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Forecasting the yield curve and the role of macroeconomic information in Turkey

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ABSTRACT

In this study we investigate the yield curve forecasting performance of Dynamic Nelson–Siegel Model (DNS), affine term structure VAR model (ATSM VAR) and principal component model (PC) in Turkey. We also investigate the role of macroeconomic variables in forecasting the yield curve. We have reached numbers of important results: 1—Macroeconomic variables are very useful in forecasting the yield curve. 2—The forecasting performances of the models depend on the period under review. 3—Considering the structural break which associates with change in monetary policy leads models to produce better forecasts than the random walk. 4—The role of exchange rate should not be ruled out in forecasting the yield curve in an emerging market like Turkey.

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1. Introduction

Forecasting the term structure of interest rates has long been of interest to financial economists, central bankers and portfolio managers since it plays a crucial role in pricing financial assets and their derivatives, managing financial risk, allocating, portfolios, structuring fiscal debt, conducting monetary policy, and valuing capital goods (Christensen et al., 2011). As the term structure of interest rates carries important information about the monetary policy and the market risk factors, numbers of theoretic and empirical researches for forecasting the yield curve are being conducted. However, as argued in Exterkate (2008), forecasting the term structure of interest rates is not an easy task and many attempts to outperform a simple random walk in forecasting the yield curve have failed.

The literature on the modeling of the yield curve is mainly dominated by the no-arbitrage affine term structure models (ATSM). This literature is started by Vasicek (1977) and Cox et al. (1985). Duffie and Kan (1996) characterize and Dai and Singleton (2000) classify these models. Vasicek (1977) and Cox et al. (1985) propose a single factor model, an instantaneous short rate that drives the market, however, it produces poor yield curve forecasts (Duffee, 2002). Chen and Scott (1993) argue that one factor is not appropriate to characterize the entire yield curve and propose multifactor generalization of the CIR (Cox, Ingersoll and Ross) model. On the other hand, Duffie and Kan (1996) characterize the exponential term structure models which are a class of models that the yields are an affine function of the latent state variables. Following Duffie and Kan (1996), these types of affine models become particularly popular (Christensen et al., 2011). Dai and Singleton (2000) analyze the affine term structure models and show that the yield curve movements can be reduced to three factors.

In a seminal paper, Ang and Piazzesi (2003) describe the joint dynamics of the term structure of interest rates and macroeconomic variables by an ATSM VAR. By assuming that the state vector follows a Gaussian VAR, they show that imposing the no-arbitrage restrictions and incorporating macroeconomic variables increase the forecasting performance of the VAR. As they bring in the picture the role of macroeconomic variables in dynamics of the yield curve movement, their study fills such a very important gap that the ATSM literature does not mention the role of macroeconomic variables so far. For 1-month ahead forecast horizon, their model shows better performance than the random walk but with a small gain.

An alternative approach is proposed by Nelson and Siegel (1987). This approach uses statistical techniques to explain the movement in the yield curve and becomes very popular among practitioners and central banks. Diebold and Li (2006) extend the yield curve model of Nelson and Siegel (1987) to the dynamic form and show that the Dynamic Nelson–Siegel Model (DNS) compared to the many benchmark models including the ATSM and the random walk, produces

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superior out of sample forecasts especially for one year ahead forecast horizon. Diebold et al. (2006) extend the model of Diebold and Li (2006) by incorporating macroeconomic variables. While Diebold and Li (2006) use a two step approach, Diebold et al. (2006) propose a one step approach using the state space framework. They argue that a one step approach should improve out of sample forecasts, however, they did not provide and forecast result. Yu and Zivot (2011) investigate out of sample forecasting performance of the one step and two step DNS models and find that a one step approach does not improve forecasting performance. Instead, a two step approach provides more accurate forecasts.

To assess the relative importance of no-arbitrage restrictions versus large information sets in forecasting the yield curve, Favero et al. (2012) investigate the forecasting performance of the DNS, the ATSM with a small number of macroeconomic variables and the ATSM with a large set of macroeconomic variables. Following the literature, instead of using all of macroeconomic variables individually, they extract common factors. They find that macro factors are very useful in forecasting the medium and the long rates and the financial factors are very useful in forecasting the short rates. They also show that the models with macroeconomic variables have superior forecasting performance than those of the random walk for most of the cases considered.

In this study, we investigate forecasting performance of the DNS, the ATSM VAR and principal component (PC) models in Turkey. By incorporating a set of macroeconomic variables, we analyze the role of macroeconomic variables in forecasting the yield curve. Since the Turkish economy has experienced a monetary policy change in 2002 accompanied by a political change around 2002, we regard this date as a potential date of a structural break. To take the structural break into account we divide the samples into pre-2002 and post-2002 periods. In our case, the change in monetary policy is associated with the implementation of an Inflation Targeting (IT) regime.

The rest of the paper consists of six parts. The first part describes the data set. The second part provides a general framework for forecast. The third part presents models and estimation techniques. The fourth part provides forecasting procedure. The fifth part presents the empirical findings and the last part concludes.

2. Data

The data set consists of monthly observation of annual interest rates over the period 1993:M1–2011:M8. To construct the yields, we use Treasury bond rates with maturities of 1, 2, 3, 4, 6 and 12 months. All the yields are continuously compounded and the *n-month* maturity yield is denoted by $y_t(n)$. These data are obtained from the Istanbul Stock Exchange database on a daily basis[1] and monthly averages are used in the estimation. It is not possible to find the interest rates for longer maturities in the Turkish economy, especially in the 90s mainly because of the lack of deep financial market, high levels of uncertainty and political instability.[2]

We use a number of macroeconomic variables namely inflation denoted by π_t, output gap denoted by gap_t, exchange rate denoted by e_t, and policy rate denoted by pr_t. Inflation rate is calculated as $\pi_t = (\log CPI_t - \log CPI_{t-12})$ where CPI denotes Consumer Price Index. The CPI series are obtained from the International Financial Statistics of the IMF and seasonally adjusted. Output gap is calculated by using seasonally adjusted Industrial Production Index. We use the method of Hördahl et al. (2006) to measure output gap in which rather than detrending full sample we generate a series recursively. In this setting, to obtain the value of output at time *t*, we fit the Hodrick–Prescott trend to the original series up to that time. This process was repeated until the end of the period. By adopting this, we ensure that our measure of output gap at time *t* does not rely on unavailable information at that point.

For exchange rate data, we use the Turkish Lira effective exchange rate against the US Dollar. For policy rate, we use the overnight interest rate of the Central Bank of Turkey (CBT).

To investigate the time series properties of these variables, we employ three different unit root tests to obtain possibly robust results. We find that all the series contain a unit root in their levels.[3] In contrast, their first differences appear to be stationary. The only exception is the inflation where only the unit root tests taking into account structural breaks indicate stationarity. As is well known, Perron (1989, 1997) asserts that a stationary series can be spuriously detected as non-stationary in the presence of breaks.

Table 1 shows the descriptive statistics of the yields. The last three columns contain the sample correlations at displacements of 1, 12 and 24 months and they suggest that the long-run interest rates are more persistent than the short-run interest rates. Fig. 1 plots the lowest (1 month), the highest (12 months) maturity interest rates and inflation. The short and long rates move very closely and both the level and the variation of interest rates have decreased after 2002. The decrease in the yields appears to be very related to the level of inflation in Turkey.

In the literature, it is well documented that the relationship between the yield curve and macroeconomic variables is unstable and the main source of instability is regarded as the monetary policy (see for example, Bansal and Zhou, 2002; Dai et al., 2003; Kozicki and Tinsley, 2001; Stock and Watson, 2003). As discussed in Elliott and Timmermann (2008) and Clements and Hendry (2006), among others, instability is one of the key determinants of forecasting performance.

In Turkey there is a monetary policy shift in 2002 in which the inflation targeting is started. Before 2002, monetary policy incorporated the practice of fixed or managed exchange rate regimes. After the deep financial crisis of February 2001, a structural transformation process involving not only the transition to the inflation targeting but also the introduction of the floating exchange rate regime coupled with the new central bank law, and structural reforms has been implemented (Basci et al., 2008). Accordingly, in many studies 2002 is regarded as a turning point for the Turkish economy (see for example, Civcir and Akçaglayan, 2010; Kaya and Yazgan, 2011; Tastan, in press).

To take the structural break into account, we estimate any given model in each period. Thus we divide the sample as 1993:01–2001:12 (pre-2002) and 2002:01–2011:08 (post-2002) and conduct forecasting exercises for these periods also.

3. A general framework for forecasting

Favero et al. (2012) propose a general state space representation to evaluate the forecasting performance of empirical models of the yield curve and the effects of incorporating additional information

[1] The interest rate data has been obtained by Riskturk (www.riskturk.com). In constructing the yield curve official bond market data has been collected from Istanbul Stock Exchange. Since the Turkish Fixed Income Bill and Bonds are traded in an official exchange (more information can be found at http://www.ise.org) a reliable official data exists and the market is rather liquid for an emerging market. Once the official data is obtained from the ISE, the spot yields are solved. More details can be found in http://www.riskturk.com.

[2] During the 1993–2002 period Turkey experienced three financial crises and a great earthquake. During 1989–1993 CBRT mostly did not sterilize the capital inflow however in the 1995–1999 period CBRT chose to sterilize inventory policy. On the other hand, over the 2000–2001 period fixed exchange rate regime is used. Turkey had 11 different governments during the period 1990 to 2000. For an overview of the Turkish economy during this period, see Telatar et al. (2003) and, Kaya and Yazgan (2011).

[3] They include 3 different ADF tests, KPSS test and Phillips–Perron test. The ADF-WS (Park and Fuller, 1995) and the ADF-GLS test (Elliott et al., 1996) are used in addition to the standard ADF test. To control structural breaks, we used Perron's (1989, 1997) unit root tests. To save space, we do not report these results; however, they are available upon request.

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