The Insight Effectiveness of the Nearby Bitcoin Futures' Hedging under Hedging Ratio Analysis

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Abstract

The study aims at finding the usefulness and the effectiveness of the use of Bitcoin futures for Bitcoin hedging. The daily returns of Bitcoin and its nearby futures from March 28, 2018 to December 28, 2019 are collected for the investigation. The graph and correlation of Bitcoin and its futures' returns show their strong association and the promised potentiality of Bitcoin futures to be used as hedging instruments. The analysis of the hedged portfolios under ordinary least squares regression model (OLS), vector autoregressive model (VAR), and vector error correction model (VECM) hedge ratios demonstrate superior performances over the unhedged portfolio concerning risk reduction and reward to risk holding. However, using different hedge ratios result different performances since OLS technique considers only the relationship of spot and futures data in the same periods, VAR counts the relationship of spot and lag variables of itself and of the futures in the short-run, and VECM takes the long-run cointegration between spot and futures into consideration. The concern of more profound relationship in VAR and VECM does not improve risk reduction. The statistical result shows that OLS hedged portfolio has the lowest risk. Nevertheless, VAR hedged portfolio offers higher reward to risk.

Keywords : Bitcoin, Futures' Hedging, Hedging Ratio Analysis

Introduction

To alleviate the 2008 financial crisis, originally caused by subprime loan default problem in U.S., the Federal Reserve introduces quantitative easing monetary policy which injects large

8 พฤษภาคม 2563 / 12 กรกฎาคม 2563 / 17 ธันวาคม 2563
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amount of dollars into the U.S. economy, (Ashraf, Hassan, and Hippler, 2017). As a result, people are afraid of inflation and lose their trust in the currency, (Braun, 2016). Bitcoin is mentioned as the first cryptocurrency which could avoid the intervention from the government or the authorities and becomes the most popular cryptocurrency (DeVries, 2016; Gandal and Halaburda, 2016; Thies and Molnár, 2018; Shen, Urquhart, and Wang, 2019; Smales, 2020).

The surging of its price after 2017 brings the coin price to its peak at 18,940.57 US dollars on December 18, 2017, as shown in Figure 1, and brings more interest in the coin investment. However, the price becomes highly fluctuated. The standard deviations are as high as 3,955.58 US dollars per day in 2017, 2,421.75 US dollars per day in 2018 and 2,662.99 US dollars per day in 2019, accordingly. As a result, holding Bitcoin must be traded off with high risk of losing wealth. This situation discourages many investors from keeping their wealth in the coin to avoid the greatly unacceptable risk.

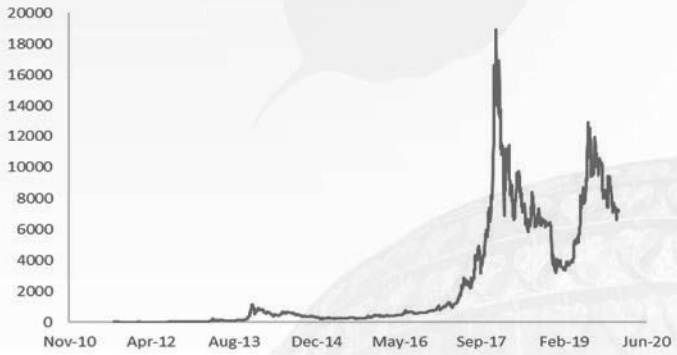

Figure 1 Bitcoin Prices in US Dollar from 2011 to 2019

Source : Reuter Database

The first Bitcoin futures trade on the Cboe Futures Exchange on December 10, 2017. In the near time, the second one was introduced on December 18, 2017 by CME group. Similar to other typical currency futures, Bitcoin futures was introduced as a hedging tool. Bitcoin holders and investors would be able to reduce their price risk exposure. Holders will be safe when their wealth is kept in Bitcoin. Investors would be able to improve their portfolio performance by focusing on their long-term investment strategies' results. Hence, Bitcoin futures bring about the fundamental condition of the sustainability of this crypto currency investment in the long run

since hedging with bitcoin futures lowers the volatility of investors' portfolio as shown lately by the study of (Chen and So, 2020).

As explained by (Charnes, Koch, and Berkman, 2003), the effectiveness of hedging instrument is dependent on the strength of the correlation between its hedged items and itself. The possibility of unequal movement on the prices and uncorrelated price movements of the futures and spot price could deteriorate the futures' hedging capacity. As a result, Bitcoin futures would be an ineffective hedging instrument. Consequently, its effectiveness for serving as a hedging instrument should be investigated. If this new instrument is not operative, other hedging instruments should be searched. Many crypto currencies such as Ethereum and Ripple which are launched during the popularity of Bitcoin also face the same price risk problem from their high price volatility (Yi, Xu, and Wang 2018). The success of Bitcoin future would be the architype for dealing with the high price fluctuation of other crypto currencies.

For the test of the Bitcoin futures' hedging effectiveness, this paper applies the technique used for examining hedging effectiveness by (Kaur and Gupta, 2018). Firstly, correlation analysis is used to find the potential of Bitcoin futures' hedging capacity. Then, different statistics approaches including ordinary least squares regression model (OLS), vector autoregressive model (VAR), and vector error correction model (VCEM) are applied to find the optimal hedge ratios by using the spot prices and futures prices from the database of CME group. The simple reason is regarding the cease of Bitcoin futures on CBOE Futures Exchange on June 19, 2019. After that, the hedged portfolios will be created according to the suggested optimal hedge ratios. The results would reveal the hedging effectiveness of the Bitcoin futures under the role of risk protector.

The focus of the research examination on one month or shorter maturity-nearby Bitcoin futures' hedging effectiveness provides very useful information to scholars and investors since the selected samples are highly liquid futures. The daily data is used for the test for several reasons. First, futures trading is made on daily mark-to-market and bitcoin price is very volatile. Investors' wealth will change at the end of the day. It is highly possible that investors might be forced to close their positions at the end of the day. Hedging with these futures would allow investors to easily close their investment position and the hedging process would be possible in practice since they tend to be more liquid as mentioned by (Luft, Lee, and Choi, 2019).

The literature review in the next section will provide fundamental knowledge and the landscape of Bitcoin futures for readers to have adequate background to understand the discussion in this research paper. Data collection and research methodology, findings and discussion, and concluding remarks, then, would be shown accordingly.

Research Objectives

This paper investigates nearby CME Bitcoin futures in order to

1. Disclose the hedging potential of the Bitcoin futures over their underlying asset and
2. Investigate the effectiveness of hedging ratios calculated under OLS, VAR, and VECM methods.

Literature Reviews

Like other currency futures, Bitcoin futures is launched to be used as a hedging instrument for its underlying, Bitcoin. However, there are very few studies on its hedging capacity because of its newness. Hence, to understand the Bitcoin futures, this study starts with the investigation of ordinary currency futures.

Most studies support the hedging effectiveness of foreign currency futures, for example, (Dale, 1981) reports that futures of British Pound, German Mark, and Japanese Yen are as effective as agricultural futures, (Hill and Schneeweis,1982) study futures contracts of British pound, German mark, Canadian dollar, Japanese yen and Swiss franc and report the direct relationship between their hedging effectiveness and their investment horizon, Kroner and Sultan (1993) conclude that currency futures could be effectively used for reducing risk. For the recent studies, (Kotkatvuori-Örnberg, 2016) also claims that futures of Australian dollar, Canadian dollar, euro, British pound and Japanese yen are effective tools for lowering risk of portfolio and (Yu, Wan, Tu and Li, 2020) demonstrate that currency futures could be used to lower multinational firms' risk. Nonetheless, some studies report contrary evidence, for instances, the study of (Guay and Kothari, 2003) which states that the use of currency futures does not significantly help large non-financial corporations to lower their risk.

The rare studies on Bitcoin futures provide mixed results concerning the futures' hedging effectiveness. (Corbet, Lucey, Peat, and Vigne, 2018) suggest that the launching of Bitcoin futures

brings about greater volatility of the spot market. (Sebastião and Godinho, 2019) claims that CBOE Bitcoin futures is an effective hedging tools for Bitcoin itself and other cryptocurrencies. The study of (Alexander, Choi, Park and Sohn, 2020) also reports the effectiveness of Bitcoin futures in lowering Bitcoin' s price risk.

To analyze the hedging effectiveness, (Park and Switzer, 1995) and (Kavussanos and Nomikos, 2000) suggest that the percentage of the decrease in the hedged portfolio's variance in relation to the unhedged portfolio might be used. For the optimal hedge ratio finding, OLS, VAR, and VECM are among the popular approaches. The hedge ratio from OLS regression could be simply found and is widely applied in many researches (Lien, Tse, and Tsui, 2002) and (Moosa, 2003) but, according to (Malliaris and Urrutia,1991) and (Herbst, Kare, and Marshall, 1993), OLS regression's main problem is concerning the autocorrelation of its residual. The study by (Juhl, Kawaller, and Koch., 2004) also suggests that the ratio might be misjudged when the futures and spot price are co-integrated. However, (Lien, 2005) provides contrast evidence that the hedge ratio from OLS method tends to perform better than the ratio calculated from other approaches. (Naliniprava, 2011) suggests that VAR is better than OLS approach since it gets rid of autocorrelation of errors, but the model might not count the long-term integration between the returns of spot and futures into hedge ratio analysis. However, in case that the two time-series data are cointegrated, (Ghosh,1993), (Lien and Luo, 1994) and (Lien, 1996) advise that the VAR model should be adjusted for the error correction term. The VECM should be used to calculate the hedge ratio. According to (Yang and Allen, 2005), VECM's hedge ratio is outperformed VAR's hedge ratio. The rarity of Bitcoin studies and the cease of CBOE Bitcoin futures suggest more studies to be done on CME Bitcoin futures. Additionally, several approaches for the futures' testing should be applied to find out the information of futures' hedging effectiveness in different aspects.

Research Methodology

Data Collection

Regarding the cease of Bitcoin futures on CBOE Futures Exchange on June 19, 2019, this research data consists of the daily spot and futures prices of bitcoin from CME group provided in Reuter database. The daily data is used since Bitcoin is highly volatile and the futures trading must

be marked to market at the end of the day. A large impact concerning the decrease of investors' wealth is likely to occur daily. Risk management, hence, should be considered on a daily basis. The research counts only the prices of the nearby futures contracts with a maturity of less than or equal to a month. These futures contracts are often in investors' attention and better reflect demand and supply of the market. Since the prices from the time the bitcoin futures market is launched on December 17, 2017 to February 28, 2018 do not meet the condition, they are ignored. The data are gathered for 457 days from March 28, 2018 to December 27, 2019.

Conceptual Framework

This study applies the techniques for investigation the hedging effectiveness of stock index and futures contracts used in (Kaur and Gupta, 2018) paper for the tests. From the study, the three hedging ratios are calculated from the OLS, VAR, and VECM techniques and compared to examine for their effectiveness.

First, the descriptive data analysis will be done to provide information on the distribution of the data. Then, the relationship between the Bitcoin price, *S,* and its futures price, *F,* and the relationship between the returns of Bitcoin and its futures contract would be investigated under graph and correlation analysis to exhibit the potential of using Bitcoin futures as hedging tools. The return of Bitcoin, ΔlnS_t, and return of its futures, ΔlnF_t, are the difference between the logarithm of the prices on day t and day t-1 as follows:

$$\Delta lnS_t = lnS_t - lnS_{t-1} \quad (1)$$

$$\Delta lnF_t = lnF_t - lnF_{t-1} \quad (2)$$

Next, the Bitcoin futures contract would be profoundly investigated for its hedging effectiveness. The percentage changes in Bitcoin's spot and futures prices are used for the examination for two reasons, first, to normalize the time-series data to avoid the bias from value differences and, second, to generate the first difference data to avoid the unit root problem which would cause the spurious statistic results. Nevertheless, the unit root test on Bitcoin spot and futures prices would be done to ensure that these time-series data are truly stationary, and the statistical results would be meaningful. The unit root test is done under Augmented Dickey-Fuller (ADF) test from the following regression equation:

$$\Delta y_t = a_1 + a_2 t + \gamma Y_{t-1} + \sum_{i=1}^{n} \propto_i \Delta y_{t-i} + \varepsilon_t \quad (3)$$

Where Δ is the difference operator, a,γ,α are coefficients, y is the time series variables, and ε is the white-noise error term.

If the preliminary tests on the time-series show no problem, investigation on the future's hedging effectiveness would be done under three approaches; ordinary least squares regression model (OLS), vector autoregressive model (VAR), and vector error correction model (VCEM), to find the hedge ratios as follows: OLS hedging ratio has been used in many studies, for examples, (Bera, Garcia, and Roh, 1997), (Grammatikos and Saunders, 1983), and (Nan and Kaizoji, 2019). OLS hedging ratio (h) is from the beta of the equation which presents only the relationship of spot and futures data in the same periods as follows:

$$\Delta lnS_t = C + h\,\Delta lnF_t \quad (4)$$

To find VAR hedging ratio (h), the 2 equations are set under bivariate VAR which counts the relationship of the dependent variable and its own lag together with other variable's lags in the short-run.

$$\Delta lnS_t = C_s + \sum_{i=1}^{n} \beta_{si}\Delta lnS_{t-1} + \sum_{i=1}^{n} \gamma_{si}\Delta lnF_{t-1} + U_{St} \quad (5)$$

$$\Delta lnF_t = C_F + \sum_{i=1}^{n} \beta_{fi}\Delta lnS_{t-1} + \sum_{i=1}^{n} \gamma_{fi}\Delta lnF_{t-1} + U_{Ft} \quad (6)$$

Where C_S *and* C_F are the intercept. β_s , β_f , γ_s , and γ_f are parameters of the equations. U_{St} and U_{Ft} are independently identically distributed. VAR hedge ratio has been applied in many studies on hedging effectiveness, for examples, (Bhaduri and Sethu Durai, 2008), (De Salles, 2013), and (Mehrara and Hamldar, 2014). The hedge ratio is calculated as follows:

$$Hedge\ Ratio = \frac{Covariance(U_{St}, U_{Ft})}{Variance\ (U_{Ft})} \quad (7)$$

The last technique, VECM, has also been applied by many researchers, for examples, (Mili, and Abid , 2004), (Degiannakis and Floros, 2010), and (Pradhan, 2011). To find VECM hedging ratio (h), the 2 equations are set under bivariate VAR and adjusted with the error correction terms:

$$\Delta lnS_t = C_S + \sum_{i=1}^{n} \beta_{Si}\Delta lnS_{t-1} + \sum_{i=1}^{n} \gamma_{Si}\Delta lnF_{t-1} + \varphi_{Si}Z_{t-1} + U_{St} \quad (8)$$

$$\Delta lnF_t = C_F + \sum_{i=1}^{n} \beta_{Fi}\Delta lnS_{t-1} + \sum_{i=1}^{n} \gamma_{Fi}\Delta lnF_{t-1} + \varphi_{Si}Z_{t-1} + U_{Ft} \quad (9)$$

Where φ_{Si} is parameters of the error correction term. Z_{t-1} is the error correction term of the equations which could be calculated as follows:

$$Z_{t-1} = S_{t-1} + C + \alpha F_{t-1}\,, \qquad (10)$$

Where C is the constant. α is the cointegrating vector. Under this technique, the long-run relationship between spot and futures is taken into consideration. The hedge ratio is calculated as in equation (5). Afterward, each hedged and unhedged portfolio's R-squares and ratio of standard deviation to return are compared to disclose the possibility of risk reduction from the use of the bitcoin futures. Like many papers such as (Ederington, 1979), the return of the hedged portfolio is the portfolio's weighted average of returns of the underlying asset and its futures and the hedging effectiveness is the decrease of variance after the portfolio is hedged to the variance of unhedged portfolio: The return of hedged portfolio is calculated as follows:

$$R_h = (1-h)^* \Delta \ln S_t + h^* \Delta \ln F_t \qquad (11)$$

And the hedging effectiveness is calculated as follows:

$$\text{Hedging effectiveness} = \frac{\text{Variance of Unhedged Portfolio} - \text{Variance of Hedged Portfolio}}{\text{Variance of Unhedged Portfolio}} \qquad (12)$$

According to the formula, the higher the ratio, the higher the variance or risk reduction. Therefore, the most effective hedge ratio belongs to the portfolio with the highest hedging effectiveness ratio.

Results

Table 1 reports descriptive statistics of daily returns of Bitcoin and daily returns of its nearby futures contract during March 28, 2018 to December 27, 2019. The returns of both Bitcoin's spot and futures average the same at -0.02% per day. Other statistical parameters of the returns of both Bitcoin's spot and futures are rather close too. The medians of returns of Bitcoin and its futures are 0.11% and 0.00%. The maximum prices of returns of Bitcoin and its futures are 20.81% and 22.24%. Both returns of Bitcoin and its futures are slightly skewed to the right at 0.12 and 0.15 and rather condensed to their means with the kurtosis value of 6.04 and 8.86 subsequently. Their fluctuations are relatively high to their means at the standard deviation of 4.33% and 4.52%. However, the minimum values of returns of Bitcoin and its futures are rather different at -15.53% and -24.62%. The return distribution of Bitcoin spot and Bitcoin futures are very similar. Returns

of both Bitcoin spot and Bitcoin futures are highly fluctuated. The main difference is the higher downside return of Bitcoin future.

Table 1 Descriptive Statistics of Daily Returns of Bitcoin and Daily Returns of its Nearby Futures Contract during March 28, 2018 to December 27, 2019

	Percentage Changes in Spot Prices	Percentage Changes in Futures Prices
Mean	-0.02%	-0.02%
Median	0.11%	0.00%
Maximum	20.81%	22.24%
Minimum	-15.53%	-24.62%
Std. Dev.	4.33%	4.52%
Skewness	0.12	0.15
Kurtosis	6.04	8.86
Observations	457	457

Figure 2 shows the daily prices of Bitcoin and daily prices of its nearby futures contract during March 28, 2018 to December 27, 2019. The graphs demonstrate that Bitcoin spot and futures prices closely move together. This information implies that Bitcoin futures contracts have high potential to be used as a good hedging instrument for Bitcoin.

Figure 2 Daily Prices of Bitcoin and Daily Prices of its Nearby Futures Contract during March 28, 2018 to December 27, 2019

Source: Reuter Database

Figure 3 exhibits daily returns of Bitcoin and daily returns of its nearby futures contract during March 28, 2018 to December 27, 2019. The graphs almost stay on the same line. This evidence supports the existence of Bitcoin futures' hedging capability.

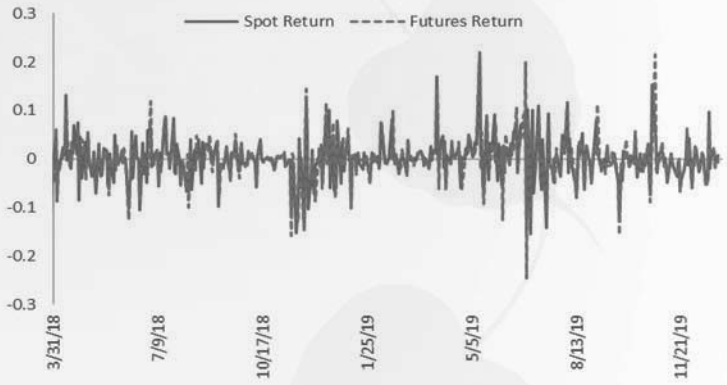

Figure 3 Daily Returns of Bitcoin and Daily Returns of its Nearby Futures Contract during March 28, 2018 to December 27, 2019

Table 2 reports that daily returns of Bitcoin and daily returns of its nearby futures contract during March 28, 2018 to December 27, 2019 are highly correlated at the correlation coefficient of 0.8138 and statistically significant at the significance level of 0.01. These evidences support the hedging capability of Bitcoin futures.

Table 2 Correlation Analysis of Daily Returns of Bitcoin and Daily Returns of its Nearby Futures Contract during March 28, 2018 to December 27, 2019.

	Daily Returns of Bitcoin	Daily Returns of Bitcoin Nearby Futures Contract
Daily Returns of Bitcoin	1.0000	
Daily Returns of Bitcoin Nearby Futures Contract	0.81***	1.0000

* Significant at 0.10 ** Significant at 0.05 *** Significant at 0.01

In order to examine the time-series data of daily Bitcoin returns and its futures returns, the unit root tests have been done in three possible characteristics of time-series; the time-series having no drift and trend, the time series having drift, and the time series have both drift and trend. The results in Table 3 shows that, even when constant and or linear trend are considered into the Augmented Dickey-Fuller test, the null hypothesis that there is unit root in the time-series of the spot and futures returns is rejected at a 5% significance level according to the (MacKinnon, 1996) one-sided p-values. The results of close and high t-statistics in all cases imply very low p-values in all cases. The null hypothesis for each time-series is rejected. Consequently, these time-series are statistically stationary and could be used for prediction without creating spurious statistical problems.

Table 3 Unit Root Test's Results of Daily Returns of Bitcoin and Daily Returns of its Nearby Futures Contract during March 28, 2018 to December 27, 2019

		Augmented Dickey-Fuller Test Statistic	
		T-statistics	Prob.*
Spot	None	-21.52	0.00
	Constant	-21.50	0.00
	Constant and Linear Trend	-21.48	0.00
Futures	None	-21.92	0.00
	Constant	-21.89	0.00
	Constant and Linear Trend	-21.87	0.00

*MacKinnon (1996) one-sided p-values

Table 4 demonstrates the hedges ratios calculated under Ordinary Least Squares (OLS), vector autoregressive model (VAR), and vector error correction model (VCEM) approaches of 0.78, 0.94, and 0.97, accordingly and summarizes the performances of 4 portfolios including unhedged portfolio which has only Bitcoin and 3 hedged portfolios which are composed of Bitcoin and its futures at the proportion according to the calculated hedge ratios.

The total return performance for the holding period during March 28, 2018 to December 27, 2019 ranked from fattest return portfolio to the lowest one are VAR hedged portfolio at 1.77%, VECM hedged portfolio at 0.58%, OLS hedged portfolio at -1.84%, and unhedged portfolio at -

9.04%, accordingly. When the performances of the portfolios are examined for the return fluctuation, the 3 portfolios hedged under OLS, VAR and VECM show their superiority of having lower risk. The average standard deviations ranked from the lowest to the highest are OLS hedged portfolio at 2.52%, VAR hedged portfolio at 2.59%, VECM hedged portfolio at 2.65%, and unhedged portfolio 4.33%.

For the percentage of variance reduction, the OLS hedged, the 3 portfolios hedged under OLS, VAR and VECM endorse their superiority of more risk reduction over other 2 portfolios. In details, the percentage of variance reduction ranked from the highest to the lowest are OLS hedged portfolio at 66.23%, VAR hedged portfolio at 64.97%, VECM hedged portfolio at 62.65%, and unhedged portfolio at 0%. For the performance based on the reward per risk, the returns to standard deviation ranked from the highest to the lowest value are VAR hedged portfolio at 0.0015, VECM hedged portfolio at 0.0005, OLS hedged portfolio at -0.0016, and unhedged portfolio at -0.0046.

Table 4 Comparison of Different Portfolios' Hedge Ratio, Total Return, Standard Deviation, Percentage of Variance Reduction, and Return to Standard Deviation for the Holding Period during March 28, 2018 to December 27, 2019

Portfolio	Hedge Ratio (h)	Total Return	Average Daily Return	Standard Deviation	Percentage of Variance Reduction	Return to Standard Deviation
Unhedged	0.00	-9.04%	-0.0198%	4.33%	0.00%	-0.0046
OLS hedged	0.78	-1.84%	-0.0040%	2.52%	66.23%	-0.0016
VAR hedged	0.94	1.77%	0.0039%	2.59%	64.07%	0.0015
VECM hedged	0.98	0.58%	0.0013%	2.65%	62.63%	0.0005

Conclusion and Discussion

This paper aims at finding the Bitcoin futures' hedging potentials to protect the holder against exchange rate risk in different aspects. The returns of CME's nearby futures contracts which mature in 1 month during March 28, 2018 to December 27, 2019 are tested against the Bitcoin returns in spot market.

The preliminary scanning by graph and correlation analysis shows the strong association between Bitcoin returns and its futures' returns which implies the potentiality of the nearby futures to be used as hedging tools. The further test on the Bitcoin futures' hedging effectiveness is done under hedge ratios calculated from OLS, VAR, and VECM approaches to find out the best potential of this hedging tool.

Similar to (Hill and Schneeweis, 1982), (Kroner and Sultan, 1993), and of (Alexander et al., 2020), Bitcoin portfolio's performance is improved after it is hedged by its futures. Compared to the unhedged portfolio, all hedged portfolios have superior returns and lower standard deviations. Hedging the Bitcoin with its futures according to the suggested hedge ratios calculated by OLS, VAR, and VECM techniques raises the portfolio's return and lowers its risk. Compared to unhedged portfolios, all of these hedged portfolios provide higher return to standard deviation.

In detail, the examination's results confirm the findings of (Lien, 2005) that the Bitcoin portfolio's percentage of variance reduction is highest and its standard deviation is lowest when it is hedged under OLS hedged ratio. However, the reward to risk analysis does not conform to the same conclusion and shows that the Bitcoin portfolio gains the highest return to standard deviation when it is hedged under VAR hedged ratio.

The study suggests investors should hedge their Bitcoin portfolio with its futures for better investment performance. Moreover, investors may apply the techniques of this study to examine the effectiveness of other hedging instruments which they may use.

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