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Yield Curve Construction: A Note on the Moldovan bond market

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Abstract

In this note we apply the Nelson Siegel model on the Moldovan Government Securities market. In the Republic of Moldova although remarkable progress for the construction of a medium yield curve has been made during the last five years, the market still lacks the liquidity and depth level that would allow the application of market-based models for the credible description of the yields. Similar to countries with comparable stage of capital market development, the application of the Nelson Siegel model will provide a credible guidance for yields for tenors that either are not traded in the secondary market or even if they are traded the volume is so small that there is no a credible price and yield discovery mechanism.

JEL classification numbers: G10, G12, E43, E44
Keywords: yield curve, bond market, liquidity level, Nelson – Siegel method

1 Introduction

In this paper we present the evolution of the Government Securities (GS) market in the Republic of Moldova. After we show that the Moldovan GS market is illiquid, we present a model for yield curve estimation. The model can be credibly used until the market is developed where the more market-based model can be used.

One of the main uses of the yield curve is the prediction of the interest rate of debt securities as a balance between maturity and debt (Mohammad Narzi, et al, 2015). In case the market is deep and liquid the literature is vast (very good synopsis of the theory and practice for market and structural based models exist in Bringo B., Mercurio F. (2006)). But when the market is illiquid yield curve construction from market price is very challenging because among other things the price discovery mechanism is not credible. In case there are many numbers of illiquid bonds, a phenomenon usual in developing markets there are models that can be used for estimating the yield curve. These models usually presuppose a polynomial shape of the curve and they use the existing bonds for estimating the parameters of the model.

After the seminal work by Nelson and Siegel (1987), many yield curve estimation models have been developed for illiquid markets. It is important to mention that bond prices do not only depend on the evolution of interest rates, but also on the liquidity of bonds (Kempf, A., Uhrig-Homburg, M., 2000). In Indian market, where is illiquid one, the Nelson and Siegel and Svensson methods are found to provide the best results in the estimation of the yield curve (Subramanian, K.V., 2001). Another method for the estimation a yield curve in illiquid markets also can be the mean absolute deviation which is better than the ordinary least square (Goutam, D., Sankarshan, B., Krishnamurthy, V., 2005). In the Shanghai Stock

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Exchange of China, being the illiquid market, for the estimation of the yield curve was chosen the trading data of listed government bonds. In this case, seven different curve-fitting models were compared: cubic, exponential, linear B, exponential B, integrated splines, Nelson-Siegel and Svensson extend models. In conclusion, the exponential spline model is optimal for this market (Chi Xie, Hui Chen, and Xiang Yu, 2006). Another example, for modeling the yield curve, as in the illiquid Croatian financial market, has been used the Nelson-Siegel and Svensson models (Davor, Z., Silvije O., 2013). The results suggest that a minimum of 5 data points need to be available for every observation in the sample to estimate models parameters properly. In the analyzed period the Nelson-Siegel model is preferred over the Svensson model due to overparameterization. According to Chakroun and Abi (2014) for the estimation of the interest yield curve in the Tunisian bond market, which is also an illiquid one, was applied the cubic spline interpolation method. Thus, was created an accurate average yield curve but not smooth. The author Kalotay A. (2017) for creating a yield curve for municipal bonds of the United States, where the market was illiquid, has used the analytical tool CurviLinear™ that minimizes the deviation between the dealer-indicated prices and the fitted bond values. Nelson-Siegel model is useful when trades are few and prices are far apart. The same opinion has authors Baskot, B., Orsag, S. and Mikerevic, D. (2018) who consider that the Nelson-Siegel model is more suitable for small markets in comparison with Svensson, and for more correct analysis, could be crucial additional macro-economic information. Even in the Nigerian bond market, which is one of the most liquid in sub-Saharan Africa, for the creation of a forward yield curve, according to different methods which were used, the best method is the Nelson–Siegel–Svensson method, followed by the variable roughness penalty method. (Lartey, V.C., L, Y., Lartey, H.D. and Boadi, E.C., 2019). Improving the methods of building yield curves in a market with low liquidity will not help to solve deep problems. Therefore, more attention should be paid to the causes of distortions in this market, as well as the submission of suggestions for their elimination (Khakimzhanov, S., Mustafin, Y., Kubenbayev, O. and Atabek, D., 2019). Taking into consideration that in an illiquid market there is not enough bond pricing with different maturities, one of the recommendations is to simplify the yield curve model and use the data from other markets (e.g. derivative market) (Макушкин М.С., Лапшин В.А., 2021).

This paper is organized as follows: In Section 2 there is a brief description of the Moldovan Debt and GS market, and the liquidity indicators, in Section 3 the Nelson Siegel model for the construction of the Moldovan yield curve and in Section 4 there are conclusions.

2 Liquidity of the Moldavan Government Securities market

The GS market in the Republic of Moldova has existed since March 1995 (Radziwiłł, 1999).

The primary market operates through Primary Dealers[4] which are banks that participate in the auctions organized by the Ministry of Finance on behalf of themselves and clients. At the moment auctions include Treasury bills (91 days, 182 days, and 364 days) and bonds with maturities 2 years, 3 years, 5 years, and 7 years. The Primary Dealers are also responsible for providing liquidity in the secondary market.

Figure 1[5] shows the distribution of internal and external debt. The distribution is almost stable for the last five quarters. As of December 31, 2021 the Central Government Debt Outstanding[6] was 77 752, 7 mil. MDL, of which the domestic debt – 42,8% and the external debt – 57,2% of the total.

[4] At the moment of writing this paper the number of primary dealers is nine.
[5] All the data for this paper are provided by courtesy of theMinistry of Finance of the Republic of Moldova , National Bank of Moldova and Bloomberg.
[6] The Central Government Debt excludes local government debt and State-Owned Enterprises.

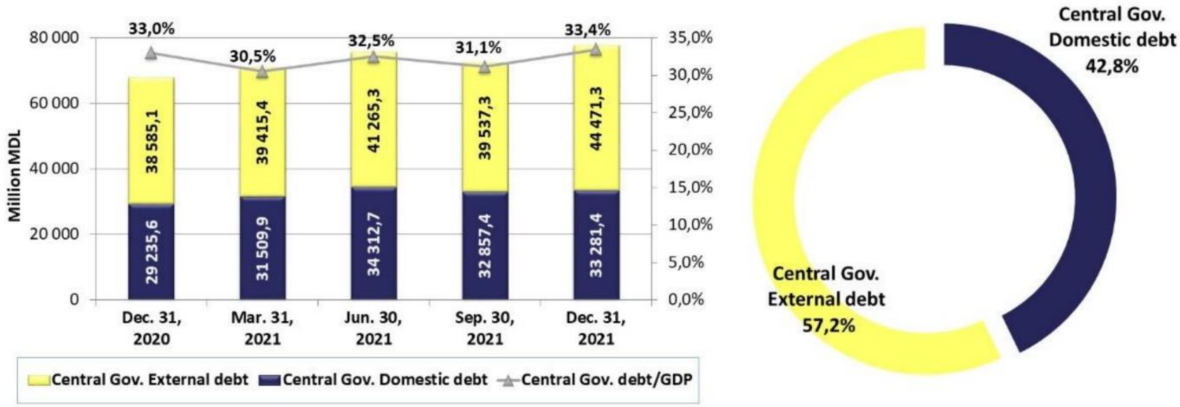

Figure 1: Central Government Debt Outstanding and ratio to GDP

The distribution of maturities in the last five quarters is shown in Figure 2. The major share of domestic debt has a maturity less than a year. As of December 31, 2021, the outstanding amount of GS issued in the primary market was 18 778,1 mil. MDL. The major share is in Treasury bills (85,9%) indicating a short duration something that under difficult economic conditions can create refinancing problems.

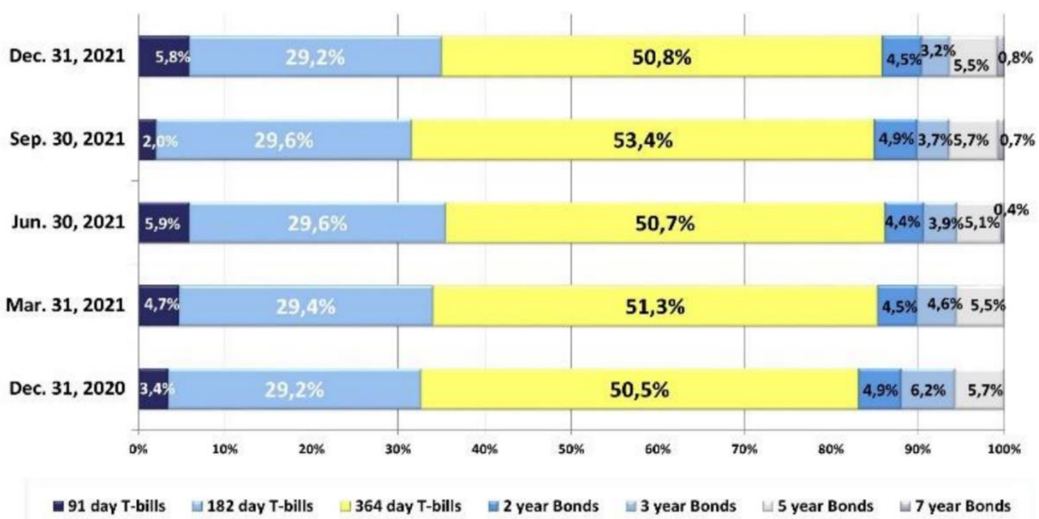

Figure 2: Maturity structure of Government Securities issued in the primary market

Despite the progress made the last five years, the secondary market is still illiquid. In order to have a general overview of market liquidity and depth the following indicators are used:

- *Number of transactions* which shows how many transactions are made during a specific period of time;
- *Turnover ratio* indicates the share of the total outstanding volume that is trading during one year. The higher the level, the higher the liquidity and depth of the market;
- *Total trading volume per quarter* measures the quarterly activity on GS;
- *Average transaction volume* describes the average size of the transacted volume per transaction. A high level shows that it is possible to trade large volumes in a single transaction;

- *Zero-trading days* is calculated as the percentage of not traded days of the GS in total working days per quarter. The higher the result, the lower the liquidity;
- *Average bid-ask spread* is the average of amount by which the ask price exceeds the bid price for GS. The more liquidity and deep is the GS market the tighter is the spread and vice versa.

Figure 3: shows the yearly Turnover ratio and the number of transactions in GS in Moldova.

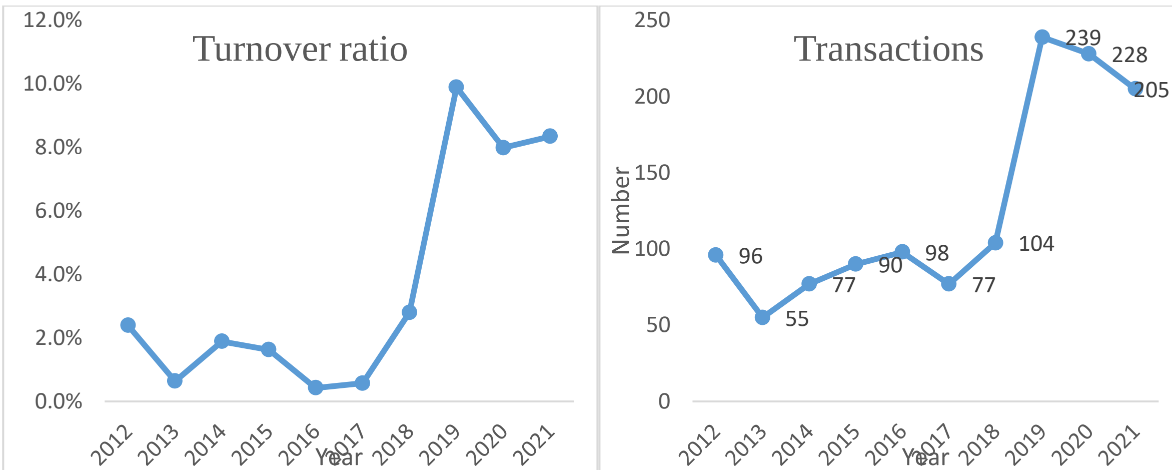

Figure 3: Turnover ratio and number of Transactions from 2012 until 2021

Although the ratio is still very low (below 12%) it has showed a remarkable increase since 2017. Also the number of transactions which was steadily below 90 until 2017 increased sharply in the least three years with peak of 239 transactions in 2019. In any case this shows a highly illiquid market with insignificant secondary market activity.

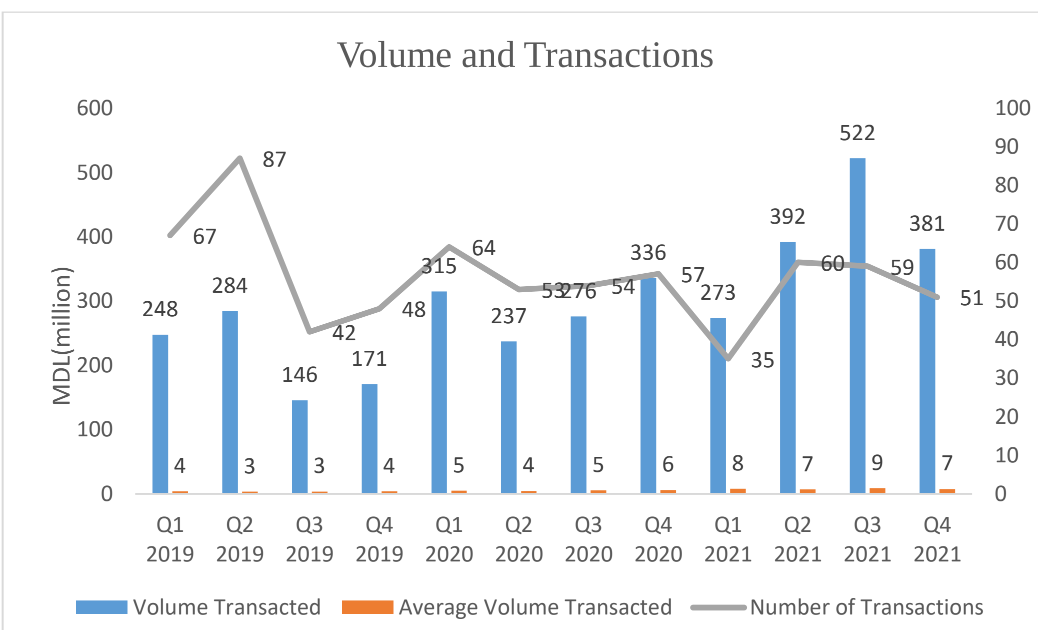

Figure 4: Quarterly volume and transactions

Figure 4 shows the volume, the number of transactions, and the average size of transactions per quarter. The same picture is confirmed here as well. The volume transacted shows a pick in the third quarter of 2021 (522 million MDL) and the average volume transacted ranges from 3 to 9 million MDL (approximately 150 to 450 thousand EUR[7]). Although there is an improvement compared to 2019 volume, the number of transactions and average volume transacted remain very low for a credible price discovery mechanism to be established.

A deeper analysis on a transaction level shows that illiquidity in the market is due to the high inactivity in the secondary market and the high bid ask spreads in the GS bonds.

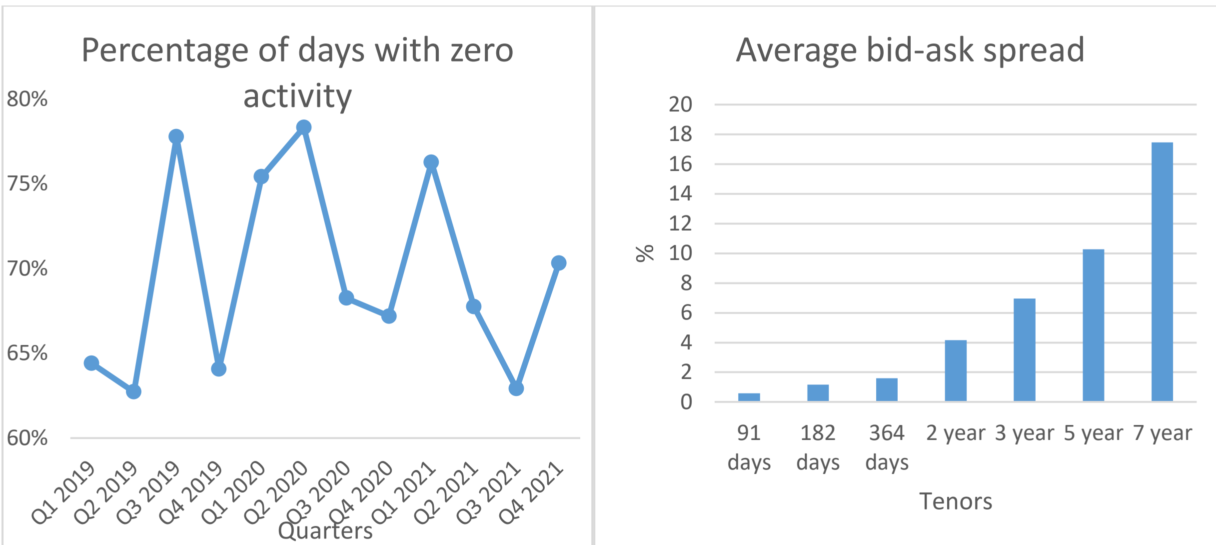

Figure 5: Days of inactivity and Average bid-ask spread[8]

Figure 5 shows that the percentage of zero-trading activity indicator oscillates in the last three years between 63% and 78% with the highest inactivity in the third quarter of 2019 and the second quarter of 2020 and the lowest in the second quarter of 2019, the fourth quarter of 2019 and the third quarter of 2021. The almost systematic pattern shown in the zero-trading days activity and the high share of inactivity periods suggest there the market making of GS in the secondary market is performed by the Primary Dealers in a passive way responding only to sporadic customer orders or for fulfilling their market making obligations[9]. This is confirmed by the bid ask spread by tenors. As it is shown, although the Average bid-ask spread is normal for developing countries for the 3 month T bills (0,6) it dramatically increases in longer tenors, reaching for maturities longer than 2 years up to around 17,5. It is clear that spreads for tenors longer than 1 year is prohibitive for any meaningful trading.

[7] At the time of writing this article, the average exchange rate of MDL compared to EUR is 20,3780.

[8] The period for the bid ask spread calculation was 10 days in the months November and December 2021. Similar results exist for all the periods.

[9] Primary dealer status demand conforming to minimum trading criteria.

3 Construction of the Moldovan yield curve

3.1 Short description of the model

The model for estimating the yield curve in the Moldovan GS market is the Nelson Siegel Model (Pooter, M., 2007). The equation that governs the yield is following:

$$y(t) = \beta_0 + \beta_1 \left[\frac{1-e^{-t/\lambda}}{t/\lambda}\right] + \beta_2 \left[\frac{1-e^{-t/\lambda}}{t/\lambda} - e^{-t/\lambda}\right] = [\beta_1, \beta_2, \beta_3] \begin{bmatrix} 1 \\ \frac{1-e^{-t/\lambda}}{t/\lambda} \\ \frac{1-e^{-t/\lambda}}{t/\lambda} - e^{-t/\lambda} \end{bmatrix} \quad (1)$$

Where $y(t)$ is the yield of a zero coupon bond with t maturity and $\beta_0, \beta_1, \beta_2, \lambda$ are the parameters of the model that need estimation. Usually the second vector in the above equation is called the component vector and their elements are the long term component (1) the short term component $(\frac{1-e^{-t/\lambda}}{t/\lambda})$ and the medium term component $(\frac{1-e^{-t/\lambda}}{t/\lambda} - e^{-t/\lambda})$. Due to the parameter λ her component can capture the usual shapes of yield curves (S-shape, increasing decreasing or humped). Justification for these names comes from the fact that on the long term yield is β_0 ($\lim_{t\to\infty} y(t) = \beta_0$) and the instantaneous short term yield is $\beta_0 + \beta_1$ ($\lim_{t\downarrow 0} y(t) = \beta_0 + \beta_1$). The parsimony and the simplicity of this model justifies its extensive use in illiquid bond markets.

3.2 Data and Results

Monthly data covering the period from 01/01/2017 until 01/04/2021[10] have been used. The evolution of the yields for the Treasury bills and the bonds appear in Figure 6.

Figure 6: Yield evolution for T-Bills and Bonds

[10] Source: National Bank of Moldova: https://www.bnm.md/en.

Since the five years yields follow broadly the international tendency of yield compression. This stopped the second half of 2021 where the inflationary pressures have started to emerge.

We have estimated the parameters for model (1) for every month in the data set. The estimations for $\beta_0, \beta_1, \beta_2, \lambda$ exist in Figure 7.

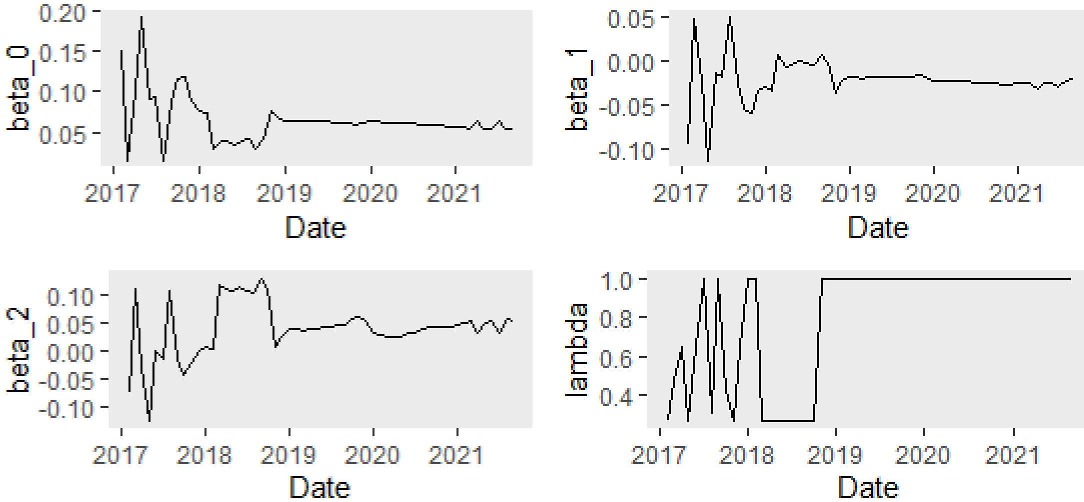

Figure 7: Evolution of model parameters

As we see the estimations of the parameters are stable and after 2019 when the liquidity in the market showed some signs of improvement the estimations show signs of stability.

The actual versus the predicted or fitted yields exist in Figure 8.

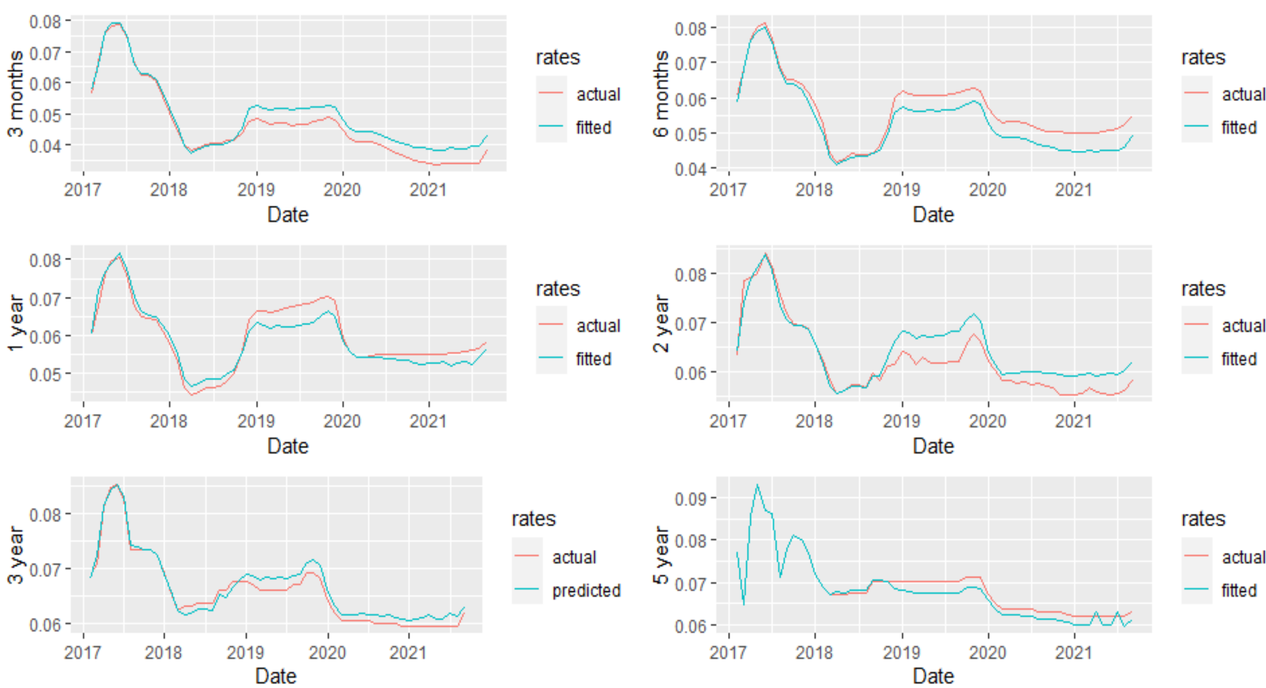

Figure 8: Actual versus fitted yields

As it is shown in Figure 8 the fitted yields are smoother than the actual ones and there is no a systematic pattern of over or underestimation per maturity. The results for the 7 year are not presented since 7 year has only two points in the data set.

Finally in Figure 9 the actual and predicted (up to 10 years[11]) yield curves as seen by the last four dates (01/06/2021,01/07/2021,01/08/2021 and 01/09/2021) in the data are presented.

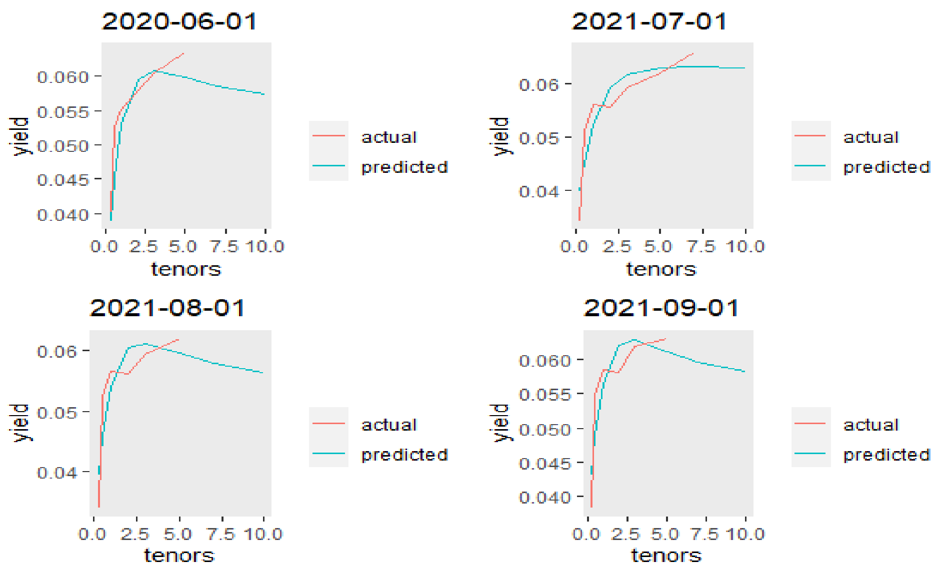

Figure 9: Yield curves using the 5 year data points

From the figure above it is obvious that the model seems to have smooth projections for the long end of the curve with data only up to 5 years. The same happens with the inclusion of the 7-year points (01/04/2021 and 01/07/2021) as it shown in Figure 10.

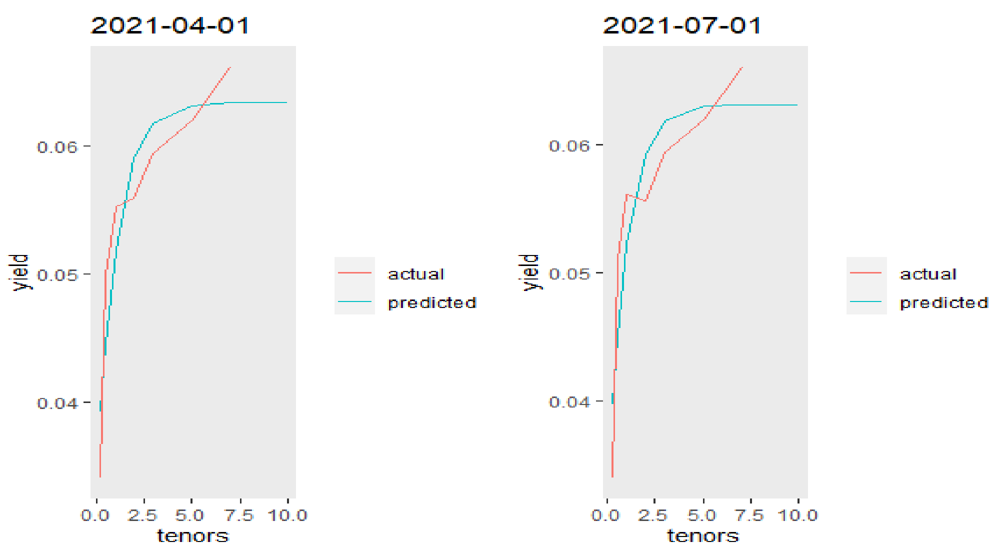

Figure 10: Yield curves using the 7 year data points

[11] The Republic of Moldova has not issued yet bonds with maturities longer than 7 years.

3 Conclusions

In this paper we apply the Nelson Siegel model to construct a yield curve for the Moldovan GS market. Due to the illiquidity and the lack of depth of the market based models cannot be used. The Nelson Siegel model, due to the small differences between actual and fitted yields, and the smooth results it produces provides a base for estimating the level of rates for maturities that are longer than the maturity of bonds that exist in the Moldovan market. This can serve as a guide either for predicting the yields in the Moldovan market or for pricing products with longer term maturities such as long term commercial loans.

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