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The yield curve and the macroeconomy: Evidence from Turkey

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ABSTRACT

This paper contributes to the literature on the relationship between the yield curve and macroeconomic variables by focusing on an emerging market case: Turkey. The most important result of the paper is that the relationship between the yield curve and macroeconomic variables is significantly affected by the change in monetary policy which is associated with the implementation of inflation targeting (IT) regime. While before the IT regime the yield curve is affected to some extent by macroeconomic variables, after the IT regime, it is mainly driven by macroeconomic variables. We also find that central bank has gained ability to affect the entire yield curve with the IT regime. The other important result is that in addition to inflation and real activities, the exchange rates also play an important role in the yield curve dynamics in Turkey.

1. Introduction

The recent events reveal the close feedback between the real economy and financial conditions, and push macroeconomists, finance economists and policymakers into a significant challenge that the macro-finance linkages need to be well established. Given that the short-term interest rate is at the interconnection of the finance and the macro literature, investigation of the term structure of interest rates and inspecting the role of macroeconomic variables in the yield curve movements can be considered as a good start for this purpose.

Until recently, in the canonical finance models, which are started by Vasicek (1977) and Cox et al. (1985), characterized by Duffie and Kan (1996) and classified by Dai and Singleton (2000), the short-term interest rate is described as an affine function of a few latent factors. In a similar fashion, the long-term interest rates are related to those same latent factors and movements in the long-term yields are mainly driven by the change in risk premiums. In this approach, the role of the macroeconomic dynamics is almost completely ignored and it is left unspecified the link between the latent factors and macroeconomic variables. On the other hand, in the macro literature, the short rate is determined by the deviations of inflation and output from targets set by central banks and the long-term interest rates are mainly determined by the expectations of future short-term interest rates. In this approach, financial frictions, the yield spreads for credit or liquidity risk and changes in risk premiums are often ignored (Diebold et al., 2005; Rudebusch, 2010).

The term structure of interest rates and macroeconomic variables have been recently started to be examined jointly. In their seminal paper Ang and Piazzesi (2003) incorporate macro factors namely inflation and growth explicitly in an affine terms structure model and show that the macroeconomic variables play an important role in movements especially in the short and middle part of the yield curve. However, it is assumed that the short rate is ineffective on the macroeconomic variables. Hördahl et al. (2006) redressing the shortcomings of unidirectional link between term structure of interest rate and macro economy, construct a dynamic term structure model entirely based on three macroeconomic factors namely inflation, output gap and short-term policy interest rate. Using German data they find that the macroeconomic factors affect the term structure of interest rates in different ways in which while inflation and output shock mostly affects the curvature of the yield curve, monetary policy shocks have a marked impact on the slope of the yield curve.

Bernanke et al. (2004) using an affine term structure model show that model which only uses macroeconomic variables, predict the yields reasonably well at all maturities. Similarly, Smith and Taylor (2009) model the yields at all maturities as an affine function of current inflation and output gap. They use the model predication to interpret the movements in the yield curve and show that an increase in the coefficients in the monetary policy rule leads to an upward shift in the coefficients of all maturities. While the models that only use macroeconomic factors give an insight about the yield curve movements, they are not as successful as models that include latent factors. Rudebusch and Wu (2008) propose a model which combines affine no-arbitrage term structure model and a small New Keynesian rational expectation model with the short-term interest rate related to macroeconomic fundamentals through a monetary policy reaction

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function. They find that there is a strong bidirectional link between the term structure of interest rate and macroeconomic variables. They show that not only short and medium rates, but also long rates respond to macroeconomic variables. On the other hand, any increase in the yields at all maturities significantly increases the output gap and inflation. Diebold et al. (2006) examine the dynamic interaction between macro economy and the yield curve by incorporating macroeconomic variables into Dynamic Nelson Siegel Model framework. They find strong evidence of macroeconomic effects on the future yield curve and rather weaker evidence that the yield curve affects future macroeconomic variables. They also show that the market yields contain important predictive information about the federal funds rate.

The studies in the literature have generally focused on the developed countries, particularly on US, and this very important literature has remained scarce for the emerging market cases. Turkey is one of the emerging market economies that can constitute an important case study for this type of research as it has one of the biggest bond markets in the world among the developing countries. Therefore, in this paper we aim to fill this gap by presenting a new research on Turkey.

In this study we investigate the relationship between the term structure of interest rates and macroeconomic variables in Turkey during the period of January 1993 to January 2009. Firstly, we document structural break on series and divide sample into pre-2002 and post-2002 periods. These periods coincide with the pre-inflation targeting (IT) and post-IT period. Secondly, to capture the yield curve dynamics, we use Dynamic Nelson Siegel Model (DNS) proposed by Diebold and Li (2006) and decompose the entire yield curve into three latent factors namely "*1evel*", "*slope*" and "*curvature*". Lastly, we investigate the relationship between the yield curve and macroeconomic variables in each period.

The rest of the paper is organized as follows. In Section 2, we introduce the data and structural break analysis. In Section 3, we introduce DNS model and estimations. In Section 4, we report the empirical relationship between the yield curve and macroeconomic variables. In Section 5, we conclude.

2. Overview of data and structural break analysis

The data consists of monthly observations of annual interest rates over the period 1993 M1–2009 M1. To construct the yields, we use Treasury bond rates with maturities *1*,*2*, *3*, *4*, *6* and *12* months. All yields are continuously compounded and *n-month* maturity yield denoted by $y_t(n)$. These data are obtained from Istanbul Stock Exchange database on a daily basis[1]and monthly averages are used in the estimation. As discussed in Telatar et al. (2003) it is not possible to obtain interest rates for longer maturities in Turkish economy, especially in the 90s mainly because of the lack of deep financial market, high levels of uncertainty and political instability.[2]The same is true even for the early 2000s, although the inflation significantly dropped due to the implementation of IT regime.

We use a number of macroeconomic variables namely inflation, growth, output gap, capacity utilization, exchange rate and policy rate. Inflation rate, denoted by π_t, calculated as $\pi_t = (logCPI_t - logCPI_{t-12})$. CPI denotes the Consumer Price Index and CPI series are collected from International Financial Statistics (IFS) of IMF. CPI series are seasonally adjusted.

We use both the growth rate of GDP[3]and seasonally adjusted industrial production index (*IPI*). Growth rates are calculated as $gr_t = (logGDP_t - logGDP_{t-12})$ and $gr^{ipi}{}_t = (logIPI_t - logIPI_{t-12})$. We also calculate two output gaps. We detrend the log of *GDP* and log of *IPI* by using *Hodrick–Prescott* (*HP*) filter. We use the method of Hördahl et al. (2006) to measure the output gap in which rather than detrending full sample we generate series recursively. In this setting, to obtain value of output at time *t*, we fit HP trend to the original series up to that time. This process is repeated until the end of the period. By adopting this, we ensure that our output gap measures at time *t* do not rely on unavailable information at that point. We also use demeaned capacity utilization, denoted by cu_t, as another proxy for the output gap. The gap obtained from the *GDP* is denoted by gap_t and the gap obtained from the *IPI* is denoted by gap_t^{IPI}. The *IPI*, *GDP* and capacity utilization series are collected from the IFS.

For the nominal exchange rate, e_t, we use the value of Turkish Lira against the US Dollar. The real exchange rate rer_t, is computed using the e_t, the Turkey and the US consumer prices indices in a way that an increase in real exchange rate means a depreciation of the Turkish Lira. For the policy rate, r_t, we use overnight interest rate of Central Bank of Turkey (CBT). The exchange rates and the price indices are collected from the IFS and the policy rate is collected from the CBT.

Fig. 1 plots the lowest (1-month) and the highest (12-month) maturities interest rates in the study and Fig. 2 plots the 1 month interest rate and inflation. The short and long rates move very closely and both the level and the variation of interest rates have decreased after 2002. Decreasing path of the yields appears to be closely related to the level of inflation in Turkey (Fig. 2).

In the literature it is well documented that the relationship between macroeconomic variables and the yield curve is not stable, and the main source of instability is regarded as monetary policy (Bansal and Zhou, 2002; Dai et al., 2003; Kozicki and Tinsley, 2001; Stock and Watson, 2003 among others).

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 aimed at reducing the public sector burden on the economy as well as promoting competition and productivity has been implemented (Basci et al., 2008). Accordingly, a simple investigation of the interest rates and macroeconomic variables suggests a structural change around 2002.[4]

In order to clarify this argument, we employ structural break test on interest rates and macroeconomic variables. By employing Quandt–Andrews endogenous structural break test on the regression in which every series is regressed only on a constant, we find a structural break around 2002 for the variables (Table 1).[5]

One simple approach to take into account a possible structural break is to estimate any given model in each period. In the light of these findings, we divide sample period as 1993:01–2001:12 (pre-2002) and 2002:01–2009:01 (post-2002), and investigate the relationship in each period.

[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, CBT mostly did not sterilize the capital inflow, however, in the 1995–1999 period, CBT choose to sterilized inventory policy. On the other hand, over the 2000–2001 period, the fixed exchange rate regime is used. Turkey had 11 different coalition governments during the period of 1990 to 2000. For detail and an overview of the Turkish economy during this period see Telatar et al. (2003) and, Kaya and Yazgan (2011).

[3] Since monthly GDP is not available, we calculate it by using the cubic-spline interpolation method. We use quarterly GDP volume series which are collected from the IFS. Firstly quarterly series are seasonally adjusted and then using the *spline* function of the MATLAB, monthly series are calculated.

[4] Kaya and Yazgan (2011) document the structural break on the relationship between inflation and the term structure of interest rates around 2002 in Turkey.

[5] We also apply another endogenous structural break test developed by Bai and Perron (2003) and find very similar break dates.