A STUDY ON THE DETERMINANTS THAT INFLUENCE THE PRICE OF BITCOIN

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ABSTRACT

This study aims to examine the determinants that influence the price of Bitcoin. The determinants used in this study include Bitcoin supply, Bitcoin hash rate, and gold price. The price of Bitcoin is the dependent variable in this study. The secondary data was extracted from online websites, which showed historical data on Bitcoin price, supply, hash rate, and gold price. All data collected are based daily from 1 January 2019 to 31 December 2022. A two-stage least squares (2SLS) regression model is applied to assess the impact of Bitcoin supply, hash rate, and gold price on Bitcoin price. The results of this study show that Bitcoin supply has a positive and significant effect on Bitcoin price. In contrast, the Bitcoin hash rate negatively and significantly affects Bitcoin price. However, this study also found that gold prices negatively and insignificantly impact Bitcoin prices. Besides, this study discovered that gold price has the most negligible impact on the price of Bitcoin, indicating that gold price does not affect Bitcoin price. On the contrary, the supply of Bitcoin is the most influential factor in Bitcoin's price. The study results provide implications for Bitcoin holders, investors intending to purchase Bitcoin, governments, academic institutions, FinTech students, and future researchers. Through the results of this study, they can better understand the significant factors that cause Bitcoin price volatility.

Keywords: Bitcoin; Gold Price: Hash Rate; Supply of Bitcoin

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1. INTRODUCTION

Bitcoin is one of the most famous types of cryptocurrencies and the first to be widely adopted. It is also often described as a digital or virtual currency because it is a completely virtual type of money (BBC, 2018). Bitcoin was created by a group or a person named Satoshi Nakamoto. He published a regulatory document in 2008, known as the "white paper", regarding creating a digital currency to replace cash offered by a central organization (Coinbase, 2022). This regulatory document proposed the concept of creating Bitcoin. 2009, Bitcoin was officially launched and started being used (Iredale, 2018). The technology behind Bitcoin is blockchain, which is a distributed ledger technology. This indicates that all Bitcoin transactions on the blockchain are carried out through a peer-to-peer network (Coinbase, 2022). Therefore, Bitcoin is not owned and controlled by a central authority or bank; everyone can participate. As Bitcoin has many unique properties, it allows for exciting uses that no previous payment system could ever cover—for example, fast peer-to-peer transactions, low processing fees and global payments (Bitcoin, 2009).

Furthermore, Bitcoin has characteristics similar to those of gold. It has a limited supply and cannot be mined forever. Thus, Bitcoin is known as "digital gold" (Bathija, 2021). When Satoshi Nakamoto launched Bitcoin, he set the total number of Bitcoin to be only 21 million. He set a cap on Bitcoin to make the cryptocurrency scarce, thereby increasing its value (Tiwari, 2022). Nearly 19.2 million Bitcoins have been mined, and only 1.8 million have yet to be mined and circulated on the market (Blockchain, 2022). According to *blockchain.com*, the remaining supply of Bitcoin will be mined out by 2140, and the price will rise yearly. In recent years, there has been an evident upward trend in the price of Bitcoin. Bitcoin's price peaked at $66,953.34 on 10 November 2021. This is the highest value since the launch of Bitcoin (CoinMarketCap, 2022). However, the price of Bitcoin does not always rise consistently, and it also has times when it falls. From the following graph, we can see that Bitcoin's price fluctuates very frequently during 2021. When the price of Bitcoin drops, this is not beneficial to investors and can affect them negatively. Therefore, it is crucial for Bitcoin owners to understand the factors that cause Bitcoin to fluctuate.

Figure 1: Bitcoin's Daily Price From 1 January 2019 to 31 October 2022

Source: (CoinMarketCap, 2022)

Many decisive factors impact Bitcoin's price fluctuations. Among them, the decisive factors are mainly internal factors and external factors. Internal factors include Bitcoin supply (Bitcoins in circulation), the Bitcoin hash rate (measuring the mining difficulty), the transaction fee and others. On the other hand, external factors include gold price, S&P 500 index, the US dollar index, and others (Kavvadias, 2017). Changes in these factors could impact the Bitcoin price and lead to some volatility. In short, since its launch, Bitcoin's price has been vulnerable to external and internal influences. Hence, this study focuses on examining the determinants that influence the price of Bitcoin.

1.1 Problem Statement

The price of Bitcoin indicates its value. It fluctuates due to internal and external factors. A study by Ge and Zhou (2019) identified that external factors (such as gold price, crude oil price and exchange rate) impact Bitcoin price. Another study determined that the main internal factors (such as the supply of Bitcoin, mining difficulty, transaction cost, and others) and external factors directly impact Bitcoin price (Sovbetov, 2018). These factors can have a positive or negative, long-term or short-term effect on the price of Bitcoin. Regarding internal factors, there is only a fixed limit on the number of bitcoins that can be mined. Ideally, the number of Bitcoins in circulation significantly impacts

Bitcoin price. Previous research has recognized a significant negative correlation between the volume of Bitcoin in circulation and its price (Kjærland et al., 2018). Another previous study mentioned no significant relationship between Bitcoin supply (total Bitcoin in circulation) and its price (Kavvadias, 2017). However, there is a conflict between the ideal and the results of two previous studies. Therefore, this research will examine the impact of the amount of Bitcoin in circulation on its price. Besides, the Bitcoin hash rate measures the difficulty of mining and the network's security. Ideally, the Bitcoin hash rate has a positive impact on its price. A previous study has identified that the Bitcoin hash rate positively impacts Bitcoin price (Bouoiyour & Selmi, 2015). Another previous study also mentioned that the hash rate positively affects Bitcoin price (Georgoula et al., 2015). However, the impact of the Bitcoin hash rate has not been empirical. Hence, this study will be carried out to empirically test the impact of Bitcoin hash rate on Bitcoin price.

Regarding external factors, Bitcoin is similar to gold because they have only a limited amount to mine. Ideally, the Bitcoin price will also rise when the gold price increases. Previous research by Kyriazis (2020) has recognized a low or negative correlation or asymmetric non-linear between gold and Bitcoin prices. Another previous study mentioned that the gold price has no impact on the Bitcoin price in the long run, but short-run causality exists (Zhu et al., 2017). As a result, there is a gap between the ideal and these two past research findings. Thus, this study will examine the impact of gold price on Bitcoin price. This quantitative study will examine the determinants that influence the price of Bitcoin. It uses independent variables (total Bitcoin in circulation, the Bitcoin hash rate, and gold price) and a dependent variable (Bitcoin price).

1.2 Research Objective

1.2.1 General Objective

- The general objective of this study is to examine the determinants that influence the price of Bitcoin.

1.2.2 Specific Objectives

- To examine the impact of Bitcoin supply on Bitcoin price.
- To determine the impact of Bitcoin hash rate on Bitcoin price.
- To identify the impact of gold price on Bitcoin price.

2. LITERATURE REVIEW

2.1 Concept of Price of Bitcoin (DV)

Bitcoin is the world's first decentralized cryptocurrency, also known as digital money (DeMartino, 2018). Bitcoin price will be based on the Bitcoin Price Index (BPI), which is an exchange rate index between Bitcoin (BTC) and the US dollar (USD) (Kavvadias, 2017). In 2009, 50 BTC were put into circulation for $0.00. Although Bitcoin was $0.00, people accepted its prospects, and more people accepted it when the price of Bitcoin crossed $1.00 (Taskinsoy, 2021). The first transaction with Bitcoin was done by Laszlo Hanyecz, who paid 10,000 BTC (equivalent to $0.008 at the time) to buy two pizzas from Papa Jones in the US (Ghimire & Selvaraj, 2018). In addition, Bitcoin is an alternative to fiat currencies such as the euro, dollar, pound and yen. Its advantages include low transaction fees and transparency of transaction information (Bouoiyour & Selmi, 2015).

2.2 Concept of Independent Variables

2.2.1 Supply of Bitcoin (Total Bitcoin in Circulation)

The supply of Bitcoin is finite and cannot be mined forever. When Satoshi Nakamoto launched Bitcoin, he set the total volume of Bitcoins at 21 million. Besides, the Bitcoin supply is predicted to be mined by February 2140 (Halaburda, 2016). There are many ways to obtain a new Bitcoin. One way is through buying; another is to decode a new block. When a new block is finally decoded, the miner is given new Bitcoins (and transaction fees) as a reward. The structure of Bitcoin regeneration rewards miners who solve each block with the same number of new Bitcoins (Kavvadias, 2017). All of this will reduce the amount of Bitcoin available for mining and increase the amount of Bitcoin in circulation in the future. No additional Bitcoin will be generated when the supply of Bitcoin reaches the cap. Bitcoin miners will likely only earn revenue from transaction fees (Barber et al., 2012).

2.3 Bitcoin Hash Rate

The Bitcoin hash rate measures the computing power used per second when mining on the network. Simply put, the hash rate measures the difficulty of mining (O'Dwyer & Malone, 2014). Besides, it is also a key security metric that can measure the health of the Bitcoin network at any given time. Each new set of transactions (blocks) in the network is followed by a cryptographic hash of previously created blocks. The SHA-256 hashing algorithm links future and previous blocks (Bradbury, 2013). Through "hashing", transactions can be verified and encrypted to ensure network security. In general, the higher the hash rate, the better. This is because the more substantial the hashing (computing) power in the network, the stronger its security and overall resistance to attacks (Pagnotta, 2018). Since a high hash rate indicates, a healthy network may also lead to a higher Bitcoin value.

2.4 Gold Price

There is a limited amount of gold, and it will be mined out one day. Gold has no nationality, is not owned or controlled by the government, and is mined by several independent operators and companies (Baur et al., 2018). Long ago, gold was used as a medium of exchange but was abandoned due to liquidity problems (Dyhrberg, 2016). Besides, the price of gold is usually measured in Swiss francs (CHF) (Kristoufek, 2015). Each year, the total world supply of gold is about 3,500 tons (Shafiee & Topal, 2010). Since gold has been mined, its price has gradually increased because its supply is limited, but its demand is increasing. Thus, most of the value of gold derives from its scarcity and the cost of mining it (Dyhrberg, 2016).

2.5 Relationship between Dependent Variables and Independent Variables Bitcoin Supply and Bitcoin Price

Past research studies have studied the relationship between Bitcoin supply and Bitcoin price. Georgoula et al. (2015) found a long-term positive relationship between the Bitcoin supply and its price using the Vector Error-Correction (VEC) Model. Similarly, Kristoufek (2015) pointed out that the supply of Bitcoin is positively correlated with the price in the long run, using wavelets methodology. However, a study by Kjærland et al. (2018) identified that Bitcoin supply and price have a significant negative correlation using Ordinary Least Squares (OLS) regression. Furthermore, Goczek and Skliarov (2019) concluded using VEC model analysis that the price of Bitcoin is not affected by supply and demand factors. On the other hand, Dubey's (2022) findings showed that the supply of Bitcoin significantly impacts the price of Bitcoin in the long run using the Granger causality test. Besides, by applying time-series analytical mechanisms, Ciaian et al. (2015) argued that supply and demand significantly influence the Bitcoin price but change over time. Therefore, according to the findings of past research, the hypothesis can be formed:

H1: There is a significant relationship between the supply of Bitcoin and the price of Bitcoin.

2.6 Bitcoin Hash Rate and Bitcoin Price

Past studies have investigated the correlation between Bitcoin hash rate and Bitcoin price. By using exponential smoothing, Fantazzini & Kolodin (2020) found that the Bitcoin hash rate and the price were not significant in the first subsample examined (01/08/2016–04/12/2017), but a significant cointegration relationship was found in the second subsample (11/12/2017–24/02/2020). Besides, a study by Bouoiyour and Selmi (2015) discovered that the hash rate positively affects the Bitcoin price in the long term by using the ARDL Bounds Testing method. Similarly, Hayes (2015) revealed a positive and significant correlation between the hash rate and the Bitcoin price but used OLS regression. In addition, Sun et al. (2023) found that the Bitcoin hash rate has a significant long-term effect on the price of Bitcoin by using the VEC model. However, the findings of Kjærland et al. (2018) showed no significant relationship between the price of Bitcoin and the hash rate using OLS regression. As a result, the hypothesis can be formed:

H2: There is a significant relationship between the Bitcoin hash rate and the price of Bitcoin.

2.7 Gold Price and Bitcoin Price

A study done by Aggarwal et al. (2019) found no positive relationship between the gold price and the Bitcoin price by using Root Mean Square Error (RMSE). Similarly, Kapar & Olmo (2021) identified that the gold price harms the Bitcoin price using the VEC model. Furthermore, by using the Cointegration test, Unit root test and Granger causality test, Ge & Zhou (2019) revealed that there is a two-way causal relationship between the Bitcoin price and the gold price at the 95% significance level, and gold has a positive effect on the Bitcoin price. However, Gozbasi et al. (2021) discovered that gold prices do not have a statistically significant effect on Bitcoin prices by using the ARDL approach. On the other hand, Das and Kannadhasan (2018) discovered a significant correlation between the gold price and Bitcoin price using wavelet-based analysis. Thus, the hypothesis is that:

H3: There is a significant relationship between the gold price and the price of Bitcoin.

3. METHODOLOGY

Secondary data will be used in this study. Secondary data is data that has been collected in the past. The data used in this study will be obtained from online sources, such as websites about the price of Bitcoin and gold (*coindesk.com, blockchain.com* and *goldprice.org*). These websites provide information about Bitcoin and gold publicly and freely available daily. Historical data on the price of Bitcoin can be found on the *coindesk.com* website. In addition, historical data in terms of Bitcoin supply (Bitcoins in circulation) and total Bitcoin hash rate can be obtained from the *blockchain.com* website. Furthermore, historical data on gold prices can be accessed from the *goldprice.org* website. The data collected is based daily from 1 January 2019 to 31 December 2022 only. Besides, the sample size of this dataset will be 1,461. In short, the nature of this study is quantitative, and data sources are secondary.

3.1 Data Analysis

The data collected for this study will be analysed using EViews. In this study, Descriptive Statistics, Correlation Analysis, Regression Analysis and Diagnostic Tests will be carried out. Hypotheses will be tested to identify the relationships between the determinants (Bitcoin supply, hash rate and gold price) and the price. In statistics, the multiple linear regression (MLR) Model will be used in this study. This MLR model helps the researcher predict one variable's outcome based on another variable's outcome. The following equation is the MLR model used in this study.

$$\boldsymbol{Y = \beta_0 + \beta_1 SY + \beta_2 HR + \beta_3 GP}$$

In this study:

Y = Price of Bitcoin

$\boldsymbol{\beta_0}$ = Intercept of the MLR Model

$\boldsymbol{\beta_1 SY}$ = Bitcoin Supply

$\boldsymbol{\beta_2 HR}$ = Bitcoin Hash Rate

$\boldsymbol{\beta_3 GP}$ = Gold Price

Table 3.1: Abbreviations for each variable

Variable	**EViews Code**	**Description**
Bitcoin Price	BTCP	Daily Bitcoin USD Price
Bitcoin Supply	BTCS	Daily Circulation of Bitcoin
Bitcoin Hash Rate	BTCHR	Daily Bitcoin Hash Rate (TH/s)
Gold Price	GP	Daily Gold USD Price

3.2 Descriptive Statistics Analysis

Table 3.2: Descriptive statistics summary for cross-sectional variables

Variable	Sample Size	Mean	Median	Standard Deviation	Skewness	Kurtosis
BTCP	1461	23528.08	17128.7	17556.4	0.71697	2.166610
BTCS	1461	18507258	1858691	495818.	-0.45794	2.135848
BTCHR	1461	1.38E+08	1.30E+0	6009384	0.36512	2.504937
GP	1461	1695.070	1763.00	199.183	-0.74455	2.452791

Note: BTCP-Bitcoin Price (DV), BTCS-Bitcoin Supply (IV1), BTCHR-Bitcoin Hash Rate (IV2), GP-Gold Price (IV3).

The above table shows the descriptive statistics summary of the cross-sectional data with a sample size of 1461 for the four years (2019-2022). The descriptive statistics summary provides measures of central tendency, including mean and median, and measures of dispersion, the standard deviation. And measures of normality, including skewness and kurtosis. Descriptive statistics based on these three measures are explained below:

3.3 Measures of Central Tendency (Mean and Median)

The above descriptive statistics summary shows that the dependent variable, *Bitcoin Price (BTCP)*, has a mean value of 23528.08, which means that the average price of Bitcoin over the four years (2019 - 2022) is US$23,528.08. Besides, BTCP has a median value of 17128.72, which implies that the middle price of Bitcoin over the four years (2019 - 2022) is $17,128.72. In terms of independent variables, *Bitcoin Supply (BTCS)* has mean and median values of 18507258 and 18586913, which indicates that the average supply of Bitcoin between 2019 and 2022 is 18,507,258 and the median supply is 18,586,913. Furthermore, for the *Bitcoin Hash Rate (BTCHR)*, the mean is 1.38E+08, and the median is 1.30E+08, which means that the average Bitcoin Hash Rate from 2019 to 2022 is 138,000,000 and the median Bitcoin Hash Rate is 130,000,000. Lastly, the mean value of the *Gold Price (GP)* is 1695.070, which implies that the average gold price over the four years (2019 - 2022) is US$1,695.070, while the median value is 1763.000, which means that the middle price of gold between 2019 and 2022 is US$1,763.

3.4 Measures of Dispersion (Standard Deviation)

The Standard Deviation (SD) measures how dispersed the data are relative to the mean. A low SD means that the data are concentrated around the mean, while a high SD indicates that the data are more dispersed and farther from the mean (Bhandari, 2020). Based on the descriptive statistics summary above, BTCP shows a lower SD value of 17556.44 compared to the mean value of 23528.08, which indicates that the data distribution of BTCP is more concentrated around the mean, and the data are more consistent. Besides, regarding independent variables, the SDs of BTCS and GP are smaller, 495818.7 and 199.1833, respectively, compared to their means of 18507258 and 1695.070. This also means that the data distribution of BTCS and GP is more concentrated around their mean values. However, the statistics show that BTCHR has the highest SD of 60093843, comparable to the mean value of 1.38E+08, indicating that more data are dispersed.

3.5 Measures of Normality (Skewness and Kurtosis)

Skewness and kurtosis are both measures used in statistics to assess the shape of a distribution. Skewness measures the degree of asymmetry of a distribution around its mean. A perfectly symmetrical distribution has a skewness of zero. In contrast, a distribution that is skewed to the right (has a long tail on the right side) has a positive skewness value, and a distribution that is skewed to the left (has a long tail on the left side) has a negative skewness value (Kim, 2013). According to Klima (2021), the distribution is considered highly skewed if the skewness is greater than +1 or less than -1, moderately skewed if the skewness is between -1 and -0.5 or between 0.5 and 1, and approximately symmetric if the skewness is between -0.5 and 0.5. Kurtosis measures the extent to which a distribution deviates from the normal distribution in terms of the heaviness or lightness of its tails. A normal distribution with a kurtosis value of 3 is called mesokurtic. If the kurtosis is greater than 3, the leptokurtic distribution indicates it has more extreme values than a normal distribution. Conversely, if the kurtosis is less than 3, the platykurtic distribution is flatter than a normal distribution (Klima, 2021). In short, to be considered normally distributed, a distribution should have a skewness close to 0 and a kurtosis close to 3. Based on the above descriptive statistics, the skewness value of the dependent variable, BTCP, is 0.716973, which means that the distribution is considered moderately skewed to the right (between 0.5 and 1). Conversely, in terms of independent variables, the distributions of BTCS and GP are moderately skewed to the left as their skewness values are between -1 and -0.5, which are -0.457942 and -0.744557. Besides, the distribution of BTCHR is approximately symmetric and skewed to the right because its skewness is between -0.5 and 0.5, which is 0.365124. In short, BTCP and BTCHR are positively skewed to the right, while BTCS and GP are negatively skewed to the left. Regarding kurtosis, the values of BTCP, BTCS, BTCHR and GP are all less than 3 or close to 3, which shows that the distribution of these four variables is platykurtic. This also means these four variables show flatter curves than the normal distribution. This indicates that the raw data for BTCP, BTCS, BTCHR, and GP is normally distributed.

3.6 Regression Analysis

This part shows the regression analysis results of the cross-sectional data, which aim to identify the impact of internal factors (Bitcoin supply and Bitcoin hash rate) and external factors (gold price) on the price of Bitcoin.

Table 3.3: Summary of multiple linear regression analysis. Dependent variable: Bitcoin price (BTCP)

Variable	Coefficient	Standard Error	t-Statistic	Prob (P-value)
Intercept	-679208.2	37613.94	-18.05735	0.0000
BTCS	0.038899	0.002311	16.82896	0.0000
BTCHR	-0.000163	1.50E-05	-10.91412	0.0000
GP	3.113434	3.115324	0.999393	0.3178

The above table shows the Multiple Linear Regression (MLR) Equation between the independent variables, Bitcoin Supply (BTCS), Bitcoin Hash Rate (BTCHR), and Gold Price (GP), and the dependent variable, which is Bitcoin Price (BTCP).
The MLR equation for the cross-sectional data of this study is as follows:

$$\mathbf{BTCP = 0.038899\ BTCS - 0.000163\ BTCHR + 3.113434\ GP - 679208.2}$$

3.7 Cross-Sectional Data Diagnostic Test

However, some diagnostic tests are required to assess the cross-sectional data's quality, appropriateness, validity and reliability before regression analysis. Diagnostic tests for this data type include normality, multicollinearity, heteroscedasticity, and serial correlation tests. These tests ensure that all cross-sectional data meet the basic assumptions of CLRM. In terms of the normality test, this test is not that important for indicating the normality of the data as the number of samples in this study was more than 30, which is 1461 (Ghasemi &

Zahediasl, 2012). Thus, the normality test was not performed in this research. In the following, the multicollinearity test, heteroskedasticity test and serial correlation test will be performed, and the validity and reliability of the cross-sectional data will be inferred from the hypotheses of each test. When breaches of those hypotheses are found, appropriate solutions will be applied. Lastly, the most appropriate cross-sectional regression model and the relevant measures of the coefficients will be applied. In short, the results of all these tests on cross-sectional data will be presented in this section.

3.8 Multicollinearity Test

CLRM considers no correlation between independent variables. If there is a strong correlation between any two independent variables, multicollinearity can occur, reducing the accuracy of the model. When this happens, we can remove a variable from the model because, according to Saxena (2020), the best way to solve the multicollinearity problem is to remove a variable from the model. The correlation coefficient is one of the tests to detect multicollinearity problems and ensure that the model is unbiased.

a) Correlations Coefficient

The following are the hypotheses and the decision rule used in the test. If the correlation values of the test are all less than 0.9, H_0 is rejected, and it can be determined that there is no multicollinearity in the regression model. Table 3.4 presents the correlation analysis for the cross-sectional data of three independent variables. It shows that the correlation value between Bitcoin supply and Bitcoin hash rate is 0.9135, but the value does not exceed the value specified by the assumption, which is 0.9 too much. Thus, we can assume that these two variables have no severe multicollinearity problem. Besides, the remaining variables show that their coefficient correlations are all less than 0.9, thus indicating that the regression model does not have the problem of multicollinearity.

Table 3.4: Correlation analysis of the variables

Correlation	BTCP	BTCS	BTCHR	GP
BTCP	1.0000			
BTCS	0.6167	1.0000		
BTCHR	0.4682	0.9135	1.0000	
GP	0.5543	0.8080	0.6600	1.0000

Source: Data extracted from EViews output.

b) VIF Method

VIF is also a method used to test for multicollinearity between independent variables and ensure that the model is unbiased. Since there is a high correlation value between Bitcoin supply and Bitcoin hash rate (0.9135), we proceed to another multicollinearity test to perform one more time to determine if there is a severe multicollinearity problem. The following is the decision rule for the VIF method:

Decision Rule: If VIF < 10, there is no multicollinearity problem.

If all the values of Centered VIF are less than 10, this proves that there is no multicollinearity between the independent variables. Table 3.5 shows that the Centered VIF values for both the Bitcoin hash rate (BTCHR) and the gold price (GP) are less than 10, meaning there is no multicollinearity between BTCHR and GP. However, the centred VIF value for the Bitcoin supply (BTCS) is high at 10.9994, which breaks the decision rule of the VIF method. Therefore, we know the independent variable BTCS has a multicollinearity problem in this regression model. So, one of the best ways to solve this multicollinearity problem is to remove BTCS from the regression model. However, the above regression analysis shows that the P-value of BTCS is 0.0000, below the 5% significance level. This implies that this variable (BTCS) explains the regression significantly. Besides, if the independent variable BTCS is dropped, the following diagnostic tests will also have problems. Therefore, in this VIF test, I did not eliminate the independent variable BTCS.

Table 3.5: VIF of the variables

Variable	Coefficient Variance	Uncentered VIF	Centred VIF
Intercept	1.41E+09	11856.2	NA
BTCS	5.34E-06	15346.8	10.9994
BTCHR	2.24E-10	42.2659	6.76367
GP	9.705245	236.909	3.22451

Source: Data extracted from EViews output.

3.9 Heteroscedasticity Test

CLRM also believes that cross-sectional data are homoscedastic, which implies continuous variation of the disturbance conditions. According to Zach (2020), heteroskedasticity leads to inconsistent testing of hypotheses, resulting in inaccurate study results. Therefore, the model should be free from heteroskedasticity in order to obtain correct test results. The assumptions of the heteroscedasticity test are as follows:

H_0: There is no heteroskedasticity issue in the data
H_1: There is a heteroskedasticity issue in the data
Decision Rule: If the p-value < 0.05, Reject H_0

Table 3.6 shows that the probability F (3,1457) is 0.0000 and less than 0.05. Based on the decision rule, H_0 is rejected as 0.0000 < 0.05. Thus, we can identify a heteroskedasticity issue in the cross-sectional data. In other words, there is no homoskedasticity in the cross-sectional data. Since there is a heteroskedasticity problem in the data, we should do a logarithmic transformation, which means transforming the dependent variable or one of the independent variables into a logarithm to solve the heteroskedasticity issue (Zach, 2019). I have tried to convert the dependent variable or one of the independent variables to logarithms. However, the above multicollinearity test still has a problem, and the following serial correlation test will also have an issue. Hence, in this heteroscedasticity test, I did not perform the logarithmic transformation on the dependent or independent variables.

Table 3.6: Heteroscedasticity test of the variables

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	61.57384	Prob. F (3,1457)	0.0000
Obs*R-squared	164.3873	Prob. Chi-Square (3)	0.0000
Scaled explained SS	160.5899	Prob. Chi-Square (3)	0.0000

3.10 Serial Correlation Test

In addition to requiring the data to be homoscedastic, it is also required that there is no serial correlation, which also implies no autocorrelation between the independent variables. The problem of autocorrelation arises when the error condition of one observation is compared with the error term of another observation. It violates the OLS principle of time-independent residuals and produces unstable hypothesis tests. Islam & Toor (2019) claim that if autocorrelation is ignored in the data set, it leads to standard errors that are smaller than the actual standard errors and misleads the true value of R-squared. In this research, the Breusch-Godfrey Lagrange Multiplier (LM) Test will be used to test autocorrelation. The following are the hypotheses and decision rules for the LM Test:

H_0: The data has no autocorrelations problem
H_1: The data has an autocorrelations problem
Decision Rule: If the p-value < 0.05, Reject H_0

Based on Table 3.7, the LM test results show that the P-value of Chi-Square (2) is 0.000 and lower than 0.05. Hence, the null hypothesis is rejected, and we can conclude that this cross-sectional data has a serial correlation problem. Due to the serial correlation issue in the data, we should add a lag term, which means adding a lag term to either the dependent variable or one of the independent variables to correct the serial correlation issue (Zhang & Clovis, 2010). However, if a lag term is added to the dependent variable or one of the independent variables, the above multicollinearity test and heteroscedasticity test will also have problems. Hence, I did not add any lag term to the dependent or independent variables in this serial correlation test.

Table 3.7: *LM* test of the variables

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	17479.88	Prob. F (2,1455)	0.0000
Obs*R-squared	1402.624	Prob. Chi-Square (2)	0.0000

3.11 Summary of Cross-Sectional Data Diagnostic Test

Table 3.8 summarizes the results of the diagnostic tests for the appropriateness and reliability of the cross-sectional data in the Multiple Linear Regression (MLR) model. It shows that the cross-sectional MLR model does not meet the assumptions of the multicollinearity test, heteroskedasticity test and serial correlation test. In short, multicollinearity, heteroskedasticity and autocorrelated residuals were observed across the data set. Therefore, a sensitivity analysis was necessary.

Table 3.8: Summary of diagnostic tests

Assumptions	Multicollinearity Test	Heteroscedasticity Test	Serial Correlation Test
BTCP	* Has multicollinearity problem	*Residuals are heteroskedasticity	*Has an autocorrelation issue

Note: (√) indicates that the hypothesis is satisfied, while (*) indicates that a violation is detected but the problem is not resolved.

3.12 Sensitivity Analysis

Although I attempted to transform the dependent variable or independent variables into logarithms or add lagged terms to the variables, the cross-sectional MLR model still has problems with heteroskedasticity and serial correlation problems. Besides, there is a high correlation value between Bitcoin supply and Bitcoin hash rate, so I determined that there may be a multicollinearity problem. Therefore, I performed a sensitivity analysis. I conducted a two-stage least squares regression model for the cross-sectional data of this study. This is because, in the OLS method, there is a basic assumption that the value of the error term is independent of predictor variables. When breaching this assumption, a two-stage least squares regression model can help us solve this problem (James & Singh, 1978).

Two-Stage Least Squares (2SLS) regression analysis is a statistical technique used for structural equation analysis. This technique is an extension of the OLS method. It is used when the error term of the dependent variable is correlated with the independent variable (Angrist & Imbens, 1995). However, several assumptions must be satisfied to run a 2SLS regression model, including that the model (equation) should be correctly identified, the error terms should be normally distributed, and the observations should be independent (James & Singh, 1978). After satisfying all the assumptions, I conducted a 2SLS regression model using EViews for the cross-sectional data of this study. Table 3.9 shows the comparison between the Multiple Linear Regression (MLR) model and the Two-Stage Least Squares (2SLS) regression model for the cross-sectional data of this study. The table shows that the results of MLR (Robust) and 2SLS are similar. The coefficient of Bitcoin supply (BTCS) has not changed much, and it still significantly affects Bitcoin price. Besides, in this 2SLS regression model, the Bitcoin hash rate still significantly negatively affects Bitcoin price. However, we can see that the impact of the gold price (GP) on the Bitcoin price changes from positive to negative, and its coefficient and t-statistic values also change from positive (3.113434 and 0.9993) to negative (-1.566953 and -0.471). In addition, the number of observations also changes. The MLR model is 1461, while the 2SLS regression model is 1460. Furthermore, regarding R-squared and adjusted R-squared, the MLR method has higher R-squared and adjusted R-squared values than the 2SLS method. Since the 2SLS regression model was not affected or distorted by the problems in the diagnostic tests discussed earlier, it is trustworthy, and its results can be used to form a conclusion.

Table 3.9: Comparison of the results of two regression estimators. Dependent variable: Bitcoin price (BTCP)

Variable	MLR (Robust)		2SLS	
	Coefficient	t-Statistics	Coefficient	t-Statistics
Intercept	-679208.2**	-18.057	-832795.5**	-16.461
BTCS	0.038899**	16.829	0.048144**	15.615
BTCHR	-0.000163**	-10.914	-0.000233**	-10.892
GP	3.113434*	0.9993	-1.566953*	-0.471
No Obs	1461		1460	
R^2	0.4355		0.4268	
adj. R^2	0.4344		0.4256	

** are significant at P-value < 0.05
* are insignificant at P-value > 0.05

3.13 Cross-Sectional Two-Stage Least Squares Regression Analysis and Test of Significance

Table 3.10 shows the Two-Stage Least Squares (2SLS) Regression equation between the dependent variable, Bitcoin Price (BTCP), and the independent variables, which are Bitcoin Supply (BTCS), Bitcoin Hash Rate (BTCHR), and Gold Price (GP). The 2SLS regression equation for the cross-sectional data of this study is as follows:

$$\mathbf{BTCP = 0.048144\ BTCS - 0.000233\ BTCHR - 1.566953\ GP - 832795.5}$$

Table 3.10: Summary of two-stage least squares regression model. Dependent variable: Bitcoin price (BTCP)

Variable	Coefficient	Standard Error	t-Statistic	Prob (P-value)
Intercept	-832795.5	50593.31	-16.461	0.000
BTCS	0.048144	0.003083	15.615	0.000
BTCHR	-0.000233	2.14E-05	-10.892	0.000
GP	-1.566953	3.328296	-0.471	0.638

3.14 Overall Fitness Model (R-squared and Adjusted R-squared)

R-squared (R^2) is a statistical measure that represents the proportion of the variance of the Bitcoin price (dependent variable) that can be explained in a 2SLS regression model by the Bitcoin supply, Bitcoin hash rate and gold price (independent variables).

Table 3.11: Summary of R-squared and adjusted R-squared

DV	R-Squared	Adjusted R-Squared
BTCP	0.4268	0.4256

According to the table above, the value of the R-squared is 0.4268. This indicates that around 42.68% of the variation in Bitcoin Price (BTCP) can be interpreted by BTCS, BTCHR and GP. Meanwhile, the remaining 57.32% of the variation in BTCP can be interpreted by other factors. The R-squared presents good explanatory power and a linear fit to the data set. Besides, the model adjusted R-squared of 42.56% (0.4256), proving that the model results are reliable in explaining the impact of internal factors (Bitcoin supply and Bitcoin hash rate) and external factors (gold price) on the price of Bitcoin.

Table 3.12: Summary of f-test

DV	F-statistic	P-value
BTCP	368.862	0.0000

The F-statistic shown in the table tests the significance of the cross-sectional 2SLS regression model. The table shows that the p-value is 0.0000, which is less than the 5% significance level. This implies that the estimated 2SLS regression model is significant in predicting the price of Bitcoin with the influence of internal factors (Bitcoin supply and Bitcoin hash rate) and external factors (gold price). Table 3.13 presents the coefficients and associated p-value of the three independent variables in the cross-sectional 2SLS regression model.

Table 3.13: Summary of 2SLS Regression coefficient analysis

Variables	DV: Bitcoin Price		
	Coefficient	P-value	Results
Intercept	-832795.5	0.000	
BTCS	0.048144	0.000	+ Significant
BTCHR	-0.000233	0.000	- Significant
GP	-1.566953	0.638	- Insignificant

Note: (+) means positive relationship, (-) means negative relationship

The estimated cross-sectional regression model can be written as:

$$\boldsymbol{BTCP = - 832795.5 + 0.048144\ BTCS - 0.000233\ BTCHR - 1.566953\ GP}$$

3.15 Relationship between Bitcoin Supply and Bitcoin Price

Table 3.14: Relationship between Bitcoin supply and Bitcoin price

DV	Bitcoin Supply	P-value	Results
BTCP	0.048144	0.000	Significant positive relationship

The above result shows that Bitcoin supply has a significant positive relationship with its price, as it has a positive coefficient value (0.048144) and a p-value of 0.000, which is less than the 0.05 significance level. In short, the supply of Bitcoin has been found to positively and significantly impact its price.

3.16 Relationship between Bitcoin Hash Rate and Bitcoin Price

Table 3.15: Relationship between Bitcoin hash rate and Bitcoin price

DV	Bitcoin Hash Rate	P-value	Results
BTCP	-0.000233	0.000	Significant negative relationship

According to the above table, the Bitcoin hash rate has a negative coefficient value of -0.000233, negatively related to the Bitcoin price. On the other hand, the p-value (0.000) is significant as it is below the 5% significance level, indicating a significant relationship between the Bitcoin hash rate and the Bitcoin price. In a nutshell, the Bitcoin hash rate negatively and significantly affects Bitcoin's price.

3.17 Relationship between Gold Price and Bitcoin Price

Table 3.16: Relationship between gold price and Bitcoin price

DV	Gold Price	P-value	Results
BTCP	-1.566953	0.638	Insignificant negative relationship

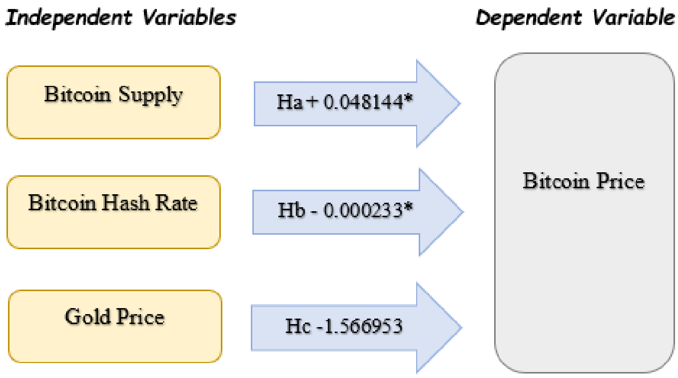
From the above table, we can see that the gold price has a negative coefficient value of -1.566953, which means that it has a negative correlation with the Bitcoin price. Besides, the gold price's p-value (0.638) is more significant than 0.05, so it is insignificant. This also indicates that the gold price has an insignificant negative correlation with the price of Bitcoin. In brief, gold prices have been found to have the most minor effect on Bitcoin prices.

4 FINDINGS AND DISCUSSIONS

4.1 Regression Analysis Findings

Figure 4.1 shows the regression analysis results of the relationship between the determinants (Bitcoin supply, Bitcoin hash rate and gold price) and the dependent variable of Bitcoin price. Among the determinants, the relationship between the two internal factors (BTCS and BTCHR) and Bitcoin price is significant at the 5% significance level. In addition, the overall results of the regression analysis model show that the gold price is a less significant factor in the Bitcoin price, as this factor is not significant and is below the 5% significance level.

Figure 4.1: **Regression Analysis Findings**



Note: (+) positive relationship, (-) negative relationship, (*) significant relationship.

4.2 Hypothesis Testing Findings

This part summarises the overall findings from the study's hypothesis testing. This study shows that two alternative hypotheses are accepted, indicating that internal factors, Bitcoin Supply and Bitcoin Hash Rate, significantly impact the price of Bitcoin. However, one alternative hypothesis is rejected: there is no correlation between the gold price and the Bitcoin price. The results of this study are in contrast to the expected and past findings. As shown in Table 4.1, all results of this study were supported by previous studies.

TABLE 4.1: Hypothesis testing findings

Hypothesis	Expected Sign	Result Sign	Hypothesis Testing	Supported Literatures
H_1 a Bitcoin Supply	+ Significant	+ Significant	Accept H_1 a	Georgoula et al. (2015); Kristoufek (2015); Ciaian et al. (2015); Kjærland et al. (2018); Dubey (2022)
H_1 b Bitcoin Hash Rate	+ Significant	- Significant	Accept H_1 b	Bouoiyour & Selmi (2015); Hayes (2015); Georgoula et al. (2015); Fantazzini & Kolodin (2020); Sun et al. (2023)
H_1 c Gold Price	+ Significant	- Insignificant	Reject H_1 c	Zhu et al. (2017). Aggarwal et al. (2019); Gozbasi et al. (2021); Kapar & Olmo (2021)

4.3 Research Findings

4.3.1 **Effect of Bitcoin Supply on Bitcoin Price**

H_1 a: There is a positive significant relationship between Bitcoin supply and the price of Bitcoin. (Accept)

The first objective is to investigate the impact of Bitcoin supply on the price of Bitcoin. The hypothesis developed in this research is that the supply of Bitcoin has a significant positive relationship with its price. Through the analysis of this research, we can find that the supply of Bitcoin has a positive relationship with the price of Bitcoin, as its correlation coefficient is 0.048144. Besides, its p-value is less than the 5% significance level, which is 0.000, indicating that the supply of Bitcoin significantly impacts the price of Bitcoin. Therefore, this research accepts the alternative hypothesis and concludes that the supply of Bitcoin has a significant positive relationship with the price of Bitcoin. So, when the supply of Bitcoin increases, the price will also increase.

The results are consistent with the findings (Georgoula et al., 2015; Kristoufek, 2015; Ciaian et al., 2015; Kjærland et al., 2018; Dubey, 2022) who found a significant relationship between Bitcoin supply and Bitcoin price. Since the release of Bitcoin, its value has been increasing significantly because it only has a certain number of supplies, which is 21 million. The supply of Bitcoin will gradually increase because people keep mining Bitcoin to meet their demands.

Therefore, when the demand increases daily, the final volume of supply.It remains the same (21 million BTC), and its price will gradually increase (Georgoula et al., 2015). Kristoufek (2015) pointed out that the supply of Bitcoin positively correlates with the price in the long run. However, the results of the past studies (Kavvadias, 2017; Goczek & Skliarov, 2019) are contrary to the results of this study as they stated that the supply of Bitcoin has no significant impact on the price of Bitcoin. Moreover, Kjærland et al. (2018) showed a significant relationship between the volume of Bitcoin circulation and Bitcoin price, but they are negatively correlated.

4.3.1 Effect of Bitcoin Hash Rate on Bitcoin Price

H_1 b: There is a positive significant relationship between the Bitcoin hash rate and the price of Bitcoin. (Accept)

The second objective is to determine the impact of the Bitcoin hash rate on the price of Bitcoin. This study predicts that the Bitcoin hash rate positively correlates with the price. According to the study results, there is a negative relationship between the Bitcoin hash rate and Bitcoin price, as its correlation coefficient is - 0.000233. Besides, the study found that the Bitcoin hash rate has a significant relationship with Bitcoin price because its p-value is lower than the significance level of 5%. Therefore, the alternative hypothesis is accepted, and the study concludes that the Bitcoin hash rate significantly negatively impacts Bitcoin's price. This implies that a decrease in the Bitcoin hash rate will increase the price of Bitcoin. This result agrees with the findings (Fantazzini & Kolodin, 2020; Bouoiyour & Selmi, 2015; Hayes, 2015; Georgoula et al., 2015; Sun et al., 2023), who found that there is a significant effect on the relationship between Bitcoin hash rate and the price of Bitcoin. Bitcoin hash rate plays a crucial role in influencing the ups and downs of the price of Bitcoin (Bouoiyour & Selmi, 2015). Fantazzini and Kolodin (2020) found a significant relationship between Bitcoin hash rate and Bitcoin price in the second subsample of their study (11/12/2017 - 24/02/2020). However, before studying the second subsample, Fantazzini and Kolodin (2020) found that the Bitcoin hash rate and price were insignificant in the first subsample studied (01/08/2016 - 04/12/2017). Thus, they showed that the hash rate did not influence the price of Bitcoin during the period 01/08/2016 - 04/12/2017. Similarly, Kjærland et al. (2018) found no significant relationship between Bitcoin price and the hash rate. Hence, they conclude that technical factors do not affect the price of Bitcoin.

4.3.2 Effect of Gold Price on Bitcoin Price

H_1 c: There is a significant positive relationship between the price of gold and Bitcoin. (Reject)

The third objective is to examine the impact of gold price on the price of Bitcoin. This study expects that gold price has a positive significant relationship with the price of Bitcoin. However, the study found that gold price has a negative insignificant relationship with Bitcoin price. The results show that the relationship between the gold price and the price of Bitcoin is insignificant, as the p-value of the gold price is 0.638, which is more than the 5% significance level. Besides, there is a negative correlation between the gold price and the Bitcoin price since the coefficient of the gold price is -1.566953. Hence, this study rejects the alternative hypothesis and concludes that gold price has a negative insignificant relationship with the price of Bitcoin. This result is in contrast to the findings of (Kyriazis, 2020; Das and Kannadhasan 2018 Ge & Zhou, 2019), who found a significant correlation between the price of gold and the price of Bitcoin. Das & Kannadhasan (2018) pointed out that in the medium to long term, the gold price has a significant positive impact on the price of Bitcoin, as Bitcoin is similar to gold in that they have only a limited amount available for mining. Nevertheless, the results of this study are in line with several past studies (Aggarwal et al., 2019; Kapar & Olmo, 2021; Gozbasi et al., 2021; Zhu et al., 2017), who found that there is an insignificant negative relationship between the gold price and the price of Bitcoin. Zhu et al. (2017) found that gold price has no effect on Bitcoin price in the long run. In addition, Gozbasi et al. (2021) proposed the hypothesis that there is no significant relationship between the gold price and the price of Bitcoin, and their findings are consistent with the proposed hypothesis.

4.4 Summary of Findings and Discussions

4.4.1 Positive Impact of Bitcoin Supply on Bitcoin Price

The empirical study found that Bitcoin supply has a positive and significant relationship with Bitcoin price, supported by the p-value of Bitcoin supply, which is lower than the significance level of 5%. Thus, the alternative hypothesis is accepted, and the research concludes that Bitcoin supply significantly and positively correlates with Bitcoin price. This means that the increase in Bitcoin supply will directly lead to a rise in the price of Bitcoin.
The results of this study are in contrast to some studies (Kavvadias, 2017; Kjærland et al., 2018; Goczek & Skliarov, 2019). These studies found that the

The supply of Bitcoin has negatively impacted its price. Simply put, they mean that when the supply of Bitcoin increases, its price will decrease. The result of this study is supported by several studies (Georgoula et al., 2015; Kristoufek, 2015; Ciaian et al., 2015; Dubey, 2022). All these researchers revealed that the supply of bitcoin has positively and significantly influenced the price of Bitcoin. Ciaian et al. (2015) concluded that there is a significant positive correlation between the supply of Bitcoin and the price of Bitcoin. This indicates that an increase in Bitcoin supply positively impacts the price of Bitcoin, i.e., the price of Bitcoin increases accordingly (see Table below).

	Bitcoin Supply (BTCS)
Objectives	To examine the impact of the supply of Bitcoin on the price of Bitcoin.
Question	How does the supply of Bitcoin affect Bitcoin's price?
Hypothesis	There is a significant positive relationship between the supply of Bitcoin and its price.
Results	There is a significant positive relationship between the supply of Bitcoin and its price.
Hypothesis Findings	***H_1 a is accepted*** Bitcoin supply has a significant positive relationship with Bitcoin price.
Supported Literature	Georgoula et al. (2015), Kristoufek (2015), Ciaian et al. (2015), Dubey (2022).

4.4.2 Negative Impact of Bitcoin Hash Rate on Bitcoin Price

This research found that the Bitcoin hash rate has a negative and significant relationship with the price of Bitcoin. This finding is supported by the fact that the p-value of the Bitcoin hash rate is less than the significance level of 0.05. Therefore, the alternative hypothesis is accepted. The study concludes that the hash rate has significantly and negatively correlated with the price of Bitcoin. In addition, it shows that the Bitcoin hash rate has an inverse effect on the price of Bitcoin. This result contradicts the studies of Hayes (2015) and Georgoula et al. (2015), where the researchers found that the Bitcoin hash rate positively affects the Bitcoin price. The idea behind this is that the complexity of the hash rate positively impacts the price of Bitcoin. It simply means that the more complex the Bitcoin hash rate is, the more secure it is and the higher its price will be. The findings of this research are supported by some past studies (Bouoiyour & Selmi, 2015; Fantazzini & Kolodin, 2020; Sun et al., 2023), which reported that.

There is a significant negative correlation between the Bitcoin hash rate and price. Bouoiyour and Selmi (2015) stated that if the hash rate is too complex, mining becomes more difficult, and the price of Bitcoin will slip a bit. They suggest that reducing the difficulty of mining could increase the price of Bitcoin (see Table below).

	Bitcoin Hash Rate (BTCHR)
Objectives	To determine the impact of the Bitcoin hash rate on Bitcoin's price.
Question	How does the Bitcoin hash rate influence Bitcoin's price?
Hypothesis	There is a positive significant relationship between the Bitcoin hash rate and the price of Bitcoin.
Results	There is a negative significant relationship between the Bitcoin hash rate and the price of Bitcoin.
Hypothesis Findings	***H_1 b is accepted*** Bitcoin hash rate has a significant negative relationship with Bitcoin price.
Supported Literature	Bouoiyour & Selmi (2015), Fantazzini & Kolodin (2020), Sun et al. (2023)

4.4.3 Negative Impact of Gold Price on Bitcoin Price

The empirical study discovered an insignificant negative correlation between the price of gold and the price of Bitcoin, as the p-value of the gold price is higher than the 5% significance level, and its coefficient value is negative. This indicates that gold price has no significant effect on Bitcoin price. As a result, this study rejects the alternative hypothesis and concludes that the gold price has no direct impact on the price of Bitcoin. Several past researchers support this finding (Zhu et al., 2017; Aggarwal et al., 2019; Kyriazis, 2020; Kapar & Olmo, 2021; Gozbasi et al., 2021), who discovered the same results as this research. However, the results of this study are contrary to the findings of

Das & Kannadhasan (2018) and Ge & Zhou (2019) found a significant positive relationship between the price of gold and the price of Bitcoin. Ge & Zhou (2019) stated that Bitcoin is also known as "paper gold" because it has many characteristics, such as its issuance method, circulation, and cost, similar to gold. Hence, Bitcoin is undoubtedly an evolved version of gold, and they will have a significant positive relationship. This previous study shows that gold prices positively impact Bitcoin prices (see Table below).

	Gold Price (GP)
Objectives	To identify the impact of the gold price on the price of Bitcoin.
Question	How does the gold price impact the price of Bitcoin?
Hypothesis	There is a significant positive relationship between the price of gold and the price of Bitcoin.
Results	There is a negative insignificant relationship between the gold price and the price of Bitcoin.
Hypothesis Findings	***H_1 c is rejected*** Gold prices have a negative, insignificant correlation with the price of Bitcoin.
Supported Literature	Zhu et al. (2017). Aggarwal et al. (2019), Kyriazis (2020), Kapar & Olmo (2021), Gozbasi et al. (2021)

5 CONCLUSION

This study aims to examine the impact of the determinants on the price of Bitcoin. In this study, Bitcoin supply and hash rate are internal factors, while gold price is external. The secondary data was extracted from online websites, which showed historical data on Bitcoin price, supply, hash rate, and gold price. Historical data on Bitcoin price was extracted from the *coindesk.com* website; Bitcoin supply and hash rate were extracted from the *blockchain.com* website; and gold price was taken from the *goldprice.org* website. All data collected are based daily from 1 January 2019 to 31 December 2022. A two-stage least squares (2SLS) regression model is used to assess the impact of Bitcoin supply, Bitcoin hash rate, and gold price on the price of Bitcoin. The results show that the supply of Bitcoin positively and significantly influences its price. In contrast, the Bitcoin hash rate negatively and significantly influences Bitcoin's price. However, this study discovered that gold prices negatively and insignificantly impact Bitcoin prices. Therefore, this also indicates that gold prices have the most negligible impact on the price of Bitcoin in this study. On the contrary, Bitcoin supply is the factor that has the most significant impact on Bitcoin's price. This study successfully achieved the research objective and answered all the research questions. The following subsections summarise all the findings of this study.

5.1 Bitcoin Supply and Bitcoin Price

The study found a positive and significant relationship between the supply of Bitcoin and the price of Bitcoin. This indicates that the supply of Bitcoin positively impacts Bitcoin's price. Some past studies are in line with this result. A possible explanation for this result is that since the release of Bitcoin, its supply has gradually increased as people keep mining Bitcoin to meet their demand for it. Thus, when the demand for Bitcoin increases daily, but its final volume of supply remains the same (21 million BTC), its price will rise. So, as the supply gradually increases, the closer it gets to its final supply, its price will gradually rise.

5.2 Bitcoin Hash Rate and Bitcoin Price

Secondly, the empirical study found that the Bitcoin hash rate has a significant negative correlation with the price of Bitcoin. This finding is interesting as it contrasts with most studies that have confirmed that Bitcoin hash rate positively impacts Bitcoin price. A possible explanation for this result is that if the hash rate is too complex, mining becomes more difficult, and the price of Bitcoin slips a bit. In other words, if the hash rate is more straightforward, mining becomes less complicated, people can mine Bitcoin easily, and the price will increase.

5.3 Gold Price and Bitcoin Price

Lastly, the study shows that gold price has a negative and insignificant effect on the price of Bitcoin. The concept of this result is that the gold price is not a significant factor affecting the price of Bitcoin. This finding is also interesting because it refutes the argument that Bitcoin has many similar characteristics to gold. However, the insignificant relationship found in this empirical study is supported by the studies of Zhu et al. (2017), Aggarwal et al. (2019), Kyriazis (2020), and Kapar & Olmo (2021).

5.4 Research Implications

This section proposes research implications for Bitcoin holders, investors intending to purchase Bitcoin, governments, academic institutions, FinTech students and future researchers.

- **Bitcoin Holders**

Typically, Bitcoin holders hold Bitcoin as one of their investments in making money. This study can help Bitcoin holders gain additional knowledge. They can clearly understand how Bitcoin supply, hash rate, and gold price affect the price of Bitcoin. This study gives Bitcoin holders a better understanding of the main factors that cause Bitcoin price fluctuations. Therefore, this study can help Bitcoin holders decide whether to buy more or sell their Bitcoin.

- **Investors**

Investors who intend to buy Bitcoin will gain valuable benefits from this research. Based on the results of this research, investors can better understand how internal and external factors affect the price of Bitcoin before buying it. In addition, this study is beneficial for investors because it provides knowledge and details of the determinants that affect the price fluctuations of Bitcoin. Thus, this study can also be used as a reference for investors considering whether to buy Bitcoin and the timing of buying Bitcoin.

- **Governments**

Although Bitcoin is not issued or regulated by governments, some regulations do affect its price. Since Bitcoin is a new challenge for governments, they implement policies and restrictions to protect the stable development of the financial system from Bitcoin. The findings of this study may help governments better understand the phenomenon of Bitcoin volatility and develop better and mutually beneficial policies.

- **Academic Institutions, FinTech Students and Future Researchers**

The results of this study will be useful to academic institutions and FinTech students in their empirical review of Bitcoin price volatility. In addition to this, the results of this study will also be important for future researchers who study Bitcoin prices. Future researchers will be able to use the findings to set prediction targets and outcomes or to make comparisons and identify research gaps.

5.5 Limitations of Research

This research has some limitations. The disclosure of these limitations is not intended to undermine this study but to provide new opportunities for future research to explore the specified areas. One limitation of this study is the variables. Previous researchers have used several independent variables in similar research topics. Those independent variables include internal factors, such as Bitcoin supply and demand, Bitcoin hash rate, Bitcoin transaction fees, and others, as well as external factors, such as gold price, crude oil price, US dollar index, and S&P 500 index. All of the variables can influence the dependent variable (Bitcoin price). In this study, the three independent variables I chose can be replaced, and other independent variables can be added. However, it is essential to note that when there are many variables, this will lead to different analyses and opinions about their study. Therefore, this would lead to many possible outcomes that would be unfavourable for the researcher to study the variables and draw conclusions. Another limitation of this study is that I did not investigate the direction of the relationship between the variables. A general limitation of correlational studies is that they can identify the relationship between variables but cannot predict causality (cause and effect). This is because correlation does not imply causation. If X and Y are shown to be correlated, then it is possible, but not sure that X caused Y. However, it is also possible that Y caused X (Lee, 2021). In this research, I conducted correlation studies to determine the relationship between internal factors (Bitcoin supply and Bitcoin hash rate) and external factors (gold price) on the price of Bitcoin. However, I did not determine the causal relationship between these variables. Hence, this study does not show the direction of the relationship between the variables.

5.6 Suggestions for Future Research

This study answered all the research objectives and identified some limitations. These limitations can be improved in similar research topics in the future. Firstly, this study used only three independent variables: two internal factors (Bitcoin supply and hash rate) and one external factor (gold price). This decreased the probability of drawing more conclusive findings. Thus, future research should involve more internal and external factors as independent variables, including those used in this study. Second, the limitation of this study is that it does not show the direction of the relationship between variables (cause and effect). Therefore, future studies that want to improve and obtain more accurate results can determine the direction of the relationship between variables by conducting the causality test. This could improve the results of the study. Thirdly, future research could include dummy variables in the study. Dummy variables include the types of news about Bitcoin. For instance, news about security breaches, political incidents, and statements regarding Bitcoin. These variables may have different outcomes and effects on the price of Bitcoin (Kjærland et al., 2018). Hence, dummy factors variables can be considered to provide deeper insights. Lastly, one of the 3 variables (gold price) has an insignificant effect on Bitcoin price. This finding allows future research to apply alternative measures to this variable to obtain robust results.

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