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Yield curve and its impact on predicting economic growth in Uzbekistan

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Annotation: One of the most important instruments of monetary policy of the state to regulate the country's economy is the open market operations of the Central Bank. Various mechanisms are used to assess the success of these operations. One of these mechanisms is the yield curve. The country influences its monetary policy through the sale and purchase of securities in domestic and foreign markets. The rate of return on bonds issued by the Central Bank is formed as a result of supply and demand for it. Through this change in the level of profitability, international investors will be able to conclude about the current and future state of the country.

This article constructs the equation of the yield curve on government securities and thus analyzes the current state of the REPO operations market.

Keywords: yield curve, treasury bonds, economic growth, Repo operations

1.   Introduction

The yield curve on securities is a curve that reflects the relationship between the maturity of the security and its yield interest rate. This curve is usually directed upwards, according to the theory of liquidity preference. That is, as the maturity of a security increases, so does its rate of return.

The yield curve is used as an indicator of the economic cycle, in other words, depending on the shape of this curve, it is possible to predict how events will develop in the stock market as well as in the real sector of the economy.

In general, the yield curve is a line that reflects the current level of interest rates, as well as the ratio of current supply and demand in the market. To better understand the nature of this curve, it is necessary to look in detail at how the law of supply and demand works, as well as to assess the importance of interest rates.

The interest rate is reflected in almost all sectors of the economy. Every day, companies receive money for certain production needs, and if the cost of borrowed funds increases (due to rising prices), companies will be forced to raise prices for their services to cover their costs.

It has been found that changes in interest rates can have a very strong impact on the economic system as a whole. Therefore, when the rate changes, this is the first signal that the economic development vector has changed, and soon this fact will affect both the stock market and the economy as a whole.

All of the above (demand and demand, as well as interest rates) are reflected in the profitability curve. This is especially true of the government bond curve, as it is this curve shape or curve that reflects the economic situation of each country.

Government bonds have different maturities, short-term (up to 1-2 years), medium-term (up to 5 years), and long-term (up to 10 years) securities and they all have different yields and different prices. Depending on what you expect (rising or falling interest rates in the future), the period in which you are willing to lend will change.

Normal yield curve. If you are hoping for an increase in interest rates, try to buy short-term bonds because in the short term you can invest in higher interest rates. As demand for short-term bonds rises, so do their prices and yields fall.
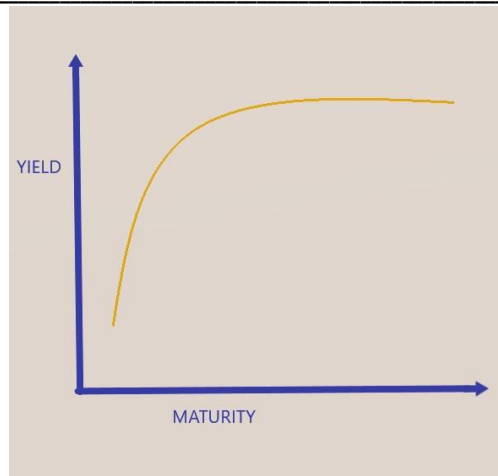
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Figure 2. Normal Yield Curve

This form of the curve is typical of a healthy economy, it emerges during periods of economic growth. The profitability curve in the normal form is based on the theory of rational expectations of the population and the theory of liquidity preference. Investors are trying to make a quick profit by buying more short-term bonds. This reduces their level of profitability.

Inverted curve. If you think interest rates will fall, then you are trying to set a high-interest rate on your yield and buy long-term stocks because after a short time the rates will go down and you will not be able to invest in such a high return. As demand for long-term bonds increases, both their price and yield fall.
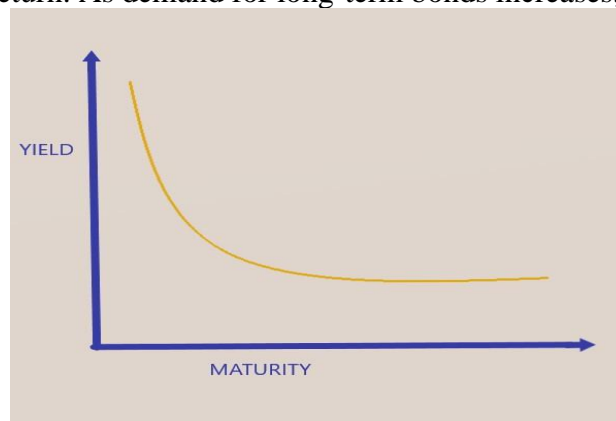

Figure 3. Inverted Yield Curve

The inverse of the curve describes the recession in the economy, which occurs during the economic crisis.

In the above forms, the bond yield curve can be presented as a straight line. This graph shows that there is a transition period in the economy:

economic situation, if the previous curve is reversed;

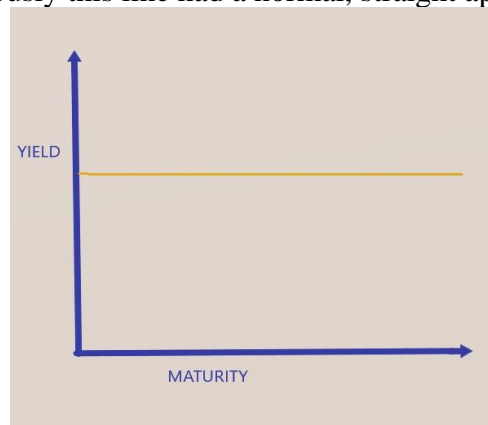or downward side, if previously this line had a normal, straight appearance.

Figure 4. Flat Yield Curve

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A flat yield curve means that the country is in transition. Typically, this condition does not last long, and the curve returns to normal or inverse in a short time. In general, the profitability curve is widely used to assess the state of the country's stock market.

2.   Materials and Methods

Yield curve is based on the rate of return on non-coupon bonds. This curve is used not only to assess the country's economy but also to identify potential risks. In other words, the formation of the inverse profitability curve is one of the important indicators of the formation of a recession in the country or the possibility of such a crisis in the near future.

There are several models used in modeling of the yield curve formula. In his comprehensive book on modeling interest rates, James and Webber point out that the following methods are proposed to solve the problem of finding [1].

- Computation using Lagrange multipliers;
- Use of parametric curves (e.g., splines, family of Nelson-Siegel models, family of Svensson equations, family of exponential multipliers, or family of limited-exponential curves of Cairns;
- Local regression using nuclei (kernels);
- Linear programming.

One of the most common methods of calculating the profitability curve is the Nelson-Siegel model. According to it, the formula of the forward rate is as follows[2]:

$$R_{NS}^{forward} = \beta_0 + \left(\beta_1 + \beta_2 \frac{t}{\tau}\right) e^{-\frac{t}{\tau}}$$

where s $\beta_0, \beta_1, \beta_2, \tau$ are the parameters to be calculated.

Continuous rate is as follows[3]:

$$r_{NS} = \beta_0 + (\beta_1 + \beta_2) \frac{1 - e^{-\frac{t}{\tau}}}{\frac{t}{\tau}} - \beta_2 e^{-\frac{t}{\tau}}$$

Siegel model is used to correctly calculate the profitability curve for a short period (up to 3 years) [4]:

$$r_{NS}^* = r_{NS} + g_1 e^{-\frac{t^2}{2}} + g_2 e^{-\frac{(t-1)^2}{2}} + g_3 e^{-\frac{(t-2)^2}{2}}$$

Although this formula differs little from the above, it allows you to build a more accurate profitability curve.

In addition to the Nelson-Siegel model, the Svenson model is also used to calculate the yield curve. It has 6 parameters unlike the above [5].

$$R_{SV}^{forward} = \beta_0 + \left(\beta_1 + \beta_2 \frac{t}{\tau_1}\right) e^{-\frac{t}{\tau_1}} + \beta_3 \frac{t}{\tau_2} e^{-\frac{t}{\tau_2}}$$

The Svenson model adds new variables to the Nelson-Siegel model.

3. Results

We assess the country's monetary policy by forming a yield curve for government securities of Uzbekistan. One of the most common methods is the Nelson-Siegel-Svensson model. Its formula was given in the above chapters:

$$r_{NS} = \beta_0 + \beta_1 \frac{1-e^{-\frac{t}{\tau_1}}}{\frac{t}{\tau_1}} + \beta_2 \left(\frac{1-e^{-\frac{t}{\tau_1}}}{\frac{t}{\tau_1}} - e^{-\frac{t}{\tau_1}}\right) + \beta_3 \left(\frac{1-e^{-\frac{t}{\tau_2}}}{\frac{t}{\tau_2}} - e^{-\frac{t}{\tau_2}}\right)$$

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[1] Jessica James & Nick Webber (2001). Interest Rate Modelling. John Wiley & Sons. ISBN 978-0-471-97523-6

[2] The zero-coupon yield curve in the GKO-OFZ market. G.Gambarov A.Balabushkin I.Shevchuk A.Nikitin Bank of Russia. 2006

[3] Zero -coupon yield curve in the GKO-OFZ market. G.Gambarov A.Balabushkin I.Shevchuk A.Nikitin Bank of Russia. 2006

[4] N. Anderson, F. Breedon, M. Deacon, A. Derry, and M. Murphy (1996). Estimating and Interpreting the Yield Curve. John Wiley & Sons. ISBN 978-0-471-96207-6.

[5] N. Anderson, F. Breedon, M. Deacon, A. Derry, and M. Murphy (1996). Estimating and Interpreting the Yield Curve. John Wiley & Sons. ISBN 978-0-471-96207-6.

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Using this model, we will form a yield curve of government securities in Uzbekistan for 2021. In doing so, we use Microsoft Excel software.

When constructing a model, the value of the parameters is calculated using the least squares method.

Table 3.
Computation using the Nelson-Siegel-Svensson model

Months	Profitability	Accrued income	Square error
1		2.16%	
2		2.03%	
3		1.85%	
4		1.70%	
5		1.58%	
6	10.86%	1.49%	0.008763
7		1.43%	
8		1.37%	
9	14.18%	1.33%	0.016504
10		1.30%	
11		1.27%	
12	12.98%	1.25%	0.013759
18		1.17%	
24	14.87%	1.12%	0.018893
36		1.08%	
			0.057919

In this case, the calculated profitability is calculated using the following estimated values:

Beta 0	Beta 1	Beta 2	Beta 3	lambda1	lambda2
0.01	0.01	0.01	0.01	1	1

Our objective function is the sum of the square errors marked in yellow in Table 3. That is, our main goal is to minimize this indicator. In the calculations, we try to minimize the use of the function "Solver" in Microsoft Excel.

As a result of calculations, we have the following indicators:

Table 4.
The found parameters of the model

Parameter	Final value
Beta 0	0.161483926
Beta 1	-0.225819399
Beta 2	-0.106414263
Beta 3	-0.123858002
lambda1	0.704610199
lambda2	0.455063523

That is, yield curve formula for Uzbekistan in 2021 is, as follaows:

$$r_{NS} = 0.161 - 0.226 \frac{1 - e^{-\frac{t}{0.7}}}{\frac{t}{0.7}} - 0.106 \left(\frac{1 - e^{-\frac{t}{0.7}}}{\frac{t}{0.7}} - e^{-\frac{t}{0.7}} \right) - 0.123 \left(\frac{1 - e^{-\frac{t}{0,45}}}{\frac{t}{0,45}} - e^{-\frac{t}{0,45}} \right)$$

where, t- maturity of the bonds, e- constant (≈ 2.71)

Table 5.
Calculated rate of return

Months	6	7	8	9	10	11	12	18	24	36
Accrued income	11.31 %	12.00 %	12.52 %	12.92 %	13.24 %	13.51 %	13.73 %	14.53 %	14.94 %	15.34 %

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The calculated rate of return on bonds for different periods is as follows (Table 5). According to him, profitability will increase over time.
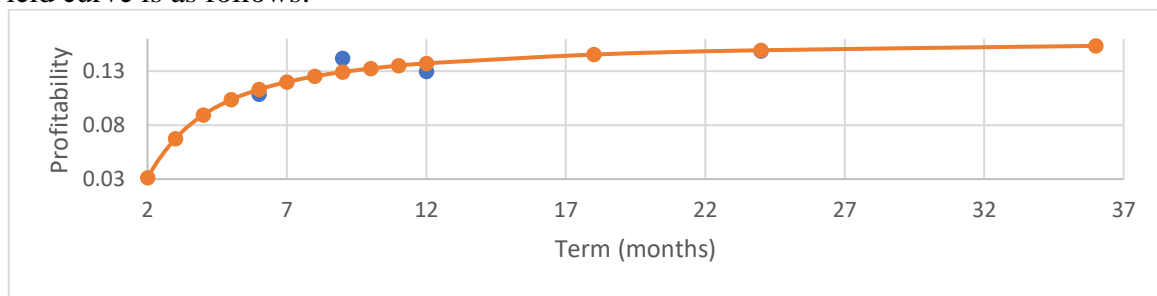
Yield curve is as follows:

Figure 10. Yield curve of government bonds in Uzbekistan for 2021[6]

We can see that yield curve of security bonds in Uzbekistan in 2021, calculated according to the Nelson-Siegel-Svensson model, has a normal appearance. This, in turn, shows that the country's current open market policy in monetary policy is effective and market participants have confidence in the policy pursued by the Central Bank.

3-year-bonds of trading in January 2021 confirm these figures.

Figure 11. The long-term yield curve in Uzbekistan[7]

In the long run, this confirms the appearance of the short-term profitability curve in Uzbekistan. It should be noted that in the long run, the yield on government securities in Uzbekistan is 16%. This indicator is based on data on the purchase and sale of bonds of the Central Bank in the national currency and reflects the state of the market in January 2022. In other words, these data do not ensure that the yield on 30-year government bonds will be 16%.

In general, in world practice, it is common for the profitability curve to be long-term (up to 60 years). We also used the Nelson-Siegel-Svensson method to draw a curve for the Uzbek economy.

4. Discussion

In Uzbekistan, too, the yield curve plays an important role in assessing the level of profitability of government securities, including government bonds.

The Central Bank continues to issue bonds not only in the domestic market but also in international stock markets. The high demand for these bonds in both the domestic and foreign markets affects their level of profitability.

Table 1.
Information on government bonds issued by the Central Bank in 2021[8]

Date	Term (months)	Amount (billion soums)	Percentage of profitability
10.01.2021	6	250	11.7
14.01.2021	6	250	10.01
17.01.2021	12	200	12.98
20.01.2021	24	200	14.87

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[6]Based on the author's calculations
[7]Based on the author's calculations
[8]Prepared by the author on the basis of data from the Central Bank

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20.01.2021	9	300	14.18

Central bank placed 6, 9, 12, and 24-month bonds worth 1,200 billion soums at the auction in January of 2021. For comparison, the bonds placed in 2019 were 5, 18, 24, and 36-month bonds.

In January 2021, relatively high-interest rates on yields were observed, as a result, the yield curve is finally close to normal.

At the auctions held on January 20, the Central Bank together with the Ministry of Finance at the Republican Currency Exchange of Uzbekistan with a nominal value of 1 million soums with a circulation period of 24 months, a total of 200,000 state securities worth 200 billion soums. Auctions were held for the placement of securities. Interest payments on securities are made quarterly.

10 dealers took part in the auction, offering competitive bids for the purchase of 453,200 bonds worth 456.98 billion soums. During the auction, 200,000 securities worth 203.47 billion soums were placed (100% of the total issue). The total amount of redemption of government securities placed at auction is 200 billion soums.

The average weighted yield of securities was 14.87% per annum, with a minimum rate of return of 13.98% and a maximum rate of return at a discounted price of 15.35%.
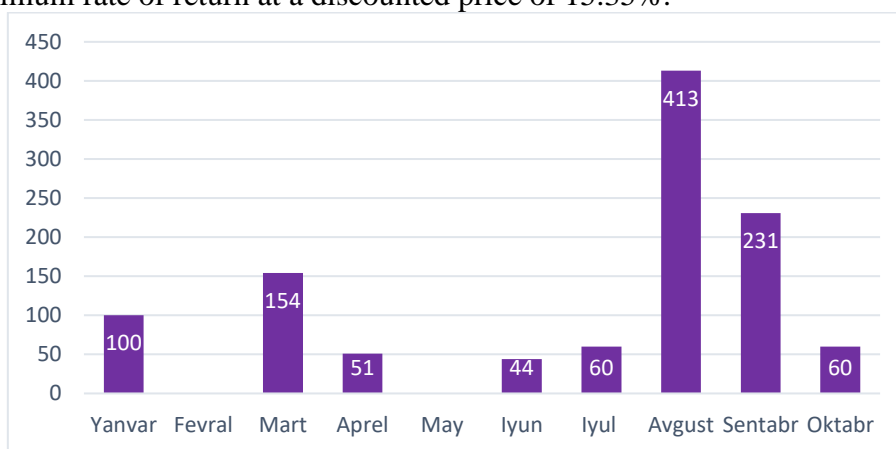

Figure 7. Secondary trade of government bonds in 2021 by months (billion soums)[9]

Also, in the third quarter of this year, secondary trading in government bonds intensified. In particular, in August in the secondary market a total of 413 billion. soums and in September a total of 231 bln. UZS worth of government securities was traded. At the same time, commercial banks, the Central Bank, and the Deposit Insurance Fund became active participants in the secondary market of government bonds.

It should be noted that the high demand in August from the results of secondary trading of government bonds in 2021 is inextricably linked with the decision of the Central Bank this month to move to a larger corridor in determining the exchange rate.

It is also noteworthy that the sale of bonds continued at a high level in September.

Figure 8. Government securities yield curve. Green – volume of security bonds in mln soums, blue line – weighted average rate[10]

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[9]Central bank information
[10]Central bank information

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The Central Bank has calculated the yield curve for government securities in the national currency for 2021. In turn, the average yield on 5-month government bonds in the initial placement was 14.1 %, the yield decreased over time and the average yield on 2 -year bonds was 8.5% per annum. At the same time, the 10.2% return on 3 -year government securities is due to macroprudential measures to regulate liquidity.

contribute to the full formation of the yield curve on government securities and its accurate reflection of the situation in the money market. in a sense it has a negative effect.

and interest rate corridor by the Central Bank under the inflation targeting regime from 2021 will also have a positive impact on the formation of the yield curve of government securities. Yield levels in secondary trades were similar to those in the primary placement, falling from 14.1% on 5-month government bonds to 7.3% on 2 -year government bonds and up to 12.6% on 3-year securities. 'shrinkage was observed. At the same time, given that secondary trading intensified in the third quarter, there is a change in inflation and devaluation expectations of commercial banks in the medium and long term. In addition, the declining trend of the profitability curve can be explained by the presence of excess liquidity in the banking system and the high interest of commercial banks in making long-term investments.
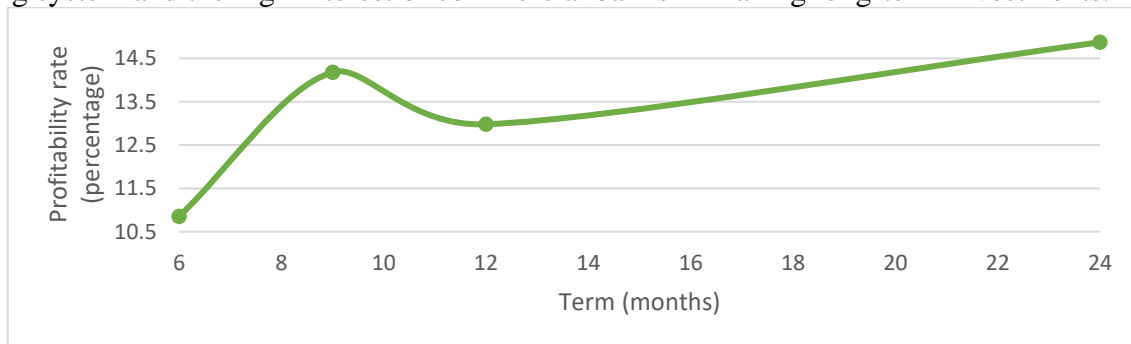

Figure 9. Profitability curve for 2021[11]

5. Conclusion

In conclusion, the yield curve of government securities shows the relationship between the maturity of government bonds and the level of yield. Because government bonds are generally the least risky security in a country, the state of the country's economy can be assessed on the basis of the yield curve.

Yield curve has one of three forms: normal, inverse, or straight. The normal curve means that profitability increases with time. It shows that the state of the economy is normal.

The inversion occurs during or before the recession. On the reverse yield curve, market participants believe that profitability will decline in the long run. Typically, this indicator is a good way to assess economic crises.

The straight-line condition is typical of transition economies, which is rare and can quickly be replaced by a normal or reverse line. There are several ways to estimate the profitability of securities, including Nelson-Siegel, Svensson methods, Lagrange multipliers, splines, and linear programming. The developed countries of the world, choosing one of the above methods, form a securities yield curve in the country.

Uzbekistan also practices the formation of a yield curve for its government bonds. The Central Bank is responsible for these calculations.

Yield curve in Uzbekistan will ensure a more effective monetary policy for the country:

- Providing information on the methods of development of the government securities curve by the Central Bank, ensuring transparency of information on how it is calculated. The fact that the Central Bank does not currently provide such information may lead to different views on this information;

- of securities sales, thus allowing further development of securities trading. In this way, the Central Bank will be able to better control the money supply. Currently, auctions are only for legal entities;

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[11]Calculated by the author based on data from the Central Bank

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