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Indonesia's Stock Investment Risk Mapping during Covid-19: Rolling Standard Deviation and Ewma Analysis

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Abstract

The COVID-19 pandemic had an impact on the world economy and made Indonesia capital market more volatile and riskier. The change in Indonesia's capital market has been popular topic since the outbreak. The main purpose of this research is to conduct risk mapping of the firm listed in JCI (Jakarta Composite Index) based on firm characteristics before COVID-19 and on COVID-19 phases to assess the dynamics of risk. This research uses the daily closing price of 67 stocks from various sector from ranging period October 2019 until June 2020. The methods used to measure the volatility are EWMA (Exponentially Weighted Moving Average) and rolling standard deviation. The expected finding is different volatility based on firm size and book to market listed in JCI before and in the COVID-19 phase. The present research uses free estimation model to measure volatility and map the volatility according to the firm characteristics. There is still few researches that assess in more detail the characteristics of companies that experience changes in volatility during the pandemic, both in terms of firm size and book to market value. The results of the risk mapping are to complement other researches related to capital market risks during the pandemic COVID-19 and shows characteristics of firm that is impacted by pandemic. The results shows that small firms volatility are not affected by COVID-19 but big firms with low *book to market equity* volatility are increasing significantly during COVID-19 phase.

Keywords: COVID-19, capital market, volatility, EWMA, rolling standard deviation

1 Introduction

In December 2019, China reported a case of coronavirus-related pneumonia. The COVID-19 pandemic has had an economic impact, and COVID-19 has impacted numerous industrial sectors, particularly the tourism and aviation industries (Zhang, Hu, and Ji, 2020). The first incidence of COVID-19 was reported in Indonesia on March 2, 2020. The pandemic that transpired created changes in the Indonesian people's social and economic structure. Similarly, investors' decisions in Indonesia's financial industry and capital market are influenced by positive and bad news during COVID-19 (Zainuri et al., 2021).



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Despite the changes in investor behavior during the Covid-19 period, the Indonesia's capital market was stable against various COVID-19 government policies compared to other Asia-Pacific countries (Ibrahim *et al.*, 2020). This makes stocks in the Indonesian capital market a safe investment instrument for the growing number of novice investors. According to Megaritis *et al.* (2021), macroeconomic shocks such as shocking news globally can affect volatility in the capital market. The changes in Indonesia's capital market during COVID-19 become an interesting research object.

There are other researches about the capital market in Indonesia during COVID-19, such as the research about the impact of COVID-19 to the stock return (Herwany *et al.*, 2021), event studies (Zainuri *et al.*, 2021), and determinants of volatility during COVID-19 (Nugroho and Robiyanto, 2021). But research about risk mapping which shows the measure of volatility based on firm size and book to market value during COVID-19 in Indonesia's stock market is still new. The aim of this research is to assess the investment risk according to the firm size and book to market by value using rolling standard deviation and EWMA as volatility measurement. The assessment of the investment risk during COVID-19 research also has contributions.

This research offers contributions for the risk investment study during pandemic COVID-19 which enriched other research about the impact of COVID-19 to stock investment in Indonesia. Another contribution is to give more insight about the impact of the pandemic on investment volatility during COVID-19. The previous research about the measurement of volatility by Ibrahim *et al.* (2020) has already examined the impact of public health crises and government response on equity market volatility in Asia developed markets. This research about risk mapping can also enriched the research of Ibrahim *et al.* (2021) but using the simpler method to measure volatility and the sample in a specific country which is Indonesia.

2 Literature review

COVID-19 outbreak has already affected some industries and has a potential impact on the financial market (Goodell, 2020). There are several studies about the impact of the pandemic on global stock market and Indonesia's stock market. The research from Zhang *et al.* (2020) shows that the spread of COVID-19 has impacts on the financial market around the world, the research measures the volatility of the top ten countries with the most confirmed cases and correlates the market volatility and confirm cases. The finding is the individual stock market reactions have correlations to the severity of the outbreak in each country, the uncertainty of pandemic has caused the market to be more volatile and unpredictable. There are also studies about the stock market volatility.



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The research by Ibrahim *et al* (2020) also measure the volatility of Asian developed markets including Indonesia. The volatility measurement using GJR-GARCH shows that market volatility is affected by COVID-19 government intervention measures and also international events. The pandemic COVID-19 also had an impact on Indonesia's stock on existing sectors, according to Herwany *et al* (2021), which measure the abnormal return value 30 days before and after the COVID-19 events occurred, shows that the abnormal return of infrastructure, utilities, and transportation sector tend to be constant, while the construction, financial, and real estate are decreasing, the other sectors are increasing.

The impact of COVID-19 on the financial market has been studied over a variety of time frames. Herwany *et al.* (2021) used a 30-day time horizon for event studies in Indonesia, Harjoto *et al.* (2021) used a 10-day time horizon for event studies on WHO and Federal Reserve announcements about the global pandemic, and Albulescu (2021) used a 30-day time horizon to measure financial market volatility in the United States. Sui *et al* (2020) examine the influence of COVID-19 portfolio performance over a three-month period, concluding that the portfolio has a considerable impact in the short term. This research uses 90 days time horizon to measure the volatility. Stock volatility can be measured using a number of different approaches.

According to Ding and Meade (2010) research about forecasting accuracy with stochastic volatility, GARCH, and EWMA under different volatility models. The result of the research shows that under high volatility the stochastic volatility is more accurate than GARCH and under moderate volatility, EWMA is more accurate. Overall EWMA appears to be more flexible and accurate for forecasting volatility. Another method to measure volatility in this research is rolling standard deviation.

Rolling standard deviation is also a method to measure volatility, research by Mukherjee and Goswami (2017) uses rolling standard deviation to capture the volatility trend of commodity futures and gold futures. Rolling standard deviation in the research by Edwards and Susmel (2003) also shows that rolling standard deviation can be used to measure the high volatility of interest rate and the measurement is aligned with SWARCH method. The use of rolling standard deviation to measure interest volatility somehow can also be applicable to measure stock volatility during COVID-19.

3 Research method

Ibrahim *et al* (2020) research shows the volatility of eleven Asian development market during COVID-19 pandemic including Indonesia using GJR-GARCH method. Herwany *et al* (2021) have done research about abnormal return during COVID-19 and which sector is more affected.



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But the researches haven't included firm characteristic that is more affected during COVID-19. Using model-free and flexible method which are rolling standard deviation and EWMA to measure the volatility and mapped the volatility based on firm size and book to market volatility, this research assesses the firm characteristics which affected by pandemic of COVID-19.

This research uses quantitative research methods and uses secondary data as the main data source. The sample studied is the stocks with highest trading frequency and volume listed on the IDX in the period September 2019 to February 2020 and have historical data. The population of this study is all companies that are members of the JCI from 2019 until 2020 period. The method of data collection is purposive sampling. Subsequently, 67 stocks were selected that fit the criteria for further testing using the EWMA and Rolling standard deviation methods. The volatility measured is ranging from period October 2019 until July 2020 (90 days before the first case of COVID-19 and during the COVID-19 phase). The firm's volatility is then mapped based on the company's characteristics: book to market value and firm size.

3.1 EWMA

Exponentially Weighted Moving Average (EWMA) is a method of measuring volatility that is heteroscedasticity or not constant. In EWMA, the weight of the old data in the prediction will decrease exponentially. The following is the equation for measuring volatility with EWMA which refers to Morgan (1996) quoted from Purba *et al* (2014).

$$\sigma_t = \sqrt{\lambda\sigma^2_{t-1} + (1 - \lambda)R^2_{t-1}} \quad (1)$$

Description:

σ_t = Standard deviation of the return day - t

λ = decay factor

R_{t-1} = Return t-1

Decay factor is weights adjusted for price changes. The decay factor value is between 0 to 1. Generally for daily data, the value is decay factor 0.94 and 0.97 for monthly data, referring to Morgan (1996) quoted from Purba *et al* (2014). This research use daily data which use decay factor 0.94.

3.2 Rolling standard deviation

Standard deviation is a statistical method that can be used to measure the volatility of the spread of returns. Rolling standard deviation is a modification of the calculation of the standard deviation by multiplying the root of the number of days trading in 1 year. The formula for rolling standard deviation is:



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$$\sigma_t = \sqrt{\frac{\sum_{t=1}^n (r_t - \bar{r})^2}{n-1}} \times \sqrt{252} \quad (2)$$

Description :

σ_t = Standard deviation

r_t = return on time – t

\bar{r} = average return

3.3 Fama French three factor model

Fama and French three-factor model in this research is used to map the firm based on firm size and book to market value. Based on Fama and French three-factor model (1993), the firms are split into big (B) and small (S) according to the firm size and categorized as low (L), medium (M), and High (H) based of book to market value. The firm size value is the result of the number of outstanding shares multiplies the share price. The firm size below the median is the group as small firm (S) and the firm size value above the median is group as big firm (B) (Sudiyatno and Irsad, 2011). Book to market value is the result of dividing book value by market value, then the firms are formed into three groups, 30% low (L), 40% medium (M), and 30% high (H) (Fama and French, 1993).

4 Results and discussion

The research begins with taking the five most active stocks daily with the largest volume and the greatest frequency from September 2019 to February 2020 from IDX stock summary. Then the samples taken were re-selected with the criteria that they were still active in 2019 to 2020 and had the historical data needed for research. The selection provided 67 samples for further research. The samples are measured for their volatility using *rolling standard deviation* and EWMA method. Volatility measurements were carried out in October 2019 to July 2020 (90 days before and after March 2, 2020). The Samples are :

Table 1. Sample of Firm's Stocks

ABBA	BUMI	INAF	PTBA	BBTN	FORZ	NATO	VIVA
ACES	BWPT	INCO	RAJA	BHIT	FREN	NIKL	WSKT
ADRO	DEAL	ISSP	SCMA	BSKL	GIAA	PGAS	YELO
ANDI	DKFT	JSKY	SIMP	BMRI	GMFI	PPRE	ZINC
ANTM	DOID	JPFA	SMBR	BMTR	GSDT	PPRO	
APLN	ELSA	KPIG	SQMI	BNLI	HMSP	PSAB	
ASII	ERAA	LMAS	TBIG	BRMS	IKAI	TNCA	
BABP	ESTI	LUCK	TINS	BRPT	MEDC	TOPS	
BBRI	FILM	MDKA	TLKM	FIRE	MNKT	TOWR	

Source: Research result



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The volatility of selected samples was then measured with rolling standard deviation and EWMA method. The result of the volatility measurement can be seen in Table 2.

Table 2. Descriptive Analytics of Volatility

Descriptive Analytiks	Rolling Std Deviation (before)	Rolling Std Deviation (During COVID-19)	EWMA (Before)	EWMA (During COVID-19)
Mean	59.32%	70.00%	63.69%	64.99%
Median	48.00%	67.24%	47.78%	72.29%
Max	157.89%	168.74%	162.65%	129.88%
Min	21.79%	0.42%	11.47%	0.07%

Source: Research result

Based on volatility measurement results, it can be seen that the occurrence of COVID-19 cases caused most of the companies in the sample to experience increased volatility. There are several companies that experienced a decrease in volatility after the COVID-19 case, which are ABBA, ANDI, BABP, BKSL, BNLI, BRMS, BUMI, FILM, FORZ, IKAI, JSKY, KPIG, MNKT, PPRO, SQMI, YELO, and VIVA. More detailed results related to the dynamics of risk through volatility can be obtained by mapping volatility by *firm size* and *book to market value*.

Furthermore, volatility mapping is carried out based on firm size and book to market equity using the volatility measurement method rolling standard deviation. According to firm size, companies are divided into large companies (B) and small companies (S) based on the value of multiplying the number of shares with the share price. Furthermore, based on book to market equity, companies are divided into low (L), medium (M), and high (H) categories. The lower book to market equity indicates that the company is overvalued or has a higher market value than its actual value. The result of risk mapping based on firm size and book to market equity can be seen in Table 3.

Table 3. Number of firm in volatility mapping based on firm size and book to market equity

Firm Size	Book to Market Equity				Total
	L	M	H		
S	1	14	18		33
B	19	13	2		34
Total					67

Source: Research Result

There are six groups of firms, S/L is a small firm with low book to market equity, S/M is a small firm with medium book to market equity, S/H is a small firm with high to market equity, B/L is a big firm with low book to market equity, B/M is a big firm with medium book to market equity, and B/H is a big firm with high book to market equity. Mapping results give different number of companies in each group of companies. From the samples analyzed, the S/L and B/H



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groups have the smallest numbers compared to other groups. The risk mapping result can be seen in table 4.

Table 4. Risk Mapping Result

Method	Rolling Standard deviation			EWMA		
Mapping Category	Before COVID-19	During COVID-19	T-test (mean)	Before COVID-19	During COVID-19	T-test mean
S/L	44.69%	21.82%	-	47.72%	7.54%	-
S/M	Mean : 87.49% Median : 99.35% Maks: 157.89% Min: 27.74%	Mean: 88.19% Median : 93.88% Maks: 146.12% Min: 0.42%	0.9687	Mean: 99.79% Median : 112.48% Maks: 161.48% Min: 11.47%	Mean: 68.31% Median : 84.39% Maks: 124.14% Min: 0.07%	0.09921
S/H	Mean : 64.30% Median : 60.76% Maks: 141.45% Min: 31.07%	Mean: 73.43% Median : 69.34% Maks: 168.74% Min: 31.24%	0.3851	Mean: 71.67% Median : 57.42% Maks: 162.65% Min: 32.51%	Mean: 66.95% Median : 69.10% Maks: 129.88% Min: 9.38%	0.70167
B/L	Mean: 44.76% Median : 45.87% Maks: 88.32% Min: 21.79%	Mean: 60.70% Median : 56.98% Maks: 98.57% Min: 33.90%	0.0074*	Mean: 45.52% Median : 44.52% Maks: 89.04% Min: 21.83%	Mean : 59.26% Median : 60.02% Maks: 92.03% Min: 13.88%	0.04143*
B/M	Mean: 46.31% Median : 43.24% Maks: 69.66% Min: 35.44%	Mean: 62.83% Median : 69.64% Maks: 85.62% Min: 2.24%	0.0230*	Mean: 44.78% Median : 41.37% Maks: 70.34% Min: 32.13%	Mean: 69.19% Median : 75.54% Maks: 82.30% Min: 0.47%	0.00179*
B/H	Mean: 47.49% Median : 47.49% Maks: 62.14% Min: 32.83%	Mean: 70.70% Median : 70.70% Maks: 76.21% Min: 65.18%	0.2765	Mean : 42.64% Median : 42.64% Maks: 53.29% Min: 31.99%	Mean: 80.02% Median : 80.02% Maks: 80.63% Min: 79.41%	0.07267

Source: Research Result

The results of volatility mapping using the EWMA volatility measurement method show that companies with firm size large (B) volatility have increased during the pandemic. However, based on the results of the t-test, only companies classified as large (B) with low book to market



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equity (L) and medium (M) had a significant increase in volatility during the COVID-19 period. The results of the mapping using the method rolling standard deviation also show the same results. The group of B/L and B/M groups consists of various stocks from different sectors.

Based on the mapping results, companies with large capitalization have a greater investment risk during the COVID-19 pandemic. Large companies themselves have certain characteristics. According to Kartiningsih and Daryanto (2020), large companies have characteristics that have been established for a long period of time, will have adequate liquidity and flow of funds, so that when companies are faced with poor financial conditions such as during the COVID-19 pandemic. Then firm size is also quite closely related to how to manage existing assets and how the market value of the company. Generally, the larger the size of the company, the more attractive it will be to investors and increase interest in investing in the company (Handayani *et al*, 2018). Based on the research of Handayani *et al* (2018), company size is one of the factors that determine the volatility of companies in the manufacturing sector and the larger the company, the more volatile the stock will be.

The increased risk of large company shares during a pandemic is also in accordance with Reinganum's (1999) statement in Chaibi (2014) that the size effect is predictable and large companies tend to be superior to small companies during an economic crisis. This is reinforced by Yuwono's (2021) research, which examines stock investments blue chip during the pandemic. Yuwono (2021) observed stock price fluctuations and found that blue chip stocks experienced price fluctuations during the pandemic. The price fluctuations in these large stocks make stocks in large companies tend to become more volatile during the pandemic. Stock value is strongly influenced by positive and negative sentiment towards the company. As a result, volatility tends to increase during a pandemic.

Book to market equity is a comparison of the company's book value to market value. The low book to market equity value indicates that the company is valued at a higher market value than its book value. According to Fama and French (1993), companies with high book to market equity have a tendency to obtain low returns on assets and vice versa for companies with low book to market equity. Generally, companies with book to market equity a low is a developing company and is considered by investors to have good development prospects.

However, a low book to market equity can also indicate mispricing, according to Lakonishok *et al* (1994) in Cakici and Topyan (2014) a low book to market equity value can also indicate that capital market players are too optimistic and consistently have high expectations excessive to the growing companies. Based on the mapping results, companies with low book to market equity have an increased risk due to positive expectations, but actually the company's performance is still not optimal or not in accordance with its value, thus increasing the risk in investing.



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It can be concluded that large companies with low book to market equity have an increased investment risk during the COVID-19 pandemic. This can be because investors tend to invest in companies with large capitalization and have good development prospects during a pandemic. Investors' expectations for the company's development can be seen from its market price which tends to be more expensive than its book value (low book to market equity). Investor speculation on these stocks causes stock prices to fluctuate and the risk increases during the pandemic.

5 Conclusions

The results of the volatility measurement using the EWMA method provide higher in the pre-pandemic period, while the rolling standard deviation volatility measurement results provide higher volatility measurement results during the pandemic. This is influenced by the weighting of the calculations in both methods. In the method rolling standard deviation, the weighting of each data is the same, while in the EWMA method there is a different weighting for each data. The results of risk mapping using firm size and book to market equity show that companies with large capitalization and having a book to market low (overvalued) have a higher risk during the COVID-19 pandemic.

Investors with a higher risk tolerance can consider stocks with a large capitalization and a low or medium book to market equity value (L or M) to get high returns during the COVID-19 pandemic, while investors with a low risk tolerance can consider companies with a large capitalization and a high book to market value. This study has a limitation in that it measures volatility over a short period of time. To understand the longer-term impact of COVID-19 on Indonesia's stock market, we need to use longer time horizons and take into account both positive and negative news about capital market volatility during COVID-19.

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