

A Comparative Study of Bitcoin and Gold Investments

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Abstract: The investment industry has changed a great deal, with commodity and virtual currency investments presenting sharp returns, therefore, requiring comparative analysis to make sound investment decisions. In this paper, we will examine gold and Bitcoin on four fronts, namely the way their prices change over time, the relationship of the two, how far their values impact the market, and the extent to which we can predict their prices of them based on LSTM neural networks. Whereas gold shows low volatility and a low but constant increase in prices, Bitcoin shows high overall increases but with high volatility. There is a high positive correlation between the two products in terms of price (0.83), and closeness to independence in returns (0.11), and gold prices are easier to predict on LSTM models than Bitcoin. These results will be useful in diversifying portfolios and making investment decisions.

Keywords: Gold, Bitcoin, LSTM

1 Introduction

Investment is all about foregoing current consumption in return for uncertain future consumption. There are two main types of investments, namely bonds, funds, commodities, virtual currencies, and others however, not many papers would take the time to compare two particular investment products and then actually offer some useful advice on which one would be advantageous. Comparing the investment products comes in as a very vital step in the investment process, since Different products may be worlds apart in terms of risk, the extent to which themselves will yield returns, how easy they are to buy or sell etc. According to the report of World Gold Council (WGC) in 2021 [1], it was stated that the Gold is the most effective commodity to invest. In the meantime, because of the pandemic, the price of virtual currencies has grown. These two products are completely different nowadays.

In forecasting the behaviour of investment products next, the traditional methods would be elements such as time series analysis (ARIMA models such as), mean-variance optimization, and machine learning software like random forests and support vectors. In more recent times deep learning has begun generating hype in financial forecasting. Recurrent neural networks (RNNs) and their more advanced counterparts, long short-term memory (LSTMs) networks, are gaining popularity as a predictive models of stock price (or exchange rate) and other financial assets models. Other researchers have gone further to use attention mechanisms and convolutional neural networks (CNNs) coupled with LSTMs in order to achieve improved

results. The point is that systematic research comparing commodity assets, such as gold and Bitcoin, in a variety of dimensions through the prism of real data and deep learning algorithms are rather uncommon now. This is the gap that this study would like to fill.

This study performs an empirical study that compares the four main aspects of gold and Bitcoin futures that include trend of prices over time, the tendency of the futures to be correlated, the volatility in prices, and the ability of the LSTM neural networks to predict their prices. Looking at two highly divergent investment products, including the thousands-of-year-old history as a store of value of gold and the relatively new but dramatically disruptive presence of Bitcoin, one can then give insights that can actually have a meaning to individuals attempting to create diversified portfolios and invest.

2 Theoretical Basis

2.1. Commodity investment

As a result of the rising application of commodity trading vehicles in investment management [2] commodity investments have dominated the investment market. It has been among the key points of interest either back then or now [3]. Examples of commodity investments are physical market (e.g. metal), equity markets (e.g. shares of users of commodities), and derivatives (e.g. futures).

The returns in the commodity investment market, especially in the commodity futures markets, do not solely hinge on the risk-taking interest of the speculators but also their capacity to predict the prices [4]. Many applications of commodities can be used as the key source of information on trends in spot and futures markets and are also used as the foundation by speculators to develop strategies of allocating assets [2]. Differently put, the returns on commodity investment are affected by both a commodity-specific factor and systemic factor, albeit to a different level.

There are also notable disadvantages of the commodity investments. This is because even though it is possible to predict part of the commodity investments using past prices, there is no certainty that the future returns of certain products will maintain the same strong results as indicated in the past [5]. This means that when speculators are too much influenced by experience, they are likely to make some mistakes that are not in line with common sense.

2.2 Gold Investment

Gold being a commodity investment product, can also be forecasted in future according to its application. Gold may be a product of investment. However, it may also be currency. It is the peculiarity of the gold investment.

Baur and Lucey's research studies established that gold has a low correlation with stocks and bonds under normal market conditions, and its correlation is negative [6]. This shows that the products related to gold possess high levels of independence. It is based on this attribute that there is an opportunity to surmise that gold is useful to investors by providing a measure of protection in a turbulent market. Liquidity is another attribute of gold investment. The liquidity level of gold is high due to lack of availability, its universally accepted value and the easy access to investing it through gold ETFs.

2.3 Virtual Currency Investment

The virtual currency history is still somewhat new, although the idea is not new at any rate [7]. The first virtual currency that society recognizes widely is Bitcoin, which was launched in 2008. Nevertheless, a virtual currency was not born without any precursors. Traditionally, the central banks of the world's economic systems were established as privately operated financial institutions, without legal tender power or monopoly status. The state monopoly of currency and other countries started to do the same only after the central bank was created in 1913 [7], to which other countries began to replicate.

This was proposed by Milton Friedman in 1986 [7], who stated that in case market turmoil set in, it was likely that the regulatory systems would be called into question and that it was even possible that floating interest rates would be introduced. That is why in 2008, during the international financial crisis Bitcoin was invented.

2.4 Bitcoin

The life of Bitcoin is 17 years of existence since its creation [7]. Due to the ever-growing influence, its importance has gone beyond the fact that it can be used as a virtual currency. The greatest shift happened throughout and following the pandemic, when developers were able to expand the market of Bitcoin due to the improvement of computing power. Traditional investment projects in this time have been performing poorly. There are lots of individuals working at home, and some lost their jobs. Bitcoin has turned out to be their new potential life raft.

Bitcoin also comes along with disadvantages. Being a non-state currency, the Bitcoin monetary market cannot be as easily controlled by the state as traditional monies. That is why the liquidity of Bitcoin is even inferior compared to traditional currencies or gold.

3. Data and Method

3.1 Material

The historical price data for both products came from Kaggle—a popular platform where people shared datasets. For gold, “XAU/USD Gold Price Historical Data (2004-2026)” is used [8]. For Bitcoin, “BITCOIN HISTORICAL DATA” is selected [9]. Both datasets follow a similar structure with opening prices, closing prices, high and low prices, and trading volume. Pretty standard stuff.

The time spans are different, though. The gold data covers from 2004 to February 2025 and includes multiple timeframes—5-minute, 15-minute, 30-minute, 1-hour, 4-hour, daily, weekly, and monthly intervals. The Bitcoin data is more straightforward: just daily records from 2014 to 2025.

3.2 Description of the summary and trend of data

To keep the research timely and relevant, the period from 2020 to 2025 is mainly focused on. This timeframe also happens to let people study how the pandemic affected these two products' prices—which seemed like a worthwhile angle to explore.

When looking at long-term changes in investment product prices, it's not enough to just stare at price fluctuations at each moment. More attention is needed to how yield rates have shifted over time. That's the bigger picture that really matters.

To keep the data manageable while still capturing meaningful patterns, weekly data points are selected for both gold and Bitcoin prices. This gave 309 valid price records and 308 valid yield records. Table 1 below lays out some basic statistics for both products.

Table 1: Statistical indicators of gold and Bitcoin

Statistical indicator	Gold (USD)	Bitcoin (USD)
Mean	2,180.60	46,629.35
Median	1,922.21	39,481.53
Standard deviation	627.50	30,592.26
Minimum	1,498.64	5,200.37
Maximum	4531.17	117,947.37

At a glance at such figures, one thing becomes immediately apparent: both of these products are not even on the same level of price. The fluctuations in the price of Bitcoin spans much further than the fluctuations in price of gold. The same is described by the standard deviation as it is much more volatile in Bitcoin.

The reason behind such a large disparity can be reduced to the degree of supervision in each market. Gold is a tangible product that all the countries of the planet appreciate and acknowledge. Bitcoin, however, is a blockchain project that is based on algorithmic deflation. That brings on board significant technical risks, which gold cannot afford.

To be able to observe a more instinctive picture, the below Figure 1 displays the time series of both product prices between 2020 and 2025.



Figure 1: Actual price trends of two products(Photo/Picture credit : Original)

The story of the price of gold of this time is essentially divided into two chapters. Between 2020 and 2023, gold was principally cycling between 1, 600 and 2, 000, which is hardly exciting.

Then was 2024 to 2025, when the price of gold became entirely parabolic, gaining between 2, 100 and 4, 500. This is over a hundred and forty percent viewpoint within a few years. During the time frame from 2020 to 2025, the price of gold increased by approximately 181%. It has almost an exponential appearance on the chart--that rising curve gets steeper and steeper.

The price trend of Bitcoin is more complicated as compared to the trend of prices of gold. The price of Bitcoin had a strong double humped movement between 2020 to 2023. There were two significant price peaks that happened between the year 2021 and 2022. The prices have increased in a step wise manner after 2023.

The following Figure 2 is the visualization of the distributions of the two products' weekly returns.

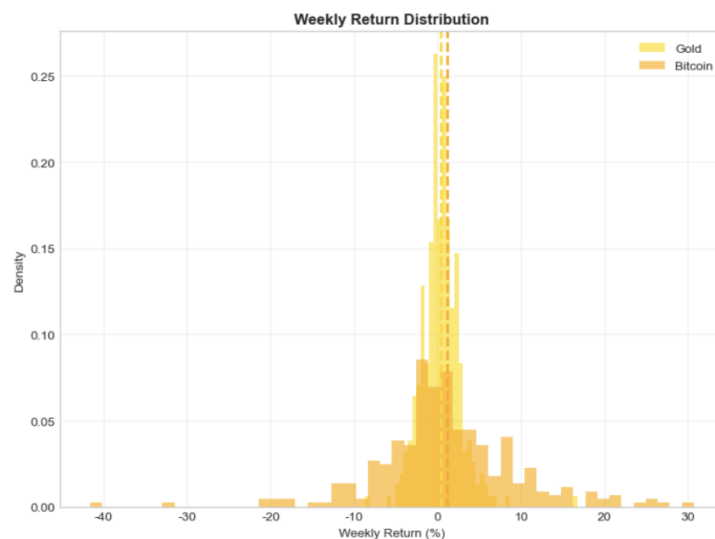


Figure 2: Return distribution of two products(Photo/Picture credit : Original)

Through the distribution of returns, the return rates of the two products are primarily clustered around zero. Gold's rate of return exhibits greater concentration and higher kurtosis, indicating that its weekly fluctuations are relatively smaller.

3.3 LSTM

The LSTM model is presented as a kind of recurrent neural network, which is created with the purpose of processing successive data. That is why it is quite applicable to price prediction which is essentially a sequence problem. According to a study conducted by Zhao, the LSTM has been demonstrated to be doing quite well with price prediction, particularly at the price peaks when the conventional methods have failed in most cases [10].

LSTM is developed based on the RNN model. RNN is a type of neural network model that processes sequential data. Their main idea is to have a hidden state vector in a network, which is kept using a recurrent structure of the network. This state, which has been hidden, is updated

at every time step and it keeps information of all the past time steps. Such a design allows the RNNs to accept input sequences of any length, as well as capture the time-dependency in the sequence.

A disadvantage of RNN models is that RNNs are not good at long-period dependencies. This is due to the fact that the RNNs are multi-layered and their layers are basically scaling the information. The more distant things are, the more they have been watered down--in fact exponentially.

LSTM is a solution to this issue as it has a group of gating. Information about the ways of flow is adaptively controlled by these gates to the network. In particular, within LSTMs, there are three gates: input, forget and output gates. The combination of these gates determines three things, which are: what new information must be retained about, what old information must be discarded and what information should be retained to be transmitted to the next time step.

4. Volatility

The quality of an investment product depends on the level of volatility. Highly volatile products do not in most cases yield high expected returns as seen in the Bali and Cakici research [11]. This is widespread in the U. S. as well as in the international market. This may confuse certain investors who may have just stepped into the world of investment industry to make false decisions. Historical patterns of a product and forms of cycles will guide them to make inferences. Studies have established that investor sentiment plays a key role in determining the movements of the market volatility, with sentiment effects being increased when the market is facing a lot of uncertainty [12]. As such, the prices of products are not regular in their variation. There are several factors that affect pricing of products. It is possible to analyze the volatility of various products in order to identify the most appropriate investor profile of an investment product.

The following Figure 3 is the annualized volatility of the gold price and the Bitcoin price.

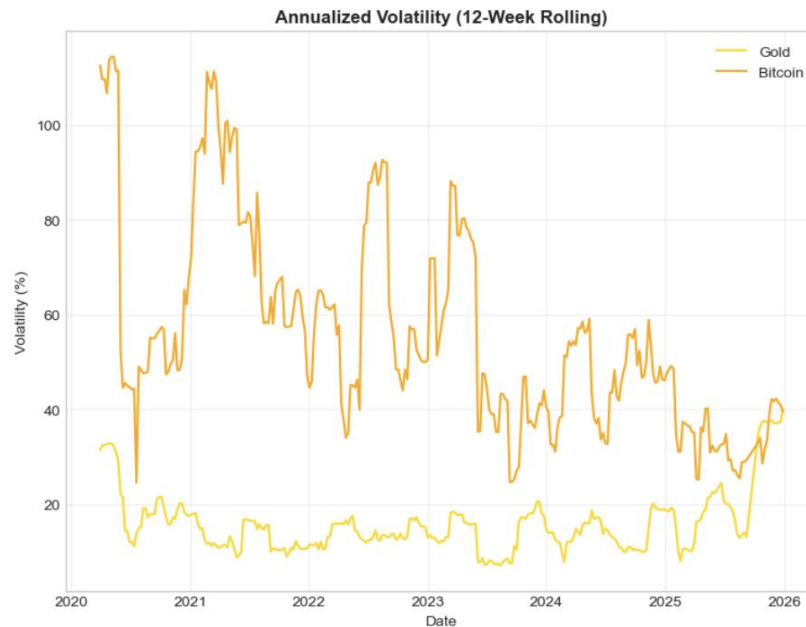


Figure 3: Annualized volatility of two products(Photo/Picture credit : Original)

Gold price volatility has long been stable within the 10%-20% range, indicating low volatility, with a significant upward trend emerging in the latter period. The reason for gold's volatility rising from 15% to 40% by the end of 2025 may be attributable to increased geopolitical uncertainty.

In early 2020, Bitcoin's volatility exceeded 110%, while between 2024 and 2026, volatility declined to 40%-60%. This indicates that the Bitcoin market is becoming increasingly mature. The risks associated with purchasing Bitcoin have decreased, but they remain higher than those for gold.

The volatility of the gold and Bitcoin prices can also be visualized by the cumulative returns of the two products.

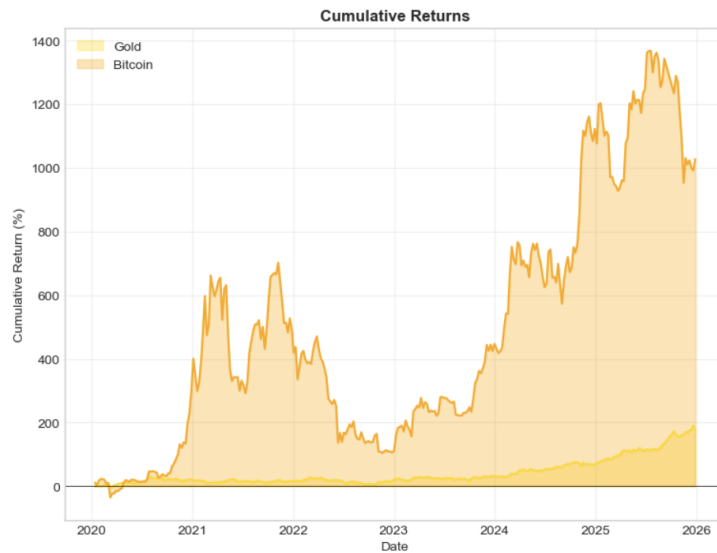


Figure 4: Cumulative returns of two products(Photo/Picture credit : Original)

Observing Figure 4 and Table 2 reveals that gold's returns have shown steady growth, while Bitcoin's long-term returns have been significantly more volatile. It turns out that the returns on gold depend on the time after investment, while the returns on Bitcoin depend on the timing of investment. This inference can also be confirmed through extreme change analysis.

Table 2: Indicators of extreme change

Indicator	Gold	Bitcoin
Largest single-week gain	16.72%	30.70%
Largest single-week decline	-8.62%	-41.63%

5 Relevance

Multitude of stocks show price correlation in the stock market. Under the influence of the pandemic, correlations between the prices of various stocks in different industries have increased substantially, as the report, Business in the Coronavirus Economy, stated[13,14].

The decision of investment is assisted by the correlation between investment products. To industry analysts, the returns on the price of investments in a commodity can enable them to ascertain the presence of causal relationship between items. To investors, it is possible to capitalize on the product price correlations to optimize the allocation in a portfolio. As an illustration, when investment products are correlated as highly, it means that they are caused by similar risk factors that can hardly be disposed in diversification.

When the numbers were run through our program, something interesting was discovered. The relationship between the price of gold and the price of Bitcoin was determined at 0.8344- fair strong. However, the association between their returns (not prices, but the degree to which they

change on an in-between basis) were merely 0.1073. That has barely anything to do with it. The reason is that overall, the price of the gold and Bitcoin is moving upwards. With the influence of inflation, the U. S dollar in 2024 and 2025 lost its value. This case became the key point in the prices of both products. The correlation in returns is low which means that the reasons behind price adjustments of both products have other factors. The dispersion of returns of gold and Bitcoin can prove it.

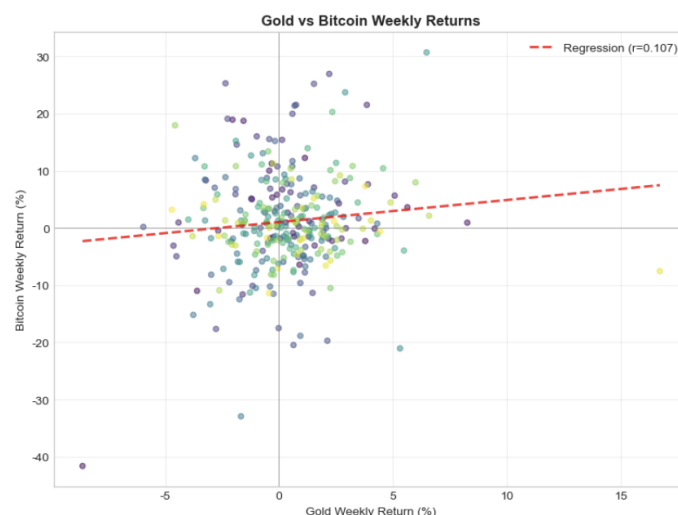


Figure 5: Scatter of returns of gold and Bitcoin(Photo/Picture credit : Original)

In the Figure 5, the distribution of sample points is concentrated around the origin, but no clear trend is evident. In other words, the sample points cannot form a regression with a high degree of confidence.

6 The adaptation of LSTM in two products

Before establishing the model, the selection of data and the division into training and test sets should be determined. As mentioned earlier, to ensure the timeliness of the research, data from 2020 to 2026 is selected. The price sequence from 2020 to 2025 serves as the training set, while the price sequence from 2025 to 2026 serves as the test set.

The following Table 3 presents the fitting and prediction parameters of the LSTM model for gold and Bitcoin prices.

Table 3: Indicators of model performance

Indicator	RMSE	MAE	MAPE	Directional Accuracy
Gold (train)	65.41	48.88	2.44	47.18%
Gold (test)	424.79	334.70	9.08	59.57%
Bitcoin (train)	12240.49	8858.40	24.73	50.00%
Bitcoin (test)	29424.62	27710.51	26.98	57.45%

The gold price was found to be fitting well in the training set as there is an RMSE of 65.41 and this was still at low levels. The value of the error measure of the price of Bitcoin on the training set when the absolute value is considered is much higher than that of gold which is in line with the properties of a large market price base and large fluctuations of Bitcoin prices. The model however has poor generalization capabilities. There is a larger prediction error in the test set as compared to the fitting error. During the training and the test set, directional accuracy is constant.

The visualization of the predicting and fitting are illustrated and found in the following Figure 6 and Figure 7.



Figure 6: Visualization of LSTM in gold prices(Photo/Picture credit : Original)

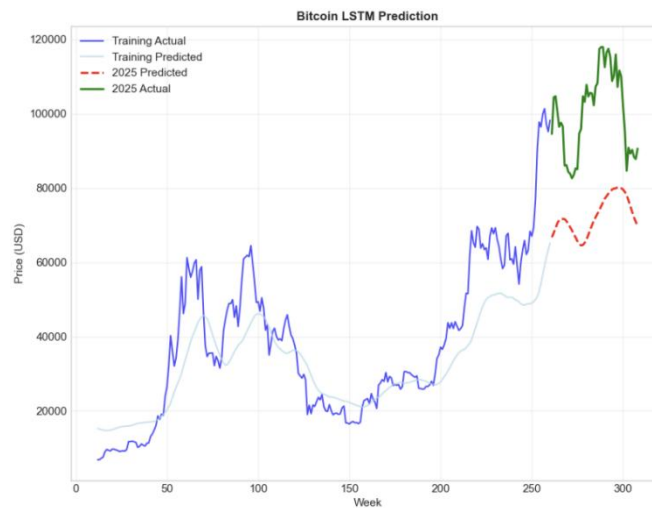


Figure 7: Visualization of LSTM in Bitcoin prices(Photo/Picture credit : Original)

By examining the visualizations of the two models, it can be observed that the models are sensitive to the timing of price inflection points but exhibit limited predictive capability regarding precise price values.

7 Conclusion

There were a few obvious differences between gold and Bitcoins as investment options found in this research. Gold is predictable and consistent. It increases steadily and consistently in price, volatility remains small in a comfortable sector of 10- 20 per cent, it is simple to purchase and market, and the LSTM models can predict it with decent precision. Bitcoin, however, does not disappoint in the long-term but it is associated with extreme price fluctuations. True to that, the volatility of the Bitcoin has decreased compared to more than 110 percent at the beginning of the year 2020 to 40-60 percent in the year 2025- that is indeed significant progress towards market currency. Never mind that it remains dramatically more volatile than gold.

The correlation test has obtained an opposite result. The price of Gold and Bitcoin have a very strong positive correlation. when the former increases in dollar value, the latter is more likely to increase as well. However, there is virtually no correlation between their returns, only 0.11. This implies that the causes of their day-to-day changes in price are completely different. Gold appears to be more closely connected to the macroeconomic environment like inflation, exchange rates and political stability. Bitcoin seems to be more reflected by the market sentiment, news of adoption, and the trading moods.

The LSTM model experiment proved what we had thought it would: It is probable that gold prices are easier to predict than it is with Bitcoin prices. The test set RMSE and MAE of Gold are significantly lesser than Bitcoin of 29, 424.62 and 27, 710.51. Another area is directional accuracy, where Gold (59.57% vs 57. 45) was slightly more accurate in the prediction of whether the price will increase or decrease.

The extreme change analysis gave a bright image of the risk difference. The largest single-week increase of 30.70 percent in Bitcoin is impressive, whereas the largest single-week drop of - 41.63 percent is horrifying. The changes of +16.72% and -8.62% of Gold seem almost meager in comparison. And this tells us something, namely that Bitcoin returns are time sensitive and gold returns are length of stay dependent.

The results can be useful in diversifying a portfolio and making investment choices in various investor profiles. Gold should be the core asset allocation of risk-averse investors who are required to have stable growth, and do not have to take up high risks because it is not very volatile and has a high prediction degree, traditional monetary characteristics and safe-havens properties during the turbulent periods in a market. To risk-takers who seek high-risk, high-return allocations in their diversified portfolio, Bitcoin can become a high-risk and high-return allocation solution because of its large long-term value increase potential and a mature market structure. Future studies might build upon this comparative map and expand it to match other emerging types of digital assets; they can attempt to combine hybrid prediction models which include macroeconomic signals, investor sentiment modeling, and sophisticated deep learning

frameworks like attention-based LSTM or transformer models to improve price forecasting and identify non-linear relationships in financial time series data.

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