Herding Behaviour in Digital Currency Markets: An Integrated Survey

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Abstract: This paper reviews the empirical literature on the highly popular phenomenon of herding behaviour in the markets of digital currencies. Moreover, a comparison takes place with outcomes from earlier studies about traditional financial assets. The present survey suggests that empirical findings about whether herding phenomena have made a significant appearance or not in cryptocurrency markets are split. The Cross-sectional absolute deviations (CSAD) and Cross-sectional standard deviations (CSSD) approaches for measuring herding tendencies are found to be the most popular. Different behaviour is detected in bull periods compared to bear markets. Nevertheless, evidence indicates that herding is stronger during extreme situations rather than in normal conditions. These findings cast light on and provide a roadmap for investment decisions with modern forms of liquidity.

JEL Classification: G14, G15

Keywords: Bitcoin, Digital Currency, Cryptocurrency, Herding, Survey

1. Introduction

The worldwide liquidity shortages brought up to the surface by the 2008 Global Financial Crisis have prompted traders, policymakers and academics to focus interest on alternative forms of money and investment assets. The introduction of Bitcoin by Nakamoto (2008) has spurred coin offerings of a wide spectrum of digital currencies that have attracted considerable attention by all types of economic agents. Digital currencies constitute alternative forms of liquidity with remarkable differences in ownership, transactions and production matters in relation to the traditional monetary assets. Their decentralized nature and the lack of regulatory authorities have rendered them widespread since 2017 and extremely popular across speculators but also uninformed investors. The high level of ignorance about fundamentals of cryptocurrencies has made these markets largely susceptible to collective actions of the market even when these are in sharp contrast to beliefs of individual persons.

Behavioural finance constitutes a sub group of behavioural economics and suggests that phychological factors and biases exert impacts on financial decisions of investors and economic units in general. These influences are at the route of anomalies in markets of financial assets and generate bull or bear phenomena in high speed. ‘‘Herding’’ in economics and finance stands for the irrational tendency that investors exhibit towards mimicking behaviour of other investors even if they totally disagree with that way of thinking (Spirou, 2013). This is closely related to irrational exuberance as has been analyzed by Robert Shiller (Shiller, 2015) that leads to over-enthusiasm and the creation of asset price bubbles. Herding behaviour can be expressed in various forms such as trading in the same direction with others, following the trend in previous trades, imitating or correlation one’s behaviour to others’ behaviour. Usually investors who lack experience are prone to become risk-lovers without being able to understand the risks that they suffer. Such thoughtless behaviour is often encouraged by lack of certainty regarding economic conditions and by extreme conditions in markets, such as during turmoil.

.Herding has made its appearance in a wide spectrum of alternative financial assets through time and has attracted early attention by high-quality academic studies (Nofsinger and Sias, 1999). To be more precise, herding phenomena have been studied concerning stock markets (Chang et al., 2000; Chiang and Zhang, 2010; Balcilar et al., 2014; Litimi et al., 2016; Dohl et al., 2017), commodities markets (Babalos and Stavroyiannis, 2015; BenMabrouk and Litimi, 2018), bond markets (Galariotis et al., 2010) and mutual funds (Deng et al., 2018). Furthermore, academic work about herding has focused on the house market (Ngene et al., 2017) and REITs (Philippas et al., 2013). Analysis has also been conducted in both microeconomic and macroeconomic levels (Venezia et al., 2011). Moreover, integrated surveys on herding in financial assets have been realized (Spirou, 2013).

This study focuses on herding behaviour in the digital currency markets as these innovative forms of liquidity are particularly attractive to investors due to their potential for very high profitability. Their fully decentralized character and the encrypted database technology that is called ‘‘blockchain’’ differentiate them from conventional forms of money and investments as they offer pseudonimity to their users (Böhme et al., 2015). Bitcoin has been the largest-capitalized digital currency during the last decade and herding phenomena in cryptocurrency markets are mainly attributed to its price fluctuations.

This integrated survey casts light on irrational investor behaviour and herding phenomena in the markets of digital currencies but also traditional assets. This enables the interested reader to have a compass when investing in digital forms of money and investments and better familiarize with the tendency of such markets to follow signals from other cryptocurrency markets, like that of Bitcoin. It should be emphasized that despite the hegemonic role of Bitcoin in digital currencies being confirmed, there is also academic work that proves lower-capitalization digital currencies being influential as well as regards the overall market sentiment.

In the remainder of this paper, Section 2 provides empirical literature on herding phenomena in traditional financial assets and provides an overview of results. Furthermore, Section 3 lays out the empirical studies investigating herding phenomena in digital currency markets and summarizes findings. Finally, Section 4 provides the economic implications, the conclusions and avenues for future research. It should be noted that Table 1 presents in a brief manner the main elements of the studies about herding in cryptocurrency markets.

2. Studies about herding phenomena in traditional financial assets

An important number of academic studies have focused on the market of financial assets and irrational behaviour of investors that mimic other investors' actions which is contrary to their own beliefs. A range of high-quality papers have looked into the nexus between herding and irrational investment decisions and how this has affected profitability and the risk-return trade-off in investor portfolios. In order to elaborate on the arguments put forward by the aforementioned strand of the literature, we dwell on specific papers that are related to herding phenomena in financial markets.

In their seminal paper, Chang et al. (2000) examine how investors behave in the US and Asian markets. It is revealed that in South Korean and Taiwanese **markets** significant herding behaviour emerges while a weaker level is detected in Japan. No herding is found in the markets of the US and Hong Kong. Various size-based portfolios confirm these findings. The role of increase in security return dispersion as a function of the aggregate market return presents higher levels during upwards market periods. When it comes to Hirshleifer and Hong Teoh (2003), they provide a literature review and insights on herding behaviour in **capital** markets. They describe why imitation is interesting in capital markets and emphasis is put on the roots and patterns of convergent behaviour. They support that herding phenomena in equity markets are likely mixtures of reputational impacts, information influences, direct payoff interactions, preference characteristics and imperfect rationality.

Furthermore, Chiang and Zhang (2010) study herding behaviour in 18 countries during the period 1988-2009. Results reveal that herding takes place in advanced **equity** markets –but not in the US- and in Asian markets whereas no herding is detected in Latin American regions. While herding phenomena are traced both during bull and bear markets, herding asymmetry is found to be more intense in Asian markets during upwards market tendencies. Moreover, contagion effects that influence neighbouring regions are found to take place. By another perspective, Demirer et al. (2010) focus on herding phenomena in the Taiwanese **stock** market and adopt alternative methodologies in order to understand the sources of herding. Their findings indicate that herding behaviour is more intense during periods of market

losses. This leaves no large space for diversification in investors; portfolios during stresses market conditions.

Economou et al. (2011) examine whether countries in Southern Europe have presented herding behaviour during the decade before the outburst of the Global Financial Crisis (GFC). Investigation takes place in relation to market characteristics. They look into whether the cross-sectional dispersion of returns in each **market** influenced by the dispersion in the other three markets. Moreover, investigation takes place about the impact of the GFC on herding behaviour. Additionally, Holmes et al. (2013) by using cross-sectional regression across all the securities examined provide evidence that institutions in the Portuguese **stock** market exhibit herding behaviour. This phenomenon is argued to be driven by reputational reasons. Such outcomes offer insights into fund manager behaviour. Moreover, herding is found to be intentional within a concentrated market. Moreover, Balcilar et al. (2014) look into the factors that establish the volatility-herding nexus in the emerging **equity** markets of the oil-rich GCC regions. They investigate the impact of herding on volatility after taking into consideration global factors. A regime-switching smooth-transition regression (STR) model is employed. Evidence indicates that switching from non-herding to herding and the other way around is mainly affected by market volatility. To be more precise, global risk factors are very influential. Contagion is found to take place in financial markets. In their study, Economou et al. (2016) study herding behaviour in the Greek Athens **Stock** Exchange during the crisis period. By using the cross-sectional dispersion approach, evidence is provided that herding exists under different market conditions. Results from quantile regressions indicate that herding is evident in the upper quantiles of the cross-sectional return dispersion.

Babalos and Stavroyiannis (2015) employ a DCC-GARCH methodology in order to find the connection between anti-herding behaviour and **portfolio** management. They argue that this behaviour comes up due to different portfolio positioning and rebalancing. More specifically, this phenomenon is more evident with the increase in the short- and long- positioning of the portfolio weights. Generally, it is found that during the financial turmoil no herding takes place and anti-herding behaviour emerges. By a somewhat different point of view, BenSaïda (2017) adopts a modification of the cross-sectional absolute deviation methodology and the GJR-GARCH model to investigate the linkage of herding behaviour with trading volume and investor's sentiment. Evidence indicates that herding takes place in almost every sector of the US **stock** market during turmoil eras. Such behaviour influences the volatility of a relatively small number of specific stocks while the overall market volatility falls. In a more or less similar vein, Gong and Dai (2017) study whether fluctuations in interest rates and currency values result in herding phenomena in the Chinese **stock** market. Findings reveal that higher interest rates and lower currency values lead to more intense herding behaviour and this is more evident during bear markets. Additionally, evidence suggests that intentional herding takes place in the Chinese stock market. Surprisingly, Bohl et al. (2017) support that a modification of

the herding measure by Chang et al. (2000) can provide clearer evidence of herding behaviour. They test this argument by investigating herding phenomena in **the SP500** and the Eurostoxx50 indices.

From their perspective, BenMabrouk and Litimi (2018) study herding behaviour at US **industries** during extreme oil market movements. By employing a modified version of the cross-section absolute deviation methodology, evidence is provided that no herding takes place in any sector. Furthermore, they support that sectoral herding is more emphasized during downwards movements of the oil market rather than upwards ones. It is further argued that higher volatility in the oil market and more intense fear sentiment weaken herding in US industries. By adopting their own viewpoint, Deng et al. (2018) look into the herding behaviour of mutual funds during bear periods in **stock** markets. There is evidence that mutual fund herding is more pronounced during periods of low information disclosure and quality. Furthermore, such herding behaviour is found to fortify the risk of abrupt falls in stock prices. Moreover, Galariotis et al. (2016) investigate for the existence of herding phenomena concerning the European government **bond** prices. They support that no investor herding took place before or after the crisis in the European Union. Emphasis is put on the finding that macroeconomic news have led to herding behaviour of bond market investors during the crisis. Furthermore, spillover effects of herding are detected.

Overall, findings indicate that economic units are more susceptible to exhibit irrational behaviour and lead to herding phenomena during turbulent periods. A number of studies support that during bull markets investors tend to follow the decisions of other investors when it comes to stock trading. On the other hand, there is a significant number of academic papers revealing that during stressed economic conditions herding phenomena become more intense. Alternative reasons for the presence of herding behaviour have been detected such as bad information and irrational thinking. The majority of studies agree that market conditions can badly affect rational decision making and distort an investor's beliefs in a large extent and regarding a large spectrum of financial assets.

3. Studies revealing herding behaviour in digital currency markets

It is very interesting that empirical academic papers with meaningful outcomes about herding behaviour in the markets of digital currencies have been brought about. **Ballis and Drakos (2019)** employ daily data concerning Bitcoin, Ethereum, Litecoin, Monero and Dash covering the period from August 2015 to December 2018. They adopt the cross-sectional standard deviation (CSSD) and the cross-sectional absolute deviation (CSAD) methodologies in order to trace herding phenomena in markets of major cryptocurrencies. Furthermore, Newey-West and GARCH estimations are conducted. They test the hypothesis that different behaviour exists in up or down

movements. Empirical outcomes reveal that market dispersion movements are less than proportionate to fluctuations of market returns. Moreover, it is found that market dispersion during up-events is faster in comparison to the down-events. Thereby, asymmetric herding behaviour exists. By a somewhat similar perspective, **Bouri et al. (2019)** adopt a GSAD methodology in order to study herding behaviour in the markets of digital currencies. Moreover, they identify structural breaks and non-linearities and adopt rolling-windows for estimations. Furthermore, the Probit model is employed and the Economic Policy Uncertainty (EPU) index is adopted in estimations. Daily data about Bitcoin, Ethereum, Ripple, Litecoin, Stellar, Dash, Nem, Monero, Bytecoin, Verge, Siacoin, BitShares, Decred and Dogecoin are used. The period under scrutiny starts from 28 April 2013 and covers until 2 May 2018. Outcomes provide evidence that significant herding phenomena exist during the sub periods a) 24 April 2016 to 28 November 2016, b) 5 January 2017 to 1 April 2017, c) 21 May 2017 until 29 May 2017 and d) 20 July 2017 until 13 September 2019. The authors argue that herding exists in cryptocurrency markets but its intensity is not stable over time. The static model finds no evidence of herding while probit results support that higher uncertainty intensifies herding phenomena.

Da Gama Silva et al. (2019) analyze herding behaviour of 50 very liquid and capitalized digital currencies spanning the period from March 2015 to November 2018. The CSAD and the CSSD methodologies are employed as well as Hwang and Salmon's (2004) model to analyze herding behaviour. Furthermore, adaptations of Forbes and Rigobon's (2002) test and extensions based on Fry et al. (2010) and Fry-McKibbin and Hsiao (2018) are adopted for measuring contagion. Findings reveal herding behaviour and extreme periods of adverse herding phenomena are detected in periods of high risk aversion. Additionally, it is shown that Bitcoin is contagiously influential to the other cryptocurrencies. Moreover, **Kaiser and Stöckl (2019)** by proposing Bitcoin as a ''transfer currency'' provide evidence that herding measures around such a currency present to researchers a more precise picture of herding behaviour in the cryptocurrency market. The CSAD methodology is employed. They support that the market of digital currencies is characterized by a large level of irrationality regarding investors' decisions and significant herding behaviour that leads to high levels of volatility. As regards **Kallinterakis and Wang (2019),** they look into herding phenomena in the cryptocurrency markets and their causes during the December 2013- July 2018 period. The CSAD measure and dummy variables about high volume and high volatility days are adopted. Results indicate that herding is considerable and is found to be more powerful during upwards tendencies in digital currency markets. Furthermore, smaller-capitalization cryptocurrencies reinforce the level of herding. Moreover, the cryptocurrency market is found to entail great destabilization risks**.**

Stavroyiannis and Babalos (2019) employ Ordinary Least Squares (OLS), the time-varying parameter (TVP) and quantile regression methodologies in order to trace herding behaviour in virtual currencies from 9 August 2015 until 18 February

2018. Moreover, the CSSD and CSAD specifications are employed. Herding behaviour is examined through a static as well as a dynamic analysis lens. Results present that herding is more intense during bull markets in comparison to bear markets. This abides by the findings of Vidal-Tomas et al. (2019). The time-varying model used reveals the lack of herding phenomena in the cryptocurrency markets. When it comes to **Vidal-Tomas et al. (2019),** they investigate herding behaviour related to an equally-weighted market portfolio. The daily data employed cover 65 digital currencies during the period from 1 January 2015 to 31 December 2017. The cross-sectional standard deviation of returns (CSSD) and the cross-sectional absolute deviation of returns (CSAD) models are employed for examination. Robustness estimations take place by adopting cap-weighted apart from equally-weighted market portfolios. It is argued that extreme price movements in the tails of distributions do not provide evidence for herding behaviour. Moreover, evidence shows that herding is more perceptible during down markets rather than during bull periods. Bitcoin, Ripple, Litecoin, Dash and Stellar are estimated to be the dominant and most influential of the digital currencies examined. When Bitcoin is absent in portfolios then the other major cryptocurrencies take its role. It should be noted that Bitcoin cannot create by itself the herding phenomenon. Furthermore, emphasis should be paid in that no evidence of herding is detected based on the cap-weighted market portfolio analysis.

It can be seen that the majority of studies on herding phenomena in digital currency markets have employed the CSAD and the CSSD methodologies though findings are far from identical. In an overall sense, there is that Bitcoin remains among the most influential cryptocurrencies though the level of this dominance and the periods during which this exerts herding effects is not unanimous across studies. Most relevant papers indicate that herding is stronger during bull markets but these are also fewer studies that support higher herding intensity during bear markets. The periods of high herding influences vary substantially as concerns their duration. Thereby, it is seen that they could last some days, a couple of months or even half a year approximately. It is quite interesting that when Bitcoin is not capable of influencing prices of other cryptocurrencies even some small-capitalization digital currencies prove influential in a certain degree for short time periods.

4. Conclusions

This study is an integrated survey on herding phenomena in financial assets with special emphasis on the markets of digital currencies. An important number of high-quality academic papers have been employed in this paper in order to provide in the clearest way a bird's-eye view on characteristics of herding behaviour in financial markets and explain the sources of such irrationality in investor decision-making.

Findings about herding phenomena in markets of traditional assets reveal that investors present an inclination towards irrational behaviour and mimicking others' decisions which is more emphasized during turbulent market periods. Nevertheless, outcomes are split concerning whether bull markets are more able to provide higher herding incentives than bear markets. It should be noted though that during normal economic conditions no evidence of herding is brought to the surface. Distortions in the rational thinking of economic units are detected in a range of financial assets. Remarkably though, it is stock markets that are found to be mainly influenced by distortions in investors' beliefs.

When it comes to the markets of digital currencies, it can also be seen that the CSAD and CSSD methodologies are popular among academic investors but also more innovative methods of estimations have emerged. Arguably, evidence indicates that Bitcoin remains the dominant and among the most influential cryptocurrencies though other highly-ccapitalized digital currencies such as Ethereum or Litecoin can also exert herding behaviour during certain periods. It is remarkable that relevant studies have revealed that even lower-capitalization currencies could be influential –though in a lesser extent- for the rational decision-making of investors. Furthermore, the majority of studies indicate that bull markets can trigger more intense herding behaviour than bear ones but the latter remain generators of distortions and mimicking. These findings contribute to a much better understanding of the hotly-debated issue of investments in markets of digital currencies and casts light on the factors that spur irrationality in human behaviour among investors.

The main aim of this study is to provide an overall perspective of determinants concerning distortions in economic thinking in the markets of conventional and especially modern forms of liquidity and investments. This integrated survey could provide a roadmap for investment decisions and contribute even in the slightest degree to better understanding of digital currencies that would give feedback for further research in this very interesting domain of economics and finance. Avenues for future investigation of digital forms of money could focus on the nexus between the volatility, trade volume and market capitalization of cryptocurrencies and the intensity of relevant herding phenomena.

Table 1. Main characteristics and findings of studies focusing on herding behaviour in digital currency markets

Authors	**Journal**	**Variables**	**Data source**	**Period examined**	**Methodology**	**Existence of Herding**
Ballis and Drakos (2019)	FRL	Bitcoin Dash Ethereum Litecoin Monero Ripple	Cryptocompare.com Coinmarketcap.com	August 2015-December 2018	Cross-sectional absolute deviations (CSAD) by Chang et al.	There is herding and is more pronounced in bull

					(2000) Cross-sectional standard deviations (CSSD) by Christie and Huang (1995) GARCH by Bollerslev (1986)	markets
Bouri et al. (2019)	FRL	Bitcoin Ethereum Ripple Litecoin Stellar Dash Nem Monero Bytecoin Verge Siacoin BitShares Decred Dogecoin	Coinmarketcap.com	28 April 2013- 2 May 2018	Cross-sectional absolute deviations (CSAD) by Chang et al. (2000)	Significant herding during 4 periods: (24 April 2016- 28 November 2016, 5 January 2017- 1 April 2017, 21 May 2017- 29 May 2017, 20 July 2017- 13 September 2017), especially from April 2016 to September 2017
Da Gama Silva et al. (2019)	JBEF	CRIX Bitcoin Ethereum Ripple Stellar Lumens Litecoin Monero Tether Dollar Dash Dogecoin BitShares Bytecoin DigiByte	Crix.hu-berlin.de Coinmarketcap.com	March 2015- November 2018	Cross-sectional absolute deviations (CSAD) by Chang et al. (2000) Cross-sectional standard deviations (CSSD) by Christie and Huang (1995)	Positive herd effect (beginning of 2015) Adverse herding (May 2015- November 2015) Positive herd effect (mid-December 2015-

		Verge MaidSafeCoin Monacoin Reddcoin Nxt Syscoin Peercoin Nexus Groestlcoin VertCoin Einsteinium Ubiq Blocknet NavCoin BitCNY Novacoin DigitalNote ViaCoin BitBay Burst WhiteCoin CloakCoin Boolberry Unobtanium Gulden BitUSD GameCredits CassinoCoin Counterparty Namecoin Feathercoin PrimeCoin Crown FlorinCoin BlackCoin ECC Diamond PotCoin			FR test for parametric contagion by Forbes and Rigobon (2002) Coasymmetry test by Fry et al. (2010) Cokyrtosis test by Fry-McKibbin and Hsiao (2018) Covolatility test by Fry-McKibbin and Hsiao (2018)	March 2016) Predominant herd effect (end June 2016-September 2016) Reversal of herd effect (end September 2016-February 2017) Herd effect (end February 2017-April 2017) Reversal in the herd impact (May 2017- July 2017) Prominent herd effect (August 2017-September 2017) Reversal of herd effect (November 2017-September 2017) Pessimism influences herd effect during 2018
Kaiser and Stöckl	FRL	Ranging from 395 to 2026	Coinmarketcap.com	1 January	Cross-sectional absolute	Bitcoin is a ‘‘transfer currency’’

(2019)		digital currencies		2015-25 March 2019	deviations (CSAD) by Chang et al. (2000)	and leads to herding
Kallinterakis and Wang (2019)	RIBAF	The top 296 cryptocurrencies	Coinmarketcap.com	27 December 2013-10 July 2018	Cross-sectional absolute deviations (CSAD) by Chang et al. (2000)	Significant herding (irrespective of Bitcoin and its trends), strongly asymmetric (is more powerful during bull markets, low-volatility and high-volume periods) and smaller digital currencies reinforce its size
Stavroyiannis and Babalos (2019)	JBEF	Bitcoin Ethereum Ripple Litecoin Dash Nem Monero Stellar	Coinmarketcap.com	9 August 2015-18 February 2018	Cross-sectional absolute deviations (CSAD) by Chang et al. (2000) Cross-sectional standard deviations (CSSD) by Christie and Huang (1995) Time-varying parameter regression model by Nakajima	No herding

					(2011) Ordinary Least Squares (OLS) with Heteroskedasticity and Autocorrelation corrected standard errors (HASCE) by Newey and West (1987)	
Vidal-Tomás et al. (2019)	FRL	65 digital currencies available in the BraveNew Coin database	BraveNewCoin database Coinarketcap.com	1 January 2015-31 December 2017	Cross-sectional absolute deviations (CSAD) by Chang et al. (2000) Cross-sectional standard deviations (CSSD) by Christie and Huang (1995)	Herding during down markets. The smallest cryptocurrencies are herding with the largest ones. Not only Bitcoin is responsible for herding

Notes: FRL, JBEF and RIBAF stand for Finance Research Letters, Journal of Behavioral and Experimental Finance and Research in International Business and Finance, respectively.

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Figure 2. Citations by Google Scholar and Plum-X captures per study as in 1 February 2020.

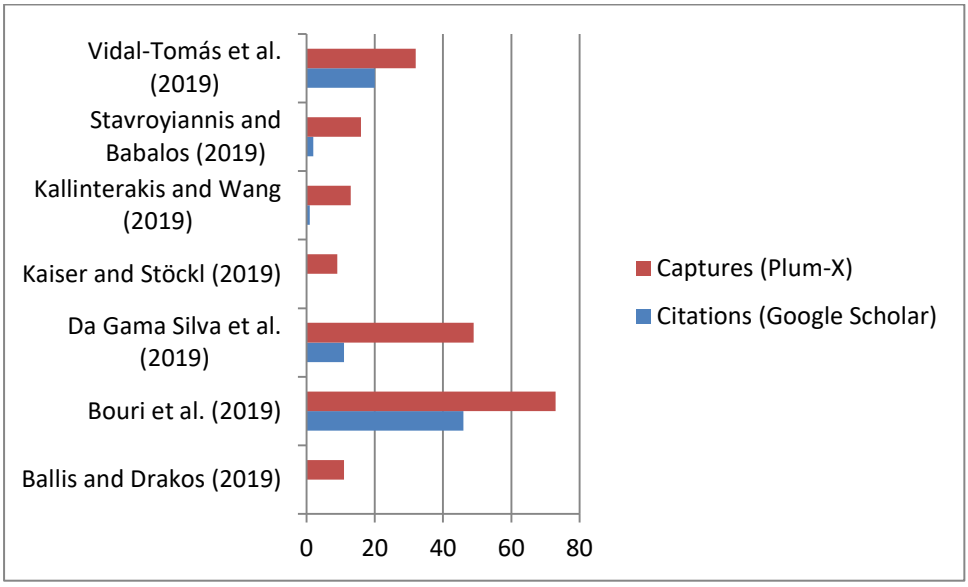


Figure 3. Total academic references on which each study examined has been based

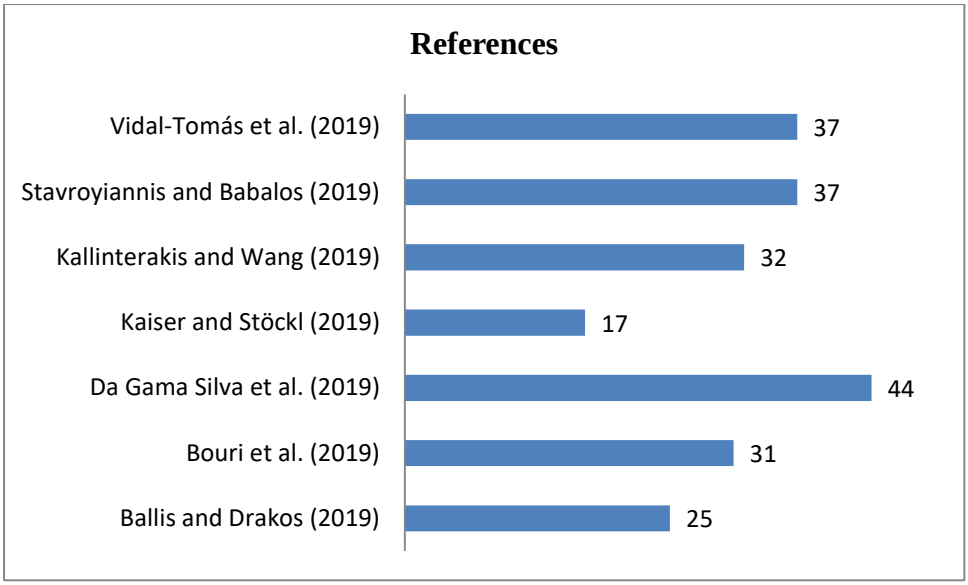
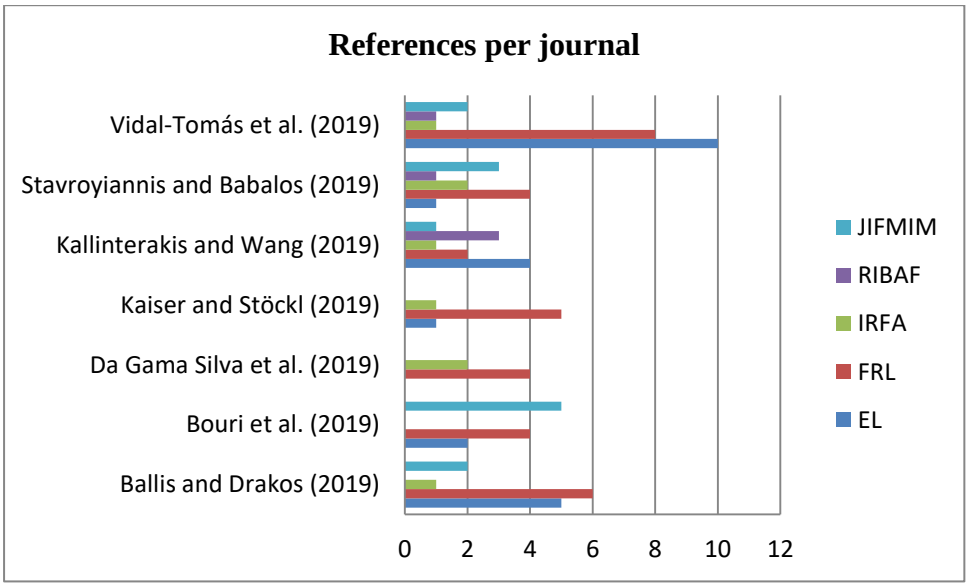


Figure 4. References that have been taken by the most popular journals about digital currencies



Notes: EL, FRL, JIFMIM, IRFA and RIBAF stand for Economics Letters, Finance Research Letters, Journal of Financial Markets, Institutions and Money, International Review of Financial Analysis and Research in International Business and Finance