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EXPLORING THE RELATIONSHIP BETWEEN GOOGLE TRENDS AND CRYPTOCURRENCY METRICS

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Abstract:

Bitcoin and Ethereum are the two largest cryptocurrencies in the world by market capitalization and trading volume and the most popular despite high price fluctuations. This paper analyzes the relationship between Bitcoin and Ethereum metrics and the internet search interest on cryptocurrencies. As the literature shows, Google searches signal investor attention and Google Trends has proven useful for nowcasting economic and financial indicators. We aim to find the impact of Google Trends on Bitcoin and Ethereum prices, trading volumes and market capitalization since 2015 and discuss the potential correlations and patterns that may exist between these metrics and Google search interest. Through correlation and time-series analysis, we provide insights into the dynamics of this relationship and its implications for understanding cryptocurrency market behavior. The interest in cryptocurrencies tracked by Google Trends is a good indicator of measuring the social interest in the cryptocurrency market that drives a price movement. On the other hand, the price fluctuations of Bitcoin and Ethereum generate media and social attention and increase the interest in these cryptocurrencies. We also observe a positive effect of Google Trends values on trading volumes. The findings could help investors to understand the cryptocurrencies dynamics and build their trading strategies and could be of special interest to policymakers.

Key words: *Bitcoin, Ethereum, price, trading volume, Google searches*

1. Introduction

The cryptocurrency market is volatile, driven by technological advancements, regulatory changes and investor sentiment. Google Trends is a useful tool for monitoring public interest and opinion on cryptocurrencies over time and across different regions and countries. Changes in search interest may reflect shifts in investor sentiment, with higher search volumes suggesting a greater interest or enthusiasm for a particular cryptocurrency. This might result in increased trading volume and price volatility as

investors react to new information or market movements. By tracking these changes, academics and investors may detect market patterns, forecast future price fluctuations and identify potential investment opportunities.

The correlation between Google Trends data and cryptocurrency metrics can be understood in the context of behavioral finance and information diffusion theory. According to behavioral finance, emotion and other psychological factors can impact investor behavior and cause market movements. Information diffusion theory posits that information spreads through media and social networks, influencing investor perceptions and decisions.

The purpose of this paper is to find the impact of Google Trends on Bitcoin and Ethereum prices, trading volumes and market capitalization since 2015 and discuss the potential correlations and patterns that may exist between these metrics and Google search interest. Through correlation and time-series analysis, we provide insights into the dynamics of this relationship and its implications for understanding cryptocurrency market behavior.

We used monthly data for Google Trends and for price, trading volume and market capitalization of Bitcoin and Ethereum in the period 01.01.2015-01.04.2024. We explored how Google Trends data correlates with different metrics and varies across different countries and periods.

Within the dataset, we examined three hypotheses:

- *search interest and price correlation:*

Null Hypothesis (H_0): There is no significant correlation between Google search interest for a specific cryptocurrency and its price movement.

Alternative Hypothesis (H_1): There is a significant positive correlation between Google search interest for a specific cryptocurrency and its price movement.

- *temporal patterns in search interest and price movement:*

Null Hypothesis (H_0): There is no significant temporal difference in search interest and price movement.

Alternative Hypothesis (H_1): There are significant temporal patterns in search interest and price movement, with higher activity during certain periods.

- *regional variations in cryptocurrency interest:*

Null Hypothesis (H_0): There is no significant difference in Google search interest for cryptocurrencies across different regions and countries.

Alternative Hypothesis (H_1): There are significant regional variations in Google search interest for cryptocurrencies, with certain regions and countries showing higher interest compared to others.

These hypotheses served as a starting point for conducting statistical analyses and exploring relationships within the dataset.

The rest of the paper is organized as follows. Section 2 is a literature review. Section 3 describes the research methodology, data collection and analysis. Section 4 presents and discusses the results and Section 5 provides conclusions and possible future research directions.

2. Literature review

The role of Google Trends has been widely used to evaluate macroeconomic variables such as financial assets (Nguyen et al., 2019; Sierszecki and Gebka, 2019), energy (Park and Kim, 2018), economic activity (Choi and Varian, 2012; Donadelli and Gerotto, 2019; Gotz and Knetsch, 2019) and unemployment (Ferreira, 2014; Nagao et al., 2019).

The growing interest in using digital data sources for market analysis has resulted in a considerable increase in the literature on the correlation between Google Trends data and cryptocurrency metrics in recent years. Many studies have examined different aspects of this relationship, including the impact of Google search interest on cryptocurrency prices, trading volume, and market sentiment.

Kristoufek (2013) was among the first who evaluated the nexus between the search terms on Wikipedia and Google Trends and Bitcoin prices. Kristoufek found a positive correlation between Google search volumes for Bitcoin-related terms and Bitcoin prices, suggesting that shifts in search interest may occur before price movements in the Bitcoin market. Garcia and Schweitzer (2015) studied the impact of Google search interest on algorithmic trading of Bitcoin, exploring how changes in search query volumes influence trading activity and price dynamics. Moat and Preis (2018) established the Bitcoin price index and investigated the link between Google search interest in Bitcoin and its price fluctuations. While the study primarily focuses on price dynamics, it may indirectly underlies the relationship between search interest and market sentiment. Sklar et al. (2019) evaluated the relationship between Google search query volumes on Bitcoin and its price dynamics using time series analysis. Zhang and Wang (2020) looked at the relationship between Bitcoin prices and investor attention as determined by Google search interest. They considered that spikes in Google search volumes for Bitcoin preceded times when prices were more volatile, suggesting a possible connection between search interest and market activity.

Other studies have investigated the predictive ability of Google Trends data in anticipating cryptocurrency prices. Preis et al. (2013) showed how Google Trends data may be used to forecast changes in the stock market and extended their research to include cryptocurrencies. They observed that variations in Google search query volumes for Bitcoin could forecast future price fluctuations. Lahmiri et al. (2019) analyzed the Bitcoin returns forecasting and found that predictive models for Bitcoin returns may be created based on variations in search query volumes for terms related to Bitcoin. Arratia and Barrantes (2021) found that Google Trends can predict Bitcoin values but inconsistently.

Researchers have also looked at the relationship between Google search interest and cryptocurrency trading volume. Chu et al. (2015) examined the link between Google search interest in Bitcoin and its exchange rate and between search query volumes, trading activity and market liquidity. Urquhart (2018) studied the role of Google Trends in explaining Bitcoin volume and volatility, finding that Bitcoin registered high trading volume and volatility every time it is searched on Google. In a comprehensive analysis of Bitcoin price and search query data, Sklar et al. (2019) showed a positive correlation between

search interest and trading volume, suggesting that changes in search query volumes could be a signal of trading activity in the Bitcoin market.

Furthermore, some studies have investigated the role of Google Trends data in predicting market sentiment and investor behavior. Preis et al. (2013) demonstrated how Google Trends data might be used to measure trading behavior in financial markets. While the paper does not particularly focus on cryptocurrency markets, it could explain how search query volumes and market sentiment are related. Zhang et al. (2018) explored how changes in search query volumes on Google Trends reflect shifts in investor sentiment about Bitcoin. Jiang et al. (2020) analyzed sentiment expressed on Twitter to predict trading volume and search interest in Bitcoin. Their results highlight the importance of sentiment research in understanding the dynamics of cryptocurrency market dynamics, even if they are not directly tied to Google Trends data.

The relationship between Google Trends data and other cryptocurrencies has also been explored in the literature. Using Google Trends data on Bitcoin search activity, McNally et al. (2018) performed an analysis on the significance of Bitcoin. Their results, which emphasize the significance of Google search interest as a proxy for public interest in the cryptocurrency industry, may apply to other cryptocurrencies. Raza et al. (2023) analyzed the nexus among Google Trends and six cryptocurrencies (Bitcoin, NEM, Dash, Ethereum, Ripple and Litecoin) by utilizing the causality-in-quantiles technique in the period January 2016-March 2021. They showed that Google Trends cause the Litecoin, Bitcoin, Ripple, Ethereum and NEM prices at majority of the quantiles except for Dash.

Moreover, the literature has examined the influence of external factors and news events on the Google Trends data and cryptocurrency metrics relationship. Sklar et al. (2019) analyzed the effect of major news events on Bitcoin price and search query data, finding that significant events often coincide with spikes in search interest and trading volume.

Finally, there are studies that explore the limitations and constraints of using Google Trends data for market analysis. Sklar et al. (2019) highlighted potential biases in Google search data, such as keyword selection and regional differences, which can affect the quality of prediction models. Because Google search interest can be influenced by search engine algorithms, marketing activities and media, it may not always correctly reflect real investor behavior and therefore, it is important to understand the limits of using Google Trends data. Thus, while Google Trends data can give helpful information about market dynamics, it should be combined with other indicators and tools to make good decisions.

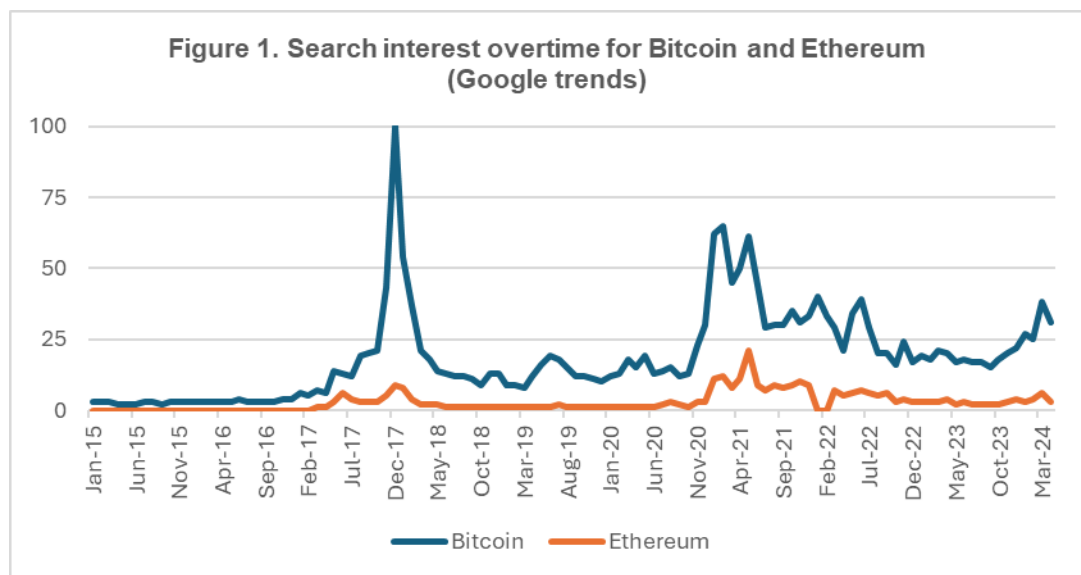
Overall, the literature provides evidence of the correlation between Google Trends data and cryptocurrency metrics, including prices, trading volume and market capitalization. However, further research is needed to better understand the underlying mechanisms of this relationship and to develop effective methodologies for cryptocurrency market analysis using digital data.

3. Data collection and analysis

We chose two of the most popular cryptocurrencies for the analysis: Bitcoin (BTC) with 53% dominance and Ethereum (ETH) with 16%. We obtained historical market data on their metrics, including price, trading volume and market capitalization, from financial data providers such as CoinMarketCap and cryptocurrency exchanges, in USD.

Google Trends provides publicly available data on search interest for specific keywords or topics over time, expressed in scores that indicate the popularity of the search term relative to the total search volume during the specified time period and geographic location. Scores for each keyword are on a scale of 0 to 100, with 100 indicating the most search interest. We collected Google Trends data for each cryptocurrency-related keyword ("Bitcoin", "Ethereum"), cleaned the data and handled any missing values or outliers. The data were obtained for the period 01.01.2015-01.04.2024, monthly intervals, to capture long-term trends and fluctuations in search interest.

Using historical data, we detected increases in Google search volumes for keywords relating to Bitcoin in 2017 and 2020, before the price increases. In such periods, investors may search for more information about the market, before deciding to buy or sell. The same trend, but at a lower level, is observed for Ethereum (Figure 1).

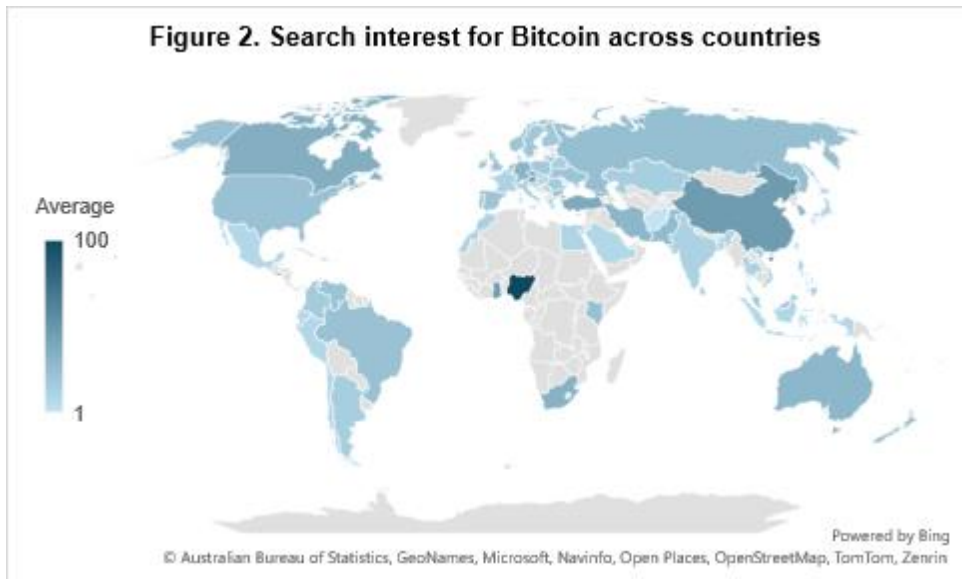


Source: Authors' preluclration based on <https://trends.google.com>

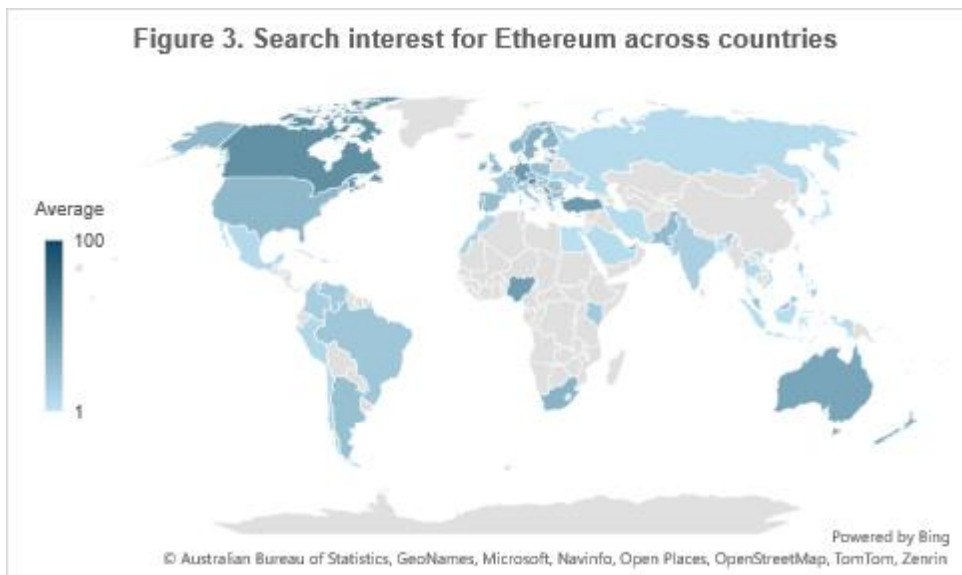
To determine regional variations in cryptocurrency interest, particularly for Bitcoin and Ethereum, we leveraged Google Trends data and used the average score of the period, which provides insights into search interest across different geographic regions and countries.

In the last years, cryptocurrencies adoption has shown an all-time high in developing countries, predominantly concentrated in Latin America, Africa and Asia. Furthermore, Bitcoin became a legal tender in El Salvador and Central African Republic in 2021 and 2022, respectively.

The higher search interest for Bitcoin, as an average of the period 01.01.2015-01.04.2024, is observed in Nigeria, El Salvador, China, Slovenia and Ghana (Figure 2) while for Ethereum registered in Kosovo, Macedonia, Slovenia, Singapore and Switzerland (Figure 3).



Source: Authors' preluclration based on <https://trends.google.com>



Source: Authors' preluclration based on <https://trends.google.com>

Among the factors that explain this distribution can be considered cryptocurrency adoption and regulatory environment.

Further, we explored correlations between Google Trends data (search interest) and cryptocurrency market metrics (price, trading volume, market capitalization) to identify potential relationships or patterns.

Detailed information related to the Bitcoin data is presented in Table 1.

Table 1. Descriptive statistics for Bitcoin

	<i>Bitcoin</i>	<i>Price (close)</i>	<i>Volume</i>	<i>MarketCap</i>
Mean	18.68	16751.66	399545286638.34	315598377284.31
Standard Error	1.51	1705.26	52603556593.05	32866567533.29
Median	15.00	9220.07	17136834484.94	167059917077.94
Standard Deviation	15.93	18046.73	556703715290.94	347827056565.61
Kurtosis	5.99	0.32	1.09	0.40
Skewness	1.96	1.14	1.31	1.16
Minimum	2.00	217.46	13949300.00	2997692310.60
Maximum	100.00	71333.65	2267152936673.90	1403108244335.61
Largest	100.00	71333.65	2267152936673.90	1403108244335.61
Smallest	2.00	217.46	13949300.00	2997692310.60
Confidence Level(95.0%)	2.98	3379.08	104237459048.71	65127297643.13

Detailed information related to the Ethereum data is presented in Table 2.

Table 2. Descriptive statistics for Ethereum

	<i>Ethereum</i>	<i>Price (close)</i>	<i>Volume</i>	<i>MarketCap</i>
Mean	3.29	847.43	219327493401.57	98197131375.50
Standard Error	0.40	115.78	39186301250.61	13824213292.73
Median	2.00	294.92	6094093001.39	28774922508.30
Standard Deviation	3.77	1104.46	373813489214.91	131874589886.83
Kurtosis	4.33	1.79	9.28	1.75
Skewness	1.78	1.59	2.56	1.59
Range	21.00	4630.74	2224800770424.97	549031419222.44
Minimum	0.00	0.74	619926.00	54351468.24
Maximum	21.00	4631.48	2224801390350.97	549085770690.68
Sum	299.00	77115.76	19958801899542.90	8935938955170.13
Largest	21.00	4631.48	2224801390350.97	549085770690.68
Smallest	0.00	0.74	619926.00	54351468.24
Confidence Level(95.0%)	0.78	230.01	77850427038.94	27464212593.92

As the tables show, in terms of cryptocurrencies' prices, the lowest mean value is for Ethereum (847.43) and the highest mean value is for Bitcoin (16751.66). Moreover, regarding Google Trends, the lowest mean value is for Ethereum (3.29) and the highest is for Bitcoin (18.68). Skewness and kurtosis are positive for all variables.

Pearson correlation coefficients were calculated to quantify the strength and direction of the correlation between Google search interest and cryptocurrencies price, trading volume and market capitalization. Statistical significance was assessed using p-values, with significance levels set at $\alpha = 0.05$.

Figure 4 presents Pearson correlation coefficients between Google search interest for Bitcoin and its metrics. The results indicate strong positive correlations between Bitcoin

search interest and price ($r = 0.63$, $p < 0.001$), trading volume ($r = 0.65$, $p < 0.001$) and market capitalization ($r = 0.62$, $p < 0.001$), suggesting that changes in search interest are associated with corresponding changes in Bitcoin metrics.

Figure 4. Correlogram for Bitcoin

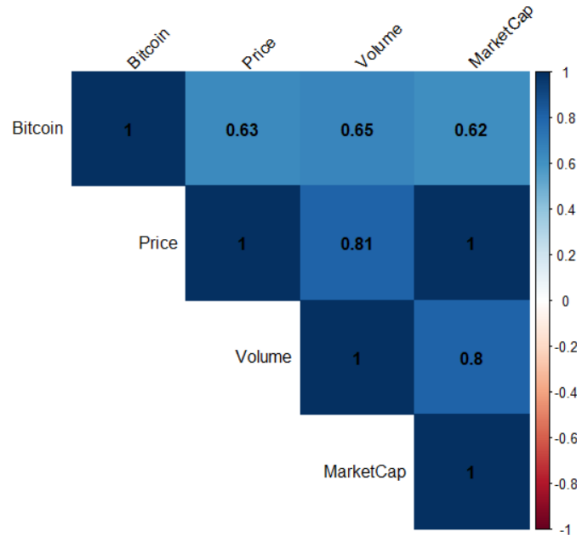
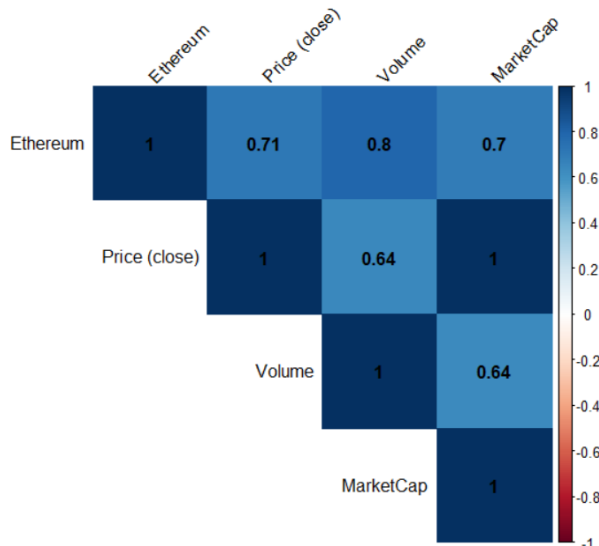


Figure 5 shows Pearson correlation coefficients between Google search interest for Ethereum and its metrics. The results indicate strong positive correlations between Ethereum search interest and price ($r = 0.71$, $p < 0.001$), trading volume ($r = 0.80$, $p < 0.001$) and market capitalization ($r = 0.70$, $p < 0.001$), greater than for the Bitcoin.

Figure 5. Correlogram for Ethereum



To explore temporal patterns and trends in Google search interest and cryptocurrencies metrics we used time-series analysis.

4. Results

The correlation analysis revealed a significant relationship between Google Trends data and Bitcoin and Ethereum metrics. Pearson correlation coefficients indicated strong positive correlations between Google search interest and cryptocurrencies prices, trading volume and market capitalization.

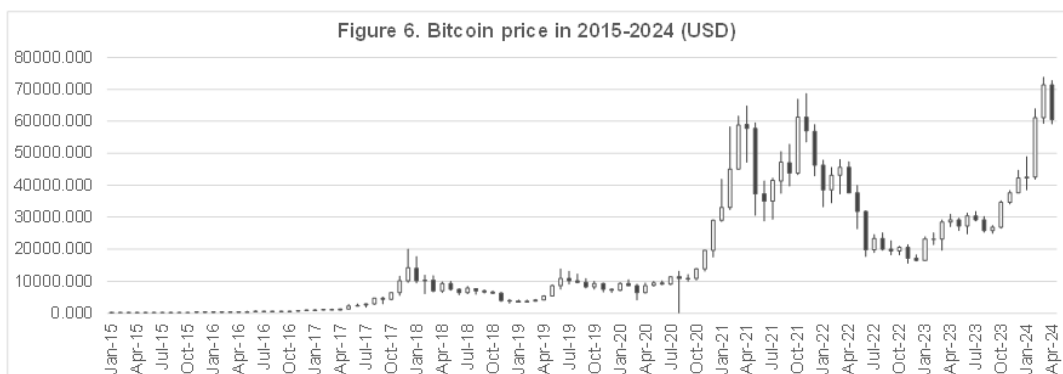
Analyzing the dataset, we observed that increased Google search interest for Bitcoin and Ethereum was positively correlated with higher cryptocurrencies prices. This suggests that peaks in search query volumes may occur before prices or market volumes increase.

We also found a strong correlation between changes in Google search interest and trading volume and market capitalization, indicating that waves in search interest were accompanied by higher levels of trading activity in cryptocurrencies markets. This implies that the interest in Google searches may be a leading indicator of trading behavior and market liquidity.

Time-series analysis showed trends and temporal patterns in Google search interest and cryptocurrencies metrics over time. We observed periodic fluctuations in search interest, with peaks matching with important news events, price fluctuations or market developments. For example, search interest tends to increase during bull markets, indicating higher curiosity and potential investment activity, while during bear markets search interest may decrease, suggesting less enthusiasm.

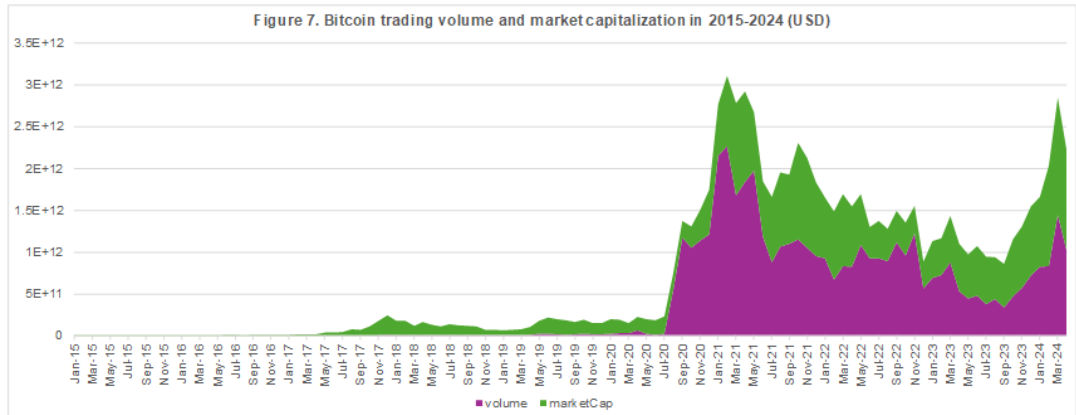
We also identified long-term trends in Google search interest, cryptocurrencies price and trading volume, indicating underlying dynamics and shifts in market sentiment over time. These trends might offer insightful information on how cryptocurrencies markets and investor behavior are changing.

All-time high price of the Bitcoin was registered on March 14, 2024 (73750.07 USD) and all-time low on July 14, 2010 (0.048 USD) (Figure 6).



Source: Authors' preelucration based on <https://coinmarketcap.com/currencies/bitcoin/>

As regarding 24h trading volume it was double for Bitcoin (26.1 billion USD) than Ethereum (12 billion USD).



Source: Authors' prelueration based on <https://coinmarketcap.com/currencies/bitcoin/>

With a market capitalization of 1254 billion USD, Bitcoin leads the cryptocurrency market, while Ethereum comes in second with 371 billion USD in April 2024 (Figure 7).

However, it is important to interpret the results within the context of the study's limitations and uncertainties. While the correlations observed are statistically significant, they may be subject to biases. Additionally, the nature of the relationship between Google Trends data and cryptocurrency metrics may vary across different cryptocurrencies, time periods and market conditions.

5. Conclusions

The correlation between Google Trends data and Bitcoin and Ethereum metrics, including price, trading volume and market capitalization, has been explored in this paper. The findings from correlation and time-series analysis provide valuable insights into the relationship between Google search interest and cryptocurrency market dynamics.

Overall, the results support the hypothesis that changes in Google search interest are associated with corresponding changes in cryptocurrency metrics. Increases in Google search interest for specific cryptocurrencies tend to precede price rallies, higher trading volumes and shifts in market sentiment.

The interest in cryptocurrencies tracked by Google Trends is a good indicator of measuring the social interest in the cryptocurrency market that drives a price movement. On the other hand, the price fluctuations of Bitcoin and Ethereum generate media and social attention and increase the interest in these cryptocurrencies. We also observed a positive effect of Google Trends values on trading volume and market capitalization. The findings could help investors to understand the cryptocurrencies dynamics and build their trading strategies and could be of special interest to policymakers.

Time-series analysis revealed temporal patterns and trends in Google search interest and cryptocurrencies metrics, highlighting the influence of major news events, price fluctuations and market developments on search behavior. Changes in search interest may reflect shifts in investor sentiment, with higher search volumes suggesting a

greater interest or enthusiasm for a particular cryptocurrency. This might result in increased trading volume and price volatility as investors react to new information or market dynamics. Long-term trends in search interest, prices and trading volume provide useful insights into the evolving nature of cryptocurrency markets and investor sentiment.

The limitations of this study include potential interferences in Google Trends data, complexity of cryptocurrency market and dynamic nature of investor behavior. For a comprehensive analysis, it is important to consider these limitations and challenges and to use Google Trends data with other relevant data sources and indicators. Future research should continue to explore the causal mechanisms underlying the relationship between Google Trends data and cryptocurrency metrics and to develop new methodologies for cryptocurrency market analysis using digital data.

In conclusion, the findings of this paper contribute to the understanding of the relationship between online search behavior and cryptocurrencies market dynamics. Researchers and investors can identify market trends and patterns, sentiment shifts and potential investment opportunities in this evolving environment by analyzing Google Trends data.

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