ARE CRYPTOCURRENCIES DEEMED RELIABLE ASSETS FOR SWING TRADING?

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Abstract

Recently the disposition of the number of financial companies to encompass cryptocurrencies in their portfolios has speeded up. Cryptocurrencies are the first pure digital assets to be included by asset directors. Although they share many things in common with more traditional assets, they have their peculiar characters and their behavior as an asset is still in the continuous phase of being understood. It is therefore significant to sum up the available research publication and finding on cryptocurrency marketing, consisting trading avenues, trading impulses, trading techniques, research and management of risk. This publication highlights an intensive survey of cryptocurrency trading research, by consulting 146 research publications on numerous aspects of the cryptocurrency business (e.g., cryptocurrency trading systems, bubble, and extreme condition, prediction of volatility, and return, crypto-assets portfolio construction, and crypto-assets, technical trading and others). This publication also investigates datasets, research inclination and dissemination among the objects of research (contents/properties) and technologies, finalizing with some promising opportunities that are open and transparent in the cryptocurrency market.

Key Words: Cryptocurrency, Econometrics, Machine Learning, Digital Assets. Trading

Introduction

Cryptocurrencies have immensely experienced wide market acceptance and rapid progress despite their conception in recent time. A lot of hedge funds and asset managers have begun to include cryptocurrency-related assets in their portfolios and trading techniques. The academia has similarly spent gargantuan efforts investigating cryptocurrency trading. This paper intends to give a comprehensive and in-depth analysis of the research on the cryptocurrency market, by which we mean any publication aimed at simplifying and constructing strategies to trade cryptocurrencies (Farel 2015).

As a research direction and emerging market, cryptocurrencies and cryptocurrency trading have experienced considerable progress an apparent, upturn in interest and activity. From Figure 1, we analyze that over 85% of publications that have appeared since 2018, showcasing the emergence of cryptocurrency trading as a new research area in financial trading. The sampling interval of this survey is from 2013 to June 2021. The literature is arranged according to six distinct aspects of cryptocurrency trading:

a. Cryptocurrency trading software systems (i.e., real-time trading systems, arbitrage trading systems, turtle trading systems);
b. Systematic trading including technical analysis, pairs trading, and other systematic trading methods;
c. Emergent trading technologies including econometric methods, machine learning technology, and other emergent trading methods;
d. Portfolio and cryptocurrency assets including research among cryptocurrency movements and crypto-asset portfolio research;
e. Market condition research including bubbles or crash analysis and extreme conditions;
f. Other Miscellaneous cryptocurrency trading research.

This research intends to compile the most related publications in these areas and sort a set of descriptive indicators that can procure an idea of the level of developmental research in this area. We also come up with assorted research dissemination (among research properties and categories/research technologies). The distribution among properties highlights and gives light to the classification of

research objectives and inclusions. The distribution among technologies defines the classification of methods or technological approaches to the study of cryptocurrency business. Specifically, we subdivide research distribution among categories/technologies into statistical methods and machine learning technologies. Moreover, we identify datasets and opportunities (potential research directions) that have appeared in the cryptocurrency trading area. To make sure that our research is self-contained, we aim to procure sufficient material to sufficiently guide financial trading researchers who are interested in cryptocurrency Swing trading (Narayanan 2016).

There has been related work that discussed or partially surveyed the literature related to cryptocurrency trading. Kyriazis, et al. (2019) investigated the efficiency and profitable trading opportunities in the cryptocurrency market. Ahamad, et al. (2013) and Sharma, et al. (2017) gave a brief survey on cryptocurrencies, the merits of cryptocurrencies compared to fiat currencies, and compared to different cryptocurrencies that are proposed in the literature. Ujan, et al.(3016) gave a brief survey of cryptocurrency systems. Ignasi, et al. (2019) performed a bibliometric analysis of Bitcoin literature. The outcomes of this related work focused on specific areas in cryptocurrency, including cryptocurrencies and cryptocurrency market introduction, cryptocurrency systems/platforms, Bitcoin literature review, etc. To the best of our knowledge, no previous work has provided a comprehensive survey particularly focused on cryptocurrency Swing trading. In a nutshell, the paper makes the following contributions into:

Definition. This paper defines cryptocurrency trading, and classifications it into: cryptocurrency markets, cryptocurrency trading models, and cryptocurrency trading strategies. The focal content of this survey is trading techniques for cryptocurrencies while we include all aspects of it.

Multidisciplinary Survey. The paper provides a comprehensive survey of 146 cryptocurrency trading publications, across different academic disciplines such as finance and economics, artificial intelligence and computer science. Some papers may cover multiple aspects and will be surveyed for each category.

Analysis. The paper analyses the research distribution, datasets, and trends that characterize the cryptocurrency trading literature. The paper identifies challenges and promising research directions in cryptocurrency trading, aimed to promote, and facilitate further research.

Cryptocurrency Trading

This segment provides an introductory aspect of cryptocurrency trading. We will delve into Blockchain, as the enabling technology, cryptocurrency markets, and cryptocurrency Localbitcoins (2020)

Swing Trading Strategies
Blockchain
Blockchain Technology Introduction

Blockchain is considered a digital ledger of economic transactions that can be used to keep records of not just financial transactions, but any object with an intrinsic value. [8]. It simply implies a series of immutable data records with timestamps, which are managed in a cluster of machines that do not belong to any single entity. Every one of these data blocks is safeguarded by cryptographic principle and bound to each other in a form chain.

Cryptocurrencies such as Bitcoin are conducted on a peer-to-peer network platform and composited structure. Each peer has an entire history of the total transactions, by this way; it records the balance of each account. For example, a transaction is a file that says "A pays X Bitcoins to B" that is signed by A using its private key. This is basic public-key cryptography, but also the sole foundation on which cryptocurrencies are based. After being signed, the transaction is broadcast on the network. When a peer discovers a new transaction, it checks to make sure that the signature is valid (this is equivalent to

using the signer's public key, denoted as the algorithm in Figure 3). If the verification is valid then the block is added to the chain; all other blocks added after it will "confirm" that transaction. For example, if a transaction is contained in block 502 and the length of the blockchain is 507 blocks, it means that the transaction has 5 confirmations (Johar, 2018).

From Blockchain to Cryptocurrencies

Confirmation is a crucial concept in cryptocurrencies; only miners can validate transactions. Miners add blocks to the Blockchain; they retrieve transactions in the previous block and combine it with the hash of the preceding block to obtain its hash, and then store the derived hash into the current block. Miners in Blockchain accept transactions, mark them as legitimate and broadcast them across the network. After the miner confirms the transaction, each node must add it to its database. In layman's terms, it has become part of the Blockchain and miners undertake this work to obtain cryptocurrency tokens, such as Bitcoin. In contrast to Blockchain, cryptocurrencies are related to the use of tokens based on distributed ledger technology. Any transaction involving the purchase, sale, investment, etc. involves a Blockchain native token or sub-token. Blockchain is an avenue that drives cryptocurrency and is a technology that acts as a distributed ledger for the network. The network provides a means of transaction and gives room for the transfer of value and information. Cryptocurrencies are the tokens used in these networks to send value and pay for these transactions. They can be thought of as tools on the Blockchain, and in some cases can also function as resources or utilities. In other instances, they are used to digitize the value of assets. In a nutshell, cryptocurrencies are the complementary segment of an ecosystem based on Blockchain technology

Introduction of Cryptocurrency Market

Cryptocurrency is a decentralized avenue, media, or platform of exchange that uses cryptographic functions to run financial transactions. Cryptocurrencies leverage Blockchain technology to gain decentralization, transparency, and immutability. In the above, we have discussed how Blockchain technology is implemented for cryptocurrency.

In general, cryptocurrency security is built on cryptography, neither by people nor by trust. For example, Bitcoin uses a method called "Elliptic Curve Cryptography". To ensure that transactions involving Bitcoin are secure. Elliptic curve cryptography is a type of public-key cryptography that relies on mathematics to ensure the security of transactions. When someone attempts to mischievously circumvent the aforesaid security encryption scheme by brute force, it takes them up to 2 billion years to find a value match when trying 250 billion possibilities every second. Considering its use as a currency, cryptocurrency has a lot of similarities to fiat currencies. It has a controlled supply. Most cryptocurrencies curtail the availability of their currency volumes. E.g. for Bitcoin, the supply will decrease over time and will reach its final quantity sometime around 2,140. All cryptocurrencies have control over the supply of tokens through a timetable encoded in the Blockchain (Doran, 214).

One of the most important characteristics of cryptocurrencies is the exclusion of financial institution intermediaries. The absence of a "middleman" lowers transaction costs for traders. For comparison, if a bank's database is hacked or damaged, the bank will rely entirely on its backup to recover any information that is lost or compromised. With cryptocurrencies, even if part of the network is compromised, the rest will continue to be able to verify transactions correctly. Cryptocurrencies also have the important feature of not being controlled by any central authority: the decentralized nature of the Blockchain ensures cryptocurrencies are theoretically immune to government control and interference.

The real digital asset is anything that exists in a digital format and carries with it the right to use it. Currently, digital assets include digital documents, motion pictures, and so on; the market for digital assets has evolved since its inception in 2009, with the first digital asset "Bitcoin". For this reason, we call cryptocurrency the "first pure digital asset".

As of December 20, 2019, there were 4,950 cryptocurrencies and 20,325 cryptocurrency markets; the market cap is around 190 billion dollars. Figure 4 shows historical data on global market capitalization and 24-hour trading volume. The blue line represents the entire cryptocurrency market capitalization and the green/red histogram represents the total cryptocurrency market volume. The total market cap is calculated by aggregating the dollar market cap of all cryptocurrencies. From the figure, we can observe how cryptocurrencies experience exponential growth in 2017 and a large bubble burst in early 2018. In the wake of the pandemic, cryptocurrencies raised dramatically in value in 2020. In 2021, the market value of cryptocurrencies has been very volatile but consistently at historically high levels (Kaal, 2020)

The prominent cryptocurrencies Bitcoin (BTC), Ethereum (ETH), and Litecoin (LTC). Bitcoin was created in 2009 and garnered massive popularity. On October 31, 2008, an individual or group of individuals operating under the pseudonym Satoshi Nakamoto released the Bitcoin white paper and described it as: "A purely peer-to-peer version of electronic cash that can be sent online for payment from one party to another without going through a counterparty, ie. a financial institution." Launched by Vitalik Buterin in 2015, Ethereum is a special Blockchain with a special token called Ether (ETH symbol in exchanges). A very important feature of Ethereum is the ability to create new tokens on the Ethereum Blockchain. The Ethereum network went live on July 30, 2015, and pre-mined 72 million Ethereum. Litecoin is a peer-to-peer cryptocurrency created by Charlie Lee. It was created according to the Bitcoin protocol, but it uses a different hashing algorithm. Litecoin uses a memory-intensive proof-of-work algorithm, Scrypt (TradingView, 2021)

Cryptocurrency Exchanges

A digital currency exchange or cryptocurrency exchange (DCE) is a financial that enables customers to carry out cryptocurrencies business. The exchange of cryptocurrencies can be market makers, usually using the bid-ask spread as a commission for services, or as a matching platform, by simply charging fees. A cryptocurrency exchange or digital currency exchange (DCE) is an avenue that provides an opportunity, for customers to trade cryptocurrencies. Cryptocurrency exchanges can be market makers (usually using the bid-ask spread as a commission for services) or a matching platform (simply charging fees).

Table 1 showcases the classical examples of cryptocurrency exchanges according to the rank list, by volume, compiled on the "comics" website. Chicago Mercantile Exchange (CME), Chicago Board Options Exchange (CBOE) as well as BAKKT (backed by New York Stock Exchange) are regulated cryptocurrency exchanges. Fiat currency data also comes from the "nomics" website. Regulatory authority and supported currencies of listed exchanges are collected from official websites or blogs (Nomics, 2020).

Table 1: Cryptocurrency Exchanges Lists

Exchanges	Category	Supported Currencies	Fiat Currency	Registration Country	Regulatory Authority
CME	Derivatives	BTC and Ethereum [24]	USD	USA [25]	CFTC [26]
CBOE	Derivatives	BTC [27]	USD	USA [28]	CFTC [29]
BAKKT	Derivatives	BTC [30]	USD USD	USA [31]	CFTC [30]
(NYSE)	Derivatives	12 cryptocurrencies [32]	USD	USA[28]	CFTC[26]
BitMex	Sport	98 cryptocurrencies [34]	USD	USA[31]	CFTC[29]
Binance	Sport	28 cryptocurrencies [37]	EUR,NG	Seychelles[33]	.
Coinbase	Sport	>100crytocurrencies[4]	NRUB.TR Y,EUR,G	Malta[35]	FATF[30]
Bitfinex	Sport	5 cryptocurrencies [43]	BP,USD,E UR,GBP,J	USA[38]	SEC [29]
Bistamp	Sport	23 cryptpcurren yicies[46]	PY,USD, EUR,UD USD	BritshVirginIsla nd[1] Luxembourg[44] USA	NYAG[42] CSSF[45] .
Poloniex					

Source: Field Survey (2023)

Cryptocurrency Trading

Cryptocurrency trading is the act of buying and selling of cryptocurrencies with the intention to make profit. The definition of cryptocurrency trading can be split into three aspects namely: object, operation mode and trading strategy. The object of cryptocurrency trading is the asset being traded, which is "cryptocurrency". The operation mode of cryptocurrency trading depends on the means of transaction in the cryptocurrency market, which can be classified into "trading of cryptocurrency Contract for Differences (CFD)" (The contract between the two parties, often referred to as the "buyer" and "seller", stipulates that the buyer will pay the seller the difference between themselves when the position closes and "buying and selling cryptocurrencies via an exchange". A trading strategy in cryptocurrency trading, formulated by an investor, is an algorithm that defines a set of predefined rules to buy and sell on cryptocurrency markets(Authority,2019).

Advantages of Trading Cryptocurrency

The benefits of cryptocurrency trading include:

Drastic Fluctuations: The volatility of cryptocurrencies are often likely to attract speculative interest and investors. The rapid fluctuations of intraday prices can provide traders with great money-earning opportunities, but they also include more risk.

24-hour Market: The cryptocurrency market is available 24 hours a day, 7 days a week because it is a decentralized market. Unlike buying and selling stocks and commodities, the cryptocurrency market is not traded physically from a single location. Cryptocurrency transactions can take place between individuals, in different venues across the world.

Near Anonymity; Buying goods and services using cryptocurrencies is done online and does not require making one's own identity public. With increasing concerns over identity theft and privacy, cryptocurrencies can thus provide users with some advantages regarding privacy. Different exchanges have specific Know-Your-Customer (KYC) measures for identifying users or customers. The KYC undertaken in the exchanges allows financial institutions to reduce financial risk while maximizing the wallet owner's anonymity (Adeyanju, 2019).

Peer-to-Peer Transactions; One of the biggest benefits of cryptocurrencies is that they do not involve financial institution intermediaries. As mentioned above, this can reduce transaction costs. Moreover, this feature might appeal to users who distrust traditional systems. Over-the-counter (OTC) cryptocurrency markets offer, in this context, peer-to-peer transactions on the Blockchain. The most famous cryptocurrency OTC market is "LocalBitcoin.".

Programmable "smart" Capabilities; Some cryptocurrencies can bring other benefits to holders, including limited ownership and voting rights. Cryptocurrencies may also include a partial ownership interest in physical assets such as artwork or real estate (Wohlin, 2014).

Disadvantages of Swing Trading Cryptocurrency

The disadvantages of cryptocurrency trading include:

Scalability Problem; Before the massive expansion of the technology infrastructure, the number of transactions and the speed of transactions cannot compete with traditional currency trading. Scalability issues led to a multi-day trading backlog in March 2020, affecting traders looking to move cryptocurrencies from their wallets to exchanges.

Cybersecurity Issues; As a digital technology, cryptocurrencies are subject to cyber security breaches and can fall into the hands of hackers. Recently, over $600 million of Ethereum and other cryptocurrencies were stolen in August 2021 in the blockchain-based platform Poly Network [51]. Mitigating this situation requires ongoing maintenance of the security infrastructure and the use of enhanced cyber security measures that go beyond those used in traditional banking.

Regulations; Authorities all over the globe face critical and challenging questions about the nature and regulation of cryptocurrency as some parts of the system and its related risks are largely unknown. Currently, there are three types of regulatory and governing systems used to control digital currencies,

they include: a closed system for the Chinese market, an open and liberal for the Swiss market, and open and strict system for the United State market.

Cryptocurrency; As once said by Buffe (2017) "It doesn't make sense. This thing is not regulated. It's not under control. It's not under the supervision of United States Federal Reserve or any other central bank" (Buffe, 2017).

Cryptocurrency Swing Trading Strategies

Cryptocurrency trading strategy and techniques is the theme on which this survey mainly focuses. There are many trading strategies, which can conventionally be divided into two: technical and fundamental. Technical and fundamental trading are two main trading analysis thoughts when it comes to analyzing the financial markets. Most of those who trade cryptocurrencies use these two analysis methods both. From a survey on stock prediction, we know that 66% of the related research work was based on technical analysis; while 23% and 11% were based on fundamental analysis and general analysis, respectively. Cryptocurrency trading has the capacity draw on the experience of stock market trading in most scenarios. So we categorize trading strategies into two main categories: technical and fundamental trading (Calo & Johnson, 2002)

Cryptocurrency Swing Trading Software System

Software Swing trading systems give room for international transactions and process customer accounts, and information, which lead to the acceptance and execution of the transaction orders. A cryptocurrency trading system is a set of principles and procedures that are pre-programmed to enable trade between cryptocurrencies and between fiat currencies and cryptocurrencies. Cryptocurrency trading systems are built to overcome price manipulation, cybercriminal activities and transaction delays. When creating a cryptocurrency trading system, capital market, base asset, investment plan, and strategies must be considered. Strategies are the most important part of an effective cryptocurrency trading system, and they will be introduced below. There exist several cryptocurrency trading systems that are available commercially, for example, Capfolio, 3Commas, CCXT, Freqtrade and Ctubio. From these cryptocurrency trading systems, professional trading strategy support, fairness and transparency are obtainable by investors from professional third-party consulting companies and fast customer services (Gerritsen, et al. 2019)

Systematic Trading is a way to comprehensively outline and define trading goals, risk management controls and rules. Generally, systematic trading encompasses high frequency trading, and slower investment types like systematic trend tracking. In this survey, systematic cryptocurrency trading is categorized into technical analysis, pairs trading and others. In cryptocurrency trading, technical analysis refers to the act of using historical patterns of transaction data to assist a trader in assessing current and projecting future market conditions for the purpose to make profitable trades. Price and volume charts summarize all trading activity made by market participants in an exchange and affect their decisions. Some experiments showed that the use of specific technical trading rules allows for generating excess returns, which is useful to cryptocurrency traders and investors in making optimal trading and investment decisions. Systematic trading strategy signifies pairs trading that consider two similar assets with slightly different spreads. If the spread widens, short the high cryptocurrencies and buy the low cryptocurrencies. When the spread narrows again to a certain equilibrium value, a profit is generated. The papers shown in this section involve the analysis and comparison of technical indicators, pairs, and informed trading, amongst other strategies (Kajtazi & Moro, 2019)

Portfolio Research

Diversification of investments to maximize returns for a given level of risk by allocating assets strategically is advocated by portfolio theory. A prominent example of this approach is the celebrated mean-variance optimization. Generally, a crypto asset denotes a digital asset (i.e., cryptocurrencies and derivatives). There are some common ways to build a diversified portfolio in crypto assets. The first

method is to diversify across markets, which is to mix a wide variety of investments within a portfolio of the cryptocurrency market.

Considering the industry sector is the second method, which is to avoid investing too much money in any one category. A diversified investment of a portfolio in the cryptocurrency market includes a portfolio across cryptocurrencies and portfolio across the global market including stocks and futures (Liu, 2019)

Paper Collections and Review Schema

The section introduces the scope and approach of our paper collection, a basic analysis, and the structure of our survey.

Survey Scope

The Bottom-up approach to the research in cryptocurrency trading is what we adopt, starting from the systems up to risk management techniques. For the underlying trading system, the focus is on the optimization of the trading platform structure and improvements in computer science technologies.

At an apex, researchers focus on the design of models to predict return or volatility in trade in real cryptocurrency markets. Bubbles and extreme conditions are hot topics in cryptocurrency trading because, as discussed above, these markets have shown to be highly volatile (whilst volatility went down after crashes). Effective methods to control risk are Portfolio and cryptocurrency asset management. We group these two areas in risk management research. Other papers included in this survey include topics like pricing rules, dynamic market analysis, regulatory implications, and so on. Table 3 shows the general scope of cryptocurrency trading included in this survey.

Since many trading strategies and methods in cryptocurrency trading are closely related to stock trading, some researchers migrate or use the research results for the latter to the former. When conducting this research, those papers whose research focuses on cryptocurrency markets or a comparison of trading in those and other financial markets are the ones that can only be considered.

Specifically, we apply the following criteria when collecting papers related to cryptocurrency

1. The paper introduces or discusses the general idea of cryptocurrency trading, or one of the related aspects of cryptocurrency trading.
2. The paper proposes an approach, study or framework that targets optimized efficiency or accuracy of cryptocurrency trading.
3. The paper compares different approaches or perspectives in trading cryptocurrency.

Table 2: Paper query results. #Hits, #Title, and #Body denote the number of papers returned by the search, left after title filtering, and left after body filtering, respectively.

Key Words #Body	#Hits		#Hits
[Crypto] + Swing Trading	612	60	41
[Crypto] + Swing Trading System	4	3	2
[Crypto] + Prediction	40	20	18
[Crypto] + Swing Trading Strategy	23	10	9
[Crypto] + Risk Management / [Crypto] + Portfolio	128	20	16
Query	-	-	86
Snowball	-	-	60
Overall	-	-	146

Source: Field Survey (2023)

Paper Collection Methodology

We use keyword searches on Google Scholar and arXiv, two of the most popular scientific databases to collect the papers in different areas or platforms We also choose other public repositories like SSRN but we find that almost all academic papers in these platforms can also be retrieved via Google Scholar; consequently, in our statistical analysis, we count those as Google Scholar hits. We choose arXiv as another source since it allows this survey to be contemporary with all the most recent findings in the area. The interested reader is warned that these papers have not undergone formal peer review. The keywords used for searching and collecting are listed below. [Crypto] means the cryptocurrency market, which is our research interest because methods might be different among different markets. We conducted 6 searches across the two repositories until February 2, 2022.

- [Crypto] + Swing Trading
- [Crypto] + Swing Trading system
- [Crypto] + Swing Trading Prediction
- [Crypto] + Swing Trading strategy
- [Crypto] + Risk Management
- [Crypto] + Portfolio

To ensure high coverage, we adopted the so-called **snowballing** method on each paper found through these keywords. We checked papers added from snowballing methods that satisfy the criteria introduced above until we reached closure.

Collection Results

The details of the results from our paper collection are shown in Table 2. Keyword searches and snowballing resulted in 146 papers across the six research areas of interest in Section 4.1.

Figure 7 shows the distribution of papers published at different research sites. Among all the papers, 48.63% papers are published in Finance and Economics venues, such as Journal of Financial Economics (JFE), Cambridge Centre for Alternative Finance (CCAF), Finance Research Letters, Centre for Economic Policy Research (CEPR), Finance Research Letters (FRL), Journal of Risk and Financial Management (JRFM) and some other high impact financial journals; 4.79% papers are published in Science venues such as Public Library Of Science one (PLOS one), Royal Society open science and SAGE; 14.38% papers are published in Intelligent Engineering and Data Mining venues, such as Symposium Series on Computational Intelligence (SSCI), Intelligent Systems Conference (IntelliSys), Intelligent Data Engineering and Automated Learning (IDEAL) and International Conference on Data Mining (ICDM); 4.79% papers are published in Physics / Physicians venues (mostly in Physics venue) such as Physica A and Maths venue like Journal of Mathematics; 10.96 papers are published in AI and complex system venues such as Complexity and International Federation for Information Processing (IFIP); 15.07% papers are published in Others venues which contains independently published papers and dissertations; 1.37% papers are published on arXiv. The distribution of different venues shows that cryptocurrency trading is mostly published in Finance and Economics venues, but with a wide diversity otherwise.

Survey Organization

The papers in our collection are organized and presented from six angles. We introduce the work of several different cryptocurrency trading software systems in Section 5. Section 6 introduces systematic trading applied to cryptocurrency trading. In Section 7, we introduce some emergent trading technologies including econometrics on cryptocurrencies, machine learning technologies, and other emergent trading technologies in the cryptocurrency market. Section 8 introduces research on cryptocurrency pairs and related factors and crypto-asset portfolio research. In Section 8.3 and Section 8.4, we discuss cryptocurrency market condition research, including bubbles, crash analysis, and extreme conditions. Section 9 introduces other research included in cryptocurrency trading not covered above. We would like to emphasize that the six headings above focus on a particular aspect of

cryptocurrency trading; we give a complete organization of the papers collected under each heading. This implies that those papers covering more than one aspect will be discussed in different sections, once from each angle.

Researches
Research among Cryptocurrency Pairs and Related Factors

Ji et al. (2019) examined connectedness via return and volatility spillovers across six large cryptocurrencies (collected from *coinmarketcap* lists from August 7 2015 to February 22, 2018) and found Litecoin and Bitcoin to have the most effect on other cryptocurrencies. The authors followed the methods of Diebold et al. (218) and built positive/negative returns and volatility connectedness networks. Furthermore, the regression model is used to identify drivers of various cryptocurrency integration levels. Further analysis revealed that the relationship between each cryptocurrency in terms of return and volatility is not necessarily due to its market size. Adjepong, et al. (2019) explored market coherence and volatility causal linkages of seven leading cryptocurrencies. Wavelet-based methods are used to examine market connectedness. Parametric and nonparametric tests are employed to investigate the directions of volatility spillovers of the assets. Experiments revealed diversification benefits to linkages of connectedness and volatility in cryptocurrency markets. Elie, et al. (2005) found the presence of jumps was detected in a series of 12 cryptocurrency returns, and significant jumping activity was found in all cases.

The importance of the jump in trading volume for the formation of cryptocurrency leapfrogging has been underscored by more results. The correlation of daily exchange rate fluctuations within a basket of the 100 highest market capitalization cryptocurrencies for the period October 1, 2015, to March 31, 2019, has been examined by Stanislaw, et al (2019). The corresponding dynamics mainly involve one of the leading eigenvalues of the correlation matrix, while the others are mainly consistent with the eigenvalues of the Wishart random matrix. The study shows that Bitcoin (BTC) was dominant during the period under consideration, signaling exchange rate dynamics at least as influential as the US dollar (USD).

Some researchers investigated the relationship between cryptocurrency and different factors, including futures, gold, etc. Hale et al. suggested that Bitcoin prices rise and go down rapidly after CME issues futures consistent with pricing dynamics. Specifically, the authors described that the rapid rise and subsequent decline in prices after the introduction of futures is consistent with trading behavior in the cryptocurrency market. The Werner et al. focused on the asymmetric interrelationships between major currencies and cryptocurrencies. The results of vast fractal asymmetric de-trending cross-correlation analysis show evidence of significant persistence and asymmetric multiplicity in the cross-correlation between most cryptocurrency pairs and ETF pairs. Bai et al. studied a trading algorithm for foreign exchange on a cryptocurrency, Market using the Automated Triangular Arbitrage method. Implementing a pricing strategy, implementing trading algorithms and developing a given trading simulation are three problems solved by this research. Kang et al. examined the hedging and diversification properties of gold futures versus Bitcoin prices by using dynamic conditional correlations (DCCs) and wavelet coherence.

DCCGARCH model is used to estimate the time-varying correlation between Bitcoin and gold futures by modeling the variance and the co-variance but also these two flexibility. The Wavelet coherence method focused more on co-movement between Bitcoin and gold futures. From experiments, the wavelet coherence results indicated volatility persistence, causality and phase difference between Bitcoin and gold. Qiao, et al (2020) used wavelet coherence and relevance networks to investigate synergistic motion between Bitcoin and other cryptocurrencies. The authors then tested the hedging effect of Bitcoin on others at different time frequencies by risk reduction and downside risk reduction. The empirical results provide evidence of linkage and hedging effects. Bitcoin's returns and volatility are ahead of other cryptocurrencies at low frequencies from the analysis, and in the long run, Bitcoin has a more pronounced hedging effect on other cryptocurrencies. Dyhrberg, et al (2016) applied the GARCH

model and the exponential GARCH model in analyzing similarities between Bitcoin, gold, and the US dollar. The experiments showed that Bitcoin, gold, and the US dollar have similarities with the variables of the GARCH model, have similar hedging capabilities, and react symmetrically to good and bad news.

The authors observed that Bitcoin can combine some advantages of commodities and currencies in financial markets to be a tool for portfolio management.

The research of Dyhrberg, et al.(2016) has been taken further by Baur et al. extended the same data and sample periods are tested with GARCH and EGARCH-(1,1) models but the experiments reached different conclusions. It has been found by Baur, et al.(2018) that Bitcoin's has unique risk-return characteristics compared with other assets. They noticed that Bitcoins excess returns and volatility resemble a rather highly speculative asset concerning to gold or the US dollar. Bouri, et al (2019). made a comparative analysis between Bitcoin and energy commodities by applying DCCs and GARCH (1,1) models. In particular, the results showed that Bitcoin is a strong hedge and haven for energy commodities. Kakushadze (2018) proposed factor models for the cross-section of daily crypto asset returns, and provided source code for data downloads, computing risk factors and back testing for all cryptocurrencies and a host of various other digital assets. The results showed that cross-sectional statistical arbitrage trading may be possible for crypto assets subject to efficient executions and shorting. Beneki, et al. (2019) tested hedging abilities between Bitcoin and Ethereum by a multivariate BEKK-GARCH methodology and impulse response analysis within the VAR model.

The results showed a volatility transaction from Ethereum to Bitcoin, which implied probably profitable trading techniques on the cryptocurrency derivatives market. Guglielmo, et al (2020).examined the weak effect in cryptocurrency markets, and explored the feasibility of this indicator in trading practice. Student t-test, ANOVA, Kruskal–Wallis and Mann–Whitney tests were carried out for cryptocurrency data to compare periods that may be characterized by anomalies with other periods. When an anomaly is detected, an algorithm was established to exploit profit opportunities (MetaTrader terminal in MQL4 is mentioned in this research). The results showed evidence anomaly (abnormal positive returns on Mondays) in the Bitcoin market by backtesting in 2013-2016.

Several of special research methods have proven to be relevant to cryptocurrency pairs, which are reflected in cryptocurrency trading. Delfabbro et al. showed that cryptocurrency trading has similarities to gambling as almost all the decisions made in trading crypto currency are often based on limited information, short-term profit motives, and highly volatile and uncertain and unpredictable outcomes. The authors examined whether gambling, and problem gambling are reliable predictors of reported cryptocurrency trading strength. Results showed that problem gambling scores (PGSI) and engaging in stock trading were significantly correlated with measures of cryptocurrency trading intensity based on time spent per day, number of trades and level of expenditure.

As the research has been taken further, Delfabbro, et al.(2021) reviewed the specific structural features of cryptocurrency trading and its potential to give rise to excessive or harmful behavior, including overspending, and compulsive checking. Several similarities are recognized between online sports betting, and day trading, but there are also some important differences. These include the 24/7 nature of trading, the global nature of the market and the powerful role of social media, social influences and non-balance sheet-related events as determinants of price movement. Cheng et al. investigated whether the economic policy uncertainty (EPU) index provided by Baker et al. can predict the returns of cryptocurrencies. The results suggest that China's EPU Index can predict monthly returns for Bitcoin, whereas the EPU Index for the US or other Asian countries has no predictive power. In addition, China's ban on cryptocurrency trading only affects bitcoin returns among major cryptocurrencies.

Crypto-Asset Portfolio Research

Many researchers applied portfolio theory to crypto assets. Corbe,t et al. (2018)carried out a systematic analysis of cryptocurrencies as financial assets. Brauneis et al. applied the Markowitz mean-variance framework in order to assess the risk-return benefits of cryptocurrency portfolios. In an out-of-

sample analysis accounting for transaction cost, they found that combining cryptocurrencies enriches the set of 'low'-risk cryptocurrency investment opportunities. In terms of the Sharpe ratio and certainty equivalent returns, the 1/N -portfolio (i.e., "naive" strategies, such as equally dividing amongst asset classes) outperformed single cryptocurrencies and more than 75% in terms of the Sharpe ratio and certainty equivalent returns of mean-variance optimal portfolios. Castro et al. produced a portfolio optimization model based on the Omega measure which is more comprehensive than the Markowitz model and applied this to four crypto-asset investment portfolios through a numerical application. Several experiments and analysis showed crypto-assets improves the return of the portfolios, but on the other hand, also increase the risk exposure.

The diversification capabilities of Bitcoin for a global portfolio spread across six asset classes from the standpoint of investors dealing in five major fiat currencies, namely the US Dollar, Great Britain Pound, Euro, Japanese Yen and Chinese Yuan have been examined and thoroughly analyzed by scholars.

They employed modified Conditional Value-at-Risk and standard deviation as measures of risk to perform portfolio optimizations across three asset allocation strategies and provided insights into the sharp disparity in Bitcoin trading volumes across national currencies from a portfolio theory perspective.

Research of this kind has been done by Antipova, et al (2019)., which explored the possibility of establishing and optimizing a global portfolio by diversifying investments using one or more cryptocurrencies, and assessing returns to investors in terms of risk, and returns. Fantazzini, et al (2020). proposed a set of models that can be used to estimate the market risk for a portfolio of crypto-currencies, and simultaneously estimate their credit risk using the Zero Price Probability (ZPP) model. The results revealed the superiority of the t-copula/skewed-t GARCH model for market risk, and the ZPP-based models for credit risk. Qiang, et al (2020). examined the common dynamics of Bitcoin exchanges. Using connectivity metric based on the actual daily volatility of the Bitcoin price, they found that Coinbase is undoubtedly the market leader, while Binance's performance is surprisingly weak. The results also suggested that safer asset extraction is more important for volatility linkages between Bitcoin exchanges relative to trading volumes. Fasanya et al. quantitatively assessed returns and volatility transmission between cryptocurrency portfolios by using a spillover approach and rolling sample analysis. The results indicated that there is a significant difference between the behavior of cryptocurrency portfolio returns and the volatility spillover index over time. Given the spillover index, the authors found evidence of interdependence between cryptocurrency portfolios, with the spillover index showing an increased degree of integration between cryptocurrency portfolios.

Conclusion

A comprehensive overview and analysis of the research work on cryptocurrency trading have been provided as well as a nomenclature of the definitions and current state of the art. The paper provides a comprehensive survey of 146 cryptocurrency trading papers and analyses the research distribution that characterizes the cryptocurrency trading literature. Research distribution among properties and categories/technologies are analyzed in this survey respectively. We further summarized the datasets used for experiments and analyzed the research trends and opportunities in cryptocurrencies trading. Future research directions and opportunities are discussed in Section 11.

It is hoped that this survey will be beneficial to academics (e.g., finance researchers) and quantitative traders alike. The survey represents an instant and easy way to get familiar with the literature on all cryptocurrency trading and its related business and can motivate more researchers to contribute to the pressing problems in the area, for example, along the lines so far identified herein.

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