

Trading Strategies for Cryptocurrencies Based on Machine Learning Scenarios

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Abstract. A Cryptocurrency is a peer-to-peer digital exchange system in which cryptography is used to generate and distribute currency units. Bitcoin as the foremost digital currency, using asymmetric cryptographic algorithms, blockchain technology, was conceptualized by Satoshi Nakamoto in 2008 and born in 2009. In 14 years, digital currency has gone from being initially controversial and worthless to rapid increase in value. The huge fluctuations in its price have attracted worldwide attention, and more people have begun to pay attention to the investment strategy of digital currency. Starting from the attributes of Bitcoin, this paper objectively compares the application effect of arbitrage strategy and trend strategy in machine learning on Bitcoin, analyzes and summarizes and predicts the future of Bitcoin's investment. To be specific, the arbitrage strategy involves three methods, i. e. , cash arbitrage, cross-exchange arbitrage and related variety arbitrage; trend strategy involves two methods, i. e. , the timing method and the multi-factor method. These results shed light on guiding further exploration of potential of investing digital currencies, which provides an in-depth summary analysis of risk-free arbitrage and digital currency value forecasts.

Keywords: Bitcoin; Arbitrage Strategy; Trending Strategy.

1. Introduction

Currency has played a vital role in human life from ancient times to the present. With the continuous development and application of blockchain and internet technology, people's interest in digital currency has been on the rise. After a large amount of capital flowed into the digital currency market, the type and value of digital currency have undergone tremendous changes, and the main digital currencies are Bitcoin, Ethereum and Ripple.

Among the many trading strategies of digital currencies, arbitrage strategies and trend strategies are selected to be discussed. In the arbitrage strategy, futures spot arbitrage, cross-exchange arbitrage and related varieties arbitrage have become the mainstream direction of the market with their mature system and excellent hedging risk efficiency [1]. In the trend strategy, the paper focuses on the time series method and the multi-factor method, through historical data and collation of previous research results, summarizes the fundamental indicators and social factors affecting the price of Bitcoin, as well as the prediction accuracy ranking of machine learning models.

Cryptocurrencies are a medium of exchange which uses cryptography to secure transactions and control the creation of trading units. Bitcoin, the foremost digital currency, was conceptualized by Satoshi Nakamoto in 2008 and born in 2009 as a peer-to-peer payment system developed using asymmetric cryptographic algorithms, blockchain technology [2]. The monetary characteristics of Bitcoin are as follows:

- Completely decentralized. Bitcoins don't rely on the centralized distribution method dominated by government entities, and the entire network is composed of users. The distribution and circulation of Bitcoin is achieved through open-source P2P algorithms.
- Global liquidity. Bitcoin can be managed on any computer with Internet access. Anyone can mine, buy, sell, or receive bitcoins, regardless of where they are located.

- Exclusive ownership. Based on cryptography, the security mechanism of Bitcoin transactions is a significant difference between them and fiat currencies.
- Low transaction fees. Bitcoins can be remitted for free, but a transaction fee of about 1 bit cent will eventually be charged for each transaction to ensure faster execution of the transaction.
- No hidden costs: direct payments can be made between users if they know each other's bitcoin addresses, with no limits on amounts or formalities.
- Cross-platform mining. Users can tap into the computing power of different hardware on numerous platforms.

With the expansion of Bitcoin's application scenario and the enhancement of its Liquidity properties, there are five fundamental reasons for its huge profitability as an investment tool.

- The reserves are limited and cannot be replicated. Bitcoins are issued through a predetermined process, with a total of 21 million in total. As the number of computers connected to the network increases, the rate at which bitcoins are produced will gradually slow down, and is expected to be issued by 2140. Which means the number of bitcoins is limited, so bitcoins can better resist the risk of inflation, and this property is not available in fiat currencies. At any time, users always buy bitcoins with the potential for continuous appreciation at the first price.
- High portability. The clearing nature of Bitcoin then gives it the ability to move money instantaneously. The digitalization of all bitcoin generation and transactions and the global computer network access makes it possible for funds and bitcoin transaction information to be quickly sent to any computer in the world via the network in just a few minutes, regardless of geographic restrictions. This is far more efficient than traditional cross-border fund settlement, which can take as long as a few days.
- High security. Only computer nodes are recorded as the subject rather than natural persons or corporate subjects, i.e., the anonymity feature, and none of the user's identity information is exposed during the transaction process.
- Decentralization. Bitcoin is a decentralized ledger on the Internet. It is maintained by the entire network of users and does not require a centralized institution similar to a bank to verify transactions, which greatly improves efficiency. Unless most Bitcoin users agree to make changes, no one or organization can change or stop Bitcoin's operations.

Acceptability. Bitcoin has been around for 14 years and its value is increasingly recognized. As of April 21, 2022, there are 10 countries recognizing the value of bitcoin as an asset, such as the United States, the United Kingdom, and Australia. Bitcoin already has two key elements to become a currency: public credibility, and negotiability. As Bitcoin's credibility increases, it is foreseeable that it will exist as a standalone asset in the future and not disappear.

In the 1980s, a team of quantitative analysts led by Morgan Stanley and other banks proposed the idea about statistical arbitrage and obtained excellent results in real trading, which led more financial practitioners as well as scholars to invest in the research of statistical arbitrage strategy. Besides, the theoretical exploration and practical analysis of statistical arbitrage strategy in foreign countries continued to deepen. In 2004, Vidyamuthy implemented a buy-low-sell-high trading strategy for stock portfolios [3]. In 2006, Gatev introduced the idea and concept of paired trading strategy [4]. In 2008, Philip et al. designed a statistical arbitrage strategy for the banking sector using genetic algorithms [5]. In 2013, Bogomolov pointed out that paired trading strategies are market neutral strategies and the steps of the strategy trading process [6].

In 2012, Martis collected and analyzed data related to the bitcoin market from June 2010 to March 2012, constructed an ARCH/GARCH model, and the study pointed out that there is a bubble in the bitcoin price [7]. In 2015, Liu and Wang constructed a regression model based on bitcoin market transactions from April 2, 2013 to April 2, 2014 constructed a regression model based on data from April 2, 2013 to April 2, 2014, pointing out that there is a herding effect on user trading behavior, user speculation and bit price interact with each other, and market structure has an impact on bitcoin price. In 2014, David et al. constructed a vector autoregressive model based on time series data to investigate the interaction between bitcoin users, price, search volume, and social media [8]. The

results showed that two feedback loops are formed between the four, social and user. in 2014, Devavrat et al. used Bayesian regression models to study the average future price change of bitcoin based on the transaction data of OKCOIN trading platform from February to July 2014 [9]. It used 10 seconds as the time point to build time series with 30 minutes, 60 minutes, and 120 minutes intervals, respectively and used it for practical tests.

The extreme price fluctuations of bitcoin since its inception have attracted many investors to participate in the trading market of digital currencies with huge profit opportunities [10]. The price fluctuations from September 2009 to September 2022 are shown in Fig. 1. Compared with traditional paper money, digital blockchain currency has a high degree of anti-counterfeiting security, portability, high efficiency, low cost and environmentally friendly nature. Studying the trading strategies of digital currencies helps to accelerate the progress of social economies. At present, although there are lots of digital currency research projects and many relevant literature results, it is still existing generally problems such as data lagging and independent methods and no effective comparison. This paper analyzes the development trend of digital currency in recent years by studying the trend strategy and arbitrage strategy method of cryptocurrency, summarizes the characteristics of the current digital currency trading strategy and makes prospects. The rest part of the paper is organized as follows. The Sec. 2 will introduce and compare three methods of Bitcoin arbitrage strategies and describe their limitations. The Sec. 3 will introduce and compare two Bitcoin trend strategy approaches and describe their limitations. The Sec. 4 will summarize the effects of arbitrage and trend strategies applied to machine learning in predicting the price of Bitcoin, finally giving an outlook for the future development of Bitcoin.

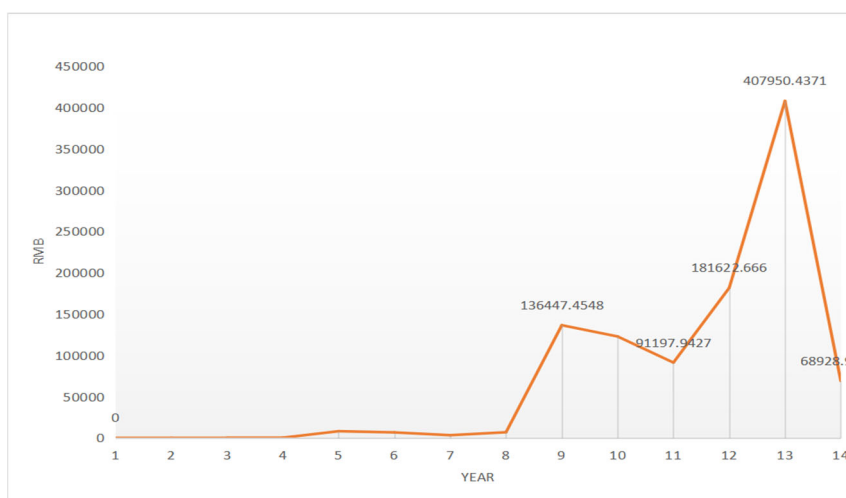


Fig. 1 The Highest Opening Price of Bitcoin from 2009 to 2022. 9.

2. Arbitrage Strategies

2.1 Arbitrage Methods

2.1.1 Futures spot arbitrage

Futures spot arbitrage is an arbitrage based on the existence of a price difference between futures and spot. If there is a price difference between the futures and spot of bitcoin, then one can arbitrage by buying the lower side and selling the higher side. Seen from Fig. 2, if investors short one futures contract for \$15 and buy one spot for \$10. When the delivery price is \$20, the gain is $(20-10)+(15-20)=\$5$. When the delivery price is 13, the gain is $(13-10)+(15-13)=\$5$. When the delivery price is \$7, the gain is $(7-10)+(15-7)=\$5$.

Hence, no matter what the delivery price is, there will always be a benefit. Zou performed futures spot arbitrage on bitcoin by collecting a large amount of data during the period from September 2019 to August 2021 [11], and the arbitrage returns are shown in Figs. 3 and 4. The results of the experiment

show that futures spot arbitrage on bitcoin is profitable with the asset mix allocated by Zou. The comparison between the two graphs above shows that arbitrage returns have a strong positive correlation with the prevailing interest rates.

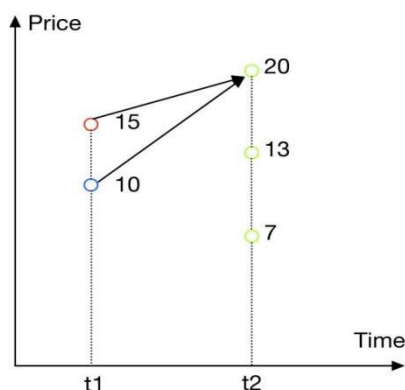


Fig. 2 Diagram of futures spot arbitrage.

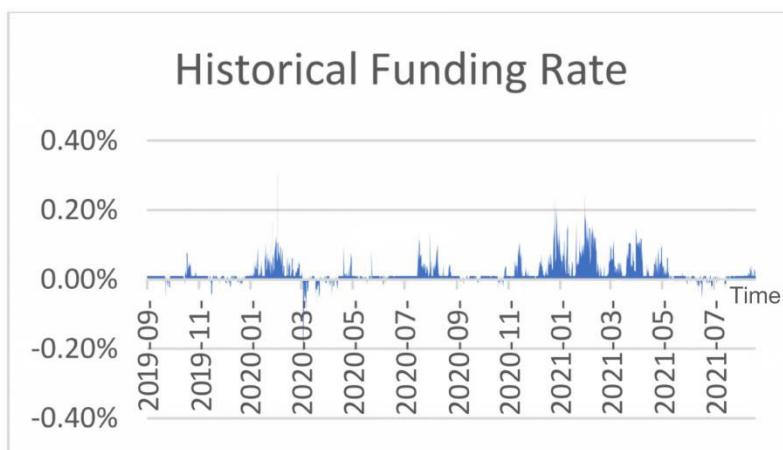


Fig. 3 Funding rate from September 2019 to July 2021.



Fig. 4 Return rates from September 2019 to June 2021.

2.1.2 Cross-exchange arbitrage

Cross-exchange arbitrage is the simultaneous buying and selling of futures for the same delivery month on two futures exchanges. Although the spreads of the same digital currency futures contracts on different exchanges will be stable in a more fixed range, sometimes there will be transient anomalies. Cross-exchange arbitrage is to profit by capturing the anomalies in the spreads. When the

price of BTC on Exchange A is higher than Exchange B, i.e., when the spread (A-B) is positive, based on the idea of mean reversion, the spread will eventually converge to zero, then sell BTC on Exchange A and buy BTC on Exchange B, that is, perform Short Spread operation. As the CNY portion of BTC may become 102CNY due to the existence of the spread, and then switch back to Exchange A, the arbitrage will be 2CNY.

Makarov and Schoar answered these questions in 2020 with a number-covariance vector autoregressive model (FCVAR). The results of the study indicate that the degree of efficiency of the U. S. and Australian bitcoin markets positively affects the cross-market arbitrage. An increase in the degree of efficiency of these markets leads to an increase in arbitrage opportunities, while the degree of efficiency of the Canadian, European, and U.K. bitcoin markets negatively affects arbitrage opportunities. In other words, the less efficient these markets are, the more cross-market arbitrage opportunities are expected.

2.1.3 Correlation arbitrage

Two commodities with a high price correlation and a relatively stable price difference. When the price difference between the two commodities fluctuates greatly, the transaction of buying or selling one commodity while selling or buying the related other commodity, and closing the position when the price difference between the two returns to normal level is called correlated species arbitrage. In this article, the two commodities are two different digital currencies. The specific operation is as follows.

- For both currencies, if one currency appreciates against the dollar and the other depreciates against the dollar, one ought to buy the futures contract corresponding to the appreciating currency and sell the futures contract corresponding to the depreciating currency.
- If both currencies appreciate against the U. S. dollar, and one currency appreciates faster than the other, one should buy the futures contract corresponding to the faster appreciating currency and sell the futures contract corresponding to the slower appreciating currency.
- When both currencies depreciate against the U. S. dollar, and one currency depreciates faster than the other, the futures contract corresponding to the faster depreciating currency is sold and the futures contract corresponding to the slower depreciating currency is bought.
- Two currencies, one of which remains unchanged against the U. S. dollar. If the other appreciates against the U. S. dollar, the futures contract corresponding to the appreciating currency is bought, while the futures contract corresponding to the currency with the same exchange rate is sold. If the other depreciates against the U. S. dollar, the futures contract corresponding to the depreciating currency is sold, while the futures contract corresponding to the currency with the same exchange rate is bought.

Nan et al. make multiple trades in the bitcoin market and then count the returns in the correlated species arbitrage [12]. Although all these returns seem to oscillate around zero, the triangular arbitrage returns show a cyclical pattern of fluctuations indicating a short-term arbitrage opportunity.

2.2 Analysis & Comparison

Based on the comparison of the above three arbitrage methods, the return of futures spot arbitrage has a strong positive correlation with the prevailing interest rate. Whereas, cross-exchange arbitrage is related to the efficiency of the market, the less efficient the market is, the more cross-market arbitrage opportunities are expected. Besides, the oscillation of its return is found to be strong in correlation arbitrage, and there are only short-term arbitrage opportunities.

2.3 Limitations

These three arbitrage methods are limited in their potential returns. The biggest disadvantage of arbitrage is that the potential returns are limited, and when limiting the risk in a trade, it is not unusual for the potential returns to be limited as well. Nonetheless, the ultimate choice of an arbitrage trade still requires weighing the many advantages and timing of arbitrage. On the other hand, excellent

arbitrage opportunities rarely arise frequently. The number of arbitrage opportunities is tied to how efficient the market is. The less efficient the market, the greater the arbitrage opportunity. In addition, it is quite difficult to get a better return and to be precise in timing. Besides, arbitrage also requires real-time stop loss, real-time profit locking, as well as improved the ratio of profit to loss in order to achieve retraction control.

3. Trend Strategies

The value of Bitcoins is as variable as stocks, and there are many algorithms on stock market data for price prediction. However, the price of Bitcoin does not depend on business events or intervening governments, the parameters which affect Bitcoin are different. In order to make right investment decisions, it's necessary to use machine learning techniques for predicting the price of bitcoin.

3.1 Method of Multi-factor

A multi-factor strategy is a widely used stock picking strategy. The core of the strategy is to find the factor indicator with the highest correlation with returns and use it to build a portfolio of stocks that is expected to outperform or underperform the index over time. If wins, one can go long on the portfolio and short the futures index; otherwise, one can go long on the futures index and short the positive alpha portfolio, earning a reverse alpha return.

This method also applies to cryptocurrencies with initial portfolio selection based on daily data for the target digital currency. Considering raw market data for Bitcoin as well as previous research, technical indicators still maintain the highest accuracy in predicting cryptocurrency prices. The high frequency technical indicators affecting returns are summarized in Table 1 [13].

Table 1. Summary statistics for technical indicators

	mean	std	min	25%	50%	75%	max
up_down	0.575	0.494	0	0	1	1	1
MA	2697	3780	0.1	94.45	481.3	5312	17555
PSY	2705	3792	0.1	95.25	484.45	5299	18502
AROON_Up	38.339	35.321	0	7.143	28.571	71.429	100
AROON_Down	51.576	37.769	0	14.286	50	92.857	100
CCI	21.237	111.939	-467	-61.395	32.313	103	372.927
CMO	9.206	30.391	-80	-11.46	6.113	28.419	100
MACD	0.090	76.655	-744	-2.416	0.039	3.759	618.132
RSI	54.491	15.411	0	44.214	53.056	64.21	100
STOCHK	56.332	24.362	0	35.489	58.595	77.887	100
STOCHD	56.314	22.679	0	37.403	58.077	76.036	100

Social factors (e.g., multimedia) have been researched and proven to have a definite impact on cryptocurrencies. Fig. 5 sets out the main influencing factors. Based on survey data from 2018 to 2022, it collates the six main social factors that affect Bitcoin: community [14], twitter ratings, COVID-19 panic level [15], the monthly ring effect [16], Bitcoin pessimism [17], and policy oversight. Bitcoin is greatly affected by the media. Speculating that the national government's supervision of bitcoin determines its use value, the monthly ring effect makes the price of bitcoin fluctuate greatly. Such high-risk investment pressure and the impact of the epidemic on the economy have exacerbated people's pessimistic attitude towards bitcoin, caused social media discussion, and finally interfered with the mentality of most investors, affecting the value of bitcoin through basic indicators.

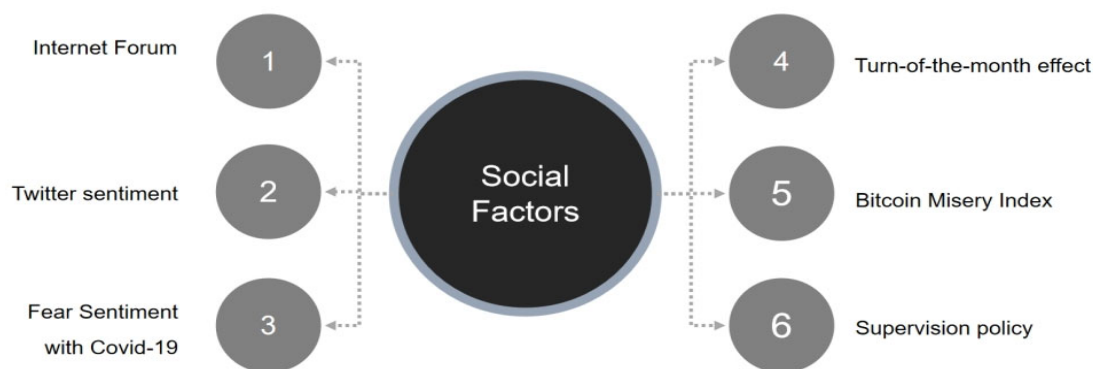


Fig. 5 Social factors which affects the price of Bitcoin.

3.2 Method of Time-series

The biggest risk of investing in cryptocurrencies is the huge volatility of their prices, but Bitcoin as a digital asset is quite elastic, which can regain value after a sharp drop in price. The use of time series methods can effectively predict cryptocurrency valuations, the principle is to establish a linear time series model for a set of stationary time series, in order to predict the law of changes in the stock market. Regression reflects the cyclical pattern of the data and complements moving averages, and from a statistical perspective can be a good predictor of time series in a one-dimensional and strongly time-correlated scenario, and ARIMA is often used as a first step experiment in time series forecasting. The (n, m) order autoregressive sliding average model, ARMA (n, m) .

$$X_t - \Phi_1 X_{t-1} - \Phi_2 X_{t-2} - \dots - \Phi_n X_{t-n} = a_t + \theta_1 a_{t-1} + \theta_2 a_{t-2} \dots + \theta_m a_{t-m} \quad (1)$$

where the time series $= 1, 2, \dots, N$; c is the autoregressive parameter, $i = 1, 2, \dots, N$; θ_j is the sliding average parameter, $j = 1, 2, \dots, m$; $a_{t-1}, \dots, a_{t-m}$ is the m two mutually independent white noise inputs. a_t is the white noise input at the time of t , which is a normally distributed and independent of each other. The mathematical expression is $a_t \sim \text{NID}(0, \sigma_n^2)$, which means the mean is zero and the variance is equal to σ_n^2 ; n is the order of the autoregressive part of the model, and m is the sliding average order in the model.

Considering only the effect of historical data on bitcoin trends, the data set for the ARMA model was constructed as illustrated in Fig. 6 to make preliminary forecasts of digital currency prices. There are numerous time series models and in order to perform multi-step prediction to get more accurate results, combined with the suitability of the dataset, this paper collated different machine learning regression and classification models based on ANN, SANN, SVM and LSTM to predict bitcoin price for different time periods, compared the results with highest accuracy and ranked them [18]. In the Fig. 7, the SANN model has a maximum accuracy of nearly 61% in one day, the SVM model has a maximum accuracy of nearly 60% in seven days, the SANN model has a maximum accuracy of 61% in one month, and the LSTM model has a maximum accuracy of nearly 66% in three months.

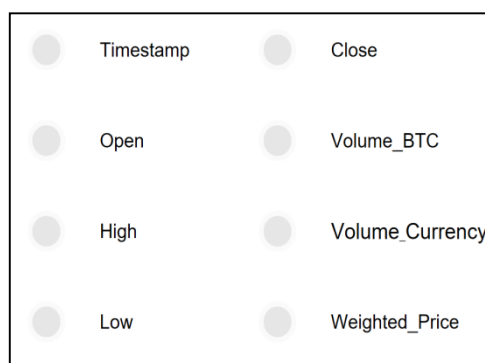


Fig. 6 Data Fields of ARMA

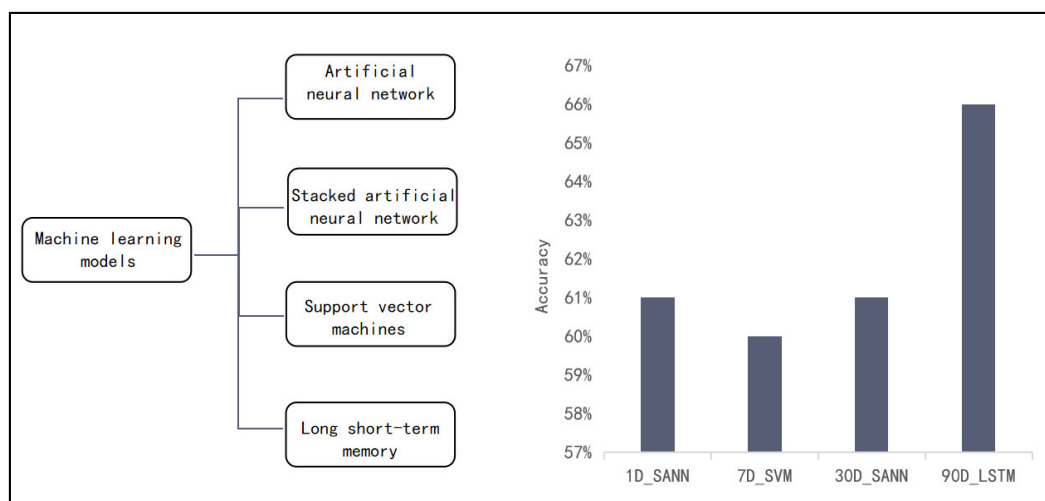


Fig. 7 Compare the accuracy of different models.

3.3 Limitations

Trend Strategies are used to capture the main trend of the market and get the average or above profit of the market. It is based on the past price history and has a time lag. As a result, investors who use this strategy always enter the market after the price trend has stabilized. Therefore, the performance of the strategy is poor when the market oscillates, and there is also the problem of the model over-interpreting historical information.

4. Conclusion

In summary, the market system of digital currency is still imperfect. Most of the research scope is limited to a single field, and there are fewer correlation studies. Due to the special properties of cryptocurrencies themselves, the liquidity is limited to a certain extent, and the research progress is slow. Arbitrage gains for cryptocurrencies are affected by interest rates and only have short-term opportunities. The technical direction of its price can refer to the stock price to a certain extent, and the social direction influencing factors are greatly affected by the media. Bitcoin and other cryptocurrencies have broad prospects as a means of value storage, but as a currency they are not. As the leader of decentralized digital currency, Bitcoin has only taken a few years from being unknown at the beginning to being chased by the masses, from being worthless at the beginning to being expensive now. Contemporarily, under complex international situation and the control of the government, cryptocurrency is emerging in the public view at an unstoppable speed owing to its unique nature. This paper argues that the development of blockchain has become the trend of history, and the decentralized nature makes all kinds of suppression means can only be short-lived suppression, as the trend of Bitcoin over the years has proved itself. The formation of a consensus mechanism requires a process, and while it is currently limited for various reasons, the trend is unstoppable. Short-term suppression is not enough to say anything, and the future of Bitcoin is looking up.

By analyzing the factors influencing the price of Bitcoin, it is significant to conclude that the ability of users to profit from Bitcoin as a high-risk investment vehicle is fundamentally dependent on the level of belief in the workings of the Bitcoin network. Bitcoin's complete decentralization inevitably dictates that its future trends are heavily influenced by external factors. In the short term, there is no mature technology that can interfere with the Bitcoin network, and its biggest hidden danger is whether the infinite growth of virtual currency value in the future can truly be independent of the country's central monetary economy. The increase in the number of users of the Bitcoin network means the growth of independent collectives, and whether such an economic group will intervene in the leadership of the government. Subsequent research into cryptocurrency prices could be done through machine learning to gather data on the impact of national policies on bitcoin prices, starting

with a macroeconomic perspective. Overall, these results offer a guideline for risky profit strategies and risk-free profit strategies for digital currencies. This paper has far-reaching implications for a more in-depth study of arbitrage and trend forecasting in digital currencies.

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