

Impact of cryptocurrencies on financial markets

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Abstract:

Cryptocurrency is no longer an unfamiliar concept. With the development of the digital economy, cryptocurrencies have gradually replaced some functions of traditional currencies. This research aims to measure and evaluate the impact of cryptocurrencies on financial markets by considering their effects on exchange rates, gold prices, oil prices, and stock indices. Data for the analysis were collected on a weekly basis from 1 January 2014 to 28 February 2021. The multiple linear regression model was used to examine the relationships in the research model using the statistical analysis software SPSS 22. The research results indicate that cryptocurrencies have an impact on the financial market. Specifically, the research also identified the inverse effect of currency pairs on cryptocurrencies and the interaction between different cryptocurrencies. Consequently, financial market regulators, especially the agency responsible for monitoring the volatility of cryptocurrencies, exchange rates, gold prices, oil prices, and stock indices, have a basis for devising appropriate plans. From this research, managers can implement policies that enhance financial education and communication to help individuals understand the nature of virtual assets, especially cryptocurrencies, while creating motivation towards accepting cryptocurrencies in Vietnam.

Keywords: cryptocurrencies, exchange rates, financial markets.

Classification number: 2.1

1. Introduction

Cryptocurrency is no longer an unfamiliar concept. With numerous outstanding features, it serves as both a currency in commercial transactions and an investment channel. It facilitates currency agreements between countries, enhancing financial market performance and cross-border remittance services. However, cryptocurrencies alone are insufficient to meet policy goals. Presently, Vietnam has not yet recognised or protected transactions involving this currency [1].

There are various cryptocurrencies worldwide, with Bitcoin and Ethereum being the most popular and widely known. Bitcoin and Ethereum are valuable cryptocurrencies that operate on blockchain technology, promoting a peer-to-peer trust mechanism based on majority node consensus. Another notable cryptocurrency is Libra, which was developed by Facebook with the mission of simplifying the monetary system and financial infrastructure [2]. The Libra Association, based in Geneva, Switzerland, is a non-profit organization overseeing the development of Libra. It ensures the value of Libra through a real asset reserve fund and governs the blockchain's rules.

Additionally, other well-known cryptocurrencies include XRP (developed by Ripple) and Litecoin.

As of 3 March 2021, there were 4,476 types of cryptocurrencies with a total market capitalisation of \$1,552 billion. The market values of 10 popular cryptocurrencies are presented in Table 1.

Table 1. Market value of 10 popular cryptocurrencies (Updated at 16:00 on 3 March 2021).

No.	Cryptocurrencies	Signal	Current price (USD)	Total market cap (billion USD)
1	Bitcoin	BTC	50,876	949.41
2	Ethereum	ETH	1,591.8	183.10
3	Cardano	ADA	1.25272	40.17
4	Binance coin	BNB	249.63	38.89
5	Tether	USDT	1.001	35.90
6	Polkadot	DOT	38.43	35.20
7	XRP	XRP	0.45113	20.48
8	Litecoin	LTC	193.67	12.95
9	Chainlink	LINK	30.8	12.70
10	Bitcoin cash	BCH	539.27	10.10

Source: <https://vn.investing.com/>.

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From February 2018 to February 2021, cryptocurrencies such as Bitcoin, Ethereum, and Litecoin experienced significant value changes against the USD (Fig. 1). In February 2018, Bitcoin was priced at only 10,315 BIT/USD, but by February 2021, the value of this cryptocurrency had significantly increased to 45,300 BIT/USD.

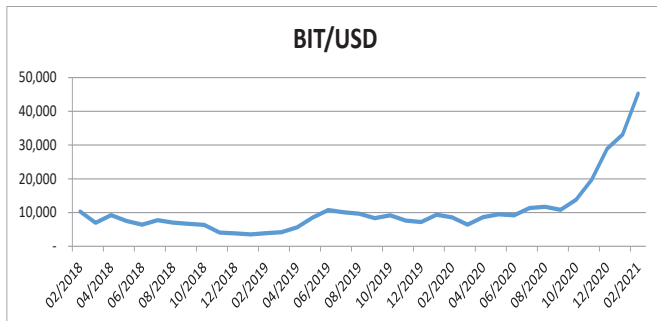


Fig. 1. Price change of Bitcoin between 2/2018-2/2021. Source: <https://vn.investing.com/>.

Over the course of three years, the value of Ethereum coin also showed a strong increase, rising from 850.85 ETH/USD to 1,418.23 ETH/USD, representing a 66.7% increase compared to the same period in 2018 (Fig. 2).

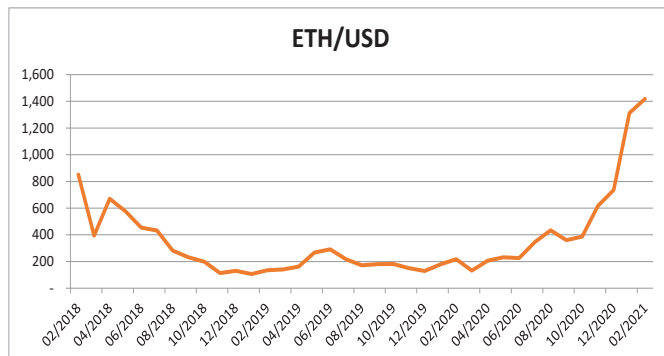


Fig. 2. Price change of Ethereum coin between 2/2018-2/2021. Source: <https://vn.investing.com/>.

While Bitcoin and Ethereum experienced substantial price increases, the Litecoin cryptocurrency remained relatively stable. In February 2018, the price of Litecoin was recorded as 202,550 LTC/USD, and by February 2021, it had decreased to 165,261 LTC/USD, equivalent to an 18.41% decrease (Fig. 3). At the end of 2018, this currency even hit a low point of only 29,830 LTC/USD.

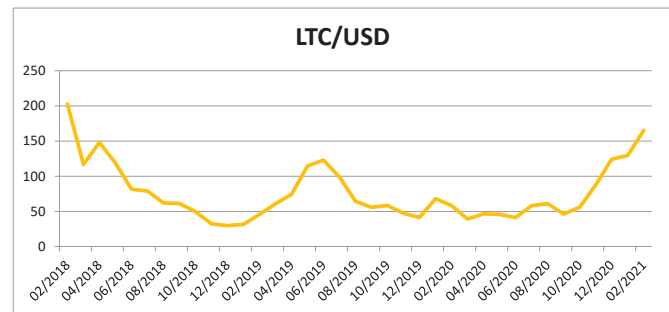


Fig. 3. Price change of Litecoin between 2/2018-2/2021. Source: <https://vn.investing.com/>.

With the development of the digital economy, cryptocurrencies have gradually replaced some functions of traditional currencies. Blockchain technology-based digital currencies offer high transaction efficiency, low transaction costs, protection against inflation to maintain asset value, and privacy [3].

According to Bloomberg statistics on currency rankings, the USD maintains the top position, although its market share has decreased compared to the previous month. The Euro follows with 37%, while the British Pound remains in third place. The Yen and the Chinese Yuan occupy the fourth and fifth positions, respectively (Table 2).

Table 2. World rankings of the most popular currencies.

Currency rating	Currency	1/2021	12/2020	1/2020
1	USD	38.26%	38.73%	40.81%
2	EUR	36.60%	36.70%	33.58%
3	GBP	6.80%	6.50%	7.05%
4	JPY	3.49%	3.59%	3.32%
5	CNY	2.42%	1.88%	1.65%

Source: Author's analysis on Yuan's popularity for global payments hits five-year high.

Given the uncertain legal status of the digital currency market, the lack of centralised regulatory institutions, the vulnerabilities of anonymous transactions, cross-border circulation, and other characteristics, there is a need to establish a unified global digital currency monitoring system.

Since the beginning of 2013, cryptocurrencies have garnered significant attention in the media and academia due to their highly volatile prices. With the continuous development and increasing popularity of

cryptocurrencies on a global scale, they have had an impact on other commodities in financial markets. This raises concerns about the impact of cryptocurrencies on the value of world currency pairs and financial markets in general. This study aims to measure and evaluate the impact of cryptocurrencies on financial markets by considering their effects on exchange rates, gold prices, oil prices, and stock indices. Additionally, the study will assess the impact of exchange rates on cryptocurrencies and the interactions between different cryptocurrencies.

2. Theoretical basis

2.1. Financial market

The financial market is a large market that encompasses various areas such as money management, insurance, banking, gold, securities, and more [4]. Financial markets provide a platform for buying and selling assets like bonds, stocks, foreign exchange, and derivatives. Businesses and investors can utilise the financial market to raise capital for business development and generate profits through investments.

Based on the influences brought about by financial markets, financial regulators in each country develop strategies suitable for the growth conditions of their respective countries. In financial markets, one of the most discussed issues is the exchange rate, which is usually directly regulated by the central bank. However, there are privately-issued coins in the world, such as the US Liberty Dollar minted between 1878 and 1904, and more recently, the \$1,000 bill in 1921. Additionally, the issuance of banknotes of the Hong Kong dollar is managed by Bank of China (Hong Kong) Limited, The Hongkong and Shanghai Banking Corporation Limited (HSBC), and Standard Chartered Bank Limited. In Vietnam, when referring to the financial market, many people immediately think of the stock market, derivatives, capital, insurance, gold, currencies, and commodities.

2.2. Cryptocurrencies

The concept of electronic money, or e-money, is understood in a wide range worldwide. The European Central Bank (ECB) describes a cryptocurrency as the monetary value stored on an electronic device commonly used to make payment transactions to other non-institutional entities. The Bank for International Settlements (BIS) defines electronic money as stored value or prepaid product, in which information about

the amount or available value of the customer is stored on an electrical device. In short, cryptocurrency is a digital currency based on cryptographic principles. Cryptocurrencies possess three unique characteristics: they provide anonymity, are independent of a central authority, and provide protection from a double spend attack [5].

Some argue that cryptocurrencies are a special form of information that has economic value unique to their owners. Cryptocurrencies can still serve as a kind of property right, making them assets [6]. In Vietnam, the draft Decree amending Decree No. 10/VBHN-NHNN from 22/02/2019 on non-cash payments recognises and provides a clear definition of electronic money: "Cryptocurrency is the monetary value stored on electronic means paid by customers to banks, foreign bank branches, and payment intermediary providers for making payment transactions. Its corresponding value is guaranteed by the bank. This includes prepaid cards, electronic wallets, and mobile money".

2.2.1. Bitcoin: Bitcoin is a cryptocurrency that operates on blockchain technology. It is primarily traded on online cryptocurrency exchanges. Unlike central banks that can arbitrarily adjust the supply of fiat currencies, the supply of Bitcoin is fixed and cannot be influenced by political decisions [7]. Bitcoin is a form of digital currency not issued by a government or a financial institution, but created and operated on a peer-to-peer computer system [8].

Being a digitally stored virtual currency, Bitcoin carries the risk of being hacked, stolen, having data altered, or experiencing trading suspensions [9]. Bitcoin can prompt financial institutions to update or add existing technologies, adjust fee structures, and enhance services or expertise to track and understand government regulatory issues. Blockchain technology can be leveraged to bring better efficiency to the financial services sector, potentially saving consumers billions of dollars per year [10]. Furthermore, the ability to value Bitcoin and related cryptocurrencies is becoming important for their establishment as legitimate financial assets [11].

2.2.2. Ethereum: Ethereum was introduced by founder Vitalik Buterin in late 2013, and the system was launched in 2015. It is the largest and most established decentralised software platform. As of January 2021, Ethereum has a market capitalisation of \$138.3 billion, roughly 19% of the size of Bitcoin [12].

Similar to the Bitcoin blockchain, an Ethereum blockchain is a platform that extends beyond facilitating a single digital currency. The main difference lies in Ethereum blocks, which not only contain block numbers and difficulty levels but also a list of recent transactions and states. Each transaction in the list creates a new state by applying the previous state [13].

2.2.3. Litecoin: After Bitcoin, Ethereum, and XRP, Litecoin is the fourth largest cryptocurrency by market capitalisation. Litecoin works similarly to Bitcoin, but transactions are processed much faster than Bitcoin. This makes Litecoin an attractive alternative coin for currency transactions.

Since more Litecoin can be generated through mining, the price of each Litecoin is cheaper than Bitcoin, making transactions easier. If Bitcoin is often referred to as “gold,” then Litecoin is seen as “silver.” Litecoin has a lower value than Bitcoin but is easier to access and better suited for regular transactions. The creation and transfer of Litecoin are based on an open-source protocol and are not regulated by any central authority.

2.3. The impact of cryptocurrencies on the financial markets

The significant growth in the quantity and value of cryptocurrencies poses challenges for financial and banking systems, as well as the management of central bank monetary policies aimed at controlling macroeconomic variables such as inflation, interest rates, and exchange rates [14].

Cryptocurrencies can influence the money supply in the market. When the total value of money changes relative to the total value of goods in the market, it affects product prices and consumption. Typically, governments take measures to adjust inflation by reducing output to stabilise prices or increasing prices to restore output. If citizens start using cryptocurrencies instead of the national currency, the demand for the national currency weakens, leading to its devaluation. Increased inflation of the national currency affects even those who do not accept cryptocurrencies [15].

Cryptocurrencies can impact a country's interest rates. A change in the price of a cryptocurrency can affect a country's monetary policy in three main ways: (1) by influencing the central bank's role as the bank for banks, (2) by affecting the central bank's role as the

government's bank, and (3) by impacting the central bank's credit control and guidance functions [16].

In the face of threats in traditional cross-border payments, cryptocurrencies are seen as an option in the financial market. Additionally, the popularity and continuous development of gaming services have helped cryptocurrencies become closer to society through service providers, which brings many potential risks.

The regulation of monetary policy for enabling technologies or personal identity influences cryptocurrency adoption and indirectly affects the quality of life [17]. A global currency can also help individuals diversify risk if its returns have a low or negative correlation with other risks [18]. However, cryptocurrencies also carry the risk of promoting illegal activities. The value of virtual currencies is primarily based on the demand for buying and selling the currency itself, posing risks related to high-tech crimes, money laundering, tax evasion, corruption, and financial market risks [19]. Operational risks involve actions that undermine the technological infrastructure and security assumptions of cryptocurrencies [20].

Another challenge arises from the fact that most Fintech providers operate through online platforms, requiring internet access for financial services. This has become the main business model for many providers [21]. The crypto market experiences intense competition as new forms of digital currency emerge, allowing secure transactions over the internet, accessible to anyone with a phone or internet connection, and offering convenience and cost-effective services similar to email. As Bitcoin's value rises against the US dollar, it also gains value relative to other cryptocurrencies [22].

Therefore, it is necessary for digital currency to monitor systems to mitigate the impact of cryptocurrencies on financial markets (Fig. 4).

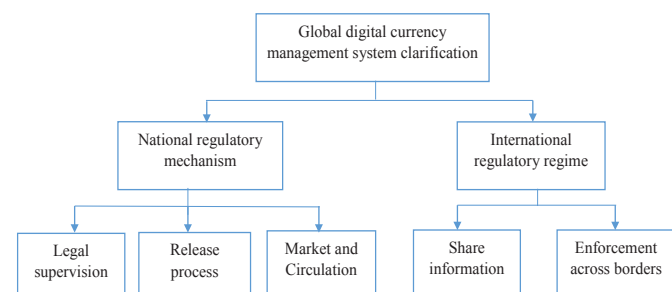


Fig. 4. Digital currency monitoring system [3].

2.4. Previous studies

First, a study by M.L. Erdas, et al. (2018) [23] examined the asymmetric causal relationship between Bitcoin and gold, Brent oil, the US Dollar, the S&P 500 index, and BIST 100 using weekly data from November 2013 to July 2018. The results indicated a relationship between the price of Bitcoin and the S&P 500 Index.

Z. Khamisa (2019) [24] explored the cryptocurrency market in more detail than previous studies, using the latest data and analysing more cryptocurrencies. The author collected data from 4 November 2015 to 31 December 2018, with a sample size of 1154 observations. The dependent variable was the market price of the relevant cryptocurrency in USD. The independent variables were divided into three groups: Market microstructure (Transaction volume, Circulating supply), Financial market (Morgan Stanley Capital International (MSCI) index, Volatility Index (VIX) index, gold price, oil price), and attention (Wikipedia visits). The study utilised the STATA 15.1 statistical analysis tool to conduct statistical analysis, run ordinary least squares (OLS) regression, and apply Cointegration correction model and vector (if cointegration was present). Otherwise, the standard vector autoregressive (VAR) model was used. The research results showed that trading volume was the main driving factor for the market. In theory, cryptocurrencies should perform better the more they are used. However, the results from the model suggested that volume shocks had a negative impact on prices in the long run. Additionally, the study also showed that the MSCI World index and oil price had no relationship with cryptocurrency price performance. However, there were interesting relationships with the price of gold, particularly with Bitcoin, Ethereum, and Monero. Furthermore, the VIX index also showed a relationship in the research model for cryptocurrencies like Bitcoin, Ethereum, and Monero.

Recently, B.Y. Almansour, et al. (2020) [25] examined the impact of exchange rates, including USD/AUD, USD/EUR, USD/GBP, and USD/JPY, on Bitcoin returns from 2014 to 2019 using the ARMA model to estimate maximum likelihood. The results indicated that Bitcoin's returns were not significantly affected by the values of foreign currencies USD/JPY, USD/EUR, USD/GBP, and USD/AUD, with a confidence level of 95%. However, GBP showed significance at a 90% confidence level. The study also suggested the possibility of expanding the investigation of the impact of exchange rates on cryptocurrencies by considering other digital currencies, not just Bitcoin. V.J. Serranía,

et al. (2021) [26] discussed the legal issues related to cryptocurrencies in the financial markets and highlighted the potential risks they pose to the financial sector. N. Chiriță, et al. (2022) [27] provided a new perspective on the development of cryptocurrencies and their interaction with other markets, emphasizing their impact on the financial system.

2.5. Research model and hypothesis

Based on the research models of previous studies [23-25] the author constructs a research model to assess the impact of cryptocurrencies on the financial market and examine the interaction between exchange rates and cryptocurrencies. The specific research model is depicted in Fig. 5.

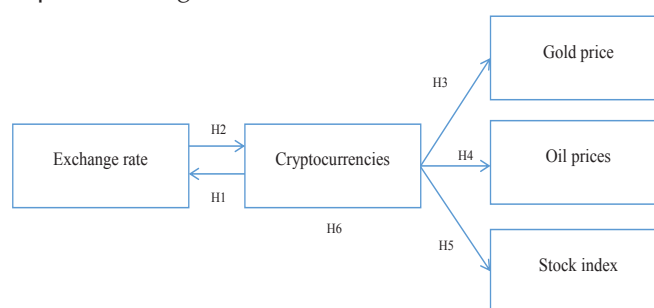


Fig. 5. Research model. Source: Author's research model.

Six research questions were posed in this study:

Research question 1: How do cryptocurrencies affect exchange rates?

Research question 2: Do exchange rates have an impact on cryptocurrencies?

Research question 3: How do cryptocurrencies affect the price of gold?

Research question 4: How do cryptocurrencies affect the prices of oil?

Research question 5: How do cryptocurrencies affect stock indices?

Research question 6: Are there any interactions among cryptocurrencies?

Based on the research model, the author sets out 6 research hypotheses as follows:

H1: There is an impact of cryptocurrencies on exchange rates.

H2: There is an exchange rate effect on cryptocurrencies.

H3: There is an impact of cryptocurrencies on the price of gold.

H4: There is an impact of cryptocurrencies on the price of oil.

H5: There is an impact of cryptocurrencies on stock indices.

H6: There is an interplay among cryptocurrencies.

3. Research methods

3.1. Research data

Data for this study was collected from 1 January 2014 to 28 February 2021. Currency pair data in this study is determined on the last day of each week. The research data was sourced from the Investing website (<https://www.investing.com/>). For detailed information about the research data, please refer to the provided source. The variables in the research model are presented in Table 3.

Table 3. Variables of the model.

Variable name	Variable details	Signal
1	Bitcoin	BIT
2	Cryptocurrencies	Ethereum
3		ETH
4		Litecoin
5	Exchange rate	LTC
6		Australian Dollar
7		AUD
8		Euro
9		EUR
10	Exchange rate	GBP
11		GBP
12		Canadian Dollar
13	Exchange rate	CAD
14		Yen
15		JPY
16	Exchange rate	Vietnamese Dong
17		VND
18		
19	Gold price	Gold price
20	Oil price	Oil prices
21	Stock index	Stock index of the S&P 500
22		SP500

Source: <https://vn.investing.com/>.

There are several standard oil prices, such as crude oil and Brent crude. For this study, the Brent Oil Futures index was chosen over Crude Oil WTI Futures, as WTI is the primary global benchmark for pricing and actually has better quality than Brent. Additionally, the chosen currencies include the Australian Dollar, Euro, British Pound, Canadian Dollar, Yen, and Vietnamese Dong. These currencies were selected due to their popularity, with the exception of the Vietnamese Dong, which is the author's native currency.

3.2. Research methods

The author conducted data synthesis using Microsoft Excel software. The relevant variables were included in Pearson correlation analysis to determine the linear relationship between them. Regression analysis was then employed, given the confirmation of a linear relationship through correlation analysis. The Pearson correlation coefficient (r) has a value ranging from -1 to

+1. The absolute value of r approaches 1 when the two variables are strongly correlated, while a value of $r = 0$ indicates no linear relationship between the variables.

Through testing, the author will determine the correlation level between the variables and assess compatibility using ANOVA analysis. If the significance value (Sig.) > 0.05 , there is no difference in variance, and if $\text{Sig.} < 0.05$, there is a significant difference in variance. The multiple linear regression model will be used to examine the relationships in the research model through SPSS 22 statistical software. Moreover, the study will determine the influence of factors through beta coefficients, where a larger beta coefficient indicates a higher degree of influence compared to other factors in the research model.

4. Results and discussion

4.1. Descriptive statistics

The sample used in this study consists of 374 observations collected from 1 January 2014 to 28 February 2021. Descriptive statistics were used to analyse the variables in the study. Table 4 provides a summary of the variables.

Table 4. Summary of variable statistics.

	Sample	Minimum	Maximum	Mean	Std. deviation
BIT	374	209.90	55838.00	5472.9374	7657.41818
ETH	163	83.85	1915.74	376.1767	342.10753
LTC	163	23.610	227.890	80.06805	46.108112
AUD	374	0.5799	0.9424	0.756878	0.0701749
EUR	374	1.0451	1.3914	1.160365	0.0811791
GBP	374	1.1643	1.7160	1.386774	0.1392280
CAD	374	1.0655	1.4540	1.281746	0.0813508
JPY	374	100.22	125.62	110.4347	5.91850
VND	374	21060	23623	22544.34	724.952
GOLD	374	1058.81	2034.62	1351.5279	215.27667
OIL	374	16.94	107.26	56.7114	18.16416
SP500	374	1782.59	3934.83	2523.8835	517.62571

Source: <https://vn.investing.com/>.

The descriptive reveals the following information about the variables in the research model: Among the cryptocurrency variables, Bitcoin had a minimum value of 209.90 on 18 January 2015, and a maximum value of 55,838.00 on 14 February 2021. Ethereum ranged from a minimum of 83.85 on 9 December 2018, to a maximum of 1,915.74 on 14 February 2021. Litecoin had a minimum value of 23.610 on 9 December 2018, and a maximum value of 227.890 on 11 February 2018.

In terms of the exchange rate variables, the Australian Dollar (AUD) had a minimum value of 0.5799 on 15 March 2020, and a maximum value of 0.9424 on 22 June 2014. The Euro ranged from a minimum of 1.0451 on 11 December 2016, to a maximum of 1.3914 on 9 March 2014. The British Pound (GBP) had a minimum value of 1.1643 on 15 March 2020, and a maximum value of 1.7160 on 29 June 2014. The Canadian Dollar (CAD) ranged from a minimum of 1.0655 on 29 June 2014, to a maximum of 1.4540 on 10 January 2016. The Vietnamese Dong (VND) had a minimum value of 21,060 on 26 January 2014, and a maximum value of 23,623 on 22 March 2020.

For the Gold (GOLD) variable, the minimum market value was 1,058.81 on 22 November 2015, and the highest value was 2,034.62 on 2 August 2020.

The Crude Oil (OIL) variable ranged from a minimum of 16.94 on 19 April 2020, to a maximum of 107.26 on 15 June 2014.

Regarding the S&P500 Index (SP500) variable, the lowest value observed was 1,782.59 on 26 January 2014, and the highest value was 3,934.83 on 7 February 2021.

These descriptive statistics provide an overview of the variable distributions and their ranges throughout the study period.

4.2. Correlation between variables

Table 5 shows the correlation between the dependent and independent variables, the results of the Pearson correlation test indicate that when the correlation between variables has a Sig value <0.05, it signifies a significant correlation. These correlated variables will be used in the regression analysis. Therefore, except for two cases (the correlation between BIT and EUR, and LTC and GOLD), all other variables show a correlation. Hence, these relationships need to be omitted in the multiple regression analysis to ensure higher accuracy.

Table 5. Correlation of variables.

		BIT	ETH	LTC	AUD	EUR	GBP	CAD	JPY	VND	GOLD	OIL	SP500
BIT	Pearson correlation	1											
	Sig. (2-tailed)												
ETH	Pearson correlation	0.850**	1										
	Sig. (2-tailed)	0.000											
LTC	Pearson correlation	0.569**	0.810**	1									
	Sig. (2-tailed)	0.000	0.000										
AUD	Pearson correlation	-0.221**	0.695**	0.674**	1								
	Sig. (2-tailed)	0.000	0.000	0.000									
EUR	Pearson correlation	0.066	0.723**	0.666**	0.825**	1							
	Sig. (2-tailed)	0.202	0.000	0.000	0.000								
GBP	Pearson correlation	-0.316**	0.684**	0.686**	0.770**	0.668**	1						
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000							
CAD	Pearson correlation	0.167**	-0.625**	-0.652**	-0.931**	-0.852**	-0.797**	1					
	Sig. (2-tailed)	0.001	0.000	0.000	0.000	0.000	0.000						
JPY	Pearson correlation	-0.309**	-0.437**	-0.320**	-0.244**	-0.498**	0.112*	0.233**	1				
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.030	0.000					
VND	Pearson correlation	0.485**	-0.585**	-0.690**	-0.828**	-0.551**	-0.879**	0.798**	-0.085	1			
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.101				
GOLD	Pearson correlation	0.680**	0.282**	-0.042	-0.278**	0.071	-0.353**	0.189**	-0.541**	0.451**	1		
	Sig. (2-tailed)	0.000	0.000	0.593	0.000	0.173	0.000	0.000	0.000	0.000			
OIL	Pearson correlation	-0.112*	0.188*	0.400**	0.792**	0.810**	0.617**	-0.843**	-0.330**	-0.560**	-0.239**	1	
	Sig. (2-tailed)	0.031	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
SP500	Pearson correlation	0.821**	0.518**	0.192*	-0.509**	-0.168**	-0.615**	0.410**	-0.294**	0.775**	0.785**	-0.270**	1
	Sig. (2-tailed)	0.000	0.000	0.014	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	

** : correlation is significant at the 0.01 level (2-tailed).

* : correlation is significant at the 0.05 level (2-tailed).

Source: <https://vn.investing.com/>.

4.3. Research results

To establish an overall model, the F-test in the ANOVA variance analysis table needs to be considered. The results of the F-statistic test, with a Sig value of 0.000 (<0.05), indicate that the multiple linear regression model is appropriate.

4.3.1. Impact of cryptocurrencies on exchange rates: In examining the impact of cryptocurrencies on exchange rates, the following regression results are obtained.

Regression results in Table 6 indicate that the variables AUD, GBP, CAD, JPY, and VND have significance levels (Sig) less than 0.05. Hence, it can be concluded that BIT has an impact on AUD, GBP, CAD, JPY, and VND. Specifically, BIT has a positive impact on CAD and VND, whereas it has a negative impact on AUD, GBP, and JPY. The EUR variable is not considered in the regression results of the independent variable BIT due to the absence of variable correlation. Additionally, there is no issue of multicollinearity as the VIF values for all tests are less than 2.

Table 6. Regression results of the independent variable BIT.

Model	Unstandardised coefficients		Standardised coefficients	t	Sig.
	B	Std. error	Beta		
AUD	-0.000002877	0.000	-0.629	-6.190	0.000
GBP	-0.000003228	0.000	-0.565	-5.430	0.000
CAD	0.0000009923	0.000	0.253	2.121	0.035
JPY	0.000	0.000	-0.793	-5.993	0.000
VND	0.018	0.002	0.876	9.191	0.000

Source: <https://vn.investing.com/>.

Regression results in Table 7 indicate that the variables AUD, EUR, GBP, CAD, JPY, and VND have significance levels (Sig) less than 0.05. Therefore, with a significance level of 5%, it can be concluded that there is an impact of ETH on variables AUD, EUR, GBP, CAD, JPY, and VND. Specifically, the variable ETH has a positive impact on AUD, EUR, GBP, JPY, and VND; conversely, it has a negative effect on CAD. There is no occurrence of multicollinearity, as the VIFs of all tests are less than 2.

Table 7. Regression results of the independent variable ETH.

Model	Unstandardised coefficients		Standardised coefficients	t	Sig.
	B	Std. error	Beta		
AUD	0.000	0.000	1.146	8.035	0.000
EUR	0.000	0.000	1.012	6.930	0.000
GBP	0.000	0.000	1.012	6.930	0.000
CAD	-0.00005742	0.000	-0.570	-3.406	0.001
JPY	0.003	0.001	0.379	2.041	0.043
VND	-0.576	0.072	-1.066	-7.975	0.000

Source: <https://vn.investing.com/>.

Regression results in Table 8 show that the significance levels corresponding to the variables EUR, GBP, CAD, and VND have Sig values less than 0.05. Therefore, at a significance level of 5%, it can be concluded that there is an impact of LTC on the variables EUR, GBP, CAD, and VND. Specifically, the variable LTC has a positive impact on EUR and GBP variables, while it has a negative impact on CAD and VND variables. The regression results show that the variables AUD and JPY are not statistically significant in the independent variable LTC. Furthermore, no multicollinearity is observed as the VIFs of all tests are less than 2.

Table 8. Regression results of the independent variable LTC.

Model	Unstandardised coefficients		Standardised coefficients	t	Sig.
	B	Std. error	Beta		
AUD	0.00009111	0.000	0.105	1.145	0.254
EUR	0.000	0.000	0.236	2.586	0.011
GBP	0.000	0.000	0.188	2.012	0.046
CAD	0.000	0.000	-0.334	-3.121	0.002
JPY	-0.010	0.007	-0.175	-1.473	0.143
VND	-1.303	0.343	-0.325	-3.798	0.000

Source: <https://vn.investing.com/>.

4.3.2. Impact of exchange rates on cryptocurrencies: Next, considering the impact of exchange rates on cryptocurrencies in the research model, we obtain the following results:

Similarly, regression results in Table 9 show that the significance levels corresponding to the variables

GBP, CAD, JPY, and VND have Sig values less than 0.05. Therefore, at a significance level of 5%, it can be concluded that there is an impact of GBP, CAD, JPY, and VND on the variable BIT. Specifically, GBP and VND have a positive impact on BIT, while CAD and JPY have a negative impact. The variable AUD does not show statistical significance. No multicollinearity is observed as the VIF of all tests is less than 2.

Table 9. Regression results of the dependent variable BIT.

Model	Unstandardised coefficients		Standardised coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	-243048.334	43554.431		-5.580	0.000
AUD	13305.668	13823.047	0.122	0.963	0.336
GBP	20181.948	5183.222	0.367	3.894	0.000
CAD	-27019.303	11367.684	-0.287	-2.377	0.018
JPY	-204.745	65.807	-0.158	-3.111	0.002
VND	11.875	1.084	1.124	10.951	0.000

Source: <https://vn.investing.com/>.

Regression results in Table 10 show that the significance levels corresponding to the variables AUD, GBP, and JPY have Sig values less than 0.05. Therefore, at a significance level of 5%, it can be concluded that there is an impact of AUD, GBP, and JPY on the variable ETH. Specifically, AUD and GBP have a positive impact on ETH, while JPY has a negative impact. The variables EUR, CAD, and VND do not show statistical significance. No multicollinearity is observed as the VIF of all tests is less than 2.

Table 10. Regression results of the dependent variable ETH.

Model	Unstandardised coefficients		Standardised coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	-1426.419	4299.952		-0.332	0.741
AUD	4015.310	1452.303	0.472	2.765	0.006
EUR	-665.790	1217.498	-0.085	-0.547	0.585
GBP	2178.152	749.394	0.320	2.907	0.004
CAD	-190.468	991.033	-0.019	-0.192	0.848
JPY	-47.297	8.399	-0.359	-5.631	0.000
VND	0.097	0.151	0.052	0.642	0.522

Source: <https://vn.investing.com/>.

Regression results in Table 11 show that the significance levels corresponding to the variables GBP, JPY, and VND have Sig values less than 0.05. Therefore, at a significance level of 5%, it can be concluded that there is an impact of GBP, JPY, and VND on the variable LTC. Specifically, GBP has a positive impact on LTC, while JPY and VND have a negative impact. The variables AUD, EUR, and CAD do not show statistical significance. No multicollinearity is observed as the VIF of all tests is less than 2.

Table 11. Regression results of the dependent variable LTC.

Model	Unstandardised coefficients		Standardised coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	2106.121	608.115		3.463	0.001
AUD	202.497	205.390	0.176	0.986	0.326
EUR	-113.488	172.183	-0.107	-0.659	0.511
GBP	227.391	105.982	0.248	2.146	0.033
CAD	-215.095	140.155	-0.161	-1.535	0.127
JPY	-3.606	1.188	-0.203	-3.036	0.003
VND	-0.072	0.021	-0.287	-3.355	0.001

Source: <https://vn.investing.com/>.

4.3.3. Impact of cryptocurrencies on gold price:

Considering the impact of cryptocurrencies on the price of gold in the research model, the results are as follows:

Regression results in Table 12 show that the significance levels corresponding to the variables BIT and ETH, with Sig values of 0.000, are less than 0.05. Therefore, at a significance level of 5%, it can be concluded that there is an impact of BIT and ETH on the variable GOLD. Specifically, BIT has a positive impact on GOLD, while ETH has a negative impact. The regression results for the dependent variable GOLD do not consider the EUR variable due to the absence of variable correlation. No multicollinearity is observed, as the VIFs of all tests are less than 2.

Table 12. Regression results of the dependent variable GOLD.

Model	Unstandardised coefficients		Standardised coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	1356.398	23.831		56.916	0.000
BIT	0.029	0.003	1.051	8.934	0.000
ETH	-0.439	0.084	-0.612	-5.202	0.000

Source: <https://vn.investing.com/>.

4.3.4. Impact of cryptocurrencies on oil prices: Considering the impact of cryptocurrencies on oil prices in the research model, the results are as follows:

Similarly, regression results in Table 13 show that the significance levels corresponding to the BIT and LTC variables, with Sig values of 0.000, are less than 0.05. Therefore, at a significance level of 5%, it can be concluded that there is an impact of BIT and LTC on the variable OIL. Specifically, LTC has a positive impact on OIL, while BIT has a negative impact. No statistical significance was found for the variable ETH. No multicollinearity is observed, as the VIFs of all tests are less than 2.

Table 13. Regression results of the dependent variable OIL.

Model	Unstandardised coefficients		Standardised coefficients		t	Sig.
	B	Std. error	Beta			
(Constant)	47.309	2.001			23.638	0.000
BIT	-0.001	0.000	-0.530		-3.826	0.000
ETH	0.008	0.007	0.205		1.055	0.293
LTC	0.146	0.034	0.535		4.301	0.000

Source: <https://vn.investing.com/>.

4.3.5. Impact of cryptocurrencies on stock index: Considering the impact of cryptocurrencies on the stock index in the research model, the results are as follows:

Regression results in Table 14 show that the significance levels corresponding to the BIT and LTC variables have Sig values less than 0.05. Therefore, at a significance level of 5%, it can be concluded that there is an impact of BIT and LTC on the variable SP500. Specifically, BIT has a positive impact on SP500, while LTC has a negative impact. No statistical significance was found for the variable ETH. No multicollinearity is observed, as the VIFs of all tests are less than 2.

Table 14. Regression results of the dependent variable SP500.

Model	Unstandardised coefficients		Standardised coefficients		t	Sig.
	B	Std. error	Beta			
(Constant)	2796.724	36.050			77.579	0.000
BIT	0.043	0.004	1.092		12.200	0.000
ETH	-0.187	0.128	-0.182		-1.453	0.148
LTC	-2.141	0.610	-0.282		-3.510	0.001

Source: <https://vn.investing.com/>.

4.3.6. Interactions between cryptocurrencies: Furthermore, when considering the interaction between cryptocurrencies in the research model, the results are as follows.

Regression results in Tables 15, 16, and 17 show that, with a significance level of 5%, it can be concluded that BIT, ETH, and LTC have an impact on each other. Specifically, BIT has the same impact on ETH and has the opposite effect on LTC. ETH has a positive impact on both BIT and LTC. LTC has the same directional impact on ETH and the opposite impact on BIT. No multicollinearity is observed, as the VIFs of all tests were less than 2.

Table 15. Regression results of the dependent variable BIT.

Model	Unstandardised coefficients		Standardised coefficients		t	Sig.
	B	Std. error	Beta			
(Constant)	4937.900	698.259			7.072	0.000
ETH	29.086	1.682	1.132		17.296	0.000
LTC	-66.310	12.478	-0.348		-5.314	0.000

Source: <https://vn.investing.com/>.

Table 16. Regression results of the dependent variable ETH.

Model	Unstandardised coefficients		Standardised coefficients		t	Sig.
	B	Std. error	Beta			
(Constant)	-147.210	18.905			-7.787	0.000
BIT	0.022	0.001	0.576		17.296	0.000
LTC	3.580	0.247	0.482		14.497	0.000

Source: <https://vn.investing.com/>.

Table 17. Regression results of the dependent variable LTC.

Model	Unstandardised coefficients		Standardised coefficients		t	Sig.
	B	Std. error	Beta			
(Constant)	44.322	3.092			14.336	0.000
BIT	-0.002	0.000	-0.431		-5.314	0.000
ETH	0.159	0.011	1.177		14.497	0.000

Source: <https://vn.investing.com/>.

4.4. Research discussion

Based on the research results, the author concludes that there is an impact of cryptocurrencies on financial markets, including exchange rates, gold prices, oil prices, and the S&P 500 stock index. All the initial

hypotheses can be accepted. Additionally, the study also found a strong interaction between currency pairs (exchange rates) and cryptocurrencies. The summaries of research results are shown in Tables 18, 19, and 20 below.

Table 18. Summary of the results of the impact of cryptocurrencies on financial markets.

	BIT	ETH	LTC
AUD	-	+	X
EUR	X	+	+
GBP	-	+	+
CAD	+	-	-
JPY	-	+	X
VND	+	-	-
GOLD	+	-	X
OIL	-	X	+
S&P500	+	X	-

Source: Author's summary of the above results.

Table 19. Summary of the results of exchange rate impact on cryptocurrencies.

	AUD	EUR	GBP	CAD	JPY	VND
BIT	X	X	+	-	-	+
ETH	+	X	+	X	-	X
LTC	X	X	+	X	-	-

Source: Author's summary of the above results.

Table 20. Summary of the results of the interplay between cryptocurrencies.

	BIT	ETH	LTC
BIT	X	+	-
ETH	+	X	+
LTC	-	+	X

Source: Author's summary of the above results.

Note: +: indicates a positive impact between the two variables; -: indicates an opposite effect between the two variables; X: indicates no effect between the two variables.

The study shows partial consensus with previous studies [23-25]. However, the research results also differ from two studies [24, 25]. Z. Khamisa's study (2019) [24], which attests that there is no relationship

between oil prices and cryptocurrency price performance, differs from this study which shows that cryptocurrencies have an impact on oil prices, particularly with Bitcoin having a negative impact and Litecoin having a positive impact. Ethereum aligns with Khamisa's findings. The difference may stem from the data collection time in Z. Khamisa's study, which spanned from 4 November 2015 to 31 December 2018. Additionally, the research methods employed also affect the results. While previous study used the OLS regression model in conjunction with Cointegration and Vector Error Correction Models (VECMs), this study used multiple regression models for implementation [24]. Regarding the study of B.Y. Almansour, et al. (2020) [25], which found that Bitcoin's returns are not significantly affected by foreign currency values except for GBP at a 90% confidence level, this study shows that Bitcoin has an impact on most exchange rate variables (except for the Euro, which was not statistically significant). The difference may be due to the variation in data collection periods, with a study spanning from 2014 to 2019 and this study covering the period from 1 January 2014 to 28 February 2021 [25]. Therefore, the results of this research model remain consistent.

5. Conclusions

The research results demonstrate that cryptocurrencies have an impact on financial markets. The study also reveals the opposite effect of exchange rates on cryptocurrencies, depending on the currency pair. Moreover, there is an interplay between cryptocurrencies Bitcoin, Ethereum, and Litecoin. Financial market regulators, particularly agencies responsible for monitoring cryptocurrency volatility, exchange rates, gold prices, oil prices, and stock indices, now have a basis for developing appropriate plans.

Although cryptocurrencies are not yet recognised as legal transactions and investments in Vietnam, global trends suggest that Vietnam will have access to cryptocurrencies in the future. With measures to encourage non-cash payments, the State Bank has given some opinions on the matter by submitting Decree No. 80/2016/ND-CP on amending and

supplementing a number of articles, Decree No. 101/2012/ND-CP on non-cash payments, and Decree No. 96/2014/ND-CP on administrative sanctions to the Government for promulgation. With the Bank's efforts to amend relevant decrees and regulations, there is increasing momentum towards cryptocurrency adoption. However, strict control and tailored monetary policies in the financial market should be considered based on more specific and in-depth studies.

The relationship between commodity prices such as gold, oil, and stock indices and exchange rate indices can influence the decisions of crypto investors in financial markets. Therefore, there should be measures to enhance financial education and communication to help individuals understand the nature of virtual assets, especially cryptocurrencies. This will enable investors to make informed decisions and avoid falling victim to scams.

This study assessed the impact of cryptocurrencies on financial markets through 374 weeks of data collected between 1 January 2014 and 28 February 2021. Given the rapidly changing nature of the cryptocurrency market, there may have been subsequent developments that could affect the results. Increasing the sample size in future studies would also lead to more accurate findings. Additionally, the impact assessment only focused on four variables: exchange rates, gold prices, oil prices, and the S&P 500 index. There are numerous other factors that cryptocurrencies may affect in the financial market, such as capital flows, the size of the stock market, bank credit, economic growth, inflation, and prices of other commodities like silver, copper, and agricultural products. Future studies could explore these factors to further develop research models. Furthermore, this study only considered three cryptocurrencies: Bitcoin, Ethereum, and Litecoin. Many other cryptocurrencies were not included, such as Cardano, Binance Coin, Tether, Polkadot, XRP, Chainlink, and Bitcoin Cash, and they may have different effects. Therefore, further research is needed to assess the impact of cryptocurrencies comprehensively.

In conclusion, the study indicates that cryptocurrencies have an impact on financial markets. The study also reveals the interplay between cryptocurrencies and exchange rates. This provides a basis for financial market regulators to develop appropriate strategies. Despite the limitations, this study contributes to the research community and serves as a baseline for future studies in this area.

COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.

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