Relationship between Gold and Cryptocurrencies: Evidence From the Granger Causality Tests

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Abstract: Cryptocurrencies such as Bitcoin are establishing themselves as an investment asset and are often named the New Gold. Firstly, we analyze and compare conditional variance properties of Bitcoin and Gold as well as other cryptocurrencies. Results show that cryptocurrencies generate much greater returns and risks than gold. Secondly, a Granger causality test between gold and cryptocurrencies indicates that an increase in gold prices tends to lead a rise in cryptocurrency prices, while the influence of cryptocurrency price changes on gold prices does not go in the same direction. These findings show that cryptocurrencies may not be a perfect substitution for gold as an inflation hedge.

Key words: Bitcoin , Cryptocurrency, Gold, Investment assets

1. Introduction

Currency always functions as an important means of exchange for financial markets. From the currency development history, many changes in the morphology and function of currencies have been experienced over time, associated with development of the world economy, i.e,. from commodity currencies such as non-metallic currencies (commodities) and metal currencies (money, zinc, copper), to currencies including coins (coins) and banknotes. Nowadays, due to the rapid development of credit institutions, along with the advances in information technology and telecommunication networks, many types of cryptocurrencies have

been introduced. These cryptocurrencies such as Bitcoin, Ethereum, Litecoin, Monero, Ripple, *etc*., have been popularly used as payment instruments and are considered as virtual assets, new investment assets in the financial markets. Given these, the cryptocurrency markets have been increasingly developed in size due to their outstanding advantages in transaction costs, transaction time, solvency, convenience and compactness. However, the role of cryptocurrencies as a means of payment has still been controversial, leading to various reactions to cryptocurrencies in countries and international institutions. Particularly, some countries accept virtual currencies as a means of payment (e.g., Japan, England, Australia, Argentina, Denmark), while a number of other countries do not recognize, or even ban the circulation of cryptocurrencies (e.g., Russia, India, Banladesh, Bolivia, Ecuador, China, Taiwan, Poland). Having been considered as investment assets such as stocks, gold, and dollars, the development of cryptocurrencies market has implications for the financial markets. As a large amount of capital flows into cryptocurrencies market, investment resources for other assets market are reduced. The high fluctuations in prices of virtual currencies may lead to changes in the risk profile of investors, and hence their expected returns for other financial assets.

Among many investment assets, gold is considered as a safe-haven and a hedge for inflation. This precious metal can add value when the stock market loses points, or in economic downturns. Due to gold's limited quantity by nature, it cannot be printed as banknotes, making it scare and valuable. Sharing similarities with gold, virtual currencies are technically limited in quantities, thus their emergence has raised the question whether they can play a similar role as gold (Klein & ctg, 2018). The answer for this question may be found by investigating the relationship between cryptocurrency prices and gold prices? If they both tend to move together in the same direction, virtual currencies could be a good substitute for gold in investment portfolios. To date, no research has been concerned about this issue. Therefore, this study will contribute to building a theoretical basis for other research in the future.

2. Literature review

2.1 Cryptocurrencies

The appearance of cryptocurrencies has marked a breakthrough in technology development, attracting more attention from the community; therefore, they have been popularly used as payment instruments and are considered as virtual assets, new investment assets in the financial markets. These high-tech products include cryptocurrencies such as Bitcoin, Ethereum, Litecoin, Monero, Ripple, *etc*. However, the role of cryptocurrencies as a means of payment has still been controversial, which led to various treatment for cryptocurrencies in countries and international institutions. Some countries accept virtual currencies as a means of payment (e.g., Japan, England, Australia, Argentina, Denmark), while a number of other countries do not recognize, or even ban the circulation of cryptocurrencies (e.g., Russia, India, Bangladesh, Bolivia, Ecuador, China, Taiwan, Poland) and currently there is no legal framework for cryptocurrencies in the world.

In the US, cryptocurrencies is considered any type of digital unit used as an exchange medium or a form of digital storage. Accordingly, cryptocurrencies is understood to include digital exchange units, in which: there is a centralized repository or is managed by an administrator; either decentralized and no centralized repository or managed by an administrator; or can be created or obtained by calculation or production. In

Europe, virtual money is defined as "a digital representation of a value not issued by the Central Bank or public authorities, also tied to a legal currency, with no legal status in monetary, however it is accepted by individuals or legal entities as a means of exchange or for other purposes and may be transferred, stored or electronically traded.

According to Yermack (2015), cryptocurrencies like Bitcoin do not get the criteria of a real currency, the daily transaction volume is low because there are few people accepting it, the price fluctuates sharply, particularly in the short term. Therefore, risk management is extremely difficult for owners. The price of converting consumer goods of cryptocurrencies requires decimal places with a sequence of leading zeros leading to inconvenience for retail participants. Moreover, the risk of hacker attacks and theft, lack of connection to the banking system and deposit insurance, is not used in consumer credit regulations or loan contracts. Therefore, cryptocurrencies are more like an investment, speculation than a currency. In general, virtual money cannot be considered as a true currency because they do not meet international requirements and principles in currency issuance and circulation.

European Central Bank (2012) states that cryptocurrencies do not create danger to financial stability because of restriction in connecting to the real economy, low transaction volumes, and lack of widespread acceptance of consumers. However, the cryptocurrencies have the highest risk among all types of virtual currencies, since investors are not fully informed about the risk due to the absence of sufficient protection mechanisms from regulatory bodies (Vandezande, 2017). Although it can be considered as a type of investment asset and a risky investment channel, the high investment demand in recent years has pushed up prices and market capitalization of cryptocurrencies. Therefore, it is not surprising that investors are attracted to the high growth of cryptocurrencies and seek to achieve these unusual returns. Many communication agencies as well as researchers are interested in cryptocurrencies; however, the most of the studies focus on Bitcoin and ignore other cryptocurrencies; moreover, lack of the link of cryptocurrencies with other markets, particularly the gold market.

2.2 Selected empirical studies on the relationship between cryptocurrencies and gold, and other investment assets

Since the emerging of cryptocurrencies, a number of empirical studies have been conducted to investigate the relationship between these cryptocurrencies with other investment assets. The empirical link between gold and cryptocurrencies is of great concern as both academics and practioners like to know whether cryptocurrencies can be a good substitution for gold in investment portfolios. Selected studies can be shown as follows. Feng, Wang and Zhang (2018) find that the cryptocurrencies exhibit some characteristics of immature market assets, such as auto-correlated and non-stationary return series, higher volatility, and higher tail risks measured by conditional Value-at-Risk and conditional expected shortfall. In addition, cryptocurrencies tend to be both left tail independent, and cross tail independent with stock indices, indicating their ability to be a great diversifier for the stock market as gold, but not enough to be a tail hedging tool like gold. Kyriazis, et al., (2019) examines the volatility of cryptocurrencies and the influence of the three highest capitalization digital currencies, namely the Bitcoin, the Ethereum and the Ripple to the other cryptocurrencies with daily data. Empirical results show that the majority of cryptocurrencies are complementary with Bitcoin, Ethereum and Ripple and that no hedging abilities exist among principal digital currencies in distressed times. Following these study, Hafner (2018) employ bubble tests that rely on

recursive applications of classical unit root tests and find the evidence that cryptocurrencies are bubble, but much less pronounced than under constant volatility. Examining whether cryptocurrencies can be legitimate investments with potential use as a hedging tool, Wong, Saerbeck and Delgado Silva (2018) show that Bitcoin and Litecoin can be useful as a hedge due to negative or zero correlations with other asset classes while Ripple shows traits of a diversifying investment. Cryptocurrencies will always increase portfolio risk, but reward with higher Sharpe ratios for gold and bond portfolios. Using advanced techniques, i.e., fractional integration and cointegration techniques, Adebola, Gil-Alana and Madigu (2019) investigate the relationship between cryptocurrencies and gold prices. The results show that the cointegration is only found in a few cases with a very small degree of cointegration in the long run relationship.

Focusing on Bitcoin, one of the most popular cryptocurrencies, a group of empirical studies compare its role to that of gold as a hedge in financial asset portfolios. Klein, Thu and Walther (2018) show that Bitcoin behaves in the exact opposite manner to gold, and that Bitcoin positively correlates with downward markets. Moreover, the study finds no evidence for stable hedging capabilities of Bitcoin. Bitcoin and Gold feature fundamentally different properties as assets and linkages to equity markets. In addition, Bitcoin does not reflect any distinctive properties of gold other than asymmetric response in variance. Analyzing the relationship between Bitcoin, gold and the US dollar, Baur, Dimpfl, and Kuck (2018) find that that Bitcoin can be classified as something in between gold and the US dollar. Compared to other assets including gold and the US dollar, Bitcoin exhibits distinctively different returns, volatility and correlation characteristics. In comparison to the roles of gold, Selmi, et al., (2018) assesses the corresponding roles of Bitcoin as a hedge, a safe haven and/or a diversifier against extreme oil price movements utilizing a quantile-on-quantile regression approach. Findings show that both Bitcoin and gold can be a hedge, a safe haven and a diversifier for oil price movements, although this property seems to be sensitive to different (bear, normal or bull) market conditions of Bitcoin and gold. Moreover, findings confirm that both Bitcoin and gold are assets where investors may park their cash during times of political and economic turmoil. Bouri, et al., (2018) examines the nonlinear, asymmetric and quantile effects of aggregate commodity index and gold prices on the price of Bitcoin using autoregressive distributed lag (ARDL) models, and indicate that the possibility to predict Bitcoin price movements based on price information from the aggregate commodity index and gold prices. Especially, the evidence of asymmetric, nonlinear, and quantiles-dependent relation between Bitcoin and other asset classes including gold is documented. Henriques and Sadorsky (2018) investigate the effects on an investment portfolio as replacing gold in with bitcoin, and show that risk-averse investors will be willing to pay a high performance fee to switch from a portfolio with gold to a portfolio with bitcoin. Investigating how the returns and volatility of gold and Bitcoin prices is affected by macroeconomic news surprises, Al-Khazali, Elie and Roubaud (2018) show that meanwhile the returns and volatility of gold systematically react to macroeconomic news surprises in a manner consistent with its traditional role as a safe-haven, those of Bitcoin do not mostly react in a similar manner. Bouoiyour, Selmi and Wohar (2019) test whether Bitcoin can replace gold as a safe haven using a dynamic Markov-switching copula model, and reveal a positive and strong correlation between gold and Bitcoin returns in some specific economic and political events. These results imply that gold and Bitcoin can be complementary, rather than in competition with each other. In addition, gold could act as a diversifier for in digital asset portfolios. Using the multivariate extreme value theory, Gkillas and Longin (2019) examine the potential benefits of bitcoin during extremely volatile periods. Results show a low extreme correlation between

bitcoin and gold, indicating that both assets can be used together to protect equity positions in times of turbulence in financial markets. In addition, the introduction of bitcoin (along with gold) substantially improves the performance of equity positions under tail risk constraints. These findings imply that bitcoin can be considered the new digital gold. Shahzad, et al., (2019) test whether Bitcoin exhibits a safe-haven property, similar to or different from that of gold and the general commodity index, for stock market investments during extreme market conditions. Results show that Bitcoin, gold, and the commodity index can be considered as a weak safe-haven asset in some cases, where this property is time-varying and differs across the stock market indices under study.

3. Research methodology

3.1 Research data

Since there are many types of cryptocurrency on the market, cryptocurrencies with the market capitalization over \$1 billion up to the September of 2018 are chosen. These cryptocurrencies comprise of Bitcoin (BTC), Ethereum (ETH), Litecoin (LTC), Monero (XMR) and Ripple (XRP). All daily data of cryptocurrency and gold (XAU) prices from 9/2016 to 9/2018 are collected from the website: www.investing.com. This time period for research is dictated by our data availability. Prices are expressed in terms of the U.S. dollars. All daily returns are calculated by taking log changes of prices as follows

$$R_{i,t} = \log(P_{i,t}) - \log(P_{i,t-1}) = \log\left(\frac{P_{i,t}}{P_{i,t-1}}\right) \qquad (1)$$

Where, $R_{i,t}$ is the returns of asset i at date t, $P_{i,t}$ is closing price of asset i at date t, and $P_{i,t-1}$ is closing price of asset i at date t-1.

3.2 Estimation methods

The causal relations between gold prices and cryptocurrencies prices are estimated using the Granger causality test. Augmented Dickey Fuller (ADF) unit root test is used to check for the stationarity of asset returns. Optimal lag length for ADF and Granger tests is selected by Akaike Information Criterion (AIC).

4. Empirical results

4.1 Descriptive statistics

Table 4.1 presents the descriptive statistics for all asset daily returns. As can be seen from the table, the returns of all virtual currencies but Ripple are negative and fluctuate in a wide range, meanwhile the returns of gold are positive and are more stable with a narrow range of changes over the sample period. These results are most likely in line with previous studies that cryptocurrency returns seem to be very much volatile, indicating a high-risk-high-return tradeoff over time.

Table 4.1 Descriptive statistics for all asset returns

Variables	N	Mean	Std.	Min	Max
R_{BTC} (%)	538	-0.1923	6.6419	-99.1622	101.7225
R_{ETH} (%)	538	-0.2214	7.0130	-99.9010	98.2726
R_{LTC} (%)	538	-0.2138	3.7018	-26.3609	13.3741
R_{XMR} (%)	538	-0.1879	5.2506	-22.3006	16.0795
R_{XRP} (%)	538	0.0504	22.4705	-163.0089	17.177
R_{XAU} (%)	538	0.0071	0.3512	-2.6402	2.7184

4.2 Unit root tests for asset returns stationarity

Table 4.2. Results of unit root test (ADF) for all asset returns

Variables	Without time trend	With time trend
$R_{BTC,t}$	-37.577***	-37.583***
$R_{ETH,t}$	-34.767***	-34.828***
$R_{LTC,t}$	-21.866***	-21.933***
$R_{XRM,t}$	-30.627***	-30.637***
$R_{XRP,t}$	-29.571***	-29.546***
$R_{XAU,t}$	-30.155***	-30.127***

*Notes: *, ** and *** denote the significant levels of 10%, 5% and 1%, respectively*

Table 4.2 show the results of unit root test (ADF) for all asset returns with and without time trend for all asset returns. Results from the table show that the null hypothesis of unit root is rejected at the 1% level of significance, confirming that all asset returns are stationary over time.

4.3 Results for Granger causality tests

Results for Granger causality test between gold and cryptocurrency returns are shown in table 4.3. Akaike Information Criterion shows that the number of optimal lags for all Granger causality tests is four.

As can be seen from the table 4.3, all F-tests of Granger causality for gold returns on the cryptocurrency returns, except for Ethereum returns, are statistically significant at the levels from 5% to 10%. The sum of coefficients of four-lagged gold returns in all equations explaining cryptocurrency returns is greater than one, ranging from about 1.5 to 13.6. These results indicate that gold returns positively "Granger-cause" Bitcoin, Litecoin, Monero and Ripple returns, indicating that an increase of 1% in gold returns leads to an increase of at least 1.5% in cryptocurrency returns. Interestingly, while the impact of gold returns on Bitcoin, Litecoin and Monero returns is less than about 3%, that of gold returns on Ripple returns is surprisingly high at about 13%.

Turning now to the Granger causality tests for cryptocurrency returns on gold returns, the sum of coefficients of four-lagged cryptocurrency returns in all equations explaining gold returns is negative and fairly small, except for the equation explaining Ethereum returns. Yet, *F*-tests that Litecoin and Ripple returns "Granger cause" gold returns are statistically significant at the 10% and 5% significant levels, while the others are not statistically significant at any traditional levels. Regarding the relationship between gold returns and Ethereum returns, no statistical evidence is found for the Granger causality in either direction.

Generally, research results show that an increase in the price of gold leads to an increase in the price of bitcoin, but not vice versa. For the remaining cryptocurrencies, the results show that an increase in the price of gold tends to lead to an increase in the price of most of these cryptocurrencies, but in the opposite direction, an increase in the price of a few cryptocurrencies has a negative effect on the gold prices. In general, this result shows that gold and bitcoin particularly, cryptocurrencies in general, do not have a strong positive correlation, hence cryptocurrencies cannot be considered as investment assets that can replace gold as an inflation hedge. The fact that an increase in gold prices leading to the increase in cryptocurrency prices could be purely coincidental, because cryptocurrencies are a highly speculative asset class and their prices have continuously increased during the time period under study.

Table 4.3 Results of Granger causality tests

Dependent variables	Granger tests	*Sum of coefficients*	*F*-value	Conclusions
R_{XAU}	R_{BTC} Granger cause R_{XAU}	-0.1006	1.18	No
R_{BTC}	R_{XAU} Granger cause R_{BTC} (+)	2.2366	2.99*	Yes
R_{XAU}	R_{ETH} Granger cause R_{XAU}	0.0038	0.42	No
R_{ETH}	R_{XAU} Granger cause R_{ETH}	1.4412	0.60	No
R_{XAU}	R_{LTC} Granger cause R_{XAU} (-)	-0.0108	3.60*	Yes
R_{LTC}	R_{XAU} Granger cause R_{LTC} (+)	1.9240	6.15**	Yes
R_{XAU}	R_{XMR} Granger cause R_{XAU}	-0.0052	1.56	No
R_{XMR}	R_{XAU} Granger cause R_{XMR} (+)	3.1006	3.61*	Yes
R_{XAU}	R_{XRP} Granger cause R_{XAU} (-)	-0.0018	3.88**	Yes
R_{XRP}	R_{XAU} Granger cause R_{XRP} (+)	13.6127	2.72*	Yes

No. of observations: 538

Stability condition for all VARs is satisfied

5. Conclusion

Recently, cryptocurrencies have emerged as one of the attractive investment channels for financial investors. Cryptocurrency is expected to be an inflation hedge replacing for gold in the future, because it has similar and even superior characteristics to gold. Using the Granger causality test between the gold prices and cryptocurrency prices for the period from September-2016 to September-2018, the results show that an increase in the price of gold can lead to an increase in the price of cryptocurrencies, but an increase in the

price of cryptocurrencies tends to be accompanied by a decrease in gold prices. In short, cryptocurrencies do not seem to have proven themselves to be a perfect substitute for gold as an investment that can preserve value against inflation.

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