

The Arbitrage Strategy for Cryptocurrency: Principle and Feasibility Based on Blockchain Technology

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Abstract—Cryptocurrency is a tradable digital asset or digital form of money based on blockchain technology, which uses encryption to authenticate and protect transactions. Contemporarily, there are over a thousand different types of cryptocurrencies in the world, which is treated as the key to a fairer future economy. This research will illustrate the principles and process of arbitrage strategy for cryptocurrency. Specifically, the arbitrage possibilities by comparing and calculating the coefficient of relationships between prices and events will be investigated based on previous data. Primarily the original idea and the developments of cryptocurrency will be introduced, from the BTC to the thousand of cryptocurrencies. Subsequently, a deep study of different principles is carried out to find the possibilities of arbitrage and verify their feasibility. Once more cryptocurrencies occurred, meaning the risk and arbitrage chances will happen more often than before. The future study will focus more on the safe arbitrage possibilities between different countries. These results offer a guideline for a safer arbitrage possibility when the price change is related to the regulatory actions.

Keywords-Cryptocurrency; blockchain; arbitrage strategy; arbitrage chances

1. INTRODUCTION

Since the late 1980s, an increasing number of liberal scientists, engineers, computer scientists and philosophers, known as cryptopunks, are discussing and debating how to use cryptography to increase their privacy in a world that will increasingly be dominated by computers and the Internet. The cypherpunk group set up a mailing list in the early 90's in which they proposed and advocated the use of different systems for their purposes. The goal has always been to create a secure environment in cyberspace, using cryptography to protect that environment from government and corporate surveillance [1]. Among the evolving discussions and suggestions, three themes emerged: privacy protection, the need for a form of currency in this protected cyberspace, and smart contracts that allow anonymous strangers to execute transactions with each other without trusting third parties.

With the launch of Bitcoin in 2009, Satoshi's brilliant invention revolutionized bitcoin, also known as the Satoshi Consensus, which largely facilitated the solution or significant improvement of these problems by integrating the parts together in a mutually reinforcing way. In the Satoshi consensus, all nodes in a peer-to-peer network send all new transactions to all other nodes. They all then use these transactions, along with information and timestamps from the previous block, as the next proof-of-work puzzle, based on the minimum difficulty threshold.

When any node reaches a result based on that threshold, it broadcasts the result to all the other nodes. When all other nodes receive proof of work, they validate against the system's algorithm and the proof chain they keep in the copy. When the proof of work is verified, all nodes credit a number of tokens to the account of the node that solved the puzzle first, according to Bitcoin monetary policy. In this way, Bitcoin guarantees the value of tokens, not only because of the scarcity imposed by monetary policy, but also due to the amount of computational work required to create new tokens.

This workload is also the key to solving the previously mentioned 33% Byzantine problem of peer-to-peer networks. Since the minimum difficulty threshold set by bitcoin's algorithm means that all participating nodes must spend an average of 10 minutes solving the puzzle, when any node discovers and sends the result, it assures the rest of the network that all other participants are also working on the puzzle. However, if anyone implements more than 50% of the computing power in the network, they can still outperform other nodes in generating blocks, which can tamper with the property ledger, which is commonly known as a 51 percent attack rate. Therefore, the Satoshi consensus improvement is that it raises the previous consensus security threshold of 33% to 50%, meaning that any set of colluding nodes that tamper with the property ledger now require more than 50% of the computing power in the system to achieve this [2]. In this way, Bitcoin has become the first successful and widely used form of purely digital money, similar to digital gold. However, in the next step, smart contracts cannot be implemented due to their internal design and limitations. A sketch of blockchain validation is presented in Fig. 1.

Additionally, as the represent of cryptocurrency, Bitcoin is not always stable as we thought to be, On May 21, 2010, an American programmer exchanged 10,000 Bitcoins for two pizzas. The market price of the two pizzas was \$30 at the time, which worked out to \$0.003 per BTC. This was the first real-world pricing of BTC. BTC rose from \$0.50 at the end of 2010 to a then-high of \$32 in June, but the first Mt.Gox hack and a series of security issues raised questions shortly thereafter sent BTC prices rapidly back down, hitting \$2 twice in late October and November.

Until October 2013, when European countries issued relevant policies on bitcoin, BTC started the crazy mode and rose to \$1163 at the beginning of December. In this round of market, BTC rose 480 times from the low of \$2 at the beginning of 2012 to December 2013. When investor enthusiasm peaked in 2017, there was a series of negative news across the market and BTC entered a downtrend, recovering weaker and weaker each time until bottoming out at \$3,122 by the end of 2018. By the rapid development of cryptocurrency, more agents find the arbitrage chance happened between different exchange, the most widely used is the triangular arbitrage parity, however the coefficient of relationships between prices and regulatory action is also necessary [3, 4].

According to previous literatures, there have been tens of thousands of exchanges in the world, however the price of each exchange is determined by different market, indicating the price of each exchange is not the same as others, which gives us many opportunities for arbitrage.

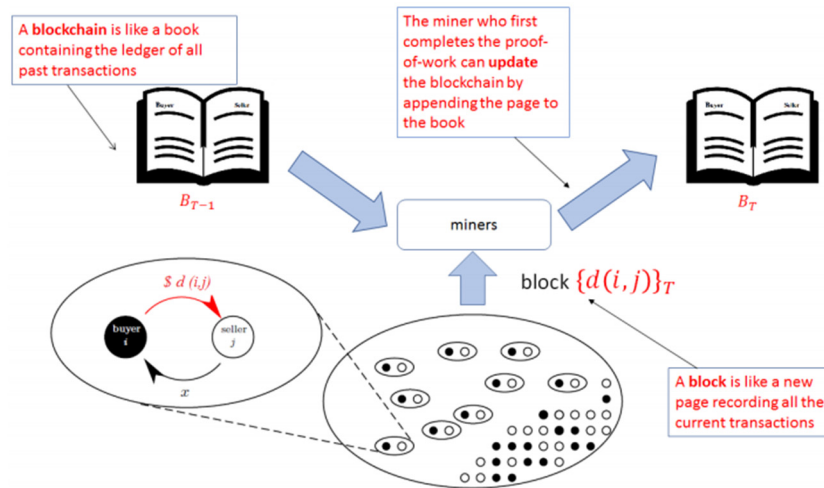


Figure 1. Blockchain Based Validation in a Cryptocurrency [2].

The rest of the paper is organized as follows. The Sec. 2 will explain the logic and technique of cryptocurrency. Then the Sec. 3 will list data as well as arbitrage principles to discuss the requirements and procedures of arbitrage. Subsequently, Sec. 4 will present an empirical study to demonstrate the feasibility of arbitrage. Eventually, Sec. 5 will give a brief summary.

2. BASIC DESCRIPTION OF CRYPTOCURRENCY

Cryptocurrency is a type of digital currency that uses cryptography to trade based on decentralization consensus mechanisms. Bitcoin and other cryptocurrencies are non-monetary assets existing in the form of electronic data. They are privately issued and do not have legal compensation and compulsion. In other words, they are not real money and should not and cannot be circulated and used in the market as money.

Blockchain is a new application model of distributed data storage, point-to-point transmission consensus mechanism, encryption algorithm and other computer technologies. Since BTC occurred, more than 9,800 cryptocurrencies have been created based on bitcoin. The top ten cryptocurrencies that have higher recognition of mainstream are BTC, ETH, DOGE, BNB, ADA, LTC, XRP, DOT, BCH and LINK. The market values and assets prices are illustrated in Fig. 2 (collected from Coinbase [5]) and the overall market value of cryptocurrency are also displayed in Fig. 3 [6].

Name	Price	Change	Price chart	Volume (24h)	Market cap	Supply	Trade
Bitcoin BTC	CN¥272,583.89	+272.28%		CN¥30.1B	CN¥5.1T	18.8M	Trade
Ethereum ETH	CN¥18,470.77	+664.62%		CN¥19.0B	CN¥2.2T	117.7M	Trade
Ethereum 2 ETH2	CN¥18,470.77	+664.62%		CN¥19.0B	CN¥2.2T	117.7M	
Cardano ADA	CN¥14.49	+2,120.85%		CN¥5.9B	CN¥465.3B	32.0B	Trade
Tether USDT	CN¥6.47	-5.42%		CN¥66.4B	CN¥443.6B	68.5B	
Binance Coin BNB	CN¥2,206.07	+1,161.33%		CN¥1.4B	CN¥370.6B	168.1M	
XRP XRP	CN¥5.98	+261.58%		CN¥3.1B	CN¥279.4B	46.7B	
Solana SOL	CN¥843.10	+3,833.73%		CN¥2.1B	CN¥250.4B	297.3M	Trade
USD Coin USDC	CN¥6.47			CN¥2.9B	CN¥199.5B	30.9B	
Polkadot DOT	CN¥186.04	+527.63%		CN¥2.0B	CN¥184.5B	987.6M	Trade
Dogecoin DOGE	CN¥1.32	+7,057.64%		CN¥1.1B	CN¥174.5B	131.4B	Trade

Figure 2. Cryptocurrency of Rank Top 10 (sorted by market value) [5].

The concept of bitcoin was proposed by Satoshi Nakamoto in November 2008 and officially born in January 2009. Bitcoin is the leading cryptocurrency, which now has one million active users. In 2021, despite the strong growth of other cryptocurrencies, it will still occupy more than 40% of the market.



Figure 3. Cryptocurrency of Rank Top 10 (sorted by market value) [6]

Bitcoin is a cryptocurrency that runs on a blockchain protocol and is characterized by decentralization and does not rely on specific institutions to issue it. The currency is based on a complex set of algorithms, in which miners are rewarded with Bitcoins for solving a particular solution. The source code caps the total number of bitcoins that can exist at 21 million, with the last one expected to appear around 2140.

On the one hand, relying on blockchain and other technical features, Bitcoin solves the problem of currency authenticity and double payment, ensuring the security of transactions. On the other hand, bitcoin does not need to open an account, rely on third-party clearing houses to transfer value, and do not need intermediaries to ensure the validity of transactions, i.e., greatly reducing transaction costs. Meanwhile, bitcoin transactions are based on the network. On this basis, there is no national boundary, no need for exchange, no need to go through banks, international clearing organizations, and direct transfer on nodes. Thus, it realizes trans-regional high-efficiency and low-cost transactions [3, 4].

The risk of trading cryptocurrencies also occurred at the same time, which involves that the first most people do not know the knowledge of cryptocurrencies. Therefore, they are open to hackers. volatility, no guarantee in the event of bankruptcy, cryptocurrencies are still not accepted in some countries. Unable to cancel payment. The account can be only accessed by the password which means it would never be found if you lose it.

3. PRINCIPLES AND PROCEDURES OF ARBITRAGE

Generally, there is a lot of bitcoin arbitrage transactions between different exchanges. These arbitrage opportunities could last for hours, days and even weeks. Besides, it should be mentioned that the arbitrage opportunities between exchanges located at different countries are much larger than those within the same country, which can be attributed to impact the regulatory actions of different country. A well-known arbitrage mode is the triangular arbitrage parity, as shown in Fig. 4 [7]. The basic idea of triangular arbitrage is to calculate a fair LTC/BTC price ($P2/P1$) by using the prices of two markets (e.g., BTC/CNY and LTC/CNY, denoted as $P1$ and $P2$, respectively). If the fair price is inconsistent with the actual LTC/BTC market price (denoted as $P3$), an arbitrage opportunity will be generated. Specific operations are mentioned in Ref. [8]. Table I lists regression results of price impact after regulatory news [9].

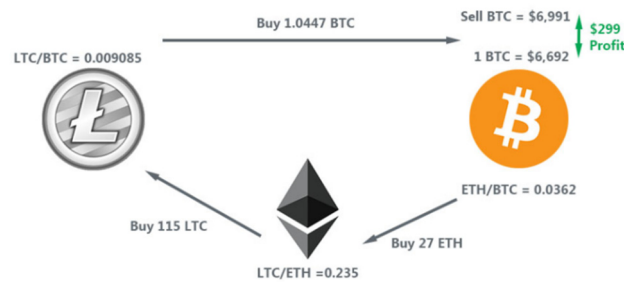


Figure 4. Triangular arbitrage cryptocurrency trading bot [8].

TABLE I. THE PRICE IMPACT OF REGULATORY NEWS: REGRESSION RESULTS (DEPENDENT VARIABLE: 10-DAY RESPONSE OF BTC/USD PRICE) [9]

	1	2	3	4	5	6
AML or crypto-exchange regulation	-7.680*** (2.070)			-6.082*** (2.074)		

Interoperability with banks or exchanges		-5.832*** (1.836)		-5.150*** (1.829)		
Legal status of cryptocurrencies			17.302*** (3.499)	16.448*** (3.489)		
General warnings					-1.147 (1.504)	
Authorities' views on CBDC						9.077 (6.368)
Observations	1.272	1.272	1.272	1.272	1.272	1.272
R-squared	0.01	0.01	0.02	0.03	0	0

Standard errors in pare, ***/**/* denotes results significant at the 1/5/10 % level.

4. EMPIRICAL ANALYSIS FOR CRYPTOCURRENCY ARBITRAGE

The cryptocurrency became one of the popular financial instruments around world and through the last ten years, more investors use the arbitrage principles to earn the differences between exchanges. According to the investigation, the price of the cryptocurrency is affected by the regulatory news, which creates more arbitrage opportunities between exchanges. One approach to crypto arbitrage is to buy a cryptocurrency on one exchange, then move it to another exchange and sell it at a higher price on that exchange. However, there are some problems with this approach. The spread usually lasts only a few seconds, but transfers between exchanges can take minutes. Recently, this problem has been solved by the computer programming [9]. Transfer fees are another issue, as there are fees associated with moving cryptocurrencies from one exchange to another, whether through withdrawals, deposits or network fees.

Triangular arbitrage involves taking three different cryptocurrencies and trading the difference between them on an exchange. Since all operations take place on an exchange, transferring fees is not an issue. However, carry trades have several risks, one of them is slippage, which occurs when a trader places an order to buy a cryptocurrency. Since the size of the order is larger than the cheapest offer in the order book, causing the order to “slip” and cost more than they expected to pay. That is a problem for traders, especially since margins are so low that slippage can wipe out potential profits [10].

$$P_i = (\sum_{j=1}^{n_{SELL}} V_j sell_j) - (\sum_{k=1}^{n_{BUY}} V_k buy_k) \quad (1)$$

Another way to trade futures is through hedging. Hedging is a way to reduce risk and is useful for traders dealing with the volatility of cryptocurrencies. Entering into a contract is a serious obligation. If the contract expires, the trader has a legal obligation to fulfill it.

Futures can cost a lot of money because you may be forced to buy bitcoin at a higher price than it currently trades at. Cryptocurrencies are one of the most volatile asset classes. As same

as bitcoin, the trading of all cryptocurrencies is risky. The cryptocurrency market (e.g., bitcoin) may be poised for a resurgence, but it is fraught with many risks and uncertainties. Once people lose confidence in cryptocurrencies due to various factors, they will face a collapse in value. Cryptocurrencies were set up to replace traditional currencies. Nevertheless, in reality, they have failed miserably as a currency [11].

In addition, the current international society the central bank has been in full swing since the study of digital currency, there are a total of 81 countries around the world (accounted for more than 90% of global GDP) is the central bank digital currency, digital currency also has many advantages of block chain, encryption money want to be with the advantages of building block chain to replace the existing monetary system idea has failed. Besides, it would also deal another blow to cryptocurrencies [12].

Cryptocurrency is more like a commodity than a currency, whereas, this is a risky and speculative commodity. Cryptocurrencies are a lot like stocks in that people buy at a low price and sell at a high price. However, the stock is endorsed by the listed company, and the appreciation and fall of the stock can be analyzed to a certain extent on the company's various business measures. Moreover, the stock also has a limit up and down mechanism, to a certain extent to ensure the stability of the stock market [12, 13]. Taking advantage of price differences between two different but related assets, the logic of cross-variety arbitrage is to find the relatively stable relationship between commodities of different varieties but with a certain correlation. The logic behinds cross-variety arbitrage can be obtained through fundamental analysis and statistic analysis. As for fundamental analysis, the two varieties are in the upstream and downstream of the same industrial chain or the two varieties have certain consumption substitutability as shown in Table II. Regarding to statistical analysis, e.g., the price trend of the two varieties has high correlation and full integration relationship.

TABLE II. CRYPTOCURRENCIES AND INVESTMENT DIVERSIFICATION: EMPIRICAL: CORRELATION MATRIX SEVEN LARGEST CRYPTOCURRENCIES [14]

	OIL	SPF500	GOLD	LIBOR	USD	BTC	XRP	LTC
OIL	1							
SPF500	0.29	1						
GOLD	0.31	0.56	1					
LIBOR	0.22	0.95	0.56	1				
USD	-0.70	-0.05	-0.38	0.07	1			
BTC	0.28	0.94	0.60	0.96	-0.18	1		
XRP	0.26	0.90	0.54	0.90	-0.24	0.92	1	
LTC	0.31	0.91	0.55	0.93	-0.29	0.97	0.95	1

5. CONCLUSION

In summary, the research discussed the principles and process of arbitrage strategy for cryptocurrency. Based on comparing and calculating the coefficient of relationships between prices and regulatory actions, the feasibility of the principles is verified. Additionally, the previous articles argued the original idea and the impacts of price changes, from the BTC to the thousand of cryptocurrencies, and compared different principles to define the most reliable one and verify the feasibility of them subsequently. However, the article did not cover the

comprehensive data and actions of all cryptocurrencies around the world. Besides, the arbitrage chances happened less than before as more agents attend to this cryptocurrency field and regulatory actions take by government. Overall, these results shed light on the most useful and safer way of arbitrage principles of cryptocurrency.

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