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Article

Do Stock Market Volatility and Cybercrime Affect Cryptocurrency Returns? Evidence from South African Economy

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Abstract: The study investigates the effects of stock market volatility and cybercrime on cryptocurrency returns in the South African economy. Daily time series data on four different types of cryptocurrencies (Bitcoin, Ethereum, Tether, and BNB) were employed. The data covers the period from 1 January 2019–31 December 2021. The study employed the dynamic conditional correlation (DCC GARCH) and Bayesian liner regression model to investigate time-varying correlations among the variables. Empirical findings suggest that stock market volatility has a positive impact on the returns of BNB, Bitcoin, and Ethereum. However, it has a negative impact on Tether. Expectedly, cybercrime poses negative impacts on the returns of BNB, Bitcoin, and Ethereum but could be said to have no impact on the returns of Tether. The study concludes that ongoing efforts to reduce cybercrime activities need to be strengthened to further the use of digital currencies.

Keywords: cryptocurrencies; cybercrime; stock market volatility; DCC; BLR



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1. Introduction

Cryptocurrency (also called crypto or crypto currency) is a modern economic and financial phenomenon that is receiving significant attention from investors, organisations, governments, and many other economic agents (Liu and Tsyvinski 2021). Cryptocurrency is defined as a decentralised virtual currency that uses cryptography to track and secure transactions. Factors that affect the cryptocurrency market are continuously emerging and are constantly changing. The increasing popularity and influence of cryptocurrency has attracted the interest of criminals. Cryptocurrency has many advantages as a virtual currency; however, it is also characterised by many threats as it operates in cyberspace. Umar (2021) states that because it operates in cyberspace, it is a favourite target for hackers and is thus vulnerable to cyber-attacks or cybercrime. The reason why crypto is a favourite of cybercriminals is because of its vulnerability to attacks, due to the anonymity granted by encrypted blockchain technology (Caporale et al. 2020). A blockchain is defined as digitally distributed, decentralised, public ledger that records digital transactions. They are sustained through several computer systems that are linked to a peer-to-peer network (Caporale et al. 2020). The inception of cryptocurrencies was based on the notion that individuals no longer trusted traditional financial authority. However, the lack of a structured regulatory framework is leading to the misuse and abuse of the public nature of its blockchain (Schipor 2019).

A prominent issue associated with cryptocurrency is the extremely high level of volatility, and the contagion effect between Bitcoin (the largest and most well-known currency) and other cryptocurrencies. Due to this, the crypto market is vulnerable to market crashes and is likely to experience bubbles (Ferreira and Pereira 2019; Schipor 2019). Due to the decentralisation of crypto, researchers note that the spillover effect might occur easily due to unrestricted transactions (Luu Duc Huynh 2019). The magnitude of the spillover effect

needs to be investigated and monitored because these spillovers may cause disruption to financial systems.

However, in the existing literature there is insufficient knowledge on the market dynamics of cryptocurrencies and traditional financial assets in the context of developing countries (Vardar and Aydogan 2019). Moreover, the impact of cybercrime on cryptocurrencies in emerging markets is not investigated. This study intends to investigate the impact of stock market volatility and cybercrime on the cryptocurrency market using South Africa as a case study. The study was conducted due to the volatile nature of the stock market and with the aim of investigating how volatility affects cryptocurrency markets. This is the case particularly in South Africa, an emerging market where the stock markets are considered more volatile than in developed markets (Duncan and Kabundi 2011). Cheteni (2016) conducted an empirical analysis on the Johannesburg Stock Exchange (JSE) and found that this market is highly volatile compared to other equity markets. Hence, this study made use of the volatility series generated from the JSE Top 40 Index. There are limited studies investigating the spillover effect of the JSE highly volatile market into cryptocurrency markets. In addition, South Africa is known to be more vulnerable to cybercrime than most other countries, which creates further opportunity to study cybercrime and its impact on cryptocurrency. The remainder of the study is structured as follows: Section 2 reviews the theoretical and empirical literature, while Section 3 discusses the empirical method. Section 4 discusses the empirical results. The conclusion is provided in Section 5.

2. Literature Review

This section is divided into two parts. The first part examines the theories that explain how stock market volatility and cybercrime impact cryptocurrency markets, while the second part reviews previous empirical attempts.

2.1. Theoretical Framework

The modern portfolio theory is applicable to cryptocurrency. The most prominent cryptocurrency, Bitcoin, has been an important subject of discussion in recent years. Several characteristics of Bitcoin have been common in financial assets, leading it to be classified as a new asset class (Liu and Tsyvinski 2021; Gil-Alana et al. 2020). Modern portfolio theory is concerned with how an investor looks at how an asset co-moves with other assets before including it into a portfolio in order to maximise expected return and reduce risk (Saksonova and Kuzmina-Merlino 2019). Observing how stock market volatility affects cryptocurrency is important in order to understand if it can be used as a diversification option.

The stock market is known for being highly volatile, and therefore investors are always looking at alternative assets to hedge risk. The “risk to safety” theory is applicable in cryptocurrency. The theory states that risk-averse investors reallocate their investment from assets facing high volatility to less-volatile assets during that particular market period (Inghelbrecht et al. 2013). When stock markets are facing periods of high volatility, investors reallocate their investment, and instead buy cryptocurrency to diversify risk. They choose cryptocurrency for the many advantages it provides.

The ‘flight to safety’ theory can also be applied to cryptocurrency markets when volatility is extremely high. Fang et al. (2021) states that consecutive cyber-attacks on cryptocurrencies trigger high volatility in cryptocurrency markets. This deteriorates investor confidence in cryptocurrency markets and deters their risk receptors. This induces ‘flight to safety’ in investors, causing them to seek more stable markets for their investments. The stock market becomes their safe haven in times of cryptocurrency market instability.

2.2. Empirical Evidence

There is a considerable amount of literature stating that cryptocurrencies behave and function as a traditional asset. Liu and Tsyvinski (2021) stated a valuation that links the fre-

quency of cryptocurrency prices to those of traditional assets. This classification has been investigated and the evidence has distinct aspects according to each study. Yeimack states that cryptocurrency is a speculative investment due to its high volatility, chances of theft and hacking, its scarcity, and the computer knowledge needed to use it. The evidence suggests that cryptocurrency is classified as an asset, not a currency. The [European Central Bank \(2012\)](#) state that this classification of cryptocurrency is now a concern due to the possibility that it might affect different asset classes and therefore threaten the stability of the financial system. Investors require more information as to whether it can be utilised further in portfolios, and specifically, the correlation it exhibits with other asset classes. Other literature supports the theory that cryptocurrency is used as a diversification option, but state that it is used because of its linkage or spillover effect between it and other traditional assets ([López-Cabarcos et al. 2021](#); [Bouri et al. 2017](#)).

A volatility spillover is defined as transmission of one asset's volatility to another asset ([Duncan and Kabundi 2011](#)). Equity markets and cryptocurrency markets have become more integrated since the beginning of the coronavirus crisis. [Iyer \(2022\)](#) conducted a study that examined the extent to which cryptocurrencies and equity markets have potential spillover in the United States and emerging markets using price returns and volatility. The results suggest that volatility spillover from S&P500 and MSCI emerging market indices to cryptocurrency markets is extremely high. They take note that bidirectional spillovers tend to increase during episodes of market volatility.

[Corbet et al. \(2018\)](#) uses an empirical approach to explore the connectedness of Bitcoin and mainstream assets. They found that the directional returns and volatility of VIX, gold, bonds, GSCI, FX, and S&P500 are very low. They concluded that cryptocurrencies are more interconnected with one another than mainstream traditional assets. [Ghorbel and Jeribi \(2021\)](#) use the BEKK-GARCH model to analyse the relationship between cryptocurrency and American market indices, using the volatility of five major cryptocurrencies and American market indices (namely S&P500, VIX, Nasdaq, oil prices, and gold). They noted that volatility spillover between cryptocurrencies is extremely high, and it is lower between cryptocurrency and the investigated traditional assets. However, they found proof of bidirectional volatility between cryptocurrencies and financial assets. [Vardar and Aydogan \(2019\)](#) pioneered an empirical study that investigated the return and volatility spillover of the cryptocurrency market. They used Bitcoin as a proxy of the market and key traditional assets, namely the Bosra Istanbul stock market index and Turkish government bonds, and included international currencies such as the US dollar and the euro. The study employed the multivariate econometric method and the VAR-GARCH model and incorporated a mean framework with the BEKK representation. The study found that there exists a cross-market shock that is bidirectional in nature. It also found that cryptocurrency and the investigated mainstream assets exhibit a volatility spillover. The study notes the exclusion in the case of the US Dollar and Turkish five-year government bonds, where there is only unidirectional volatility spillover from the assets to Bitcoin.

Cyber-attacks and cryptocurrency spillovers are of importance to investors because they contain important information that affects investor behaviour and their preferences ([Yousaf et al. 2021](#)). [Caporale et al. \(2020\)](#) investigates the volatility spillover between different cryptocurrencies and the role of cyber-attacks in these spillovers. The study estimated the trivariate GARCH-BEKK models that included dummy variables corresponding to the suitably defined cyber-attack. The results concluded that cyber-attacks reduce diversification opportunities by strengthening cross-market linkages. [Ciaian et al. \(2016\)](#) further states that cyber-attacks on crypto market exchanges are found to reduce their attractiveness to investors.

[Umar \(2021\)](#) conducted a study that explored how cryptocurrency attacks affect crypto price, return, and liquidity. The study used a multiple linear regression model that included a categorical independent variable plus quantile-on-quantile regression. The results supported the evidence of [Fang et al. \(2021\)](#), stating that cyber-attacks do not have any effect on cryptocurrency prices and return. Furthermore, cyber-attacks enhance the liq-

uidity of cryptocurrency. However, there exists evidence that suggests the opposite, that the frequent occurrence of cybercrime has the negative effect of destabilising the cryptocurrency market (Yousaf et al. 2021). Caporale et al. (2020) conducted a study and found that cryptocurrencies are extremely vulnerable to cybercrime. They continue to state that cyberattacks are classified as a risk factor due to the disruptions caused to the cryptocurrency market through the negative impact on returns, volatility, and trading volumes. Ramos et al. (2021) used cumulative abnormal return models (CAR) to investigate the effect of cybercrime on cryptocurrency returns. The results indicate that reported cyber-attacks (51% attacks) have a negative effect on returns and that unreported attacks have the opposite effect. Cryptocurrency exchanges are highly volatile and cyberattacks are found to increase this volatility (Marella et al. 2021).

Corbet et al. (2019) used DCC-GARCH to analyse intra-day trading of cryptocurrencies. The study determined that international trading times, volatility of oil prices, GBP/USD, and cybercrime events affect intra-day volatility. The study observed that cybercrime activities lead to higher volatility of the affected cryptocurrency. Sanusi and Dickason-Koekemoer (2022) investigate the effects of stock market volatility and cybercrime on cryptocurrencies’ returns in the South African economy using time series data using Generalized Autoregressive Score Model (GAS) and regime-switching approach. Their findings show that the effects of the cyberattack on the returns of the cryptocurrencies could be said to be non-regime dependent. Their findings also show that the effect of stock market volatility is regime-dependending. Stock market volatility has positive effects on the returns of each of the cryptocurrencies. The study provides evidence which states that the cryptocurrency market is highly vulnerable to cybercrime. Cybercrime is observed to be a risk factor and causes disruptions in the cryptocurrency market through the effects on returns, volatility, and trading volumes.

3. Materials and Methods

3.1. Data Description and Summary

Daily time series data on 4 types of cryptocurrencies (Bitcoin, Ethereum, Tether, and Binance Coin (BMB)) from the first day of January 2019 to last day of December 2021 were obtained from CoinMarketCap. Data on cybercrime were taken from the Hackmageddon database on cybercrime. Daily data on the Johannesburg Stock Exchange Top 40 Index (FTSE/JSE Top 40) was taken from Thompson Reuters Eikon database. The study aims to investigate the impact of stock market volatility and cybercrime on cryptocurrency returns in the South African economy. The choice and the scope of the data are informed by the availability of data. Volatility series were generated using the GARCH (1,1) model.

3.2. GARCH-DCC Model

The GARCH-DCC is a multivariate model also known as the dynamic conditional correlation (DCC) model. The DCC model was adopted to examine the time-varying correlations against static correlation. The specified GARCH(p,q) model was estimated using maximum likelihood estimation (MLE) techniques. It is represented by the subsequent equations, where r_t is a residual from the fitted VAR equation:

$$r_t = \theta_0 + \epsilon_t \tag{1}$$

$$\log(\sigma_t^2) = \alpha_0 + \sum_{j=1}^p \beta_j \log(\sigma_{t-j}^2) + \sum_{i=1}^q \alpha_i \epsilon_{t-i}^2 \tag{2}$$

ϵ_t is the already-standardised disturbance term as a result of mean removal from the VAR residual series. The log of volatility of ϵ_t is given as a function of its own lagged values and lagged standardised disturbance terms. β 's are the persistence of volatility and α 's represent the GARCH effects. The standardised residual from the VAR equations is re-

standardised. The following variant of DCC is used for estimation in the R statistical package:

$$Q_t = (1 - \alpha - \beta) \bar{Q} + \alpha z_t z_t' + \beta Q_{t-1} \tag{3}$$

where Q_t is the dynamic conditional correlation, z_t is the standardised residual from the GARCH's. α and β are the persistence of correlation, and \bar{Q} is the initial correlation matrix at $t = 0$ i.e., $\bar{Q} = Q_{t=0}$.

$Q_{t=0}$ = correlation of standardised residuals of GARCHS. The obtained correlations would shed light on the time-varying contemporaneous relationships between the variables.

3.3. Bayesian Linear Regression Model

The empirical approach employed in the study is the Bayesian linear regression model (BLR). The general multiple linear regression model can be written as:

$$Y = X\beta + \epsilon \tag{4}$$

where Y is a column matrix of the dependent variable.

X is a vector of independent variables.

β is a vector of regression model parameters.

ϵ is a column vector of error terms.

Bayesian linear regression obtains parameter estimation by means of prior, likelihood distribution, and posterior distribution. Estimation of parameters is done through posterior distribution which is used to multiply both prior distribution and likelihood distribution. The linear regression model assumes error terms are normally distributed, and as such, variables are assumed to be normally distributed. In the Bayesian approach, the probability density function of the variables can be stated as follows:

$$p(Y/X, \beta, \sigma^2) = 1/\sqrt{(2\pi\sigma^2)^n} \exp \{-1/(2\sigma^2) (Y - X\beta)'(Y - X\beta)\} \tag{5}$$

The likelihood function of the variables can be stated as follows:

$$p(Y/X, \beta, \sigma^2) = \prod_{i=1}^n 1/\sqrt{(2\pi\sigma^2)} \exp \{-1/(2\sigma^2) (Y - X\beta)'(Y - X\beta)\} \tag{6}$$

$$p(Y/X, \beta, \sigma^2) = (\sigma^2)^{-n/2} \exp \{-1/(2\sigma^2) (Y - X\beta)'(Y - X\beta)\} \tag{7}$$

$$p(Y/X, \beta, \sigma^2) \propto (\sigma^2)^{-n/2} \exp[-(Y - X\beta)'(Y - X\beta)/(2\sigma^2)] \times (\sigma^2)^{-n/2} \exp \{-1/(2\sigma^2) (Y - X\beta)'(Y - X\beta)\} \tag{8}$$

The Bayesian approach to regression analysis makes use of several prior distributions. Parameter estimation using the Bayesian approach can be executed through iteration of the marginal posterior. Posterior distribution is obtained by multiplying both the prior distribution and the likelihood function.

$$p(\beta, \sigma^2/Y, X) \propto p(Y/X, \beta, \sigma^2) p(\sigma^2) p(\beta/\sigma^2)$$

$$p(\beta, \sigma^2/Y, X) \propto (\sigma^2)^{-n/2} \exp \{-1/(2\sigma^2) (Y - X\beta)'(Y - X\beta)\} \times (\sigma^2)^{-(v/2 + 1)} \exp[-(vs^2)/\sigma^2] \times (\sigma^2)^{-k/2} \exp[-1/(2\sigma^2) (\beta - \mu)' \Lambda (\beta - \mu)]$$

The study makes use of the MCMC (Markov Chain Monte Carlo) algorithm to obtain regression model parameters. The Gibbs sampling method of algorithms in MCMC is adopted. The MCMC pack is available in the R statistical package.

4. Results

4.1. Preliminary Analysis

Table 1 presents the summary statistics. The means of BNB returns, Bitcoin returns, and Ethereum returns are positive, suggests a bullish trend during the period under investigation. The mean of Tether returns indicates a reduction in the volatility because it is negative. While Figure 1 shows the graphical presentation of returns of each type of Cryptocurrencies considered in the study as well as the plots of the volatility series of FTSE/JSE Top 40 and cybercrime.

Table 1. Summary statistics of the Cryptocurrencies returns.

Statistics	BNB	Bitcoin	Ethereum	Tether
Mean	0.004083	0.002279	0.002934	-1.75×10^{-5}
Median	0.002189	0.001705	0.002550	-6.10×10^{-5}
Maximum	0.529243	0.171820	0.230704	0.053393
Minimum	-0.542809	-0.464730	-0.550714	-0.052570
Std. Dev.	0.057131	0.039260	0.050309	0.003984
Skewness	-0.194613	-1.433718	-1.467205	0.314088
Kurtosis	21.28703	22.86319	19.14648	64.45056
Jarque-Bera	15236.73	18342.75	12265.26	171991.1
Probability	0.000000	0.000000	0.000000	0.000000
Observations	1093	1093	1093	1093

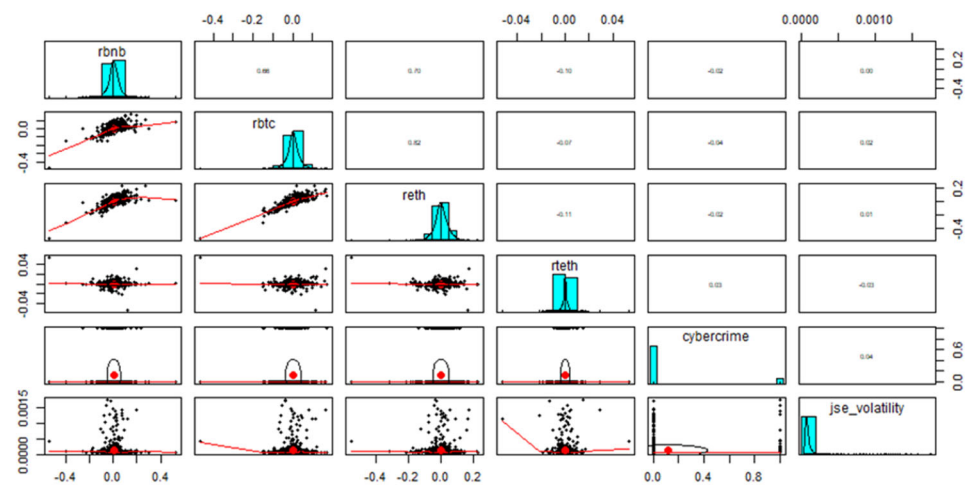


Figure 1. Correlation chart of cryptocurrency returns with cybercrime and stock market volatility.

Figure 1 shows the correlation chart among the variables otherwise known as the static correlation coefficient. The correlation coefficients between cybercrime and each of the cryptocurrency returns is negative, with the exception of Tether’s returns. Conversely, the correlation coefficients between stock market volatility and each of the cryptocurrency returns is positive, with the exception of Tether’s returns. However, these coefficients have been accused of being static as they do not reflect the correlation changes which take place over time, as static correlation only shows instant relationships over a period of time. The study hence utilizes dynamic conditional correlation (DCC GARCH) to investigate time-varying correlations among the variables. The histograms of the plots of the returns of the cryptocurrencies are shown in Figure 2.

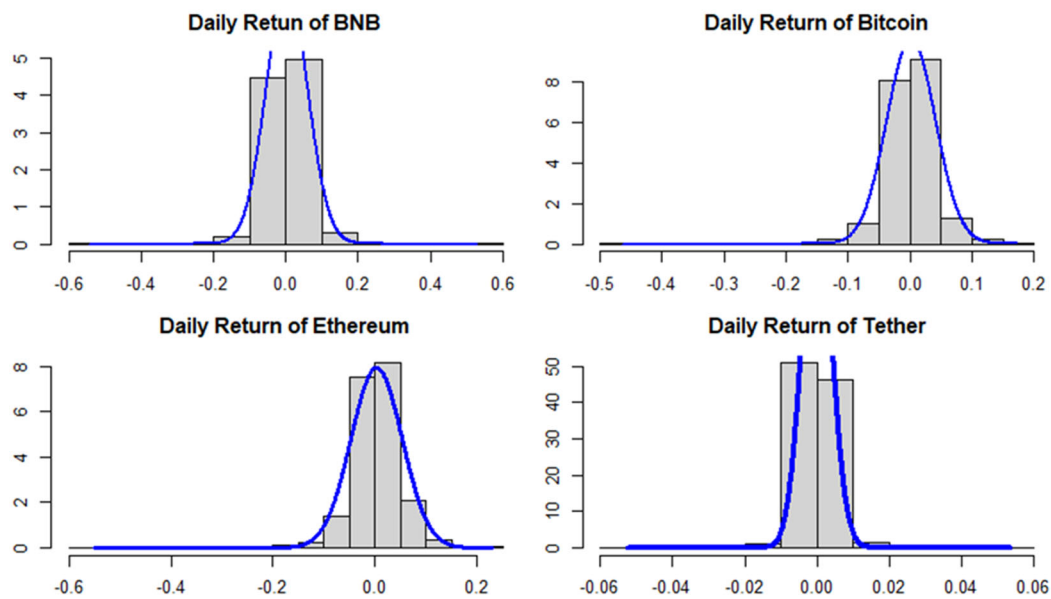


Figure 2. Histogram plot of cryptocurrency returns.

4.2. DCC GARCH Results

The cryptocurrency returns, together with the cybercrime and stock market volatility series, are then fitted to into a DCC GARCH model. A DCC with multivariate skew student-t distribution (sstd) and a DCC with multivariate student-t distribution (std) were modelled. The DCC with the multivariate student-t distribution yielded lower Akaike information criteria.

The time-varying correlations between returns on BNB and cybercrime, and time-varying correlations between returns on BNB stock market volatility, are presented in in Figure 3. As shown in Figure 1, the dynamic correlation between returns on BNB and cybercrime was found to be largely oscillating between 0.00 and -0.05 . However, a positive coefficient of 0.1 is somewhat observed around mid-2021. The dynamic conditional correlations between returns on BNB and stock market volatility were found to be highly negligible and insignificant for the majority of the period, with some cases of negative coefficients. Stock market volatility was observed to have its highest negative correlation with BNB’s return around mid-2020. This could be a result of the COVID-19 pandemic which significantly worsened global economic performance. The overall picture is that conditional correlations between returns on BNB and cybercrime as well as stock market volatility are highly unstable and volatile.

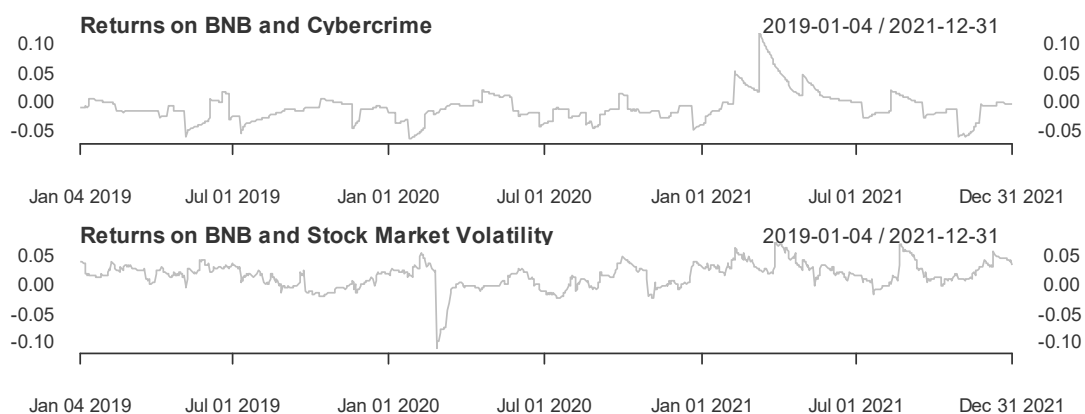


Figure 3. Time-varying correlation coefficients between returns on BNB and cybercrime and stock market volatility.

The time-varying correlations between returns on Bitcoin and cybercrime, and the time-varying correlations between returns on Bitcoin and stock market volatility are presented in Figure 4. As shown in Figure 4, the dynamic correlation between returns on Bitcoin and cybercrime is found to oscillate between positive and negative regions with the majority of the coefficients being negative. In other words, the conditional correlation coefficients are mostly within the negative region with few episodes of unstable positive values. The dynamic conditional correlation between returns on Bitcoin and stock market volatility is found to be largely negative. The overall picture is that conditional correlations between returns on BNB and cybercrime as well as stock market volatility are highly unstable and volatile.

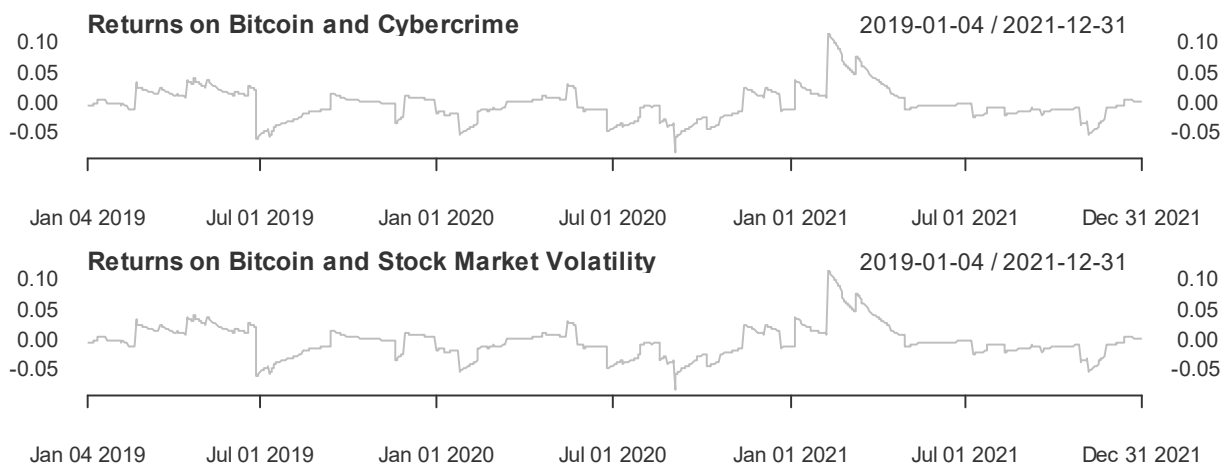


Figure 4. Time-varying correlation coefficients between returns on Bitcoin and cybercrime and stock market volatility.

Figure 5 presents the dynamic correlation coefficients between returns on Ethereum and cybercrime, and time-varying correlations between returns on Ethereum and stock market volatility. As reflected in Figure 5, the dynamic correlation between returns on Ethereum and cybercrime is found to be entirely unstable throughout the period under consideration. They show that the conditional correlation coefficients oscillate between 0.05 and -0.05 . The dynamic conditional correlations between returns on Ethereum and stock market volatility could also be said to be dynamically unstable.

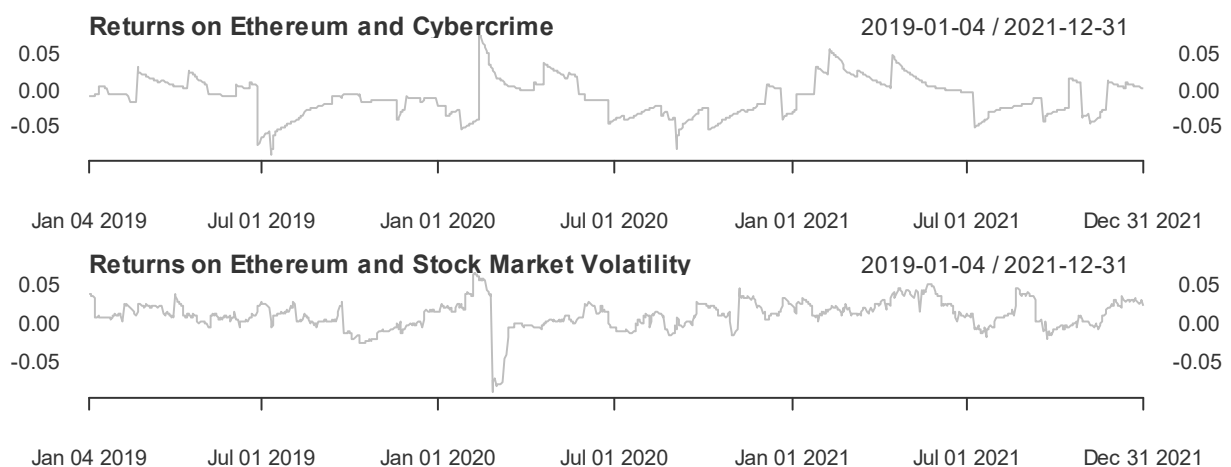


Figure 5. Time-varying correlation coefficients between returns on Ethereum and cybercrime and stock market volatility.

The time-varying correlations between returns on Tether and cybercrime as well as the time-varying correlations between returns on Tether and stock market volatility are presented in Figure 6. As shown in Figure 6, the dynamic correlation between returns on Tether and cybercrime largely oscillate in the positive region. In other words, the conditional correlation coefficients are mostly within the positive region with very few episodes of unstable negative values. The dynamic conditional correlation between returns on Tether and stock market volatility is found to exhibit a similar pattern as observed with cybercrime. In other words, conditional correlation coefficients are largely in the positive region with few cases of negative coefficients.

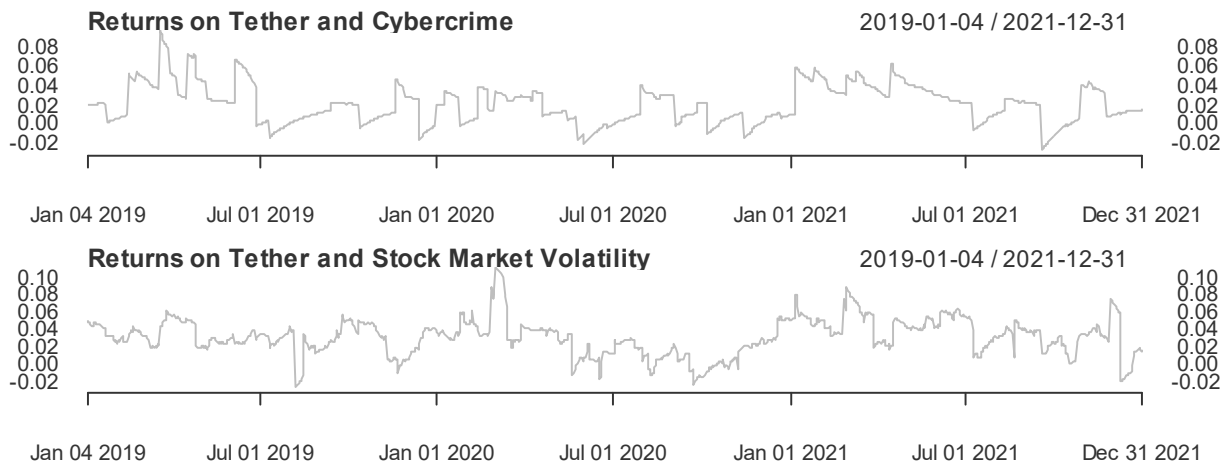


Figure 6. Time-varying correlation coefficients between returns on Tether and cybercrime and stock market volatility.

4.3. BLR Results

The Gibbs sampling algorithm approach using the Markov Chain Monte Carlo (MCMC) method is employed in the Bayesian estimation process in order to obtain the posterior distribution. Iteration used as many as 10,000 with a burn of 500 and a thin of 1. Table 2 shows the BLR results of the effects of stock market volatility and cybercrime on BNB’s returns, with posterior distributions plotted in Figure 7. From the results in Table 2, stock market volatility is found to have a positive impact on the returns of BNB while cybercrime is seen to have a negative impact on BNB’s returns.

Table 3 shows the BLR results of the effects of stock market volatility and cybercrime on returns on Bitcoin in the South African economy, with posterior distributions plot in Figure 8. From Table 3, stock market volatility is found to have positive effects on Bitcoin returns while cybercrime has a negative impact on the returns of Bitcoin for the period under review. Based on the observed data, other factors being equal, we believe there is a 95% possibility that the returns on Bitcoin will increase by 8.55 to 16.21 with additional stock market volatility, while returns will reduce by 0.0131 to 0.0020 with an increased cybercrime rate.

Table 2. BLR results with Return on BNB as dependent variable.

Statistics	Posterior Mean	Posterior STD	2.5%	97.5%
Intercept	0.004275	0.002138	1.46×10^{-4}	0.0084
Stock Market Volatility	1.537	9.205	-1.6	19.745
Cybercrime	-0.003519	0.005561	-1.5×10^{-2}	0.00733
Sigma ²	0.003275	0.000141	3.0×10^{-3}	0.00356

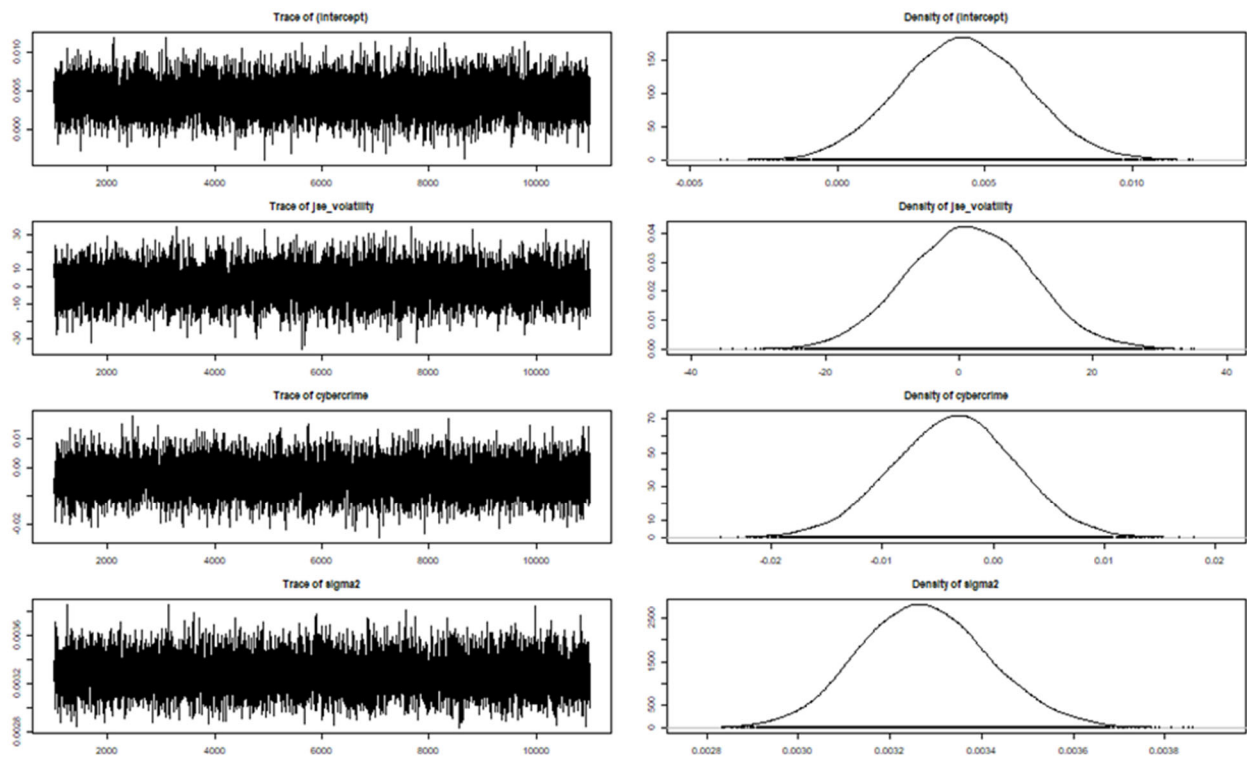


Figure 7. Posterior distribution of the variables with return on BNB as dependent variable.

Table 3. BLR results with Return on Bitcoin as dependent variable.

Statistics	Posterior Mean	Posterior STD	2.5%	97.5%
Intercept	0.002422	1.468×10^{-3}	-0.0004	0.0053
Stock Market Volatility	3.712267	6.321	8.55326	16.2158
Cybercrime	-0.005455	3.818×10^{-3}	-0.0131	0.0020
Sigma ²	0.001544	6.649×10^{-5}	0.00141	0.00168

Table 4 shows the BLR results of the effects of stock market volatility and cybercrime on returns on Ethereum in the South African economy, with posterior distributions plot in Figure 9. From Table 4, stock market volatility is found to have positive effects on returns of Ethereum while cybercrime is found to have a negative impact on returns of Ethereum during the period under consideration in the South African economy. Based on the observed data, ceteris paribus, we believe there is a 95% possibility that returns on Ethereum will increase by 1.2 to 19.18 with additional stock market volatility, while returns will reduce by 1.33 to 0.0020 with an increased cybercrime rate.

Table 4. BLR results with Return on Ethereum as dependent variable.

Statistics	Posterior Mean	Posterior STD	2.5%	97.5%
Intercept	0.00288	0.0018826	-7.5×10^{-4}	0.0066
Stock Market Volatility	3.15337	8.1055105	1.201	19.1875
Cybercrime	-0.00311	0.0048965	1.303	0.00645
Sigma ²	0.00254	0.0001093	2.33×10^{-3}	0.0027

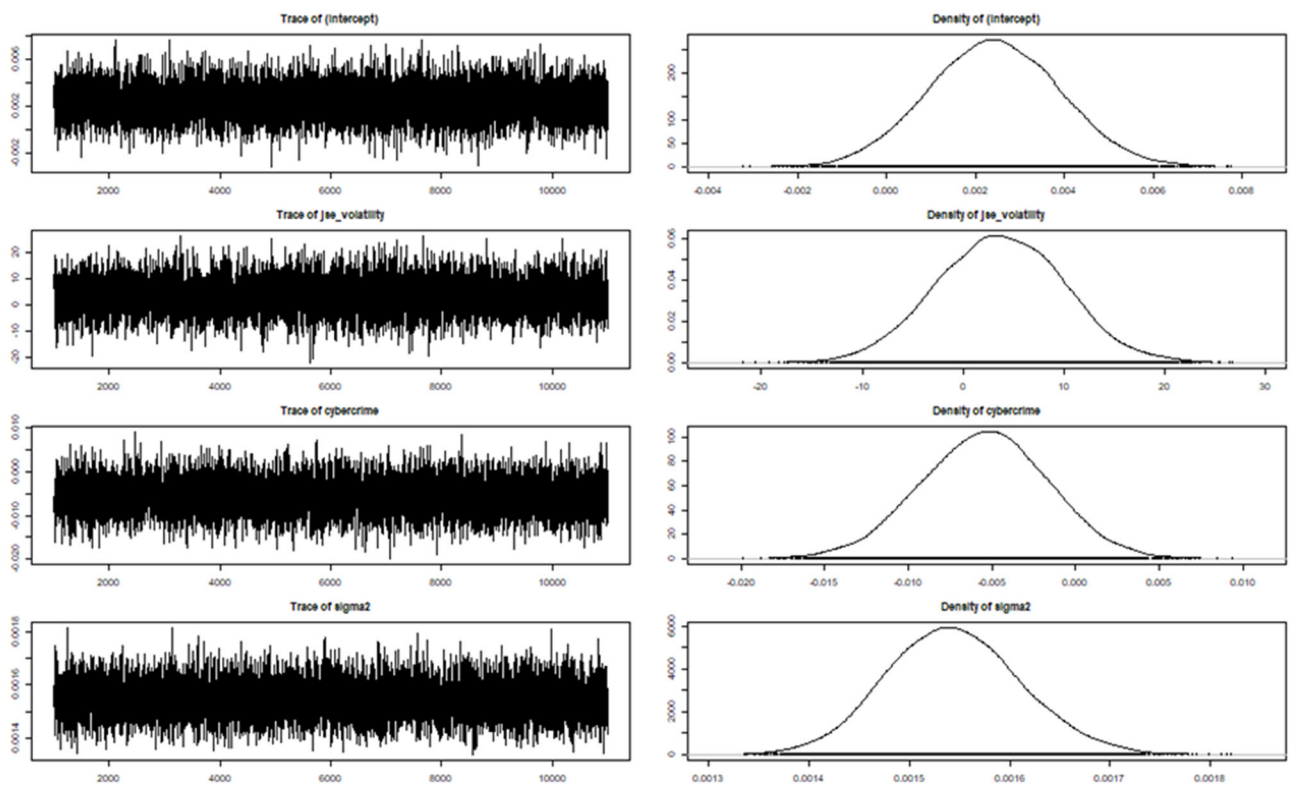


Figure 8. Posterior distribution of the variables with return on Bitcoin as dependent variable.

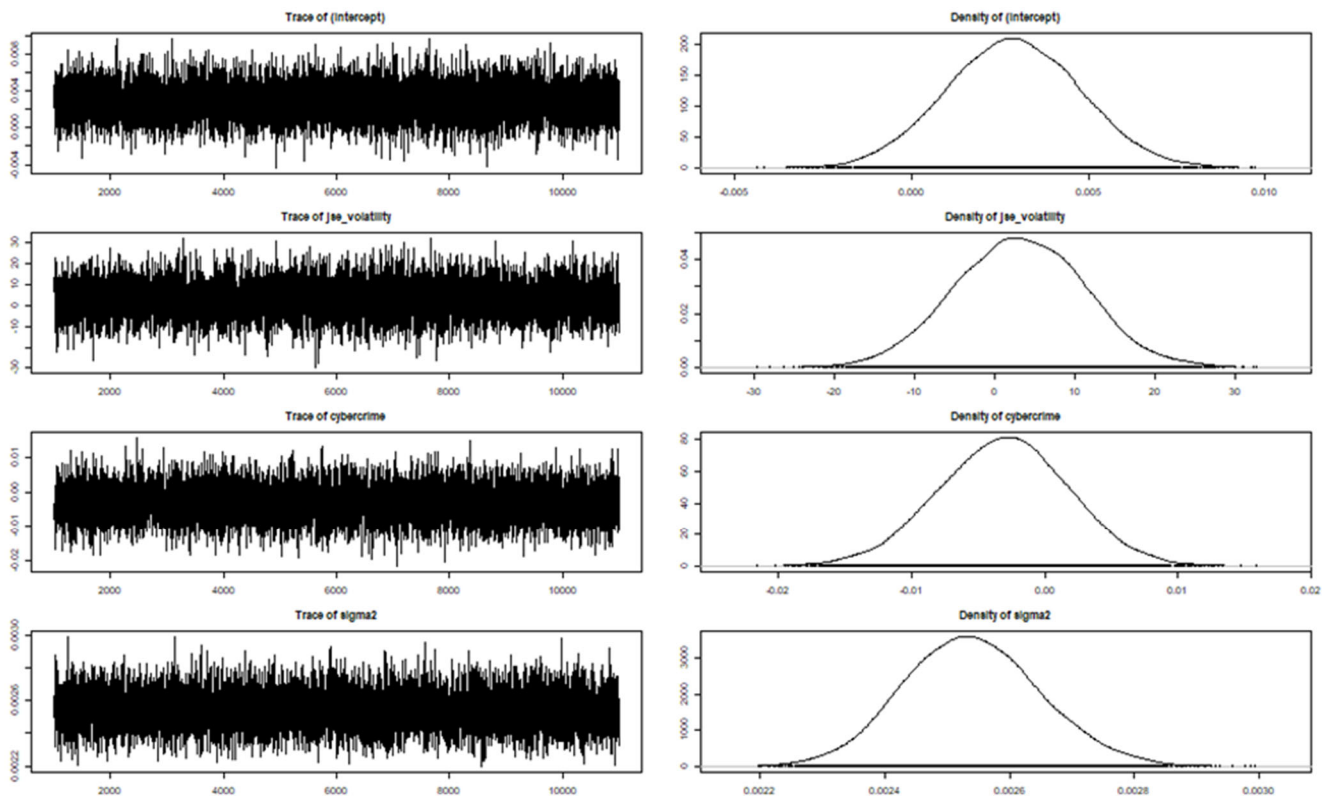


Figure 9. Posterior distribution of the variables with return on Ethereum as dependent variable.

Table 5 shows the BLR results of the effects of stock market volatility and cybercrime on returns of Tether in the South African economy, with posterior distributions plot in

Figure 10. From Table 5, it is observed that stock market volatility has negative effects on returns of Tether while cybercrime is found to have an insignificant positive impact on the returns of Tether during the period under consideration in the South African economy. Based on the empirical findings, other factors being equal, there is a 95% possibility that the returns on Tether will reduce by 1.8 to 0.734 with additional stock market volatility, while the increased cybercrime rate will have an insignificant impact on Tether’s returns.

Table 5. BLR results with Return on Ethereum as dependent variable.

Statistics	Posterior Mean	Posterior STD	2.5%	97.5%
Intercept	1.112×10^{-5}	1.532×10^{-4}	-2.8×10^{-4}	3.11×10^{-4}
Stock Market Volatility	-0.5718	6.598×10^{-1}	-1.8	7.34×10^{-1}
Cybercrime	0.0003	3.986×10^{-4}	0.0004	0.0011
Sigma ²	1.683×10^{-5}	7.245×10^{-7}	1.63×10^{-5}	7.24×10^{-9}

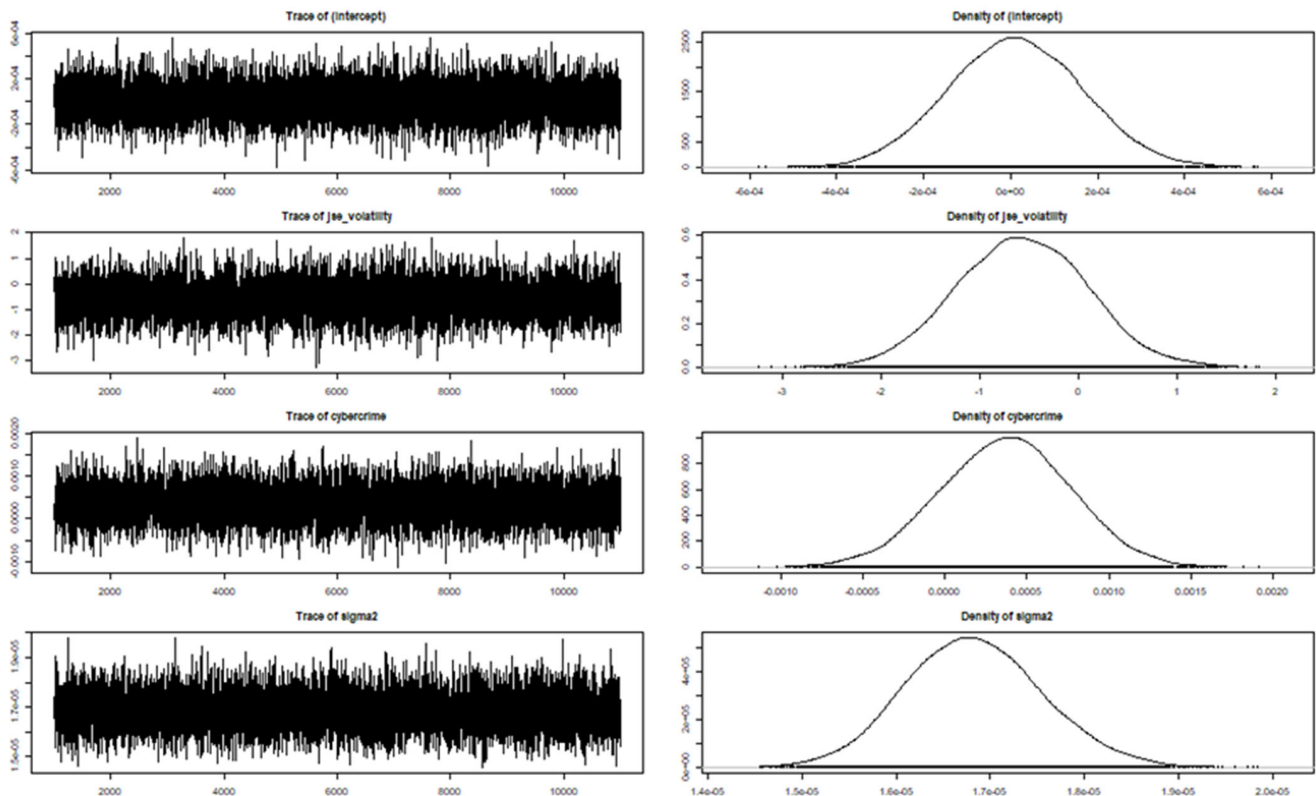


Figure 10. Posterior distribution of the variables with return on Tether as dependent variable.

5. Discussion

From the empirical results obtained, cybercrime is seen to have a negative impact on cryptocurrency returns. The implication is that the growth of digital currencies is being hindered by the increased rate of cybercrime in the South African economy. This is consistent with some empirical studies in the literature, such as Caporale et al. (2020) and Ciaian et al. (2016) and Sanusi and Dickason-Koekemoer (2022). However, the study is at variance with studies such as those undertaken by Umar (2021) and Fang et al. (2021), which claim that cyber-attacks do not have an effect on cryptocurrency prices and return. Similarly, the correlation relationships between stock market volatility and the cryptocurrency returns are largely positive. This is not unexpected, as stock market volatility often motivates investors to diversify their portfolio through diversification into digital currencies. This is, however, at variance with Gil-Alana et al. (2020), who argued that there is no link between the cryptocurrency market and other financial major assets, such as the stock market. Also,

the findings from the Bayesian linear regression model show that cybercrime has a quantitative negative impact on cryptocurrency returns. This is consistent with existing studies in the literature. This finding confirms the theory that cybercrime activities have consistently been a major impediment to the growth of Fin-Tech in developing countries. This is because the potential and existing investors in Fin-Tech are being deterred and discouraged from the industry. This has been a major threat to the overall growth and development of digital currencies and financial technology in general. The positive impact of stock market volatility follows the theoretical expectation as enunciated by the modern portfolio theory, as investors look at how an asset co-moves with other assets before investing in it. The negative co-movement between stock market volatility and investment in cryptocurrencies would undoubtedly motivate investors to diversify into digital currencies, which in turn raises the returns due to increased investment.

6. Conclusions

This study presented empirical findings on the effects of stock market volatility and cybercrime on cryptocurrency returns in the South African economy. Daily time series data on four different types of cryptocurrencies (Bitcoin, Ethereum, Tether, and BNB) were employed. The data covers the period 1 January 2019–31 December 2021. The data were sourced from CoinMarketCap. Data on cybercrime were taken from the Hackmageddon database on cybercrime. Daily data on the Johannesburg Stock Exchange Top 40 Index (FTSE/JSE Top 40) were taken from the Thompson Reuters Eikon database, and the volatility series was generated using the GARCH (1,1) model.

This study, in addition to contributing to relatively scarce studies on the effects of stock market volatility and cybercrime on cryptocurrency returns in the South African economy, is largely unique as it employs dynamic conditional correlation (DCC GARCH) to investigate the time-varying correlation between the returns of each cryptocurrency and cybercrime, as well as stock market volatility. We also used the Bayesian linear regression model to investigate the effects of stock market volatility and cybercrime on cryptocurrency returns. Our findings can be summarised as follows. Firstly, the dynamic correlation between returns on BNB and cybercrime was found to be largely oscillating between 0.00 and -0.05 . The dynamic conditional correlations between returns on BNB and stock market volatility were found to be highly negligible and insignificant for the majority of the period. Secondly, the conditional correlation coefficients between returns on Bitcoin and cybercrime are mostly within the negative region with few episodes of unstable positive values, while dynamic conditional correlations between returns on Bitcoin and stock market volatility were found to be largely negative. Thirdly, the dynamic correlation between returns on Ethereum and cybercrime was found to be entirely unstable throughout the period under consideration, while the dynamic conditional correlations between returns on Ethereum and stock market volatility were also noticed to be dynamically unstable. Fourthly, the conditional correlation coefficients are mostly within the positive region with very few episodes of unstable negative values, while the dynamic conditional correlations between returns on Tether and stock market volatility exhibit similar patterns as observed with cybercrime. Finally, stock market volatility was found to have a positive impact on the returns of BNB, Bitcoin, and Ethereum, however it had a negative impact on Tether. Expectedly, cybercrime had negative impacts on the returns of BNB, Bitcoin, and Ethereum, but could be said to have no impact on the returns of Tether. The study concludes that ongoing efforts to reduce cybercrime activities need to be strengthened in order to further the use of digital currencies. Furthermore, given the varying impacts of stock market volatility on cryptocurrencies, more policy measures must be taken to ensure reduced or moderate stock market volatility. Future research could adopt other time-varying correlation models, such as the GAS, among others.

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