

THE INTERVAL EFFECT DURING THE COVID-19 PANDEMIC – THE CASE OF THE WARSAW STOCK EXCHANGE

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Abstract One of the difficulties in the process of estimating beta coefficients (β) is indicating the interval for measuring the return necessary to calculate it. Using various time intervals to calculate β , significant differences in estimates were noticed. The occurrence of these differences is called the interval effect. The aim of this study is to determine whether the occurrence of the interval effect also occurred among shares in the Warsaw Stock Exchange Index during the COVID-19 pandemic. The significant destabilisation of economic conditions has led to strong turmoil in capital markets. This situation creates research motives that can be used to discover new dependencies in capital markets. The aim of this paper is to check whether in years of spread of the COVID-19 pandemic, it was possible to observe other levels of β among companies on the WIG in the situation of a different approach to estimating returns on their shares). Therefore, in the period analysed, the interval effect can be noticed on the WSE. Interestingly, among the detailed relationships analysed, it was noticed that along with the extension of the time interval of returns, the β increased for companies with higher capitalisation.

Keywords:
interval effect,
beta coefficient,
COVID-19,
Warsaw Stock
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shares

1 Introduction

Risk is one of the fundamental criteria taken into account by investors in the process of making decisions. For many years, investors have been prompted to look for increasingly effective methods of measuring risk. Among the many methodological proposals, the single-index model proposed by William Sharpe (1963) is very popular. It makes the volatility of the returns of companies' shares dependent on one factor, which is considered to be the market index.

One of the parameters of the Sharpe model is the beta coefficient (β). It reflects the non-diversifiable part of the volatility of rates of return. The process of its estimation is associated with numerous decision-making difficulties (Feder-Sempach, 2017, pp.20-21). Among them, the author indicates: the selection of the appropriate length of the research sample, the need to specify the stock exchange index that adequately represents the market for the companies selected for the sample, or the indication of the interval for measuring the return necessary to calculate it. The latter is often mentioned in scientific studies in which authors discuss what the most appropriate interval is for measuring returns that will later be used to estimate beta coefficients.

When using different time intervals (from daily to several years) to calculate beta coefficients, significant differences in estimates were noticed. The occurrence of these differences in the values of the β coefficients depends on the adopted period of the used share quotations of companies, which is called the interval effect or the intervaling effect.

The purpose of this article is to determine whether the occurrence of the interval beta coefficient effect also occurred among companies grouped in the Warsaw Stock Exchange Index (WIG) during the COVID-19 pandemic. The significant destabilisation of economic conditions led to strong turmoil on the capital markets, which was particularly observed in the first half of 2020. According to some researchers, the increase in price volatility on the stock market during the current turmoil is higher than in the periods of the previous great crises of 1930, 1987 and 2008 (Thakur, 2020; Zhang et al., 2020). This situation creates research motives that can be used to discover new dependencies in capital markets. These undoubtedly include the attempt to verify the occurrence in the present reality of the interval effect noticed in the 1970s. To achieve the main goal is necessary to formulate the

main hypothesis, which is following: The explosion and spread of the COVID-19 pandemic have resulted in different beta levels depending on the time horizon used to calculate returns. In connection with the above, the occurrence of the so-called interval effect can be observed.

The aim of this paper is to check whether in the year of the spread of the COVID-19 pandemic (i.e. 2020) and in the next year of its duration (i.e. 2021) it was possible to observe other levels of the beta coefficient of companies listed in the WIG index on the Warsaw Stock Exchange in a situation of differentiated approaches to estimating the returns on their shares (daily, weekly, biweekly or monthly respectively). The author's research on the occurrence of the interval effect in the time of the COVID-19 pandemic on the WSE will allow a deepening of knowledge of capital market participants in the scope of the possibility of using the beta coefficient to measure systematic risk in times of instability on the capital markets.

2 Review of interval effect literature

Choosing the right timeframe to measure returns was of interest to researchers as early as the 1970s. The first empirical study showing the differences in beta coefficient estimates depending on the change in the length of the interval for estimating returns was carried out by Gerald Pogue and Bruno Solnik (1974). They analysed the aforementioned parameters on the American market and seven European markets (Belgium, France, the Netherlands, Germany, Switzerland, Great Britain, Italy). In their study, Pogue and Solnik diagnosed the occurrence of a range effect (measured by the quotient of the monthly and daily beta value) for the above-mentioned markets. Importantly, it was noticeable to a much greater extent on the then less developed Belgian and Dutch stock exchanges. The survey results could indicate a link between the occurrence of the interval effect and the degree of development of the capital market in a given country. In another study on the selection of the appropriate time horizon for the calculation of the beta coefficient, the authors noticed that errors in the coefficient forecast resulting from the adopted different time intervals can be reduced by applying the coefficient correction proposed by Marshall Blume (1975), thus increasing the number of companies in the portfolio or extending the estimation period (Eubank, Zumwalt, 1979).

The authors of subsequent studies came to interesting conclusions. Gabriel Hawawini (1983) and Puneet Handa, S.P. Kothari and Charles Wasley (1989) noticed the differentiation of the beta interval effect depending on the capitalisation of companies. In the first of the above, the beta coefficient was supposed to increase along with the shortening of the interval for measuring returns. However, this dependence was to apply only to companies with higher-than-average capitalisation and trading volumes. This relationship was confirmed by the second of the 1989 articles quoted above. The researchers noticed a decrease in the value of the beta coefficient with the extension of the interval of returns for companies with higher capitalisation, while the relationship was opposite for companies with capitalisation below the average level.

The interval effect was also tested in non-US markets. When examining companies listed on the Brussels Stock Exchange, it was noticed that the values of beta coefficients converge to their asymptotic values and depend on the day adopted for the first day of verification of the interval effect (Corhay, 1992). The same author also noticed that the existence of the interval effect is inversely proportional to the market value of the companies. The observations relating to the occurrence of the interval effect were confirmed in the Australian market (Brailsford, Josev, 1997). These researchers built two equity portfolios, the first of which comprised companies with the lowest capitalisation, and the second with the highest capitalisation. In their study, Brailsford and Josev noticed that the beta coefficient of companies with the highest (lowest) capitalisation decreased (increased) along with the extension of the time horizon adopted for its estimation. They also showed that the determination coefficient increases simultaneously with the extension of the interval for measuring returns for both of these portfolios.

Based on the methodology used in the Australian market, a similar study was conducted on the Greek capital market (Diacogannis, Makri, 2008). However, the authors noticed that the mean of estimated beta coefficients increases for both small and large capitalisation companies in the case of extending the range of estimating return rates from daily to fortnightly.

The interval effect was also confirmed on the Bucharest Stock Exchange (Oprea, 2015). Using the standard market model, the aforementioned article found that beta estimates for the same stocks vary significantly when using daily and monthly returns. Furthermore, using a linear regression model, the article shows that the differences between monthly and daily beta estimates are negatively related to some stock characteristics such as market capitalisation and transaction intensity.

The Polish capital market was also subject to research on the interval effect. In terms of the WSE, there have also been some really interesting publications on the interval effect. Among the first were the studies by Janusz Brzeszczyński, Jerzy Gajdka and Tomasz Schabek (2010, 2011). The authors estimated the effect of the interval for 1-, 5-, 10-, and 21-day returns on stocks. The estimation was performed with the use of heteroscedastic ARCH autoregressive models. In the analysis of the 2005-2008 period, they noticed the existence of the convergence effect of beta coefficients in consecutive sub-periods. However, this convergence was conditioned, *inter alia*, by the interval for defining rates of return or the selection of the stock index used for calculations. The comparative analysis of the interval effect on the example of shares of companies from the WIG20 index and the German DAX (Feder-Sempach, 2017) or the one carried out for the 33 largest companies listed on the Warsaw Stock Exchange (Dębski, Feder-Sempach, 2015) is also interesting.

In recent years, the emergence of new conclusions about the interval effect has been noticeable. Among them, it should first be pointed out that the occurrence of the interval effect is related to the autocorrelation of rates of return on securities (Hong, 2016). The degree of autocorrelation of returns on securities with the market return determines the occurrence and direction of the interval effect. This effect disappears as the time horizon used to calculate returns increases. Verifying the existence of the interval effect on the exchange-traded fund (ETF) market (Milonas, Rompotis, 2013) was a revealing issue. When examining 40 ETFs listed on the NASDAQ Stock Exchange, the authors found that the average beta ratio increased as the time horizon of returns increased. The differences between the daily, weekly and monthly returns were statistically significant. Moreover, the authors used various methods to estimate the beta coefficient, noting significant differences between them.

3 **Estimated beta parameters of WIG index companies during the COVID-19 pandemic**

As mentioned in the introduction, the main goal of this study is to obtain knowledge about the beta interval effect of shares of companies listed in the WIG index during the time of the COVID-19 pandemic. The author's aim was to verify whether the uncertainty of the economic situation, which caused an increase in the volatility of the market valuation of issuers, is reflected in the levels of the aforementioned coefficient when it is calculated on the basis of returns that differ in the period of their estimation (daily, weekly, biweekly and monthly).

The interval effect has been verified by calculating the beta systematic risk factors for shares of selected issuers from the WIG index. For this purpose, the author of this paper decided to narrow the research sample to the 140 largest companies grouped in the three main WSE indices: WIG20, mWIG40 and sWIG80. These indices include, in turn, 20 companies with the highest market capitalisation, 40 medium-sized companies and 80 small companies. For consistency with the date of the outbreak of the COVID-19 pandemic, the author decided to use the historical portfolios of these indices as of the first quarter of 2020 (WSE, 2020), which was a period of the significant spread of the pandemic, and thus an increase in volatility in financial markets.

The beta coefficients have been calculated using the OLS method for the daily, weekly, biweekly and monthly returns. The WIG broad market index has been used to indicate the market rate of return. The period of analysis coincides with the years of the outbreak and duration of the COVID-19 pandemic, i.e. 2020-2021. The quotations of shares of the indicated entities taken from the stooq.com quotation database (2022) were used to calculate the beta coefficients.

In order to better compare the calculated beta coefficients for different intervals of measuring the returns, the author decided to estimate the value of the R^2 coefficient of determination for each of the results. Its value informs what part of the volatility of returns was explained by the calculated beta coefficients (Kornacki, Wesolowska-Janczarek, 2008). R^2 indications closer to one indicate a higher definition of a company's risk of systematic risk. Consequently, beta coefficients characterised by a

higher level of determination should be considered as carrying a greater information value.

The averaged values of the beta coefficients calculated during the COVID-19 pandemic in the aforementioned time horizons of returns for the companies grouped in the WIG20, mWIG40 and sWIG80 indices are shown in Table 1 below. It also includes the R^2 determination coefficients and descriptive statistics of the coefficients (mean and standard deviation).

Table 1: Values of beta coefficients for a varied horizon, estimated returns for selected WSE companies for the years 2020-2021 (128 cases)

Return interval	Average Beta	Average R^2	SD of Beta	Highest R^2 (number of cases)	Lowest Beta (number of cases)	Highest Beta (number of cases)
Daily	0.873*	0.204	0.387	5	54	19
Weekly	0.958	0.289	0.479	31	23	26
Biweekly	1.013*	0.325	0.557	29	17	23
Monthly	1.015*	0.360	0.701	63	34	60
Total number of companies:				128	128	128

*Statistically significant differences of means at $p < 0.05$ (U Mann-Whitney Test).

Source: author's own calculation

From the entities grouped from the three main indices of the WSE, 128 qualified for the final research sample. Due to their withdrawal from the stock exchange in the analysed period, it was necessary to omit 12 entities (1 company from WIG20, 1 from mWIG40 and 10 from sWIG80).

It can be observed that the averaged values of beta coefficients were characterised by the highest value for monthly returns. Moreover, also in this case, the highest value of the R^2 coefficient of determination was recorded, which in the case of monthly returns is 36% (the beta coefficient explains 36% of their volatility). These results are consistent with those of previous researchers verifying the existence of the interval effect on the WSE (Olbryś, 2014; Feder-Sempach, 2017). Unfortunately, in the case of monthly returns, the standard deviation of beta coefficients is also the highest, which proves their greatest volatility in relation to other returns horizons. The increase in errors in estimating β along with the extension of the time horizon of returns has already been reflected in existing literature on the subject (Podgórski,

2019). Interestingly, the averaged values of the beta coefficients for daily and weekly returns would suggest to qualify companies to group of defensive ($\beta < 1$) issuers, which react less well than the market. However, when looking at the values of the coefficients with the use of two-week and monthly returns, the aggressive ($\beta > 1$) character of the analysed companies can be concluded.

It is worth noting that in almost half of the analysed cases (60 out of 128), the beta coefficient was the highest at the time of using monthly returns for its estimation. Moreover, the lowest values (54 out of 128 cases) were those beta coefficients estimated on the basis of daily returns. It can be said with a high degree of probability that the COVID-19 pandemic did not disturb the existence of the interval effect. This is evidenced by the statistical significance of the mean values for the beta coefficient calculated using the Mann-Whitney U test (at level $p < 0.05$). When observing the quantification of beta coefficients for 140 (ultimately 128) of the largest WSE companies in 2020-2021, different levels can be observed depending on the adopted time horizon of returns. However, based on previous discoveries exploring this issue, the previously noticeable tendency to decrease the value of beta coefficients along with the extension of the time horizon of returns (e.g. Hawawini, 1983; Corhay, 1992; Brailsford, Josev, 1997) in the case of companies with higher capitalisation has not been observed on the WSE during the COVID-19 pandemic. Moreover, a slight increase was noticeable.

4 Conclusions

The main purpose of this article was to indicate whether the beta interval effect also occurred during the COVID-19 pandemic. To verify this research goal, the author decided to calculate the beta coefficients of WSE companies listed in the WIG20, mWIG40 and sWIG80 indices in the years 2020-2021. Using daily, weekly, biweekly and monthly returns, differences in averaged values of beta coefficients were observed. Moreover, these differences made it impossible to explicitly classify the analysed companies to the group of defensive (reacting weaker than the market) and aggressive (reacting stronger than the market) issuers. Moreover, it was noticed that the beta coefficients based on monthly returns had the highest values and were characterised by the highest R^2 coefficient of determination. Therefore, it seems justified to confirm the research hypothesis set out in the introduction of this study,

which indicated the occurrence of an interval effect during the COVID-19 pandemic.

The obtained research results shed new light on the shaping of the interval effect in comparison to the previously conducted research on this issue. There have not been any decreases in the value of beta coefficients for companies with high capitalisation along with the extension of the time horizon of returns, which has been repeatedly confirmed by researchers dealing with this subject. These results are an original contribution to the current area of capital market research during the COVID-19 pandemic. This provides the basis for further scientific research on the search for more detailed relationships characterising the interval effect during the increased volatility in financial markets caused by the COVID-19 pandemic.

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