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Review Article

Crypto-Currency: Trends and Determinants

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Abstract

In this paper, author analyses the role of cryptocurrencies in the economy and showed the trends of prices of Bitcoin and Ethereum in terms of US$ during $2017m_1$-$2021m_{12}$ and also showed the trends of the market capitalization of Bitcoin during $2017m_1$-$2021m_{12}$. All the trendlines are non-linear with cyclical behavior. Traditional regression model revealed that the market capitalization of Bitcoin is positively related with prices of Bitcoin and inflation rate and negatively related with price of Ethereum significantly from $2019m_1$ to $2021m_{12}$. Cointegration and VEC model suggested that the market capitalization of Bitcoin has long run causality with the prices of Bitcoin and Ethereum and inflation rate but the cointegrating equation has been proved diverging away from equilibrium. Bitcoin price and market capitalization have bi-directional short run causality and the price of Ethereum has short run causality to market capitalization of Bitcoin during the specified period. The volatility of market capitalization of Bitcoin showed a non-stationary process.

Keywords: Cryptocurrency, Bitcoin, Ethereum, market capitalization, trend, cycles, short run causality, long run causality.

JEL Classification codes-C22, C32, E32, E50, F30, F40, G15, G32, G33.

INTRODUCTION

As on 18th December,2021, there are 9254 cryptocurrencies in the world whose total market capitalization stood 2.20 trillion US$. Cryptocurrencies have become extremely popular due to its huge gain on speculative motive. It is a digital alternative to fiat currency. The working of cryptocurrency happened through blockchain technology with distributed ledger under cryptography in a decentralized manner. Now, Bitcoin is used as intermediate currencies to streamline money transfers across borders. Cryptocurrency offers cheaper, faster and peer to peer payment option for consumers although its prices are too volatile. Cryptocurrencies are not backed by gold or any reserves assets. Some experts considered as an asset but using it as currency is complicated. Even, Federal Bureau of Investigation deciphered digital trial of cryptocurrencies for transaction purposes. In European Union, cryptocurrencies are legal. Malta, Singapore, Switzerland promote use of cryptocurrency. Japan's Payment Services Act defines Bitcoin as legal tender property. El Salvador allows Bitcoin as legal tender money from December 2021. But South Korea, Bangladesh, China, Bolivia, Taiwan, Lebanon banned cryptocurrencies. Although, cryptocurrencies are considered for VAT, capital gains and property tax. Rapid increase of cryptocurrency assets capitalization has challenged the process of dollarization. Cryptoization reduces the ability of central banks to effectively implement monetary policy, also creates financial stability risks in the areas of consumer protection and financial integrity. Increased demand for crypto-assets facilitates capital outflows which has negative impact on foreign exchange market. In the developing countries, cryptoization weakens the central bank credibility. Many cryptocurrency exchanges and wallets have been hacked over years with million of dollars of coins stolen. It is believed that a cryptocurrency crash may involve wider global financial crisis. Even though, the demand for cryptocurrency have been catapulting at an increasing rate. India funded 638 million US$ in cryptocurrency and blockchain investment in 2021 in 48th round according to data by industry tracker Tracxn where global funding is 24,857 million US$(India's share is 38.9%). India's demand for cryptocurrency grew 641% from July 2020 to June 2021 including in the areas of Central and Southern Asia and Oceania. The bulk of capital invested in coinDCX and Coin Switch Kuber amounting to 1 billion US$. It was found that in 2016 at

7th round the total funding was 18.87 million US$ which increased to 37.56 million US$ in 2020 at 25th round [1].

Whether cryptocurrency is to be considered as currency or asset or quasi-asset and on what conditions any cryptocurrency will be considered as stable coin digitally that will emerge a long debate on monetary economics. However, presently it is considered as decentralized finance where financial speculation has been creating technology driven capital outflows in an unregulated manner that hampers growth potentiality of capital formation in real terms. During the attempt of considering cryptocurrency as stable coin the people have been casting votes in several countries where Paraguay leads the first position by getting 460442 votes followed by Venezuela(363952 votes), Anguilla(217426 votes), Panama(88758 votes), USA(83869 votes) and India(76304 votes) respectively as on 18/12/2021. Therefore, the regulation/non-regulation of cryptocurrency in the era of introduction of worldwide central bank digital currency is a question of public policy choice in the transformation of money in one hand and financial stability on the other hand.

In this paper, the author has studied the cryptocurrencies with special emphasis on Bitcoin and Ethereum during the specified period from $2019m_1$ to $2021m_{12}$.The study covers the decomposition of trends, cycles and seasonal variation of prices of Bitcoin and Ethereum and market capitalization of Bitcoin. The determinants of market capitalization of Bitcoin and its integration and vector error correction model have been exclusively examined during the survey period.

LITERATURE REVIEW

There are innumerable literatures on cryptocurrencies in which mainstream literatures are confined with growing demand and importance of crypto as currency and as asset. Even, a group of writers eager to prove it as money and digital gold. A few writers are involved in analyzing the areas of monetary revolution through the development of Fintech and some are simply academicians. A debate has been evolved regarding its regulation and consideration of asset. However, this paper attempted to explain some important issues.

Nakamoto (2008) described that from a technical perspective, cryptocurrencies work through a peer-to-peer, distributed, and decentralized network through blockchain technology. There are no specific regulatory bodies that verify and control the transactions and the transfer of value within the network. The settlement time of cryptocurrencies is much shorter than other payment methods. In the case of bitcoin, the settlement time of ten minutes on average is much faster than with any non-cash financial transaction, which may take days or weeks.

Avdeychik and Capozzi (2018) expressed that the growing momentum of cryptocurrencies and Fintech brings certain risks that raise several questions and concerns regarding the viability of the future integration of virtual currencies in the monetary and financial system, particularly in the absence of legislation and regulatory standards.

Scharding (2019) noted that cryptocurrencies vitalize illegal monetary transactions, money laundering, drug trading that create black market, and threatens stability of people's lifestyles and their incomes. Alonso and Luis (2019) said that there is no regulation or rulings on how to operate using cryptocurrencies for some European countries, such as Austria, Belgium and Croatia. Afzal and Asif (2019) stated that the transactions through cryptocurrencies are generally untraceable due to its decentralised nature for which criminal activities in disguise emerge rapidly.

Bolt and Van Oordt (2019) outlines three key elements of the cryptocurrency value: convertibility into fiat money or ability to buy goods and services, investors' expectations, and factors that determine acceptance of the cryptocurrency in the future, by both vendors and buyers.

Fernández-Villaverde and Sanches (2019) find that when private currency competes with a central bank issued e-money the former should vanish in equilibrium, yet it remains unclear what happens if cryptocurrencies are not a perfect substitute to fiat money.

Momtaz (2019) studied ICOs (Initial Coin Offerings) market although it is still at the infancy stage but the size of this market is substantial because the scope of the ICO has exponentially expanded beyond its initial purpose. Moreover, the OECD (2019) lays out basic principles and typical steps of an ICO. An important distinction between tokens and cryptocurrencies is that there is a liability or some sort of commitment behind the token, and this liability determines its value. Now that this crypto asset bears more similarity with traditional assets, one would expect also the main predictions of neoclassical finance to come true.

Fadeyi *et al*., (2020) said that cryptocurrencies became more popular and recognition which spill over into industries and other domain although the blockchain technology that is used in cryptocurrency mining require huge electricity consumption, graphic processing units, and power-intensive computing abilities.

[1] Economic Times dated 1/1/2022

Fantazzini and Zimin (2020) estimated the risk of default of cryptocurrencies in a set of models on 42 digital coins extending traditional risk analysis to cryptocurrencies and distinguished market risk and credit risk where the former indicated movements in prices of other assets and latter indicated traditional finance with the failure of the counterparty to repay. Authors found credit risk of cryptocurrency in the possibility of them losing credibility among users, and thus becoming value-less, or "dead" and the market risk of cryptocurrencies is driven by Bitcoin, suggesting some degree of homogeneity in the crypto market. As for the credit risk, the one-year trading volume and the average yearly Google search volume work remarkably well, suggesting indeed a similarity between the newly defined credit risk for cryptocurrencies and the one traditionally used for other asset classes.

Chirita and Nica (2020) evaluated the effects that the appearance of the cryptocurrencies had on the cybernetic economic system in Romania applying multi-dimensional analysis on the price of Bitcoin from 23/4/2013 to 23/12/2019 in Romania and found that the speculative bubbles (like tulip bubble) that led to the emergence of systemic shocks that spread contagiously in the respective network and led to economic crises. Haryanto *et al*., (2020) studied the disposition effect and the herding behaviour in the cryptocurrencies realm by investigating the trading behaviour at a crypto exchange and found a reverse disposition effect in bullish periods where a Bitcoin price increases while a positive disposition effect is observed in bearish period.

Rejeb, Rejeb and Keogh (2021) emphasized that cryptocurrencies promote innovation and create new business models. A cryptocurrencies-based ecosystem can provide opportunities for new market entrants and supports start-ups through facilitating the process of fundraising. The lack of governance in peer-to-peer networking transactions is the biggest hurdles in the spread of cryptocurrencies. Users are at risk of being victims of fraud and cyberattacks. Cryptocurrencies mining require substantial electric energy consumption that often necessitates economies of scale. Investors and businesses might also consider the use of cryptocurrencies to facilitate tax evasion, money laundering and the financing of illicit activities.

Zhu *et al*., (2021) used VAR model of Bitcoin prices from 1/7/2013 to 31/5/2020 showing Granger causality, volatility, asymmetry, and explored the relationships between investor attention and Bitcoin market, specifically for the forecasting abilities of investor attention. The results show that regarding the Bitcoin return, incorporating the investor attention surely improve the forecasting accuracy. However, predictive models with investor attention do not outperform the benchmark model regarding the Bitcoin realized volatility. The Bitcoin earnings forecasts based on investor attention have significant economic values as the Sharpe ratio is indeed increased.

Objectives of the paper

The paper studied the nature of cryptocurrency especially, Bitcoin and Ethereum. The non-linear trend lines of prices of Bitcoin, and Ethereum and market capitalization of Bitcoin was analyzed through trend lines. The Hamilton filter of Bitcoin market capitalization, its ARMA nature were observed through Hamilton (2018) model and ARIMA (p, d, q) model. Its nonstationary character of fluctuations was also tested through some models. The relation of market capitalization of Bitcoin with its price, Ethereum price and world inflation rate was found out. The cointegration, vector error correction, short run and long run causalities and impulse response functions among above relations were extensively studied.

Methodology and sources of data

Semi-log regression model was applied for getting trend lines of prices of Bitcoin and Ethereum and the market capitalization of Bitcoin. ARMA Maximum Likelihood (OPG-BHHH) model was used for analysing autoregressive and moving average property of market capitalisation of Bitcoin. Hamilton filter model (2018) was fitted to find out the cycles, trends and seasonal variation of the market capitalisation of Bitcoin during $2017m_1$-$2021m_{12}$. Donoho and Johnstone model (1998) was used to estimate of wavelet shrinkage of coefficient of variance of market capitalisation of Bitcoin. The traditional seasonal unit root test was done to verify the seasonality and fluctuations of the market capitalisation of Bitcoin by applying the Hylleberg,Engle,Granger and Yoo(1990) model. The multiple regression model confirmed the relation among Bitcoin market capital capitalisation, prices of Bitcoin and Ethereum and the world inflation rate during $2019m_1$-$2021m_{12}$. Johansen (1988) cointegration and vector error correction model were applied for finding cointegration, long run and short run causalities and impulse response functions. The Wald test (1943) was utilised for showing short run causalities. The monthly data on market capitalisation of Bitcoin from $2017m_1$ to $2021m_{12}$ were collected from www.statista.com, the monthly data from $2019m_1$ to $2021m_{12}$ on the prices of Bitcoin and Ethereum were collected from www.in.investing.com and the monthly data on world inflation (measured by Producer's Price Index by commodity: Final demand: Finished goods less food and energy) from $2019m_1$ to $2021m_{12}$ were collected from Federal Reserve Bank of St. Louis. The unit of Bitcoin market capitalisation is billion US$, the prices of bitcoin and Ethereum are BTC/$, and ETH/$ respectively.

Observations from the models

[A] The Trends

The world-wide cryptocurrency market capitalization from April 29,2013 to December 18,

2021 have been depicted in Figure 1 whose overall trend is upward but it is cyclical consisting of many downswings and upswings and it is highly volatile.

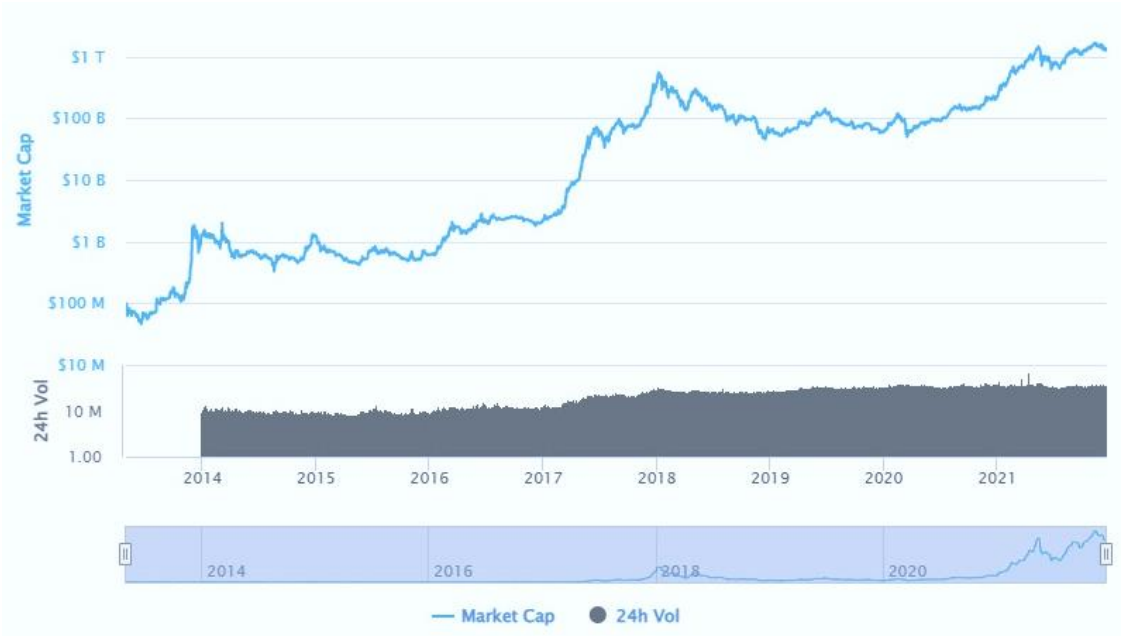


Figure 1: Market capitalization of cryptocurrency
Source: coinmarketcap.com

In the Table 1, the top ten cryptocurrencies along with their market capitalization and prices in terms of dollar as on 18/12/2021 have been shown where Bitcoin is headed in the list followed by Ethereum, Binance Coin, Tether, Solana and so on.

Table 1: Cryptocurrencies, price, and market capitalization

Name of currency	Symbol	Price in USDollar	Market capitalization (billion USDolar)
Bitcoin	BTC	46827.5	888.24
Ethereum	ETH	3951.10	470.62
Binance Coin	BNB	529.21	88.49
Tether	USDT	1.0005	76.34
Solan	SOL	180.043	55.86
Cardano	APA	1.2485	42.79
USD Coin	USDC	0.9997	41.97
XRP	XRP	0.82256	38.95
Avalance	AVAX	114.31	28.08
Terra	LUNA	71.4583	27.08

Source: www.investing.com

The value of Bitcoin in terms of US Dollar has been estimated as four phases trend line during2019m_1-2021m_{12} which is significant at 5% level in each phase and is given below.

$Log(btc\$)=-62.982+7.348t-0.276t^2+0.0045t^3-2.68e^{-05}t^4$

(-4.27)* (4.93)* (-5.02)* (5.12)* (5.17)*

R^2=0.93, F=106.85*, DW=0.719, btc$=value of Bitcoin in terms of dollar, t=month, *=significant at 5% level, n=36

In Figure 2, the trend line is shown where its cyclical nature is clear in which it is increasing in the first phase followed by decreasing, increasing and decreasing successively.

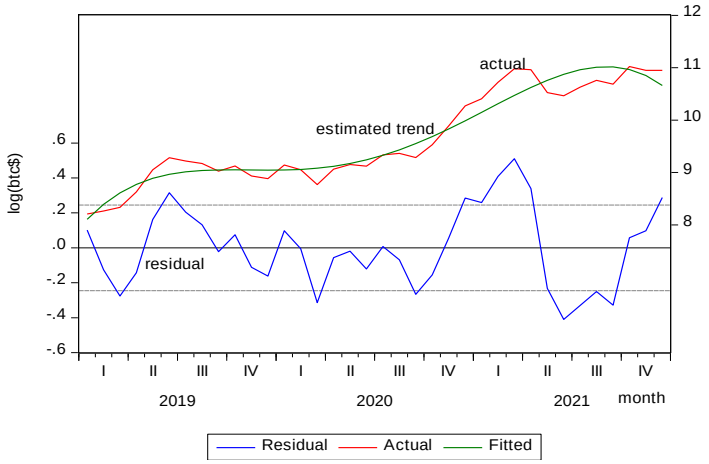


Figure 2: Trend line of value of bitcoin

This estimated trend line is a stable model which was tested by cumulative sum of squares line which lies ±5% level of significance and is shown in Figure 3.

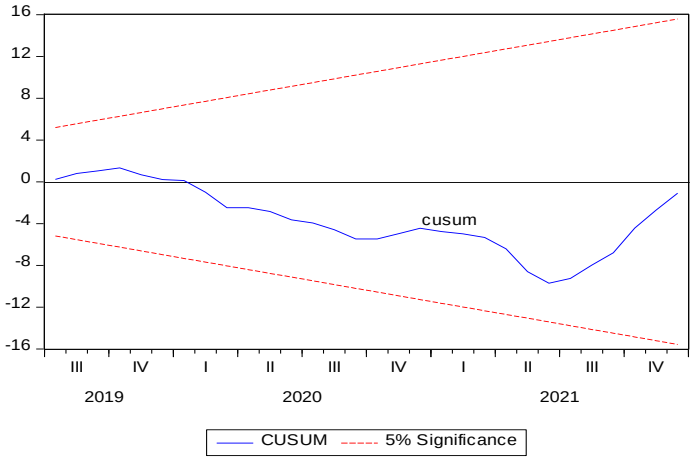


Figure 3: Stability of trend line of bitcoin value

The market capitalisation of Bitcoin during $2017m_1$-$2021m_{12}$ has been rising with a cyclical fashion where its trend line is estimated as four phases which is given below.

$Log(mk)=1.873+0.501t-0.028t^2+0.00064t^3-4.67e^{-06}t^4$

(8.22)* (9.86)* (-8.56)* (7.81)* (-6.98)*

R^2=0.918, F=155.95*, DW=0.532, Mk=market capitalisation of Bitcoin, t=month, *=significant at 5% level. n=60

In Figure 4, it is found as four phases trend line in an increasing fashion.

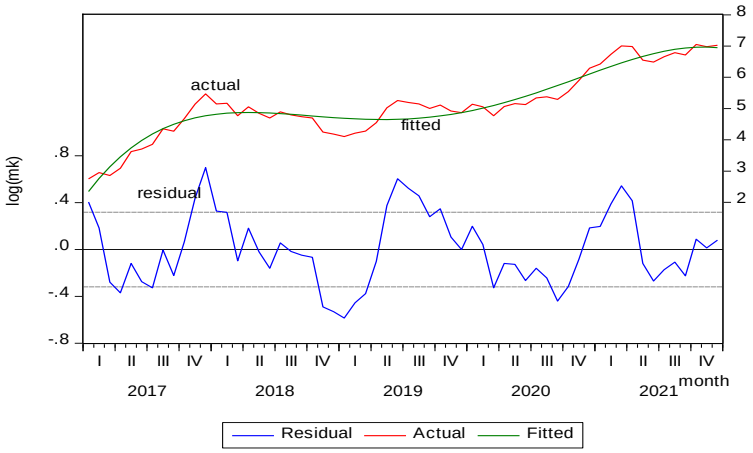


Figure 4: Trend line of market capitalisation of bitcoin

The estimated trend line of market capitalisation of Bitcoin is stable according to cumulative sum of squares line which lies within ±5% significant level. It is shown below in Figure 5.

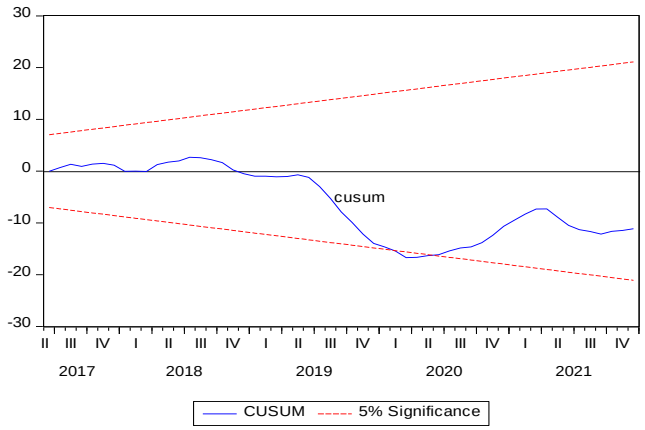


Figure 5: Stability of trend line of bitcoin market capitalisation

The value of Ethereum in terms of US Dollar from 2019m_1 to 2021m_{12} has been increasing steading after the second phase. The trend line is estimated below.

$$\text{Log(eth\$)} = -62.298 + 7.188t - 0.279t^2 + 0.0046t^3 - 2.83e^{-05}t^4$$
$$(-4.64)^* \quad (5.30)^* \quad (-5.58)^* \quad (5.84)^* \quad (-6.01)^*$$

R^2=0.97, F=276.74*, DW=1.23, eth$= value of Ethereum in terms of US$, n=36, *=significant at 5% level.

In Figure 6, the trend line of the value of Ethereum has been plotted where all the four phases are distinctly visible starting from upswing.

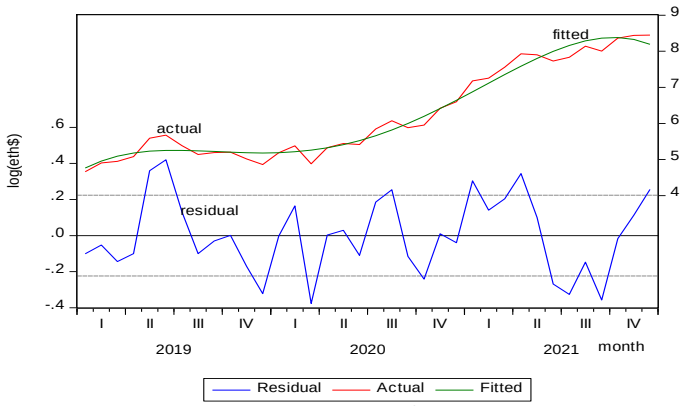


Figure 6: The trend line of Ethereum

The estimated trend line is tested as stable since it is passing through ±5% significant level which is shown in Figure 7.

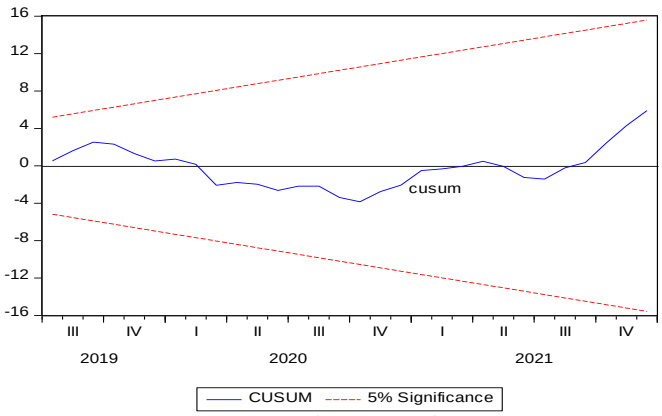


Figure 7: Stability of trend line of Ethereum

The value of Bitcoin in terms of dollar is volatile where its autoregressive and moving average in lag one model is estimated by ARMA Maximum Likelihood (OPG-BHHH) model from $2019m_1$ to $2021m_{12}$ and is found significant at 5% level.

$Log(btc\$)=9.606+0.9709log(btc\$)_{t-1}+0.399\varepsilon_{t-1}+0.0394\sigma^2_t$

(11.16* (19.01)* (2.09)* (3.20)*

R^2=0.948, F=196.76*, DW=1.98, AR root=0.97, MA root=-0.40, n=36,*=significant at 5% level

The AR coefficient and MA coefficient are significant at 5% and their values of coefficients are less than one which implies convergence and their roots are less than one which implies the model is stable. The t value of the variance is significant and its value is not high so that the volatility in ARMA (1,1) model is minimised. Since the value of DW is high then the model has no autocorrelation problem.

The decomposition of trend, cycles and seasonal variation can be found from the Hamilton regression filter model (2018). The regression equation of Bitcoin market capitalisation from $2017m_1$ to $2021m_{12}$ is calculated below.

$Log(mk)_t=4.242+0.1684log(mk)_{t-24}-0.259log(mk)_{t-25}-0.065log(mk)_{t-26}$

(3.24)* (0.23) (-0.28) (-0.07)

$+0.5024log(mk)_{t-27}+v_t$

(0.81)

R^2=0.098, F=0.766, DW=0.111, mk=market capitalisation of Bitcoin, *=significant at 5% level, n=33

So, the residual v_t becomes the Hamilton (2018) regression filter residual.

$v_{t=}$ $Log(mk)_t-4.242+0.1684log(mk)_{t-24}-0.259log(mk)_{t-25}-0.0656log(mk)_{t-26}+0.5024log(mk)_{t-27}$

The decomposition of cycles, trends and seasonal variation of market capitalisation of Bitcoin during $2017m_1$ -$2021m_{12}$ can be obtained by applying STL method of the v_t.

In Figure 8, the first panel explained the cyclical behaviour of the market capitalisation of Bitcoin where there are many cycles of upswings and downswings consisting of 8 peaks and 7 troughs and the overall patterns of cycles consist of four phases. In the second panel, the trend of the market capitalisation of Bitcoin behaves strongly upward. In the third panel, the seasonal variation showed extremely volatile with upward and downward fashions having inverse U shaped but the fluctuation gradually decreases.

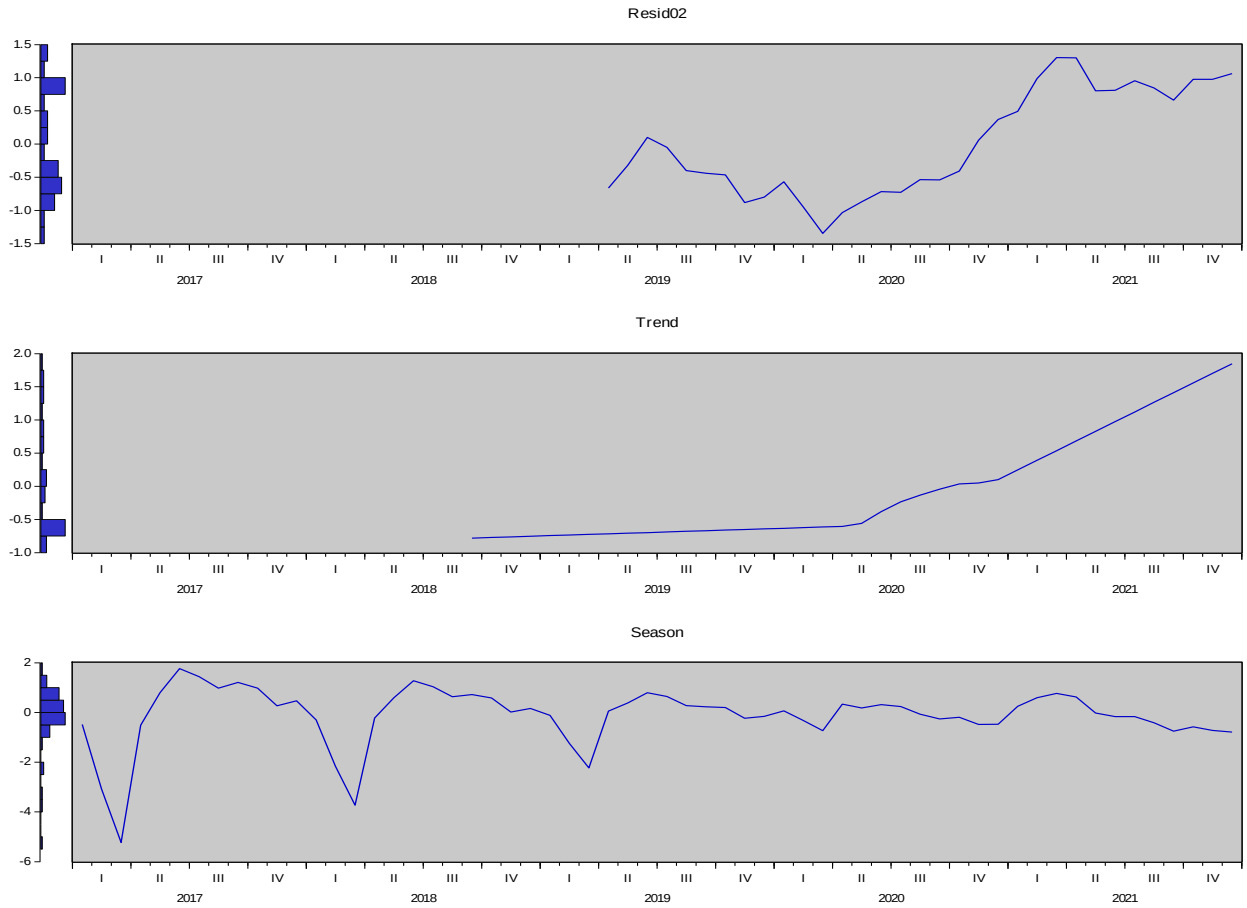


Figure 8: Cycles, trend and seasonal variation of market capitalisation of Bitcoin
Source: Plotted by author

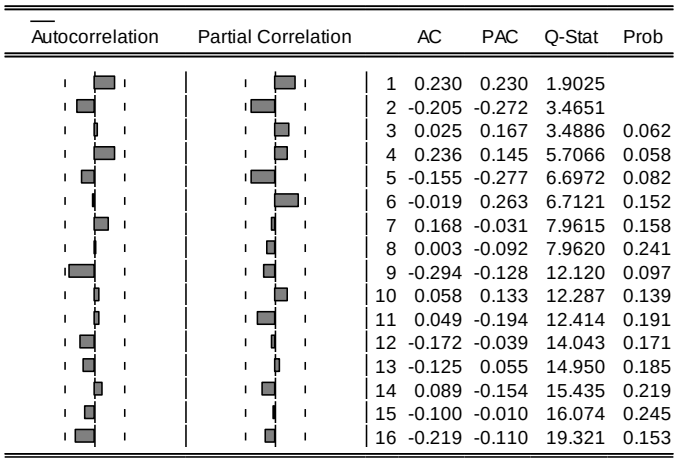
If the Hamilton model passes through the ARMA (p, q) model which is obtained from the automatic selection from 25 best models where AIC is minimum then it was found that ARMA (1,3) model is the best fitted (with the help of ARMA Maximum Likelihood (OPG - BHHH)) model where AIC=0.040068530217 which is minimum. The estimated ARMA (1,3) of the residual of regression filter remains as below,

$v_t = 0.08258 + 0.9333v_{t-1} + 0.207\varepsilon_{t-3} + 0.06635\sigma^2_t$
(0.125) (11.32)* (0.983) (3.12)*

R^2=0.892, F=80.12*, DW=1.47, AR root=0.93, MA roots=0.30±0.51i, -0.59, *=significant at 5% level, period=2017m_1 -2021m_{12}, n=33

It states that the autoregressive part of the residual filter of Hamilton model showed convergent and significant but the moving average part of the model showed convergent but insignificant which confirmed that the volatility never stops although the system is stable model since its roots are less than one. Above all, in the ARMA (1,3) model, the t value of coefficient of variance is significant and its value is minimum so that it may diminish but not certain since it is nonstationary.

The Residual test for correlogram of this model proved that the seasonal variation would not be removed because both the ACF and the PACF continuously varied from positive to negative values indefinitely which in other words can be represented as there is continuous process of volatility. In Figure 9, the values of ACF and PACF and their Q stat are given whose probabilities are shown above 5% level of significance.



	AC	PAC	Q-Stat	Prob
1	0.230	0.230	1.9025	
2	-0.205	-0.272	3.4651	
3	0.025	0.167	3.4886	0.062
4	0.236	0.145	5.7066	0.058
5	-0.155	-0.277	6.6972	0.082
6	-0.019	0.263	6.7121	0.152
7	0.168	-0.031	7.9615	0.158
8	0.003	-0.092	7.9620	0.241
9	-0.294	-0.128	12.120	0.097
10	0.058	0.133	12.287	0.139
11	0.049	-0.194	12.414	0.191
12	-0.172	-0.039	14.043	0.171
13	-0.125	0.055	14.950	0.185
14	0.089	-0.154	15.435	0.219
15	-0.100	-0.010	16.074	0.245
16	-0.219	-0.110	19.321	0.153

Figure 9: ACF and PACF of ARMA (1,3)
Source: Plotted by author

Wavelet Shrinkage Estimator (on soft threshold) on the noise of market capitalization of Bitcoin from 2017m_1 to 2021m_{12} using coefficient variance (Gaussian type) also proved that it is not converging towards equilibrium and was found non-stationary and unstable. On the other hand, its noise is completely volatile which is seen in Figure 10 below.

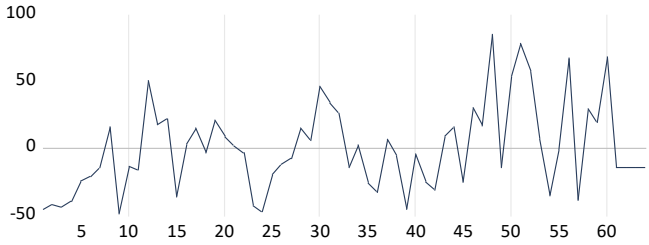


Figure 10: Wavelet Shrinkage estimator
Source: Plotted by author

The seasonal fluctuations consist of the components of trend, growth and cycle where the nature of the deterministic and stochastic seasonal fluctuations can be determined by the seasonal unit root test (Darne and Diebolt, 2002). Using Hylleberg, Engle, Granger and Yoo (1990) model ,the seasonal unit root test for log of market capitalisation of Bitcoin from 2017m_1 to 20211m_{12} with lag 10 assured that there is unit root where t value of the test is greater than the absolute value at 5% level of significant which is stated below(assuming periodicity=12).

HEGY test statistic in all seasonal frequencies was found 6.356 at n=38 whose 5% significant level is 7.31 and HEGY test statistic in all frequencies was found as 6.482 at n=38 whose 5% significant level is 6.82.

[B] The Determinants

In this paper, it is assumed that the value of market capitalization of Bitcoin is generally influenced by the price of Bitcoin itself and the price of Ethereum and the inflation rate although the prices of other cryptocurrencies have equally influence on the market capitalization of Bitcoin. For simplicity, the prices of two main cryptocurrencies have been taken for analysis.

The traditional regression analysis states that the market capitalization of Bitcoin is positively associated with the value of Bitcoin and the world inflation rate and inversely related with the price of Ethereum significantly during $2019m_1$-$2021m_{12}$.Moreover,one percent increase in Bitcoin price and inflation rate per year lead to 1.057% and 1.015% increase in market capitalization of Bitcoin per year and one per cent increase in price of Ethereum leads to 0.0358% decrease in market capitalization of Bitcoin per year from $2019m_1$ to $2021m_{12}$.

Log(mk)=-9.7668+1.0572log(btc$)-0.0358log(eth$)+1.0451log(inf)
(-4.64)* (69.60)* (-2.49)* (2.56)*

R^2=0.999, F=28364.69*, DW=1.035, inf=world inflation rate (producers price index), *=significant at 5% level. n=36,

This estimated model is significant and stable which was obtained from CUSUM of squares that passes through ±5% significant level which is shown below in Figure 11.

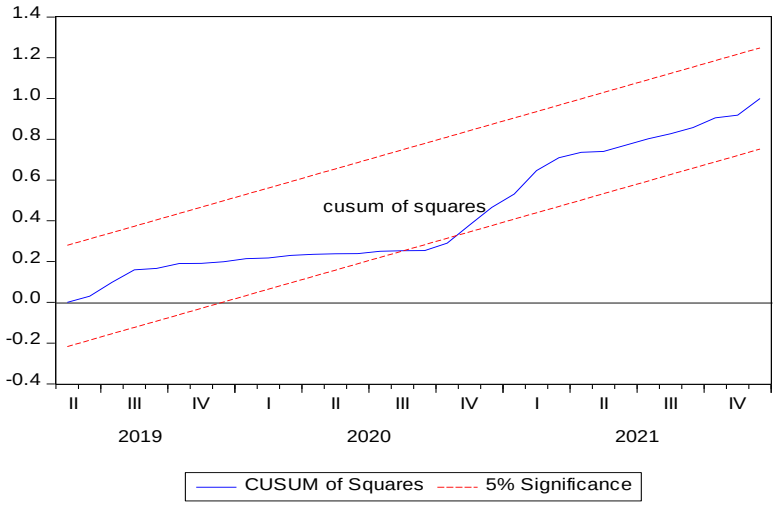


Figure 11: Stability of regression model
Source: Plotted by author

Unrestricted Johansen cointegration rank test among the first difference series of market capitalisation of Bitcoin, prices of Bitcoin and Ethereum and inflation rate during $2019m_3$ – $2021m_{12}$(adjusted samples) with the assumption of linear deterministic trend has explored one cointegrating equation in significant Trace statistic and Max Eigen statistic. In Table 2, the values of Trace statistic, Max Eigen statistic with critical value and probabilities have been clearly shown.

Table 2: Johansen cointegration test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.754853	67.45534	47.85613	0.0003
At most 1	0.291004	19.65480	29.79707	0.4466
At most 2	0.194264	7.961998	15.49471	0.4695
At most 3	0.018013	0.618023	3.841465	0.4318
		Max-Eigen Statistic		
None*	0.754853	47.80053	27.58434	0.0000
At most 1	0.291004	11.69281	21.13162	0.5782
At most 2	0.194264	7.343975	14.26460	0.4493
At most 3	0.018013	0.618023	3.841465	0.4318

Source: Calculated by author
*Denotes rejection of the hypothesis at the 0.05 level, **denotes MacKinnon-Haug-Michelis (1999) p-value

The estimated equations of the vector error correction model are given below.

$[1](\Delta mk)_t=33.168+1.456EC_1-29.569(\Delta mk)_{t-1}-18.019(\Delta mk)_{t-2}+0.5606(\Delta btc\$)_{t-1}$
(0.61) (0.72) (-2.81)* (-1.88)* (2.88)*
$+0.346(\Delta btc\$)_{t-2}-0.348(\Delta eth\$)_{t-1}-0.138(\Delta eth)_{t-2}+71.309(\Delta inf)_{t-1}+51.363(\Delta inf)_{t-2}$
(1.92)* (-3.55)* (-1.04) (1.32) (1.01)
R^2=0.69, F=5.69, SC=12.23, AIC=11.78,*=5%significant level
$[2](\Delta btc)_t=1990.837+82.815EC_1-1652.88(\Delta mk)_{t-1}-1023.344(\Delta mk)_{t-2}$
(0.69) (0.77) (-2.97)* (-2.01)*
$+31.292(\Delta btc\$)_{t-1}+19.658(\Delta btc\$)_{t-2}-18.57(\Delta eth\$)_{t-1}-8.669(\Delta eth\$)_{t-2}$
(3.03)* (2.05) (-3.56)* (-1.23)

$+3811.34(\Delta inf)_{t-1}+2547.82(\Delta inf)_{t-2}$
(1.33) (0.95)
R^2=0.69,F=5.76* AIC=19.72,SC=20.17,*=5% significant level.
$[3](\Delta eth\$)_t=402.549+18.058EC_1-19.903(\Delta mk)_{t-1}-31.636(\Delta mk)_{t-2}$
(4.14)* (4.96)* (-1.05) (-1.83)*
$+0.397(\Delta btc\$)_{t-1}+0.635(\Delta btc\$)_{t-2}-1.456(\Delta eth\$)_{t-1}-0.902(\Delta eth\$)_{t-2}$
(1.13) (1.95)* (-8.21)* (-3.76)*
$+61.097(\Delta inf)_{t-1}-156.9008(\Delta inf)_{t-2}$
(0.62) (-1.709)*
R^2=0.883,F=19.46,AIC=12.96,SC=13.41,*=5% significant level
$[4](\Delta inf)_t=1.0023+0.0322EC_1-0.054(\Delta mk)_{t-1}-0.0113(\Delta mk)_{t-2}+0.001002(\Delta btc\$)_{t-1}$
(3.67)* (3.16)* (-1.01) (-0.23) (1.017)
$+0.0002(\Delta btc\$)_{t-2}-0.00058(\Delta eth\$)_{t-1}-0.0005(\Delta eth\$)_{t-2}-0.1527(\Delta inf)_{t-1}$
(0.22) (-1.18) (-0.76) (-0.56)
$-0.456(\Delta inf)_{t-2}$
(-1.78)*
R^2=0.61,F=4.02,SC=1.66,AIC=1.21,n=34,*=significant at 5% level,n=34

The estimates of ECM state that the increment of market capitalisation of Bitcoin at current year is positively related with the increments of prices of Bitcoin and Ethereum in the short and in the long run. The increment of price of Bitcoin at current year is negatively related with the increment of market capitalisation of Bitcoin and the increment of the price of Ethereum in the short and in the long run. The increment of the price of Ethereum at current price is negatively related with the increments of market capitalisation of Bitcoin, price of the Ethereum and the inflation rate at the long run.

VEC model showed three-unit roots which state that the model is nonstationary and other two roots are greater than one so that it is unstable also because three roots lie outside the unit circle (Figure 12). In Table 3, the roots are given.

Table 3: The roots of VECM

Roots	Modulus
1.278516 - 0.454180i	1.356791
1.278516 + 0.454180i	1.356791
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
-0.464365 - 0.855954i	0.973803
-0.464365 + 0.855954i	0.973803
0.751224	0.751224
-0.643169 - 0.117671i	0.653845
-0.643169 + 0.117671i	0.653845
0.067914 - 0.526745i	0.531105
0.067914 + 0.526745i	0.531105

Source: Calculated by author

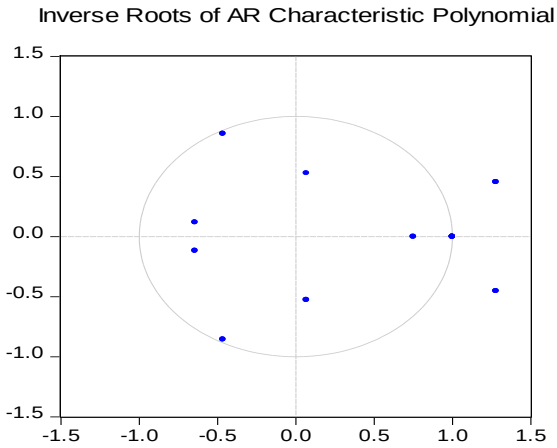


Figure 12: Unit circle
Source: Plotted by author

There is long run causality from Bitcoin and Ethereum prices and inflation rate in which long run causality from Bitcoin price to Bitcoin market capitalisation is highly significant but long run causality from Ethereum price and inflation rate are insignificant. The cointegrating equation has been diverging away from equilibrium because the coefficient of $(mk)_{t-1}$ is positive and its t value is also insignificant.

$(Mk)_t$=1.4563$(mk)_{t-1}$-0.0179$(btc\$)_{t-1}$+0.0086$(eth\$)_{t-1}-0.2419(inf)_{t-1}$
(0.72) (-79.01)* (1.38) (-0.186)
+27.809
Where *=significant at 5% level.

In Figure 13, the cointegrating equation which represents the long run causalities has been moving away from the equilibrium line 0 steadily.

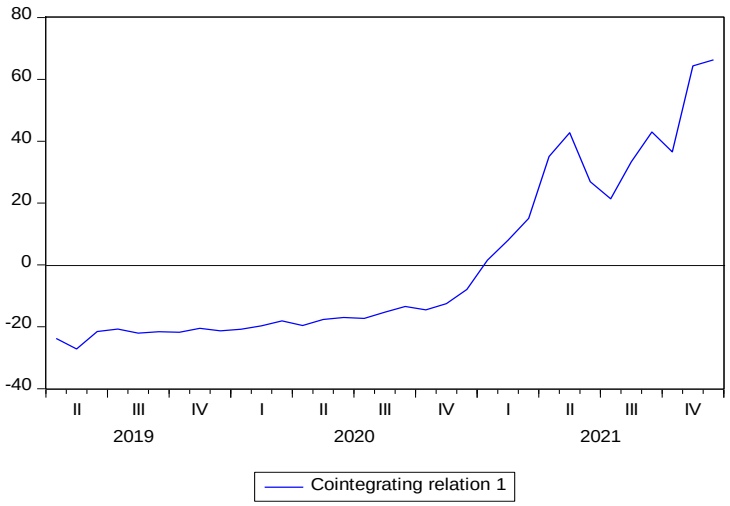


Figure 13: Cointegrating equation
Source: Plotted by author

In the following Table 4 the short run causalities have been shown in details by applying Wald test which states that there are short run causalities from Bitcoin market capitalisation to the price of Ethereum and there is bidirectional causality between Bitcoin price and Bitcoin market capitalisation.

Table 4: Short run causalities

Causality from …to…..	Value of Chi-square	Probability	df	F	Probability	H0=no causality is rejected
From Bitcoin price to Bitcoin market capitalisation	9.000056	0.0111	2	4.500028	0.0256	There is causality
From Ethereum price to Bitcoin market capitalisation	14.82551	0.0006	2	7.412754	0.0033	There is Causality
From Bitcoin market capitalisation to Bitcoin price	9.66364	0.0080	2	4.831822	0.0177	There is causality

Source: Calculated by author

In the Figure 14, the impulse response functions measured by Cholesky one standard deviation innovations have been plotted which implies that all the impulse response functions have been diverging away from equilibrium and there is no tendency to move towards equilibrium which concludes that the market capitalisation of Bitcoin, price of Bitcoin and Ethereum are highly volatile and showed no signs of convergences.

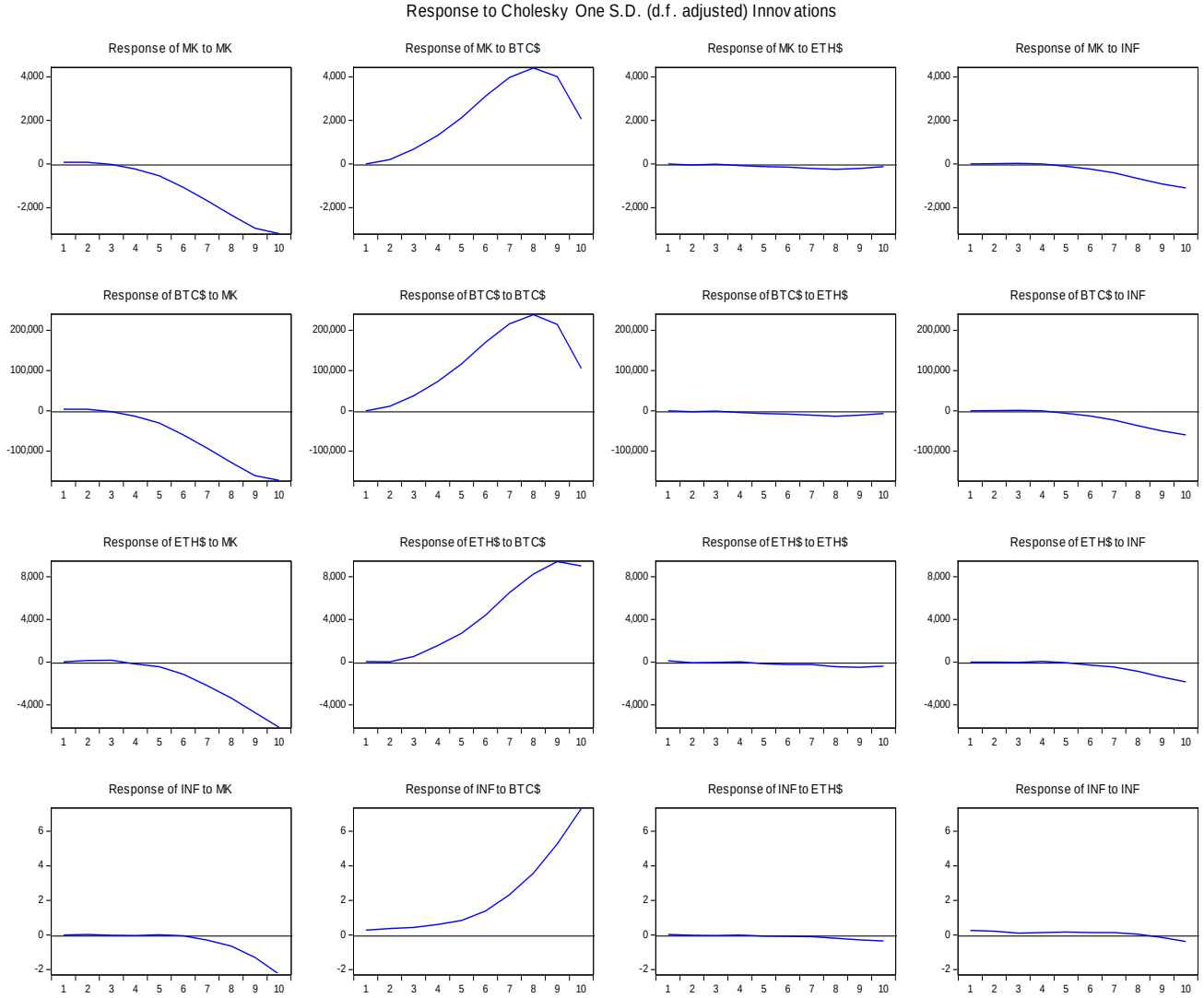


Figure 14: Impulse response functions.
Source: Plotted by author

Scope of future research and limitations

This paper enables potentialities of future research on capital market innovation for Bitcoin or other cryptocurrencies and how volatility of market capitalisation of Bitcoin influences on various assets of financial market and so on. The determinant of inflation differentials, interest rate and GDP were excluded from this simple analysis of the paper. It finds another scope of research in this area.

Policies of regulations

The complete ban on cryptocurrency trading is a solution otherwise partial regulations on its illegal trading can be done through[i] impositions on restrictions in cryptocurrency exchanges,[ii]setting quota on per day trading per exchange control,[iii] regulate buyer from his accounts of buying or selling cryptocurrencies,[iv] controlling on exchanging with US$ from home country,[v]setting centralised control on it through licensing,[vi] forcing to send returns on daily trading,[vii] monitoring through cyber security branches and so on.

CONCLUSION

The paper concludes that the trendline of Bitcoin price and Ethereum price in terms of dollar and the market capitalisation of Bitcoin during $2019m_1$ – $2021m_{12}$ showed non-linear with four phases starting with upward swings, all of which are significant and stable model. Hamilton filter model (2018) of market capitalisation of Bitcoin from $2017m_1$ to $2021m_{12}$ by applying STL method assured strong upward trend line

without swings and the cyclical patterns showed 8 peaks and 7 troughs and the seasonal variation constituted U shaped and the seasonal variation was diagnosed by autocorrelation and partial autocorrelation functions. The seasonal fluctuations were also tested by the seasonal unit root test. Wavelet Shrinkage Estimator noise assured the nonstationary behavior of market capitalization of Bitcoin.The Hamilton filter model of market capitalisation of Bitcoin was passed through automatically selected ARMA (1,3) model where autoregressive process is convergent and significant but the moving average process is convergent but insignificant which implies that the model is nonstationary but stable since the roots AR and MA of the model are less than one. The traditional multiple regression analysis suggested that the market capitalisation of Bitcoin is positively related with Bitcoin price and world inflation rate and inversely related with price of Ethereum during $201m_1$-$2021m_{12}$ which is significant and stable. Johansen cointegration and VAR model states that market capitalisation of Bitcoin has one significant cointegrating equation with Bitcoin and Ethereum price and inflation rate but its cointegrating equation diverged away from equilibrium because the long run causality is insignificant although there is significant short run bidirectional causality between Bitcoin price and Bitcoin market capitalisation and price of Ethereum has short run causality with market capitalisation of Bitcoin respectively during the specified period. All the impulse response functions move away from the equilibrium which implies that the volatility of market capitalisation of Bitcoin exhibits a never ending process.

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