

The Analysis of the Change and Stability of Bitcoin, Gold Prices, and the S&P Using Wavelet Correlation

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Abstract: In this paper, we employ wavelet correlation analysis to investigate the fluctuations and stability of Bitcoin, gold prices, and the S&P index. Our study utilizes data spanning from January 1, 2020, to June 1, 2022, to delve into their interconnectedness and causal relationships. The findings underscore the importance of thoughtful investment strategies, as revealed by the dynamic interactions among these assets. By offering insights into the interplay of these key financial indicators, our research aims to equip investors with a more informed and nuanced perspective on their investment decisions, ultimately facilitating a clearer understanding of the intricacies involved in the investment landscape.

1. Introduction

Nearly these years, people's economic level has gradually gone up. More people are looking for a way to not only some profit but also have little chance of losing money. More people are eager to invest, and the investment market become complete and more multiple-choice. From low risk to high risk but high profit, the investment market produces much investment production. The investment is not completely safe. Consumers need to learn about the changes in the investment market and know some economic policies.

Needs push developments. People desire to look for any ways that measure how the economic market changes. In order to measure policy-related economic uncertainty, people create an index from three types of underlying components. The first component qualifies the newspaper of policy-related economic uncertainty. The second part of the index cites reports from the Congressional Budget Office (CBO). The third component draws on the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters. People came up with a new index named the Economic Policy Uncertainty Index [1]. The Economic Policy Uncertainty Index (EPU) is a kind of index that can show us how some investment products' prices change due to different economic policies. One standard deviation increase in uncertainty leads to about one percentage point decline in investment growth rate. Thus, economic policy uncertainty materially impacts the investment climate in the country [2]. The financial market changes a lot. How the policy-related economic uncertainty affects the investment? We use the Federal monetary policy as an example to indicate how policy can impact people's investment. When The Fed controls inflation and slows economic growth, the higher interest rates have a negative influence on bonds. Equities face high risk and cash deposits lose investment attraction [3]. Many investors ignore the importance of economic policy so that makes money lost. Thus, this paper is going to use three examples: BTC (Bitcoin), SPX (Standard and Poor's 500), and gold prices to draw a wavelet coherence with EPU. The paper studies how three investments change due to the EPU. The paper [4] uses data of Chinese listed enterprises and economic policy uncertainty index for empirical analysis to find that when economic policy uncertainty is low and may have a suppressive effect on R&D investment when monetary policy uncertainty is high. The effects of an unexpectedly accepted and far-reaching referendum in Switzerland in February 2014 indicate that the uncertainty shock mainly dampened firms' plans to extend their production capacities, while other types of investment such as replacement investment were not affected, and increased policy uncertainty dampens investment plans of firms [5].

Apart from the introduction, the other sections are the "Literature review" section, which deals with the literature survey. The definitions of variables and econometrical methods are detailed in the "Methodology" section. The section "Empirical analysis" goes into empirical model estimation and interpretation. Finally, in the "Conclusion" section, the study results, and policy implications reports are detailed, some study limitations and what we can improve in future research.

2. Literature Review

We review the literature on the relationship between the financial and Economic Uncertainty Index in the past ten years and the literature on the use of wavelet correlation in this study. Due to the unpredictable nature of monetary, political, regulatory, and fiscal policies, economic uncertainty reflects economic instability [6]. As a result of the negligible risk spillover caused by the EPU, Bitcoin may be viewed as a haven asset or a diversified investment instrument in case of severely unpredictable economic policies [7]. Wavelet analysis breaks down time series into simpler functions that carry sequence information, which is one of its benefits. The lack of researching on the dynamic interdependence graph of foreign exchange markets on various time scales may be remedied by employing exchange rate returns in conjunction with wavelet decomposition to examine the connectivity between foreign currency markets [8]. Therefore, we study the wavelet coherence between BTC, SPX, GOLD, and EPU. The results show that BTC, SPX, and gold all have a low correlation with EPU. However, the size and variety of the sample in this study are relatively small, such as the relationship between wavelet coherence analysis of different cryptocurrencies (such as bitcoin and Litecoin) and the differences in research results on how EPUs affect the cryptocurrency market and gold price, which can be used as in-depth approaches for further research in the future.[9]

3. Method

The data used in our research contains BTC (Bitcoin), EPU (Economic policy Uncertainty Index), SPX (US Standard & Poor's Index) and gold price. We use wavelet coherence to study changes over time in our study samples. Our collected data are from January 1st 2020 to June 1, 2022, yielding 883 observations that are converted into natural logarithmic series. Continuous wavelet transform convert to a function with two variables: period and scale. In these figures, we can see that we use a 200-day cycle, which can help us understand and analyze our study better. Most investors will do make some risk estimates resulting the results are not exactly the same as the traditional econometric machines' measurement. At this time, wavelet coherence reflects a certain advantage.

We got a formula from a serious of studies [10] [11] [12] [13]

$$Wx(t, s) = \int_{-\infty}^{\infty} x(t) \tilde{\varphi}_{t,s}^*(t) dt,$$

According to the formula, τ is the translation parameter that controls the position of the wavelet in time, and s is the scale factor that determines the length of the wavelet.

$\tilde{\varphi}_{t,s}^*(t)$ is the complex conjugate function and $\tilde{\varphi}$ is obtained by scaling and shifting the mother wavelet ψ . To investigate how they relate to each other, we compiled this formula from survey data. [14]

4. Empirical Analysis

In Figure 1, we analyze the relationship between Standard & Poor's 500 Index and EPU to present wavelet Coherence. We looked for data from January 1, 2020 to June 1, 2022, which can be used to estimate the wavelet coherency.

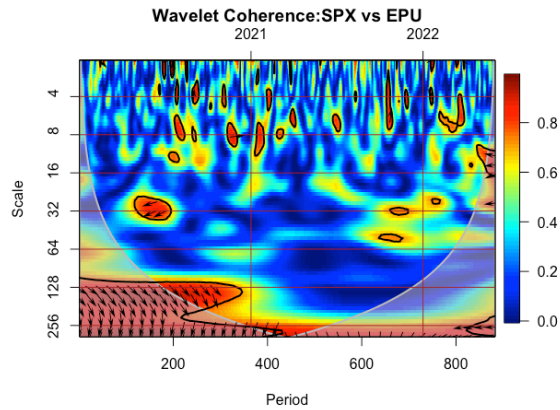


Figure 1 Wavelet Coherence: SPX vs EPU

The horizontal axis and vertical axis are represented separately period and scale. In the figure we can see many colors, warm color series (red) indicates strong co-motion of two variables, cool color series (blue) indicates weak co-motion of two variables and the black outline indicates a 5% significance level. The right arrow indicates that EPU and SPX are positively correlated, whereas the left arrow indicates that they are negatively correlated. The upper right and lower left arrows mean that EPU leads SPX, whereas the lower right and upper left arrows indicate that SPX leads EPU. The straight up and down arrows imply that the EPU is pioneering and hysteretic respectively.

We can see that most areas of the graph are blue, and red is mainly distributed on the left side of the graph. The red area on the left is larger than the area on the right, but they are always connected, indicating that their significant correlation occurs continuously. In the red area on the left, we can see that there are three arrow directions. The straight down arrow indicates that EPU is in a lagging state, the lower left arrows means EPU leads SPX and the lower right arrows indicate that SPX leads EPU. In 2022, the arrows are left which can show EPU and SPX are negatively correlated.

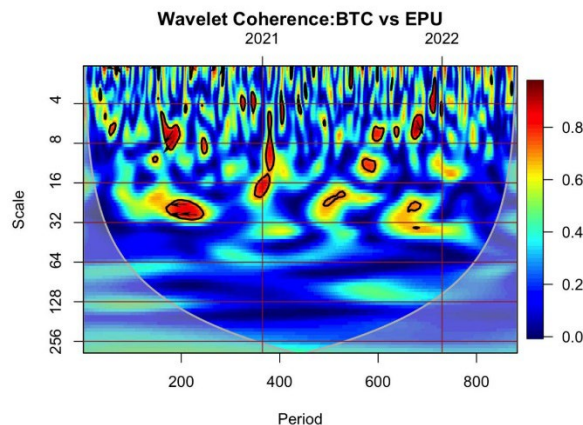


Figure 2 Wavelet Coherence: BTC vs EPU

We display the wavelet coherency between EPU and BTC in this image to explore their interdependence in figure 2. On both the horizontal (from January 2020 to June 2022) and vertical axes, time and frequency are displayed. Daily frequency is used.

Warmer colors (red) represent regions with high co-movements, whereas colder colors (blue) represent regions with weak co-movements on wavelet coherence plots, where the black outline indicates the 5% significance level. Arrows pointing to the left (←) indicate that EPU and BTC are negatively correlated. The ↙ arrows mean that EPU leads BTC, whereas the ↘ arrows indicate that BTC leads EPU.

Figure 2 shows the wavelet coherence plot, which is almost dominated by blue, shows weak independence, while the red area is distributed in the central part, with some dispersed and small

areas. In other words, the EPU and the BTC have significant interconnection from 2020 to 2022. In red areas, we observe the arrow points left (\leftarrow) indicating that EPU and the BTC are negatively correlated. Noticeably, we find that the arrow points \nearrow , which implies that the EPU leads the BTC. As for the arrow points \searrow in 2022, implying that BTC leads EPU

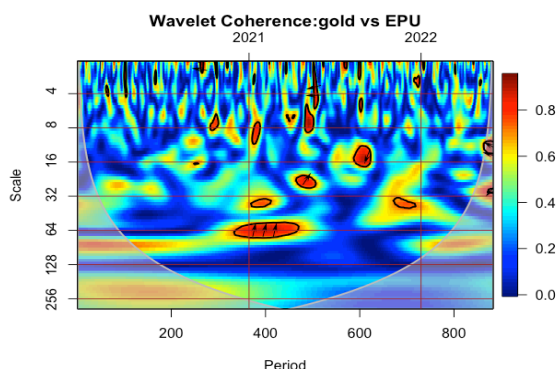


Figure 3 Wavelet Coherence: gold vs EPU

In this section, we use wavelet coherence between gold and EPU daily to study how they influence each other from January 2020 to June 2022. We draw the wavelet coherence by the statistics to estimate the relationship of interdependence in Figure 3.

The horizontal axis (from 200 to 800 period) of the wavelet coherence presents historical statistics over 800 days. The vertical axis shows the scale of how being influenced. The light color (blue) areas present low movements and the dark areas that present big scale show a deep interdependent relationship between gold and EPU. The figure contains different arrows and different arrows display how the gold price change over time passing. The \nearrow arrow s means EPU affects the gold price from a big scale to a small one. The \nwarrow arrow points to the opposite meaning of the \nearrow arrow, a small scale changing into a big one. The \rightarrow arrow indicates EPU and gold prices are negatively correlated. The \leftarrow arrow is the positive correlation between EPU and gold price.

From 2020 to 2022, EPU has a little influence on gold prices. Only in 2021, the gold prices continuously maintain a high level. From the 400 to 700 period, the red area changes from strong movements to low movements intermittently. Discontinuous red areas indicate gold prices can maintain a steady level no matter how the EPU changes. In the stock market, we can know buying gold stock is one of the safest, has no investment risk, and more people choose to buy gold stock.

5. Conclusions

In this article, we mainly study the wavelet correlation of Chinese and American foreign exchange, American S&P 500, and gold prices. According to the graphs, we find that Bitcoin changes more steadily in response to the crisis. According to the analysis of wavelet correlation, both Bitcoin and gold can be a good short-term investment. The research draws three wavelet coherences with BTC, SPX, and gold prices. It uses vivid images to prove the relationships between three investments and EPU. However, it is not completely reliable, and the research still has some short backs to improve in future research. A closer look at the three images reveals that the red areas are dispersive and not vivid. The proportion of every red area in the whole image is small and there may exist some uncertainty and occasionality. And the timeline is a little bit short for a complete research. The three statistics are about three years, but most research statistics are over ten years. Besides, arrows in the images only have a little direction. The image with arrows from eight directions is much more constructive and reliable.

Thus, in future research, people should collect more investment price change statistics in order to get more reliable and constructive results. Also, choosing the investment should be more serious and thoughtful. The gold price is stable over several years so this kind of investment should not be considered as the object investment. The gold wavelet coherence only has little red area that has no

study value. Stocks and currency are some of the best investments that are easy to be affected by the related policy. People should choose objects that are sensitive to policies. Therefore, future research should focus more on deciding on objects and looking for more reliable statistics.

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