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INVESTMENT CHARACTERISTICS OF INDONESIAN GOVERNMENT BOND MARKET DURING THE COVID-19 PANDEMIC

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Abstract. The purpose of the study is to define the main investment characteristics of the Indonesian government bond market during the COVID-19 pandemic. The subject of the analysis is the yield to maturity yield curve of Indonesian government bonds, the dynamics for the period 2 January 2020–15 February 2022 is analyzed with various quantitative methods such as descriptive statistical analysis, time series analysis, correlation and autocorrelation analysis, probability distribution analysis, principal component analysis and graphical analysis. The study reveals that under the COVID-19 pandemic, the yield curve on Indonesian government bonds is highly stable and lacks the strong general volatility of highly developed debt markets during the same period. Quantitative analysis shows that the yield of the investigated bonds has many of the well-studied characteristics that are present in the developed debt markets. However, there are some specifics and anomalies, such as a strong correlation along the entire yield curve and inhomogeneous volatility of medium-term yields. Therefore, despite the probable existence of incorrectly priced debt instruments, Indonesian government bonds should be considered by investors as an appropriate instrument for hedging interest rate risk in the COVID-19 environment.

Keywords: fixed-income securities, bond yield, yield to maturity yield curve, Indonesian debt market, COVID-19.

JEL Classification: G11, G12, G15, H63.

Introduction

Debt markets are some of the most important instruments for capital transfer. As such, they are a key indicator of the state and growth of any national economy. As bonds offer relatively low but predominantly fixed yields, they are the key component of the low-risk portfolios of large institutional investors, including pension funds. Although they are often overshadowed by stock markets, global debt markets significantly exceed them in terms of market capitalization. According to a 2019 study by the Securities Industry and Financial Markets Association (SIFMA, 2019), fixed-income security markets have a total capitalization of $102.8 trillion, while at the same moment equity instruments have a total capitalization of only $74.7 trillion. Traditionally, one of the main big issuers of bonds are national governments (Bank for International Settlements, 2019, p. A11). In turn, due to their characteristics, investors consider government bonds to be risk-free, and therefore they are a very attractive investment instrument. This is why processes related to government bond markets and the dynamics of their yields are considered an indicator of the future development of financial markets (Reserve Bank of Australia, 2021, p. 1).

The outbreak of the COVID-19 pandemic has led to shocks in the financial world, with a particularly severe impact on the stock markets. Bond markets, and in particular those of government debt instruments of the world's leading economies such as the United States, Britain, France, Germany and Australia, have also been affected severely. In the beginning of 2020, their yields began to decline (Reuters, 2020b), mostly due to national monetary and fiscal stimulus policies. At present, however, the government bond yields in these countries have already restored their upward trend, largely due to expectations of higher and prolonged inflation. Against this background, the less-developed debt markets stay out of investment community's focus of attention. Moreover,

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less developed debt markets are often ignored by both investors and researchers. Many of the debt markets to which the global investment community does not pay much attention are located in Asia. One of them is the bond market in Indonesia, which is the fifth largest Asian economy (World Bank Group, 2022) and one of the largest markets for government debt instruments in Southeast Asia. Currently, studies on its characteristics and state are few and limited in scope. Therefore, research on its main investment characteristics and specific development in the context of the COVID-19 pandemic and the current economic processes in Southeast Asia related to it can be defined as very topical. Therefore, the current study aims to define the investment characteristics of the Indonesian government bond market through a quantitative analysis of their yields. To achieve its objective, the investigation employs a quantitative methodology based on statistical techniques like descriptive statistical analysis, time series analysis, correlation analysis, autocorrelation analysis, principal component analysis, probability distribution analysis, hypothesis testing and graphical analysis. The research is structured in four main parts. The first part presents a review of the literature on the subject and describes the main characteristics of bond yields in developed debt markets. The second part presents the data used, the research methodology and the employed quantitative methods. The third part of the study contains the main empirical results, and the last part summarizes the main findings and outlines the directions for further work.

1. Literature review

The great importance of debt markets for the world economy logically determines the scientific community's interest in studying their investment characteristics. Currently, most of the research on this topic is focused on the characteristics of debt instruments yield as it is the easiest and fastest way to estimate the processes within the debt markets, the investors' expectations for their dynamics and the expectations for economic development. The general review of the achievements of investment theory in this field shows that some bond yield characteristics are fundamental across all debt instruments, others are related to their individual behavior, still others are related to the probability distribution of the yields, and there are also characteristics that are related to the behavior of the entire yield curve. The historical analysis of various studies that reveal the characteristics of fixed-income security yields shows that the financial community first identified the fundamental characteristics. For example, in an analysis of the stock market situation in 1989 and 1990, Schwert found that the stock price volatility in developed capital markets was several times higher than the volatility of fixed-income securities (Schwert, 1989) and Schwert (1990). Similar conclusions were made in 2000 by Reilly et al. (2000) and in 2002 by Johnson and Young (2002). In 2001, Bali and Neftci (2001) revealed that the volatility of debt instrument yields decreases as their term to maturity increases. Thus, they introduce the concept of time structure volatility in the field of debt markets. In 2002, in a quantitative study of government bond markets, Smith revealed that the absolute changes in their yields were stationary over time (Smith, 2002). A study conducted by Martellini, Priaulet and Priaulet on the swap market in France in 2003 discovers that the spot interest rates with maturities between 1 month and 10 years do not have a strong correlation in their joint behavior (Martellini et al., 2003, p. 70). Probably the main reason for this phenomenon was the discovery made in 1991 by Litterman and Scheinkman (1991) that there are three main factors of the dynamics of the yield curve, which are often defined as parallel shift, slope, and curvature. This conclusion is subsequently corroborated by the studies of D'Eclesia and Zenios (1994), Buhler and Zimmermann (1996), Barber and Cooper (1996), Lardic et al. (2003) and by the recent study of Yee et al. in 2019 (Yee et al., 2019). Studies conducted by Kozicki and Tinsley (2001, 2002), Hordahl et al. (2003) and Rudebusch and Wu (2003) show that these three factors can actually be related to the influences of inflation, economic growth and central banks' monetary policies. Choudhry in 2004 pointed out that when the spot and forward interest rates are high, the probability distribution of their absolute changes approximates the lognormal distribution and when the spot and forward interest rates are low, the probability distribution of their absolute changes is normal (Choudhry, 2004, pp. 219–220). On the other hand, in 2006, Diebold and Li found that there is a strong autocorrelation of the forward interest rates on US government bonds (Diebold & Li, 2006). There are research publications which claim that similarly to the stock markets the bond markets also have some anomalies. Such an anomaly was described by Dybvig et al. (1996) and, later on, by Dhillion and Lasser (1998). According to both studies, the yield on 30-year bonds traded on the world's leading debt markets is subnormal, i.e. their yields are underpriced.

2. Data and methodology

The investment characteristics of Indonesian government bonds were analyzed using a database of their yield to maturity for the period 02 January 2020–15 February 2022 published in the World Government Bonds section of the financial portal Investing.com (Investing, 2022b). There are two main reasons for choosing the first business day of 2020 as the initial day of the survey. First, the official Chinese authorities confirmed the outbreak of the new coronavirus as late as December 31, 2019 (Reuters, 2019). This means that when the financial markets in Asia opened in 2020, they already had the necessary information to calculate the possible risks for the Asian economies from the new coronavirus. Second, the dynamics of the IDX Composite Index, presented in Figure 1, show that the Indonesian capital market started with a slight

decline in 2020 and by mid-January investors were not very sure about the direction of its development under the new conditions. After January 15, 2020, however, the value of the IDX Composite Index began to decline rapidly and kept falling almost until the end of March. All this proves that by mid-January, the Indonesia's financial markets had already had an idea of the possible damage to the global and local economy associated with the new coronavirus pandemic. This should undoubtedly have been considered by investors in the Indonesian debt market. This is why it is completely logical and justified that the beginning of the analyzed period is the first business day of 2020, rather than the beginning of March in the same year, when the first official case of COVID-19 was reported in Indonesia. On the other hand, the initial analysis of the empirical data available for the maturity range from 1 month to 30 years shows that the short-term bonds of the Indonesian government are illiquid. This means that its inclusion in the analysis is undesirable because it may affect the reliability of its final results. For this reason, the study excludes bonds with maturities of 1, 3 and 6 months from its scope and focuses only on the analysis of the yield to maturity of Indonesian government bonds with a residual maturity of 1, 3, 5, 10, 15, 20, 25 and 30 years.

For the purposes of the analysis, the study adopts the assumption that if there is no yield on a certain bond for any given trading day, it is replaced by its last known value. Thus, the length of the database used in the study is 537 trading days, and it itself is composed of 8x537 or 4296 yields. As for the values of the IDX Composite Index, they are also analyzed on a daily basis for the period 02 January 2020–15 February 2022.

The concrete research methodology is based on the following principal assumptions:

- The IDX Composite Index is considered as a benchmark characterizing the overall state of the Indonesian stock market.
- The daily return of the IDX Composite Index is calculated using a continuously compounded return, which is averaged by using an arithmetic mean.
- The average daily return of the IDX Composite Index and its variance are annualized under the assumption of 250 trading days per year.
- The autocorrelation coefficient and partial autocorrelation are used to determine the presence of autocorrelation in the yields of the analyzed fixed-income securities.
- The stationarity of absolute deviations is investigated with the Augmented Dickey-Fuller test and their probabilistic distribution is analyzed using the skewness, kurtosis, and Jarque-Bera coefficients.
- The significance of the correlation coefficients is tested using the standard t-test for correlation coefficient significance.
- The analysis of the factors influencing the dynamics of the yield to maturity yield curve is performed by using the principle component analysis on the absolute value of the studied yields.

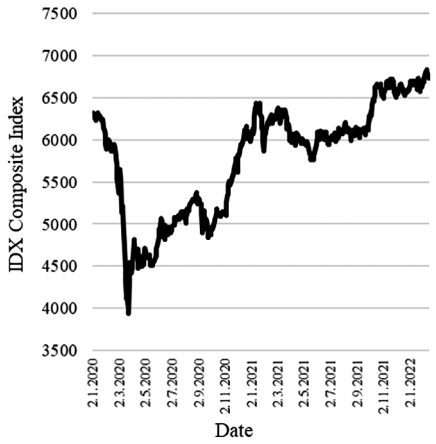

Figure 1. Dynamics of the IDX Composite Index for the period 02 January 2020–15 February 2022 (source: Investing, 2022a, Jakarta Stock Exchange Composite Index section, Historical Data subsection)

- All econometric calculations are performed using the EViews 12 software package.

3. Empirical results

Figure 1 shows that the stock market in Indonesia was affected very early by negative expectations for the value of the companies included in the IDX Composite Index. In a purely historical perspective, the effect was observed about two months prior to the official registration of COVID-19 in Indonesia. It can be seen that after a decline of about 37.33% for the period 02 January–24 March 2020, the stock market in Indonesia managed to recover in full in early 2021. However, the situation in the Indonesian government bond market is not so volatile and dynamic.

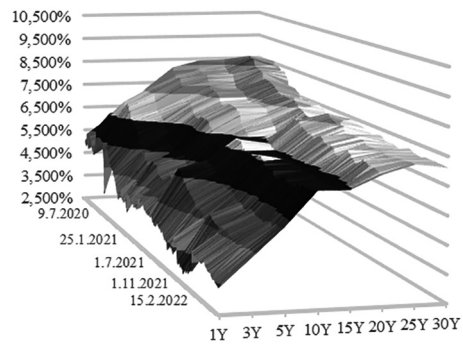

Figure 2. Evolution of the Indonesian government bond yield curve for the period 02 January 2020–15 February 2022 (source: Investing, 2022b, World Government Bonds section, Indonesia subsection)

Figure 2 shows the dynamics of the yield curve of Indonesian government bonds with maturities of 1 to 30 years. Obviously, there weren't any rapid changes of the yields and the prices of the analyzed debt instruments over the period. There are no changes whose magnitude over time resembles the dynamics of the IDX Composite Index. On the contrary, there is a smooth

general downward trend in all yields across the analyzed maturity range although the decline was not sharp and significant. For the Indonesian government bonds with maturity between 1 and 5 years the average decline over the period was 1.51% and for those with maturities of 10 to 30 years it was 0.67%. It can also be seen that over the analyzed period, the yield curve sloped upward and has not been reversed at any point. This shows that despite the decline in the Indonesian economy in 2020, the debt markets were not affected by expectations of a significant or long-term slowdown in its growth. Moreover, the slope of the curve is markedly steep, with a trend for widening of the spread between long-term and short-term yields tending in 2022.

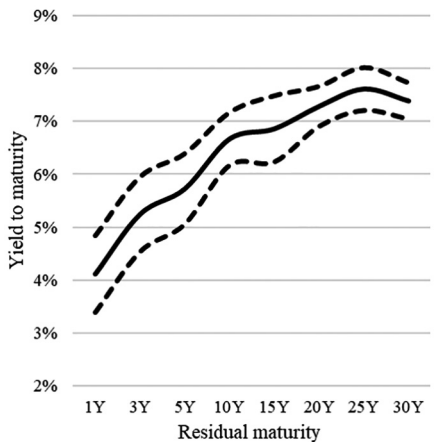

Figure 3. Average yield curve of Indonesian government bonds for the period 02 January 2020–15 February 2022 (source: author's own calculations on the base of the information published in Investing, 2022b, World Government Bonds section, Indonesia subsection)

The steep slope of the yield curve of Indonesian government bonds over the period 02 January 2020–15 February 2022 is confirmed quantitatively in Figure 3. It presents the average yield curve over the period, as well as its upper and lower bounds defined by +/– one standard deviation. It clearly shows that over the analyzed period the average spread between the long-term and short-term government bond yields is within 3.27%. This is much more than the average spread between short-term and long-term bond yields in many developed economies such as the United States, Britain, Germany, Japan and Australia.

However, Figure 3 reveals two very interesting facts that are difficult to figure out directly in Figure 2. First, the data show that Indonesia's longest-term 30-year government bonds have on average 0.23% lower yields than those of the 25-year maturity bonds. This means that for the investigated period, the yield of Indonesia's longest-term government bonds is underpriced. This directly confirms one of the characteristics of the yield of debt instruments derived from some developed capital markets. However, the second conclusion that can be made from Figure 3 is much more interesting and important. The point is that anomalies in the yield of investigated debt instruments are not only present at the long-term end of the yield curve. They are also observed in its medium-term regions between 5 and 15 years to maturity.

Table 2. Average annual return, annual standard deviation and annual variance of IDX Composite Index for the period 02 January 2020–15 February 2022 (source: author's own calculations)

Indicator	IDX Composite Index
Average return	3.60%
Annual standard deviation	20.35%
Annual sample variance	4.14%

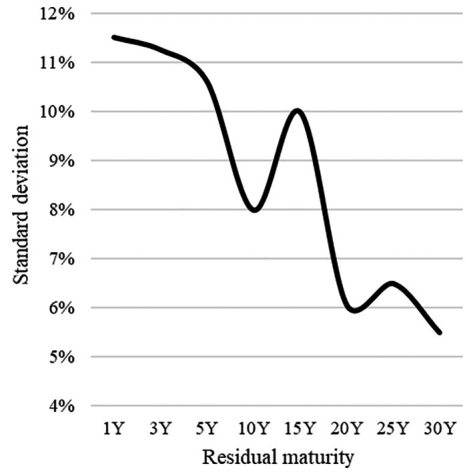

Figure 4. Volatility profile of the Indonesian government bond yield curve for the period 02 January 2020–15 February 2022 (source: author's own calculations)

As mentioned above, one of the main quantitative characteristics of the yield of debt securities is its lower volatility than that of stock markets. The analysis of this feature of the yield of Indonesia's government bonds can be made on the basis of the information in Table 1 and

Table 1. Average yield, annual standard deviation and annual variance of the yield to maturity of Indonesian government bonds for the period 02 January 2020–15 February 2022 (source: author's own calculations)

Indicator	Residual maturity							
	1Y	3Y	5Y	10Y	15Y	20Y	25Y	30Y
Average yield	4.03%	5.20%	5.70%	6.67%	6.83%	7.28%	7.59%	7.37%
Standard deviation	11.50%	11.25%	10.60%	7.99%	9.99%	6.07%	6.50%	5.50%
Sample variance	1.32%	1.27%	1.12%	0.64%	1.00%	0.37%	0.42%	0.30%

the data in Table 2 about the average annual yield, the standard deviation and the sample variance of the yield of Indonesia's government bonds and the IDX Composite Index. A comparison of the results in the two tables shows that for the period from 02 January 2020 to 15 February 2022, Indonesian government bonds offered better average yields than the leading index of the Indonesian capital market. What is more, this is achieved at a much lower standard deviation at all analysed maturities. This unequivocally confirms the thesis that under the conditions of COVID-19 the yield of Indonesian government bonds has lower volatility than that of the return of equity securities traded on the capital market in the country. Depending on the maturities, the volatility of their yields is from 1.79 to 3.6 times lower.

The information in Table 1 confirms that volatility of the investigated yields decreases with the increase of the term to maturity, because for the one-year bonds it is 11.5% and decreases to 5.5% for the thirty-year debt instruments. However, the volatility profile in Figure 4 shows that volatility does not decrease smoothly over longer maturities. For example, the standard deviation of the 10- and 20-year bond yields is much lower than that of the nearest maturity bonds, and the volatility of the 15-year bond yields is probably slightly higher than is normal for these bonds. All this reinforces the impression that during the analyzed period there are anomalies in the market prices of the debt instruments traded in the medium-term segments of the Indonesian government bond market.

Table 3. Autocorrelation coefficients of the yield to maturity of Indonesian government bonds for the period 02 January 2020–15 February 2022 (source: author's own calculations)

Lag	Residual maturity							
	1Y	3Y	5Y	10Y	15Y	20Y	25Y	30Y
1	0.976	0.992	0.994	0.992	0.995	0.991	0.994	0.990
2	0.963	0.984	0.987	0.980	0.989	0.981	0.988	0.981
3	0.942	0.975	0.980	0.968	0.982	0.968	0.980	0.972
4	0.927	0.967	0.973	0.957	0.977	0.955	0.972	0.963
5	0.911	0.959	0.966	0.946	0.972	0.941	0.964	0.954
6	0.898	0.951	0.958	0.935	0.967	0.926	0.955	0.942
7	0.884	0.943	0.949	0.924	0.960	0.909	0.946	0.929
8	0.875	0.934	0.941	0.913	0.954	0.894	0.937	0.918
9	0.866	0.925	0.932	0.901	0.949	0.878	0.928	0.907
10	0.858	0.916	0.924	0.887	0.942	0.860	0.919	0.896

The autocorrelation coefficients of the studied yields are presented in Table 3. It shows that they have very high values for all maturities in the range from 1 to 30 years, even at a lag of 10. With the exception of the yields on one-year bonds, all other autocorrelation coefficients with a lag of 1 period have values close to one. On the other hand, the values of the partial autocorrelation coefficients in Table 4 show that practically the most significant impact on the current yields of Indonesian government bonds have the observations with a lag of one period and less significant – those with a lag of two periods. However, a significant effect on some of the analyzed yields can be found for lags of 3 and even 4 periods. All this shows that the current yield to maturity yield curve of Indonesian government bonds is largely a function of past economic information, and the Indonesian government bond market is likely to be relatively weak efficient.

The data that the current yield to maturity of Indonesian government bonds under COVID-19 contains financial information with sufficient quality to be used for forecasting makes the analysis of the stationarity of its absolute changes very valuable. The analysis is based on the results of the Augmented Dickey-Fuller test statistic presented in Table 5. The values of the test statistics exceed the critical values at the 99% confidence interval across the entire maturity spectrum. That is, there is no unit root in the analyzed data, which means that the absolute changes in the yield to maturity of Indonesian government bonds

Table 4. Partial autocorrelation coefficients of the yield to maturity of Indonesian government bonds for the period 02 January 2020–15 February 2022 (source: author's own calculations)

Lag	Residual maturity							
	1Y	3Y	5Y	10Y	15Y	20Y	25Y	30Y
1	0.976*	0.992*	0.994*	0.992*	0.995*	0.991*	0.994*	0.990*
2	0.202*	–0.005	–0.144*	–0.226*	–0.206*	–0.113*	–0.003	0.048
3	–0.107*	–0.017	0.054	-0.008	0.039	–0.108*	–0.125*	–0.036
4	0.061	0.033	0.011	0.083	0.130	–0.019	–0.085*	0.016
5	–0.001	–0.014	–0.020	–0.015	–0.038	–0.088	0.029	–0.013
6	0.053	–0.007	–0.127	–0.032	–0.067	0.015	–0.045	-0.115
7	0.014	–0.031	–0.026	0.015	–0.027	–0.093	0.043	-0.113
8	0.088	–0.026	0.068	–0.025	0.059	0.076	–0.075	0.102
9	0.032	–0.004	–0.049	–0.062	–0.024	–0.071	0.064	0.005
10	0.002	–0.046	–0.033	–0.090	–0.111	–0.063	–0.050	-0.033

Note: * greater than the threshold value.

Table 5. Augmented Dickey-Fuller test statistic values of the absolute changes in the yield of Indonesia's government bonds in the period 02 January 2020–15 February 2022 (source: author's own calculations)

Indicator	Residual maturity							
	1Y	3Y	5Y	10Y	15Y	20Y	25Y	30Y
T-Stat.	–14.19	–22.99	–19.00	–18.03	–15.02	–20.27	–13.83	–24.69
Test critical values								
1% level	–2.57	–2.57	–2.57	–2.57	–2.57	–2.57	–2.57	–2.57
5% level	–1.94	–1.94	–1.94	–1.94	–1.94	–1.94	–1.94	–1.94
10% evel	–1.62	–1.62	–1.62	–1.62	–1.62	–1.62	–1.62	–1.62

for the period 02 January 2020–15 February 2022 are a stationary process and do not have a significant trend. This means that investors in Indonesian government bonds will not face any difficulties in making their investment policy because they could model and forecast very easily the expected changes in their yields.

Against the background of the established stationarity, the absolute changes of the analyzed yields, of particular research interest is whether their probability distribution deviates from the normal one. The extremely high values of the Jarque-Bera coefficient in Table 6 show that there is no doubt that the absolute change in the yield to maturity of Indonesian government bonds does not have a normal probability distribution. This is confirmed by the high values of their kurtosis coefficient.

On the other hand, the positive values of the skewness coefficient for all maturity terms except for the maturity of the 10-year bonds indicate that there is a positive skewness of the analyzed data. In practice, this means that, with few exceptions, the absolute change in Indonesian government bond yields is likely to be close to the lognormal distribution. As for the 10-year Indonesian government bonds, their negative skewness also indicates that there are market anomalies in the medium-term segment of the analyzed debt market.

Table 7 shows that the correlations between the analyzed yields to maturity are very strong along the entire yield curve. The only weaker correlation is between the yields on bonds maturing in 1, 10, 15 and 20 years, but even in these cases the value of the correlation coefficients is greater than 0.72. As the statistical tests performed show that all coefficients are significant in the 99% confidence interval, it can be certainly said that in terms of this feature there is a significant difference between the Indonesian debt market and the developed debt markets. This, however, is not necessarily a bad thing – on the contrary, the strong correlation between the different segments of the analyzed bond market can actually only facilitate the work of the investment managers, that form portfolios of Indonesian government bonds.

Table 6. Skewness, kurtosis, and Jarque-Bera coefficient values of the yield of Indonesian government bonds for the period 02 January 2020–15 February 2022 (source: author's own calculations)

Indicator	Residual maturity							
	1Y	3Y	5Y	10Y	15Y	20Y	25Y	30Y
Skewness	1.09	0.50	0.75	–0.79	2.33	0.94	1.61	2.46
Kurtosis	45.29	8.86	12.08	16.48	32.62	19.41	24.24	37.33
Jarque-Bera	40054*	788*	1893*	4111*	20077*	6090*	10309*	26867*

Note: *statistical significance at the 99% confidence interval.

Table 7. Correlation coefficients of the yields to maturity of Indonesian government bonds for the period 02 January 2020–15 February 2022 (source: author's own calculations)

Residual maturity	1Y	3Y	5Y	10Y	15Y	20Y	25Y	30Y
1Y	1							
3Y	0.865*	1						
5Y	0.835*	0.961*	1					
10Y	0.745*	0.880*	0.959*	1				
15Y	0.782*	0.861*	0.899*	0.918*	1			
20Y	0.727*	0.859*	0.933*	0.968*	0.897	1		
25Y	0.838*	0.931*	0.956*	0.925*	0.950*	0.917	1	
30Y	0.825*	0.921*	0.961*	0.954*	0.931*	0.958*	0.963*	1

Note: * statistical significance at the 99% confidence interval.

The specific causes of the very strong correlations can be explained with the data shown in Table 8 and Figure 5, which present the results of the principal component analysis of the yield to maturity yield curve of Indonesian government bonds for the period 02 January 2020–15 February 2022. The values of the main components of the analyzed yield curve in Table 8 show that the first three components account for about 97.46% of its dynamics during the investigated period.

Table 8. Values of the principal components and their effect on the dynamics of the yield curve of Indonesian government bonds for the period 02 January 2020–15 February 2022 (source: author's own calculations)

Principal component	Value	Proportion	Cumulative Proportion
1	7.342679	91.78%	91.78%
2	0.314254	3.93%	95.71%
3	0.139827	1.75%	97.46%
4	0.100429	1.26%	98.71%
5	0.044672	0.56%	99.27%
6	0.027252	0.34%	99.61%
7	0.022134	0.28%	99.89%
8	0.008753	0.11%	100.00%

Figure 5 shows the values of the component loadings of the first three principal components from Table 8 for the analyzed maturities. Clearly, the first principal component has the same effect on the dynamics of all yields, i.e. it causes a parallel shift of the yield curve. Given the fact that it explains 91.78% of the dynamics of the analyzed yield curve, it can be concluded that the change in the yield curve on Indonesian government bonds during the study period is not caused so much by expectations for economic growth as by expected inflation in Indonesia.

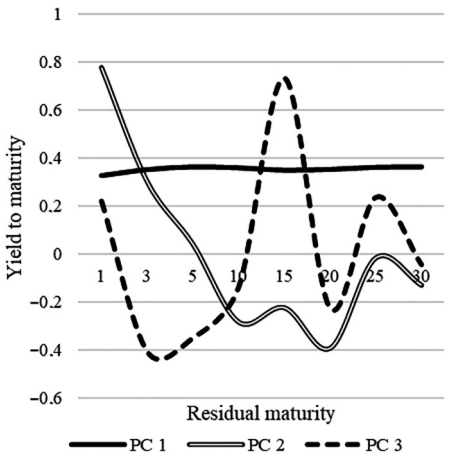

Figure 5. Component loadings of the first three main components of the dynamics of the Indonesian government bond yield curve for the period 02 January 2020–15 February 2022 (source: author's own calculations)

It can be seen that the values of the component loadings of the second main component are positive for maturities between 1 and 5 years, after which they become negative. Therefore, the second principal component can be defined as a slope oscillation with a turning point at about 5 years to maturity. The third component has a markedly positive effect only on bonds with maturities from 10 to 20 years, i.e. it is the change in the curvature of the yield curve.

Conclusions

The study presents a quantitative analysis of the investment characteristics of the yield of Indonesian government bonds for the period 02 January 2020–15 February 2022. The results showed that in the context of the COVID-19 pandemic, it has most of its well-known quantitative characteristics, such as lower volatility compared to the volatility of the return on equity securities traded on the same market, decreasing volatility with increasing maturity, autocorrelation, the presence of three main components in the dynamics of the yield curve, and stationarity of the absolute changes and deviation of their probability distribution from the normal distribution. However, the dynamics of the analyzed yield curve has certain unconventional characteristics, such as a strong correlation between yields across all maturities and an inhomogeneous volatility profile. This shows that the government bond market in Indonesia has its own specific characteristics that distinguish it from the debt markets in developed economies. The other main conclusions of the study can be formulated as follows:

First. The widening spread between short-term and long-term yields in 2022 is an indicator that Indonesian debt markets expect the economic recovery from the COVID-19 crisis to continue.

Second. The presence of obvious anomalies in the volatility of the yield to maturity of medium-term bonds means that during the analyzed period, some of the Indonesian government bonds with medium-term maturity were incorrectly priced. The indirect proof of this is the negative skewness of the yield on 10-year government bonds. This means that in the future the value of Indonesia's 5-year and 15-year government bonds may go down and the value of the 10-year bonds will go up.

Third. The high and significant autocorrelation of the analyzed yields to maturity with lags of 1 and 2 periods shows that the current yield curve in Indonesia contains enough information to be effectively modelled and forecasted for 1 or 2 trading days ahead. This conclusion is additionally corroborated by the stationarity of the absolute changes in the yield to maturity across the entire analyzed maturity range.

Fourth. With the exception of 10-year government bond yields, all other yields to maturity of Indonesian government bonds do not change significantly. This is probably largely due to the fact that the yields of Indonesian government bonds are relatively high compared to

those in developed capital markets. On the other hand, this finding means that the interest rate risk on Indonesian government bonds under COVID-19 is relatively low, which protects investors from incurring large losses.

Fifth. The presence of very strong correlations along the entire yield curve of the Indonesian government bonds and the fact that the parallel shift explains about 91.78% of its dynamics means that investment managers can quite easily manage port-folios of Indonesian government bonds because such portfolios could easily be hedged against much of the interest rate risk even by using simple tools such as duration or modified duration.

Nonetheless, this study does not address all issues related to the analysis of the investment characteristics of the Indonesian government bond market. As we have pointed out, it has certain anomalies, which should be studied in greater detail in further investigations on this research topic. The development of optimal investment strategies which include Indonesian government bonds could be defined as a prospective topic for further research in this field.

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