COSTING:Journal of Economic, Business and Accounting
Volume 7 Nomor 1, Juli-Desember 2023
e-ISSN : 2597-5234

VOLATILITY SPILLOVER CRYPTOCURRENCY ON BANKING INDUSTRY PERFORMANCE AND FOREIGN EXCHANGE WITH BEKK GARCH METHOD

VOLATILITAS SPILLOVER CRYPTOCURRENCY TERHADAP KINERJA INDUSTRI PERBANKAN DAN VALUTA ASING DENGAN METODE BEKK GARCH

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ABSTRACT

The first cryptocurrency launched in 2014 was Bitcoin. With the emergence of these new assets, investors need to conduct a risk and return analysis of the type of investment in the cryptocurrency category. This study analyzes whether a price effect appears with cryptocurrency on stock prices from banks in Indonesia. Furthermore, this study also wants to see the impact of cryptocurrency on foreign exchange, which is often traded. This study is a panel data research from 2015 to 2019, so the BEKK GARCH method is used to analyze whether there is a spillover effect of volatility caused by Cryptocurrency on Banking closing price stocks and Foreign Exchange stocks. The results showed the existence of cryptocurrency on several closing prices of banking and foreign exchange prices. BEKK GARCH Test results show that banking stocks and foreign exchange have some influences not influenced by cryptocurrency as one of the investment instruments increasing investors. This study advises investing in cryptocurrency, with price volatility required with current asset portfolio investments.

Keywords: *Cryptocurrency, Banks Performance, Foreign Exchange, BEKK GARCH, Volatility Spillover*

ABSTRAK

Volatilitas Spillover Cryptocurrency terhadap Kinerja Industri Perbankan dan Eks Asing Cryptocurrency pertama yang diluncurkan pada tahun 2014 adalah Bitcoin. Dengan munculnya aset baru ini, investor perlu melakukan analisis risk and return terhadap jenis investasi dalam kategori cryptocurrency. Penelitian ini menganalisis apakah muncul efek harga dengan adanya cryptocurrency terhadap harga saham dari bank-bank di Indonesia. Selain itu, penelitian ini juga ingin melihat dampak cryptocurrency terhadap valuta asing yang sering diperdagangkan. Penelitian ini merupakan penelitian data panel dari tahun 2015 hingga 2019, sehingga metode BEKK GARCH digunakan untuk menganalisis apakah ada efek spillover dari volatilitas yang ditimbulkan oleh Cryptocurrency terhadap saham harga penutupan Perbankan dan saham Valuta Asing. Hasil penelitian menunjukkan adanya cryptocurrency pada beberapa harga penutupan saham perbankan dan saham valuta asing. Hasil Uji BEKK GARCH menunjukkan bahwa saham perbankan dan valuta asing memiliki beberapa pengaruh yang tidak dipengaruhi oleh cryptocurrency sebagai salah satu instrumen investasi yang meningkatkan investor. Penelitian ini menyarankan untuk berinvestasi pada cryptocurrency, dengan volatilitas harga yang diperlukan dengan investasi portofolio aset saat ini.

Kata kunci: Cryptocurrency, Kinerja Bank, Valuta Asing, BEKK GARCH,Volatilitas Spilloverchange dengan metode BEKK GARCH

INTRODUCTION

Public interest in cryptocurrency is increasing, with the most popular currencies, such as Bitcoin, Litecoin, and Ripple. *Cryptocurrency* is defined as a combination of secret (crypto) and money or a medium of exchange (currency) (Hossain, 2017). The demand and supply conditions of the cryptocurrency market are absorbing. The critical difference between cryptocurrencies and strong currencies or fiat currencies (USD et al.) is in terms of supply and movements in the market. Cryptocurrencies have a limited supply, whereas fiat currencies have an unlimited supply. Cryptocurrency movements tend to influence global fundamental factors, while the central bank of a particular country controls fiat currency movements (Hossain, 2017).

Previous research on cryptocurrency mainly discussed understanding movements based on the characteristics of non-physical (moneyless) financial products, such as movements in gold prices, currency exchange rate indices, shares, and bonds. Cryptocurrencies are starting to be accepted as an investment tool traded on futures exchanges. This open attitude towards investment products has encouraged the significant growth of miners. According to Trabelsi (2018), the Chicago Mercantile Exchange (CME) and Crypto Facility Ltd. launched two Bitcoin pricing products: BRR (Bitcoin Reference Rate) and BRTI (US Dollar Index of One Bitcoin). According to Trabelsi (2018), the increasingly widespread acceptance of cryptocurrency as a form of investment marks the beginning of integrating cryptocurrency with traditional financial markets (stock and bond markets). As a result, cryptocurrency is gaining more attention among some investors. Like investing in a futures exchange, cryptocurrency creates new networks, creating a flow of financial information while triggering shocks in financial markets. This study uses a spillover index approach to explore cryptocurrency product features by evaluating the relationship between Cryptocurrency characteristics and banking performance and the Foreign Exchange Index.

According to Kenton (2019), the spillover effect in this research refers to the impact resulting from events unrelated to each other in one country but impact the economy in another. Spillover refers to the negative impact of an event in a country, such as an earthquake, stock market crisis, or other macroeconomic event. The phenomenon of cryptocurrency's effects on stocks indicates the crypto/stock market correlation declining in 2019. The phenomenon revealed that most of these events depend on market sentiment, and market correlation tends to be higher in the short term than in the long term.

The reason for studying panel data before the COVID-19 pandemic was that the global market was under deep pressure during the COVID-19 pandemic period (2020 – 2022), so the spillover provided would provide a significant difference. Research before the COVID-19 pandemic is expected to provide valuable insights into the interconnectedness of these financial markets and an incredibly detailed examination of how information and shocks in the cryptocurrency market are transmitted to the banking industry and foreign exchange markets, providing insights into the overall efficiency of the financial system. Thus, this research further discovers whether cryptocurrency has a spillover effect on banking and foreign exchange performance in Indonesia. The study aims to determine and analyze the spillover effect of Cryptocurrency volatility on Banking and Foreign Exchange Performance.

Literature Review

Cryptocurrency

Cryptocurrency is a currency that uses Internet media to carry out financial transaction activities using cryptographic functions.

Cryptocurrency is a system that provides secure online transaction payments in the form of virtual "tokens," facilitating the direct transfer of funds between two parties in a transaction without the need for a trusted third party such as a bank and is facilitated through the use of public keys and private keys for security purposes (Frankenfield, 2019). Cryptocurrencies are difficult to counterfeit because they have security

features and a decentralized system based on Blockchain technology, namely a distributed ledger enforced by a network of different computers (Rosic, 2017). The first Blockchain-based cryptocurrency was Bitcoin, which remains the most popular and valuable. Currently, there are thousands of alternative cryptocurrencies with various functions or specifications. The attraction and function of cryptocurrency is Blockchain technology, which it uses to store an online ledger or ledger of all transactions carried out using cryptocurrency. Many experts see Blockchain as essential in online voting or crowdfunding technologies. Large financial institutions such as JP Morgan Chase see the potential of cryptocurrency to lower transaction costs by making payment processing more efficient. However, cryptocurrencies are considered by some economists in many countries to be a short-term trend due to concerns that currency units, such as Bitcoin, are not rooted in any material goods (Frankenfield, 2019). The following discussion explains Bitcoin, Ripple, Ethereum, and Litecoin as types of cryptocurrency.

Bitcoin is a type of cryptocurrency stored using public and private "keys," long strings of numbers and letters linked through the mathematical encryption algorithm used to create them. Bitcoin, a virtual currency, has a market capitalization of approximately 40% of the entire Cryptocurrency market (Trabelsi, 2018). In its purest form, digital coins are a peer-to-peer cash payment system and unregulated currency introduced in 2008 without legal status. Bitcoin is the first digital currency to use peer-to-peer technology to facilitate payments. Many Bitcoin supporters believe the digital currency is the future, as it enables a faster and more free payment system for transactions worldwide. Although a government or central bank does not yet back Bitcoin, it can be exchanged for fiat currency. Its exchange rate against the dollar attracts investors and traders interested in currency games. As with any other asset, the buy low and sell high principle applies to Bitcoin. The most popular way to collect currency is through purchases on Bitcoin exchanges (Frankenfield, 2019).

Ripple technology acts as a cryptocurrency and digital payment network for financial transactions. Ripple operates on an open-source and peer-to-peer decentralized platform that allows seamless money transfer in any form, whether USD, Yen, or Bitcoin (Frankenfield, 2019). Ripple uses a medium known as a Gateway, which functions as a link in the chain of trust between two parties wishing to make a transaction. The gateway is an intermediary that receives and sends currency to public addresses via the Ripple network. Anyone or any business can register and open a gateway that authorizes the registrant to act as an intermediary to exchange currency, maintain liquidity, and transfer payments on the network (Frankenfield, Ripple, 2019). Unlike banks that take days or weeks to complete transfers, Ripple only takes a short time. The fees for making transactions on Ripple are also very cheap, with the minimum transaction fee required for a standard transaction set at 0.00001 XRP, compared to the enormous fees banks charge for making cross-border payments.

Launched in 2015, Ethereum is a decentralized software platform that allows Smart Contracts and Distributed Applications (ĐApps) to be built and run without downtime, fraud, control, or interference from third parties. The platform is also the basis for its virtual

currency, Ether. Ethereum is a software platform and a programming language (Turing Complete) that runs on the Blockchain, helping developers build and publish distributed applications and making Ethereum's potential applications very diverse. Ethereum's (ETH) market capitalization is far behind Bitcoin's (BTC). Ethereum can "codify, decentralize, secure and trade anything." One of Ethereum's significant projects is Microsoft's partnership with ConsenSys, which offers "Ethereum Blockchain as a Service (EBaaS) on Microsoft Azure so clients and developers can

Litecoin, an alternative Cryptocurrency based on the Bitcoin model, was launched in 2011. Litecoin is based on an open-source global payment network not controlled by banking or government authorities. Litecoin is a fully decentralized peer–to–peer internet currency and a global payments network. Litecoin was developed to correct the shortcomings of Bitcoin, which has gained industry support along with high trading volume and liquidity over the years. Litecoin was launched as the "silver" to Bitcoin's "gold" and has gained much popularity since its launch. Litecoin has consistently been one of the largest Cryptocurrencies in market capitalization, with over 50 Million coins in circulation. (Frankenfield, 2019).

Spillover Volatility and Foreign Exchange Spillovers

QAccording to Klashorst (2018), a rational explanation for the volatility spillover phenomenon is usually sought in economic interconnectedness, as countries depend on each other through international trade and investment. Hence, any news about economic fundamentals in one country is likely to have implications for its trading partners. From a behavioral perspective, speculative trading and noise trading are potential explanations, as fads and herd instincts are transmittable across borders. Behavioral explanations are the most plausible when examining volatility spillover effects in the context of cryptocurrencies, as cryptocurrencies are supranational, and their value is not based on underlying economic fundamentals. According to Aulia (2019), Volatility Spillover is a condition where one market's volatility affects others. The term volatility spillover is also used to express a condition where instability or shock conditions provide transmission from one market to another or, in this research, from one cryptocurrency to another. According to Purbasari (2019), the main objective of researching Volatility Spillover is to understand how combined volatility movements influence the distribution of portfolio returns. The distribution of portfolio returns has implications for daily risk management, portfolio selection, and derivative pricing. The combined movement of volatility helps in understanding the transmission of shocks in the global financial system; however, some effects influence the volatility of financial markets and their assets, namely volatility spillover.

Foreign Exchange (Foreign Exchange or FX) trades one currency for another. For example, one can exchange US dollars for Euros. Foreign exchange transactions can occur in the foreign exchange market or the Forex Market. According to Ardraviz (2018), the Forex Market or Foreign Exchange Market is a place that organizes currency exchange activities from various countries. Transactions take place continuously for 24 hours, and the end of trading in one country will be followed by the opening of trading in other countries. The Forex market can be divided into two categories: the client market and the interbank market. Customers for the

foreign exchange market include governments, central banks, exporters, importers, and financial institutions that do not have access to the interbank market.

GARCH Model

Generalized Autoregressive Conditional Heteroskedasticity (GARCH) is a process for estimating volatility in financial markets. Financial experts often use the GARCH process to create financial modeling because the GARCH process describes the actual context of other approaches to predict the price of financial instruments. The GARCH model has three steps. First, namely, to estimate the autoregressive model. Second, to calculate the autocorrelation value of the errors. According to Bollerslev (2009), the calculation for the GARCH Model is as follows $\sigma 2\ t = \omega + \beta(L)\sigma 2\ t-1 + \alpha(L)\eta 2$. A new parameterization of the conditional variance matrix Ht is defined by Baba et al. (1990) and known as the BEKK model, which is seen as another limited version of the VEC (Vector Error Correction) model, created to ensure positive certainty. It achieves positive certainty of conditional covariance by formulating the model such that the structure of the model implies this property. According to Klashorst (2018), the BEKK model form $H_t = \Omega'\Omega + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1}B$.

METHODOLOGY

This descriptive research discusses banking stock performance and foreign exchange spillover volatility. The data used are secondary quantitative data derived from the published company's financial reports on the corporate website (BRI, BCA, BNI, BRI). Judgmental sampling was applied to select banking and foreign exchange performances based on their composition and liquidity during a research period. The panel data consists of price time series data for four cryptocurrency currencies (Bitcoin, Ethereum, Litecoin, and Ripple), four banking performances (BRI, BCA, BNI, BRI), and the closing price data of four foreign exchanges (exchange (Euro/USD), GBP/USD, USD/JPY, USD/CAD) from 2015 to 2019. The Augmented Dickey-Fuller unit root test is carried out to test the stationarity of data and produce stationary data, which has a manageable variance and tends to be close to the average value of the data. Next, a multivariate model is needed to examine the interaction of Cryptocurrency volatility spillover on Banking and Foreign Exchange Performance. This research uses the BEKK - GARCH model without limitations, which can be expressed by: $Ht = W\ 'W + A'\varepsilon t-1\varepsilon' t-1A + B'Ht-1B$. According to Klashorst (2018), this model allows for interactions between different asset returns and volatility and requires relatively few parameters compared to alternative multivariate models. The conceptual framework is drawn as follows:

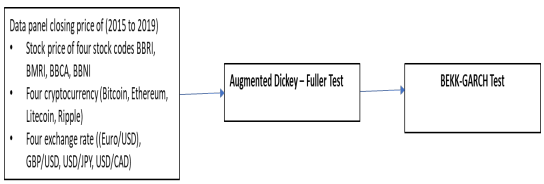

Figure 1. The Conceptual Framework

DATA ANALYSIS AND DISCUSSION

The results of the stationarity test using Augmented Dickey-Fuller (ADF) on the Cryptocurrency stock market, Indonesian Banking, and Foreign Exchange showed (Table 1) that the p-values of the entire cryptocurrency stock market, Indonesian banking, and foreign exchange in this period are greater than

the significance level (α) of 5% (p-values > 0.05. It indicates that the time series data of the cryptocurrency stock market, Indonesian banking, and foreign exchange are not stationary at any level. Then, the ADF unit root test using the first difference method was implemented, and the result is shown in Table 2 below:

Table 1. Unit Root Test Data For The Cryptocurrency Stock Market, Banking, And Foreign Exchange Using The Augmented Dickey–Fuller Method At The Level.

Harga Saham	t-Statistic	Prob.
Cryptocurrency		
Bitcoin	-1,567	0,499
Ripple	-1,657	0,065
Ethereum	-2,526	0,109
Litecoin	-2,310	0,169
Perbankan Indonesia		
BMRI	-1,216	0,669
BBCA	1,079	0,997
BBNI	-1,280	0,641
BBRI	-0,411	0,905
Foreign Exchange		
EURUSD	-2,830	0,054
GBPUSD	-2,060	0,261
USDCAD	-1,791	0,073
USDJPY	-2,118	0,238

Table 2. Unit Root Test Data For The Cryptocurrency Stock Market, Banking, And Foreign Exchange Using The Augmented Dickey-Fuller Method At The First Difference Level.

Harga Saham	t-Statistic	Prob. (p-values)
Cryptocurrency		
Bitcoin	-11,456	0,000
Ripple	-9,734	0,000
Ethereum	-6,310	0,000
Litecoin	-11,740	0,000
Perbankan Indonesia		
BMRI	-36,033	0,000
BBCA	-38,902	0,000
BBNI	-34,572	0,000
BBRI	-27,046	0,000
Foreign Exchange		
EURUSD	-37,025	0,000
GBPUSD	-34,860	0,000
USDCAD	-35,627	0,000
USDJPY	-37,040	0,000

Table 2 indicates the results of the stationarity test using Augmented Dickey-Fuller (ADF) on the Cryptocurrency stock market, Indonesian Banking, and Foreign Exchange at the First Difference level. The p-values of the entire Cryptocurrency stock market, Indonesian Banking, and Foreign Exchange in this period are smaller than the significance level (α) of 5% or p-values < 0.05, so it can be stated that there is a unit root so that the market time series data Cryptocurrency shares, Indonesian Banking and Foreign Exchange are stationary at the First Difference level. The next step is to test the model using the BEKK GARCH test to determine volatility spillover. Table 3 shows the mean and variance equation parameters obtained from the BEKK - GARCH model. It showed that the Banking stock market, which consists of BMRI, BBCA, BBNI, and BBRI, is influenced by the Cryptocurrency stock market, which in this case is the Bitcoin stock market. It can be seen by the coefficient values respectively being 0.762976***, 0.356823***, -0.6242***, and 0.937698*** and by the adjusted r-square values respectively also 0.322385; 0.525483; 0.35564, and 0.318482. Based on the adjusted R-square value, it can be stated that the influence of Bitcoin's closing price on BBCA's closing price is highest and BBRI's is lowest.

Table 3. BEKK – GARCH Bitcoin Test Results for Banking

Estimate	Bitcoin			
Conditional variance equation	**BMRI**	**BBCA**	**BBNI**	**BBRI**
M(1,1)	1124,877**	28082,64*	4820,592***	448,7303***
M(1,2)	24,785	-510,740	311,738	29,986
M(2,2)	0,860184***	0,713427***	0,806525***	0,849397***
A1(1,1)	0,762976***	0,795141***	0,909018***	0,824801***
A1(2,2)	0,358868***	0,356823***	0,360447***	0,366044***
B1(1,1)	0,758798***	-0,724085***	-0,6242***	-0,703439***
B1(2,2)	0,943194***	0,941489***	0,93998***	0,937698***
R-squared	**0,322922**	**0,525859**	**0,356151**	**0,319022**
Adjusted R-squared	**0,322385**	**0,525483**	**0,35564**	**0,318482**

Table 4 shows the mean and variance equation parameters obtained from the BEKK - GARCH model, bringing results that the Foreign Exchange stock market, which consists of EUR/USD, GBP/USD, and USD/CAD, is influenced by the Cryptocurrency stock market, which is the Bitcoin stock market. It showed that from the coefficient values, respectively being 1.317013***, 0.284052***, and -0.010974, and by the adjusted r-square values, respectively being -0.38627; -0.278187, and -0.316239 while USD JPY is not affected by the Bitcoin Cryptocurrency stock market with a coefficient of -0.010974. Based on the adjusted R-square value, the highest influence of the closing price of Bitcoin is on the closing price of GBP USD, and the lowest is on USD JPY.

Table 4. BEKK – GARCH Bitcoin Test Results against Foreign Exchange

Estimate	Bitcoin			
Conditional variance equation	**EUR USD**	**GBP USD**	**USD JPY**	**USD CAD**
M(1,1)	0,288043***	0,508878***	0,33974***	21,83064***
M(1,2)	-0,261642	0,602344	-0,063787	0,13986
M(2,2)	0,665252***	0,752381***	0,605921***	0,718594***
A1(1,1)	1,317013***	1,322532***	1,304422***	1,33143***
A1(2,2)	0,288026***	0,284052***	0,292562***	0,28726***
B1(1,1)	-0,004082	-0,07195	-0,010974	-0,008849
B1(2,2)	0,960856***	0,96134***	0,959717***	0,961011***
R-squared	**-0,38551**	**-0,277486**	**-0,438392**	**-0,315517**
Adjusted R-squared	**-0,38627**	**-0,278187**	**-0,439181**	**-0,316239**

Table 5 shows the mean and variance equation parameters obtained from the BEKK-GARCH model, bringing results that the banking stock market, which consists of BMRI, BBCA, BBNI, and BBRI, is influenced by the Cryptocurrency stock market, which in this case is the Ripple stock market. It can be seen from the coefficient values, respectively 1.040154***, 0.569597***, 0.408604***, and 0.888172***; and the adjusted r-square value, respectively 0.184926; 0.411603; 0.198951, and 0.222035. Based on the adjusted R-square value, the highest influence of Ripple's closing price is on BBCA's closing price, and the lowest is on BMRI.

Table 5. BEKK – GARCH Ripple Test Results for Banking

Estimate	Ripple			
Conditional variance equation	**BMRI**	**BBCA**	**BBNI**	**BBRI**
M(1,1)	31110,7***	13924,79	6714,341***	7703,415**
M(1,2)	0,116391***	-0,001867	-0,000525***	-0,01586**
M(2,2)	0,000000821***	0,0000000181***	-0,0000000383***	-0,00000044**
A1(1,1)	1,040154***	0,831163***	0,81363***	0,912062**
A1(2,2)	0,570602***	0,569597***	0,587144***	0,575671**
B1(1,1)	0,172015***	0,75592***	0,408604***	0,546852**
B1(2,2)	0,890423***	0,885106***	0,88282***	0,888172**
R-squared	**0,185572**	**0,412069**	**0,199586**	**0,22265**
Adjusted R-squared	**0,184926**	**0,411603**	**0,198951**	**0,22203**

Table 6 shows the mean and variance equation parameters obtained from the BEKK-GARCH model, showing that the Foreign Exchange stock market, which consists of EUR USD, GBP USD, and USD CAD, is influenced by the Cryptocurrency stock market, which in this case is the Ripple stock market. It can be seen from the coefficient values respectively 0.814083***, 0.499184***, 0.656753*** and 0.885403***; and with adjusted r-square values respectively -0,405263; -0.284535, 0.001378 and -0.422384. Based on the adjusted R-square value, the highest influence of Ripple's closing price is on the closing price of USD JPY, and the lowest is on USD CAD.

Table 6. BEKK - GARCH Ripple Test Results against Foreign Exchange

Estimate	Ripple			
Conditional variance equation	**EUR USD**	**GBP USD**	**USD JPY**	**USD CAD**
M(1,1)	0,694705***	0,398032***	-547,0693	0,770435*
M(1,2)	0,000353***	0,0000465***	-0,000477	-0,00000
M(2,2)	-0,000000949***	-0,00000121***	-0,000000281***	-0,0000000837*
A1(1,1)	0,814083***	0,870688***	0,996985***	0,963857*
A1(2,2)	0,526191***	0,499184***	0,475974***	0,699796*
B1(1,1)	0,59178***	0,555137***	0,656753***	0,511346*
B1(2,2)	0,926522***	0,927203***	0,926126***	0,885403*
R-squared	**-0,404492**	**-0,283830**	**0,001926**	**-0,4216**
Adjusted R-squared	**-0,405263**	**-0,284535**	**0,001378**	**-0,4223**

Table 7 shows the parameters of the average and variance equations obtained from the BEKK-GARCH

model where the banking stock market, which consists of BMRI, BBCA, BBNI, and BBRI, is influenced by the Cryptocurrency stock market, which in this case is the Ethereum stock market. It can be seen by the coefficient values, respectively 1.135239***, 0.568470***, 0.878662***, and 0.906574***, and by the adjusted r-square values, respectively 0.255018; 0.617012; 0.277694, and 0.555731. Based on the adjusted R-square value, the highest influence of the closing price of Ethereum is on the closing price of BBCA, and the lowest is on BMRI.

Table 7. BEKK – GARCH Ethereum Test Results for Banking

Estimate	Ethereum			
Conditional variance equation	BMRI	BBCA	BBNI	BBRI
M(1,1)	8652,557***	3.569	1264,575**	2304,638
M(1,2)	-0,722765	1,120450	-0,156308	-0,5003
M(2,2)	0,000662	0,000166	0,000876	-0,004991*
A1(1,1)	1,135239***	0,568784***	0,552065***	0,651132*
A1(2,2)	0,458971***	0,568470***	0,577462***	0,514909*
B1(1,1)	0,205469***	0,879381***	0,878662***	0,825310*
B1(2,2)	0,923044***	0,882218***	0,880688***	0,906574*
R-squared	**0,255731**	**0,617379**	**0,278385**	**0,5561**
Adjusted R-squared	**0,255018**	**0,617012**	**0,277694**	**0,5557**

Table 8 shows the parameters of the average and variance equations obtained from the BEKK-GARCH model where the Foreign Exchange stock market, which consists of EUR USD, GBP USD, and USD CAD, is influenced by the Cryptocurrency stock market, which in this case is the Ethereum stock market. It can be seen from the coefficient values respectively 1.315143***, 0.381608***, -0.002003 and 0.942247*** and by adjusted r-square values respectively -0.454472; -0.422924, -0.501276 and -0.486835. Based on the adjusted R-square value, it can be stated that the highest influence of the closing price of Ethereum is on the closing price of GBP USD, and the lowest is on USD JPY.

Tabel 8. BEKK – GARCH Ethereum Test Results against Foreign Exchange

Estimate	Ethereum			
Conditional variance equation	EUR USD	GBP USD	USD JPY	USD CAD
M(1,1)	0,232374***	0,518829***	27,34701***	0,320586**
M(1,2)	0,002502	0,005021	-0,024042	0,0070
M(2,2)	0,000297	0,000570	0,000584	0,0004
A1(1,1)	1,315143***	1,323595***	1,344235***	1,320638**
A1(2,2)	0,379942***	0,381608***	0,377962***	0,385657**
B1(1,1)	-0,000687	-0,002910	-0,002003	-0,0254
B1(2,2)	0,943706***	0,943309***	0,944685***	0,942247**
R-squared	**-0,453567**	**-0,422038**	**-0,500341**	**-0,4859**
Adjusted R-squared	**-0,454472**	**-0,422924**	**-0,501276**	**-0,4868**

Table 9 shows the parameters of the mean and variance equation obtained from the BEKK-GARCH model, showing that the banking stock market, which consists of BMRI, BBCA, BBNI, and BBRI, is influenced by the Cryptocurrency stock market, which in this case is the Litecoin stock market. It can be seen by the coefficient values respectively being 0.856596***, 0.408989***, 0.504075***, and 0.943993*** and by the adjusted r-square values respectively 0.257106; 0.579434; 0.285538, and 0.291523. Based on the adjusted R-square value, it can be stated that the highest influence of Litecoin's closing price is on BBCA's closing price, and the lowest is on BMRI

Table 9. BEKK – GARCH Litecoin Test Results for Banking.

Estimate	Litecoin			
Conditional variance equation	BMRI	BBCA	BBNI	BBRI
M(1,1)	1185,787**	45096,68	5864,325***	171,0123
M(1,2)	0,157376	-0,931125	0,895331	0,033384
M(2,2)	0,000083***	0,000133	0,000863***	0,00089***
A1(1,1)	0,856596***	0,727656***	1,176274***	0,860186***
A1(2,2)	0,335569***	0,408989***	0,315353***	0,32827***
B1(1,1)	0,769404***	0,69265***	0,504075***	0,775093***
B1(2,2)	0,942662***	0,934008***	0,948888***	0,943993***
R-squared	**0,257695**	**0,579767**	**0,286104**	**0,292084**
Adjusted R-squared	**0,257106**	**0,579434**	**0,285538**	**0,291523**

Table 10 shows the parameters of the average and variance equations obtained from the BEKK-GARCH model describing the Foreign Exchange stock market, which consists of EUR USD, GBP USD, and USD CAD, which

is influenced by the Cryptocurrency stock market, which in this case is the Litecoin stock market. It can be seen by the coefficient values, respectively 1.315143***, 0.381608***, -0.002003 and 0.942247***, and by the adjusted r-square values, respectively -0.454472; -0.422924, -0.501276 and -0.486835. Based on the adjusted R-square value, the highest influence on the closing price of Litecoin is on the closing price of GBP USD, and the lowest is on USD JPY.

Table 10. BEKK – GARCH Litecoin Test Results against Foreign Exchange

Estimate	Ethereum			
Conditional variance equation	EUR USD	GBP USD	USD JPY	USD CAD
M(1,1)	0,232374***	0,518829***	27,34701***	0,320586***
M(1,2)	0,002502	0,005021	-0,024042	0,007045
M(2,2)	0,000297	0,000570	0,000584	0,000496
A1(1,1)	1,315143***	1,323595***	1,344235***	1,320638***
A1(2,2)	0,379942***	0,381608***	0,377962***	0,385657***
B1(1,1)	-0,000687	-0,00291	-0,002003	-0,025417
B1(2,2)	0,943706***	0,943309***	0,944685***	0,942247***
R-squared	**-0.453567**	**-0.422038**	**-0,500341**	**-0.485905**
Adjusted R-squared	**-0.454472**	**-0.422924**	**-0,501276**	**-0.486835**

Overall, the BEKK – GARCH test results of the cryptocurrency spillover volatility effect on the currencies EUR/USD, GBP/USD, USD/JPY, and USD/CAD show that the exchange rate most affected by cryptocurrency is GBP/USD and the exchange rate is relatively unaffected was USD/JPY. The negative number indicates that the higher the closing price value of the cryptocurrency, the lower the closing price value against GBP/USD (-0.278187). The USD/JPY (-0.439181) was relatively unaffected by cryptocurrencies. Furthermore, the results of this test can also help investors who play in foreign currencies in taking positions to switch foreign currencies based on the volatility of the closing price of the cryptocurrency. The overall analysis after using the BEKK – GARCH test, the effect of cryptocurrency spillover volatility on the closing prices of four banking stocks (BMRI, BBCA, BBNI, and BBRI), shows that the most affected average is BBCA, and what is relatively unaffected is BMRI. This positive number means that the higher the closing price value of the cryptocurrency, the higher the closing price value of BBCA. BMRI has effects that are relatively unaffected by cryptocurrencies.

Table 11. Comprehensive Analysis of BEKK – GARCH Test

INSTRUMENT		BITCOIN	RIPPLE	ETHEREUM	LITECOIN
FOREIGN EXCHANGE	BATAS ATAS	-0,278187 GBP/USD +	0,001378 USD/JPY +	-0,422924 GBP/USD +	-0.422924 GBP/USD +
	BATAS BAWAH	-0,439181 USD/JPY -	-0,422384 USD/CAD -	-0,501276 USD/JPY -	-0,501276 USD/JPY -
BANKING	BATAS ATAS	0,525483 BBCA +	0,411603 BBCA +	0,617012 BBCA +	0,579434 BBCA +
	BATAS BAWAH	0,318482 BBRI -	0,184926 BMRI -	0,255018 BMRI -	0,257106 BMRI -

CONCLUSION

The research results allow some conclusions to be drawn, showing that all cryptocurrencies have the highest influence on BBCA. For the foreign exchange, three cryptocurrencies (Bitcoin, Ethereum, and Litecoin) showed the highest influence on GBP USD and the lowest on USD JPY. Only Ripple showed the highest influence on USD JPY and the lowest on USD CAD. It is also suggested that investors who want to start investing in cryptocurrency must pay attention to the JCI movement represented by the banking sector because cryptocurrency is a non-fiat currency. For investors who tend not to be risk takers, cryptocurrency is not suitable to add to an asset portfolio, and cryptocurrency can be a moving effect of several investment instruments for investors.

Future Research

The COVID-19 pandemic has significantly impacted the global market and economics. Hence, analyzing volatility spillover from cryptocurrencies to the banking industry

and foreign exchange using the BEKK GARCH method during the COVID-19 pandemic (the year 2020 to 2022) will be critical for understanding the dynamics of financial markets in a crisis context. However, future research using a data panel will provide insights into market stress, the impact of crisis-driven events, the financial system's resilience, policy responses, and changes in investor behavior, all of which are crucial considerations during this unprecedented global health crisis.

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