Bond Market Emergence: Case of Serbia

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June 21, 2006

Abstract
We analyze an emerging Serbian bond market to compare its behavior to developed markets and to indicate what is behind the bond market emergence. As an analytical tool we model the term structure of the bond market. We find that the modified standard model performs rather well in the environment of an emerging market with numerous imperfections and external shocks involved since we obtain a concave yield curve as in developed markets. Further, we show the link of such structure to macroeconomic developments in terms of responsiveness of interest rates to changes in industrial production and inflation. Finally, frequency of trading, market liquidity and transparency can be considered as drivers that make the market emerge.

KEY WORDS: emerging bond market; impulse response; Nelson-Siegel; Serbia; term structure; transition; yield curve

JEL CLASSIFICATION: E43; E44; G12; O23; P24, P34

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†CERGE-EI is a joint workplace of the Center for Economic Research and Graduate Education, Charles University, and the Economics Institute of the Academy of Sciences of the Czech Republic.
1 Introduction

The transition process that began in the early 1990’s in Europe can be considered as a prominent structural change in economic development aside from its political dimension. It brought massive changes in ownership structures as well as macroeconomic climate, and emergence of financial markets, a new feature to the region (e.g. see Filer and Hanousek 2000, European Bank for Reconstruction and Development 2005). Since their inception, European emerging markets have been more volatile, have operated with more frictions and higher cost structures, and have been more prone to mismanagement and less-than-optimal regulation (e.g. see Durnev, A., K. Li, R. Mørck, and B. Yeung, 2004). The European emerging markets are under-researched and pose challenges to the choice of the proper modeling strategy; as such they are in a sharp contrast to developed markets. Our aim is to analyze an emerging bond market to compare its behavior to developed markets and to indicate what is behind the bond market emergence.

As an analytical tool we model how the interest rates on government bonds vary with the time to maturity of such bonds (the yield curve). Further, we show the link of such structure to macroeconomic developments in an emerging market with numerous imperfections and external shocks involved. For this purpose we chose Serbia as it is a good example of the above-described market, including the institutional defects. Due to the delayed launch of the transition from plan to market as well as several years of war, Serbia is now truly an emerging market. This newly emerged bond market is a natural experiment in progress and has not yet been studied by researchers. Exploiting a rich data set of Serbian bond prices, we are able to study market emergence, thus filling a gap in the literature.

In brief, the Serbian bond market was created from scratch in the early 2000’s. It consists of two major segments. The first is characterized by standard treasury bills and government bonds, denominated in domestic currency, that are issued by the National Bank of Serbia and the Serbian Ministry of Finance, respectively. The second originates
from converting the frozen foreign deposits held by the public in the 1990’s. Deposits converted into bonds have become Foreign Currency Savings Bonds (FCS-Bonds), which are denominated in euros.

Aside from the common facts stated above there are several specific institutional features that have to be accounted for in the technical part of our analysis (estimating the bond market yield curve). The market is segmented since bonds are denominated in domestic currency as well as in euros. Auctions for some bonds are held on a bi-weekly or even irregular basis, while simultaneously there exists daily trading. Important is also the fact that some bonds have unrealistically high yields close to their maturity. In terms of external shocks, Serbia experienced the split of the former Yugoslavia, ethnic turmoil, several local wars, an economic downturn due to the transition from plan to market as well as an economic crisis due to internationally imposed restrictions. These specific features pose modeling challenges and we elaborate on them later on when we characterize the market for Serbian government bonds by estimating its term structure (the yield curve).

The first step in our quest to analyze the Serbian bond market is the choice of a term structure model. The existing types of modeling framework can be roughly divided into two groups: one theoretically motivated and the other empirically driven. Theoretical models make explicit assumptions about the development of state variables and uses either arbitrage or equilibrium arguments.\(^1\) The empirically driven dynamic statistical models smooth data from asset prices without incorporating explicit factors presumed to drive the yield curve. Current dynamic statistical modeling originates in the methodology introduced in McCulloch (1971) and McCulloch (1975), and further advanced in Langetieg

\(^1\)Major examples of no-arbitrage models are those of Vasicek (1977), Hull and White (1990) and Heath, Jarrow, and Morton (1992). Such models typically concentrate on fitting the term structure at each point in time by imposing no-arbitrage conditions. While they might be very useful in pricing derivatives, they do not reveal much in terms of dynamics or the forecasting of interest rates. The fundamental contributions in the equilibrium tradition include Cox, Ingersoll, and Ross (1985), Duffie and Kan (1996), and more recently, de Jong (2000) and Dai and Singleton (2000). Since the equilibrium models focus on the process driving the instantaneous rate, they can potentially be used for forecasting. However, Duffee (2002) demonstrates that they forecast rather poorly and are inconsistent with many stylized facts.
and Smoot (1981), who all use polynomial splines to approximate a discount function. The failure of these models to generate a variety of shapes for the yield curve and to produce stable forward rates led to the improvement suggested in Vasicek and Fong (1982).²

Nelson and Siegel (N-S, 1987) further advance the results of Vasicek and Fong (1982). They propose a simple exponential model, which is sufficiently flexible to generate a variety of yield-curve shapes. The N-S model is a three-factor model where the factors are actually time-varying parameters and can be interpreted as the level, slope, and curvature of the yield curve. Its improved version is described in Svensson (1994) and further discussed in Diebold and Li (2003).³ Since the N-S model is relatively easy to estimate, has an intuitive interpretation, conforms to stylized facts, relates to macroeconomic variables, and can be used for forecasting, we use it to analyze the term structure of the Serbian bond market.

The results of our analysis offer surprisingly unambiguous results in spite of the problems associated with the newly emerged market.⁴ We find that the altered N-S model performs rather well in the environment of an emerging market. It does not only fit the yields on the daily traded FCS-Bonds but also the short term Treasury yields. As a robust check to our yield curve estimation, we investigate the relationship between the state of the Serbian economy and the term structure, similarly to Diebold, Rudebush and Auroba (2003, DRA). As is the case in developed markets, a concave yield curve is associated with a greater growth of the economy. A subsequent analysis also shows responsiveness of interest rates to changes in industrial production and inflation. The model itself contains relevant information for predicting inflation, exchange rate depreciation and industrial

²They transform the argument of the discount function rather than the function itself, which enables them to apply the standard OLS estimation of the discount factor coefficients and to avoid tedious non-linear estimation. The application of this methodology on US T-Bills results in stable forward rates, which are a continuous function of time. Moreover, the implied term structure can assume a variety of shapes often observed in reality.
³Variations of this model are often used by central banks to form inflationary expectations - e.g. the Bank of England (see Deacon and Derry 1994).
⁴Primary vs. secondary market, dinar-denominated vs. euro-denominated bonds, bi-weekly or irregular auctions vs. daily trading, and bonds maturing in May.
production. We also identify the features behind the market emergence: frequency of trading, market liquidity and transparency can be considered as drivers that make the market emerge.

The rest of the paper is organized as follows. Section 2 discusses the timeline of the Serbian bond market emergence and the debt repayment program. Data section 3 provides detailed information regarding the types of bonds available in Serbia and describes the macroeconomic variables. Section 4 describes the N-S model and reports its estimation results. Section 5 addresses the relationship between term structure and macroeconomy in Serbia. Section 6 concludes.

2 Time-line of Emergence

The bond market in Serbia originated in before the transition. Throughout the 1970s and 1980s one of the major resources of foreign capital in the former Yugoslavia were the bank savings of its residents, but even more of the savings of citizens working abroad. However, under the former socialist regime, all banks were under government supervision and therefore major investment decisions could not be reached without political consent. Therefore, profit was not the leading criterion behind most of investment decisions. Since the banks were unable to generate enough profit to repay deposits with generous interests, by 1990 it was too late for most depositors to claim their savings. By that time, due to the shortage of any hard currency, banks first severely limited withdrawal amounts and later cancelled withdrawals altogether. In 1991, due to the inability to resolve this situation in any other way, a moratorium on government debt towards all private depositors, referred to as “old foreign currency savings”, was put into force. At the time of the moratorium, the total outstanding balance was close to 6 billion DEM.

The build-up of political tensions that led to the collapse of former Yugoslavia left Serbia and Montenegro united in an effort to continue the legacy of the previous country.
However, with civil war on its borders, the country was not setting economic development as its top priority. By 1992, Serbia and Montenegro were politically and economically isolated. A high level of inflation was followed by a rapid depreciation of the local currency, the dinar.

The first attempt to resolve the government debt based on “old foreign currency savings” was made with the adoption of the law on regulating the public debt arising from citizens’ foreign exchange savings. As part of a new financial infrastructure in Serbia, three key institutions were established: the National Savings Bank, the Belgrade Stock Exchange (BSE), and the Central Registry. Each of these institutions fits in a complex mosaic and plays a role in the financial environment. The government also recognized most of its financial liabilities towards private depositors and committed itself legally to pay all the frozen deposits by 2011. Nevertheless, this new law was from the very beginning full of technical and practical difficulties. It assumed a debt conversion into bonds on a voluntary basis. The bonds were issued in paper format and thus were liable to forgery and theft. The non-electronic format of bonds proved to be complicated for trading and clearing procedures as well. Finally, the law was tied to the GDP growth levels which were unattainable at that time.

In 2002, a new law was adopted, which presented a modified and more realistic solution to the “old savings” problem. It kept the spirit of the previous law by avoiding the withdrawal of old bonds; the new solution was to convert the government debt of private depositors into bonds of the Republic of Serbia and the Republic of Montenegro. The payment schedule was also changed and included bond maturity between 2002 and 2016. All bonds issued by the previous law could be converted on a ‘one to one’ basis into new

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5The BSE was reactivated during socialist reforms in 1989 and it has been functioning without interruption ever since. The institutional framework and activities of the stock exchange are stipulated by the Law on Securities and Other Financial Instruments’ Market.

6It was founded by a separation from the National Bank and in connection with the shareholders’ database from the temporary depository of the Privatization Agency. It plays a crucial role in over-the-counter market bond trading by keeping a unified record of owners of all issued securities on the territory of Serbia.
‘series A’ bonds of the Republic of Serbia. Bonds were issued in electronic format in order to avoid all major difficulties experienced under the previous law. All data regarding the bond holders, maturities and payment schedules were stored in the Central Registry, an institution set up for this purpose. This solution required that all bond holders have a specialized trading account in a bank of their choice. The procedure assumed that all trading went through the Central Registry and that money was transferred into bank accounts. This improved and simplified the securities trading and reduced the possibility of mistake or fraud.

One of the objectives of the new law was to coordinate the bond maturity structure with budget income. According to the payoff model, an estimated GDP growth of 3% to 5% was needed in order to avoid economic slow downs. This was a realistic projection and proved to be a sustainable burden for the budget in the first two years of bond payments. The trading volume in the first six months was around EUR 100 million. During that period the annual yields varied from 13% to 14% for short-term bonds, and from 8% to 15% for longer term maturity bonds. Initially, the bonds were traded with less than daily frequency, despite the fact that BSE formally operated on a daily basis. The structural change with respect to the market emergence occurred in September 2002 when the additional bond series were introduced. This move increased the total volume of trading of long-term bonds almost by five times. Introduction of additional bonds not only dramatically increased the extent of trading but also elevated trading frequency with the original bond series. At this moment, the effective daily trading begun and the market was born.

3 Data

Bonds Traded in Serbia

There are currently two types of government bonds with maturity less then one year in Serbia. These are the bills issued by the National Bank of Serbia (NBS-Bills) and the
Republic of Serbia Treasury Bills (RS-Bills) issued by the Serbian Ministry of Finance. The first auctions of NBS-Bills occurred in April 2000, while RS-Bills were first issued three years later.\(^7\) Auctions for NBS-Bills take place approximately once every two weeks. RS-Bills are auctioned irregularly, approximately in one to two month periods. Although they were presented as an additional instrument for the development of the financial market, RS-Bills never reached the stock exchange. Instead, they have only been traded in online auctions through the Ministry of Finance system. The typical maturities of NBS-Bills are 7, 14-15, 30, and 60 days while those of RS-Bills are longer, e.g. 91, 154, and 182 days. There is no secondary market for either type of bill and they are denominated in dinars. The first NBS-Bills matured on January 8, 2001. Data on the short term bonds were kindly provided by the National Bank of Serbia.

The only available bonds with maturities over one year are Foreign Currency Savings Bonds. These FCS-Bonds are traded on the Belgrade Stock Exchange and over-the-counter (OTC). On the BSE, a transaction is concluded at the moment the total quantity requested is met or when a pre-specified share of the quantity of a trading order placed on the BSE is executed. When the transaction is executed, the confirmation has to be converted into electronic format and then submitted in the same format to the Central Registry and to the member who concluded the transaction. All transactions are settled through Beoclearing, which is a delivery-versus-payment system. The settlement period for bonds is T+3. Following the execution of the transaction, brokers and custodian banks inform their clients about the concluded settlement. According to the rules of trading of the BSE, authorized traders on the OTC are obliged to submit information about completed trades by electronic mail. Furthermore, all prices concluded on the trading session should be published on the BSE web page. This rule is not obeyed in practice. For example, as of now, no information regarding the OTC market is available.

\(^7\)Initially, NBS-Bills were traded on the stock exchange. Online trading was introduced in October 2003, with lower transaction costs and higher trading volumes. While interest rates were not significantly affected, the number of market participants decreased.
While we do not have records on prices in OTC transactions, the Central Registry provided us with partial information on OTC trading, which includes the number of bonds traded over-the-counter in 2004. We merge this information with the data from the BSE: the OTC trades are mostly close to 80% of the overall trading volume (see Table 1 for volumes by A-series bonds and months). While this is not unusual (a similar number would be 100% in the Czech Republic or Hungary), the fact that prices for this segment of the bond market are not publicly available is a sign of potential problems such as price setting, insider trading, and lack of liquidity. For example, the National Savings Bank was formed with the primary purpose of providing services in bond distribution and the debt repayment program. Most bond holders preferred to sell their bonds before maturity, which left the National Savings Bank with a large supply. This situation put it in a position to affect the secondary market for bonds and the bank is hence often viewed as a monopoly. Another potential (this time legitimate) reason for the large portion of FCS-Bonds being traded OTC is that banks are in a position to form larger portfolios (for amounts over 1 million euros) and exploit the possibility of block-trading at the BSE to generate profit. Taking into account the size of the OTC market, our results need to be viewed with some caution. Inclusion of this data (existing but not released by the Central Registry) would make our analysis more complete and could potentially alter some of our findings. The data could also shed some light on inefficiencies and arbitrage opportunities, which are likely to be present in a non-transparent market.

FCS-Bonds are traded actively on a secondary market and we possess the daily data series, which were purchased from the Belgrade Stock Exchange. The data on FCS-Bonds issues has been available since November 2001 for single price auctions which were replaced by continuous trading in March 2003. The following series were issued: A2002, A2003, A2004, and B. We took the B series out of our dataset since it was clearly an outlier with unrealistically high yields. Additional bond series were introduced in August 2002 and
their trading on the BSE started on September 9, 2002.

**Calculation of Yields**

We base our analysis of the yield curve on the simplest fixed-income instrument, a zero-coupon bond. The zero-coupon bond promises to pay a unit of currency on a given date in the future. The time between a current period and the pre-specified future date determines the maturity of the bond. If kept till maturity, the bond earns a fictional, constant, annual interest rate, which is the bond’s yield. Plotting yields of zero-coupon bonds, as a function of their respective maturities, results in the yield curve. A convenient feature of the FCS-Bonds in our dataset is that they are in fact zero-coupon bonds, which eliminates the need to calculate the fictional yield from data on coupon bonds, a necessary step in the yield curve estimation when one uses data from developed markets.

Some aspects of the Serbian data are less suitable for the term structure estimation. One issue is that maturing FCS-Bonds have extremely high yields inside of sixty days prior to their expiration date at the end of May. The yields are about 60% (annually) and are significantly greater than the interest rate on time deposits of foreign exchange funds in some commercial banks. We noticed that the number of traded securities of bonds close to maturity decreased in the last two months before the expiration date. This observation is consistent with a lower demand for bonds at BSE, which may be caused by an existing market friction. Since the percentage for A2004 bonds traded OTC increases in May 2004 (see Table 1), the trading volume increases on the OTC market as well and it is likely that low bond prices at BSE are the results of bonds flowing out of the stock of exchange. A potential friction can be a fixed fee per bond by the National Savings Bank (or another big player on the bond market) or possibly rounding down a bond price since it should be between 99 and 100 euro. Trading on BSE then ensures that interest rates on bonds with higher maturities are higher as well. To avoid the apparent bias, we decided to exclude yields of FCS-Bonds during the two-month period before their expiration dates.
The yield curve is typically extracted from the prices of discount bonds, which are not observed since bonds with long-term maturities are coupon bonds. Our analysis is in this aspect simplified since all the FCS-Bonds are discount bonds. On the other hand, these bonds are denominated in euros. Typically, foreign currency deposits are riskier than domestic ones and domestic investors require a positive premium to purchase them. In the case of Serbia however, FCS-Bonds are perceived as safer and the premium can actually be negative. However, to simplify our estimation, we assume it is zero. For each maturity, we simply adjust the yields on the FCS-Bonds by accounting for dinar depreciation. Specifically, let us define the annual nominal yield as $i_t$, the adjusted yield as $y_t$, and the dinar/euro Exchange rate as $S_t$. The adjustment is then calculated as

$$y_t\% = i_t\% + \frac{S_t}{S_{t-\text{one year}}} \times 100\%.$$ 

The exchange rate float only starts in January 2001, so for this year we use annualized depreciation with respect to January 2001. Finally, we merge annualized yields on bonds with those on bills. We comment on the historical yields later on, when comparing them to our estimates.

**Macroeconomic series**

We choose three series to characterize macroeconomic conditions: inflation, depreciation and industrial production. The initial data period is September 2002, to be consistent with our analysis of yields. We use monthly series for Consumer Price Index and industrial production obtained from the Serbian Statistical Office and the exchange rate dinar/euro from the NBS. The summary statistics are in Table 2. Both inflation and depreciation are less than 1% a month. Industrial production grows on average 2.5% with respect to the average of the previous year.

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8 The National Bank of Serbia (NBS) has the exchange rate policy of a managed float. Officially, the dinar is determined by levels of supply and demand on the money market and the level of the exchange rate is formed on a daily basis. However, like most central banks, the NBS is interested in keeping the exchange rate stable, thus avoiding the potential imbalances in the real sector that could follow.
4 Yield Curve Estimation

Methodology

In principle, a suitable term structure model should be able to reproduce the stylized facts documented in the literature and also be sufficiently flexible to accommodate the idiosyncrasies of a given bond market. Following Diebold and Li (2003), the stylized facts could be summarized as follows: (i) The mean yield curve is increasing and concave. (ii) The shape of the yield curve can change over time. Potential shapes include upward sloping, downward sloping, humped, and inverted humped. (iii) Dynamic properties of yields are more persistent than those of yield spreads. (iv) The long end of the yield curve is less volatile than the short end. (v) Short rates are less persistent than long rates.

Diebold and Li (2003) argue that a version of the Nelson and Siegel (1987) yield curve with somewhat altered factorization meets the above criteria. The model is given as follows:

$$y_t(\tau) = \beta_{1t} + \beta_{2t} \left( \frac{1 - e^{-\lambda_t \tau}}{\lambda_t \tau} \right) + \beta_{3t} \left( \frac{1 - e^{-\lambda_t \tau}}{\lambda_t \tau} - e^{-\lambda_t \tau} \lambda_t \tau \right),$$

where $y_t(\tau)$ is the nominal interest rate, $\tau$ is the maturity of a given bill and $t$ is the current date. This factorization allows for an intuitive interpretation of the three latent dynamic factors $\beta_{1t}$, $\beta_{2t}$ and $\beta_{3t}$. It also avoids estimation difficulties due to multicollinearity. Since the loading on the first factor is a constant, it can be interpreted as a long-term factor, which does not converge to zero with increasing maturity. The loading on the second factor begins at 1 but quickly decreases to zero and can thus be viewed as a short-term factor. Finally, the loading on $\beta_{3t}$ starts at 0, increases, and then slowly declines; hence it can be viewed as a medium-term factor.

From a different perspective, the three factors can be interpreted as level, slope, and curvature of the yield curve, respectively. To see that $\beta_{1t}$ determines the level of the term structure, it is enough to realize that its size affects yields of all maturities equally and that $y_t(\infty) = \beta_{1t}$. If we define the yield curve slope as $y_t(\infty) - y_t(0)$, it exactly equals
Moreover, $\beta_{2t}$ changes the slope of the yield curve since its loading is greater for shorter yields than for longer yields. The medium term factor has the greatest loading on yields with medium maturities and therefore increases the yield curve curvature, typically defined as $2y_t(24) - [y_t(3) + y_t(120)] = .00053\beta_{2t} + .37\beta_{3t}$, with maturity given in months.

The Nelson-Siegel yield curve formula is parsimonious yet flexible and capable to replicate the stylized facts regarding yield curves. In particular, the average term structure is calculated using factor averages and can be in general increasing and concave. It can also reproduce a variety of shapes on a given date, which can change depending on the variability of the factors. Strong persistence in the level factor translates into persistent yield dynamics and weak persistence in the slope factor translates into weak persistence of the spreads. The variance of short yields depends on the variance in the first two factors and the long yield variance only on the level. Therefore, short-term yields are more volatile. The same reasoning implies that longer rates are more persistent than shorter ones.

To characterize the yield curve, we need to estimate the parameters $\theta = (\beta_{1t}, \beta_{2t}, \beta_{3t}, \lambda_t)'$. Parameter $\lambda_t$ is typically not estimated but set to the value maximizing the loading factor next to the $\beta_{2t}$ (medium-term part) at 30 months i.e., setting $\lambda = 0.0609$. Diebold and Li (2003) estimate the factors using ordinary least squares at each date. Due to the lack of bonds of different maturities on any given date, we cannot use this strategy and fit the yield curve daily. Instead, we assume that the coefficients are stable in a short time period (two weeks) and use a cross-section of data of selected daily observations on bond interest rates. Using ordinary least squares (OLS), we then estimate $\beta_{1t}$, $\beta_{2t}$, and $\beta_{3t}$ on a bi-weekly basis.

Estimation Results
We first conduct our estimation using the data series starting in December 2001 and ending in February 2005 (79 two-week periods). To characterize the evolution of cross-sectional
beta estimates $\hat{\beta}_t = (\beta_{1t}, \beta_{2t}, \beta_{3t})'$ over time we report their time series in the left panel of Figure 1. One can clearly see the development of the bond market in Serbia. Before September 2002, only a few series of the FCS-Bonds were traded. The estimates settle down somewhat after the introduction of additional bond series. A similar pattern can be identified using confidence intervals from cross-sectional regressions. To view the Serbian market from yet another perspective, we plot the number of observations for yields over time as well, which also marks September 2002 as a break-point (see Figure 2).\(^9\) Hence we estimate the yield curve factors using only data since September 2002 (61 two-week periods) and present the newly estimated $\beta$'s in the right panel of Figure 1, with summary statistics in Table 2. The three plots indicate that all $\hat{\beta}$'s are more stable with narrower confidence intervals.\(^10\) This feature is driven by the fact that since September 2002 the additional government bonds started to be traded on a daily basis.

We follow the estimated term structure over time and show snapshots from September 2002, 2003, and 2004, and from February 2005 (see Figures 3 to 6). The yield curve is concave in all cases, indicating positive growth of the economy. The prediction is roughly confirmed: real GDP growth rates in the years 2002-2005 are 4.3%, 2.4%, 8.8%, and 5.5%, respectively (the Economist Intelligence Unit 2006). We also compare the estimates with the observed yields. Figure 7 shows yields for bills with maturity approximately equal to three months and Figure 8 for bonds with a five year maturity. The observed and estimated three month yields are typically getting closer in March of each year when A-series bonds fall into the three month range. Otherwise the observed yields are only Serbian Treasury Bills, which are auctioned infrequently and hence have only a small effect on the estimated term structure. In spite of this irregularity, the yields are getting closer towards the end of the sample period even for other months. The five year bonds are always the FCS-Bonds and hence the observed and estimated yields are close for all

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\(^9\)The number of observations drops regularly around the end of each year, marking the beginning of the Serbian Christmas season. Serbia celebrates Christmas according to the Eastern Orthodox Church, which uses the Julian calendar, making January 6 Christmas Eve.

\(^10\)Please note a different scale on the y-axis in the left and right panels of Figure 1.
The results of our estimation show that the estimates of the term structure fit best the data on the FCS-Bonds that are traded on a daily basis, but work less reliably with the less traded bills. The frequency of traded volumes and the relative availability of information contained in prices formed on the market should be seen as the main drivers of these results.

When we pair our estimation results with the liquidity issue we see that the spread of the Serbian bonds relative to common European benchmarks is in an unsuitable range from the medium-term perspective. A significant part of the spread (about 15 basis points) of FCS-Bonds relative to euro-area government securities of comparable maturity is accounted for by differences in liquidity and credit risk.\(^\text{11}\) We believe that the current situation would improve with introducing higher liquidity, while decreasing the credit risk is a long-term objective. For increased transparency and liquidity of the secondary bond market specific market microstructure improvements are needed. Eliminating additional barriers in the settlement and clearing system and in the system of transaction fees is a necessary step. In particular, the transparency of over-the-counter trading should be greatly increased since there is very limited information about trades conducted over-the-counter and such an absence decreases market efficiency and hurts price formation mechanisms.

5 Macroeconomy and the Yield Curve

As a robust check to the previous estimation, we now investigate the interaction between an economy and the yield curve. We follow the approach in Diebold, Rudebush, and Auroba (2003) who use impulse response functions and variance decomposition. While the macro variables react very little in response to changes in slope or curvature, they

\(^\text{11}\)The high liquidity and range of maturities of government securities differs markedly across markets. The U.S. treasury securities are liquid in all maturities (from 3 months to 30 years), while the EU government securities are not liquid in all maturities (and typically have their benchmark – the “benchmark” is defined as the lowest-yielding issue – well below 10 years).
respond strongly to the level factor. An increase in level causes increases in capacity utilization, the funds rate, and inflation. In other words, an increase in future perceived inflation implies a lower real interest rate, giving a boost to real economic activity followed by a the reaction of the Federal Reserve. Of interest are also responses of the yield curve factors to changes in macro variables. For example, an increase in the funds rate is followed by an increase in slope, and then a decline, perhaps due to monetary policy raising the short end of the yield curve. Also, the level factor responds positively to inflation surprises.

The present paper examines the relationship among the yield curve factors and macroeconomic variables for the case of Serbia. Based on data availability, we will focus on the interaction among the N-S factors and inflation, industrial production, and exchange rate. All the considered time series have been tested for unit roots using the Augmented Dickey Fuller test with lag selection based on the Schwartz information criteria and the Phillips Perron test with the Barlett kernel estimation and the Newey-West data dependent bandwidth. The null hypothesis of the unit root has been rejected in all cases at the 10% level of significance.

We first conduct Granger causality tests (see Granger 1969). The concept of Granger causality does not refer to the common understanding of the word; rather, it reflects the mutual predictability of given variables. It attempts to quantify the usefulness of a variable (say, \( y \)) in the prediction of another variable (say, \( x \)). \( y \) is said to Granger-cause \( x \) if \( x \) and its past values improve prediction of \( y \) when used in addition to past \( y \)'s. The following bivariate regressions are estimated:

\[
\begin{align*}
y_t &= \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \ldots + \beta_l x_{t-l} + \epsilon_t, \\
x_t &= \alpha_0 + \alpha_1 x_{t-1} + \ldots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \ldots + \beta_l y_{t-l} + \nu_t
\end{align*}
\] (2)

for all 30 pairs of the term structure factors and macroeconomic variables. The null hypothesis is

\[ H_0 : \beta_1 = \beta_2 = \ldots = \beta_l = 0, \] (3)
and if it is rejected, then $x$ Granger causes $y$ in the first regression and vice versa in the second regression.

Table 3 reports F-statistics, which are the Wald statistics for the joint hypothesis (3). The level factor $\beta_1$ and inflation are intimately related via Granger causality, confirming the relationship found in DRA. The curvature factor provides extra information in the explanation of the time series behavior of the slope factor $\beta_2$, depreciation and industrial production. This is perhaps not so surprising since the curvature parameter contains not only information about the yields but also about the past depreciation of the dinar, which can have additional predictive content. Finally, inflation also improves the prediction of the curvature factor as well.

Following DRA and complementing Granger causality tests, impulse responses to exogenous shocks are calculated as well. Contrary to the notion of Granger causality, the impulse responses do address the question of causality in the standard sense. A VAR process for the six series is estimated with only two lags for endogenous variables due to a small number of observations. Impulse response functions are shown in Figure 9 and Figure 10 and include 95% confidence intervals. We can see (almost) significant responses of the level factor to inflation and of the slope factor to industrial production, similarly to DRA (who use capacity utilization instead of industrial production). In other words, the macroeconomic situation determines the shape of the yield curve. According to DRA, the opposite is not true; in our case however, depreciation does respond to changes in the slope factor. There are two potential explanations for this phenomenon: it may be artificially caused by the fact that our yield data do include ex-post depreciation or it may be caused by the smaller size of the Serbian economy as compared with the United States, in which case some of the interest changes may be exogenous.
6 Conclusion

Emerging bond markets in transition economies has attracted little attention so far, despite their importance for creating standard conditions for state and firm debt financing, and financial stability and economic growth in general. Similarly, pointing at driving forces behind their emergence towards efficiency has been neglected as well. We analyze the Serbian bond market and its emergence by modeling its term structure along with assessing its important links to macroeconomic variables.

We use the Nelson-Siegel (1987) model whose estimated three yield curve factors are stable over time since September 2002. The term structure is concave during the estimated period, followed by a subsequent positive growth of real GDP. The level factor is increasing and so is inflation. The curvature is declining, which is in line with a depreciating dinar. We further examine the relationship among the term structure factors and macroeconomic indicators, namely inflation, depreciation, and industrial production. They are highly correlated and shocks in inflation and industrial production are reflected in the time series behavior of the level and slope factors, respectively. We identify important links among the yield curve factors and macroeconomic variables. These links confirm the predictive power of the term structure with respect to the business cycle in Serbia.

The presented analyses allow us to interpret the results in terms of market irregularities and needs for institutional changes. Despite some weaknesses, yield curve estimation results indicate that there is a promising transition pattern towards a more mature market. Moreover, we document a standard relationship between the term structure and macroeconomic developments. Since Serbian market is one of the most fragile and volatile emerging markets, we believe that a similar approach can be applied to also to other developing economies.

Based on our empirical analysis we are able to pin point factors that seem to be of importance not only in Serbia but also in countries that are trying to set up a well working bond market in the wake of substantial instability. Following summary points at what
countries in a similar situation can learn from the Serbian bond market experiment.

According to our results the estimates of the term structure fit best the data on the bonds that are traded on a daily basis, but work less reliably with the less traded bills. Daily frequency of traded volumes should be regarded as important feature of the market then. Further, Serbia should work on changing the term structure of the government bonds by shifting their debt towards domestic currency-denominated bonds of long-term maturities. This step will eliminate opaqueness in the market caused by the co-existence of government bonds denominated in two different currencies. It should also add stability to the debt management as well as attract foreign investors. In the same spirit countries with new bond markets should avoid double-currency denominated bonds and domination of short maturities.

Further, the transparency and liquidity of the secondary bond market should be increased by the enforcement of the existing laws, and stronger reporting requirements should be imposed by the Securities Exchange Commission. Clearly, our model indicates several problems related to the OTC trading, which is most pronounced for OTC-traded bonds close to the maturity, mainly due to the lack of information on prices and volumes. Thus, in addition to the Belgrade Stock Exchange, it is imperative to continue building a transparent trading system to minimize the use of private or insider information. Similar approach should be adopted where a new bond markets are about to open.

To conclude, we believe that the overall fit of the model and its link to macroeconomic variables would be enhanced if off-market trading was suppressed or at least minimized. Price formation mechanism is a key for better fit of the model and market functioning. Our results show that the frequency of trading and market liquidity deeply matter for the new bond market emergence. Together with transparency they can be considered as drivers that make the market emerge.


### Table 1: OTC trading as a percentage of total trading (i.e. OTC+BSE)

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Table 2: Data summary statistics (2002:9-2004:12)

Note:
BETA1-BETA3 are the time series of the OLS estimates of the yield curve parameters, INFL is the inflation rate, DEPR is depreciation of YUD w.r.t. EURO, and IPCHANGE is the change of the industrial production index w.r.t. to the average of the previous year

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<th>BETA3</th>
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<th>DEPR</th>
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<th>INFL</th>
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Table 3: Pairwise Granger causality tests (2002:09 2004:12, 2 Lags)

Note:
BETA1-BETA3 are the time series of the OLS estimates of the yield curve parameters, INFL is the inflation rate, DEPR is depreciation of YUD w.r.t. EURO, and IPCHANGE is the change of the industrial production index w.r.t. to the average of the previous year. Only tests significant at 10% are reported.

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<td>INFL does not Granger Cause BETA3</td>
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<td>0.06</td>
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<td>BETA1 does not Granger Cause INFL</td>
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<td>0.07</td>
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<td>BETA3 does not Granger Cause DEPR</td>
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<td>0.05</td>
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<td>BETA3 does not Granger Cause IPCHANGE</td>
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<td>0.10</td>
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<tr>
<td>Yield curve → yield curve</td>
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<td>BETA2 does not Granger Cause BETA1</td>
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<td>BETA3 does not Granger Cause BETA2</td>
<td>2.96</td>
<td>0.07</td>
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</table>
Figure 1: Time series of $\hat{\beta}$’s (with 95% confidence intervals) - the whole sample and data since September 2002.
Figure 2: Number of observations over time
Figure 3: Observed versus estimated yields, September 2002

Figure 4: Observed versus estimated yields, September 2003
Figure 5: Observed versus estimated yields, September 2004

Figure 6: Observed versus estimated yields, February 2005
Figure 7: Time series of 3-month yields

Figure 8: Time series of 5-year yields
Figure 9: Impulse responses of macroeconomic variables to shocks to the yield curve factors

Note:
BETA1-BETA3 are the time series of the OLS estimates of the yield curve parameters, INFL is the inflation rate, DEPR is depreciation of YUD w.r.t. EURO, and IPCHANGE is the change of the industrial production index w.r.t. to the average of the previous year. Response to Cholesky one s.d. innovations ± 2 s.e. are reported.
Figure 10: Impulse responses of the yield curve factors to shocks to macroeconomic variables

Notes:
BETA1-BETA3 are the time series of the OLS estimates of the yield curve parameters, INFL is the inflation rate, DEPR is depreciation of YUD w.r.t. EURO, and IPCHANGE is the change of the industrial production index w.r.t. to the average of the previous year. Response to Cholesky one s.d. innovations ± 2 s.e. are reported.