Investor Reactions to Russia-Ukraine War Years 2022 Using a Bayesian Analysis Approach

Dmitry Alekseyevich Morozov [a]✉, Noldy Takaliuang[b], Yulia Nur Hasanah[b]
[a]Siberian State University of Telecommunications and Information Sciences
[b]Sekolah Tinggi Ilmu Ekonomi Sulawesi Utara-Indonesia
[c]Telkom University-Indonesia

* Corresponding author's e-mail : d.morozov@sibsutis.ru

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ABSTRACT. The purpose of this study was to determine the market reaction to changes in stock prices on the Russian-Ukraine war event on the Indonesia Stock Exchange in 2022. This research using Bayesian analysis Approach on banking stocks. The results show that the AAR and CAR Before-After of the three models do not show significant results or market anomaly. The implications of the results of this research for investors and researchers that the events of the Russian-Ukraine war in 2022 can be taken into consideration for investors to be more rational in responding to political events in making investments in both the financial sector or other sectors, and for other researchers the EMH theory is no longer relevant to recent world developments. The limitations in this study are only in the financial sector in banking stocks, and the future big agenda will be expanded in several sectors, namely manufacturing, infrastructure and technology on the Indonesia stock exchange. The novelty in this research is that it uses the Bayesian analysis approach to the three models of approaches that have been and are often used, but in this case it is very different from previous researchers who have never used the Bayesian analysis approach.

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JEL Classification : C11,G1, G4,

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INTRODUCTION

As an extreme geopolitical event, the outbreak of war has a non-negligible impact on economic and financial systems. Demir, Et al (2019), This can not only damage the infrastructure and economic base of the regions at war, but can also trigger shocks to global financial markets through the path of economic globalization. The Russia-Ukraine conflict began on February 24, 2022, when Russia announced the start of "special military operations", Research on the impact of the Russia-Ukraine conflict has been conducted by experts in various fields. In finance, Agyei (2023) found that the stock markets of seven emerging economies (E7) showed heterogeneous and asymmetric reactions. Furthermore, Bossman and Gubareva (2023) concluded that except for China and Russia, other E7 stocks responded positively when the conflict broke out. Several studies also confirm the significant impact on other stock markets and cryptocurrency markets (Umar Z, et al, (2022),Bedowska-Sojka (2022),Rigobon and Sack (2005).

Economic Standards and Financial Standards

The concepts presented in economic and financial standards are similar. In economic standards, the underlying idea is called rationality, which is the basis for theories, predictions and recommendations in economics. That is, it is assumed that all people are rational. This assumption states that people appreciate the value of everyday life choices and choose the best way to act (Ariely, 2008). Therefore, in standard economics, it is assumed that individuals systematically and purposefully choose the best way to achieve their goals based on available opportunities.

In 1776, economist Adam Smith, in his book titled "An Inquiry into the Nature and Causes of the Wealth of Nations," stated that the market price of a particular commodity (good or service) is governed by the proportion between the quantity coming into the market and the demand of those willing to pay the natural price of that commodity (actual demand). When the amount of a commodity transferred to the market is lower than the market demand, some people tend to spend more money on the commodity. As a result, competition arises among them, causing the market price to jump above the natural price, so the degree of deprivation, wealth, and luxury possessed by the competitors can either encourage or discourage them from competing. Among competitors who have the same wealth and luxuries, the same shortages will generally give rise to more or less vigorous competition, to the extent that the acquisition of commodities becomes more or less important to them. Setayesh and Sarmadinia (2019)

Mankiw (2010) believes that prices of goods and services are formed through the process of supply and demand in transactions. Therefore, to determine how an event or policy affects the efficiency of market behavior (i.e. the efficiency of participants' behavior in transactions), it is first necessary to decide how the event or policy affects the supply and demand process of participants in transactions. In other words, to determine the level of influence of an event on the efficiency of market behavior, it must first be determined how it affects the behavior of buyers and sellers.

The assumption that investors in transactions are rational is one of the basic concepts in standard finance as well. It is assumed that the decisions of ordinary people are unbiased and adopted to maximize their interests. Hence, they want higher expected returns in return for a higher level of risk-taking. Likewise, standard finance assumes that if investors in a transaction make a mistake in decision-making, it indicates a lack of solidarity so they cannot influence the price (Baker & Nofsinger, 2010).

Efficient Market Hypothesis (EMH)

The EMH efficient market hypothesis became widely accepted in academic circles since the late 1950s and early 1960s. This was associated with the development of the "theory of random walks" in the finance literature and the "rational expectations theory" in economics by Jensen (1978). In this regard, Fama (1965b); Malkiel (2003) relate the EMH to the notion of a random walk process in stock price series where all subsequent price changes are represented as random and independent of previous prices Alexander (1961). Two main claims are associated with the Efficient Market Hypothesis (EMH). First, price changes are almost random in financial markets. Second, prices reflect economic fundamentals. Fama (1965b) defined EMH as a competitive market, where the random character of fluctuations is explained by the fact that prices converge to fundamental values Samuelson (1965) the randomness of price variations and uncertainty can be easily explained by competition between investors without regard to fundamental

Fama (1970) a market is said to be efficient if no one, neither individual investors nor institutional investors will be able to obtain abnormal returns after adjusting for risk by using existing trading strategies. This means that the prices formed in the market are a reflection of the available information or "stock prices reflect all available information". Busse and Green (2002). In studying the concept of efficient markets, our attention will be directed to the extent to which and how quickly information can affect the market which is reflected in changes in security prices. Imagine for a moment that investors can accurately predict future stock price movements. How lucky they would be, They would immediately reap profits simply by buying stocks that they know will go up in price and selling stocks that they know will go down. This situation assumes that all investors have access to the same information at no cost and interpret it accurately. However, as we will see later, even if that is true, this situation cannot last (Nikoforos, 261:2013).

The efficient market hypothesis suggests that the most intelligent people cannot outperform the least intelligent people in investment performance. Their better understanding has previously been reflected in stock prices Shiller (2015). The basic assumption of the efficient market hypothesis is that behavioral finance advocates have gone to great lengths to reject this hypothesis. Since the efficient market hypothesis is based on the rational behavior of investors, it can be concluded that this hypothesis only assumes that information determines the level of supply and demand. In other words, access to the latest information from investors in competition is the most decisive thing. In an informationally efficient market, the arrival of new information in the public domain can cause a stock market reaction that can be observed through movements in the price and volume of shares related to the news flow Yao (2014).In this case, Haugen (2001) divides the information group into three, namely (1) information in past stock prices, (2) all public information, and (3) all available information including inside information. Each of these information groups reflects the degree of efficiency of a market.

METHODS

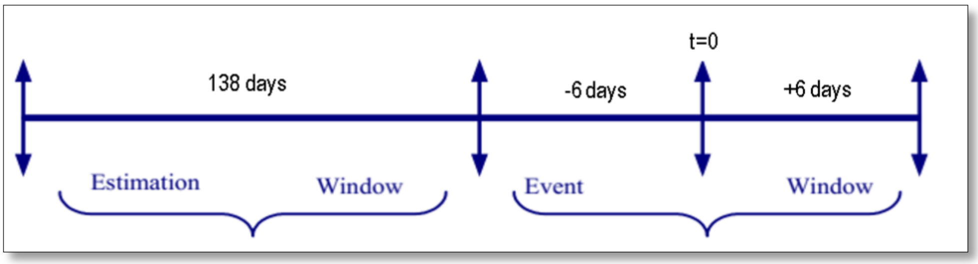
This research takes place on the Indonesia Stock Exchange in 2024 (https://www.idx.co.id//), the sample used is 44 issuers in the financial-banking sector that meet the requirements to be sampled using purposive sampling technique, the sampling period starts from July 30, 2021 to March 08, 2022. On the website https://finance.yahoo.com/quote//. The data is processed using the help of JASP Ver 18.3 Software and Microsoft Excel, with the analysis used in this research is the Bayesian Paired Sample T-Test.

Event Study Methodology

Event study methodology, an empirical method for analyzing firm/stock market performance in international business, has become more widely recognized by scholars. Kothari and Warner (2005) show that during 1974-2000, five major finance journals published 565 papers related to event studies. To better adapt to the diversity and complexity of financial data, this method has many variants. The event study suggested by Fama et al. (1969) is the main methodology in this analysis, this approach has been widely used in financial markets, to measure the impact of war and the significance of market reactions to a particular event, Maneenop and Kotcharin. (2020), Campbell and MacKinlay (1997) The basic idea of event studies is that the impact of an event containing new information will be directly reflected in the public valuation of the affected company. Therefore, the impact of the event can be captured by abnormal stock returns. When applying the event study methodology several things must be considered as below:

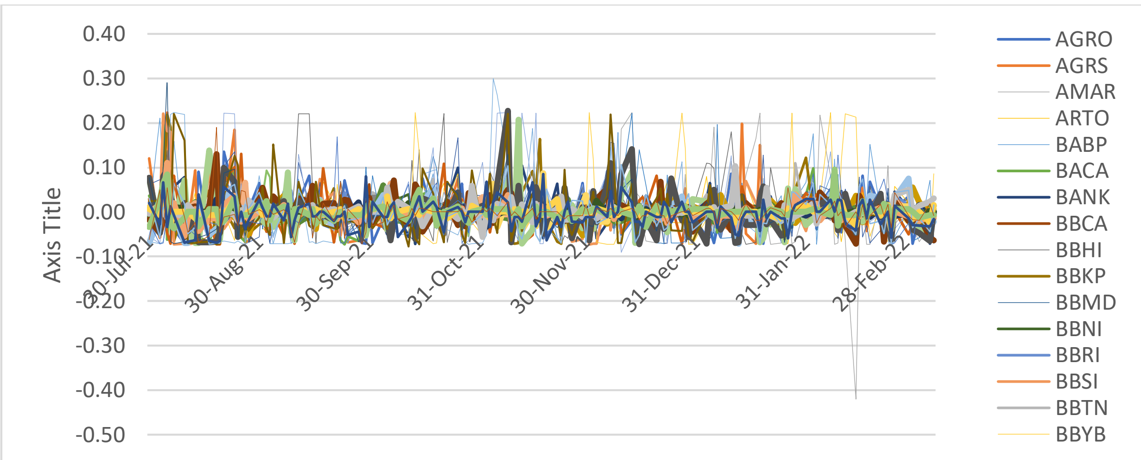
1. Events: The outbreak of war between Russia and Ukraine in 2022
2. Event day: February 24, 2022
3. 138-day estimation period starting July 30, 2021 to February 15, 2022
4. Event period of 12 days, starting February 16, 2024 to March 8, 2022

Figure 2.1. Event Study Method Procedure



1. Stock returns with log ratios have the advantage that longer period returns can be easily calculated by multiplying the log ratios of the intermediate periods. Furthermore, if stock pricing is assumed to be a continuous-time process, log ratios are the infinite limit of the arithmetic return (e.g. Aas 2004), Black and Scholes (1973) The stock pricing process in the Black-Scholes model is lognormal, i.e., given the price at one time, the logarithm of the price at the next time is normally distributed. To calculate the stock return, the formula is used:
(Ln) = P1/(P-1)
Ln (Logarithm)
P1 Current day closing stock price
P-1 Previous day closing stock price

Figure 3.1. Banking Stock Return



Source: MS Excel Output, Processed 2024

2. Ln= To calculate the market return, the formula is used:
Ln= (JCI1)/(JCII-1)
Ln = (Logarithm), JCI1 = Current day closing composite stock price index and JCI-1 = Previous day closing composite stock price index.

Figure 3.2. Development of Jakarta Stock Exchange Window Estimation - Event Window

Source: MS Excel Output, Processed 2024

3. The approach to calculating abnormal returns is based on the MacKinlay (1997) technique where the actual stock market return during the event window for each company is compared to the expected return as follows:

$$ARit = Rit - E(Rit| Xi)$$

$ARit$ = abnormal return Rit = actual return, E (Rit| Xi) in period t and Xt is conditioning information for normal returns, based on the market model, where Xi is the market return.

4. To calculate the Expected return, that is:
ERi = Rit - Ṝt
ERit = Expected Return or Predicted Return
Rit = Stock Return
Ṝt = Average return of security i for many days before day t
To calculate the Expected return there are several models used in this study, namely
(a) *Mean Adjusted Return*, the Mean Adjusted Returns model assumes that the ex ante expected return for security i is equal to a constant Ki which can differ between securities: E(Ṝi)= Ki. The expected ex post return in security period t is equal to Ki. Abnormal return εi = the difference between the observed return, Ri, and the predicted return Ki: EṜt, = Ri,-Ki. The Mean Adjusted Returns model is consistent with the Capital Asset Pricing Model; assuming that securities have constant systematic risk and a stationary efficient frontier, the Asset Pricing Model also predicts that a security's expected return is constant. Brown and Warner (1980
(b) *Market Adjusted Return*, This model assumes that the ex ante expected return is the same for all securities, but not necessarily constant for a particular security. Since the market portfolio of risky assets M is a linear combination of all securities, E(R ̄it,) = E(R ̄mt,) =Kt for security i. The ex post abnormal return of security i is given by the difference between its return and the market portfolio return: εit = Rit, - Rmt, The Market Adjusted Return Model is also consistent with the Asset Pricing Model if all securities have unitary systematic risk. Brown and Warner (1980).
(c). Market Model, Fama, French, Jensen & Roll (1969) stated that the stock market is efficient, and stock market prices adjust to new information very quickly, and they developed a new model, the Market Model. Brown and Warner (1980) found that the market model performs very well based on a simple methodology in different situations. Bastholdy, Olson, and Peare (2005), proved that some adjustments to the event methodology can fulfill the requirements. Kothari and Warner (2006) found that the effect of event methodology may change with different calendar times and also depending on the sample of firms. To calculate the Market Model, the formula is used:

$$E(Rit| Xi) = \alpha + \beta Rmt + \varepsilon it$$

where Rit and Rmt are the period t security return and the market portfolio or JKSE or JCI, respectively. This approach assumes a stable linear relationship between market and security returns.

5. Calculate An average of abnormal returns across N firms on day t

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t}$$

6. Cumulative Abnormal Return

$$CAR_i(T_1,T_2) = \sum_{t=T_1}^{T_2} AR_{i,t}$$

Cumulative sum of stock abnormal returns over the window (T1,T2)

Bayes Factor

In statistical inference, there are two ways for probability interpretation, namely Frequentist (or Classical) inference and Bayesian inference. Frequentist and Bayesian inference are not the same as each other in the nature of classical probability. Classical inference defines probability as a limit on the relative frequency of an event for a large number of trials and only in terms of well-defined randomized trials. On the other hand, Bayesian inference can impose a probability on every statement when random processes are not involved. In the Bayesian sense, probability is a way of indicating one's level of confidence in a statement. Bayesian inference is a different interpretation of probability, and also a different approach depending on that interpretation. Bayes' theorem presents a relativity about two conditional probabilities that are the inverse of the other. the term Bayes' theorem is in honor of Reverend Thomas Bayes, and is referred to as Bayes' law in Stigler S. (1963) This theorem shows the conditional probability or posterior probability of an event A after B is observed in terms of the prior probability of A, the prior probability of B and the conditional probability of B given A. It holds in all interpretations of probability. Bayes' formula is a way of revising probability statements using data. Bayes' law (or Bayes' rule) is:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \qquad (1)$$

The definition of conditional probability is defined as follows:

$$P(A \cap B) = P(A|B)P(B) = P(B|A)P(A) \qquad (2)$$

Bayes rule is shown as:

$$P(A|B) \propto P(A) = P(B|A)$$

Where P(A) is the prior (distribution), P(B|A) is the likelihood and P(A|B) is the posterior (distribution). The main result of Bayesian statistics is that statistical inference can rely on the simple device posterior ∝ prior ∗ likelihood. The dice rolling example is not controversial. The debate about the likelihood uses Bay's rule as follows:

$$P(Truth|Data) = \frac{P(Data\ |\ Truth)P(Truth)}{P(Data)} \qquad (3)$$

Where is:

$$P(Truth) = the\ prior \qquad (4)$$

The second part we need is data, coupled with how the data relates to the truth which is nothing but the classic concept of determining random relationships :

$$P(Data\ |\ Truth) = \textit{the likelihood} \qquad (5)$$

for all associated Truth values, that P(Data |Truth) is not applied as a probability distribution for different data, but as the probability of a given data for different Truths., noting that (replace Truth with T), the probability of Data (P(Data)) can be written as follows:

$$P(Data) = \int P(T)\ P(Data|T)\ dT \qquad (6)$$

As a function of P(T) and P(Data| T), it is clear that the prior and likelihood allow, using 1 to create a new probability statement about T given the data as follows:

$$P(Truth \mid Data) = \textit{the Posterior} \qquad (7)$$

Model-based Bayesian inference

The basis of Bayesian inference continues with Bayes' theorem. From Stigler S (1983), replacing B with observation y, A with the set of parameters θ, and probability P with density p, yields the following result:

$$p(\theta|y) = \frac{p(y|\theta)p(\theta)}{p(y)} \qquad (8)$$

where p(y) is the marginal likelihood of y, p(θ) is the prior distribution of the parameter set θ before y is observed, p(y | θ) is the likelihood of y under the model and p(θ | y) is the joint posterior distribution of θ which expresses the uncertainty about the parameter set θ after incorporating the prior and data into the system. Since there are often multiple parameters, θ is a set of j parameters, we have

$$\theta = \theta 1, \theta\ 2, \ldots, \theta\ j:$$

Conditionally

$$p(y) = \int p(yI\theta)p(\theta)d(\theta) \qquad (9)$$

determines the marginal likelihood (or prior prediction distribution) of y introduced by Jeffreys (1961), and can be set to c where c is an unknown constant. This distribution indicates what y should look like according to a given model, before y is observed. Only the prior probability and likelihood function of the model are used for p(y). The presence of p(y). normalizing the joint posterior distribution, p(Θ | y) guarantees that it is a proper distribution and integrates to 1. From replacing p(y). with the proportionality constant c, Bayes' theory becomes:

$$p(\theta|y) = \frac{p(y|\theta)p(\theta)}{c} \qquad (10)$$

And obtained

$$p(\theta|y) = \propto p(y|\theta)p(\theta) \qquad (11)$$

when ∝ is proportional to This formulation (11) is shown as a joint unnormalized posterior that is proportional to the likelihood multiplied by the prior. However, the purpose of the model is often not to infer the joint unnormalized posterior distribution, but to infer the marginal distribution of the parameters. The set of all θ can be partitioned as :

$$\theta = \{ \Phi, \Lambda\} \qquad (12)$$

when the sub-vector of interest is denoted by Φ and the complementary sub-vector of Θ is denoted by Λ, usually referred to as the nuisance parameter vector. For the Bayesian scope, the existence of nuisance parameters does not pose formal and theoretical problems. A nuisance parameter is a parameter present in the joint posterior distribution of a model, even though it is not a parameter of interest. The marginal posterior distribution of φ, the parameter of interest, can be shown as :

$$p(\Phi|y) = \int p(\Phi \Delta|y)d\Lambda$$

In model-based Bayesian inference, Bayes' theorem is applied to estimate the joint unnormalized posterior distribution, and finally, users can evaluate and make inferences based on the marginal posterior distribution. Tejedor (2017)

Components of Bayesian inference

In this section, we present the components of Bayesian inference which consist of the prior distribution, the likelihood or likelihood function, and the joint posterior distribution as follows:

1. p(θ) is the prior distribution for the set θ, and uses probability as a method to measure uncertainty about θ before inputting data into the system.
2. p(y|θ) is the likelihood function where all variables are linked in the full probability model.
3. p(θ|y) is the joint posterior distribution which shows the uncertainty about θ after taking the prior and data into the system. If θ is partitioned into one parameter of interest φ and the

other parameters are considered as nuisance parameters, then the marginal posterior distribution of the marginal posterior distribution of φ is denoted by p(θ|y)

Prior Distribution

The prior distribution is a key Bayesian concept and denotes information about θ that is uncertain which is combined with the probability distribution of the new data to produce the posterior distribution which in turn is applied to future inferences and decisions about θ. The existence of a prior distribution for each problem can be justified by some axioms of decision theory; we now focus on how to organize the prior distribution for any given application. In general, Θ will be a vector, but for simplicity we will refer to p(θ). With a well-identified and large sample size, the corresponding alternative of p(Θ) will have a small effect on the posterior inference. This definition may seem circular, but in practice we can check the dependence on p(θ) by sensitivity analysis: comparing the posterior inference under various suitable alternatives of p(θ). Tejedor (2017). If the sample size is small, or the available data provides only indirect information about the parameter of interest, then p(θ) becomes more important. However, in many cases, the model can be organized hierarchically, so that groups of parameters have the same p(θ), which can be approximated from the data. Prior probability distributions have fallen into one of two types, namely informative priors and uninformative priors.

Likelihood

To fully define Bayesian, both the prior distribution and the likelihood must be estimated or determined completely. The likelihood or p(y|θ), contains the available information provided by the sample. The likelihood is $p(y|\theta) = \prod_{i=1}^{n} p(yi|\theta)$. The data y affects the posterior distribution p(θ| y) only through the probability p(θ | y). In this way, Bayesian inference trusts the likelihood principle which states that for a data sample, two probability models p(θ|y) that have the same likelihood yield the same conclusion for Θ, Tejedor (2017).

Posterior distributions

Recent theoretical and applied reviews of Bayesian statistics, including many examples and uses of posterior distributions, Bernardo & Smith (1994), Carlin & Louis (1996) Chapman and Hall (1996), Gelman A, Carlin, Stern & Rubin (1995). The posterior distribution for decision making about home radon exposure in the home is discussed Lin CY, et al (1995). The posterior distribution summarizes the current state of knowledge about all uncertainties in Bayesian analysis. Analytically, the posterior density is the product of the prior density and the likelihood.

Hypothesis Development.

Hypothesis testing used the T-test method, with a paired t-test using a Bayesian approach. The t-test is designed to assess whether or not two population means are different. This question is fundamental to the test, and the t-test has grown rapidly in the empirical sciences. This research discusses the Bayesian t-test originally developed by Jeffreys (1948) in a one-sample setting, and recently extended to a two-sample setting by Gönen et al. (2005) and subsequently, Rouder et al. (2009). In his work on hypothesis testing, Jeffreys focused on the Bayes factor (Etz and Wagen-makers (2017); Kass and Raftery (1995); Wagen-makers (2016a, 2016b); Robert, Chopin, and Rousseau (2009)), which is a predictive updating factor that measures changes in relative beliefs about hypotheses H1 and H0 based on observed data Wrinch and Jeffreys (1921,387).

Assuming perfect information and investor rationality, the efficient market hypothesis (EMH) states that financial markets are efficient enough to incorporate market information into equity prices promptly (Fama 1970; Fama and French 1993). Rigobon and Sack (2005) found that the risk of the Iraq war had a negative impact on the US equity market, making the war risk factor useful for estimating stock price variations during wartime. Brown and Warner (1980, 1985) recommend the mean adjusted return method as a robust method like any other method for both monthly returns and daily returns, The event study results of the Mean Adjusted Return Model clearly show the positive abnormal returns generated by the press release effect of the 25-year AMR list in the event window (0, +1), Shi and Yu (2018), The hypotheses built in this study are:

1. H1: There is a difference in AAR before and AAR after the Russian-Ukraine War event in the Mean Adjusted Return Model.
2. H2: There is a difference in CAR before and CAR after the Russia-Ukraine War event in the Mean Adjusted Return Model.

The Market Adjusted Return Model, Lakonishok & Vermaelen (1990), or adjusting for market sensitivity as such is likely to work best for events that coincide with significant market movements. This model assumes all assets have the same market sensitivity (beta).

3. H3: There is a difference in AAR before and AAR after the Russian-Ukraine War event in the Market Adjusted Return Model.
4. H4: There is a difference in CAR before and CAR after the Russia-Ukraine War event in the Market Adjusted Return Model.

The Market Model was classically used in Fama, Fisher, Jensen, and Roll (1969). It continues to be the most widely used model in the field, including in international finance. It accounts for market risk, and allows different assets to exhibit different sensitivities to market movements.6 Brown and Warner (1980: 205) find that the model "performs well under a wide variety of conditions". In international finance, local market factors may be replaced by global factors, or by a combination of local and global factors depending on the characteristics and origin of the event firm.

5. H5: There is a difference in AAR before and AAR after the Russia-Ukraine War event in the Market Model.
6. H6: There is a difference in CAR before and CAR after the Russia-Ukraine War event on the Market Model

RESULT AND DISCUSSION

Descriptive Statistic

Tabel 3.1. Descriptive Statistic AAR-CAR Before- After Model Mean Adjusted Return

	N	Mean	SD	SE	Coefficient of variation
AAR Before	6	0.002	0.009	0.004	4.908
AAR After	6	-0.009	0.012	0.005	-1.463
CAR Before	6	0.081	0.401	0.164	4.976
CAR After	6	-0.378	0.54	0.22	-1.429

Source: JASP output ver .18.3

Based on the research results in Table 3.1. AAR Before has an SD value of 0.9% of the average value of stock movements of 0.2% and is higher in value than the average value of AAR After -0.9% which is within the SD value of 0.12%. this shows that the market reacted negatively to the Russia-Ukraine war event. The amount of dispersion of the AAR Before is CV 491% of the average value of the AAR Before is greater than the AAR After which is the value of CV -.146%, this shows the magnitude of changes in investor reactions that occur after the war event. The SE of the two populations is 0.4% for AAR Before and 0.5% AAR After. While the SD on CAR Before is 40.1% of the average value of stock movements of 8.1% lower than the average value of CAR After of 54%. This indicates a greater change in investor reaction to the occurrence of the Russia-Ukraine war event. The magnitude of the change in investor reaction from CAR Before, namely CV 498%, is higher than CAR After of CV -143%, this indicates a change in investor reaction down after the war event. With SE of 16.4% on CAR Before and CAR After of 22%.

Tabel 3.2. Bayesian Paired Sample T-Test AAR dan CAR Mean Adjusted Return Model

Measure 1		**Measure 2**	**BF₁₀**	**error %**
AAR Before	-	AAR After	1.208	0.022
CAR Before	-	CAR After	1.199	0.021

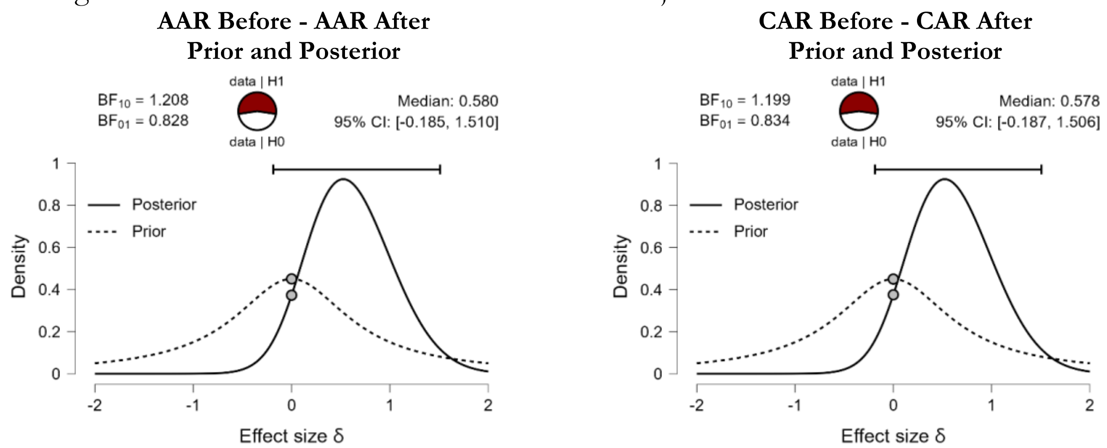
Source: JASP output Ver .18.3

Hypothesis :
H_0 : There is no difference between AAR Before and AAR After Russia-Ukraine war.
H_1 : There is a difference in AAR Before and AAR After the Russia-Ukraine war
H_0 : There is no difference between CAR Before and CAR After the Russia-Ukraine war.
H_2 : There is a difference between CAR Before and CAR After the Russia-Ukraine war.

Based on the research results in Table 3.2. above, the BF_{10} value of 1.208 indicates weak evidence in favor of the alternative hypothesis, which suggests that there is a difference between the Before AAR and the After AAR. This value is only slightly above 1, which means the data supports the weak hypothesis that the average abnormal return has changed after the event. The percentage error is 2.2%, which indicates good accuracy of the Bayes factor calculation. CAR Before vs CAR After (BF_{10} = 1.199, error % = 0.021), the Bayes factor of 1.199 also indicates weak evidence in favor of the alternative hypothesis H_2 (i.e., there is a difference between CAR Before-After) compared to the null hypothesis H_0, in the mean adjusted return model. As with the first measure, the evidence is weak, and a BF_{10} close to 1 indicates that the data does not strongly support a difference between Before-After measures. The percentage error of 0.021% is very low, which means that the Bayes factor is calculated with high precision.

The weak evidence for both measures (AAR and CAR) has Bayes factors slightly above 1, suggesting weak evidence in favor of post-event differences. However, the evidence is not strong enough to conclude with confidence that there is a significant difference between the before and after states. Given the weak evidence provided by the Bayes factor, against the AAR and CAR in the MEAR Model of a significant effect, further analysis or additional data may be required to draw more definitive conclusions. A very low Margin of Error or percentage error indicates that the Bayes factor calculations are reliable, but the overall weak evidence means that further examination or stronger data may be required to make firm conclusions.

Fig. 3.2. Prior and Posterior AAR-CAR Mean Adjusted Return Model



Source : Output JASP Ver 18

Figure 3.2. displays the posterior distribution (solid line) and prior distribution (dashed line) for the effect size (δ). The Bayes factors (BF_{10} = 1.208, BF_{01} = 0.828) indicate weak evidence in favor of the alternative hypothesis (H_1) over the null hypothesis (H_0). The mean effect size was 0.580, with a 95% credible interval (CI) value of [-0.185, 1.510]. Since the CI includes zero, proving that

the evidence for a significant effect is not strong, suggesting that the true effect size could be close to zero or even negative.

BF_{10} = 1.208 > BF_{01} = 0.828 (AAR Before - After): This indicates weak evidence in support of the alternative hypothesis (H2) that there is a difference in Adjusted Abnormal Returns (AAR) before and after the event. BF_{10} = 1.199 > BF_{01} = 0.834 (CAR Before - After): Similarly, this indicates weak evidence in favor of the alternative hypothesis that there is a difference in Cumulative Abnormal Returns (CAR) before and after the event. In both cases, since BF_{10} is only slightly greater than 1, the evidence in favor of the alternative hypothesis is considered weak or anecdotal according to the Jeffreys scale.

Table 3.3. Descriptive Statistic AAR-CAR Before- After Market Adjusted Return Model

	N	Mean	SD	SE	Coefficient of variation
AAR Before	6	-0.002	0.005	0.002	-3.286
AAR After	6	-0.009	0.008	0.003	-0.973
CAR Before	6	-0.057	0.222	0.091	-3.875
CAR After	6	-0.391	0.372	0.152	-0.95

Source: Output JASP Ver 18

Based on the research results in Table 3.3. AAR-Before has an SD value of 0.5% of the average value of stock movements of -0.2% and is lower in value than the average value of AAR After -0.9% which is within the SD value of 0.8%. This indicates that the market reacted negatively to the Russia-Ukraine war event. The amount of dispersion of the AAR Before which is CV -329% of the average value of the AAR Before is greater than the AAR After which is equal to the value of CV -.97.3%, this shows the magnitude of changes in investor reactions that occur after the war event. The SE of the two populations is 0.22% for CAR Before and 0.37% CAR After. While the SD on CAR Before is 22.2% of the average value of stock movements of 8.1% lower than the average value of CAR After of 54%. This indicates a greater change in investor reaction to the occurrence of the Russia-Ukraine war event. The magnitude of the change in investor reaction from CAR Before is CV 498% higher than the CAR After of CV -143%, this indicates a change in investor reaction down or negative after the war event. With SE of 16.4% on CAR Before and CAR After of 22%.

Table 3.4. Bayesian Paired Sample T-Test AAR dan CAR Market Adjusted Return Model

Measure 1		Measure 2	BF_{10}	error %
AAR Before	-	AAR After	0.902	0.017
CAR Before	-	CAR After	0.954	0.018

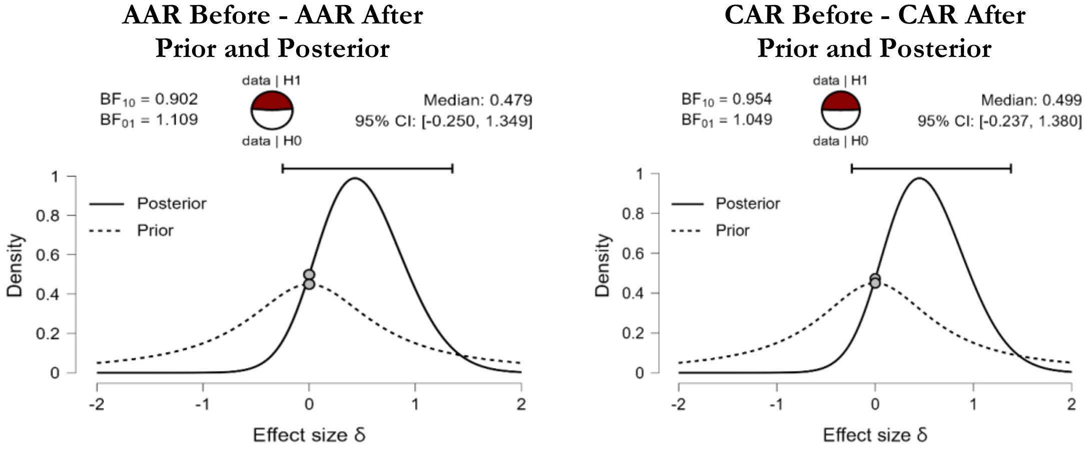
Source: Output JASP Ver 18.3

Hypothesis :
H_0 : There is no difference between AAR Before and AAR After Russia-Ukraine war.
H_3 : There is a difference between AAR Before and AAR After the Russia-Ukraine war
H_0 : There is no difference between CAR Before and CAR After the Russia-Ukraine war.
H_4 : There is a difference between CAR Before and CAR After the Russia-Ukraine war.

The Bayesian T-test results in Table 3.4. shows that for AAR Before vs AAR After: The Bayes factor (BF_{10}) is 0.902 with a percentage error of 0.017. The value of BF_{10} which is close to 1 indicates that there is no strong evidence supporting the null hypothesis (no difference) or the alternative hypothesis (there is a difference) regarding AAR before and after the event. Whereas CAR Before vs CAR After: Bayes factor (BF_{10}) is 0.954 with a percentage error of 0.018. Similar to the AAR comparison, a BF_{10} value close to 1 indicates that there is no strong evidence supporting either hypothesis regarding CAR before and after the event. Thus, the results do not have a meaningful impact on abnormal returns using the Market Adjusted Return Model, as the statistical evidence does not strongly support any difference in AAR or CAR before and after the event.

In both cases, the BF_{10} value is close to 1, meaning that the evidence provided by the data is not strong enough to make a definitive conclusion regarding the difference between the "Before" and "After" measures for AAR and CAR using the Market Adjusted Return Model. The low percentage error indicates that the precision of the Bayes factor is good, but the lack of strong evidence may indicate that the event or intervention did not have a significant impact on the AAR and CAR.

Figure 3.3. Prior and Posterior AAR-CAR Mean Adjusted Return Model



Source: Output JASP Ver 18.3

Graph results in Fig. 3.3. The unbroken line is the posterior distribution of the effect size (δ), based on the data and the dashed line is the prior distribution assumed before observing the Before-After AAR data. Bayes factor (BF_{10} = 0.902), This value, shown in the upper left corner, is consistent with the previous table. The value of (BF_{10} 0.902) indicates that the data slightly favors the null hypothesis over the alternative hypothesis H3, but the evidence is weak. Whereas (BF_{01} = 1.109), It is the inverse of BF_{10}, which indicates the likelihood ratio of the null hypothesis to the alternative hypothesis. Since $BF_{01} > 1$, it indicates that the null hypothesis is more supported than the alternative hypothesis, but the evidence is not strong. The median and 95% CI of the posterior distribution are 0.479, indicating a trend 95% confidence interval (CI) of [-0.250, 1.349] that there is a 95% chance that the true effect size lies within this interval. Since this interval includes 0, it indicates that there is no strong evidence for a significant effect.

While the Before-After CAR on the Bayes Factor (BF_{10} = 0.954), indicates that the data slightly support the null hypothesis (no difference) over the alternative hypothesis (there is a difference). However, support for the null hypothesis is weak, given that BF_{10} is close to 1. And the Median 95% CI: value of the posterior distribution is 0.499, indicating that the central estimate of the effect size is close to 0.5. The 95% interval (CI) of [-0.237, 1.380] includes 0, indicating that the true effect size could be negative, zero, or positive. This further suggests that there is no strong evidence for the Before-After CAR.

Fig. 3.3. This Before-After CAR, like the previous Before-After AAR graph, supports the conclusion that there is no strong evidence to suggest a significant difference between the paired measures The Bayes factor indicates weak support for the null hypothesis, and the confidence interval includes zero, meaning that any observed difference may be due to random variation or chance. The evidence is not strong enough to state with confidence that there is a meaningful impact of the event.

Table 3.5. Descriptive Statistic of AAR-CAR Before-After Market Model

	N	Mean	SD	SE	Coefficient of variation
AAR Before	6	0.005	0.008	0.003	1.55
AAR After	6	0.008	0.007	0.003	0.911
CAR Before	6	0.223	0.359	0.146	1.611
CAR After	6	0.355	0.334	0.137	0.941

Source: Output JASP Ver 18.3

Based on the research results in Table 3.5. AAR-Before has an SD value of 0.8% of the average value of stock movements of 0.5% and a lower SD value of 0.7% but a higher average value of AAR After 0.8% compared to the average value of AAR Before. this shows that the market reacted positively to the Russia-Ukraine war event. The amount of dispersion of the AAR Before, which is a CV value of 155% of the average value of the AAR Before, is greater than the AAR After, which is a CV value of 91.1%, this shows the magnitude of changes in investor reactions that occurred after the war event. The SE of the two populations of AAR Before-After is 3%.

While the SD value of CAR Before is 35.9% of the average value of stock movements of 22.3% lower than the average value of CAR After of 35.5%, while the SD value of CAR Before is higher than the SD value of CAR After. Of course, the average value of CAR After is greater than the value of CAR Before, indicating that investors reacted to the Russian-Ukraine war event. The amount of deviation from CAR Before of 161.1% is greater than CAR After, indicating a change in investor reaction even though it is small on the occurrence of the Russian-Ukraine war event. With SE of 14.6% on CAR Before and CAR After of 13.7%.

Table 3.6. Bayesian Paired Sample T-Test of AAR and CAR Market Model

Measure 1		Measure 2	BF_{10}	error %
AAR Before	-	AAR After	0.502	0.006
CAR Before	-	CAR After	0.5	0.006

Source: Output JASP Ver 18.3

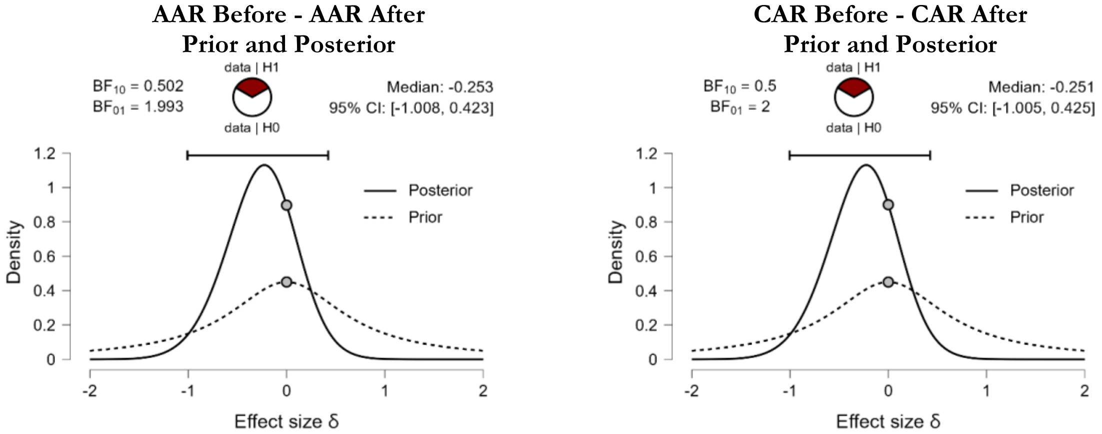
Hypothesis :
H_0 : There is no difference between AAR Before and AAR After Russia-Ukraine war.
H_5 : There is a difference between AAR Before and AAR After the Russia-Ukraine war.

H_0 : There is no difference between CAR Before and CAR After the Russia-Ukraine war.
H_6 : There is a difference between CAR Before and CAR After the Russia-Ukraine war.

In Table 3.6. The BF_{10} value of 0.502 indicates that the data provides almost equal evidence for the null hypothesis (no difference between Before and After AAR) and the alternative hypothesis (there is a difference). This indicates that there is no strong evidence to conclude that the average abnormal return changed significantly after the event. The low percentage error (0.6%), indicates the high precision of the Bayes factor calculation. Similarly, the BF_{10} value of 0.5 indicates that the evidence is balanced between the null hypothesis (no difference between Before and After CAR) and the alternative hypothesis. This suggests that there is no strong evidence to conclude that CAR changed significantly after the event. The percentage error (0.6%), which is low again reflects the high precision in the estimation and trustworthiness.

The Paired Sample Bayesian T-test results for the AAR and CAR Market Model show that there is no strong evidence to support a difference "before" and "after" the Russia-Ukraine war event. The Bayes factor (close to 0.5) implies almost equal support for the null hypothesis and the alternative hypothesis, meaning that the observed data does not give a firm indication of an effect. The results suggest that the event may not have had a significant impact on either AAR or CAR when evaluated with the Market Model. The results of the analysis do not indicate a meaningful impact of the event on abnormal returns, as the statistical evidence does not support a difference in returns before and after the event.

Fig.3.4. Prior and Posterior AAR-CAR Market Model



Source: Output JASP Ver 18.3

Based on the results in Figure 3.4. AAR-Before and After, the Bayes Factor (BF_{10} = 0.502): The Bayes factor is 0.502, indicating that the evidence slightly favors the null hypothesis (no difference) over the alternative hypothesis (there is a difference), but the evidence is almost balanced. BF_{01} = 1.993: This is the opposite of BF_{10} and indicates that the null hypothesis is about twice as likely as the alternative hypothesis. However, this is still weak evidence. The Median value and 95% CI: of the posterior distribution is -0.253, indicating that the central estimate of the effect size is slightly negative. The 95% Credible Interval (CI) of [-1.008, 0.423] includes 0, suggesting that the true effect size may range from negative to positive, with a significant probability that the effect size may be close to zero.

Fig. 3.4. This supports the conclusion that there is no strong evidence of a significant difference in AAR-CAR before vs. after the event in the Market Model. The Bayes factor of 0.502 indicates very weak evidence in favor of the null hypothesis, and the credible interval that includes zero further indicates that the observed data does not provide decisive support for a difference. Overall, the analysis suggests that the event is unlikely to have a meaningful impact on abnormal returns, as the effect size is small, and the data does not strongly support the presence or absence of a difference.

Based on Fig. 3.4. CAR-Before and After (BF10 = 0.5), this shows evidence in favor of the alternative hypothesis (H6) relative to the null hypothesis (H0). A value of 0.5 indicates that the data is half as likely to support the alternative hypothesis (H6) compared to the null hypothesis. (BF01= 2), This is the opposite of BF10 (BF01 = BF10). This indicates evidence in favor of the null hypothesis relative to the alternative hypothesis. A value of 2 indicates that the data is twice as likely under the null hypothesis compared to the alternative hypothesis. Median and 95% (CI) Median = -0.251: This is the central tendency of the effect size, indicating a negative effect, but not necessarily a strong effect. 95% CI [-1.005, 0.425]: This interval indicates that the true effect size lies between -1.005 and 0.425 with 95% probability. Since this interval includes 0, it implies that the effect could be zero, which aligns with the weaker evidence provided by the Bayes Factor. The Bayes factor (BF10 = 0.5) indicates weak evidence in favor of the alternative hypothesis. In contrast, BF01 = 2 shows moderate evidence in favor of the null hypothesis. The mean effect size (-0.251), and 95% CI including zero, indicate uncertainty about the direction and effect significance. Overall, the evidence suggests that the data slightly support the null hypothesis, and there is considerable uncertainty about the true effect size, which could be close to zero.

DISCUSSIONS

Investors did not react to the financial sector because the financial market is not directly related to the stock market in Russia or Ukraine, so there is no difference in AAR and CAR before and after in the mean adjusted return model. In addition, high market conditions and volatility can obscure signals to stocks in the financial sector. Researchers agree with Klein and Rosenfeld (1987) in four different return generating models. When events occur during a bear market, both the mean-adjusted model and the raw-market returns model produce abnormal returns that are biased up or down, while the market-adjusted model and the single-index model show less evidence of unusual price activity during the same interval.

Dyckman, Philbrick and Stephan (1984) also do not recommend the use of mean adjusted and market models in the calculation of excess returns. The high growth of the market in the financial sector compared to the composite stock price index in the Indonesia stock exchange as one of the factors investors did not react to the Russia-Ukraine war. In addition, the sample size and time span in this research may be too short or long which may affect the average stock return, this is in line with Kothari and Warner (2007). The mean adjusted return model in this research only takes into account market movements and does not consider other risks such as company fundamentals, industry-specific shocks, macroeconomic factors and political factors. In the Market Adjusted Return model, the Jakarta Composite Index stock market proxy chosen, does not represent the sector index because this index reflects all sectors, although most financial research uses the Jakarta composite index (JCI) in line with the thoughts of Brown and Warner, (1980). In the Market Model also shows the same result that there is no difference in AAR and CAR, although the alternative hypothesis (H6) shows there is evidence that exceeds the null hypothesis, the changes that occur are random and occur by chance because it does not show a clear direction.

CONCLUSION

Thus, it can be concluded that the Russia-Ukraine war event did not have a statistically significant impact on the AAR and CAR on the Indonesia Stock Exchange, especially in the financial sector and contrary to the theory of Efficient Market Hypothesis. because Emerging markets (Indonesia), although growing rapidly, are a smaller portion of the global economy compared to developed markets such as the United States, the European Union, and Japan. Due to their relatively smaller size, fluctuations in emerging markets may not always have a large impact on the global economy, emerging markets are not deeply integrated into the global financial system. This means that the Russia-Ukraine war did not have a direct or immediate impact on the stock market in Indonesia in the banking sector could also be due to information leaks about the war so that the market did not react more.

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