Unraveling the Effects of Google Search on Volatility of Cryptocurrencies

Short Paper

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Abstract

Although cryptocurrencies have garnered enormous public attention in recent times, extensive fluctuations in their prices have deterred prospective investors. Due to the absence of a centralized valuation authority, the credibility of cryptocurrencies as a viable investment vehicle remains elusive. Building on attention theory, this study posits that prospective investors of cryptocurrencies are likely to search online for information before deciding whether to make a commitment. We hence investigate the effects of Google search on the return and risk of 268 cryptocurrencies over 181 trading days. Results indicate that the Google Search Volume Index (SVI) of a given cryptocurrency exerts significant and positive impact on its price and turnover.

Keywords: Cryptocurrency, attention economy, Google search, return, risk

Introduction

Cryptocurrency, a virtual coinage system enabled by blockchain technology to accommodate transactions for goods and services without a centralized trust institution (Farell 2015), is gaining traction at an astonishing pace since the inception of Bitcoin in 2009 (Mai et al. 2018; White 2015). Cryptocurrency transactions can be processed and stored in a decentralized manner while ensuring their immutability. Consequently, even without regulation, cryptocurrency transactions are protected against fraud and

tampering (Gandal and Halaburda 2016). With its autonomous and decentralized infrastructure, the cryptocurrency market has considerably lower entry barriers due to minimal regulatory oversight and a multitude of entry options. Consequently, the accessibility of the cryptocurrency market has magnetized the attention of prospective investors (Farell 2015). Notably, the total capitalization of the cryptocurrency market has already surpassed the USD $700 billion mark in early 2018 and is continuing to build up momentum (Martin 2018).

Due to overwhelming public attention, the valuation of cryptocurrency fluctuates wildly as compared to other financial assets (Bouri et al. 2017; Hayes 2017). As alleged by Caporale and Plastun (2018), the variation in the daily trading price of the cryptocurrency market is ten times that of Foreign Currency Exchanges (FOREX), seven times that of stock markets, and five times that of commodity markets. This distinct volatility of cryptocurrency can be attributed to the absence of mandatory accounting reports, such as 10-K and 10-Q (Hayes 2017), from cryptocurrency issuing companies. Furthermore, cryptocurrencies are often issued to finance entrepreneurs who seek to disrupt existing markets with innovative business models. However, these business models, which encapsulate cryptocurrency as their main value proposition, are not easily comprehensible and demands intricate assessment (Kazan et al. 2015).

For the abovementioned reasons, prospective investors of cryptocurrencies are compelled to search online for information before deciding whether to make a commitment (Drake Michael et al. 2012). Yet, the decentralized nature of cryptocurrency implies that there is a paucity of trusted informational sources for investors to turn to. In this sense, investors searching for information on cryptocurrencies encounter high uncertainty in relation to information credibility. To compensate for the lack of centralized authority, we anticipate that prospective investors are likely to expend effort to extend the reach of their information search activity. We hence contend that Google, the dominant search engine with over 90% market share[1], could act as the gateway for prospective investors to enrich their information search activities. We posit that Google search volume for a given cryptocurrency should grow as prospective investors allocate more attention to the topic (Barber and Odean 2007; Da et al. 2011). Since querying a cryptocurrency on Google precedes prospective investors' actual investment decision, higher search volume is often indicative of greater investment potential.

To this end, this study marks a pioneering attempt to explicate how the valuation of cryptocurrency as a viable investment vehicle is predicated on the information search patterns of Google users. Particularly, we explore how Google search trend for each available cryptocurrency affects both its return and risk. To do so, we extracted daily trading data for 268 cryptocurrencies from CoinMarketCap and search volume data for 181 trading days from Google Trends. The trading and search data were then matched at a daily level to generate 48,508 observations. Employing a fixed-effect regression model, we demonstrate that attention to a cryptocurrency, as mirrored via Google Search Volume Index (SVI), exerts a significant impact on its return and risk. Whereas return of a cryptocurrency is measured by its closing price at the end of a trading day, risk is operationalized as the turnover on a daily basis. Findings from our preliminary data analysis act as a stepping stone for further research into how the geographical distribution of the search volume could potentially shape the valuation of cryptocurrencies.

Theoretical Foundation and Hypotheses Formulation

Cryptocurrency Market

Cryptocurrency is a novel form of digital asset that is empowered by blockchain technology and relies on cryptographic techniques to automate, store, and validate business transactions (Gandal and Halaburda 2016). Transactions are maintained in a peer-to-peer network without centralized governance. Specifically, transactions are verified by decentralized miners who contribute computational power in exchange for cryptocurrency as a reward (Hayes 2017). The cryptographic foundation of blockchain guarantees a robust and secure platform for cryptocurrencies to be utilized in transactions as tradable tokens. This in turn gives rise to a cryptocurrency economy, a.k.a. coin economy, as a universal platform for governing business transactions and contractual relationships that promise accessibility, low cost, privacy, and security (Farell

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[1] Latest statistics on search engine market share are available at http://gs.statcounter.com/search-engine-market-share.

2015; Weber 2016). Given its merits, cryptocurrency has fueled entrepreneurship ventures that possess the potential of disrupting existing markets (Kazan et al. 2015).

But at the same time, the infancy stage of development for cryptocurrencies signifies that there is an absence of consensual criteria and established standards for assessing the business value of cryptocurrencies. For this reason, current valuations of cryptocurrencies are often subjected to speculations on the part of prospective investors, which in turn contributes to the former's volatility (Farell 2015; Fry and Cheah 2016). We therefore postulate prospective investors' attention towards a given cryptocurrency as the main driver behind its volatility. Such a postulation is consistent with Jakub (2015), who has alluded to the sensitivity of the cryptocurrency market to new information. Likewise, Jafarinejad and Sakaki (2018) discovered that the volatility of Bitcoin, the cryptocurrency with the dominant share of the market, can be explained by a sudden rise in interest among prospective investors. In the same vein, we strive to account for market valuations of cryptocurrencies by empirically examining the impact of attention on their volatility as manifested through return and risk.

Investors' Attention and Google Search Volume

Attention theory has been employed to interpret investor behavior in financial activities. According to the theory, attention is a scarce resource held by investors (Peng and Xiong 2006). When investors try to select stocks to invest in, it is likely for them to be overwhelmed by the massive number of options to choose from. Due to bounded rationality and limited cognitive capacity, investors tend to reduce their choice set to a manageable size by focusing on a few prominent options that draw their attention (Barber and Odean 2007). Li and Yu (2012) attested to the predictive power of investors' attention in driving future market return. Realizing the importance of attention, Lou (2014) documented how managers adjust marketing strategy to attract investor's attention and inflate short-term stock return whereas Yuan (2015) revealed market-wide attention-grabbing events as a predictor of investors' trading behavior and market response.

In light of the criticality of investors' attention, scholars have endeavored to operationalize the concept through a variety of measures. For example, Barber and Odean (2007) employed news, unusual trading volume, and extreme return as proxies of attention. Li and Yu (2012), on the other hand, advanced two proxies for measuring investors' attention, namely the extent to which the stock price approaches Dow 52-week high and Dow historical high. Yuan (2015) equated investors' attention with market-wide attention-grabbing events by isolating occasions when the closing price of the Dow Jones Industrial Average hits a record high.

Google search volume has been proposed as a novel and adequate measure of investors' attention (Da et al. 2011). A recent report, which solicits data from various Google services (e.g., Google maps), found that Google commands a dominating 90.8% market share of web, mobile, and in-app searches (Desjardins 2018). Search Volume Index (SVI) released by Google Trends reflects the number of queries containing a search term normalized by the maximum daily search volume. Since the seminal work of Da et al. (2011) in which they adopted SVI as a measure for capturing investors' attention towards Initial Public Offering (IPO), researchers have embraced SVI as an indicator of investors' attention in other commodity and financial markets such as crude oil (Li et al. 2015), FOREX (Goddard et al. 2015), futures (Wang et al. 2017), and stock (Liu and Ye 2016). Indeed, empirical evidence has testified to the impact of SVI on liquidity (Bank et al. 2011), price (Drake Michael et al. 2012), return (Da et al. 2015), trading volumes (Chi and Shanthikumar 2016), and volatility (Fricke et al. 2014). Despite extensive investigation on the influence of investors' attention, as measured by SVI, on traditional financial markets, its role in the cryptocurrency market remains unexplored. We thus aim to bridge the aforementioned knowledge gap by exploring the role of investors' attention, as operationalized via SVI, in affecting the volatility of market valuations of cryptocurrencies.

Effects of Google Search Volume on Price Trend of Cryptocurrencies

Investors' attention on financial instruments has been shown to be influential in shaping trading behaviors within centralized financial markets (Barber and Odean 2007). This effect should be much more pronounced in the context of the cryptocurrency market as cryptocurrency issuing companies are not obliged to disclose accounting information to the general public. This in turn implies that investors would have to devote attention to alternative informational sources to inform their trading decisions. We therefore

expect online information search to occupy a more prominent role in expanding investors' exposure to relevant information sources (Farell 2015; Jafarinejad and Sakaki 2018). Arguably, information search through search engines (i.e., Google) would be representative of investors' attention, which in turn reflects their probability of investing in a cryptocurrency (Da et al. 2011). As information search on a cryptocurrency becomes more frequent, prospective investors should deem this cryptocurrency worthier of their attention. The said cryptocurrency would then attract more investments, driving up its valuation due to the heightened interest from prospective investors. We therefore hypothesize that:

Hypothesis 1: Investors' attention towards a cryptocurrency, as expressed through Google search, will positively influence its price.

Turnover, which refers to the rate at which a cryptocurrency is traded, serves as another indicator of the volatility in how the cryptocurrency is valuated. Business models, whose value proposition is centered on cryptocurrencies, are usually innovative and unconventional, meaning that most prospective investors would encounter challenges in evaluating the value of the said cryptocurrencies (Kazan et al. 2015). This uncertainty in valuing cryptocurrency is exacerbated by the absence of a trusted central information source. Consequently, prospective investors are inclined to compensate for the heightened uncertainty by not only searching for more information, but also by reacting more intensely to the acquired information. Investors who pay more attention to a given cryptocurrency are likely to learn more about the value proposition and latest developments pertaining to the cryptocurrency (Drake Michael et al. 2012). By alleviating their information asymmetry, investors are more confident in their decisions and are likely to trade more frequently (Healy and Palepu 2001). Moreover, cryptocurrency investors tend to acquire greater sensitivity to and grow more dependent on the information they received (Caporale and Plastun 2018). In this sense, investors who actively search for information are more prone to react to retrieved information with trading actions than those who do not. We therefore hypothesize a positive relationship between the attention received by a cryptocurrency and the frequency with which it is traded:

Hypothesis 2: Investors' attention towards a cryptocurrency, as expressed through Google search, will positively influence its turnover.

Preliminary Data Analysis

Variables and Data Collection

To validate our hypotheses, we collected daily cryptocurrency transaction data from CoinMarketCap [https://coinmarketcap.com] and SVI data from Google Trends. CoinMarketCap is a primary data source for cryptocurrency transactions as established through past academic studies on the cryptocurrency market (Fry and Cheah 2016; Hayes 2017). It provides 24/7 trading data about listed cryptocurrencies such as price, available supply, trading volume, and market capitalization. Google Trends is a public web facility containing statistics on how often a particular search-term is entered relative to the total search-volume across multiple regions of the world. SVI is an index reflecting the number of searches for a term scaled by its time-series average. Because SVI constitutes a popular index for measuring online search volume (Chi and Shanthikumar 2016; Da et al. 2011; Drake Michael et al. 2012), it is employed for data analysis in this study. The sample comprises 268 cryptocurrencies from September 4th, 2017 to March 3rd, 2018, 181 trading days in total. Data was analyzed at cryptocurrency-day level and consisted of 48,508 observations.

Cryptocurrency price was measured at the close of each trading day. We calculated the turnover for each listed cryptocurrency by dividing its trading volume with its total capitalization (Lowry et al. 2010). We employed the name of each cryptocurrency as the search term to attain the SVI index in Google Trends. Table 1 depicts descriptive statistics for each focal variable as well as the correlations among them. Based on multicollinearity tests, we found that the highest Variance Inflation Factor (VIF) was 1.040 and the lowest tolerance value was 0.961. Multicollinearity occurs when the VIF is higher than 10 and the tolerance value is lower than 0.10. We can hence conclude that multicollinearity was not a threat to our study.

Table 1. Descriptive Analysis and Correlations								
	Max	Min	Mean	SD	Median	SVI	Price	Turnover

Google Search Volume Index (SVI)	100.000	0.000	27.679	27.222	19.000	**1.000**		
Price	19497.400	0.000	56.395	635.021	0.633	0.005	**1.000**	
Turnover	1640.727	0.000	5.349	27.323	1.374	0.039	-0.003	**1.000**

Empirical Models

To illustrate the effect of SVI on cryptocurrency price and turnover, we developed the empirical models below. For all variables, the natural logarithm of their values is utilized in regression analyses. We computed lagged SVI for three days to tease out their distinctive impact. We also incorporated the natural logarithm of Bitcoin price and turnover as control variables. Similarly, these two variables were lagged for three days together with their contemporary value as influencing factors.

$$Ln(price_{it}) = \alpha_0 + \alpha_1 Ln(SVI_{i,\ t-1}) + \alpha_2 Ln(SVI_{i,\ t-2}) + \alpha_3 Ln(SVI_{i,\ t-3}) + \alpha_4 Ln(BitPrice_{i,\ t})$$
$$+ \alpha_5 Ln(BitPrice_{i,\ t-1}) + \alpha_6 Ln(BitPrice_{i,\ t-2}) + \alpha_7 Ln(BitPrice_{i,\ t-3}) + \alpha_8 Ln(BitTurnover_{i,\ t})$$
$$+ \alpha_9 Ln(BitTurnover_{i,\ t-1}) + \alpha_{10} Ln(BitTurnover_{i,\ t-2}) + \alpha_{11} Ln(BitTurnover_{i,\ t-3}) + \varepsilon_{i,\ t}$$

$$Ln(turnover_{it}) = \beta_0 + \beta_1 Ln(SVI_{i,\ t-1}) + \beta_2 Ln(SVI_{i,\ t-2}) + \beta_3 Ln(SVI_{i,\ t-3}) + \beta_4 Ln(BitPrice_{i,\ t})$$
$$+ \beta_5 Ln(BitPrice_{i,\ t-1}) + \beta_6 Ln(BitPrice_{i,\ t-2}) + \beta_7 Ln(BitPrice_{i,\ t-3}) + \beta_8 Ln(BitTurnover_{i,\ t})$$
$$+ \beta_9 Ln(BitTurnover_{i,\ t-1}) + \beta_{10} Ln(BitTurnover_{i,\ t-2}) + \beta_{11} Ln(BitTurnover_{i,\ t-3}) + \varepsilon_{i,\ t}\varepsilon_{i,\ t}$$

Analytical Results

Hypotheses were tested via fixed-effects model as shown in Table 2. The SVIs from all three prior days exert significantly positive effects on cryptocurrency price. The SVI of each cryptocurrency from the previous day has the strongest impact ($\alpha_1 = 0.030$, $t = 19.036$) on its price compared to that of the other two days ($\alpha_2 = 0.025$, $t = 15.730$; $\alpha_3 = 0.024$, $t = 15.197$). Similarly, SVI significantly increases the turnover of cryptocurrencies. The SVI of each cryptocurrency from the previous day has the most significant influence on turnover ($\beta_1 = 0.091$, $t = 30.172$) followed by that of the second ($\beta_2 = 0.044$, $t = 14.475$) and third ($\beta_3 = 0.026$, $t = 8.653$) prior days.

Table 2. Results of Regression with Fixed-Effects Model				
Dependent Variable / **Independent Variable**	**Price**		**Turnover**	
	Coefficient	**Std. Error**	**Coefficient**	**Std. Error**
SVI$_{t-1}$	0.030***	0.002	0.091***	0.003
SVI$_{t-2}$	0.025***	0.002	0.044***	0.003
SVI$_{t-3}$	0.024***	0.002	0.026***	0.003
Bitcoin price $_t$	0.221***	0.009	0.330***	0.017
Bitcoin price $_{t-1}$	-0.027*	0.012	-0.030	0.023
Bitcoin price $_{t-2}$	-0.007	0.012	-0.025	0.023
Bitcoin price $_{t-3}$	0.014	0.009	-0.005	0.018
Bitcoin turnover $_t$	0.101***	0.007	0.239***	0.013
Bitcoin turnover $_{t-1}$	0.036***	0.008	-0.082***	0.014

Bitcoin turnover $_{t-2}$	0.050***	0.008	-0.103***	0.015
Bitcoin turnover $_{t-3}$	0.109***	0.007	-0.038**	0.013
R^2	0.293		0.118	
Adjusted R^2	0.289		0.113	

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Discussion, Implications and Limitations

Results from our data analysis support our hypotheses that investors' attention, expressed in the form of SVI, on a given cryptocurrency exerts positive effect on its price and turnover. When inspecting the impact of investors' attention with three time lags of progressive length, more insights can be gleaned from our study. With regards to cryptocurrency price, the effect of investors' attention is significantly positive across all three time period. This indicates that investors' attention has a relatively persistent effect on the valuation of cryptocurrency. According to attention theory, prospective investors seek information for a select group of cryptocurrencies to adjust their consideration set before determining which one to invest in. Because it takes time for investors to make investment decisions on the basis of the information they have gathered through online search (Barber and Odean 2007), we a three-day lagged SVI could still exercise significant influence on cryptocurrency price.

On the other hand, even though SVIs continue to positively affect turnover across all three time periods, it is discernable that the impact diminishes as the length of time lag increases. This implies that the effect of investors' attention on behavioral response dissipates as time goes by. Investors seem to prefer immediate reaction to the information they received via online search (Caporale and Plastun 2018), such impulses are not sustainable for a prolonged period of time. In turn, this finding points to a potential remedy in curtailing the volatility in cryptocurrency valuation: imposing a deliberation period in online cryptocurrency exchanges to deter impulsive trading.

Extending attention theory, this study sets out to investigate investors' attention as a plausible cause of volatility in the valuation of cryptocurrencies. Leveraging on panel data harvested from CoinMarketCap and Google Trends, findings from this study bear witness to the prominent role played by investors' attention in bolstering the price and turnover for a given cryptocurrency. Inspired by recent studies on cryptocurrencies (Dwyer 2015; Fry and Cheah 2016; Weber 2016), this research denotes a concrete step towards tackling the seemingly unpredictable valuation of cryptocurrency. Furthermore, we contribute to attention theory by discerning the extent of its applicability to highly volatile markets in the likes of cryptocurrencies. Indeed, while tenets of attention theory have been mostly corroborated, we can generate novel insights for the context of cryptocurrencies. As unearthed in this study, the effect of investors' attention on turnover diminishes on a daily basis. The rapid pace by which investors lose interest is not only caused by market volatility, but it can also be attributed to the unique characteristic of cryptocurrencies in generating a huge amount of online information daily. As a consequence, investors are easily distracted, thereby undermining the impact of their attention on the turnover of cryptocurrencies.

Pragmatically, the cryptocurrency market is an emerging economy facing a confluence of ethical, legal, and regulatory challenges (Fry and Cheah 2016). The high volatility of the cryptocurrency market makes it difficult for investors to predict future market movements. We hence strive to unravel determinants of cryptocurrency price and turnover. Through analyzing a panel dataset of 268 cryptocurrencies over 181 trading days, we can infer that investors' attentions matter in the cryptocurrency market. Prospective investors are therefore well advised to keep abreast of current search trends when deciding on which cryptocurrency to invest. But at the same time, it is important to note that despite the positive influence of investors' attention, such influence decreases over time. For this reason, investors must remain equally vigilant of when their peers start to lose interest in order to safeguard against late exits from the market. Conversely, it is imperative for cryptocurrency companies to roll out initiatives for attracting the attention of prospective investors in order to ensure a higher price and turnover. Such attention-grabbing initiatives should take the form of continuous rather than singular events to counter the temporality of investors' attention. For example, cryptocurrency companies could build up strong Research and Development (R&D) teams to maintain a steady stream of token updates for sustaining investors' attention.

This study has several limitations that should be addressed through future research. First, our sample size could be enlarged to accommodate a greater number of cryptocurrencies and a longer trading period. An increase in the sample size allows us to not only conduct additional tests to address causality issues, but to also ascertain the effects of SVI over a longer time period. This in turn may aid in reinforcing the reliability and robustness of our findings. Second, more control variables would be incorporated into the regression model (e.g., tenure of each cryptocurrency since its inception) to better isolate the impact of investors' attention. Third, due to limited accessibility of Google search to individuals in mainland China, search observations from prospective Chinese investors are underrepresented in our sample. Nevertheless, since the trading of cryptocurrency is currently banned by the Chinese government, the exclusion of search volume from mainland China could actually enhance the internal validity of our findings.

Future Research

Building on the findings from this preliminary study, our proposed next step is to conduct a more granular analysis by breaking down the search volume in accordance with their originating geographical locations. Chi and Shanthikumar (2016) have remarked that local bias is still a substantial issue in the Internet era. By analyzing stock market trading data, Chi and Shanthikumar (2016) uncovered that local bias, measured by the proportion of online information searches for a firm's stock originating from the localized area of the firm's headquarter, would dictate market responses to earning reports. The heterogeneous distribution of the originating geographical locations for queries on each cryptocurrency, as unveiled through our closer scrutiny of Google search volume (see Figures 1 and 2), also hints at the possibility that the attractiveness of cryptocurrencies could be constrained by geographical proximity despite its decentralized nature.
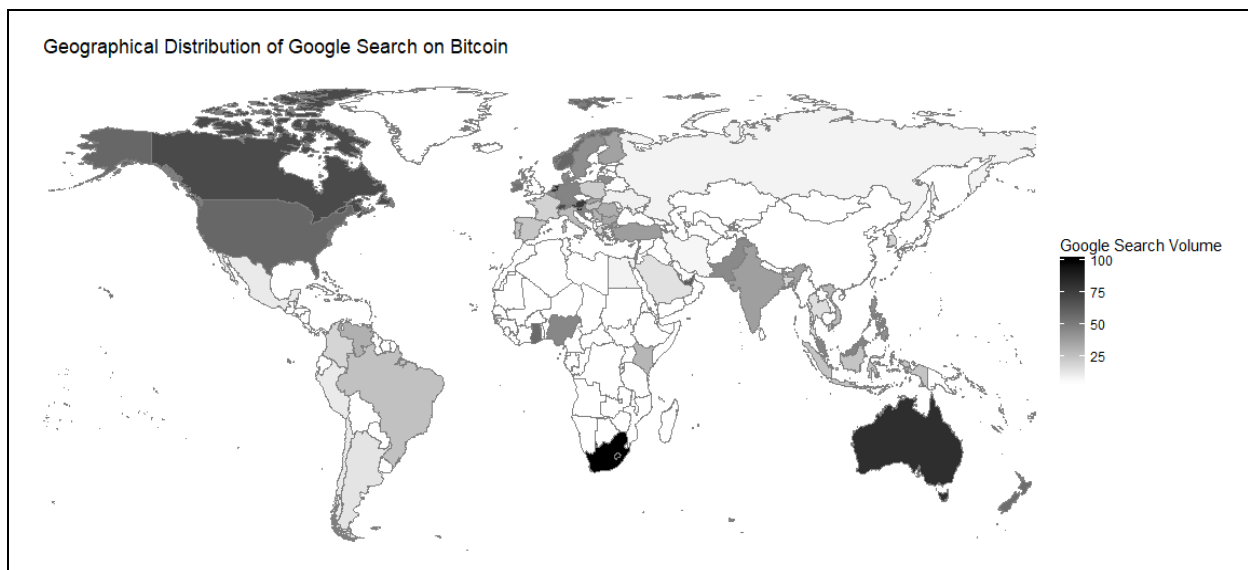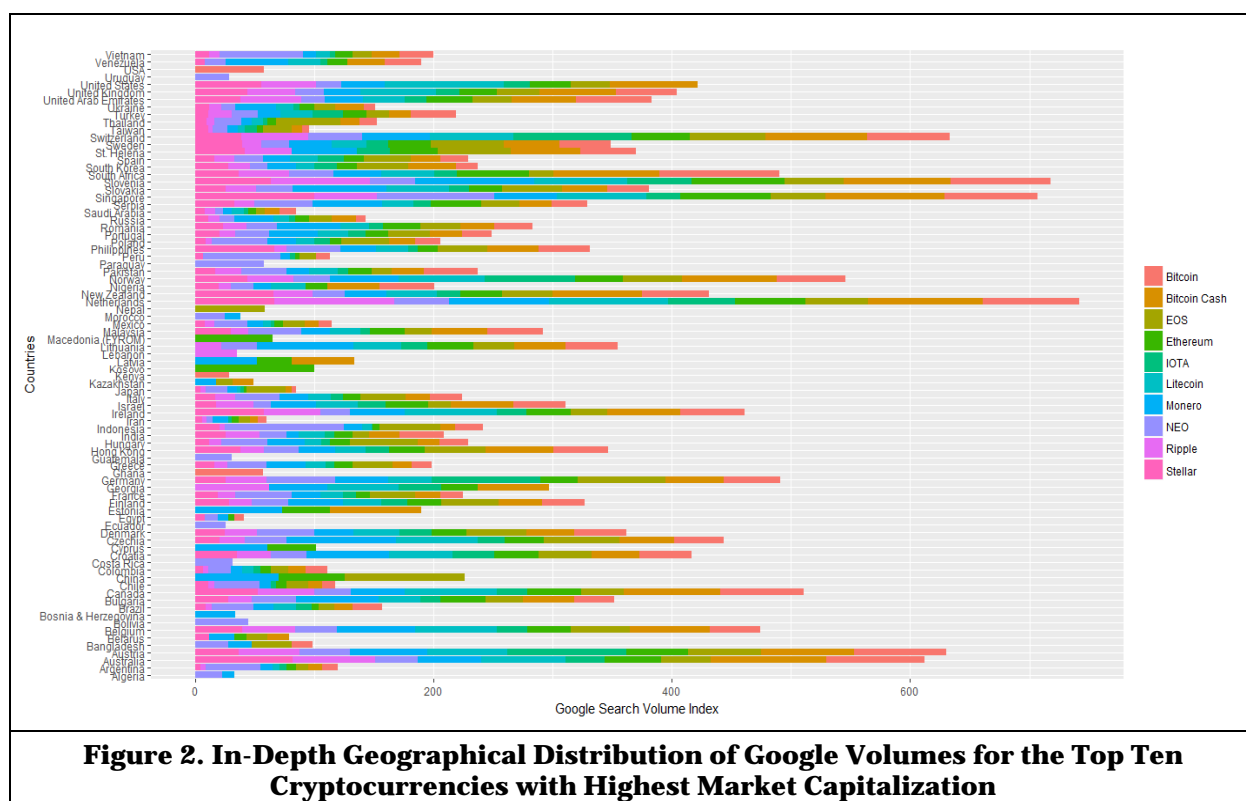

Figure 1. Geographical Distribution of Google Search Volume for Bitcoin

There are two plausible reasons that can account for the observed localization effect in the valuation of cryptocurrency. The first proposition is rooted in local information advantage, which refers to the likelihood of localized investors possessing private information and tacit knowledge about the value proposition for the underpinning cryptocurrency (Ivković and Weisbenner 2005). From this perspective, local investors rely more on the information collected offline rather than on those gathered online. Conceivably, the influence of online information search on cryptocurrency valuation is less salient if it was performed by investors located in close vicinity to the issuing company.

A competing hypothesis could stem from familiarity bias, which assumes that investors tend to invest in cryptocurrencies with which they are more familiar (Huberman 2001). Investors who are located in close vicinity to the issuing company for a cryptocurrency tend to feel more comfortable investing in the said cryptocurrency. Due to this elevated confidence, these investors are more likely to trade in the particular cryptocurrency in response to the information they have elicited through online search. As a consequence, their attention towards the cryptocurrency may be magnified as an indicator of its valuation.

Figure 2. In-Depth Geographical Distribution of Google Volumes for the Top Ten Cryptocurrencies with Highest Market Capitalization

From above, it is clear that the two competing hypotheses entail conflicting arguments about how geographical factors could shape the relationship between investors' attention and cryptocurrency valuation. Because the extraordinary growth potential exhibited by the emerging cryptocurrency economy could be eroded by the volatility in its valuation, deciphering how prospective investors value such novel digital assets would yield implications not only for scholars who crave a better appreciation of the cryptocurrency economy, but also for practitioners who are keen to invest in the cryptocurrency market. This preliminary study thus acts as a platform for disentangling the convoluted influence posed by investors' attention and local bias on cryptocurrency valuation in order to derive a comprehensive framework for valuing cryptocurrencies.

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