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Quantitative Dimensions of Yield Curve Dynamics in Post-Pandemic Environment – The Case of Romania

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Abstract

The purpose of the research is to explore the characteristics in the dynamics of the Romanian government bond yield curve during the post-pandemic period and to reveal the related expectations for the development of the Romanian economy. Its results show that the Romanian government bond market begins the analysed period with clear positive expectations for the country's economic growth, but ends it with projections for short-term economic slowdown at a moderate reduction of inflation. The study also reveals that in the behaviour of the Romanian government bond market there are two distinct segments influenced by different economic factors – one in the maturity spectrum 6 months–1 year and the other in the maturity range between 2 and 10 years. The results from conducted principal component analysis show that the most important factor of the dynamics in the studied yield curve is inflation with a contribution of 88.16%, followed by economic growth and the type of the monetary policy with weights of 8.89% and 1.33% respectively. In turn, the direction of influence of these factors reveals that in the post-pandemic period, portfolios of Romanian government bonds with maturities between 2 and 10 years can be successfully hedged against interest rate risk even using duration-based techniques alone.

Keywords: Romanian government bond market, government bonds, yield curve, yield curve dynamics, principal component analysis.

JEL Classification: G10, G12, G15, H60, H74.

1. Introduction and Literature Review

The modern history of the Romanian government bond market began relatively long ago in 1994. However, it can be defined as relatively new against the background of the developed European and global debt markets. Quite in tune with

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this statement is the fact that, for its existence so far, the Romanian government bond market has gone through various different stages of development related to its creation and establishment, increasing transparency, growing investor interest, its institutional development, and its modern functioning. It is the existence of these stages that practically shows the degree of development of the Romanian government bond market and largely directs and determines the scientific interest of the academic community, mainly from Romania, in its exploration. In addition, the different dimensions in the development of this bond market also determine the depth of available studies that reveal its main characteristics. For example, the first in-depth scientific study that clarifies the characteristics, development prospects, and possible ways to transform the Romanian government bond market into a credible and liquid bond market is that of Pop et al. (2012). A descriptive analysis by Pop and Georgescu from 2013 reveals the attributes of the treasury bond market segment of Bucharest Stock Exchange for the period 2008-2012 and identifies low transparency, the lack of reliable financial information, and weak institutional flexibility as the main factors hindering positive development on the secondary government bond market in Romania (Pop & Georgescu, 2013). The conducting of these studies can be defined as belated against the background of the first significant studies of other segments of the bond market in Romania such as that of municipal bonds and corporate bonds, which were first investigated, respectively, by Pop and Dumbrava (2004) and by Corduneanu and Milos (2008). However, there is a very important reason for this delay. It is related to the lack of adequate, detailed, and reliable data on the issuance of Romanian government bonds in the reports of the Romanian Ministry of Finance until mid-2007, which does not allow effective analyses. Gradually, however, the increased interest in government bond investments since the outbreak of the global financial and economic crisis of 2008-2009, combined with the possibility for trading of Romanian government bonds on the Bucharest Stock Exchange since August 2008, surged the popularity of the Romanian government bond segment. The increased attractiveness of Romanian government bonds among the investors, together with the policy change of the Romanian Ministry of Finance, leads to feeding the scientific community with appropriate data, enabling adequate scientific research. However, to date, the government bond market has a lower popularity among the scientific community in Romania against the background of the municipal and corporate bond markets in the country. Thus, for example, in recent years, only publications of Oprea (Oprea, 2019; Oprea, 2022) have addressed various aspects related to the bonds issued by the Romanian government. Of these, only the second one analyses the possibilities of building relative value investment strategies on the Romanian government bond market by studying the behaviour of an important economic and market indicator such as its yield curve for the period between March 2019 and March 2022. However, there has been a lack of such research since the end of the COVID-19 crisis. This is what motivates the conduct of the present study. Therefore, its main purpose is to explore the characteristics of the behaviour of the Romanian government bond yield curve during the

post-pandemic period and thus to reveal the expectations that this benchmark debt market has for the future state of the Romanian economy.

2. Study period, Data and Methodology

The main factors that determine each studied period are the purpose of the study and the available data. For this reason, a clear definition of the beginning of the post-pandemic period in the functioning of social and economic processes in Romania is needed in the present study. However, due to the policy of the Romanian government, this is a very easy task, because on March 9, 2022, the Romanian authorities removed all restrictions preventing the spread of COVID-19 (Reuters, 2022). Therefore, it can be assumed that, from this date, public life, the Romanian economy, and financial market function under post-pandemic conditions. In turn, the end of the research period is fixed on February 9, 2024, thus the whole study period spans 702 calendar days. On the other hand, the database of the study is formed by data for the yield to maturity on Romanian government bonds with a daily frequency, obtained from the World Government Bonds section of the global financial platform Investing.com (Investing.com, 2024). The database contains information for yields on Romanian government bonds with residual maturities of 6 months, 1, 2, 3, 4, 5, 7 and 10 years. Here, the need to ensure the time equivalence of the data and their correct structuring requires that the missing yields for certain time periods be replaced with the last available or quoted values from a previous period.

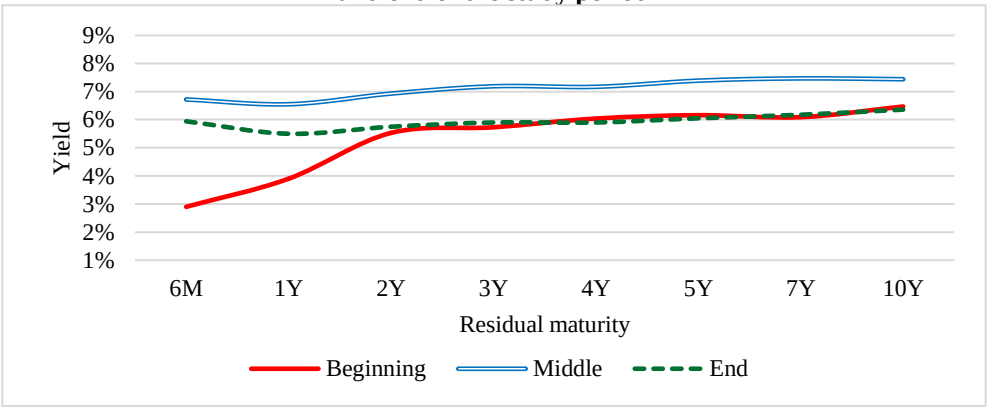
In concrete terms, the research methodology involves using of techniques for analysing the dynamics of the studied yield curve and the dynamics of the spread between the longest-term and the shortest-term yields within the studied maturity spectrum. Next, to reveal the volatility profile of the Romanian government bond yields, the analysis of their standard deviation and correlation dependences is used. The most powerful quantitative tool that the research engages in revealing the characteristics in the dynamics of the studied yield curve is principal component analysis (PCA). PCA is an econometric technique that reveals the main factors (components) in the dynamics of a studied dataset by reducing its dimensionality without losing essential information (Jolliffe, 1986, p. 1). The quantitative technique allows us to reveal the strength and direction of the influence of these factors through the so-called component values and component loadings. The calculations are usually done using as a basis a covariance or correlation matrix (Dunteman, 1989, p. 15), presenting the relation in the behaviour of the studied time series. In the present study, the correlation matrix is chosen as the basis of the computation procedures. This is due to the fact that its use has a higher information value and produces easily interpretable results.

3. Empirical Results

The general picture of the dynamics of the Romanian government bond yield curve for the period March 9, 2022–February 9, 2024 is presented in Figure 1. In order to facilitate the analysis and increase its informational value, the figure

shows the analysed yield curve only at the beginning, middle and end of the investigated period. It can be seen that the studied period begins with a clear positive slope of the analysed yield curve with a total spread between the yields of the ten-year and six-month bonds issued by the Romanian government of 3.57%. The observed slope is particularly steep between 6 months and 2 years residual maturity, where the spread has a value of 2.63%. This is 73.67% of the total yield spread between the yields of the longest-term and the shortest-term Romanian government bonds as of March 9, 2022. Therefore, Romanian debt markets enter the post-pandemic period with clear and definite positive expectations for the development of the Romanian economy, which are particularly strong in the short term. Although it is not the subject of analysis, the mentioned fact also shows that the Romanian government bond market was not concerned about positive economic growth in the country, even in the conditions of COVID-19.

Figure 1. Romanian government bond yield curve at the beginning, middle and end of the study period



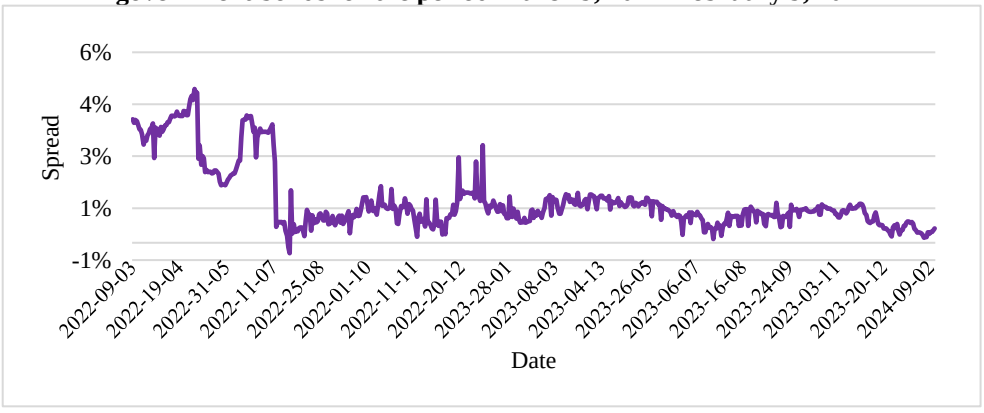
Source: own calculations based on data from Investing.com (Investing.com, 2024).

However, between the beginning and the middle of the studied period, there is a major change in the Romanian government bond yield curve. Thus, by the middle of February 2023, a general increase of all analysed yields was observed by an average of 1.76%. This positive change is particularly strong for short-term Romanian government bond yields. To a large extent, the noted upward movement of the investigated yields is due to the increasing inflation in Romania during this period, which has reached 16.76% by November 2022. On the other hand, it can be seen that towards the middle of the studied period the analysed yield curve is flatter, with the spread between the ten-year and six-month Romanian government bond yields of only 0.72%. This is a clear indicator that, at the beginning of 2023, the Romanian government bond market has already started to emit negative expectations for the economic development of the country. Moreover, at the end of the studied period, these negative expectations deteriorate further. As of February 9, 2024, the positive slope of the analysed yield curve continues to decrease, and the spread between the yields of the 10-year and 6-month bonds issued by the Romanian government falls

to 0.42%. This is also accompanied by a clear parallel shift down with an average drop in all considered yields of about 1.16%. That is, between the middle and the end of the studied period, market predictions for an economic slowdown in Romania become stronger, this time accompanied by lower inflation expectations, due to the progressively decreasing inflation rate in the country from the beginning of 2023.

Figure 2 provides more details of the observed slope oscillation process, that makes the investigated yield curve flatter. It shows the dynamics of the yield spread between the 10-year and 6-month Romanian government bonds for the period March 9, 2022–February 9, 2024. Until the beginning of 2024 the spread steadily decreases from levels of about 3.5–4.4% to 0.42%. An interesting detail here is that until mid-2022 this spread is markedly positive, but at the end of June 2022 it drops sharply and even takes negative values. That is, then the analysed yield curve even becomes inverted. After that, there is a slight recovery of the positive slope of the Romanian government bond yield curve, with the spread between the yield of 10-year and 6-month debt instruments for long periods reaching levels above 1% and sometimes even above 2%. From March 2023, the trend in its dynamics becomes downward again. Therefore, it can be confidently concluded that between the end of June 2022 and the end of March 2023, the Romanian government bond market begins to experience strong uncertainty about the direction of economic development in Romania. At the time of the finalisation of the research, the Romanian government bond market is rather beginning to calculate a slowdown in economic activity of the country with lower inflation expectations, which, however, do not indicate a serious decline in the inflation rate.

Figure 2. Dynamics of the yield spread between 10-year and 6-month Romanian government bonds for the period March 9, 2022–February 9, 2024



Source: own calculations based on data from Investing.com (Investing.com, 2024).

The information in Figure 1 shows another interesting fact regarding the dynamics of the analysed yield curve. It is about the fact that for the entire investigated period, the yield to maturity of the Romanian government bonds with a residual maturity between 6 months and 2 years varied the most. Against this background, the overall variation in bond yields with maturities between 2 and 10 years is significantly

smaller. This is also confirmed by the term structure of volatility and the correlations in the yield to maturity on Romanian government bonds for the period 9 March 2022–9 February 2024 presented in Table 1.

Table 1. Volatility profile and correlation coefficients of yields to maturity on Romanian government bonds for the period March 9, 2022–February 9, 2024

Residual maturity	6M	1Y	2Y	3Y	4Y	5Y	7Y	10Y
6M	1							
1Y	0,851*	1						
2Y	0,592*	0,814*	1					
3Y	0,639*	0,842*	0,974*	1				
4Y	0,588*	0,806*	0,965*	0,990*	1			
5Y	0,617*	0,823*	0,962*	0,992*	0,990*	1		
7Y	0,621*	0,827*	0,952*	0,985*	0,982*	0,993*	1	
10Y	0,613*	0,799*	0,922*	0,955*	0,952*	0,970*	0,976*	1
Standard deviation	1,180%	1,139%	0,906%	0,933%	0,934%	0,894%	0,874%	0,826%

* indicates significance at 99% confidence interval.

Source: Own calculations based on data from Investing.com (Investing.com, 2024).

Information on the yield volatility of fixed income securities issued by the Romanian government shows that it decreases as the maturity increases. This is completely consistent with the results from a previous empirical study on the characteristics of interest rate volatility (Bali & Neftci, 2001). What is special here, however, is that the standard deviation of the yield-to-maturity of the shortest-term Romanian government bonds – those with maturities of 6 months and 1 year – is significantly higher than the yield volatility of debt instruments from all other maturities. This indicates that in a post-pandemic environment, the behaviour of the two shortest-term segments of the Romanian government bond market is likely to be driven by specific factors different from those shaping the rest of the analysed yields. This finding is unequivocally supported by the analysis of the correlations among the yields from the studied maturity spectrum. Their value clearly indicates the presence of two main groups of yields within the post-pandemic Romanian government bond market. Government debt instruments with maturities of 6 months and 1 year fall into the first one. Their yields to maturity have weaker correlation with all other studied yields, with correlation between the yield of six-month Romanian government bonds and the all other yields being around 0.6, and relative to the yield of two- and four-year debt instruments even below this value. The second group includes bonds with maturities between 2 and 10 years, where the correlation in their yields to maturity can be defined as very strong. There, with one exception, the measured correlation coefficients exceeded a value of 0.95.

The reasons for the already revealed behaviour of the analysed yield curve can be quantitatively defined and distinguished by the analysis of the principal components in its dynamics. The first results of the application of the econometric technique are

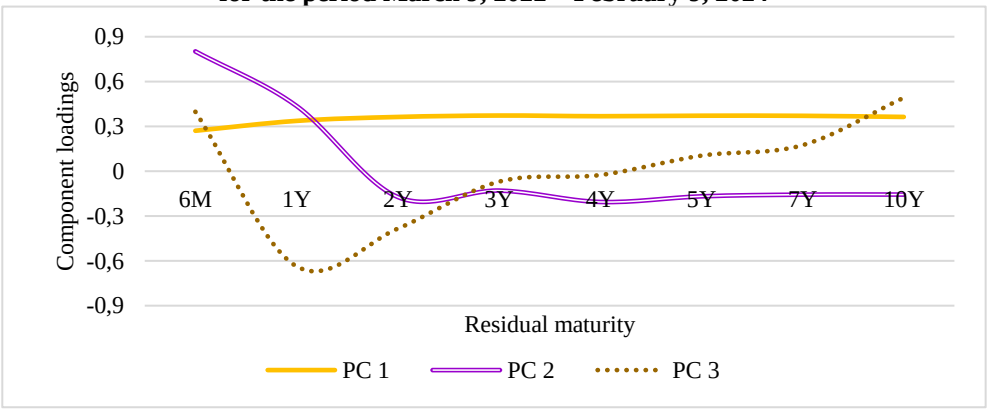
presented in Table 2. The data show that for the post-pandemic period, the most information, amounting to about 98.38%, on the dynamics of the Romanian government bond yield curve can be described by the influence of its first three principal components. The influence of the first of them is the strongest, as it has a weight of 88.16% in the overall dynamics of the studied yield curve. The second principal component has a contribution to its dynamics of 8.89%, and the third can explain only 1.33% of its variation.

Table 2. Value and influence strength of the principal components in the dynamics of the Romanian government bond yield curve for the period March 9, 2022 – February 9, 2024

Principal component	Component value	Proportion of the influence	Cumulative proportion
First	**7.053**	**88.16%**	**88.16%**
Second	**0.711**	**8.89%**	**97.05%**
Third	**0.107**	**1.33%**	**98.38%**
Fourth	0.073	0.92%	99.30%
Fifth	0.035	0.44%	99.73%
Sixth	0.011	0.13%	99.87%
Seventh	0.006	0.08%	99.95%
Eighth	0.004	0.05%	100%

Source: own calculations based on data from Investing.com (Investing.com, 2024).

Figure 3. Component loadings for the first three principal components in the dynamics in the Romanian government bond yield curve for the period March 9, 2022 – February 9, 2024



Source: own calculations based on data from Investing.com (Investing.com, 2024).

Figure 3, in turn, details the direction of influence of the three main factors already identified. The figure clearly shows that the first principal component has a constant influence on the analysed yield curve regardless of the maturity, that is, it is a factor of the change in its level. In the financial literature, this influence is associated with inflation and inflation expectations (Kaya, 2014). Therefore, it can be concluded that

in the post-pandemic period, inflation in Romania affected equally all analysed maturity segments. During the studied period, the second main component propelled the six-month and one-year yields upwards, and under its influence the yields of Romanian government bonds with maturities from 2 to 10 years were pushed downwards. Thus, this second main component, associated in the financial literature with the influence of economic growth (Abdymomunov, 2013), causes a rotation of the analysed yield curve with a pivot point between 1- and 2-years residual maturity.

Some quantitative studies relate the influence of the third principal component also to the influence of economic growth (Abdymomunov, 2013), while others associate it with the influence of the monetary policy of the central bank (Rudebusch & Wu, 2008). Of course, there is a direct connection between the two views because the monetary policy of the central bank has a direct impact on economic growth and prospects for economic development. In the case presented, it can be seen that the third principal component has a stronger negative impact mainly on one-year yields and a weaker but still negative impact on two-, three-, and four-year yields. For the remaining maturities, the influence of this component is moderately positive. Therefore, it can be said that it makes the short-term end of the studied yield curve concave, which is the probable reason that at the end of the studied period it is slightly inverted between residual maturities of 6 months and 4 years. That is, at the time of conducting the research, the Romanian government bond market shows clear signals that it treats the interest rate policy of the Romanian National Bank as restrictive and restricting short-term economic growth of the country. For this reason, it is very likely that it will begin to change.

4. Conclusions

The study presented an analysis of the dynamics of the Romanian government yield curve for the period March 9, 2022–February 9, 2024. It revealed that one of the most important debt markets in Romania starts the post-pandemic period with clear expectations of a positive economic development of the Romanian economy. However, these expectations change in the middle of 2022. Thus, at the end of the analysed period, the Romanian government bond yield curve becomes almost flat with a relatively weak inversion in the segment between 6 months and 4 years to maturity at a higher overall interest rate level. However, the behaviour of the research showed that in the Romanian government bonds market during the studied period, two distinct segments are observed, driven by apparently different market, financial, and economic processes. The first includes bonds with a maturity of 6 months and 1 year, and the second contains debt instruments with a residual maturity between 2 and 10 years. Against this background, the other important conclusions of the study can be formulated as follows:

First. The steeper slope of the Romanian government bond yield curve in the maturity region between 6 months and 2 years indicates that at the beginning of the post-pandemic period, the positive expectations for economic growth in the country were only short-term. Even at this point, market participants expected a slowdown in Romanian economic growth in the medium and long term.

Second. At the time of completion of the study, the Romanian government bond market is projected to show a moderate decline in both short-term and long-term inflation in the country.

Third. The slight inversion of the Romanian government bond yield curve in the range between 6 months and 4 years of residual maturity indicates that the likely deterioration or slowdown in economic growth in the country will be relatively weak and/or with a short-term horizon of a maximum of 3 to 4 years.

Fourth. The most important factor of the dynamics of the investigated yield curve with a contribution of 88.16% in it is the inflation in Romania. After it, in second place, with a weight of 8.89%, comes economic growth, which is a significant factor in the increase of short-term yields throughout the studied period. The third most important factor with a share of 1.33% is the influence of the central bank's monetary policy on Romanian economic growth.

Fifth. The empirical characteristics of the dynamics of the studied yield curve during the post-pandemic period show that bond portfolios of Romanian government bonds with maturities between 2 and 10 years and especially with maturities of 3 to 5 years can be effectively hedged against interest rate risk even using the simplest duration-based techniques. However, investments in Romanian government debt instruments with maturities of 6 months and 1 year require the use of more sophisticated techniques for this purpose. Of course, this conclusion is to some extent conditional due to the low liquidity of the short-term segment of the Romanian government bond market.

Sixth. The significant flattening of the Romanian government bond yield curve towards the end of the study period, in combination with its down-parallel shift and its weak inversion at its short-term end, shows that the probability for cutting the monetary policy rate by the Romanian central bank starts to rise. However, this can happen only if there are clear signals of a significant slowdown of inflation in Romania.

However, the above-stated conclusions are made for the entire study period. On the other hand, the empirical results show that there are practically two distinctive subperiods within the investigated period. The first of them can be defined as a stage of the positive slope of the Romanian government bond yield curve, which starts on March 9, 2022 and lasts until mid-June 2022. The second subperiod can be defined as the flattening period of the studied yield curve. Therefore, as the main direction for continuing the work on the topic of Romanian government bond yield curve can be indicated, a detailed study of the characteristics of these two subperiods can be indicated. In this way, a more detailed picture of the current state and prospects for the development of the Romanian government bond market and the Romanian economy will be revealed.

Contribution statement

The study is conducted and written by the authors as follows: assoc. prof. Alexander Ganchev, PhD – Sections 1. Introduction and Literature Review, 3. Empirical Results and 4. Conclusions; assoc. prof. Catalin Deatcu, PhD – Section 2. Study Period, Data and Methodology.

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