_t are white noise errors. The first part of the equation with β and δ represents the short run dynamics of model and the second part of the equation with λ 's represents the long-run dynamics of the model. If the all λ 's are zero it means that there is no long-run relationship between variables.

6.2 Testing the Relationship Between Term Structure of Interest Rate and Real Economic Activity in Turkey: ARDL Model Approach

Many studies in the literature showed that there are strong relationship between term structure of interest rate and real economic activity**.** As depicted above main findings show that steepness of yield curve is positively related with future growth of real economy. To examine the relationship between term spread and real economic activity in Turkey the following relationship is examined:

$$y_t = \alpha + \beta_1 s_t + \varepsilon_t \qquad (8)$$

Where y is growth of seosanally adjusted industrial production index, s is term structure of interest rate and ε is error term. The data are monthly and range from April 1991 to November 2006. The first series monthly industrial production index is obtained from IMF's International Financial Statistics 2006 CD Room. The other series are Treasury bond interest rates of term 30, 60, 90, 120, 180, 270 and 360 days taken from Istanbul Stock Exchange database as a daily interest rate and obtained with interpolation method by Prof. B. Saltoğlu. Thanks to Prof. Saltoğlu to allow us to use his data. Mainly because of the lack of deep financial market and high risk in Turkey, term length not being much long. On the other hand, financing budget deficit by issuing treasury bonds and bills cause the term lengths stay short in Turkey (Şahinbeyloğlu and Yalçın, 2004). However although one year very short term according to 10 years, which is mainly used in term structure papers due to the plenteous information content, it can be bear in mind that it is Turkey's long term.

Table 4: Unit Root Test Results

	ADF*(0)	ADF(1)	ADF(2)	ADF(3)	ADF(4)	ADF(5)	ADF(6)	ADF(7)	ADF(8)
y	-19.24 (0.0000)[sic]	-12.808 (0.0000)	-9.920 (0.0000)	-9.694 (0.0000)[aic]	-8.791 (0.0000)	-7.072 (0.0000)	-6.269 (0.0000)	-5.625 (0.0000)	-4.982 (0.0000)
s_360_30	-3.357 (0.0138) [sic,aic]	-2.893 (0.0480)	-2.775 (0.0638)	-2.744 (0.0686)	-2.507 (0.1154)	-2.197 (0.2082)	-2.054 (0.2636)	-1.761 (0.3986)	-1.798 (0.3803)
s_360_60	-3.428 (0.0112)[sic]	-2.841 (0.0545)	-2.270 (0.1828)[aic]	-2.360 (0.1545)	-2.516 (0.1131)	-2.104 (0.2431)	-2.284 (0.1781)	-1.879 (0.3415)	-1.898 (0.3325)
s_360_90	-3.719 (0.0045)[sic]	-3.310 (0.0158)	-2.553 (0.1046)[aic]	-2.574 (0.1000)	-2.701 (0.0757)	-2.444 (0.1310)	-2.518 (0.1127)	-2.219 (0.2001)	-2.272 (0.1821)
s_360_120	-3.849 (0.0029)	-3.613 (0.0063)[sic,aic]	-2.985 (0.0382)	-2.873 (0.0504)	-3.007 (0.0361)	-2.548 (0.1058)	-2.706 (0.0748)	-2.400 (0.1432)	-2.433 (0.1340)
s_360_180	-4.535 (0.0002) [sic]	-3.820 (0.0033)	-3.775 (0.0038)	-3.245 (0.0190)	-3.639 (0.0059) [aic]	-3.220 (0.0204)	-3.447 (0.0106)	-3.007 (0.0360)	-3.123 (0.0266)
s_360_270	-6.845 (0.0000)[sic]	-5.784 (0.0000)	-5.450 (0.0000)	-4.033 (0.0016)	-4.408 (0.0004)[aic]	-3.740 (0.0042)	-3.653 (0.0056)	-3.417 (0.0116)	-3.444 (0.0107)
s_270_30	-3.510 (0.0087)[sic]	-2.854 (0.0528)[aic]	-2.877 (0.0499)	-2.802 (0.0598)	-2.608 (0.0931)	-2.351 (0.1572)	-2.096 (0.2465)	-1.794 (0.3822)	-1.839 (0.3605)
s_270_60	-3.650 (0.0057)	-3.092 (0.0288)	-2.293 (0.1753) [sic,aic]	-2.339 (0.1608)	-2.432 (0.1342)	-2.288 (0.1768)	-2.175 (0.2162)	-1.833 (0.3635)	-1.704 (0.4275)
s_270_90	-3.959 (0.0020)	-3.894 (0.0025)	-2.433 (0.1340) [sic,aic]	-2.610 (0.0927)	-2.509 (0.1148)	-2.552 (0.1049)	-2.276 (0.1809)	-2.022 (0.2772)	-2.013 (0.2811)
s_270_120	-4.015 (0.0017)	-4.086 (0.0013)	-2.713 (0.0736)[sic]	-3.013 (0.0355)[aic]	-2.871 (0.0508)	-2.595 (0.0957)	-2.378 (0.1493)	-2.008 (0.2831)	-2.107 (0.2423)
s_270_180	-4.992 (0.0000)[sic]	-4.391 (0.0004)	-3.475 (0.0097)	-3.192 (0.0220)	-3.743 (0.0042)	-3.589 (0.0069)	-3.173 (0.0232)	-2.564 (0.1024)[aic]	-2.594 (0.0959)
s_180_30	-3.938 (0.0022)	-3.057 (0.0317)[sic]	-3.260 (0.0182)	-3.479 (0.0096)	-2.788 (0.0619)[aic]	-2.524 (0.1114)	-2.505 (0.1158)	-2.271 (0.1823)	-2.403 (0.1421)
s_180_60	-3.720 (0.0045)	-2.962 (0.0405)[sic]	-2.458 (0.1274)	-2.779 (0.0631)[aic]	-2.495 (0.1182)	-2.585 (0.0977)	-2.400 (0.1432)	-2.280 (0.1794)	-2.015 (0.2799)
s_180_90	-4.516 (0.0003)	-4.103 (0.0012)	-2.798 (0.0604) [sic,aic]	-2.682 (0.0790)	-2.461 (0.1267)	-2.614 (0.0919)	-2.498 (0.1175)	-2.335 (0.1619)	-2.163 (0.2206)
s_180_120	-5.122 (0.0000)	-4.248 (0.0007)	-3.188 (0.0222)[sic]	-3.025 (0.0344)	-2.520 (0.1123)[aic]	-2.601 (0.0945)	-2.353 (0.1565)	-2.124 (0.2355)	-2.197 (0.2080)
s_120_30	-4.847 (0.0001) [sic,aic]	-4.076 (0.0013)	-4.094 (0.0013)	-3.615 (0.0063)	-2.992 (0.0374)	-2.918 (0.0452)	-2.851 (0.0532)	-2.618 (0.0910)	-2.798 (0.0605)
s_120_60	-4.641 (0.0002)	-3.335 (0.0147)[sic]	-2.769 (0.0647)[aic]	-2.649 (0.0851)	-2.554 (0.1045)	-2.692 (0.0772)	-2.558 (0.1036)	-2.634 (0.0880)	-2.496 (0.1181)
s_120_90	-6.597 (0.0000)	-5.040 (0.0000)**sic**	-3.520 (0.0085)	-3.104 (0.0279)	-2.542 (0.1072)	-2.916 (0.0454)	-2.643 (0.0862)	-2.866 (0.0513)	-2.311 (0.1694)[aic]
s_90_30	-5.836 (0.0000) [sic,aic]	-5.297 (0.0000)	-4.968 (0.0000)	-4.205 (0.0009)	-3.617 (0.0063)	-3.512 (0.0087)	-3.372 (0.0132)	-2.838 (0.0550)	-3.036 (0.0335)
s_90_60	-7.077 (0.0000)	-4.439 (0.0004)[sic]	-3.602 (0.0066)[aic]	-3.291 (0.0167)	-2.837 (0.0550)	-3.063 (0.0312)	-2.840 (0.0547)	-2.845 (0.0541)	-2.502 (0.1166)
s_60_30	-6.887 (0.0000) [sic,aic]	-5.842 (0.0000)	-5.595 (0.0000)	-5.183 (0.0000)	-4.195 (0.0009)	-3.784 (0.0037)	-3.929 (0.0023)	-3.188 (0.0223)	-3.244 (0.0191)

Note: The null hypothesis is variables have a unit root.
*Augmented Dickey-Fuller (ADF).
The values in parenthesis are **p values**.
y =First difference of natural logarithm of industrial production index which is seasonally adjusted by Tramo/Seats. Include in test equation: only intercept
s_M_N= Spread between M days interest rate and N days interest rate. Include in test equation: only intercept
AIC: Akaike Info Criterion (Max lag=8)
SIC: Schwarz Info Criterion (Max lag=8)

Table 3 shows the Augmented Dickey- Fuller test results for industrial production growth and all yield spreads, and the lags that are chosen by the Akaike Information Criterion (AIC) and Schwartz Information Criterion (SIC). P values are in parenthesis. As it can bee seen in the table, industrial production growth is stationary which means I(0). On the other hand, yield spreads shows indefinite results. Some of them seems I(0) and some of them seems I(1). At this point ARDL bounding test approach came to allow us to make cointegration analysis irrespective of whether all variables are integrated same order or not.

The ARDL(*p,q*) model for equation (8) is following:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + \sum_{i=0}^{q} \delta_i \Delta s_{t-i} + \lambda_1 y_{t-1} + \lambda_2 s_{t-1} + \upsilon_t \qquad (9)$$

In the equation (9) the terms with summation signs represents the error correction dynamics and the terms with the λ represents the long-run relationship. To test the non-existence of long-run relationship between growth of industrial production index and term structure of interest rate two separate bond test applied. In the first step it is used *F*-test for the null hypothesis $\lambda_1 = \lambda_2 = 0$ and t-test for the null hypothesis of $\lambda_1 = 0$. Rejecting the null hypothesis will lead to reach stable long-run relationship between term structure of interest rate and growth of industrial production. For ARDL(*p,q*) model the we get long-run relationship such that:

$$y_t = \alpha + \sum_{i=1}^{p} \beta_i y_{t-i} + \sum_{i=o}^{p} \varphi_i s_{t-i} + \upsilon_t \qquad \text{Then}$$

$$y_t = \alpha + \beta_1 y_{t-1} + \beta_2 y_{t-2} + ... + \beta_p y_{t-p} + \varphi_0 s_t + \varphi_1 s_{t-1} + ... + \varphi_q s_{t-q} + \upsilon_t$$

Thus long run relationship is $\tilde{y}_t = \frac{\alpha}{1-(\beta_1+\beta_2+...\beta_p)} + \left(\frac{\varphi_0+\varphi_1+...\varphi_q}{1-(\beta_1+\beta_2+...\beta_p)}\right)\tilde{s}_t + \upsilon_t$ (10)

where $\left(\frac{\varphi_0+\varphi_1+...\varphi_q}{1-(\beta_1+\beta_2+...\beta_p)}\right)$ is long-run effect of s_t on y_t.

To estimate long-run coefficients, firstly it is required to estimating equation (9) by OLS. Optimal number of lagged differences determined s_t is regressed on y_t by using maximum 8 lag for each variable, and then model is selected by AIC, SIC and Hannan and Quinn Criterion (HQ) . The ARDL method estimates $(p+1)^k$ number of regressions to obtain optimal lag length for each variable, where *p* is the maximum number of lag to be used and k is the number of variables in equation. Hence to obtain optimal lag length we needed to estimate $21*(8+1)^2= 1701$ regressions. At this process we estimate only the ARDL (p,q) models such that $p=q$ for every yield spreads (21*8=96 regressions) and ignore the mid-forms.

Table 5: AR statistics and Lagged Differences Selected by Criterion

Lags	*F* statistics	SIC	HQ	AIC
		s_360_30		
1	0.82746 [0.5658]	4.0157<	4.0579<	4.0867<
		s_360_60		
1	1.0586 [0.3925]	4.0123<	4.0545<	4.0833
3	0.73500 [0.6426]	3.9501	4.0344	4.0920<
		s_360_90		
1	1.5062 [0.1682]	4.0557<	4.0845<	4.0135
4	0.90904 [0.5010]	3.9329	4.0383	4.1102<
		s_360_120		
1	1.1769 [0.3185]	4.0105<	4.0527<	4.0814
5	0.55397 [0.7923]	3.8818	4.0083	4.0947<
		s_360_180		
1	1.2747 [0.2656]	4.0126<	4.0548<	4.0836
5	0.95360 [0.4672]	3.8792	4.0057	4.0920<
		s_360_270		
1	0.77275 [0.6109]	4.0128<	4.0550<	4.0838
5	0.38859 [0.9081]	3.8836	4.0102	4.0965<
		s_270_30		
1	0.93050 [0.4844]	4.0118<	4.0540<	4.0828<
		s_270_60		
1	1.0077 [0.4276]	4.0090<	4.0511<	4.0799
4	0.66233 [0.7036]	3.9052	4.0107	4.0826<
		s_270_90		
1	1.5364 [0.1581]	4.0103<	4.0525<	4.0812
4	0.72380 [0.6520]	3.9285	4.0340	4.1059<
		s_270_120		
1	1.0014 [0.4321]	4.0121<	4.0543<	4.0831<
		s_270_180		
1	0.84270 [0.5534]	4.0175<	4.0596<	4.0884
2	1.1122 [0.3577]	3.9834	4.0466	4.0898<
		s_180_30		
1	1.5639 [0.1493]	4.0141<	4.0563	4.0851
2	1.1791 [0.3174]	3.9966	4.0599<	4.1030<
		s_180_60		
1	0.89906 [0.5086]	4.0122<	4.0544<	4.0832<
		s_180_90		
1	1.0636 [0.3891]	4.0128<	4.0550<	4.0838
4	0.81668 [0.5747]	3.9174	4.0229	4.0948<
		s_180_120		
1	0.79136 [0.5955]	4.0076<	4.0498<	4.0785<
		s_120_30		
1	1.5845 [0.1430]	4.0160<	4.0582<	4.0870
2	0.99452 [0.4371]	3.9934	4.0566	4.0998<
		s_120_60		
1	1.0122 [0.4244]	4.0192<	4.0614<	4.0901
6	0.33186 [0.9385]	3.8466	3.9942	4.0949<
		s_120_90		
1	1.4735 [0.1798]	4.0281<	4.0703<	4.0990
6	0.82642 [0.5667]	3.8723	4.0199	4.1206<
		s_90_30		
1	1.7562 [0.0992]	4.0089<	4.0511	4.0799
2	0.76019 [0.6214]	3.9968	4.0600<	4.1032<
		s_90_60		
1	1.1086 [0.3599]	4.0089<	4.0511<	4.0798<
		s_60_30		
1	1.7153 [0.1084]	4.0104<	4.0525	4.0813
2	0.64929 [0.7146]	3.9993	4.0626<	4.1057<

Note: The null hypothesis is there is no autocorrelation.
p value of *F* statistics is in parenthesis.
First column shows the selected lag order by criterions.

Table 4 shows selected lag order according to SIC, HQ and AIC and the F statistic for testing no residual correlation against order. In all instance the null hypothesis of no residual correlation can not be rejected. All criterions select 1 lag for *s_360_30*, *s_270_30*, s*_270_120, s_180_60, s_180_120* and *s_90_60*. For the other variables, as SIC and HQ select usually 1 lag, AIC select 2 lags for *s_270_180, s_180_30, s_120_30, s_90_30* and *s_60_30,* 3 lags for *s_360_60*, 4 lags for *s_360_90, s_270_60, s_270_90* and *s_180_90*, 5 lags for *s_360_120, s_360_180, s_360_270* and 6 lags for *s_120_60* and *s_120_90.*

By considering selected lag order, it is estimated ARDL (*1,1*), ARDL (*2,2*), ARDL (*3,3*) and ARDL (*4,4*) models for all spreads. To test the whether there is cointegrating relationship or not, two separate bound test applied: the *F test* for testing the null hypothesis of $\lambda_1 = \lambda_2 = 0$ and *t* test for the null hypothesis of $\lambda_1 = 0$. Associated *F* and *t* statistics for our models are depicted on Table 5.

Table 6: Bound Test, *F* and *t* statistics

Spreads	ARDL *(1,1)*		ARDL *(2.2)*		ARDL *(3.3)*		ARDL *(4.4)*	
	F	*t*	*F*	*t*	*F*	*t*	*F*	*t*
s_360_30	151.41*	-17.2*	66.313*	-11.5*	45.973*	-9.50*	35.586*	-8.32*
s_360_60	148.98*	-17.3*	60.443*	-11.0*	45.459*	-9.48*	36.271*	-8.45*
s_360_90	148.54*	-17.2*	61.351*	-11.1*	43.554*	-9.30*	36.613*	-8.51*
s_360_120	145.91*	-17.1*	62.262*	-11.2*	43.727*	-9.31*	35.190*	-8.34*
s_360_180	149.33*	-17.3*	65.272*	-11.4*	42.780*	-9.23*	33.512*	-8.17*
s_360_270	145.86*	-17.1*	66.600*	-11.5*	43.710*	-9.33*	33.615*	-8.20*
s_270_30	144.38*	-17.0*	64.753*	-11.3*	43.312*	-9.21*	35.796*	-8.32*
s_270_60	138.24*	-16.6*	58.117*	-10.8*	43.263*	-9.25*	37.196*	-8.53*
s_270_90	142.28*	-16.8*	59.023*	-10.9*	42.834*	-9.22*	37.644*	-8.61*
s_270_120	136.15*	-16.5*	59.008*	-10.8*	42.768*	-9.21*	36.395*	-8.46*
s_270_180	144.12*	-17.0*	62.570*	-11.2*	42.374*	-9.20*	33.983*	-8.22*
s_180_30	148.92*	-17.2*	72.345	-11.9*	46.955*	-9.57*	36.726*	-8.43*
s_180_60	143.62*	-16.9*	63.380*	-11.2*	45.530*	-9.47*	38.905*	-8.71*
s_180_90	148.17*	-17.2*	62.480*	-11.1*	43.668*	-9.29*	39.091*	-8.74*
s_180_120	141.35*	-16.8*	62.712*	-11.1*	43.409*	-9.24*	37.895*	-8.58*
s_120_30	151.04*	-17.4*	72.390*	-11.9*	46.108*	-9.48*	35.189*	-8.24*
s_120_60	150.62*	-17.3*	66.378*	-11.5*	45.850*	-9.51*	36.443*	-8.44*
s_120_90	154.06*	-17.5*	65.472*	-11.4*	43.369*	-9.29*	36.482*	-8.48*
s_90_30	148.71*	-17.2*	71.588*	-11.8*	44.080*	-9.23*	34.043*	-8.09*
s_90_60	145.69*	-17.0*	68.617*	-11.6*	44.684*	-9.34*	33.325*	-8.05*
s_60_30	148.99*	-17.3*	71.563*	-11.8*	45.568*	-9.38*	34.208*	-8.08*

The *F* statistics is used to test for the null hypothesis $\lambda_1 = \lambda_2 = 0$ and t statistics for the null hypothesis of $\lambda_1 = 0$ in equation (9). Asymptotic critical values for *F* statistic are obtained from Table CI(iii) Case III: Unrestricted intercept and no trend, asymptotic critical values for t statistic are obtained from Table CII(iii) Case III: Unrestricted intercept no trend (Pesaran et al, 2001). Critical values for F statistics for the number of independent variable k=1, at %1 level: lower bound [I(0)] is 6.84 and upper bound I(1) is 7.84. Critical values for t statistics for the number of independent variable k=1, at %1 level: lower bound is -3.43 and upper bound is -3.82 (Pesaran et al, 2001).
* Statistic is above the 0.01 upper bound.

The calculated *F* and *t* statistics are compared with the critical values (*upper and lower bound*) tabulated by Pesaran et al (2001). If the sample test statistics are below the associated lower bound critical value the null hypothesis of no long-run relationship can be rejected regardless of the underlying variable is I(0) or I(1). If the sample test statistics fall in between upper and lower bound critical value, the results is inconclusive. On the other hand, if sample test statistics are above the upper bound critical value the null hypothesis of long-run relationship can not be rejected irrespective of underlying variable I(0) or I(1). When the integrated order of underlying variable is I(0), decision is made according lower bound and when the underlying variable is I(1) the decision made according to the upper bound.

All F and t statistics are far above the %1 upper bound critical values for all models. Hence the null hypotheses of no cointegration are rejected at %1 level. *F* and *t* statistics reached the highest value in ARDL (*1,1*) specification and as the lag order increases, *F* and *t* statistics decrease.

As test results indicate that there is long run cointegrating relationship between term structure of interest rates and growth of industrial production index, in second step it is needed to estimate the long-run relationship coefficients from ARDL specifications. Table 6 shows the estimated long-run coefficients from ARDL(*1,1*).

Table 7: Estimated Long-run coefficients for ARDL (1,1)

Spreads	Constant	Coefficient of s_t		Spreads	Constant	Coefficient of s_t
s_360_30	0.002 (0.865) (0.388)	0.003 (0.259) (0.796)		s_270_30	0.002 (0.879) (0.380)	0.004 (0.265) (0.791)
s_360_60	0.002 (0.878) (0.381)	0.003 (0.225) (0.822)		s_270_60	0.002 (0.882) (0.379)	0.004 0.234) (0.815)
s_360_90	0.002 (0.760) (0.448)	0.008 (0.436) (0.664)		s_270_90	0.002 (0.720) (0.472)	0.011 (0.493) (0.623)
s_360_120	0.001 (0.644) (0.520)	0.014 (0.644) (0.520)		s_270_120	0.001 (0.524) (0.601)	0.023 (0.789) (0.431)
s_360_180	0.001 (0.692) (0.490)	0.026 (0.817) (0.415)		s_270_180	0.001 (0.423) (0.673)	0.06 (1.21) (0.226)
s_360_270	0.003 (1.09) (0.179)	0.004 (0.068) (0.945)		s_180_30	0.003 (1.24) (0.215)	-0.002 (-0.147) (0.883)

The value in first parenthesis is *t* statistics.
The value in second parenthesis is *p* value of *t* statistics.

Table 6: Estimated Long-run coefficients for ARDL (*1,1*) (*Continued*)

Spreads	Constant	Coefficient of s_t		Spreads	Constant	Coefficient of s_t
s_180_60	0.004 (1.39) (0.166)	-0.009 (-0.357) (0.721)		s_120_90	0.004 (1.60) (0.112)	-0.052 (-0.571) (0.569)
s_180_90	0.003 (1.25) (0.214)	-0.005 (-0.152) (0.879)		s_90_30	0.003 (1.36) (0.176)	-0.002 (-0.0973) (0.923)
s_180_120	0.003 (1.04) (0.300)	0.007 (0.129) (0.897)		s_90_60	0.004 (1.65) (0.101)	-0.045 (-0.620) (0.536)
s_120_30	0.004 (1.37) (0.173)	-0.006 (-0.239) (0.811)		s_60_30	0.003 (1.29) (0.199)	0.010 (0.230) (0.819)
s_120_60	0.005 (1.67) (0.097)	-0.031 (-0.697) (0.486)				

The value in first parenthesis is *t* statistics.
The value in second parenthesis is *p* value of *t* statistics.

The results are curious. While ARDL bound test results indicate the existence of high degree of long-run cointegration relationship, static long-run solution for ARDL(*1,1*) shows that for all spreads, constant and the long-run coefficient of s_t are insignificant. For the models ARDL (2,2), ARDL (3,3) and ARDL (4,4) results are very similar[1]. As discussed in the literature; nonexistence information content of yield spreads about economic activity may because of the lack of deep financial market, lack of long term yield spread data, unstable macroeconomic conditions such as high inflation, volatile growth and high risk factors in Turkey. As 360 days interest rate is regarded as long term in Turkey, it is not enough to reflect long run expectations of economic actors. In addition to this, the level effects may play important role in this result. Also getting long-run cointegrating relationship may indicate that both variables are affected by common factors, such as capital movements, risks etc. However, to investigate the nature of the effects of possible common factors on y_t and s_t is out of the scope of this thesis. Hence it is left to future researches.

Although it is not investigated the effects of common factors, it may be give an opportunity to have intuitions behind the results, to examine the reverse relationship between terms structure of interest rate and growth of industrial production index. Ang and Piazzesi (2003) and Diebold et al (2006) analyze the bidirectional relations between yield curve and macroeconomic variables and find strong evidence of macroeconomic effects (including real economic activities such as industrial production, capacity

[1] The relatioship between quarterly yield spreads and growth of GDP also examined but the result does not chahge.

utilization) on the future yield curve[2]. Therefore we look at the relations between growth of industrial production index and some selected yield spreads by using ARDL model which is;

$$\Delta s_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta s_{t-i} + \sum_{i=0}^{q} \delta_i \Delta y_{t-i} + \lambda_1 s_{t-1} + \lambda_2 y_{t-1} + \upsilon_t \qquad (11)$$

To investigate the reverse relationship, the spreads of *s_360_30, s_270_3, s_180_30, s_120_30, s_90_30* and *s_60_30* are used as dependent variable. Table 7 shows the AR statistics and selected lags.

Table 8: AR statistics and Lagged Differences Selected by Criterion for Reverse Relation

Lags	***F* statistics**	**SIC**	**HQ**	**AIC**
		s_360_30		
2	0.690 [0.6796]	2.5140<	2.5773<	2.6204<
		s_270_30		
2	0.847 [0.5498]	2.6613<	2.7246<	2.7678<
		s_180_30		
2	2.338 [0.0266]**	2.9098<	2.9730	3.0162
3	1.395 [0.2105]	2.8926	2.9769<	3.0345
5	0.121 [0.9967]	2.8365	2.9630	3.0493<
		s_120_30		
3	1.015 [0.4224]	3.0359<	3.1202<	3.1778
5	0.092 [0.9986]	2.9769	3.1035	3.1898<
		s_90_30		
1	3.058 [0.0047]*	2.9933<	3.0355	3.0643
3	0.904 [0.5044]	2.9917	3.0761<	3.1336
5	0.415 [0.8917]	2.9231	3.0496	3.1359<
		s_60_30		
3	1.304 [0.2511]	3.5483<	3.6327<	3.6902<

Note: The null hypothesis is there is no autocorrelation.
p value of *F* statistics is in parenthesis.
First column shows the selected lag order by criterions.
*Null hypothesis rejected at %1 level. ** Null hypothesis rejected at %5 level,.

Table 7 shows selected lag order according to SIC, HQ and AIC and the *F* statistic for testing no residual correlation against order. We can reject the null hypothesis of no residual correlation for lag 2 when *s_180_20* is dependent variable and for lag 1 when *s_90_30* is dependent variable. By considering the selected order it estimated only the ARDL (*p,q*) models such that *p=q* for every yield spreads and ignore the mid-forms. Table 8 shows the ARDL bound test statistics for reverse relationships.

[2] Ang and Piazzesi (2003) uses inflataion and real activity as macroeconomic variables. CPI, the PPI of finished goods spot market commodity prices used to capture inflation and the index of Help Wanted Advertising in Newspapers, unemployment, the growth rate of employment and the growth rate of industrial production used to capture real activity. Diebol et al (2006) used inflation, federal funds rate and manufacturing capacity utilization as macroeconomic varibles.

Table 9: Bound Test, *F* and *t* statistics

Dependent Variable	ARDL *(1,1)*			ARDL *(2.2)*			ARDL *(3.3)*			ARDL *(4.4)*	
	F	*t*		*F*	*t*		*F*	*t*		*F*	*t*
s_360_30	6.8527**	-2.26		10.540*	-2.00		11.092*	-1.88		6.9198**	-1.75
s_270_30	11.268*	-3.45**		13.507*	-2.91**		13.546*	-2.97**		8.2935*	-2.69
s_180_30	14.083*	-3.51**		15.250*	-3.26**		18.690*	-3.61**		9.926*	-3.42**
s_120_30	13.876*	-4.82*		14.165*	-4.15*		21.837*	-4.56*		14.090*	-3.83*
s_90_30	17.264*	-5.73*		16.419*	-5.24*		23.257*	-5.32*		14.834*	-4.33*
s_60_30	22.669*	-6.70*		19.511*	-5.67*		27.513*	-5.83*		17.522*	-4.97*

Asymptotic critical values for *F* statistic are obtained from Table CI(iii) Case III: Unrestricted intercept and no trend, asymptotic critical values for t statistic are obtained from Table CII(iii) Case III: Unrestricted intercept no trend (Pesaran et al, 2001). Critical values for F statistics for the number of independent variable k=1, at %1 level: lower bound [I(0)] is 6.84 and upper bound I(1) is 7.84 and at %5 level 4.94 and 5.73 respectively. Critical values for t statistics for the number of independent variable k=1, at %1 level: lower bound is -3.43 and upper bound is -3.82, at %5 level -2.86 and -3.22 respectively (Pesaran et al, 2001).
* Statistic is above the 0.01 upper bound.
** Statistic is above the 0.05 upper bound.

As depicted on Table 8, for all spreads *F* statistic are the highest in ARDL (*3,3*) model the and above the 0.01 upper bound[3]. Hence there is long-run cointegrating relationship between growth of industrial production index and yield spreads. Table 9 shows the static long-run solutions.

Table 10: Static Long-run Solutions

	ARDL *(1,1)*		**ARDL *(2.2)***		**ARDL *(3.3)***		**ARDL *(4.4)***	
Dependent variables	Constant	y_t	Constant	y_t	Constant	y_t	Constant	y_t
s_360_30	0.199 (4.57)*	-6.035 -2.09)**	0.220 (4.47)*	-12.655 (-2.35)**	0.234 (4.53)*	-17.024 (-2.36)**	0.235 (4.20)*	-17.316 (-2.07)**
s_270_30	0.177 (4.69)*	(-5.727 (-2.24)**	0.197 (4.39)*	-11.962 (-2.37)**	0.206 (4.63)*	-14.595 (-2.45)**	0.204 (4.23)*	-14.21 (-2.08)**
s_180_30	0.136 (5.06)*	-3.738 (-2.29)**	0.154 (4.70)*	-9.260 (-2.64)*	0.162 (5.45)*	-11.668 (-3.00*	0.154 (5.14)*	-9.282 (-2.44)**
s_120_30	0.089 (5.30)*	-1.765 (-1.93)***	0.097 (5.15)*	-4.031 (-2.60)*	0.104 (6.21)*	-6.381 (-3.40)*	0.108 (5.55)*	-7.35 (-2.95)*
s_90_30	0.062 (4.97)*	-0.768 (-1.21)**	0.065 (5.16)*	-1.75 (-1.95)***	0.072 (6.08)*	-3.819 (-3.26)*	0.074 (5.40)*	-4.579 (-2.85)*
s_60_30	0.0316 (4.30)*	-0.165 (-0.452)	0.034 (4.43)*	-1.050 (-1.91)***	0.038 (5.42)*	-2.240 (-3.24)*	0.038 (5.02)*	-2.294 (-2.70)*

The value in parenthesis is *t* statistics
*Significant at %1 level, ** Significant at %5 level, ***Significant at %10.

As we can see, *t* statistics are the highest for ARDL (*3,3*) specification. The long-run coefficient of growth of industrial production index is negative and significant at %5 level when dependent variable is *s_360_30* and *s_270_30*, and significant at %1 level when all others are. Constant is significant at %1 level for all model. The long-run coefficients of y are very high especially for the models that dependent variable is *s_360_30* and *s_270_30* and *s_180_30*. Very interestingly, the associated results

[3] These *F* statistics very low compare to ARDL (*1,1*) the bound test *F* statistic in the previous relationship.

indicate that in the long-run any increase in y cause a decrease in s. For example, in the long-run one percentage of increase in y cause 17 percentage of decrease in *s_360_30,* 14.5 decrease in *s_270_30* and 2.24 decreases in *s_60_30.* Consequently, while we cannot find the link of yield spreads to real economic activity indicated theoretically, we find the significant and negative reverse relationship.

6.3 Testing the Relationship Between Short Term Interest Rate and Real Economic Activity in Turkey

Although the findings show that yield spreads does not contain any information about growth of industrial production index, we don't know the information content of short interest rate about real economic activity yet. Predicting power of yield spreads compared with Federal Funds rate (Gamber 1996; Gertler and Lown, 2000) and short term real interest rate (Estrella and Hardauvelis, 1991) in real economic growth is found to be high. However, Ang et al (2006) found that short term interest rate outperform the term structure of interest rate in and out of sample in forecasting GDP growth. To examine the relationship between short interest rate and real economic activity in Turkey the following relationship is examined:

$$y_t = \alpha + \beta_1 (i\_30) + \varepsilon_t \tag{12}$$

where i_30 is the is Treasury bond interest rates of term 30 days.

The ARDL (*p,q*) specification of (11) is as follows:

$$\Delta y_t = \alpha + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \sum_{i=0}^{q} \delta_i \Delta (i\_30)_{t-i} + \varphi_1 y_{t-1} + \varphi_2 (i\_30)_{t-1} + \omega_t \tag{13}$$

Table 10 shows the Augmented Dickey Fuller unit root test results for i_30. As it is expected i_30 has unit root. Akaike Information Criterion (AIC) and Schwartz Information Criterion (SIC) select the lag 0 among maximum 8 lag.

Table 11: Unit Root Test on i_30

	Lag	ADF t statistic	P value	Selected lag by AIC	Selected lag by SIC
i_30	0	-2.298	(0.1737)	**0**	**0**

Note: The null hypothesis is i_30 has a unit root.

By following same procedure to determine ARDL model, we use maximum 8 lag, and regress i_30 on y and then select model by using AIC, SIC and (HQ) .

Table 12: AR statistics for i_30 and Lagged Differences Selected by Criterion

i_30	F statistics	SC	HQ	AIC
1	1.0266 [0.4144]	4.0612<	4.1034<	4.1322
5	0.75411 [0.6265]	3.9553	4.0819	4.1682<

Note: The null hypothesis is there is no autocorrelation.
p value of *F* statistics is in parenthesis.
First column shows the selected lag order by criterions.

While SIC and HQ selects lag 1, AIC select lag 5. F statistic also shows that there is no residual autocorrelation. By considering selected order we estimate, ARDL (*1,1*), ARDL (*2,2*), ARDL (*3,3*), ARDL (*4,4*) and ARDL (*5,5*).

Table 13: ARDL Bound Test for i_30

	F	*t*
ARDL (*1,1*)	134.57*	-16.4*
ARDL (*2,2*)	62.581*	-11.2*
ARDL (*3,3*)	39.963*	-8.94*
ARDL (*4,4*)	33.729*	-8.21*
ARDL (*5,5*)	32.528*	-8.05*

Asymptotic critical values for *F* statistic are obtained from Table CI(iii) Case III: Unrestricted intercept and no trend, asymptotic critical values for t statistic are obtained from Table CII(iii) Case III: Unrestricted intercept no trend (Pesaran et al, 2001).
Critical values for F statistics for the number of independent variable k=1, at %1 level: lower bound [I(0)] is 6.84 and upper bound I(1) is 7.84. Critical values for t statistics for the number of independent variable k=1, at %1 level: lower bound is -1.53 and upper bound is -1.80 (Pesaran et al, 2001).
* Reject the null hypothesis of no cointegration at %1 level.

For all ARDL specification it is rejected the null hypothesis of there is no long-run relationship between short term interest rate and growth of industrial production. As it can be seen in Table 12, *F* and *t* statistics reached the highest value in ARDL (*1,1*) specification.

Table 14: Long-run Solution for i_30

	Constant			i_30		
	Coefficient	*t statistic*	*p value*	*Coefficient*	*t statistic*	*p value*
ARDL (*1,1*)	0.012	2.99	0.003	-0.017	-2.49	0.014
ARDL (*2,2*)	0.011	2.88	0.004	-0.014	-2.31	0.022
ARDL (*3,3*)	0.009	2.57	0.011	-0.012	-1.94	0.054
ARDL (*4,4*)	0.008	2.48	0.014	-0.009	-1.75	0.082
ARDL (*5,5*)	0.007	2.44	0.016	-0.007	-1.56	0.122

The static long-run solutions for ARDL specifications are tabulated above. Coefficient of long-run relationship is negative and significant at %5 level for ARDL (*1,1*) and ARDL (*2,2*), and at %10 level for ARDL (*3,3*) and ARDL (*4,4*). Hence the long run effects of short term interest rate on the growth of industrial production are significant and negative. Besides of this, constant is positive and significant at %5 level for all specification. Absolute value of coefficient of i_30 is decreasing, as ARDL lag order increase.

When there is significant long-run relationship between variables there exists an error correction (EC) representation based on ARDL specification. Estimated error correction model (ECM) allow us to analyze the short run dynamics. ECM results show the speed of adjustment toward long-run equilibrium after a short run shock. A general ECM for our specification is as follows:

$$\Delta y_t = \alpha + \xi EC_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \sum_{i=0}^{q} \delta_i \Delta(i\_30)_{t-i} + \omega_t \tag{14}$$

EC is error correction which calculated by using estimated coefficients of long-run relationships such that:

$$EC_t = y_t - constant - longrun\ coefficient\ of\ i\_30 * (i\_30)_t$$

The coefficient of EC_{t-1} shows what magnitude of short-run deviations will be cleaned up in the long-run and it is expected to be negative (Karaca, 2005). The short-run dynamics of the ARDL *(1,1)*, ARDL *(2,2),* ARDL *(3,3)* and ARDL *(4,4)* specifications can be seen on the following tables. We exclude the ARDL *(5,5)* ECM model because of the insignificant long-run coefficient of i_30.

Table 15: ARDL (*1,1*) Model ECM Results

	Coefficient	*t statistics*	*p value*
Constant	-0.0001	-0.0475	0.962
Δy_{t-1}	0.0737	1.02	0.308
$\Delta(i\_30)_t$	-0.0478	-2.10	0.037
$\Delta(i\_30)_{t-1}$	0.0353	-1.55	0.124
EC_{t-1}	-1.311	-11.5	0.000

R^2=0.625
F statistic = 74.35 [0.000]
DW statistic = 2.04

Table 16: ARDL (*2,2*) Model ECM Results

ARDL (2,2)	*Coefficient*	*t statistics*	*p value*
Constant	-3.32255e	-0.0152	0.988
Δy_{t-1}	0.121	1.04	0.300
Δy_{t-2}	0.0170	0.242	0.809
$\Delta(i\_30)_t$	-0.0463	-2.04	0.043
$\Delta(i\_30)_{t-1}$	-0.0328	-1.43	0.154
$\Delta(i\_30)_{t-2}$	-0.0502	-2.20	0.029
EC_{t-1}	1.381	-9.10	0.000

R^2=0.636246
F statistic = 51.31 [0.000]
DW statistic = 2.05

Table 17: ARDL (*3,3*) Model ECM Results

	Coefficient	*t statistics*	*p value*
Constant	3.40154e	0.0157	0.988
Δy_{t-1}	0.254	1.64	0.102
Δy_{t-2}	0.116	1.01	0.316
Δy_{t-3}	0.0563	0.804	0.423
$\Delta(i\_30)_t$	-0.0425	-1.88	0.062
$\Delta(i\_30)_{t-1}$	-0.0325	1.41	0.161
$\Delta(i\_30)_{t-2}$	-0.0481	2.11	0.037
$\Delta(i\_30)_{t-3}$	-0.0442	-1.93	0.056
EC_{t-1}	-1.543	-8.31	0.000

R^2=0.646131
F statistic = 39.71 [0.000]
DW statistic = 2.07

Table 18: ARDL (*4,4*) Model ECM Results

	Coefficient	*t statistics*	*p value*
Constant	3.97026e	0.0186	0.985
Δy_{t-1}	0.454	2.39	0.018
Δy_{t-2}	0.271	1.76	0.080
Δy_{t-3}	0.166	1.45	0.148
Δy_{t-4}	0.058	0.835	0.405
$\Delta(i\_30)_t$	-0.046	-2.05	0.042
$\Delta(i\_30)_{t-1}$	-0.030	-1.35	0.179
$\Delta(i\_30)_{t-2}$	-0.049	-2.16	0.032
$\Delta(i\_30)_{t-3}$	-0.043	-1.89	0.060
$\Delta(i\_30)_{t-4}$	-0.059	-2.59	0.010
EC_{t-1}	-1.776	-8.07	0.000

R^2=0.6618
F statistic = 33.66 [0.000]
DW statistic = 2.03

Coefficient of Δy is insignificant for all ARDL specifications except ARDL *(4,4)*. In ARDL *(4,4)* ECM results, coefficient of Δy_{t-1} is significant at % 5 level and Δy_{t-2} is significant at %10 level. On the other hand, for all specifications, while the coefficient of $\Delta(i\_30)_{t-1}$ is insignificant, the coefficient of other lagged values of $\Delta(i\_30)$ is significant at %10 level. This results indicate that the short-run change in contemporaneous and 2 to 4 lags of short interest rate have negative effect on the change in growth of industrial production.

The coefficient of EC_{t-1} is significant at %1 level for all ECM model and as it is expected it is negative. In addition to this, the results show that the absolute value of coefficient of EC_{t-1} is greater than 1 for all models. This means that the disequilibria of previous period, in here previous month, came to the equilibrium by fluctuating (Karagöl et al, 2007).

7. CONCLUSION

The term structure of interest rate has long been regarded as one of the main indicators for future changes in real economic activity and inflation. In the literature there are quite a few studies analyzing information content of term structure of interest rate about future economic activity.

Following four results become prominent in the studies examining relationships between yield spreads and economic activity. 1) There is positive relationship between yield spread and, real economic activity and inflation. 2) Predicting power of term structure of interest rate on future real economic activity is better than on inflation. 3) Predicting power of term structure of interest rate is rising with parallel to rise in spread horizon. 4) The predictive power of yield spread is not structural and affected by monetary policy.

Even though many terms structure models are treated especially for developed country, number of studies conducted for Turkey is very limited. In Turkey only Şahinbeyoğlu and Yalçın (2000) and, Telater and Ratti (2003) analyzed the predicting ability of yield spread about future inflation. Sahinbeyoğlu and Yalçın (2000) found that term structure of nominal interest rates have a significant but, as a contrary to theoretical framework and previous studies, negative effects on future inflation path. Telatar at al (2003) used a time-varying-parameter model and found positive relationship between slope of yield curve and inflation but information content of yield curve about future inflation is limited. On the other hand Eraslan (2005) investigated the relations of yield spread and real economic activity. And found that, there is significant relationship between term structure of interest rate and economic activity, but the predicting power of yield spread is limited. They all state that immature financial market, lack of long maturities, unstable economic environment and large government deficit limits the information content of term structure.

In this thesis, to analyze the relationships between term structure of interest rate and growth of industrial production index during the period April 1991-November 2006 in Turkey the ARDL bound test approach applied. It is used Treasury bond interest rates of term 30, 60, 90, 120, 180, 270 and 360 days:

We found that there are strong long-run cointegrating relationship between yield spreads and growth of industrial production index. However static long-run solutions show that none of long-run coefficients of yield spreads is significant. Immature financial market, unstable and volatile character of economy and political instability may leads to getting such results. Also 360 days interest rate is used as long term in Turkey and it is not long enough to reflect long run expectations of economic actors and make long run decision. Besides of this, interest rates are very in high in Turkey. Hence level effects may play very important role in the relationship.

In addition to this, the level effects may play important role in this result**.** The results take us to examine inverse relationship and we found that all examined long-run coefficient of growth of industrial production index are negative and significant. Also they are very high especially for the models that dependent variable is *s_360_30* and *s_270_30* and *s_180_30*. Surprisingly, the associated results indicate that in the long-run any increase in y cause a decrease in s. In addition to arguments, about nonexistence of plenteous information content of yield spread, come up with previous researches, getting cointegrating relationship and negative significant long-run reverse relationship may indicate that variables are affected by some common factors, i.e. capital movements and risks.

On the other hand investigating the relationship between short term interest rate and growth of industrial production index we found that there is significant and negative long-run relationship between short term interest rate and growth of industrial production index. Also by using error correction mechanism the short run effects of short term interest rate on change in growth of production index is analyzed. It is found that any short-run deviations from equilibrium are cleaned up in the long-run in a not slow adjustment process.

Consequently, our results corroborate the findings of previous term structure studies conducted in Turkey. Central Bank or another economic policy maker cannot use the term structure of interest rate as a guide for policy making. To understand the nature of relationship between yield spreads and real economic activity, it can be helpful to examine the effects of possible common factor on variables. Also using time varying models in order to analyze relationship in different periods or examining bidirectional relations between yield curve and macro economy, by using latent factor approach or joint econometric models and also analyzing the level, slope and curvature effect individually can give rise to new conclusions. It is also expected that as financial market deepen and macroeconomic stability accomplished, term structure of interest rate becomes more generous about future economic activity.

8. REFERENCES

Ang, A., Piazzesi, M. and Wei, M. (2006). "What does the yield curve tell us about GDP growth?", *Journal of Econometrics*, Vol. 131. pp. 359-403.

Ang, A., Piazzesi, M., 2003. A no-arbitrage vector autoregression of term structure dynamics with macroeconomic and latent variables. Journal of Monetary Economics, Vol. 50, pp. 745–787.

Attfied and Duck (1982). "Tests of the rational expectations model of the term structure of U.K. interest rates", *Economics Letters*, Vol. 10., pp. 115-121

Bonser C., Morley.R.N. and Morley.R.T(1997). "Does the yield spread predict realeconomic activity? A multicountry analysis", *Economic Review of Federal Reserve Bank of Kansas City*, Third Quarter,.37-53

Bordo, M. D. And Haubrich, J. G. (2004). "The yield curve, recessions, and the credibility of the monetary regime: long-run evidence, 1875-1997," *Working Paper 0402*, Federal Reserve Bank of Cleveland.

Chauvet, M. and Potter, S. (2005). "Predicting a recession: evidence from the yield curve in the presence of structural breaks", *Economics Letters* , Vol. 77, pp. 245–253

Cox, J. C., Ingersoll, J. E., Ross, S. A. (1981). "A theory of the term structure of interest rates", *Econometrica*, Vol. 53, 385–407.

Culberston, J.M., (1957). "The term structure of interest rates", *Quarterly Lournal of Economics,* Vol. 71, pp. 485-517.

Cuthberston, K. (1996). "The expectation hypothesis of term structure: The UK interbank market", *The Economic Journal*, Vol.106 (May), pp. 578-592.

Dibooğlu, S. and Kibritçioğlu, A., (2004). "Inflation, output growth and stabilization in Tukey", 1980-2002, Journal of Economics and Business, vol. 56, pp.43-61.

Diebold, F.X., Rudebush, G.D and Aruoba, S.B (2006). "The macroeconomy and the yield cuve: a dynamic latent factor model", *Journal of Econometrics*, Vol.131, pp. 309-338.

Elliott, G. and U. Muller (2003). "Optimally testing general breaking processes in linear time series models", *UCSD Working Paper*.

Engle, R.F. ve Granger, C.W.J. (1987). "Cointegration and error correction: representation", Estimation and Testing. *Econometrica*, vol.55 (2), pp. 251-276.

Eraslan, N. (2005). "An ampirial investigaiton of term structure and economic activity in Turkey", Unpublished Master Thesis. Marnara University.

Esteve, Vicente., (2006). "A note on nonlinear dynamics in the Spanish term structure of interest rates", *International Review of Economics and Finance*, Vol.15, pp. 316-323.

Estrella, A. and F. S.Mishkin (1997), “The predictive power of the term structure of interest rates in Europe and the United States: Implications for the European Central Bank”, *European Economic Review*, Vol.41, pp. 1375-1401.

Estrella, A., (2005). "Why does the yield curve predict output and inflation?," *Economic Journal, Royal Economic Society*, Vol. 115(505), pp. 722-744,.

Estrella, A., A. P. Rodrigues, and S. Schich (2003). “How stable is the predictive power of the yield curve? evidence from Germany and the United States”, *The Review of Economics and Statistics* Vol.85(3), pp. 629-644.

Estrella, A., Hardouvelis, G.A., (1991). “The term structure as a predictor of real economic activity”, *Journal of Finance*, Vol.46, pp. 555–576.

Estrella, A., Mishkin, F.S., (1998). “Predicting US recessions: financial variables as leading indicators”, *Review of Economics and Statistics,* Vol.80, pp. 45–61.

Fama, E. F. (1990). “Term structure forecast of interest rates, inflation and real returns”, Journal of Monetary Economics, Vol. 25. pp, 59-76.

Fama, E., Bliss, R., (1987). “The information in long-maturity forward rates”, *American Economic Review,* Vol.77, pp. 680–692.

Friedman, B. M. & Kuttner, K. N. (1991). “Indicator properties of the paper-bill spread: lessons from recent experience”, *The Review of Economics and Statistics*, Vol. 80, pp 34-44.

Galbraith, J.W., and Tkacz, G. (2000). “Testing for asymmetry in the link between the yield spread and output in the G-7 countries”, *.Journal of International Money and Finance*, Vol. 19, pp. 657-672.

Gamber, E.N., (1996). “The policy content of the yield curve slope”*, Rewiev of Financial Economics*, Vol.5, No.2., pp. 193-179

Gertler, M. and Lown, C. S. (2000). “The information in the high yield bond spread for the business cycle: evidence and some implications”, *NBER Working Paper* 7549.

Giacomini, R., and Rossi, B. (2005). "How stable is the forecasting performance of the yield curve for output growth?", *Working Papers 05-08*, Duke University, Department of Economics.

Hamilton, J. D. (1988). “Rational expectations econometric analysis of changes in regimes: An investigation of the term structure of interest rates”, *Journal of Economic Dynamics and Control*, Vol.*12*, pp. 385–432.

Harrison, B. and Pierce, D.G. (1996). “Monetary economics”, University of London Press, London.

Harvey, C.R., (1988). “The real term structure and consumption growth”, *Journal of Financial Economics,* Vol.22, pp. 305–333.

Hicks, J.R. (1946). “Value and capital”, Second edition, Oxford University Press, London.

Ivanova, D., Lahiri, K. and Seitz, F. (2000). "Interest rate spreads as predictors of German inflation and business cycles," *International Journal of Forecasting*, Elsevier, Vol. 16(1),pp.39-58

Jardet, C. (2004). “Why did the term structure of interest rates lose its predictive power?”, *Economic Modeling* , Vol.21. pp. 509–524

Johansen, S. ve Juselius, K. (1990). “Maximum likelihood estimation and ınference on cointegration with applications to the demand for money”, *Oxford Bulletin of Economics and Statistics*, Vol. 52 (2), pp. 169-210.

Jones, D.S., and Roley, V.V**.** (1983). "Rational expectations and the expectations model of the term structure. A test using weekly data," *Journal* of *Monetary Economics***,** Vol. 12, pp. 453-465.

Jorion, P.,and Mishkin, F. (1991). “A multicountry comparison of term structure forecasts at long horizons”, *Journal of Financial Economics*, Vol.*29*, pp.59–80.

Karaca, O. (2005). “Türkiye’de faiz oranları ile döviz kuru arasındaki ilişki: faizlerin düşürülmesi kurları yükseltir mi?”, Türkiye Ekonomik Kurumu, Tartışma Metni 2005/14.

Karagöl, E, Erbaykal, E. and Ertuğrul, H.M. (2007). “Consuption in Turkey; a bound test approach”, Doğuş Üniversitesi Dergisi, Vol. 8 (1), pp. 72-80.

Kim, K.A., Limpaphayom, P., (1997). “The effect of economic regimes on the relation between term structure and real activity in Japan”. *Journal of Economic and Business* Vol.49, pp. 379–392.

Kollias, C., Mylonidis, N., and Paleologou, S.M., (2006)., The Felstainihoriaoka Puzzle Across Eu Members: Evidence From The Ardl Bounds Approach and Panel Data, International Review of Economics and Finance, fothcoming.

Kozicki, S. and Tisley, P.A. (2005). “What do you expect? Imperfect policy credibility and test of expectation hypothesis”, *Journal of Monetary Economics*, Vol.52, 421-447.

Kozicki, Sharon (1998). “Predicting real growth and inflation with the yield spread,” Federal Reserve Bank of Kansas City *Economic Review,* Vol. 82(4) pp. 39-57.

Kugler, P and Brutta, H. (1993). “An empirical note on euro market interest rates, domestic interest rates and expectation theory of the term structure”, *Empirical Economics*, Vol.18, pp. 95-101.

Longstaff (2000). “The term structure of very short-term rates: New evidence for the expectations hypothesis”, *Journal of Financial Economics*, Vol.58, pp. 397-415

Mankiw, N.G., Miron, A.J., (1986). “The changing behaviour of the term structure of the ınterest rates”, *Quarterly Journal of Economics*, Vol.101, pp. 211-28.

Mishkin, F. S. (1990). “What does the term structure tell us about future inflation?” *Journal of Monetary Economics*, Vol.*25*, pp.77–95.

Mishkin, F. S.(1998). “The economics of money, banking and financial markets” (Fifth edition). Massachustts, Addison Wesley Longman Press.

Modigliani, F. and Sutch, R. (1966). “Innovation in interest rate policy”, *American Economic Review*, Vol.56, pp. 178-197.

Nagayasu, J. (2002). “On the term structure of interest rates and inflation in Japan”, *Journal of Economics and Business*, Vol.54., pp. 505–523

Nakaota, H. (2005). “The term structure of interest rates in Japan: the predictability of economic activity”, *Japan and the World Economy*, Vol. 17, pp. 311–326

Paleaz, Rolando, F. (1997). “Riding the yield curve: term premiums and excess returns”, *Review of Financial Economics*, Vol. 6., No.1., pp.113-119

Park, T.H. and Switzer, L.N., (1997). "Forecasting interest rates and yield spreads: the informational content of implied futures yields and best-fitting forward rate models", *Journal of Forecasting*, Vol. 16 (4), pp. 209-224.

Paya, I., Venetis, I. A. and Peel, D. A. (2004). "Asymmetry in the link between the yield spread and industrial production. threshold effects and forecasting,” *Working Papers. Serie AD 2004-4*1, Instituto Valenciano de Investigaciones Económicas, S.A. (Ivie).

Peel,D. A. and Ioannidis, C. (2003). “Empirical evidence on the relationship between the term structure of interest rates and future real output changes when there are changes in policy regimes”, *Economics Letters*, Vol.78. pp. 147–152

Peel,D. A. and Taylor, M P. (1998). “The slope of the yield curve and real economic activity: tracing the transmission mechanism”, *Economic. Letters*. Vol.59, pp.353–360.

Pesaran, M. Hasem and Ron P. Smith (1998). “Structural analysis of cointegrating VARs”, *Journal of Economic Survey, Vol.* 12(5), pp. 471-505.

Pesaran, M. Hasem and Yongcheol Shin (1999). “An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis, In S. Strom, A. Hollly and P. Diamond (Eds.), *Econometrics and Economic Theory in the 20th Century: The Ranger Frisch Centennial Symposium*. Cambridge, Cambridge University Press.

Pesaran, M.H., Shin, Y. ve Smith, R.J. (2001). “Bounds testing approaches to the analysis of level relationships”, *Journal of Applied Econometrics*, Vol. 16 (3), pp. 289-326.

Phillips, Aoran, L (2003). “The term structure of interest rates: evidence of market segmentation in the long end of the spectrum”, Journal *of the Academy of Business and* Economics, January.

Plosser, C.I. and Rouwenhorst, K.G. (1994). “International term structures and real economic growth”, *Journal of Monetary Economics* Vol.33, pp. 133–155.

Ratti, R. A, Telatar, E., Telatar, F., (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*, Vol.25, pp. 931-946.

Şahinbeyoğlu, G. and Yalçın, C. (2000). "The term structure of interest rates : does it tell about future inflation", *Discussion Papers 0002*, Research and Monetary Policy Department, Central Bank of the Republic of Turkey.

Schich, Sebastian T. (1999). "What the yield curves say about inflation: Does it change over time", *OECD Economics Department Working Papers*, No. 227

Shrestha, M. B., (2005). "ARDL modelling approach to cointegration test", New Zealand Association of Economists The 46th Annual Conference. Available at: http://www.nzae.org.nz/conferences/2005/13-SHRESTHA.PDF.pdf

Simon, D.P., (1991). "Segmentation in the treasury bill market: evidence from cash management bills", *Journal of Financial and Quantitative Analysis*, Vol. 27 (1), pp.97-108.

Taylor, M.P., (1992). "Modeling the Yield Curve", *The Economic Journal*, Vol. CII, pp. 524-537.

Telatar, E., Telatar, F. and Ratti, R. A. (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*, Vol.25., pp. 931–946

Tkacz, G. (2004). "Inflation changes, yield spreads, and threshold effects"*, International Review of Economics and Finance*, Vol.13, pp. 187–199

Tzavalis, E. and Wickens, M.R (1996). "Forecasting inflation from the term structure", *Journal of Empirical Finance,* Vol.3, pp. 103-122

Wu, T., (2002). "Monetary policy and the slope factors in empirical term structure estimations", *Federal Reserve Bank of San Francisco Working Paper,* 02-07.