



Research Paper

Impact of Russia-Ukraine War on Crypto currencies and Stock Market Volatility of Emerging Economies

Dr Shivani Inder

CBS, Chitkara University, Rajpura

Col Amar Parkar, 2120982515, MBA (Fin& Banking)

Abstract

Cryptocurrency is considered to be the new age digital gold, a global currency of the future. Such instruments of financial exchange cannot be insulated from the global geopolitical changes. The ongoing Russia Ukraine conflict is having adverse effects on the world economy and its impact on trade, oil exports, food security et al is slowly but surely showing. The cryptocurrency cannot be left behind considering the status of these two countries before the conflict and the emergence of cryptocurrency as an alternate means of cross border transactions be it for commercial use or humanitarian aid. This paper conducts an analysis of the volatility of the cryptocurrency, its effect on the stock market indices of eight major emerging economies under the shadow of the ongoing global upheaval due to the Russia Ukraine war. The paper conducts a network analysis to ascertain the correlation between the volatility of cryptocurrencies and stock market prices.

Key words: cryptocurrency, stock market, emerging economies, Russia Ukraine conflict, network analysis

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I. INTRODUCTION

1.1 The present global financial world is a quagmire of a plethora of assets and instruments coerced by foreign policy and the age old truth of demand and supply. The financial world is continuously looking for more efficient and profitable ways of earning and exponentially increasing the wealth of the various institutions. Stock market index is a major economic indicator which gives a fair picture of the global economy. The stock market volatility especially that of the emerging economies reflects all the stake holders of the financial world. Since its introduction in 2008, cryptocurrency has become a buzzword for exponential profits and financial intrigue. This paper attempts to study the correlation between stock market volatility and cryptocurrencies in the shadow of the ongoing Russia-Ukraine conflict which is a global geopolitical crisis of humungous proportions affecting each and every aspect of the financial world be it the effect of sanctions, the trade deficit and consequent balance of payments issue, the food and gas security angle as well as the constant need to identify newer avenues for hedging against the downward trends in known financial assets. Is cryptocurrency the new gold to offset the losses in the stock market or is it an instrument to supply global platform for transferring humanitarian aid or political support to various parties in this geopolitical conflict?

1.2. History of Cryptocurrency. The most important question which intrigues the financial circles is “What is Money?”. Money is a store of value which is used as an instrument to fulfil an obligation towards the other party. From the era of the Barter System to Pricey Metal coins to Paper money, the instrument has changed. However, a third Party always backs it viz. the Monarchy/ Central Authority. The present system of transaction requires third party validation. The third party has to be trustworthy and impartial. The transaction of today is not irreversible, thus leading to disputes which would require mediation. All dispute resolution mechanisms involve time and cost. The two parties obviously share this cost. These kind of transactions also require a substantial amount of information from both the parties. To explain these requirements, let us take a simple transaction of buying a shoe online using a credit card. The credit card company needs financial details, even the PAN at times and it charges a transaction fee for supplying the validation. Imagine that the credit card company goes bankrupt

at the time of the transaction or the value of the currency changes, can the transaction be honored, and if not, who will decide its legal standing?

1.3 Uncertainty in the Present System. The present system of transaction supplies a legal framework which is backed by the Central Bank of the country. Thus, the US dollar (USD) is considered a globally acceptable fiat currency only because it is backed by the US Federal Bank and the Federal Government. The USD also has the backing of the gold bullion which is stored in the US Federal Bank vaults. However, in spite of this solid backing, there are no instances where the USD has collapsed (Lehmann Brothers), or there has been added printing of currencies (Germany), Foreign reserve crisis (East Asian Financial Crisis). There is also the rising inflation and the uncertainty of the value of the currency at a given time. There is always a possibility that the Government may change the policy about the interest rates, taxes, pension thus changing the value of the hard earned currency of an individual or an institution. The Bitcoin is an innovation which was born out of the mistrust of the average person in the age old traditional system of transaction.

1.4 The cryptocurrency industry spiraled into a downward trend owing to the incidents which were triggered by the Russian action. On February 21, Russian President Vladimir Putin recognized the two new pro-Russian regions- Donetsk and Luhansk in Eastern Ukraine as separate entities thus paving the way for military intervention under the UN charter section 7. Russia invaded Ukraine on 24 February 2022 contrary to the clauses of the 2015 Minsk Agreement. (Balbaa, 2022) Ukraine has long played an important, yet sometimes overlooked, role in the global security order. Ukraine is on the cusp of becoming an important nation having a wealth of natural resources, geographical importance, and the infrastructure to supply defence systems to the world. In recent elections, Ukrainians have clearly showed that they see their future in Europe, but the country continues to grapple with extreme corruption and deep regional rifts that could impede its path. Meanwhile, Russia's aggression in Ukraine has triggered the greatest security crisis in Europe since the Cold War. Though the US and its allies have taken significant punitive actions against Russia during the seven-year-old conflict, they have made little headway in helping to restore Ukraine's territorial integrity. (Aloisi & Daniel, 2022) And ever since the entire world is facing an economic turmoil (Balbaa, 2022; Li et al., 2022). This manmade crisis comes close at the heels of the omnipresent COVID pandemic and has triggered a major economic turmoil throughout Europe and the entire world. The current onset of recession, volatility of the Oil prices and the underlying impact of non-availability of Russian gas is slowly but surely crippling the world economy (Kovacevic, 2009; Larrabee, 2010).

1.5 History and Politics. As part of the Soviet Union, Ukraine was the second-most powerful Soviet republic after Russia, and was crucial strategically, economically, and culturally. The two countries have age old cultural and linguistic ties. For many in Russia and in the ethnically Russian parts of Ukraine, the shared heritage of the countries is an emotional issue that was exploited for electoral and military purposes. In 2013, Ukraine's then-President Viktor Yanukovich, decided against signing an association agreement (AA) with the European Union (EU), sparking major pro-European protests in Ukraine. In Feb 14, the Ukrainian parliament voted to impeach Yanukovich, who fled Kyiv. Subsequently, in Mar 14, Russia annexed Crimea, an autonomous peninsula in southern Ukraine with strong Russian loyalties, on the pretext that it was defending its interests and those of Russian-speaking citizens. (Charap & Darden, 2014; Feklyunina, 2016). Shortly afterwards, pro-Russian separatists in Ukraine's Donetsk and Luhansk regions declared their independence from Kyiv, prompting months of heavy fighting. The EU, the US, and other countries, imposed sanctions on Russia. The EU-Ukraine AA entered into force in Sep 17. Russia has apprehensions about the Ukrainian aspirations of joining the NATO and the consequent unchecked access to the NATO armies to Russian Borders.

1.6 Russia's Political Stand. Russia is apprehensive of the NATO presence in close proximity of its Borders. It claims that the east Ukrainian region has Pro Russian population which wants to merge into Russia. Russia has its own understanding of the two Minsk agreements. Russia wants the trilateral Minsk agreements between Russia, Ukraine and OSCE should be honoured. Russia wants assurances from the NATO that Ukraine will not become a member and no weapons will be supplied to or deployed in Ukraine. Russia wants Ukraine to remain a non-nuclear, non-NATO buffer zone between Russia and the Rest of Europe essentially UK, France, and US. (Aloisi & Daniel, 2022)

1.7 Russia's Economic Concerns. Russia supplies 60% of the gas used in Europe using the gas pipelines which flow under Ukrainian territory. Ukraine gets a royalty for the pipelines. Ukraine is the gateway to Europe for all Russian trade viz. Oil, Gas and Wheat. (Balbaa, 2022; Stober, 2022)

1.8 Ukrainian Political Stand. In its three decades of independence, Ukraine has sought to forge its own path as a sovereign state while looking to align more closely with Western institutions, including the European Union and the North Atlantic Treaty Organization (NATO). Ukraine is presently trying to balance its external relations

with the internal populist desires. A more nationalist, Ukrainian-speaking population in Western parts of the country has supported greater integration with Europe, while a mostly Russian-speaking community in the East has favoured closer ties with Russia. Ukraine was a nuclear power before it returned all the erstwhile Soviet nuclear arsenal back to Russia. Ukraine is also a major defence industry hub manufacturing MiG aircrafts and T-59 tanks.

1.9 Ukrainian Economic Concerns. Ukraine is the wheat producer for the world, it is also the largest producer of sunflower and thus a major supplier of sunflower oil. The Russian gas pipelines supply billions of Dollars' worth of transit fees. On the other hand, Ukraine is also notorious for widespread corruption in its economic system. Ukraine is presently a landlocked country without access to the Black Sea, post the annexation of Crimea by Russia in 2014. Ukraine is also surrounded by NATO nations from all sides except the east. Ukrainian Government considers that membership of NATO will accelerate the growth of their country. However, the transit fees from gas pipelines are a major source of income. Russian sanctions indirectly affect Ukraine too.

1.10 Effects on Global Economy.

1.10.1 Russia controls the supply of oil, gas, and metals to Europe . Gas prices have already skyrocketed thus causing economic imbalance throughout Europe and the US.(Berner et al., 2022)

1.10.2 Russian control of Crimea implies that the sea routes are controlled by Russia and not by a NATO friendly country viz. Ukraine.(Charap & Darden, 2014)

1.10.3 Ukraine is the second largest reservoir of mineral resources, coal mines, natural gas, petroleum, manganese, nickel, and agricultural land in the world. Ukrainian sunflower oil , wheat and corn cannot be supplied to the world thus causing an increase in costs leading to global inflation and recession. Commodity importers in Europe are facing a supply crisis while the low-income households are facing the brunt on their budgetary thresholds.(Li et al., 2022)

1.10.4 OSCE has imposed severe sanctions on Russia for the invasion which includes banning of the SWIFT currency exchange programme. Thus, the Russian rouble cannot be exchanged. This has affected the Common Russian citizen whose hard-earned roubles have no value . Also, the oligarchs of Russia cannot move their wealth from European and American banks. (Santorsola et al., 2022)

1.10.5 The sanctions are affecting the Balance of payment situation across the world. The Russian economy is being affected because Dollar to Rouble conversion is not being allowed. However, at the same time the countries which export items to Russia are also not getting paid. Essentially, these sanctions are leading to global recession because the entire global business is interconnected and is affected in some manner or the other.(Berner et al., 2022)

1.10.6 The conflict also increases the risk of a more permanent fragmentation of the world economy into geopolitical blocks with distinct technology standards, cross-border payment systems, and reserve currencies. Such divisions will lead to an economic breakdown in the long run with a major dent to free world trade. (Oregon, n.d.)

1.10.7 The Russian GDP is expected to drop by 1.5%(Al-Farabi Kazakh National University et al., 2021). The IMF has brought down the projected global growth rate to 3.6%.

1.11 The geopolitical crisis has definitely affected the stock markets and the cryptocurrency market. The effect of the crisis on these assets was gauged by conducting the networking analysis amongst the cryptocurrencies and the stock market indices of emerging economies. This paper aims at conducting this correlation analysis.

II. MAJOR CRYPTOCURRENCIES AND THEIR SIGNIFICANCE

2.1 Cryptocurrency can be broadly defined as an electronic money created with technology controlling its creation and protecting transactions, while hiding the identities of its users. This money does not require a bank/ financial institution to certify/ verify/ back the transactions. It is done by a peer-to-peer network and thus the value of the money cannot be controlled by change in government policies or inflation or such like institutionally driven changes. Cryptocurrency is based on the block chain technology. After the first cryptocurrency viz. Bitcoin was introduced , more different variants have cropped up. There are three main types of cryptocurrencies: Bitcoins, Alt coins and Tokens.(M, n.d.)

2.2 Bit Coins. In order to address these issues , a group of individuals or an individual using the pseudonym 'Satoshi Nakamoto,' proposed a new digital electronic peer to peer transaction system in 2009 . This system assures that the two parties which are conducting do not need a third party validation. The time of the transaction is recorded using a time stamp and the transaction once conducted is irreversible. The validation of the transaction is conducted by a No of Miners who solve complex math problems to confirm the transaction details. These details are recorded in a block and the block header stores the information of the root of the

transaction. The information is stored in the form of Merkel Trees. A Nonce(Number once used) is attached to decide the transaction time and authenticity. All these transactions are based on Public Key Cryptography using SHA 256 algorithm. The private key is not visible to anyone except the authorized user while the public key is globally available on the network. In order to confirm a transaction , the Miner has to check the transaction details using the public key and reach the desired random bit sequence which is same as that generated by the private key. As an incentive for solving the math problem, the Miner is paid in terms of a transaction fee which is a crypto token called Bit Coin. As the total No of Bitcoins is fixed, the supply is limited and therefore there is no scope of inflation. Also , the Bit Coin cannot be created by any other means , thus generation of fake currency is not possible.(Farrell, 2015; Mukhopadhyay et al., 2016; Nakamoto, n.d.; Narayanan et al., 2016). The pros and cons of the bitcoin are counted below :-

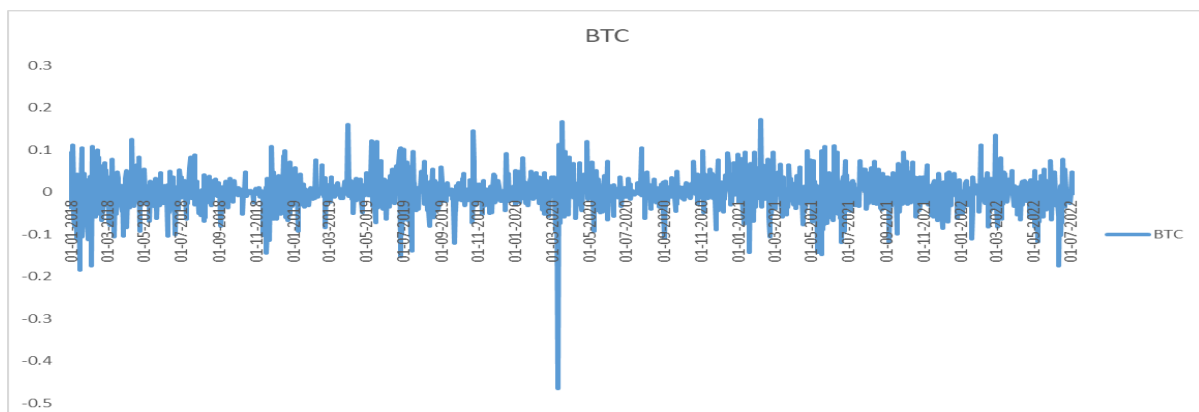
2.2.1 Pros.

- (i) Fixed Quantity. There will only ever be twenty-one million Bitcoins. Hence the supply is restricted and as demand increases, the prices will increase.
- (ii) Easy Liquidity. Bitcoin is easier to liquidate than rival cryptocurrency types due to its popularity and greater acceptance. Therefore, trading volumes are always high compared to other cryptocurrencies.
- (iii) Bitcoin is the first and biggest cryptocurrency and dominates 40% of the market.

2.2.2 Cons.

- (i) Massive Volatility. Bitcoin fluctuates to the tune of almost 50%. This leads to uncertainty amongst investors and leads to major losses.
- (ii) Innovative altcoins can replace Bitcoin. Any of these newer coins could eventually replace Bitcoin — they are newer and further advanced.
- (iii) Criminal Activity. Bitcoin is notorious for its use in smuggling of arms, tax evasion, drugs trade and any other imaginable illegal activity.

2.2.3 The graphical representation of the price movement of the Bitcoin over a period from Jan 2018 till Jul 2022 is appended to realize the volatility of this cryptocurrency.



2.3 Altcoins. Alt coins are variants of the bitcoin by using different algorithms to mine the bitcoins. However, these alt coins can be mined or staked for completely different goals or purposes.(Amsyar et al., 2020). After the introduction and unprecedented success of the Bitcoin, a No of tweaks and variants of the blockchain based currency have appeared. There are over 550 cryptocurrencies which have been launched over the years which compete with Bitcoin. The variance is in terms of the algorithm used, the block chain sequencing and the mining process. The variants have certain specialties e.g. Ethereum is suitable for smart contracts, Tether is used for conversion between the fiat currency (USD) and any other cryptocurrency.(Akyildirim et al., 2021; Amsyar et al., 2020; Bouri et al., 2019; Gkillas et al., 2018; Liu & Tsyvinski, 2021)

2.4 Ethereum. Ethereum is a variant of Bitcoin which has been developed with a flexibility of creating and executing smart contracts using cryptocurrency and tokens. Its currency is called Ether (ETH). Ethereum introduced smart contracts to the crypto world when it launched in 2015. A smart contract can automatically execute transactions when certain conditions are written into the smart contract when it is created. Because of smart contracts, no third party is needed in lots of transactions like the sale of a house, the sale of electricity, or the sale of stock on the stock market. A token is used in a smart contract to stand for the electricity. The main pros and cons for Ethereum are :-

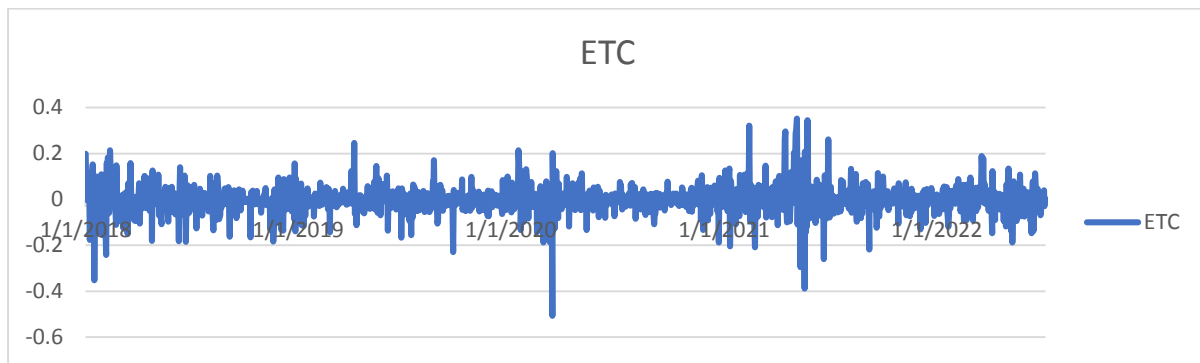
2.4.1 Pros

- (i) Ether is necessary for all transactions on the Ethereum blockchain. Hence ether will never lose its utility.
- (ii) Speed. Ethereum can process transactions in a matter of seconds, while Bitcoin's transactions take upwards of 10 minutes.

2.4.2 Cons.

- (i) Unlike the BTC , ETH coins are not limited . Thus, the supply demand ration is not controlled. However, the speed of generation of new ether coins is quite slow, thus controlling the supply.

2.4.3 The graphical representation of the price movement of the Ethereum Classic over a period from Jan 2018 till Jul 2022 is appended to realize the volatility of this cryptocurrency.



2.5 Tether (USDT).

2.5.1 Tether issues one of the most popular and widely used cryptocurrencies on the crypto market, a stable coin called tether (USDT). Its protocol is connected to the crypto exchange Bitfinex .Tether's history goes back to 2014, when it first issued a dollar-backed digital currency called real coin(later renamed as Tether) on the Bitcoin network to help transfer fiat currencies on the blockchain. Stable coins like tether serve as an important link between the real world and cryptocurrencies. With their prices tied to a stable asset such as a central bank-issued (fiat) currency like the U.S. dollar, stable coins promise to shield crypto holders from volatility and are well-suited for transactions and trades on and between blockchains.

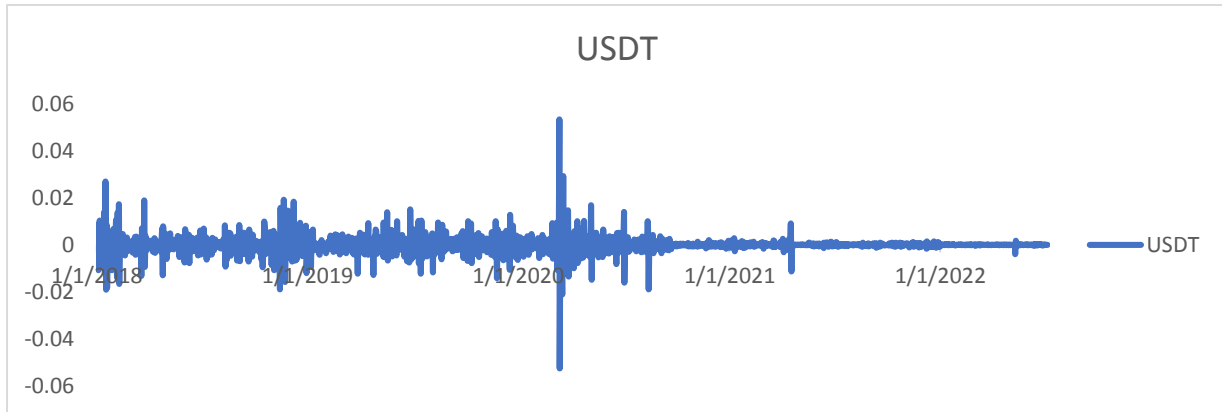
2.5.2 Pros Of Tether.

- (i) The USDT can be used to transfer money over the decentralized network at a cheaper and faster rate. Since the token has been created in a way that it always holds an equivalent value of 1 US dollar, it can be used to transfer money to anyone across the network. The token still keeps all the features of a mainstream cryptocurrency The advantage of sharing money over the USDT network is that people will not suffer any loss of fund due to market capitation as the value of USDT is fixed.
- (ii) The primary advantage of using USDT on the tether network is the reselling option a user gets on the platform itself. You can withdraw your USDT in fiat currency as well.
- (iii) USDT also help other crypto platforms to enhance their platform as due to legal bindings they cannot use fiat on the platform. This issue is where USDT comes in as a savior since the token holds an equivalent value of USD.
- (iv) USDT helps make new cryptocurrency platforms compatible with the tether. In this way, the new startups can exchange their fiat funds for USDT and keep it as a backup fund. The stability factor of the token would mean that their investment never goes into the loss.
- (v) The token is also said to be quite easy to integrate other cryptocurrencies through a specific program.

2.5.3 Cons of Tether.

- (i) There is a lack of anonymity as there is documentation involved including identity of the buyer .
- (ii) Although the volatility of USDT is limited , it is not zero since the USD itself is not completely stable.
- (iii) There is no provision for public mining of tether and hence the value against the USD is not always fixed.

2.5.4 The graphical representation of the price movement of the Tether over a period from Jan 2018 till Jul 2022 is appended to realize its volatility.



2.6 Stellar (XLM).

2.6.1 Stellar Lumens with the symbol XLM is an open-source, decentralized blockchain platform that seeks to function as the bridge between crypto and fiat currencies. The Stellar coin is designed to help cross-border transactions at a zero cost. This is expected to help migrant laborers from developing countries who need to send money to their families back home. Stellar attempts to cut down on the high fees of traditional payment systems like Western Union by cutting intermediaries to confirm and verify transactions. This is achieved by using a decentralized ledger system which is made secure and scalable using the Stellar Consensus Protocol (SCP).

2.6.2 Pros. The following factors make the Stellar payment protocol and cryptocurrency attractive and popular:-

(i) High Speed of Transactions. The stellar protocol processes two thousand transactions per second. As a result, each transaction gets confirmed within 5 seconds maximum which helps in cross-border payments.

(ii) Low Transaction Costs. The low transaction time and high operational efficiency translates to a lower cost of transactions. Also stellar is as a payment protocol that has low profit margins.

(iv) Stellar can incorporate elements such as blockchain smart contracts, alongside features like multi signatures which enhance the functionality of the payment protocol in general.

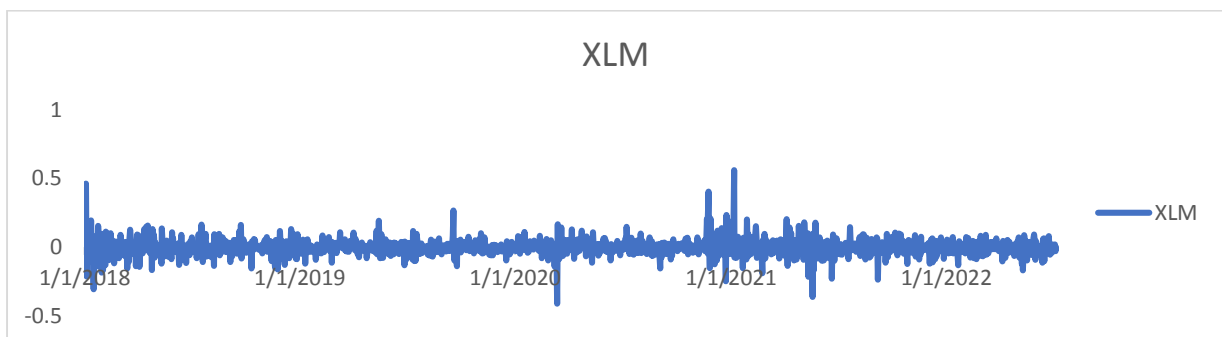
(v) Decentralization of Stellar. The Stellar Protocol does not have a set number of validators. Thus, more validators can ensure decentralization of the currency.

2.6.3 Cons. The major challenges faced by the stellar protocol are

(i) High Competition. Stellar faces a great deal of competition and hence it is difficult for it to hold ground. The Ripple payment protocol is its biggest competitor. The centralized banking system has also launched SWIFT payment system to counter such alternate systems.

(ii) Minimum Limit for Having Access. There is a need to have at least 20 XLM coins before the protocol can be used. This is a drawback.

2.6.4 The graphical representation of the price movement of the Stellar over a period from Jan 2018 till Jul 2022 is appended to realize the volatility of this cryptocurrency



2.7. Dogecoin.

2.7.1 Dogecoin (DOGE) is an open-source, peer-to-peer cryptocurrency that was made as a parody of the crypto market following the establishment of Bitcoin. It was originally created as a light-hearted joke for crypto enthusiasts, but it quickly exploded to be one of the leading cryptocurrencies in use today. The Shibu Innu imaged coin was created in December 2013 and was based on the same basic technology of other cryptocurrencies like

Bitcoin and Litecoin. However, Dogecoin introduced improvements, which included faster access speeds and more affordable transactions. Dogecoin has an extremely high market cap owing to its less power intensive algorithm and faster processing.

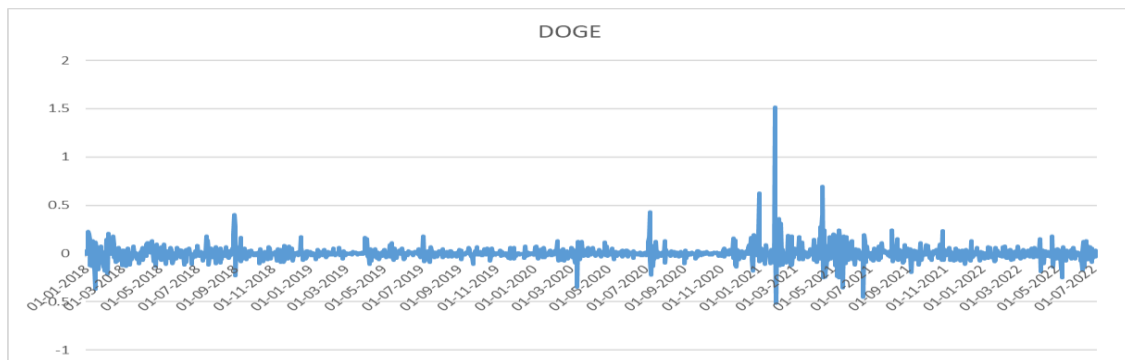
2.7.2 Pros of Dogecoin

- (i) It has a faster block time of 60 seconds with a re-target time of four hours.
- (ii) Dogecoin is the apt choice for small transactions, owing to its less value. It has greater quantity of coins with low value hence it is easier to enter this platform.
- (iii) Dogecoin has a low transaction fees which makes it more suitable for regular use.
- (iv) Due to its low value, it is used for online tipping, gaming thus becoming more popular.

2.7.3 Cons of Dogecoin

- (i) It is a coin of lesser value and is less stable and mature than other coins in the market.
- (ii) It has lesser security compared to other altcoins.
- (iii) It is not profitable to mine Dogecoin since it is a Proof of Work (PoW) coin.

2.7.4 The graphical representation of the price movement of the Dogecoin over a period from Jan 2018 till Jul 2022 is appended to realize the volatility of this cryptocurrency.



2.8 Ripple.

2.8.1 Ripple is a privately held company that aims to create and enable a global network of financial institutions and banks. It does so by using the Ripple Net blockchain software to lower the cost of international payments. Ripple is an open source payment protocol which aims at reducing the transaction fees by having a decentralized peer to peer system. Payment providers can also use it to expand reach into new markets, supply faster payment settlements, and lower foreign exchange costs. Ripple is taking a stand against what they call “walled gardens” of financial networks consisting of banks, credit cards, and other institutions such as PayPal. These organizations tend to restrict the flow of money with fees, currency exchange charges, and processing delays.

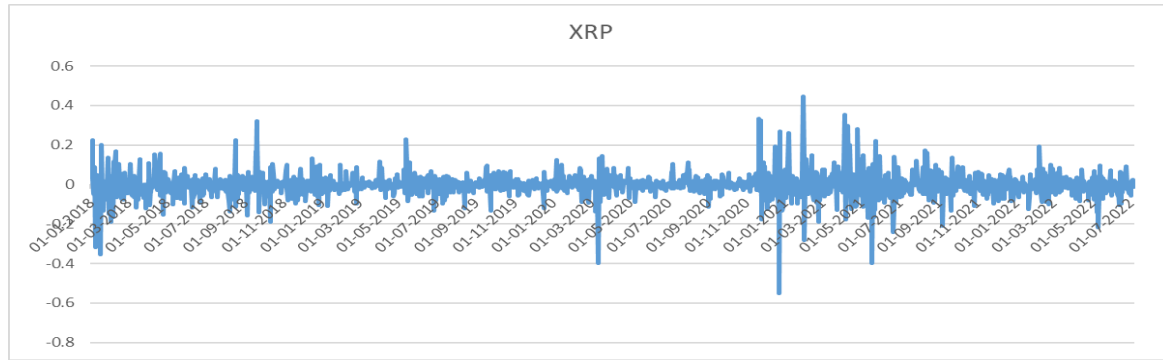
2.8.2 Pros.

- (i) Ripple boasts of a well-structured infrastructure which allows transaction time to be down to three minutes. The team behind Ripple is aiming at 1500 Transactions per second in near future.
- (ii) Great Partnerships and Better Investors. Ripple partners with financial institutions to enable wider acceptability.
- (iii) Stability and price factor. Ripple is in the small price bracket for XRP (currently at \$0.40). The low cost of a token implies wider reach of the system. Another factor that adds a feather to its cap is its stability when compared to recent Market crash; Ripple showed the least volatility.

2.8.3 Cons.

- (i) The absence of Real World use. The biggest hurdle in the growth of any cryptocurrency or modern technology, in general, is real-world use. XRP faces similar problems, even though it has the trust and investments from major banks and institutions.
- (ii) A Regulation Headache and ‘Centralized System’ controversy. Ripple has faced severe charges of misconduct and lawsuits claiming that the coin is indirectly controlled by the inventors, Ripple Lab to manipulate the market.

2.8.4 The graphical representation of the price movement of the Ripple Coin over a period from Jan 2018 till Jul 2022 is appended to realize the volatility of this cryptocurrency



2.9 Cardano (ADA).

2.9.1 Cardano is one of the biggest cryptocurrencies by market cap. It is designed to be a next-gen evolution of the Ethereum idea with a blockchain that is a flexible, sustainable, and scalable platform for running smart contracts, which will allow the development of a wide range of decentralized finance apps, new crypto tokens, games, and more. The goal of Cardano is providing developers with a blockchain platform that is robust, secure, scalable, and highly energy-efficient is currently awaiting the upgradation to smart contracts. ADA is presently used to store value (as part of your investment portfolio), to send and receive payments, and for taking & pay in transaction fees on the Cardano network.

2.9.2 Pros.

(i) Open-Source Code. The open source platform supplies flexibility to the users and gives interoperable platform for faster transactions.

(ii) Double Layered Character. The first layer is the settlement layer meant for recording and processing all transactions on the platform. The second layer is for added functionalities such as the blockchain smart contracts. The dual layer not only adds to the functionality, but it also enhances the efficiency by separating the work of two different layers.

(iii) Energy efficient consensus protocol. Cardano uses Proof Of Stake variety to make sure it is an energy efficient way to mine blocks, without needing the use of inordinately expensive or heavy computing equipment.

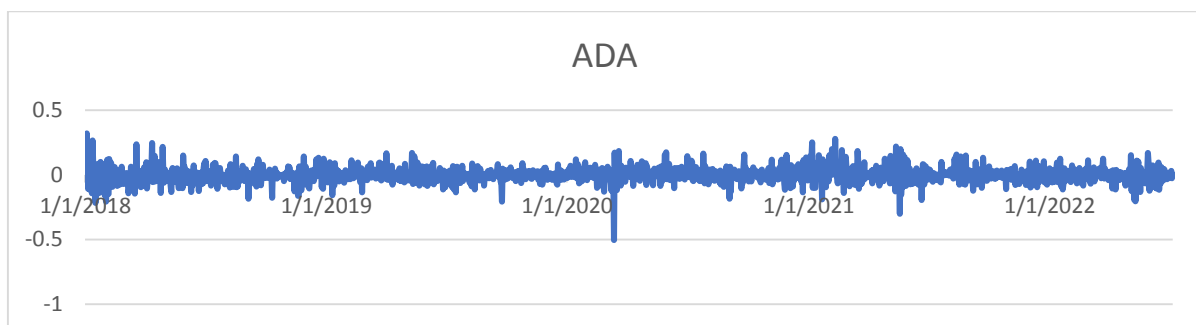
2.9.3 Cons of Cardano.

(i) Centralization Concerns. POS implies that there are a limited No of validators therefore there is the fear of lack of decentralization.

(ii) Security Vulnerability. The Proof of Stake protocol leaves a loophole where an attacker can double spend by sending a transaction and then simply conducting a fork of the blockchain right before the said transaction.

(iii) New Programming Language. The programming language Plutus is new and has not yet been proven to be robust to manage fintech issue.

2.9.4 The graphical representation of the price movement of the Cardano over a period from Jan 2018 till Jul 2022 is appended to realize the volatility of this cryptocurrency.



2.10 Chain Link .

2.10.1 Chain link is a decentralized network of nodes based on the Ethereum blockchain. The network uses nodes called oracles and provides real-world data from third-party to smart contracts. Its native ERC-20 token (LINK) is rewarded to oracles who supply correct data. (LINK).

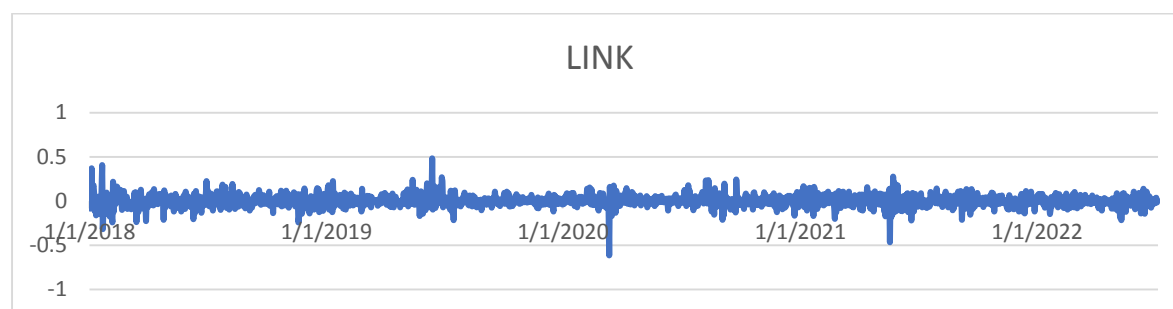
2.10.2 Pros.

- (i) Notable Partnerships. LINK has been able to develop partnerships with reputable firms and banking systems notably SWIFT.
- (ii) Innovative Objective. Interoperability based on decentralized oracle system is the aim of LINK.
- (iii) Resilience to The Bear Market. Its price has not been affected by the bearish stock markets.

2.10.3 Cons.

- (i) Lack of Marketing Efforts. Under par marketing efforts have truncated the spread of awareness of this currency .
- (ii) Possibility of Overdependence on SWIFT. Dependence on SWIFT may show possible central control in future.

2.10.4 The graphical representation of the price movement of the LINK over a period from Jan 2018 till Jul 2022 is appended to realize the volatility of this cryptocurrency.



2.11 It is only possible to see the larger movements in price in these figures. By seeing the figures, it seems like the prices have moved in the same direction in most cases during the sample period. There is exceedingly high volatility around the first week of March which may be due to the immediate shock effect of the commencement of hostilities on 24 Feb 22. The comparable price movements could imply that there might be a cointegrating relationship between Bitcoin and the altcoins.

2.12 Tokens. The third type of cryptocurrency is the token. The token is completely different than a bitcoin or alt coin because a token is a mere symbolism or representation of any item of perceived value . The token does not have its own blockchain. The token has a value assigned on an Application (DApp, Metaverse) and is used on that application to buy/ sell the items available on the application. An important concept to be understood is that a Token rides on other blockchain and hence the transaction fee for that token transaction has to be made in terms of some cryptocurrency on which the token is based. Cardano, Ripple, Link can be considered as Tokens.

2.13 The crypto currency industry is developing over the years with an evolving mechanism which involves the crypto wallets for the individual investors, the crypto exchanges for the trading of the cryptocurrencies and a No of applications to bring the trading of crypto currencies at the fingertips of the smart phone users. The issues of peer to peer transactions and lack of central authorities and the possible threats of the dark web and related illegal activities are being addressed by the various governments.(Abramowicz, 2016; Wątołek et al., 2021).

2.14 The cryptocurrencies have shown high volatility due to the following reasons :

- (i) Lack of regulation.
- (ii) Investor sentiment.
- (iii) Limited Supply and Major Holdings by few entities.
- (iv) News and Development in the financial markets.
- (v) Onset of fully Digitized Fiat currencies.
- (vi) Government policies / restrictions on the cryptocurrency trading.
- (vii) Illegal activities .

2.15 While the reasons given above seem logical and plausible, the impact of geopolitical crisis on the volatility of the stock markets and its effect on crypto currency, if any, needs to be studied.

III. SIGNIFICANCE OF STOCKMARKETS OF EMERGING ECONOMIES

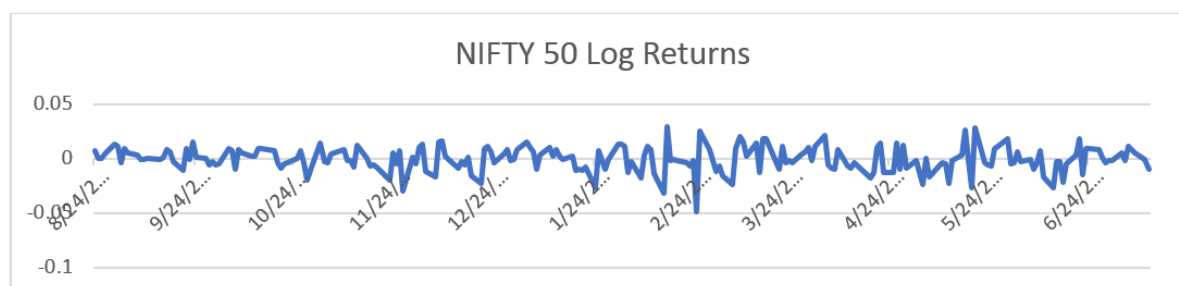
3.1 Introduction.

Investments in foreign equity has gained importance since the nineties when the fiscal institutions realised that the surplus currency in their countries (especially developed countries) can be used to influence the emerging economies and thereby control the supply demand cycle and the price of manufacturing and raw materials in those countries. Portfolio diversification through global markets has also reduced the portfolio risks of these institutions. It is seen that the factors affecting the stock market indices of different countries depend on varying economic and political indicators and are rarely the same. This provides a safety net to the foreign institutional investors with respect to their investments and if these indicators are studied carefully, today's fintech solutions also supply fleeting opportunities to earn handsome profits merely by shifting of invested funds from one stock market to another based on market and geopolitical trends.

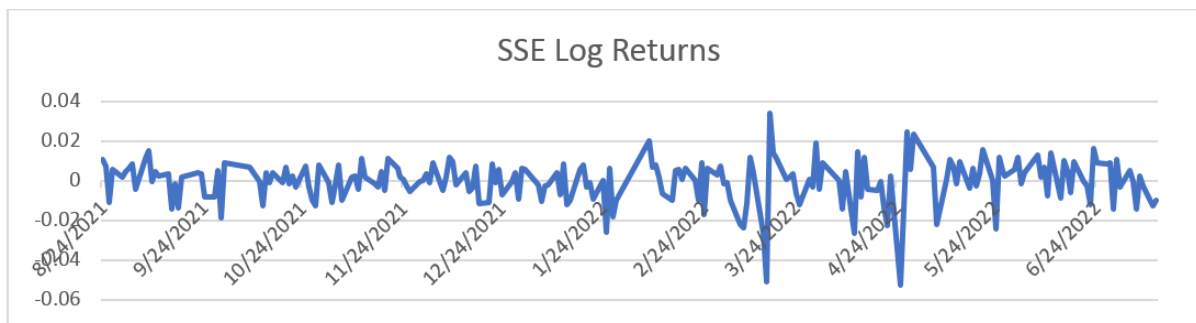
3.2 The 1990s brought to fore , the potential of the developing countries and their economic conditions. The world bank in 2008 released figures which showed that the collective GDP of the developing countries grew by 5% every year and the growth rate peaked at 8%. These figures made the investors sit up and consider investing the funds in the emerging economies. Among the developing countries, there are few countries that are showing tremendous potential for huge growth. Brazil, Russia, India, China, and South Africa (commonly known as BRICS) are leading this bunch of developing nations into a fast economic growth trajectory. Over the last decade, South- East Asian countries have also shown exponential rise in the overall growth rate and GDP. Between 1986 and 1995 stock market capitalization in emerging countries grew ten-fold from \$171 billion to 1.9 trillion and market share held in capitalization increased from 4 percent to 11 percent, mostly to the nine major emerging markets including Brazil, India, and Hong Kong (now a province of China). In the 1990s FDI in developing countries as a ratio of GDP increased from 7 to 21 percent. Most of the increase in FDI went to developing countries like Brazil, China, and India. Russia, since the dissolution of the Soviet Union and the financial crisis of 1997 has achieved more price and currency stabilization, orderly elections, and seen its inflation rate drop from 215% in 1994 to 8.3% in 1998, making it an attractive target for diversifying asset holdings.(Gay Jr, 2008).

3.3 With an aim to study the stock markets of emerging economies, the stock markets of Brazil, Russia, India, China, Hongkong, Taiwan, Indonesia, and that of the developed superpower viz US have to be analysed to study the stock market indices trends over extended periods through the volatile economic cycle. Every country has its own socio political and economic parameters which lead to internal fluctuations in the respective indices. However, global geopolitical events have an all-encompassing effect on the stock market indices of all the emerging economies. There is a need to analyse the stock market trends to draw inferences. To do this, the volatility and returns from the stock markets prior to the geopolitical event i.e., the Russia Ukraine war and after four months into the conflict, were studied. A brief of the various emerging economies and their stock markets is given in succeeding paras.

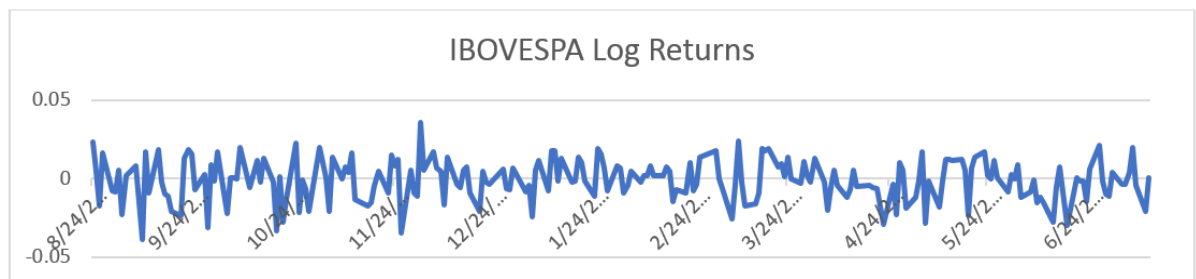
3.4 NIFTY 50. The NIFTY 50 is a diversified 50 stock index accounting for 13 sectors of the economy. It is used for a variety of purposes such as benchmarking fund portfolios, index-based derivatives, and index funds. NIFTY 50 is owned and managed by NSE Indices Limited. NSE Indices is India's specialised company focused upon the index as a core product. ("NIFTY 50 Index - NSE - National Stock Exchange of India Ltd.") The NIFTY 50 Index stands for roughly about 66.8% of the free float market capitalization of the stocks listed on NSE. The total traded value of NIFTY 50 index constituents for the last six months ending March 2021 is approximately 53.4% of the traded value of all stocks on the NSE. Impact cost of the NIFTY 50 for a portfolio size of Rs.50 lakhs is 0.02% for the month March 2021.NIFTY 50 is ideal for derivatives trading. ("NSE - National Stock Exchange of India Ltd.") The volatility of the index over the period from 23 Aug 21 to 12 Jul 22 is given below:-



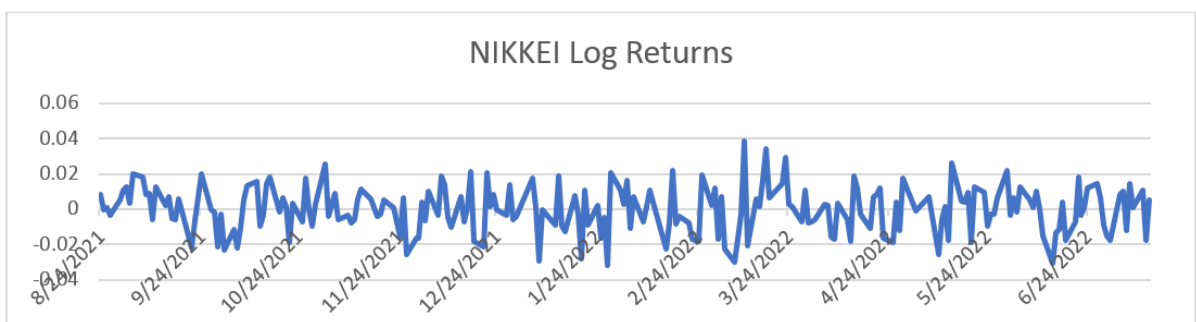
3.5 Shanghai Stock Exchange. The Shanghai Stock Exchange (SSE) is a stock exchange based in the city of Shanghai, China. The Shanghai Stock Exchange is the world's 3rd largest stock market by market capitalization at US\$7.62 trillion as of July 2021. It is also Asia's biggest stock exchange. Unlike the Hong Kong Stock Exchange, the Shanghai Stock Exchange is still not entirely open to foreign investors and often affected by the decisions of the central government, due to capital account controls exercised by the Chinese mainland authorities. It is a non-profit organization directly administered by the China Securities Regulatory Commission (CSRC). The SSE Composite (also known as Shanghai Composite) Index is the most commonly used indicator to reflect SSE's market performance. Constituents for the SSE Composite Index are all listed stocks (A shares and B shares) at the Shanghai Stock Exchange. The volatility of the index over the period from 23 Aug 21 to 12 Jul 22 is given below:-



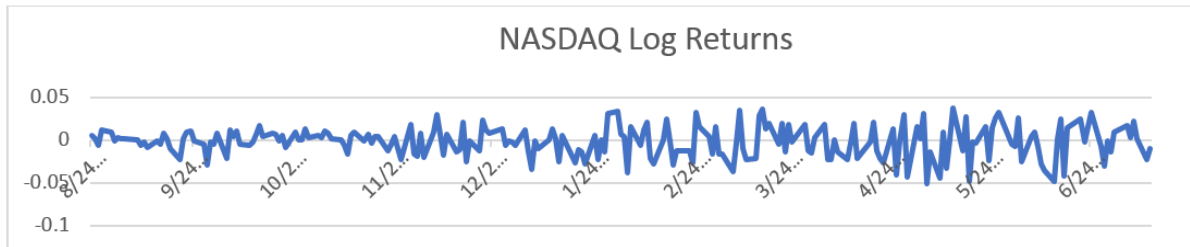
3.6 IBOVESPA. The IBOVESPA is an index of about 50 stocks and is the main indicator of the Brazilian stock market's average performance. The index is a total return index composed by a theoretical portfolio as follows Selection criteria: Being amongst the eligible stocks that account for 85% in descending order by individual tradability ratio (IN); Traded in 95% of the trading sessions; 0.1% of the value traded on the cash equity market (round lots); and must not be a penny stock. It is weighted by free float. It is revised on a 4-month portfolio cycle in January, May, and September. On average, the components of IBOVESPA represent 70% of all the stock value traded. The volatility of the index over the period from 23 Aug 21 to 12 Jul 22 is given below:-



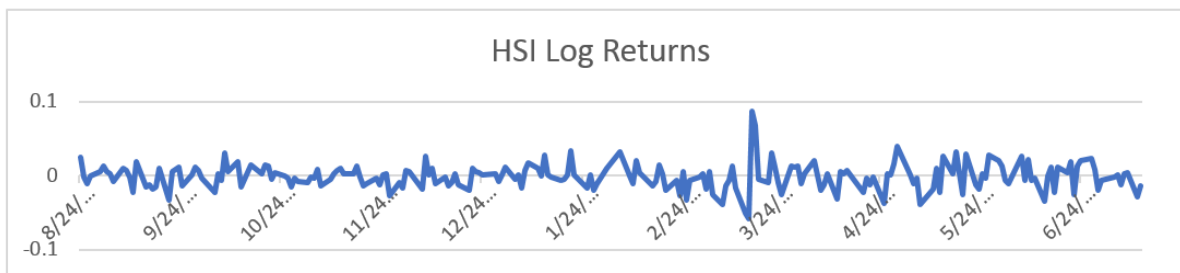
3.7 NIKKEI. The Nikkei 225 Index (N225), otherwise known as the Nikkei, is a price-weighted index that is made up of the 225 largest blue chip Japanese companies on the Tokyo Stock Exchange. The index is similar to the Dow Jones Industrial Average (DJIA) in that it is weighted by price rather than by market capitalization. The Nikkei index is a price-weighted (as opposed to market cap weighted index) that tracks the performance of Japan's top 225 blue-chip companies. Because it is price weighted, it is the Japanese equivalent to the DJIA in the United States.



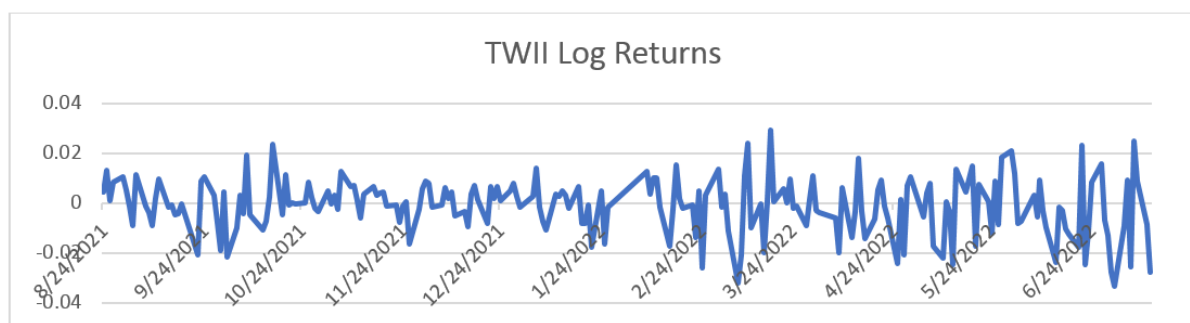
3.8 US NASDAQ. The Nasdaq 100 Index is a basket of the 100 largest, most actively traded U.S. companies listed on the Nasdaq stock exchange. The index includes companies from various industries except for the financial industry, like commercial and investment banks. These non-financial sectors include retail, biotechnology, industrial, technology, health care, and others. The index is constructed on a modified capitalization method. This modified method uses individual weights of included items according to their market capitalization. Weighting allows constraints to limit the influence of the largest companies and balance the index with all members. To accomplish this, Nasdaq reviews the composition of the index each quarter and adjust weightings if the distribution requirements are not met.



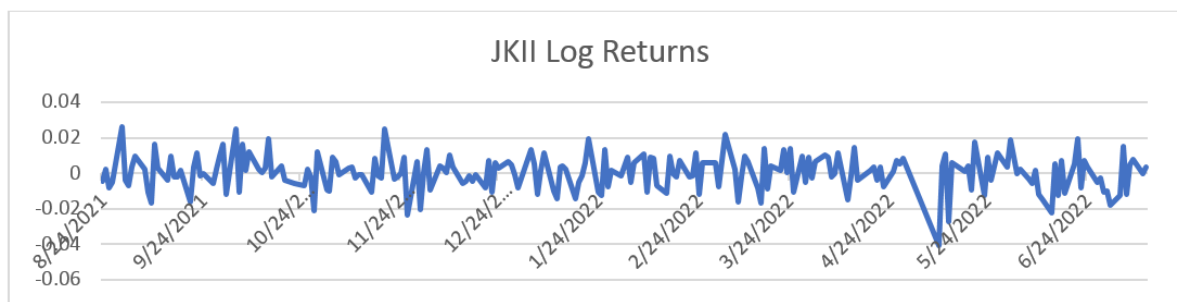
3.9 HSI. The Hang Seng Index ("HSI"), the most widely quoted gauge of the Hong Kong stock market, includes the largest and most liquid stocks listed on the Main Board of the Stock Exchange of Hong Kong. The index includes the largest and most liquid stocks listed in Hong Kong. Stocks are free float-adjusted for invest ability representation. 8% capping is applied to avoid single stock domination. Four sector sub-indexes are also available viz. Finance, Utilities, Properties, Commerce & Industry. The performance of HSI over the period from 23 Aug 21 to 12 Jul 2022 is given below:-



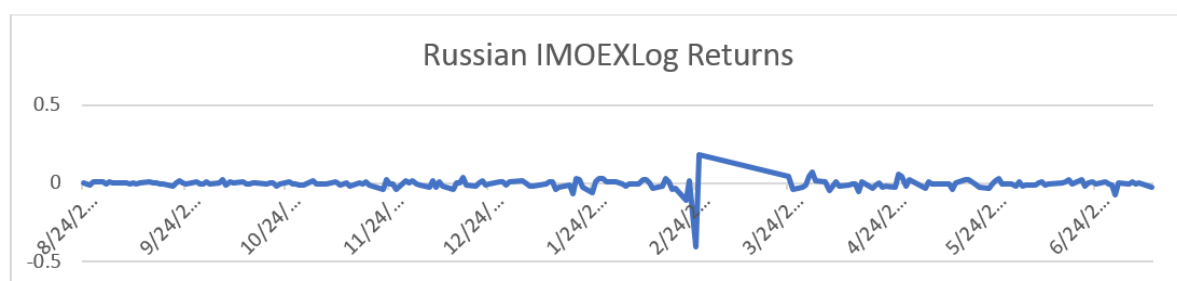
3.10 TWII. The Taiwan Capitalization Weighted Stock Index or TWSE Capitalization Weighted Stock Index is a stock market index for companies traded on the Taiwan Stock Exchange (TWSE). TAIEX covers all of the listed stocks excluding preferred stocks, full-delivery stocks, and newly listed stocks, which are listed for less than one calendar month. It was first published in 1967 by TWSE with 1966 being the base year with a value of 100. The performance of TWII over the period from 23 Aug 21 to 12 Jul 2022 is given below:-



3.11 JKII. "Jakarta Composite Index (JCI) is an index of all stocks that trading Indonesia Stock Exchange (ISX), formerly known as Jakarta Stock Exchange (JSX)." ("Statistical characteristics of Jakarta Composite Index (JCI) dynamics ...") JCI was established in April 1983. The JKII has reached over 4000 points in recent times. The performance of JKII over the period from 23 Aug 21 to 12 Jul 2022 is given below:-



3.12 IMOEX. The MOEX Russia Index, or IMOEX, is a stock index that tracks the performance of the 50 largest and most liquid stocks across 10 sectors in Russia. It is a capitalization-weighted composite index, which means that companies with larger market capitalization will constitute a larger percentage of the index's value. Some of the top holdings are Gazprom (GAZP), an oil and gas exploration and development company; Sberbank (SBER), a state-owned banking and financial services company; Aeroflot (AFLT), Russia's largest airline; Rosneft (ROSN), a state-controlled company that extracts, produces, refines, and sells petroleum and natural gas; and Novatek (NVTK), the largest independent company that explores, produces, and markets natural gas in Russia. The performance of IMOEX over the period from 23 Aug 21 to 12 Jul 2022 is given below:-



3.13 Given the background of the geopolitical situation today and the history of the macroeconomic parameters affecting the stock market indices, the question arises whether the present Russia Ukraine war will affect the stock market indices of emerging economies as listed above and whether it will impact the volatility of the cryptocurrencies considered in Chapter Two above.

IV. LITERATURE REVIEW

There is a plethora of research on crypto currency ever since it was first introduced as an concept by Nakamoto (Liu & Tsyvinski, 2021; Nakamoto, n.d.) .Being a current topic with continuous developments , there have been a no of articles and papers which cover the Russia Ukraine conflict (Charap & Darden, 2014; Feklyunina, 2016; Larrabee, 2010; Salvatore, n.d.), its reasons and its fallouts. There are also a No of articles on the impact of the Russia Ukraine conflict on the financial markets and the global finance as a whole (Balbaa, 2022; Batten et al., 2022; Kovacevic, 2009; Li et al., 2022; Mbah & Wasum, 2022).

The impact of the conflict on wheat(an important commodity and one of Ukraine's staple export product) has also been studied indicating that there is a scope for other countries to step in and provide wheat to major dependents especially Africa(Stober, 2022).

Kavya Clanganthuruthil Sajeev and Mohd Afjal studied the effect of Bitcoin prices on the stock markets and empirically inferred that there is low correlation between Bitcoin and stock markets , indicating that Bitcoin can be taken as an asset to hedge against the risk of these stock markets.(Sajeev & Afjal, 2022).

Governance , Geopolitics and the volatility of cryptocurrency have been studied closely by Dr Karthik H (Hegadekatti, 2016) to bring out the impact of cryptocurrencies on the governance, policies and the geopolitical scenarios.

The paper, War, and crypto currency : an empirical investigation contributes to the literature by investigating the reaction of cryptocurrency markets to international military conflicts. Using daily returns on the top 10 cryptocurrencies and the event study methodology, the paper estimates cryptocurrency abnormal returns around the 2022 Russian invasion of Ukraine.(Barguelli, 2022).

The economic impact of the war on the crypto currencies was analyzed by Salmen and Yehzanov by considering the impact of the Global GDP , inflation rate and foreign trade. (Al-Farabi Kazakh National University et al., 2021).

Similarly, there are a number of articles and papers which study the volatility of the stock markets based on various factors viz. economic indicators(Chun et al., 2020),macroeconomic variables (Gay Jr, 2008),oil price fluctuations (Bashir, 2022; Le & Chang, 2011; Wen et al., 2019),impact of commodities on market prices(Mensi et al., 2021), impact of information content (Ji et al., 2019),political instability(Irshad, 2017), reactions to conflicts(Schneider & Troeger, 2006) . There is an interesting study on the co-movements of the stock price volatility amongst emerging economies(Hwang et al., 2013; Younis et al., 2020).

However , there are extremely limited articles which cover the impact of the Russia Ukraine conflict on cryptocurrencies. The immediate effect (up to Mar 2022) of the invasion on crypto currency has been analyzed in a thesis by Andrew Jae Gnazzo which shows that cryptocurrencies underperformed compared to their expected returns, but once evaluated over time windows surpassing four days, the market experienced greater returns than expected. Further, cryptocurrencies with longer market-tenures experienced greater returns compared to cryptocurrencies with shorter market-tenures (Gnazzo, 2022).

An empirical investigation on the impact on cryptocurrencies has been carried out from Feb 2022 to Apr 2022 which brings out that all the cryptocurrencies except Binance have shown a downward trend during this period of consideration as a fallout of the invasion.(Barguelli, 2022). These studies have a limited window considered as the event and therefore analyze only the immediate impact following the invasion.

After reviewing the literature above, it is identified that there may not be any study on the correlation between the cryptocurrencies and stock market indices .This study aims to identify the co relation between the various crypto currencies and the stock market indices of eight different emerging economies in the wake of the recent geopolitical crisis viz the Russia Ukraine war .

V. DATA AND METHODOLOGY

5.1 As seen in the literature review, there has been a downward trend seen in the days at once following the invasion. This belies claims that the cryptocurrency is an alternative to currency and is the new virtual or digital gold (Yatie, 2022). Cryptocurrency may not be the ideal instrument to hedge funds for protecting against stock market volatility during geopolitical turmoil.

5.2 Data. In order to consider the long term effect on the crypto-currencies vis a vis the effect on fiat currencies and major commodities, this paper considers a window from Aug 2021 to July 2022. This period enables us to analyze the trend before the invasion (pre 24 Feb 2022) , the immediate effect (post 24 Feb 2022) and the long term effect considering the imposition of sanctions and the ripple effect of the gas supply disruptions from Russia up to Jul 2022. The data includes the daily prices of the chosen stock market indices and the cryptocurrencies. This study has considered the daily prices of the chosen stock market indices of eight emerging markets viz. USA, UK, China, India, Indonesia, Malaysia, Hongkong, Japan and the value of eight different cryptocurrencies viz. Bitcoin, Ethereum, USDT(Tether), Stellar, Cardano, Ripple, Chain Link, Dogecoin. The data has been obtained from the historical data provided by Yahoo Finance and Coin Base.

5.4 Sample Size. The 217 samples obtained have been worked upon to calculate the natural logarithmic returns over a period of about eight months with 24 Feb 2022 being the event date(date of commencement of hostilities). The sample period has been matched such that the data of both the cryptocurrencies and the stock market indices are available for the dates considered.

5.5 Treatment on the Data. The data was treated using Jeffreys's Amazing Statistics Program (JASP) and correlation estimator to obtain the descriptive statistics and network analysis. Descriptive statistics of the cryptocurrencies and of the stock indices were considered for the study. Network analysis is a new and promising method for modeling interactions between large numbers of variables. Instead of trying to reduce the structure of the variables to their shared information, as is done in latent variable modeling, we have estimated the relation between all variables directly. Similarly, using network analysis, the relation between a single variable (in this paper , a cryptocurrency) and other latent variables (stock market indices) has also been studied. The correlation between the cryptocurrency and the stock market indices of emerging economies has been considered for each of the eight selected cryptocurrencies.

VI. RESULTS AND ANALYSIS

6.1 Hypotheses. We aim to determine if there is a correlation between cryptocurrencies and stock market indices during a geopolitical crisis. In this case, the null and alternative hypotheses would be :

Ho ---The cryptocurrency returns are unrelated with the stock market indices returns during a geopolitical crisis.

H1---The cryptocurrency returns and the stock market indices returns are related.

6.2. Assumption Testing.

1. *Are the variables continuous ?*

The variables are continuous , interval level data which is appropriate for correlation analysis. JASP has also labelled them with a ruler icon.

2. Are the variables normally distributed?

To determine this, we have undertaken the descriptive statistics of the variables. We will obtain the box plots, distribution plots and also check for the skewness and kurtosis numerical estimates.

6.3 Descriptive Statistics.

| Descriptive Statistics of Stock Indices | | | | | | | | | | |
|---|----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|-----------|-----------|
| | NIFTY50 | SSE | BVSP | NIKKEI | NASDAQ | HSI | TWI | JKI | S&P500 | IMOEX |
| Valid | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 |
| Median | 2.250e-5 | 8.060e-4 | -5.360e-4 | 9.490e-4 | -1.670e-5 | 1.950e-5 | -9.850e-5 | 6.270e-4 | -2.050e-4 | -8.840e-4 |
| Mean | 3.277e-5 | -2.744e-4 | -7.090e-4 | -1.976e-4 | -0.001 | -9.147e-4 | -9.156e-4 | 1.947e-4 | -7.227e-4 | -0.003 |
| Std. Deviation | 2.012e-5 | 0.011 | 0.013 | 0.013 | 0.018 | 0.017 | 0.011 | 0.010 | 0.013 | 0.037 |
| Skewness | 1.633 | -1.096 | -0.335 | -0.041 | -0.302 | 0.587 | -0.399 | -0.291 | -0.417 | -5.562 |
| Std. Error of Skewness | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 |
| Kurtosis | 1.304 | 4.171 | -0.041 | -0.195 | -0.014 | 3.765 | 0.419 | 0.939 | 0.513 | 67.365 |
| Std. Error of Kurtosis | 0.329 | 0.329 | 0.329 | 0.329 | 0.329 | 0.329 | 0.329 | 0.329 | 0.329 | 0.329 |
| Minimum | 2.230e-5 | -0.053 | -0.038 | -0.032 | -0.051 | -0.059 | -0.033 | -0.041 | -0.041 | -0.405 |
| Maximum | 1.120e-4 | 0.034 | 0.036 | 0.039 | 0.037 | 0.087 | 0.029 | 0.026 | 0.030 | 0.183 |

6.4 It is observed that the data (except that for SSE and HSI) is normally distributed as the skewness and kurtosis is within the acceptable range of -3 to +3. The IMOEX data is skewed with the kurtosis statistics showing abnormal figure of 67.365.

| Descriptive Statistics of Cryptocurrencies | | | | | | | | | |
|--|--------|--------|--------|--------|-----------|--------|--------|--------|--|
| | DOGE | BTC | XLM | ADA | USDT | XRP | ETC | LINK | |
| Valid | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | |
| Median | -0.008 | -0.003 | -0.004 | -0.009 | -1.200e-5 | -0.007 | -0.007 | -0.004 | |
| Mean | -0.008 | -0.005 | -0.006 | -0.009 | -2.885e-5 | -0.007 | -0.007 | -0.009 | |
| Std. Deviation | 0.058 | 0.040 | 0.051 | 0.058 | 4.824e-4 | 0.052 | 0.055 | 0.063 | |
| Skewness | -0.163 | -0.330 | -0.649 | 0.047 | -2.080 | -0.366 | -0.334 | -0.417 | |
| Std. Error of Skewness | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | |
| Kurtosis | 3.607 | 2.045 | 1.580 | 0.972 | 21.013 | 2.498 | 1.558 | 0.582 | |
| Std. Error of Kurtosis | 0.329 | 0.329 | 0.329 | 0.329 | 0.329 | 0.329 | 0.329 | 0.329 | |
| Minimum | -0.249 | -0.174 | -0.236 | -0.204 | -0.004 | -0.217 | -0.218 | -0.216 | |
| Maximum | 0.234 | 0.136 | 0.105 | 0.170 | 0.002 | 0.191 | 0.179 | 0.138 | |

6.5 It is observed that the data (except that for USDT) is normally distributed as the skewness and kurtosis statistics are within range. In case of USDT, the kurtosis data shows abnormal value of 21.013. Thus, it indicates that investment in USDT and in IMOEX during the period of study can lead to extremely high risks and may give very low returns.

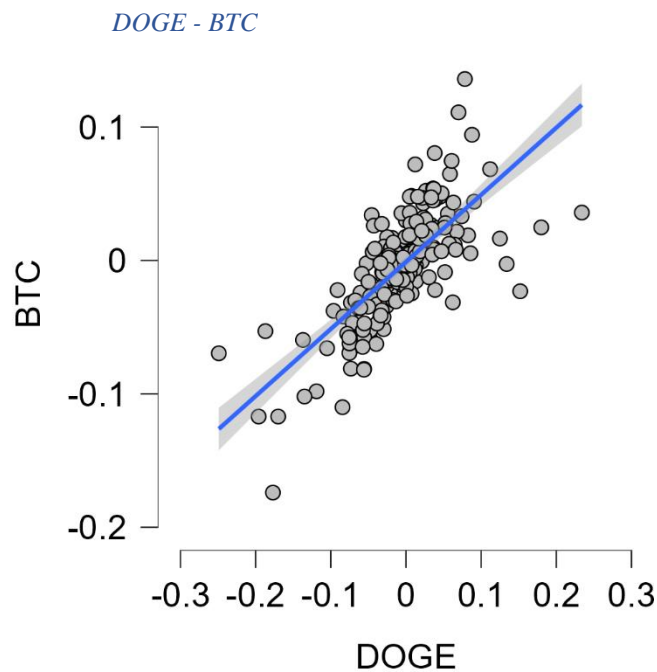
| Descriptive Statistics of all variables | | | | | | | | | | | |
|---|-------|-----------|-----------|----------------|----------|------------------------|----------|------------------------|----------|----------|--|
| | Valid | Median | Mean | Std. Deviation | Skewness | Std. Error of Skewness | Kurtosis | Std. Error of Kurtosis | Minimum | Maximum | |
| DOGE | 217 | -0.008 | -0.008 | 0.058 | -0.163 | 0.165 | 3.607 | 0.329 | -0.249 | 0.234 | |
| BTC | 217 | -0.003 | -0.005 | 0.040 | -0.330 | 0.165 | 2.045 | 0.329 | -0.174 | 0.136 | |
| XLM | 217 | -0.004 | -0.006 | 0.051 | -0.649 | 0.165 | 1.580 | 0.329 | -0.236 | 0.105 | |
| ADA | 217 | -0.009 | -0.009 | 0.058 | 0.047 | 0.165 | 0.972 | 0.329 | -0.204 | 0.170 | |
| USDT | 217 | -1.200e-5 | -2.885e-5 | 4.824e-4 | -2.080 | 0.165 | 21.013 | 0.329 | -0.004 | 0.002 | |
| XRP | 217 | -0.007 | -0.007 | 0.052 | -0.366 | 0.165 | 2.498 | 0.329 | -0.217 | 0.191 | |
| ETC | 217 | -0.007 | -0.007 | 0.055 | -0.334 | 0.165 | 1.558 | 0.329 | -0.218 | 0.179 | |
| LINK | 217 | -0.004 | -0.009 | 0.063 | -0.417 | 0.165 | 0.582 | 0.329 | -0.216 | 0.138 | |
| NIFTY50 | 217 | 2.250e-5 | 3.277e-5 | 2.012e-5 | 1.633 | 0.165 | 1.304 | 0.329 | 2.230e-5 | 1.120e-4 | |
| SSE | 217 | 8.060e-4 | -2.744e-4 | 0.011 | -1.096 | 0.165 | 4.171 | 0.329 | -0.053 | 0.034 | |
| BVSP | 217 | -5.360e-4 | -7.090e-4 | 0.013 | -0.335 | 0.165 | -0.041 | 0.329 | -0.038 | 0.036 | |
| NIKKEI | 217 | 9.490e-4 | -1.976e-4 | 0.013 | -0.041 | 0.165 | -0.195 | 0.329 | -0.032 | 0.039 | |

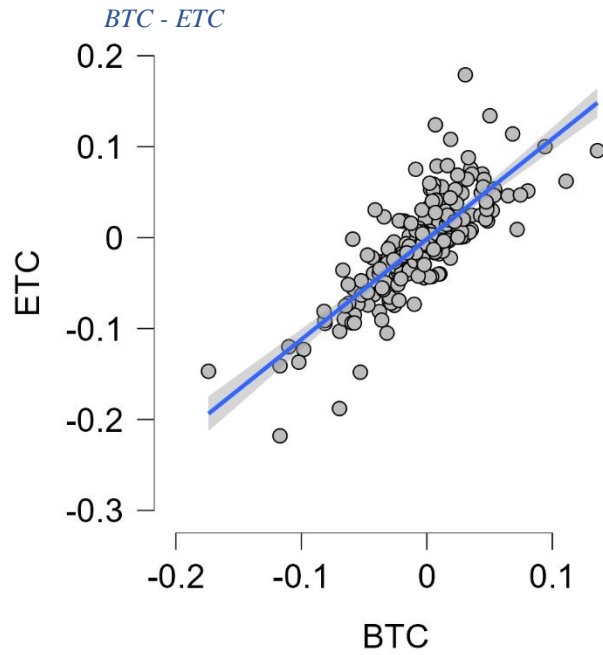
| Descriptive Statistics of all variables | | | | | | | | | | | |
|---|-------|-----------|-----------|----------------|----------|------------------------|----------|------------------------|---------|---------|--|
| | Valid | Median | Mean | Std. Deviation | Skewness | Std. Error of Skewness | Kurtosis | Std. Error of Kurtosis | Minimum | Maximum | |
| NASDAQ | 217 | -1.670e-5 | -0.001 | 0.018 | -0.302 | 0.165 | -0.014 | 0.329 | -0.051 | 0.037 | |
| HSI | 217 | 1.950e-5 | -9.147e-4 | 0.017 | 0.587 | 0.165 | 3.765 | 0.329 | -0.059 | 0.087 | |
| TWI | 217 | -9.850e-5 | -9.156e-4 | 0.011 | -0.399 | 0.165 | 0.419 | 0.329 | -0.033 | 0.029 | |
| JKI | 217 | 6.270e-4 | 1.947e-4 | 0.010 | -0.291 | 0.165 | 0.939 | 0.329 | -0.041 | 0.026 | |
| S&P500 | 217 | -2.050e-4 | -7.227e-4 | 0.013 | -0.417 | 0.165 | 0.513 | 0.329 | -0.041 | 0.030 | |
| IMOEX | 217 | -8.840e-4 | -0.003 | 0.037 | -5.562 | 0.165 | 67.365 | 0.329 | -0.405 | 0.183 | |

6.6 The descriptive statistics of all the variables (cryptocurrencies and stock market indices) shows that the data is normally distributed with the exceptions mentioned above (marked in red).

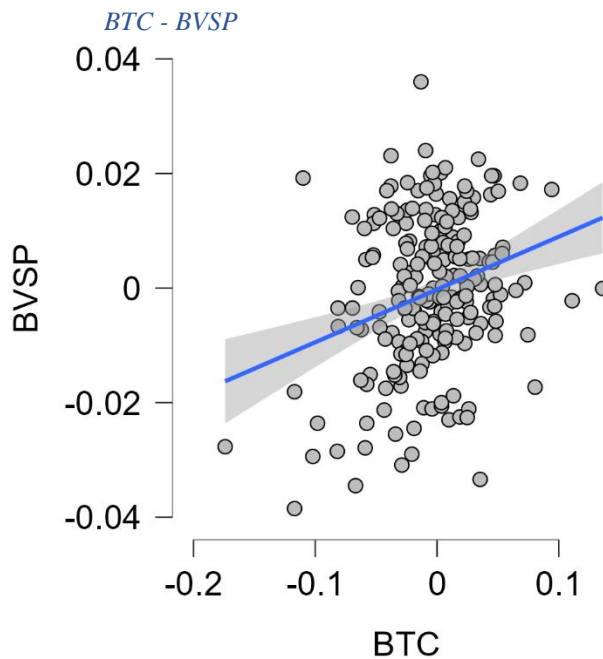
6.7 From the box plots, it is observed that there are some outliers in most of the data, however, since the data is normally distributed, it is acceptable for carrying out further analysis.

6.8 Scatter Plots. In order to verify if the data is liner, the scatter plots between the variables were plotted . It is observed that there is a strong positive correlation between the cryptocurrencies with most of the values lying close to the central line and the centre thus indicating the linearity of the data. A representative plot between DOGE – BTC and BTC-ETC is given below.

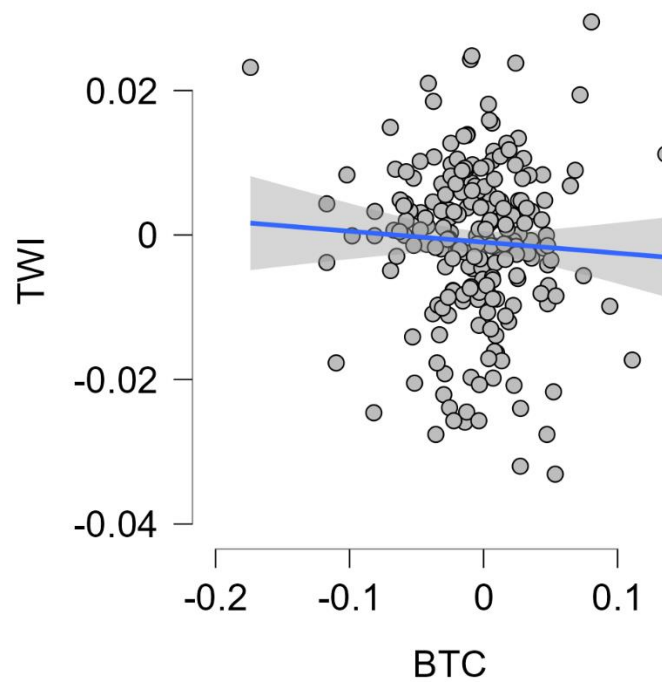




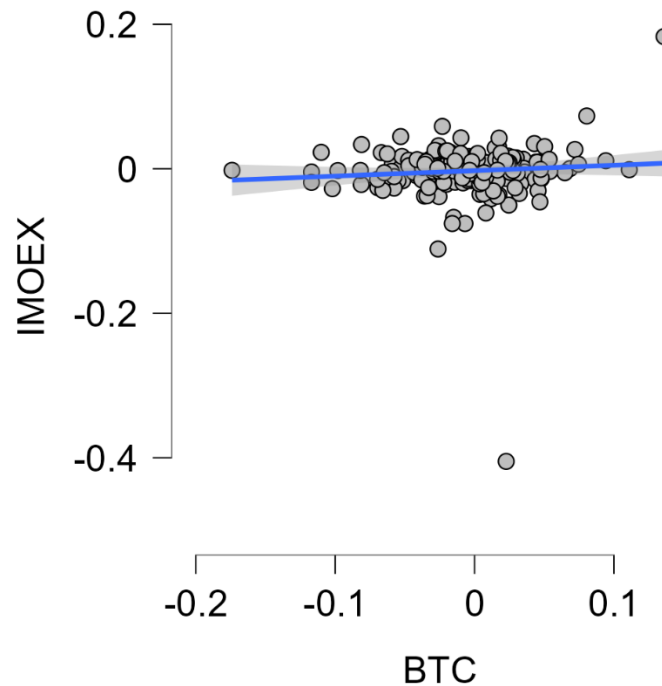
6.9 The scatter plots between BTC and the Stock indices shows different types of correlation with different indices. However, in all cases, most of the data is clustered at the middle of our x axis but are still evenly distributed along the line (because our variables are not skewed), so the pattern of the relationship does appear to follow a rough line. Thus the data is linear in nature.



BTC - TWI



BTC - IMOEX



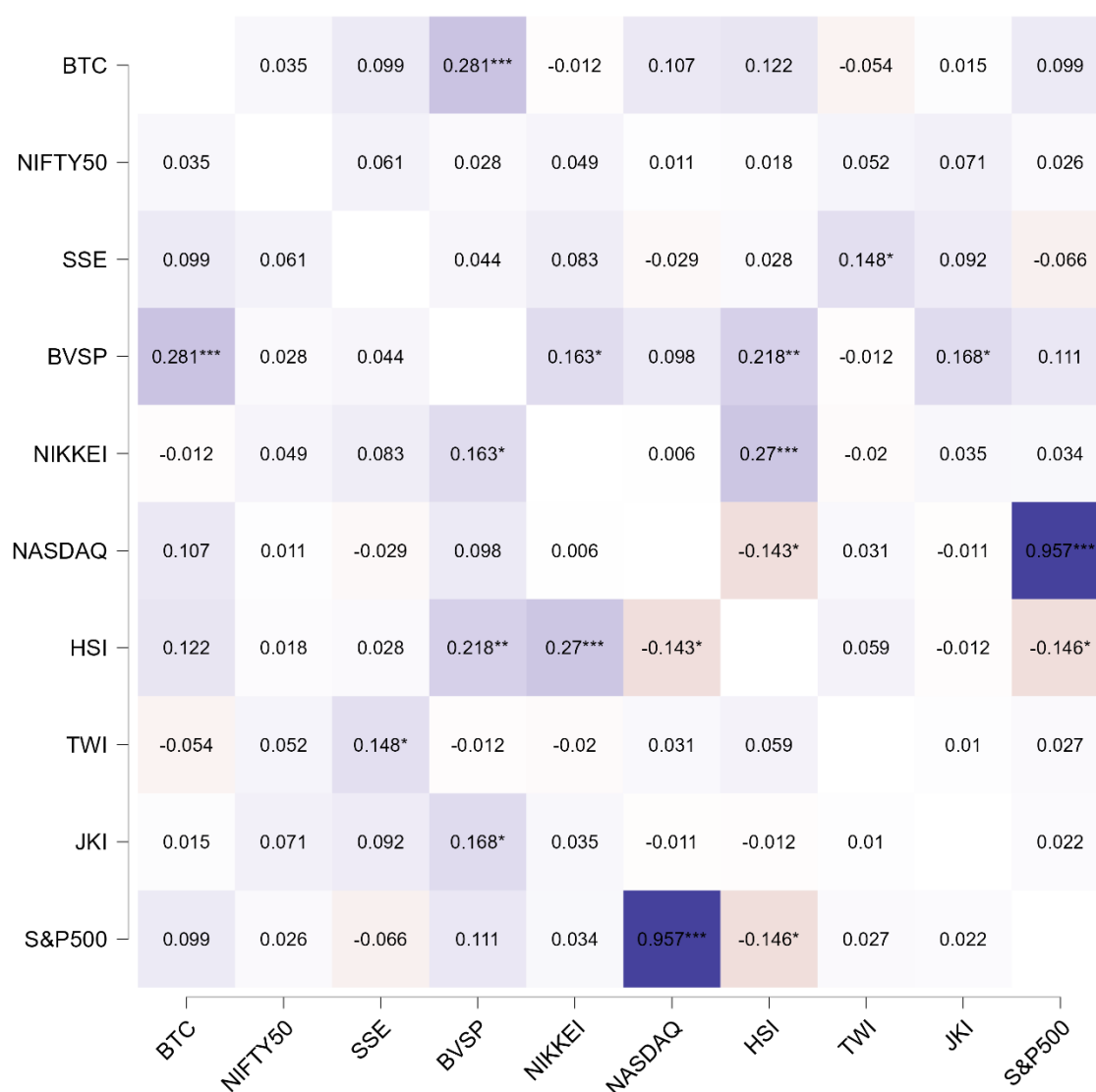
6.10 The correlation between the Bit coin (BTC) and the stock indices has been plotted using the Pearson's r coefficient . The p value indicates that the null hypothesis can be rejected and there exists a correlation between the cryptocurrencies and the stock indices. Similarly, the pairwise Pearson's coefficient correlation has also been plotted along with the r heat map. The heat map indicates that there is a very strong positive correlation between the cryptocurrencies and there is some correlation between certain crypto currencies and the stock market indices returns.

Pearson's Correlations

| Variable | | BTC | NIFTY50 | SSE | BVSP | NIKKEI | NASDAQ | HSI | TWI | JKI | S&P500 |
|------------|--------------|--------|----------|--------|---------|---------|-----------|-----------|--------|--------|--------|
| 1. BTC | n | — | | | | | | | | | |
| | Pearson's r | — | | | | | | | | | |
| | p-value | — | | | | | | | | | |
| | Upper 95% CI | — | | | | | | | | | |
| | Lower 95% CI | — | | | | | | | | | |
| 2. NIFTY50 | n | 217 | — | | | | | | | | |
| | Pearson's r | 0.035 | — | | | | | | | | |
| | p-value | 0.610 | — | | | | | | | | |
| | Upper 95% CI | 0.167 | — | | | | | | | | |
| | Lower 95% CI | -0.099 | — | | | | | | | | |
| 3. SSE | n | 217 | 217 | — | | | | | | | |
| | Pearson's r | 0.099 | 0.061 | — | | | | | | | |
| | p-value | 0.145 | 0.368 | — | | | | | | | |
| | Upper 95% CI | 0.229 | 0.193 | — | | | | | | | |
| | Lower 95% CI | -0.034 | -0.072 | — | | | | | | | |
| 4. BVSP | n | 217 | 217 | 217 | — | | | | | | |
| | Pearson's r | 0.281 | ***0.028 | 0.044 | — | | | | | | |
| | p-value | < .001 | 0.680 | 0.517 | — | | | | | | |
| | Upper 95% CI | 0.399 | 0.161 | 0.176 | — | | | | | | |
| | Lower 95% CI | 0.153 | -0.105 | -0.090 | — | | | | | | |
| 5. NIKKEI | n | 217 | 217 | 217 | 217 | — | | | | | |
| | Pearson's r | -0.012 | 0.049 | 0.083 | 0.163 | * | — | | | | |
| | p-value | 0.866 | 0.475 | 0.222 | 0.016 | — | | | | | |
| | Upper 95% CI | 0.122 | 0.181 | 0.214 | 0.290 | — | | | | | |
| | Lower 95% CI | -0.144 | -0.085 | -0.050 | 0.030 | — | | | | | |
| 6. NASDAQ | n | 217 | 217 | 217 | 217 | 217 | — | | | | |
| | Pearson's r | 0.107 | 0.011 | -0.029 | 0.098 | 0.006 | — | | | | |
| | p-value | 0.115 | 0.867 | 0.670 | 0.150 | 0.934 | — | | | | |
| | Upper 95% CI | 0.237 | 0.144 | 0.105 | 0.228 | 0.139 | — | | | | |
| | Lower 95% CI | -0.026 | -0.122 | -0.162 | -0.036 | -0.128 | — | | | | |
| 7. HSI | n | 217 | 217 | 217 | 217 | 217 | 217 | — | | | |
| | Pearson's r | 0.122 | 0.018 | 0.028 | 0.218 | **0.270 | ***-0.143 | * | — | | |
| | p-value | 0.072 | 0.794 | 0.679 | 0.001 | < .001 | 0.035 | — | | | |
| | Upper 95% CI | 0.251 | 0.151 | 0.161 | 0.341 | 0.389 | -0.010 | — | | | |
| | Lower 95% CI | -0.011 | -0.116 | -0.105 | 0.087 | 0.142 | -0.271 | — | | | |
| 8. TWI | n | 217 | 217 | 217 | 217 | 217 | 217 | 217 | — | | |
| | Pearson's r | -0.054 | 0.052 | 0.148 | *-0.012 | -0.020 | 0.031 | 0.059 | — | | |
| | p-value | 0.425 | 0.450 | 0.029 | 0.862 | 0.771 | 0.651 | 0.389 | — | | |
| | Upper 95% CI | 0.079 | 0.183 | 0.276 | 0.121 | 0.114 | 0.163 | 0.190 | — | | |
| | Lower 95% CI | -0.186 | -0.082 | 0.015 | -0.145 | -0.153 | -0.103 | -0.075 | — | | |
| 9. JKI | n | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | — | |
| | Pearson's r | 0.015 | 0.071 | 0.092 | 0.168 | *0.035 | -0.011 | -0.012 | 0.010 | — | |
| | p-value | 0.825 | 0.300 | 0.176 | 0.013 | 0.612 | 0.874 | 0.858 | 0.884 | — | |
| | Upper 95% CI | 0.148 | 0.202 | 0.223 | 0.294 | 0.167 | 0.123 | 0.121 | 0.143 | — | |
| | Lower 95% CI | -0.118 | -0.063 | -0.041 | 0.035 | -0.099 | -0.144 | -0.145 | -0.123 | — | |
| 10. S&P500 | n | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | — |
| | Pearson's r | 0.099 | 0.026 | -0.066 | 0.111 | 0.034 | 0.957 | ***-0.146 | *0.027 | 0.022 | — |
| | p-value | 0.148 | 0.700 | 0.330 | 0.104 | 0.614 | < .001 | 0.031 | 0.691 | 0.746 | — |
| | Upper 95% CI | 0.229 | 0.159 | 0.067 | 0.240 | 0.167 | 0.967 | -0.013 | 0.160 | 0.155 | — |
| | Lower 95% CI | -0.035 | -0.107 | -0.198 | -0.023 | -0.099 | 0.944 | -0.274 | -0.106 | -0.111 | — |

* p < .05, ** p < .01, *** p < .001

Pearson's r heatmap



Pearson's Correlations (Pair wise relations between Indices and cryptocurrencies)

| | | Pearson's r | p | Lower 95% CI | Upper 95% CI |
|---------|----------|-------------|-------|--------------|--------------|
| NIFTY50 | - SSE | 0.061 | 0.368 | -0.072 | 0.193 |
| NIFTY50 | - BVSP | 0.028 | 0.680 | -0.105 | 0.161 |
| NIFTY50 | - NIKKEI | 0.049 | 0.475 | -0.085 | 0.181 |
| NIFTY50 | - NASDAQ | 0.011 | 0.867 | -0.122 | 0.144 |
| NIFTY50 | - HSI | 0.018 | 0.794 | -0.116 | 0.151 |
| NIFTY50 | - TWI | 0.052 | 0.450 | -0.082 | 0.183 |
| NIFTY50 | - JKI | 0.071 | 0.300 | -0.063 | 0.202 |
| NIFTY50 | - S&P500 | 0.026 | 0.700 | -0.107 | 0.159 |
| NIFTY50 | - IMOEX | 0.046 | 0.499 | -0.088 | 0.178 |
| NIFTY50 | - DOGE | -0.027 | 0.691 | -0.160 | 0.106 |
| NIFTY50 | - BTC | 0.035 | 0.610 | -0.099 | 0.167 |
| NIFTY50 | - XLM | 0.003 | 0.969 | -0.131 | 0.136 |
| NIFTY50 | - ADA | 0.010 | 0.885 | -0.123 | 0.143 |
| NIFTY50 | - USDT | -0.131 | 0.054 | -0.259 | 0.002 |
| NIFTY50 | - XRP | 0.006 | 0.928 | -0.127 | 0.139 |
| NIFTY50 | - ETC | -0.049 | 0.470 | -0.181 | 0.084 |
| NIFTY50 | - LINK | -0.040 | 0.556 | -0.172 | 0.093 |
| SSE | - BVSP | 0.044 | 0.517 | -0.090 | 0.176 |
| SSE | - NIKKEI | 0.083 | 0.222 | -0.050 | 0.214 |
| SSE | - NASDAQ | -0.029 | 0.670 | -0.162 | 0.105 |

| Pearson's Correlations (Pair wise relations between Indices and cryptocurrencies) | | | | | | |
|--|----------|--------------------|----------|---------------------|---------------------|--------|
| | | Pearson's r | p | Lower 95% CI | Upper 95% CI | |
| SSE | - HSI | 0.028 | 0.679 | -0.105 | 0.161 | |
| SSE | - TWI | 0.148 | * | 0.029 | 0.015 | 0.276 |
| SSE | - JKI | 0.092 | | 0.176 | -0.041 | 0.223 |
| SSE | - S&P500 | -0.066 | 0.330 | -0.198 | 0.067 | |
| SSE | - IMOEX | 0.133 | 0.051 | -3.236e-4 | 0.261 | |
| SSE | - DOGE | 0.053 | 0.440 | -0.081 | 0.185 | |
| SSE | - BTC | 0.099 | 0.145 | -0.034 | 0.229 | |
| SSE | - XLM | 0.103 | 0.130 | -0.030 | 0.233 | |
| SSE | - ADA | 0.111 | 0.102 | -0.022 | 0.241 | |
| SSE | - USDT | -0.034 | 0.620 | -0.166 | 0.100 | |
| SSE | - XRP | 0.113 | 0.097 | -0.021 | 0.242 | |
| SSE | - ETC | 0.119 | 0.079 | -0.014 | 0.249 | |
| SSE | - LINK | 0.077 | 0.262 | -0.057 | 0.208 | |
| BVSP | - NIKKEI | 0.163 | * | 0.016 | 0.030 | 0.290 |
| BVSP | - NASDAQ | 0.098 | | 0.150 | -0.036 | 0.228 |
| BVSP | - HSI | 0.218 | ** | 0.001 | 0.087 | 0.341 |
| BVSP | - TWI | -0.012 | | 0.862 | -0.145 | 0.121 |
| BVSP | - JKI | 0.168 | * | 0.013 | 0.035 | 0.294 |
| BVSP | - S&P500 | 0.111 | 0.104 | -0.023 | 0.240 | |
| BVSP | - IMOEX | -0.087 | 0.200 | -0.218 | 0.046 | |
| BVSP | - DOGE | 0.153 | * | 0.024 | 0.020 | 0.280 |
| BVSP | - BTC | 0.281 | *** | < .001 | 0.153 | 0.399 |
| BVSP | - XLM | 0.245 | *** | < .001 | 0.116 | 0.367 |
| BVSP | - ADA | 0.231 | *** | < .001 | 0.101 | 0.353 |
| BVSP | - USDT | -0.010 | 0.883 | -0.143 | 0.123 | |
| BVSP | - XRP | 0.214 | ** | 0.002 | 0.083 | 0.337 |
| BVSP | - ETC | 0.241 | *** | < .001 | 0.112 | 0.363 |
| BVSP | - LINK | 0.244 | *** | < .001 | 0.115 | 0.365 |
| NIKKEI | - NASDAQ | 0.006 | 0.934 | -0.128 | 0.139 | |
| NIKKEI | - HSI | 0.270 | *** | < .001 | 0.142 | 0.389 |
| NIKKEI | - TWI | -0.020 | 0.771 | -0.153 | 0.114 | |
| NIKKEI | - JKI | 0.035 | 0.612 | -0.099 | 0.167 | |
| NIKKEI | - S&P500 | 0.034 | 0.614 | -0.099 | 0.167 | |
| NIKKEI | - IMOEX | -0.110 | 0.106 | -0.240 | 0.023 | |
| NIKKEI | - DOGE | -0.050 | 0.466 | -0.182 | 0.084 | |
| NIKKEI | - BTC | -0.012 | 0.866 | -0.144 | 0.122 | |
| NIKKEI | - XLM | -0.027 | 0.694 | -0.159 | 0.107 | |
| NIKKEI | - ADA | -0.072 | 0.291 | -0.203 | 0.062 | |
| NIKKEI | - USDT | -0.011 | 0.870 | -0.144 | 0.122 | |
| NIKKEI | - XRP | -0.026 | 0.706 | -0.158 | 0.108 | |
| NIKKEI | - ETC | -0.047 | 0.490 | -0.179 | 0.087 | |
| NIKKEI | - LINK | -0.027 | 0.695 | -0.159 | 0.107 | |
| NASDAQ | - HSI | -0.143 | * | 0.035 | -0.271 | -0.010 |
| NASDAQ | - TWI | 0.031 | 0.651 | -0.103 | 0.163 | |
| NASDAQ | - JKI | -0.011 | 0.874 | -0.144 | 0.123 | |
| NASDAQ | - S&P500 | 0.957 | *** | < .001 | 0.944 | 0.967 |
| NASDAQ | - IMOEX | 0.017 | 0.801 | -0.116 | 0.150 | |
| NASDAQ | - DOGE | 0.066 | 0.335 | -0.068 | 0.197 | |
| NASDAQ | - BTC | 0.107 | 0.115 | -0.026 | 0.237 | |
| NASDAQ | - XLM | 0.089 | 0.194 | -0.045 | 0.219 | |
| NASDAQ | - ADA | 0.142 | * | 0.037 | 0.009 | 0.270 |
| NASDAQ | - USDT | 0.174 | * | 0.010 | 0.042 | 0.300 |
| NASDAQ | - XRP | 0.144 | * | 0.035 | 0.011 | 0.272 |
| NASDAQ | - ETC | 0.153 | * | 0.024 | 0.020 | 0.281 |
| NASDAQ | - LINK | 0.095 | 0.161 | -0.038 | 0.226 | |
| HSI | - TWI | 0.059 | 0.389 | -0.075 | 0.190 | |
| HSI | - JKI | -0.012 | 0.858 | -0.145 | 0.121 | |
| HSI | - S&P500 | -0.146 | * | 0.031 | -0.274 | -0.013 |
| HSI | - IMOEX | 0.028 | 0.681 | -0.105 | 0.161 | |
| HSI | - DOGE | 0.047 | 0.495 | -0.087 | 0.179 | |
| HSI | - BTC | 0.122 | 0.072 | -0.011 | 0.251 | |
| HSI | - XLM | 0.106 | 0.120 | -0.028 | 0.236 | |

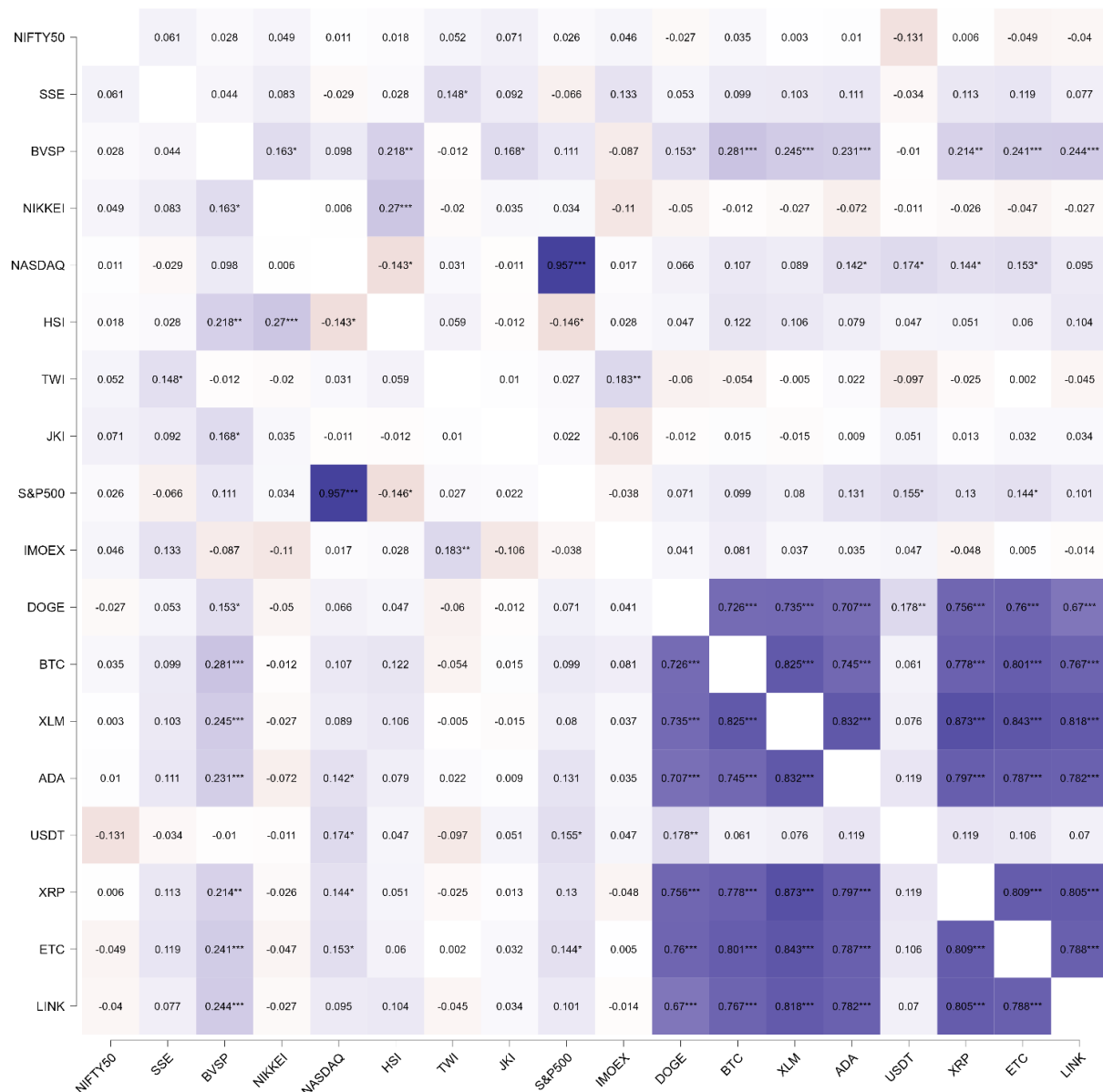
| Pearson's Correlations (Pair wise relations between Indices and cryptocurrencies) | | | | | |
|--|----------|--------------------|----------|---------------------|---------------------|
| | | Pearson's r | p | Lower 95% CI | Upper 95% CI |
| HSI | - ADA | 0.079 | 0.247 | -0.055 | 0.210 |
| HSI | - USDT | 0.047 | 0.490 | -0.087 | 0.179 |
| HSI | - XRP | 0.051 | 0.457 | -0.083 | 0.183 |
| HSI | - ETC | 0.060 | 0.380 | -0.074 | 0.192 |
| HSI | - LINK | 0.104 | 0.125 | -0.029 | 0.234 |
| TWI | - JKI | 0.010 | 0.884 | -0.123 | 0.143 |
| TWI | - S&P500 | 0.027 | 0.691 | -0.106 | 0.160 |
| TWI | - IMOEX | 0.183 | ** | 0.007 | 0.309 |
| TWI | - DOGE | -0.060 | 0.380 | -0.192 | 0.074 |
| TWI | - BTC | -0.054 | 0.425 | -0.186 | 0.079 |
| TWI | - XLM | -0.005 | 0.941 | -0.138 | 0.128 |
| TWI | - ADA | 0.022 | 0.745 | -0.111 | 0.155 |
| TWI | - USDT | -0.097 | 0.152 | -0.228 | 0.036 |
| TWI | - XRP | -0.025 | 0.714 | -0.158 | 0.108 |
| TWI | - ETC | 0.002 | 0.977 | -0.131 | 0.135 |
| TWI | - LINK | -0.045 | 0.505 | -0.178 | 0.088 |
| JKI | - S&P500 | 0.022 | 0.746 | -0.111 | 0.155 |
| JKI | - IMOEX | -0.106 | 0.121 | -0.235 | 0.028 |
| JKI | - DOGE | -0.012 | 0.856 | -0.145 | 0.121 |
| JKI | - BTC | 0.015 | 0.825 | -0.118 | 0.148 |
| JKI | - XLM | -0.015 | 0.821 | -0.148 | 0.118 |
| JKI | - ADA | 0.009 | 0.890 | -0.124 | 0.142 |
| JKI | - USDT | 0.051 | 0.452 | -0.082 | 0.183 |
| JKI | - XRP | 0.013 | 0.854 | -0.121 | 0.146 |
| JKI | - ETC | 0.032 | 0.638 | -0.101 | 0.165 |
| JKI | - LINK | 0.034 | 0.622 | -0.100 | 0.166 |
| S&P500 | - IMOEX | -0.038 | 0.578 | -0.170 | 0.096 |
| S&P500 | - DOGE | 0.071 | 0.295 | -0.062 | 0.203 |
| S&P500 | - BTC | 0.099 | 0.148 | -0.035 | 0.229 |
| S&P500 | - XLM | 0.080 | 0.241 | -0.054 | 0.211 |
| S&P500 | - ADA | 0.131 | 0.053 | -0.002 | 0.260 |
| S&P500 | - USDT | 0.155 | * | 0.023 | 0.283 |
| S&P500 | - XRP | 0.130 | 0.055 | -0.003 | 0.259 |
| S&P500 | - ETC | 0.144 | * | 0.011 | 0.272 |
| S&P500 | - LINK | 0.101 | 0.136 | -0.032 | 0.232 |
| IMOEX | - DOGE | 0.041 | 0.544 | -0.092 | 0.174 |
| IMOEX | - BTC | 0.081 | 0.232 | -0.052 | 0.212 |
| IMOEX | - XLM | 0.037 | 0.584 | -0.096 | 0.170 |
| IMOEX | - ADA | 0.035 | 0.613 | -0.099 | 0.167 |
| IMOEX | - USDT | 0.047 | 0.490 | -0.087 | 0.179 |
| IMOEX | - XRP | -0.048 | 0.478 | -0.180 | 0.085 |
| IMOEX | - ETC | 0.005 | 0.946 | -0.129 | 0.138 |
| IMOEX | - LINK | -0.014 | 0.834 | -0.147 | 0.119 |
| DOGE | - BTC | 0.726 | *** | < .001 | 0.656 |
| DOGE | - XLM | 0.735 | *** | < .001 | 0.667 |
| DOGE | - ADA | 0.707 | *** | < .001 | 0.633 |
| DOGE | - USDT | 0.178 | ** | 0.009 | 0.046 |
| DOGE | - XRP | 0.756 | *** | < .001 | 0.692 |
| DOGE | - ETC | 0.760 | *** | < .001 | 0.697 |
| DOGE | - LINK | 0.670 | *** | < .001 | 0.589 |
| BTC | - XLM | 0.825 | *** | < .001 | 0.777 |
| BTC | - ADA | 0.745 | *** | < .001 | 0.679 |
| BTC | - USDT | 0.061 | 0.372 | -0.073 | 0.193 |
| BTC | - XRP | 0.778 | *** | < .001 | 0.720 |
| BTC | - ETC | 0.801 | *** | < .001 | 0.748 |
| BTC | - LINK | 0.767 | *** | < .001 | 0.706 |
| XLM | - ADA | 0.832 | *** | < .001 | 0.786 |
| XLM | - USDT | 0.076 | 0.265 | -0.058 | 0.207 |
| XLM | - XRP | 0.873 | *** | < .001 | 0.838 |
| XLM | - ETC | 0.843 | *** | < .001 | 0.800 |
| XLM | - LINK | 0.818 | *** | < .001 | 0.769 |
| ADA | - USDT | 0.119 | 0.080 | -0.014 | 0.248 |

Impact of Russia-Ukraine War on Cryptocurrencies and Stock Market Volatility of ..

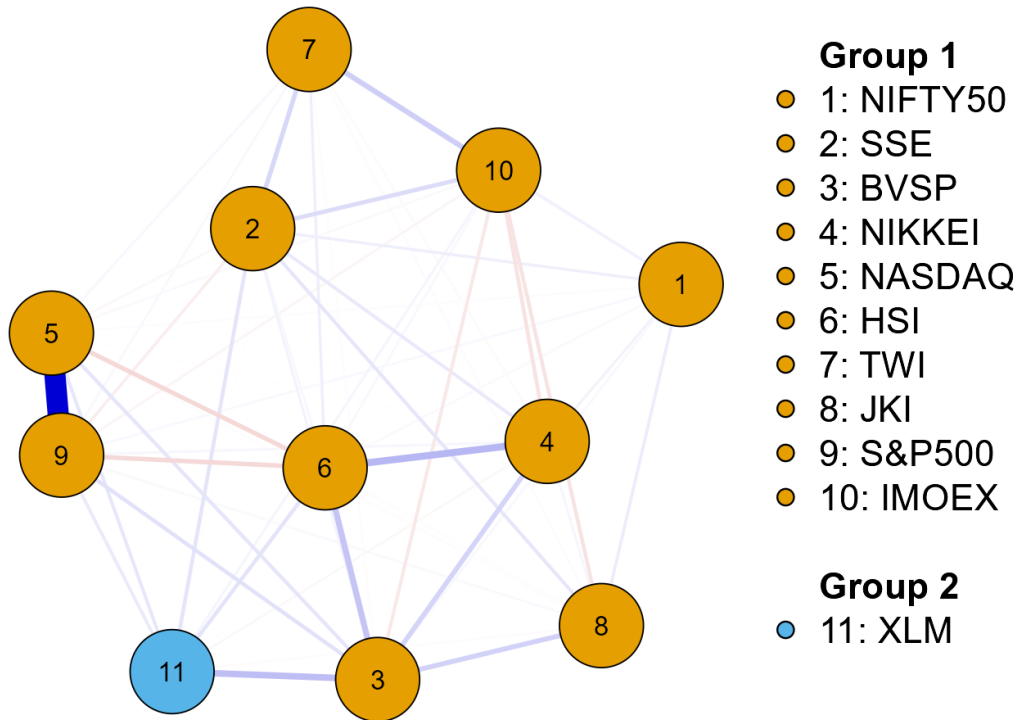
| Pearson's Correlations (Pair wise relations between Indices and cryptocurrencies) | | | | | | |
|---|--------|-------------|-----|--------------|--------------|-------|
| | | Pearson's r | p | Lower 95% CI | Upper 95% CI | |
| ADA | - XRP | 0.797 | *** | < .001 | 0.743 | 0.841 |
| ADA | - ETC | 0.787 | *** | < .001 | 0.731 | 0.833 |
| ADA | - LINK | 0.782 | *** | < .001 | 0.724 | 0.829 |
| USDT | - XRP | 0.119 | | 0.081 | -0.015 | 0.248 |
| USDT | - ETC | 0.106 | | 0.118 | -0.027 | 0.236 |
| USDT | - LINK | 0.070 | | 0.306 | -0.064 | 0.201 |
| XRP | - ETC | 0.809 | *** | < .001 | 0.758 | 0.851 |
| XRP | - LINK | 0.805 | *** | < .001 | 0.753 | 0.848 |
| ETC | - LINK | 0.788 | *** | < .001 | 0.732 | 0.834 |

* p < .05, ** p < .01, *** p < .001

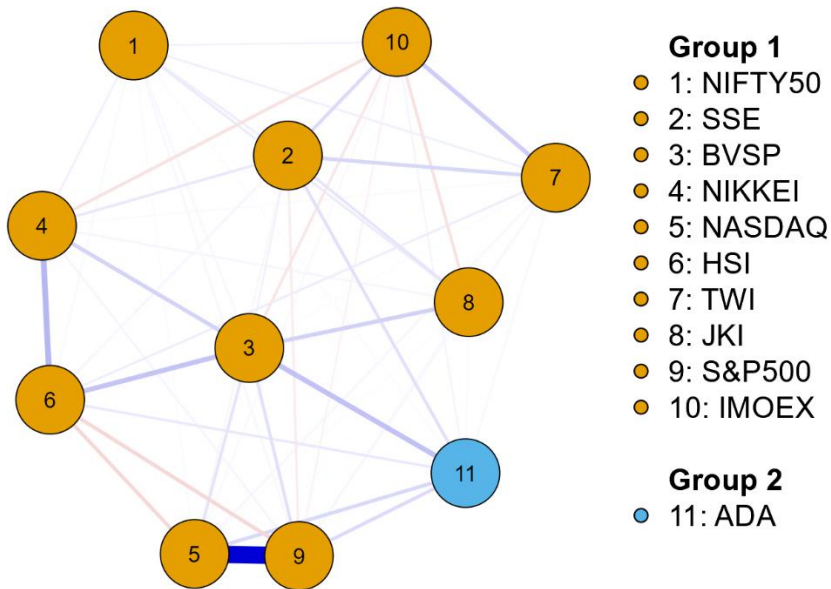
Pearson's r heatmap



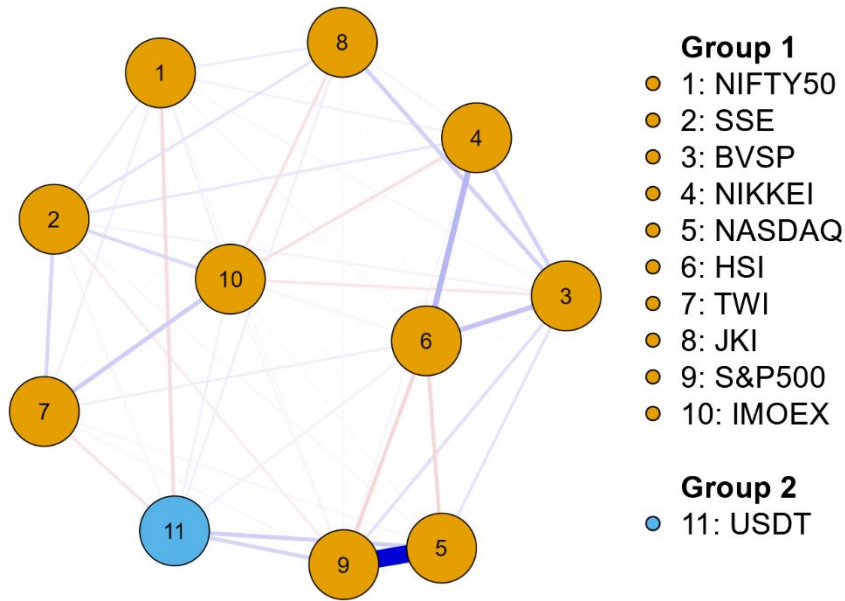
Network Analysis XLM-Indices



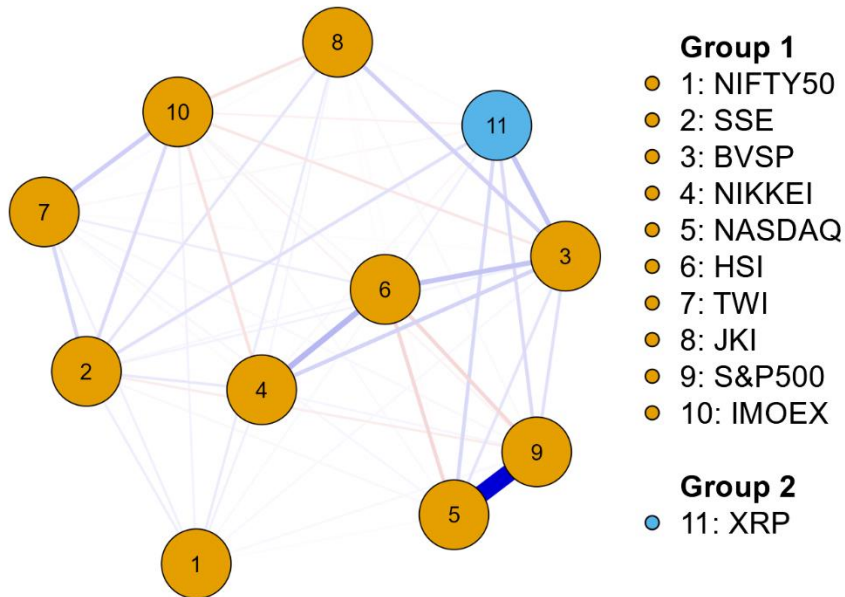
Network Analysis ADA-Indices



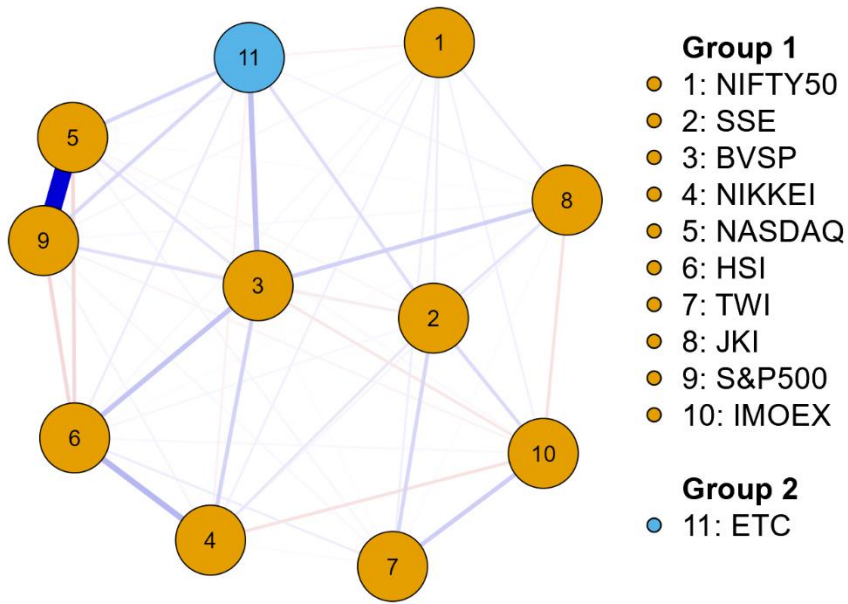
Network Analysis USDT-Indices



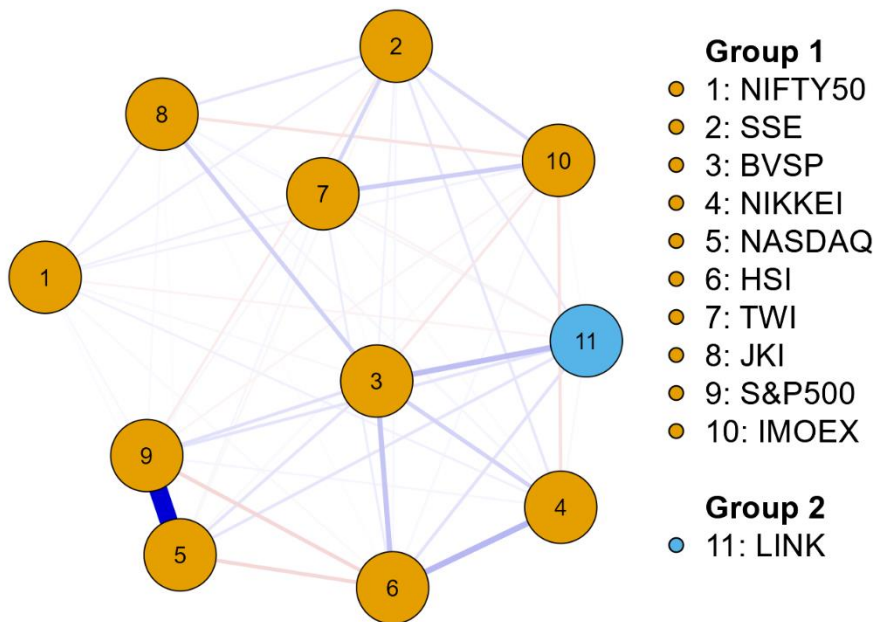
Network Analysis XRP-Indices



Network Analysis ETC-Indices



Network Analysis LINK-Indices



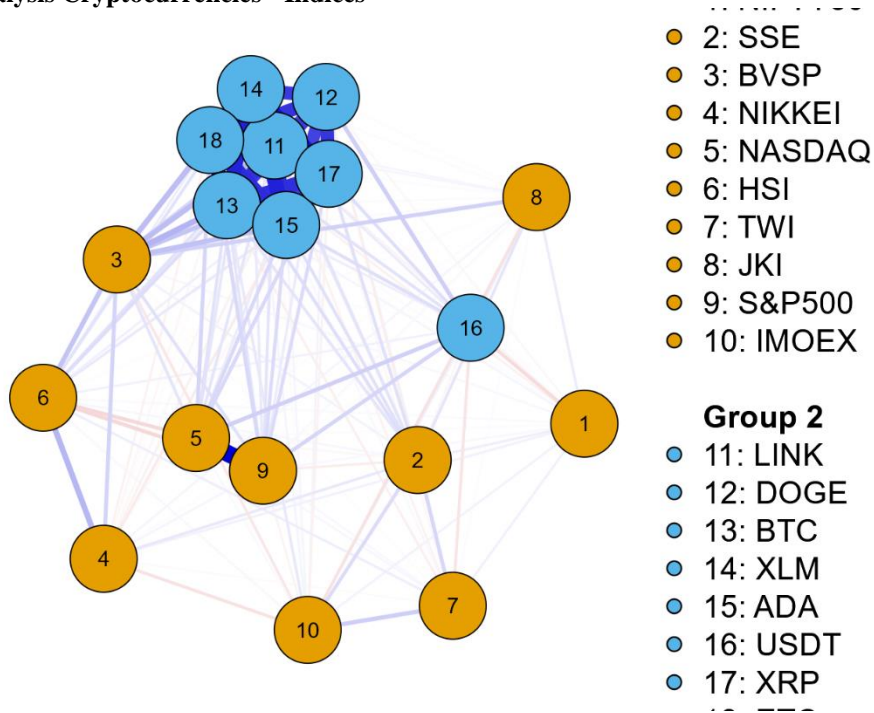
6.11 The network analysis of all the variables (cryptocurrencies and stock market indices) is as follows:

| Summary of Network | | |
|--------------------|--------------------------|----------|
| Number of nodes | Number of non-zero edges | Sparsity |
| 18 | 153 / 153 | 0.000 |

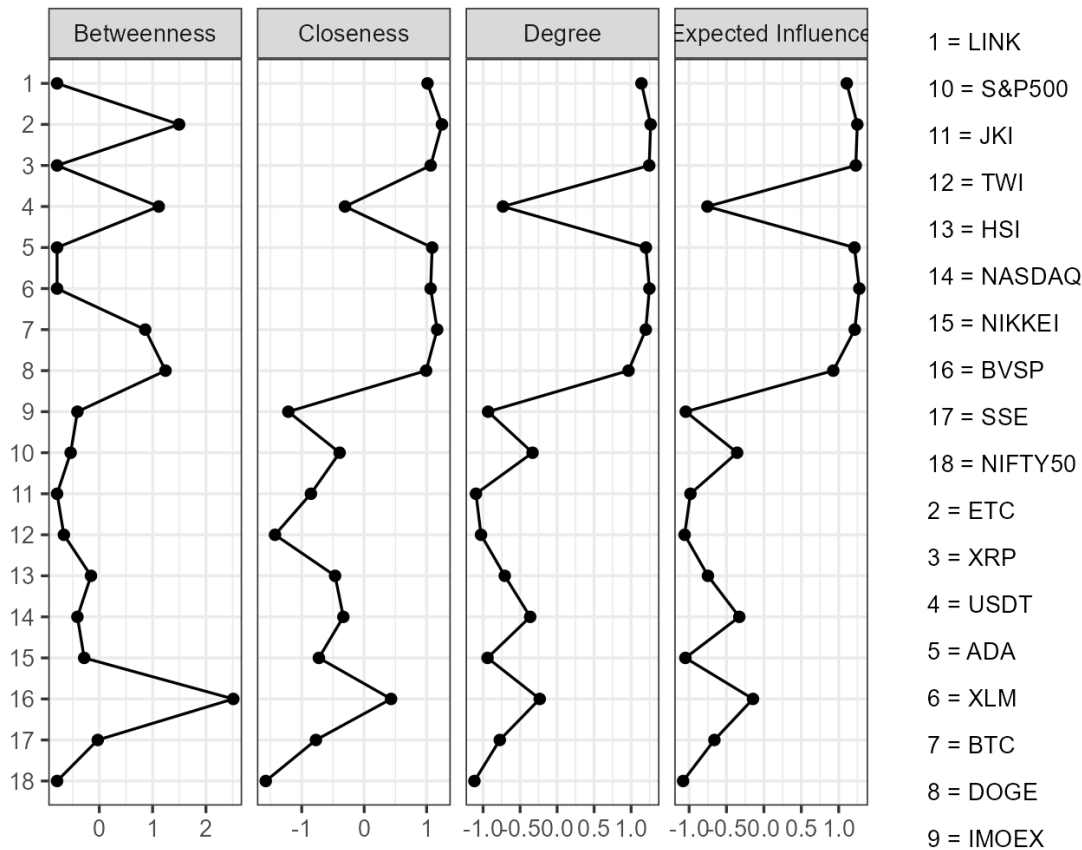
Centrality measures per variable

| Variable | Network | | | |
|----------|-------------|-----------|----------|--------------------|
| | Betweenness | Closeness | Strength | Expected influence |
| NIFTY50 | -0.791 | -1.576 | -1.117 | -1.080 |
| SSE | -0.028 | -0.772 | -0.775 | -0.662 |
| BVSP | 2.513 | 0.431 | -0.235 | -0.146 |
| NIKKEI | -0.282 | -0.726 | -0.940 | -1.050 |
| NASDAQ | -0.409 | -0.334 | -0.364 | -0.329 |
| HSI | -0.155 | -0.466 | -0.707 | -0.748 |
| TWI | -0.664 | -1.428 | -1.028 | -1.060 |
| JKI | -0.791 | -0.854 | -1.096 | -0.982 |
| S&P500 | -0.536 | -0.393 | -0.332 | -0.358 |
| IMOEX | -0.409 | -1.215 | -0.932 | -1.045 |
| LINK | -0.791 | 1.014 | 1.140 | 1.108 |
| DOGE | 1.242 | 0.992 | 0.965 | 0.927 |
| BTC | 0.861 | 1.169 | 1.198 | 1.215 |
| XLM | -0.791 | 1.064 | 1.247 | 1.276 |
| ADA | -0.791 | 1.089 | 1.200 | 1.211 |
| USDT | 1.115 | -0.307 | -0.732 | -0.755 |
| XRP | -0.791 | 1.065 | 1.245 | 1.229 |
| ETC | 1.496 | 1.246 | 1.264 | 1.249 |

Network Analysis Cryptocurrencies - Indices



Centrality Plot



6.12 The network analysis has been conducted between the cryptocurrencies and the stock market indices by considering the log returns of these variables for the period between 23 Aug 2021 to 06 Jul 2022. The event date is 24 Feb 2022. The aim of considering this period was a comprehensive window of five months on both sides of the event. It is seen that all the cryptocurrencies are closely correlated with each other with an extraordinarily strong bond. However, the USDT is not correlated with the other selected cryptocurrencies. This is due to the overdependence of the USDT on the USD which implies that the USDT will fluctuate as per the changes in the US dollar which is the strongest fiat currency.

6.13 The network analysis of the individual cryptocurrency with the stock market indices reveals that there is a correlation between the stock market indices and the cryptocurrencies. There is a strong correlation between the cryptocurrencies and the southeast Asian stock markets viz. HSI, NIKKEI, JKII and IBOVESPA while the other stock markets have a low correlation. This relation may be due to the large no of crypto investors in Southeast Asia. There is a faint correlation between the cryptocurrencies and the indices of NASDAQ, IMOEX, SSE, TWII and NIFTY 50.

6.14 The cryptocurrencies which have the maximum influence are Bitcoin (BTC), Ethereum Classic(ETC) and Ripple(XRP). Cryptocurrency transactions have increased in the window post the conflict. This is due to the use of the crypto currency as an alternative to the SWIFT protocol to circumvent the sanctions on Russia.

6.15 The aim of the study was to analyze if there has been an impact of the geopolitical crisis on the cryptocurrency and the stock market indices of emerging economies and whether there exists a correlation between the two assets. It can be inferred that there is a correlation between the two assets and there has been a significant impact on the two assets of the Russia Ukraine conflict.

6.16 It can also be inferred that there is a strong linkage between the crypto currencies and the stock market. This is in line with the previous studies on the subject matter. (Aysan et al., 2019; Gay, 2008; Keilbar & Zhang, 2021; Sajeev & Afjal, 2022; Su et al., 2020).

VII. Limitations and Way Ahead

7.1 Limitations. The study has considered a period of about five months before and after the commencement of hostilities. However, there may be a need to conduct a comprehensive and detailed study on the effects of the ongoing tensions in the region on the cryptocurrencies and the market indices. Further the data was limited to a few selected cryptocurrencies without considering their contribution in Eastern Europe and the USA. It may be possible that there are other cryptocurrencies which have been abnormally affected by the crisis. These aspects need to be studied in detail in further studies on the subject.

7.2 Way Ahead. The study has proven that there is a correlation between the returns of stock market indices and the cryptocurrencies during the geopolitical crisis. There is a need to expand the scope of the study by including a longer period of time as well as including additional parameters to identify the reasons for the correlation and the specific causes of abnormal trends during geopolitical crisis. This can be included in future research. Further the present network analysis is based on correlation. This can be expanded to undertake network analysis using EBIC Glasso estimator.

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