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YIELD CURVE IN BOSNIA AND HERZEGOVINA: FINANCIAL AND MACROECONOMIC FRAMEWORK

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Abstract

Finance and macroeconomics have different perspectives on the yield curve. In the case of Bosnia and Herzegovina, specific context, data issue and financial market that is in its developing phase, do not allow us to have one, unique perspective. The Nelson-Siegel yield curve model could be appropriate, but additional information provided by factor augmented vectorautoregression, that is found to be appropriate macro-economic tool, could be crucial for the correct analysis. Nelson-Siegel model performs better than Svensson model in this case, but results interpretation could be confusing. The reason for that could be, the significant importance of „foreign“ factors for the observed economy. Factor analysis allows us to control certain latent factors and in the nexus „domestic“ versus „foreign“ factor this could be crucial feature. The overall relative significance of “foreign”, when it is compared to the significance of the “domestic” factor, convince us in the importance of exogenous factors for B&H’s economy.

Keywords: Nelson-Siegel model, factor analysis, vector autoregression.

Jel Classification: 43; E44; G10

INTRODUCTION

It is hard to have unique perspective of yield curve, and it becomes even harder in the case of Bosnia and Herzegovina (B&H). The financial market is not deep enough, lack of data and market distortions, are some of the problems. We will try to provide the perspective from the macroeconomic and financial standing point, simultaneously. Usually, macroeconomist look at the interaction between yield curve, inflation, output

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and other parameters related with the economic activity. On the other side, financial economists do not put huge importance on those factors.

First, we will estimate the yield curves on the financial markets in B&H, based on monthly data in years 2014 and 2015 both with Nelson-Siegel and Svensson model, and compare obtained results. Here, we can go a step further and research problems related to some “strange results” that have been provided by the preliminary research. We will try to find explanation for those results by analyzing relation between interest rates, domestic and foreign factors, in vector autoregression macro-economic framework (VAR)

Many activities on the financial markets are actually determined by the relationship between the interest rate and the maturity. The fixed-income pricing relies heavily on the spot rates, which are zero-coupon investment rates that start at the current time. From the spot rates, we can infer the forward rates, which are the rates that start at the future spot rates.

The conventional literature focuses, as one could expect, on the most developed financial markets in the world. This remark stands especially for the papers that have been produced during 20th century. Developed markets are deep, and that is one of the main difference between those markets and emerging markets.

The liquidity issue, is one of the main problems of emerging financial markets that are the markets with increasing significance. There is a possibility that approach and methodology used for developed markets could not be suitable for emerging markets by default.

Here, we want to impose the question about the key drivers of the interest rates in B&H and emphasize the importance of additional analysis during the interpretation of information gained by yield curve approach.

We are dealing with the economy that has no autonomous monetary policy, but has huge participation of remittances, loans and foreign aid in capital flows and high unemployment. Intuition allows suspicion that the foreign factor could have the significant importance in overall economic activity. Therefore, we use the factor analysis as methodology to emphasize the importance of the conditional interpretation of information gained by yield curve.

Additional problem is that there is no reference interest rate. Nexus interest rates, financial market and currency board in B&H looks like black box. It is hard to make some concrete conclusion in this specific macro-economic context.

We use the factor analysis to see what drives the interest rates, in general. Are the domestic factors key drivers, or the foreign factors have crucial impact? So, we will construct “foreign” and “domestic” factor, and then we will apply factor augmented vector autoregression (FAVAR).

We have the interest rates on the loans to private sector and the interest rates on the loans to households. We use those time series to see how interest rates in general response on the shock caused by factors that are classified as domestic and foreign. For factors noted as “domestic” we use several time series related with output, prices, net export and money in B&H. Factors, notes as “foreign” and “foreign2”, reflect the economic activity of the two major trading partners for Bosnia and Herzegovina: Germany and Italy.

Contribution of this paper is that provides analysis of the yield curve in B&H in the classic financial context. Also, we make additional step, and analyze interest rates

movements in FAVAR framework. Confirmation of high dependence on the main trading partner and EU, in general, is a clear implication for the policymakers. Naturally, this could be associated with lack of autonomous monetary policy, but this theoretically based doubt now gets its confirmation.

The rest of the paper is organized as follows. Section 1 presents the literature review. Section 2 presents theoretical background for methods that are used. Section 3 summarizes the stylized facts about B&H's economy and presents the appropriate yield curve model, section 4 describes and discusses the loadings for the factors and overall construction of the factors. The results of the empirical undertaking are documented in Section 5. Final section offers concluding remarks.

1. LITERATURE REVIEW

It is possible to observe the yield curve from micro and macro aspects. On micro aspect the yield curve helps investors alerting them on the possible recession, or opposite, the upturn of the economy. Also, the yield curve can be used as a benchmark for pricing other securities with fixed interest rates. Macro aspect of the yield curve emphasizes the importance of the term structure of interest rates for the macroeconomic analysis. Also, global yield level and slope factors do indeed exist. Moreover, the global yield factors appear linked to global macroeconomic fundamentals (inflation and real activity). Diebold, Li and Yue have made additional steps in terms of forecasting by incorporating a simple first-order autoregressive model, but for that approach, time series with certain properties are essential (Diebold, Li, and Yue 2007).

We want to impose “foreign” and “domestic” factors that define yield curve, and those are basically latent factors. Yield curve from financial perspective is defined by “slope”, “curvature” and “level”. None of those factors are not in the direct relation with the macroeconomic context. That context has huge importance, if it is as specific as it is in the case of B&H.

Zoricic and Orsag suggested that parametric (Nelson-Siegel and Svensson) models dominate spline and other yield curve modeling approaches in illiquid and undeveloped financial markets. Authors in this paper have come to interesting conclusion that will be exploited in this paper in the context of B&H: for smaller financial markets, Nelson-Siegel is preferred over the Svensson model (Zoricic and Orsag 2013).

For long, there has being interest in estimates of rates of interest on standard bonds in terms of a standard list of times to maturity, interpolated from the rates of interest on bonds of those maturities that are actively traded (Schiller and McCulloch 1987).

Vasicek has derived a general form of the term structure of interest rates with following assumptions: spot interest rate follows a diffusion process, the price of a discount bond depends only on the spot rate over its term and market is efficient (Vasicek 1977).

Also, there are models that are specifying the simple relationships among the yields and providing term structure derivative prices, that are both computationally tractable and consistent with the absence of arbitrage (Duffie 1996).

Yield curves can be monotonic, humped or S shaped. Last option is relatively rare. Sometimes, hump can be spike, and somehow it seems that situation is relatively often

for Svensson model in situation where we have relatively illiquid markets, that are, almost by definition, also undeveloped.

Often used model for developing yield curve in the practice is the Nelson-Siegel model presented back in 1987.

Nielsen and Siegel wanted to provide the basis for parsimonious model capable of representing the range of shapes previously associated with the yield/term to maturity relationship or yield curve and that has been achieved by solution of a second order differential equation.

The Nelson-Siegel model is highly nonlinear. That might be the reason for estimation problems reported by many users. This model is a result of transformation of nonlinear estimation problem into a simple linear problem. This procedure is performed by fixing the shape parameter that causes the nonlinearity (Annaert et al. 2013).

As it can be expected, markets that are not deep enough would not provide good base for prediction out of the sample. So, one could argue the justification of the potential implementation of pricing model that is not able to provide pricing a long-term bond.

The second part of the paper addresses the problem of defining the key factors for the interest rates movements in B&H.

Principle component analysis (PCA) is often used for yield curve analysis. Several authors have addressed issue: Litterman and Scheinkman (1991), Barber and Copper (1996), Falkenstein and Hanweck (1997), Lekkos (2001) and so on. But, focal point is the paper by Stock and Watson.

PCA uses eigenvectors and eigenvalues to reduce the data dimensionality. Factor analysis (FA) is intuitively similar approach. But, there are some differences. Sometimes FA could be defined as more flexible than PCA, but also it looks technically more demanding. We can set problems in context of factor-augmented vector autoregression, as some authors, to exploit numerous macroeconomic variables for factor construction, and then set the problem where all variables are endogenous. Result is improved forecasting performances (Moench 2008).

Stock and Watson have showed that for consistency we need sufficiently large N and T . Also, they suggested that we will face the instability of the factors over time in the form of stochastic drifts. But, if the drift is not too large, the model should be robust enough (Stock and Watson 2002). Here, we will assume this robustness and that assumption will be based on previous data transformation.

Here we want to make a step to model that is a combination of no-arbitrage finance specification of the term structure of interest rates and the classic macroeconomic output inflation nexus. This is only one step in that direction and there is a long way to the final model as it has been presented by Rudebusch and Wu (Rudebusch and Wu 2008).

We use vector autoregression, or factor augmented vector autoregression with exogenous variables (FAVARX) to be precise. Vector autoregression has been used in the same context, because it is shown that VAR is solid approach for forecasting interest rates. Even further, arbitrage, affine term structure can be used for VAR priors and that should increase the forecasting performances (Carriero 2011).

We want to include the real economic parameters in the macroeconomic context to overlook the movements of interest rates, because the real economic agents have the interest for the information provided by the yield curve. Inclusion of the real economic factors and parameters related with the prices is important (Aruoba and Diebold 2010).

There are numerous examples of factor analysis application in the macroeconomic yield curve overlook. This logic can be applied for the analysis of the excess bond premiums and macroeconomic parameters (Ludvigson and Ng 2009).

Nelson-Siegel model assumes the expectations hypothesis. So, basically, long-term interest rates are expectations of future averaged short-term rates. Gurkayn and Wright showed that yield curve constructed under the expectations hypothesis imposes some open questions. The macroeconomic factors do play significant role, but it is suggested that inflation plays almost crucial role (Gurkaynak and Wright 2012). In B&H we have low inflation rate with extremely low variability, so explanation power of inflation in any context could be questioned.

We were not able to go deeper in the sense of imposed restriction in context of relation between slope and macroeconomic parameters, as it can be found it existing literature (Kurmman and Otrok 2013). It is hard to have strong underlying assumption for those kind of restrictions in the context of B&H.

2. MODEL

We have two models, one that addresses the issue of the yield curve, and second one that describes the FA.

2.1. Yield curve model

Nelson and Siegel set problems in following terms.

If instantaneous forward rate at maturity m is given by the solution to second-order differential equation with real and unequal roots, we would have

$$r(m) = \beta_0 + \beta_1 \exp\left(-\frac{m}{\tau_1}\right) + \beta_2 \exp\left(-\frac{m}{\tau_2}\right) \quad (1)$$

where τ_1 and τ_2 are time constants associated with the equation and β_0 , β_1 , and β_2 are determined by initial conditions.

The Nelson-Siegel's model to describe the yield curve is:

$$R(m) = \beta_0 + \beta_1 \frac{1 - \exp(-m/\tau)}{m/\tau} + \beta_2 \left(\frac{1 - \exp(-m/\tau)}{m/\tau} - \exp(-m/\tau) \right) \quad (2)$$

Intuition behind the components becomes more meaningful when their limitation is observed with respect to the time to maturity. In that context, if we look at the slope and curvature component when the time to maturity grows to infinity, we can see that those components are disappearing. Also, long-term forward and spot rate will converge to the same constant level of the interest rate, β_0 .

A class of functions that readily generates the typical yield curve shapes is associated with solutions to differential of difference equations. The expectations theory of the term structure of interest rates provides heuristic motivation for investigating this class. Since spot rates are generated by a differential equation, then forward rates, being forecasts, will be the solution to the equations (Nelson and Siegel 1987).

The forward rate curve contains the same information as the spot rate curve. Difference is that first one provides information that is easier to interpret for monetary policy purposes. Therefore, the forward rate curves separate market expectations for the short, medium and long term more easily than the spot rate curve.

2.2. Factor augmented vector autoregression

FAVAR as framework was initially proposed by Bernanke, Boivin, and Elias (2005). The key idea is that model catches the impact of observable economic variables but also the impact of unobserved factors.

We follow the same original notations as Bernanke, Boivin, and Elias (2005):

- Y_t is vector of observable economic variables, with dimensions $M \times 1$
- F_t is vector of unobserved factors, with dimensions $K \times 1$

We can write for the joint dynamics:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + v_t, \quad (3)$$

where a conformable lag polynomial is noted with $\Phi(L)$, v_t stands for error term with zero mean and covariance matrix.

As we have said, the factors F_t are unobservable. So, equation (3) cannot be estimated directly. Basically, we hope to capture some of the information related to those factors from relatively large set of time series. So, we have time series X_t that are related to the unobservable factors F_t and the observed variables Y_t . So, we have the equation that is given by:

$$X_t = \Lambda^f F_t + \Lambda^y Y_t + e_t \quad (4)$$

In this relation we have:

- Matrix of factor loadings Λ^f with dimensions $N \times K$.
- Λ^y is $N \times M$ dimension.
- e_t is $N \times 1$ vector of error terms.

We assume that error terms are normal and uncorrelated. It is possible to assume the small amount of the cross-correlation, depending on the estimation procedure.

The key idea is that Y_t and F_t stand for forces that affect the X_t . Conditional on Y_t , the X_t are noisy measures of the factors that work in the behind of observed dynamics (in this case those factors are F_t). In the relation (3) we can see that X_t does not depend on lagged values. But, in FAVAR(X) factor can be interpreted throughout the perspective that includes lags of the factors.

3. STYLIZED FACTS AND YIELD CURVE MODEL

B&H is a small, open economy that is under the currency board regime. As a result, we have no autonomous monetary policy, therefore there is no high expectation regarding usual monetary transmission mechanisms. So, question what determines yield curve is a complex in this case and providing the one-dimensional answer is not possible.

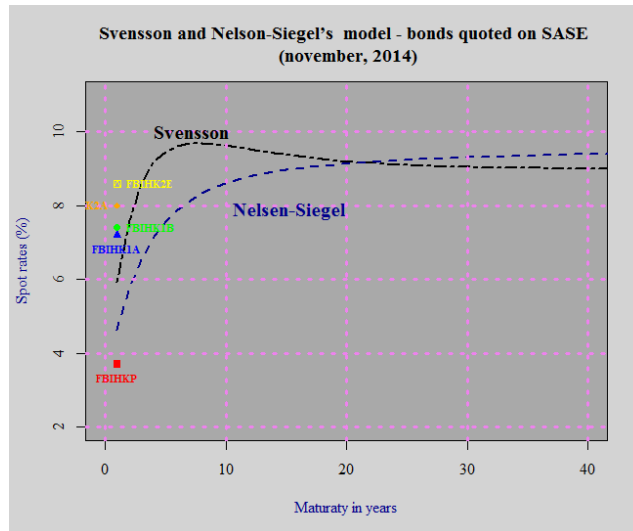


Figure 1. Bonds quoted on SASE

Inflation is low, remittance are high as well as unemployment. In the recent history, although there is the trading balance deficit, the reserves of central bank have increased, and we recorded persistent growth of M2. All this could provide some suspicion that B&H is highly sensitive on the exogenous shocks (Baskot 2016).

Now, we come to the question how to overlook the interest rates movements by the curve that is constructed according to the yield on bonds that are quoted in such macro-financial context?

In B&H, we have two types of bonds:

- Fixed-coupon bonds pay a fixed percentage of the principal every period and the principal as a balloon payment at maturity.
- Zero-coupon bonds, which pay no coupons but only the principal; their return is derived from price appreciation only.

There are two different stock exchanges on two different locations. One stock exchange is located in Sarajevo –SASE and other one is located in Banja Luka –BLSE. Bonds are quoted on clean price basis. For bonds quoted on BLSE there are yields provided by stock exchange itself. For bonds that are quote on SASE, calculation of yield will be performed by author (based on dirty price).

If we compare figures 1 and 2 then we could potentially conclude that in first case we have in some sense the result that is more logical. Svensson and Nelson-Siegel curves are converging. Second case Svensson curve provides meaningless result for time period over 10 years.

Let us go further and as it was suggested, for illiquid and undeveloped markets, we will use the Nelson-Siegel model because it is shown that this approach is preferable in this kind of situations. For instance, the Svensson model suffers from overparameterization in the Croatian financial market. Similar to the case of the B&H, it adjust itself too much to the available sample data which leads to the yield curve estimates that are not smooth and are often distorted. Results of that kind of distortion are upward and downward pointing spikes at the short end.

We have available data from BLSE for following four data points: November 2014, June 2015, November 2015 and March 2016 (one additional data point would be May or June 2016) (figure 5, appendix).

We can see that we have different curves for different data points. So, one could say that we have relatively confusing results.

First, we have the slightly humped curve, then it goes to sharply humped but not spike curve. Later on, from almost flat line we get upward curve.

There are numerous reasons for the certain obscurities regarding yield curve in B&H. One of main feature of Bosnia's economy would be chonical "randomness". This can be relatively simply observed. If one take a look at industrial production, for last 11–15 years it is hard to spot some kind of pattern. Essentially, we have a random walk in that case. So, we do not have any kind of classical business cycle (Baskot 2016).

Banks justify higher interest rates in B&H because of the higher country risk premium. That can explain why we have decline in the domestic interest rates until 2008. B&H was progressing, war conflict was in the past and country risk was declining. But, after 2008 we could not say that the country risk has started to rise.

Therefore, we will try to see what drives interest rates in B&H. FA analysis is convenient because it allows the action of latent factors.

4. YIELD CURVE IN B&H: "DOMESTIC" AND "FOREIGN" FACTOR CONSTRUCTION

We have choose FA as model because we want to examine the overall importance of "domestic" and "foreign" factors for interest rates movements in B&H. Both of these two factors could be qualified as latent, because we cannot precisely define them from official statistical reports. It is possible to form some sort of an index, or factor, that is constructed from several available time series.

The factor that is noted as "domestic" is constructed from 4 time series related with consumer price index (CPI), net export, real exchange rate (REER) and index of industrial production in B&H (IP).

We choose two factors constructed from those variable as the parallel analysis has suggested (Appendix, figure 6). Loadings for domestic factors are shown in table 1.

Table 1. Factor loadings and unique variances for domestic factors (LR test: independent vs. saturated: $\chi^2(6) = 104.55$ Prob> $\chi^2 = 0.0000$)

Variable (logs)	domestic1	domestic2	Uniqueness	Scoring coeff. for domestic1	Scoring coeff. for domestic2
CPII_ cpi	0.6439	0.0655	0.5811	0.27593	0.05225
net export -l_net_export	0.0971	0.3748	0.8501	0.00508	0.30958
REER -l_reer	-0.4905	0.2827	0.6795	-0.17473	0.31903
IP -l_IPbh	0.7890	0.0762	0.3716	0.54433	0.13285

We have used regression as method for defining scoring coefficients.

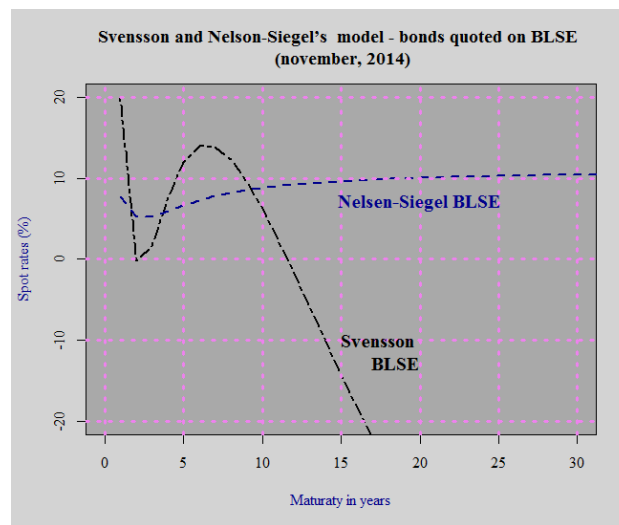


Figure 2. Bonds quoted on BLSE

For “foreign” factor we used index of industrial production and consumer price index for Germany and Italy (main trading partners of B&H). Also, we choose two factors constructed from those variable as the parallel analysis has suggested (Appendix, figure 7), and according to loadings presented in table 2.

Table 2. Factor loadings and unique variances for foreign factors (LR test: independent vs. saturated: $\chi^2(6) = 1090.13$ Prob> $\chi^2 = 0.0000$)

Variable (logs)	foreign1	foreign 2	Uniqueness	Scoring coeff. for foreign	Scoring coeff. for foreign2
German CPI - l_cpiD	0.9958	0.0136	0.0081	0.69642	0.60118
Italy CPI - l_cpil	0.9930	-0.0165	0.0136	0.41657	0.16343
IP German - l_ipD	0.5832	0.7582	0.0851	-0.06308	0.39507
IP Italy - l_ipI	-0.8291	0.5298	0.0319	0.09040	1.19256

All data are monthly data starting from 2005 until June 2017, except IP for B&H. Monthly IP for B&H is available from 2006 until June 2017. Data are gained from Central Bank and Agency for Statistics of B&H. Data that are related to B&H’ main trading partners are gained from Eurostat’s website.

6. FAVAR: RESULTS AND APPLICATION

After we had formed the factors, decided which one to use, we can proceed with VAR. Identification scheme is simple. The foreign factors are set as exogenous. It is reasonable to assume that there is no way that the economy of B&H can have the impact on the economic activities of Germany and Italy. We cannot impose any assumption regarding the ordering of two domestic factors. So, we assume it is irrelevant which, *domestic1* or *domestic2*, comes on first place (in the context of the Cholesky decomposition).

There is no long enough time series related to reference interest rate for B&H. Therefore, we use interest rates on household loans and interest rates on private sector loans to construct two separate FAVARX model. Aim is to draw global conclusion about interest rates movements.

Number of lags is 2. We did not want to make large VAR model, because we want to get the picture about direction of response of interest rates. To be precise, we are satisfied with contours of the picture that will allow us to compare the impact of foreign factors versus domestic factors.

So, we do not have the pressure of the forecasting procedure to deliver the model with high precision performances. Finally, we chose the FAVARX (FAVAR with exogenous variable) because:

- VAR allows us to exploit the endogeneity as a feature.
- But, we have the possibility to make foreign factors totally exogenous.
- If there is any cointegration we will use it – stability of the models is easily confirmed with unit root test.

Model 1

First we look at the interest rates on private sector loans. Model has following specification:

$$\begin{array}{l} \text{endogenous} \left\{ \begin{array}{l} \text{PrivateEntInterest} - \text{private sector loans interest} \\ \text{domestic} - \text{first domestic factor} \\ \text{domestic2} - \text{second domestic factor} \end{array} \right. \\ \text{exogenous} \left\{ \begin{array}{l} \text{foreign} - \text{first foreign factor} \\ \text{foreign2} - \text{second foreign factor} \end{array} \right. \end{array}$$

Let us look the main impulse-response functions at figure 3.

As it could be expected, the model lacks precision, but that was not the point at the first place. If nothing else, than the log transformation will decrease “the sharpness” of the model.

We can see the unit roots and confirmation of the model stability at figure 7 (Appendix)

If we compare the loadings and the results of the first domestic factor (*domestic*) we can see that, although CPI comes with the huge loading, it seems that due to the significance issue, we could not assume positive impact of domestic prices on interest rates. Second domestic factor (*domestic2*) comes with the huge loadings of REER. In that context, we see more reasonable situation – postponed effect of net export and REER on interest rates. But, what does effect of REER means in the currency board regime for the policy makers?

Overall, it seems that output has no influence on the interest rates on the loans for private sector, except when it addresses the part that is related with the export.

There are two “domestic” factors. One comes with the high loadings for CPI and IP, and second one is coming with the high loadings for export and REER. Low loadings for net export and negative loadings for REER, for the first factor, indicates low correlation of export and negative correlation of REER with the rest of the loadings (variables). The positive correlation of REER and net export is expected, because the trading balance deficit will rise with the currency appreciation. But, if we look at the relation between net export and domestic prices and output, then we can doubt the power of domestic factors to make any impact on the export ability. We can go further in analyzing tradable sectors, but this is beyond the scope of this paper.

On the other side, foreign factors have clear impact on interest rates on private sector loans. If we look the IRFs, than we can see clear, significant impact of both factors on interest rates. But, what could be puzzling, is the direction of the impact of the first, “foreign” factor – when the prices of main trading partners go up, interest rates on the loans to the private sector go down (and opposite). This could be explained as a result of a strange relation between EU interest rates and interest rates in B&H. The second explanation is related with the lagged effect of increased overall economic activity in the main trading partners. In that sense, the second, “foreign2”, factor has expected impact. This factor, according to loadings in table 2, is related to main trading partners’ output. Therefore, it is expected to have negative impact of this factor on the interest rates.

We do not want to go deeper in analyzing this “puzzling” situation. But, we want to point the feature that is obvious from observing the significance of IRFs on the figure 3 – foreign factors have significant impact and that is not for true for both domestic factors.

Model 2

Now, the variable *interest rates on loans to households* come into the vector autoregression. The model has the following specification:

$$\begin{array}{l} \text{endogenous} \left\{ \begin{array}{l} \text{HouseholdsInterest} - \text{interest rates on loans to households} \\ \text{domestic} - \text{first domestic factor} \\ \text{domestic2} - \text{second domestic factor} \end{array} \right. \\ \text{exogenous} \left\{ \begin{array}{l} \text{foreign} - \text{first foreign factor} \\ \text{foreign2} - \text{second foreign factor} \end{array} \right. \end{array}$$

We can see the unit roots and confirmation of the model stability at figure 7 (Appendix)

The domestic factors have the significant impact on the interest rates on household loans, although the magnitude of the impact is not high. But, still we can conclude that domestic factors have the significant impact on interest rates on household loans. Interest rates go up if the first domestic factor goes up. According to this positive relation between the factor and the interest rates, and loadings, it seems that CPI impact is crucial, in this specific framework. It is reasonable to assume that household loans are related with the part of the consumption related to the households, and this part of consumption highly depends on domestic prices.

The same direction is the impact of the second domestic factor, although the reaction is postponed, and this is expected, because the net export and REER need some time to influence on the loans that are related with the households.

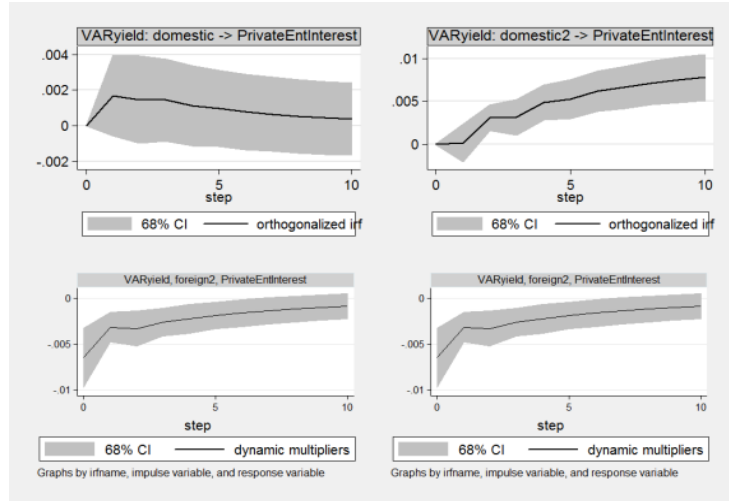


Figure 3. IRF: Impact of foreign and domestic factors on the interest rates on loans to private sectors

The impact of the foreign factors is even more significant than it is the case with domestic factors. Direction of that impact is persistent with one that we have seen in the case of the interest rates on the loans to the private sector.

It is obvious that this model needs a lot of “calibration adjustments” but we do not need forecasting performances. We have enough evidences to see that foreign factors have more “emphasized” effect relative to the domestic factors. This conclusion is highly conditional and should be interpreted only in broader context

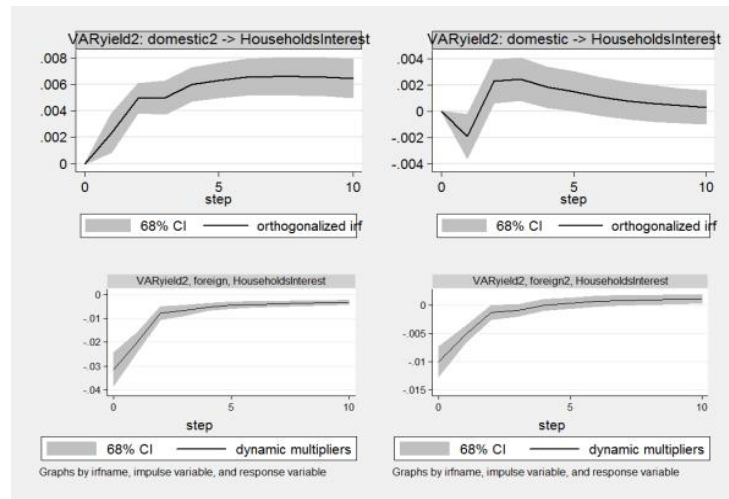


Figure 4. Impact of foreign and domestic factors on interest rates on loans to private sectors

CONCLUSION

We started with the classical yield curve approach in the process of the overseeing the interest rates movements. This approach assumes the inclusion of the various bonds in analysis.

One fact should be noted. Svensson yield curve is sharply humped. Intuitively, speaking, that could be one of the reasons why Nelson-Siegel model is more suitable for small markets, as we have mentioned.

ECB uses Svensson model. But in the case of B&H (and Croatia) that kind of approach does not provide usable results. On the other hand, Nelson-Siegel model seems to provide solid result.

We decided to choose approach that goes on the line with results presented in Zoricic and Orsag (2013). Results presented in that paper suggest that the minimum of five data points need to be available for every observation in the sample in order to estimate the Nelson-Siegel yield curve

In the case of B&H, as an illiquid and undeveloped financial market, there are some additional problems related with the maturity spectrum. That spectrum for financial markets is relatively narrow. Starting point for financial markets in B&H is closer in the past than it is the case for other markets in region that are considered as illiquid and undeveloped.

Nelson-Siegel yield curve is a quantitative approach that in its foundation has logic of autoregressive process (AR) (that is shown by Diebold, Li, and Yue). If we put the analysis in the econometrical framework, we could find numerous reasons for its bad performances. Most of those reasons would have its starting point at the data issue. Short time series, structural breaks, outliers, and so on, do not allow us to catch the dynamics of the interest rates. In addition, we have the specific global framework. Orthodox currency board, high unemployment, huge importance of remittances, are some of the factors of that framework.

FAVARX approach is robust regarding data issues. Also, this approach allows exploiting information from various time series. That information could be used to overlook the feature of latent, unobservable factors. This comes with the certain price. We do not have high precision and ability of a nice interpretability of the results, as it is the case with the AR models. But, we do not need that – in this case the IRFs give us enough information. We can clearly see that “foreign” factors have significant impact on both time series related with interest rates in B&H.

Further work could address yield curve, if additional information could be found. Also, there is possibility to go further on the line with macro-economic context of the interest rates movements.

But, we have seen that one dimensional perspective of interest rates movements is not suitable for the case of B&H. As it is shown in this paper, policymakers should always have on mind the activity in the main trading partners and EU and exogenous factors, generally. This does not provide the alibi for the policymakers. They should show even more capability in decision making than it is in the case of the conventional framework.

Appendix A

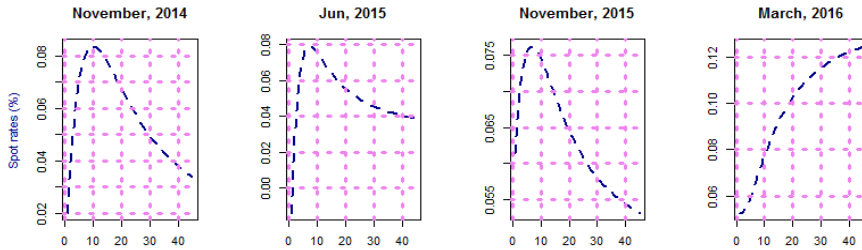


Figure 4. Bonds quoted BLSE -four different data points (right)

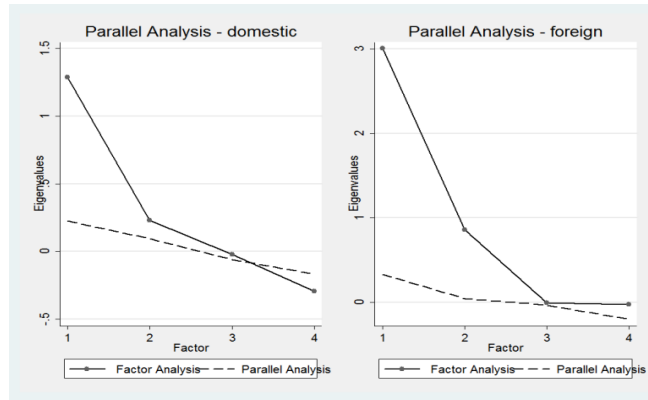


Figure 5. Parallel Analysis for “domestic” and “foreign” factor

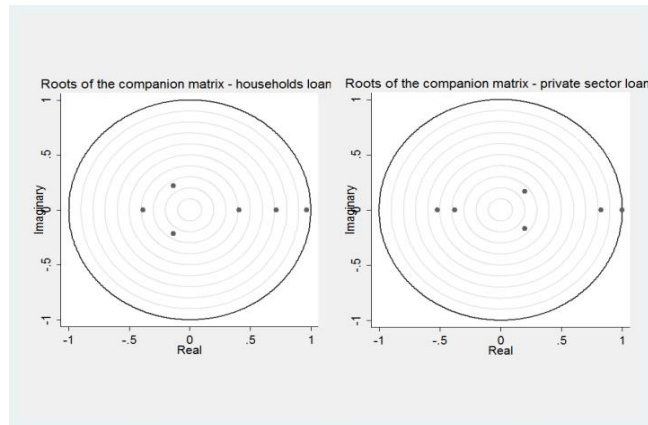


Figure 6. Unit roots – FAVAR with interest rates on the loans to the households

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