



# FinTech HO2020 Project

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# Document Information

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TITLE	Repository of research consortium papers (BC)
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# 1

## Repository of Blockchain research papers

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The University of Pavia and the University of Paris I Pantheon-Sorbonne, with the support of all the project partners, has developed the repository of papers related to blockchain. The repository all research papers outputted regarding blockchain. The material has been developed by individual partners and by collaborations from within the consortium. The papers have been presented at various academic conferences and have been published in Open Access Journals or have been archived by the authors to maintain an open access copy in an Open Access Repository e.g. Arxiv, SSRN.

Specifically, the final repository contains the following information about the papers.

- Title
- Authors
- Abstract
- Partners
- Journal
- Date
- Link (doi for open access articles and also SSRN for those not open access)

The papers are sorted by publication date.

## Title

Using High-Frequency Entropy to Forecast Bitcoin's Daily Value at Risk

## Authors

Daniel Traian Pele and Miruna Mazurencu-Marinescu-Pele

## Abstract

In this paper we investigate the ability of several econometrical models to forecast value at risk for a sample of daily time series of cryptocurrency returns. Using high frequency data for Bitcoin, we estimate the entropy of intraday distribution of logreturns through the symbolic time series analysis (STSA), producing low-resolution data from high-resolution data. Our results show that entropy has a strong explanatory power for the quantiles of the distribution of the daily returns. Based on Christoffersen's tests for Value at Risk (VaR) backtesting, we can conclude that the VaR forecast build upon the entropy of intraday returns is the best, compared to the forecasts provided by the classical GARCH models.

## Partners

- Bucharest University

## Journal

Entropy

## Date of Publication

22 January 2019

## Link

<https://doi.org/10.3390/e21020102>

## Title

A probative value for authentication use case blockchain

## Authors

Dominique Guégan & Christophe Henot

## Abstract

The Fintech industry has facilitated the development of companies using blockchain technology. The use of this technology inside banking system and industry opens the route to several questions regarding the business activity, legal environment, and insurance devices. In this paper, considering the creation of small companies interested to develop their business with a public blockchain, we analyse from different aspects why a company (in banking or insurance system, and industry) decides that a blockchain protocol is more legitimate than another one for the business which it wants to develop looking at the legal (in case of dispute) points of view. We associate with each blockchain a probative value which permits to assure in case of dispute that a transaction has been really done. We illustrate our proposal using 13 blockchains providing in that case a ranking between these blockchains for their use in business environment. We associate with this probative value some main characteristics of any blockchain as market capitalization and log-return volatilities that the investors need to also take into account with the new probative value for their managerial strategy.

## Partners

- University of Paris 1

## Journal

Digital Finance

## Date of Publication

12 April 2019

## Link

<https://doi.org/10.1007/s42521-019-00003-0>

## Title

Metcalfe's law and log-period power laws in the cryptocurrencies market

## Authors

Daniel Traian Pele and Miruna Mazurencu-Marinescu-Pele

## Abstract

In this paper the authors investigate the statistical properties of some cryptocurrencies by using three layers of analysis: alpha-stable distributions, Metcalfe's law and the bubble behaviour through the LPPL modelling. The results show, in the medium to long-run, the validity of Metcalfe's law (the value of a network is proportional to the square of the number of connected users of the system) for the evaluation of cryptocurrencies; however, in the short-run, the validity of Metcalfe's law for Bitcoin is questionable. According to the bidirectional causality between the price and the network size, the expected price increase is a driver for more investors to join the Bitcoin network, which may lead in the end to a super-exponential price growth, possibly due to a herding behaviour of investors. The authors then used LPPL models to capture the behaviour of cryptocurrencies exchange rates during an endogenous bubble and to predict the most probable time of the regime switching. The main conclusion of this paper is that Metcalfe's law may be valid in the long-run, however in the short-run, on various data regimes, its validity is highly debatable

## Partners

- Bucharest University

## Journal

Economics

## Date of Publication

May 15, 2019

## Link

<https://doi.org/10.5018/economics-ejournal.ja.2019-29>

## Title

Can Cryptocurrencies Preserve Privacy and Comply With Regulations?

## Authors

Geoff Goodell and Tomaso Aste

## Abstract

Cryptocurrencies offer an alternative to traditional methods of electronic value exchange, promising anonymous, cash-like electronic transfers, but in practice they fall short for several key reasons. We consider the false choice between total surveillance, as represented by banking as currently implemented by institutions, and impenetrable lawlessness, as represented by privacy-enhancing cryptocurrencies as currently deployed. We identify a range of alternatives between those two extremes, and we consider two potential compromise approaches that offer both the auditability required for regulators and the anonymity required for users.

## Partners

- University College London

## Journal

Frontiers in Blockchain

## Date of Publication

28 May 2019

## Link

<https://doi.org/10.3389/fbloc.2019.00004>

## Title

Momentum and contrarian effects on the cryptocurrency market

## Authors

Krzysztof Kosc, Paweł Sakowski, Robert Ślepaczuk

## Abstract

We report the results of investigation of the momentum and contrarian effects on cryptocurrency markets. The investigated investment strategies involve 100 (amongst over 1200 present as of date Nov 2017) cryptocurrencies with the largest market cap and average 14-day daily volume exceeding a given threshold value. Investment portfolios are constructed using different assumptions regarding the portfolio reallocation period, width of the ranking window, the number of cryptocurrencies in the portfolio, and the percent transaction costs. The performance is benchmarked against: (1) equally weighted and (2) market-cap weighted investments in all of the ranked assets, as well as against the buy and hold strategies based on (3) S&P500 index, and (4) Bitcoin price. Our results show a clear and significant dominance of the short-term contrarian effect over both momentum effect and the benchmark portfolios. The information ratio coefficient for the contrarian strategies often exceeds two-digit values depending on the assumed reallocation period and the width of the ranking window. Additionally, we observe a significant diversification potential for all cryptocurrency portfolios with relation to the S&P500 index.

## Partners

- University of Warsaw

## Journal

Physica A: Statistical Mechanics and its Applications

## Date of Publication

1 June 2019

## Link

<https://doi.org/10.1016/j.physa.2019.02.057>



## Title

Data Management for Platform-Mediated Public Services: Challenges and Best Practices

## Authors

Agnieszka Rychwalska, Geoffrey Goodell, Magda Roszczynska-Kurasinska

## Abstract

Data harvesting and profiling have become a de facto business model for many businesses in the digital economy. The surveillance of individual persons through their use of private sector platforms has a well-understood effect on personal autonomy and democratic institutions. In this article, we explore the consequences of implementing data-rich services in the public sector and specifically the dangers inherent to undermining the universality of the reach of public services, the implicit endorsement of the platform operators by government, and the inability of members of the public to avoid using the platforms in practice. We propose a set of good practices in the form of design principles that infrastructure services can adopt to mitigate the risks, and we specify a set of design primitives that can be used to support the development of infrastructure that follows the principles. We argue that providers of public infrastructure should adopt a practice of critical assessment of the consequences of their technology choices.

## Partners

- University College London
- University of Warsaw

## Journal

Surveillance & Society

## Date of Publication

17 Sep 2019

## Link

<http://dx.doi.org/10.2139/ssrn.3455123>

## Title

High Frequency Price Change Spillovers in Bitcoin Markets

## Authors

Paolo Giudici and Paolo Pagnottoni

## Abstract

The study of connectedness is key to assess spillover effects and identify lead-lag relationships among market exchanges trading the same asset. By means of an extension of Diebold and Yilmaz (2012) econometric connectedness measures, we examined the relationships of five major Bitcoin exchange platforms during two periods of main interest: the 2017 surge in prices and the 2018 decline. We concluded that Bitfinex and Gemini are leading exchanges in terms of return spillover transmission during the analyzed time-frame, while Bittrex acts as a follower. We also found that connectedness of overall returns fell substantially right before the Bitcoin price hype, whereas it leveled out during the period the down market period. We confirmed that the results are robust with regards to the modeling strategies.

## Partners

- University of Pavia

## Journal

Risks

## Date of Publication

1 November 2019

## Link

<https://doi.org/10.3390/risks7040111>

# Title

A Decentralized Digital Identity Architecture

# Authors

Geoff Goodell and Tomaso Aste

# Abstract

Current architectures to validate, certify, and manage identity are based on centralized, top-down approaches that rely on trusted authorities and third-party operators. We approach the problem of digital identity starting from a human rights perspective, with a primary focus on identity systems in the developed world. We assert that individual persons must be allowed to manage their personal information in a multitude of different ways in different contexts and that to do so, each individual must be able to create multiple unrelated identities. Therefore, we first define a set of fundamental constraints that digital identity systems must satisfy to preserve and promote privacy as required for individual autonomy. With these constraints in mind, we then propose a decentralized, standards-based approach, using a combination of distributed ledger technology and thoughtful regulation, to facilitate many-to-many relationships among providers of key services. Our proposal for digital identity differs from others in its approach to trust in that we do not seek to bind credentials to each other or to a mutually trusted authority to achieve strong non-transferability. Because the system does not implicitly encourage its users to maintain a single aggregated identity that can potentially be constrained or reconstructed against their interests, individuals and organizations are free to embrace the system and share in its benefits.

# Partners

- University College London

# Journal

Frontiers in Blockchain

# Date of Publication

05 November 2019

## Link

<https://doi.org/10.3389/fbloc.2019.00017>

## Title

Editorial on the Special Issue on Cryptocurrencies

## Authors

Jörg Osterrieder & Andrea Barletta

## Extract

Computer science has created the economic world that von Hayek (1976) envisioned, with de-nationalized and independent money creation. At the same time, crypto-currencies operate in a fundamentally different way. They require no trust in a central bank, other national authorities, or in private financial institutions. Trust derives from mathematical algorithms, and the blockchain technology ensures consensus on each electronic transaction in a purely peer-to-peer network. Private digital currencies revive the ideas of the “Chicago Plan” and pose novel challenges for policy makers.

Moreover, like all new technologies, money by cryptographic convention comes with risks. In markets for traditional nominal claims, much is known about their risks: not so in the markets for cryptos. There, market participants face huge challenges due to the uncertainty about the statistical features of crypto prices. The joint presence of several hundred crypto-currencies intensifies the problem: Due to the low cost of launching, a multitude of different blockchain-based currencies has been introduced, with varying degrees of technological innovation and financial success.

## Partners

- Zurich University of Applied Sciences

## Journal

Digital Finance

## Date of Publication

08 November 2019

## Link

<https://doi.org/10.1007/s42521-019-00015-w>

## Title

Lead Behaviour in Bitcoin Markets

## Authors

Ying Chen, Paolo Giudici, Branka Hadji Misheva and Simon Trimborn

## Abstract

We aim to understand the dynamics of Bitcoin blockchain trading volumes and, specifically, how different trading groups, in different geographic areas, interact with each other. To achieve this aim, we propose an extended Vector Autoregressive model, aimed at explaining the evolution of trading volumes, both in time and in space. The extension is based on network models, which improve pure autoregressive models, introducing a contemporaneous contagion component that describes contagion effects between trading volumes. Our empirical findings show that transactions activities in bitcoins is dominated by groups of network participants in Europe and in the United States, consistent with the expectation that market interactions primarily take place in developed economies.

## Partners

- University of Pavia
- Zurich University of Applied Sciences

## Journal

Risks

## Date of Publication

4 January 2020

## Link

<https://doi.org/10.3390/risks8010004>

## Title

Analysing Social Media Forums to Discover Potential Causes of Phasic Shifts in Cryptocurrency Price Series

## Authors

Andrew Burnie, Emine Yilmaz and Tomaso Aste

## Abstract

The recent extreme volatility in cryptocurrency prices occurred in the setting of popular social media forums devoted to the discussion of cryptocurrencies. We develop a framework that discovers potential causes of phasic shifts in the price movement captured by social media discussions. This draws on principles developed in healthcare epidemiology where, similarly, only observational data are available. Such causes may have a major, one-off effect, or recurring effects on the trend in the price series. We find a one-off effect of regulatory bans on bitcoin, the repeated effects of rival innovations on ether and the influence of technical traders, captured through discussion of market price, on both cryptocurrencies. The results for Bitcoin differ from Ethereum, which is consistent with the observed differences in the timing of the highest price and the price phases. This framework could be applied to a wide range of cryptocurrency price series where there exists a relevant social media text source. Identified causes with a recurring effect may have value in predictive modelling, whilst one-off causes may provide insight into unpredictable black swan events that can have a major impact on a system.

## Partners

- University College London

## Journal

Frontiers in Blockchain

## Date of Publication

28 January 2020

## Link

<https://doi.org/10.3389/fbloc.2020.00001>

## Title

Explainability of a Machine Learning Granting Scoring Model in Peer-to-Peer Lending

## Authors

Miller Janny Ariza-Garzón; Javier Arroyo; Antonio Caparrini; Maria-Jesus Segovia-Vargas

## Abstract

Peer-to-peer (P2P) lending demands effective and explainable credit risk models. Typical machine learning algorithms offer high prediction performance, but most of them lack explanatory power. However, this deficiency can be solved with the help of the explainability tools proposed in the last few years, such as the SHAP values. In this work, we assess the well-known logistic regression model and several machine learning algorithms for granting scoring in P2P lending. The comparison reveals that the machine learning alternative is superior in terms of not only classification performance but also explainability. More precisely, the SHAP values reveal that machine learning algorithms can reflect dispersion, nonlinearity and structural breaks in the relationships between each feature and the target variable. Our results demonstrate that it is possible to have machine learning credit scoring models be both accurate and transparent. Such models provide the trust that the industry, regulators and end-users demand in P2P lending and may lead to a wider adoption of machine learning in this and other risk assessment applications where explainability is required.

## Partners

- Universidad Complutense de Madrid

## Journal

IEEE

## Date of Publication

30 March 2020

## Link

<https://doi.org/10.1109/ACCESS.2020.2984412>



# Title

A Statistical Classification of Cryptocurrencies

# Authors

Daniel Traian Pele, Niels Wesselhöfft, Wolfgang K. Härdle, Michalis Kolossiatis, Yannis G. Yatracos

# Abstract

The aim of this paper is to derive the main factors that separate cryptocurrencies from the classical assets, by using various classification techniques applied to the daily time series of log-returns. In this sense, a daily time series of asset returns (either cryptocurrencies or classical assets) can be characterized by a multidimensional vector with statistical components like variance, skewness, kurtosis, tail probability, quantiles, conditional tail expectation or GARCH parameters. By using dimension reduction techniques (Factor Analysis) and classification models (Binary Logistic Regression, Discriminant Analysis, Support Vector Machines, K-means clustering, Variance Components Split methods) for a representative sample of cryptocurrencies, stocks, exchange rates and commodities, we are able to classify cryptocurrencies as a new asset class with unique features in the tails of the log-returns distribution. The main result of our paper is the complete separation of the cryptocurrencies from the other type of assets, by using the Maximum Variance Components Split method. In addition, we observe a synchronicity in the evolution of the cryptocurrencies, compared to the classical assets, mainly due to the tails behaviour of the log-return distribution.

# Partners

- Bucharest University

# Journal

Journal of Empirical Finance

# Date of Publication

30 Mar 2020

## Link

SSRN:<http://dx.doi.org/10.2139/ssrn.3548462>

## Title

Initial Coin Offerings: Risk or Opportunity?

## Authors

Anca Mirela Toma and Paola Cerchiello

## Abstract

Initial coin offerings (ICOs) are one of the several by-products in the world of the cryptocurrencies. Start-ups and existing businesses are turning to alternative sources of capital as opposed to classical channels like banks or venture capitalists. They can offer the inner value of their business by selling “tokens,” i.e., units of the chosen cryptocurrency, like a regular firm would do by means of an IPO. The investors, of course, hope for an increase in the value of the token in the short term, provided a solid and valid business idea typically described by the ICO issuers in a white paper. However, fraudulent activities perpetrated by unscrupulous actors are frequent and it would be crucial to highlight in advance clear signs of illegal money raising. In this paper, we employ statistical approaches to detect what characteristics of ICOs are significantly related to fraudulent behavior. We leverage a number of different variables like: entrepreneurial skills, Telegram chats, and relative sentiment for each ICO, type of business, issuing country, team characteristics. Through logistic regression, multinomial logistic regression, and text analysis, we are able to shed light on the riskiest ICOs.

## Partners

- University of Pavia

## Journal

Frontiers in Artificial Intelligence

## Date of Publication

16 April 2020

## Link

<https://doi.org/10.3389/frai.2020.00018>

## Title

A hidden Markov model to detect regime changes in cryptoasset markets

## Authors

Paolo Giudici, Iman Abu Hashish

## Abstract

The objective of this work is to understand the dynamics of cryptocurrency prices. Specifically, how prices switch between different regimes, going from “bull” to “stable” and “bear” times. For this purpose, we propose a hidden Markov model that aims at explaining the evolution of Bitcoin prices through different, unobserved states. The implementation of the proposed model includes a likelihood ratio test that allows to compare models with different states and with different covariance structures. Our empirical findings show that the time movements of Bitcoin prices across different exchange markets are well-described by the proposed model. In particular, a parsimonious model with a diagonal covariance matrix leads to better predictions, compared with a model with a full covariance matrix.

## Partners

- University of Pavia

## Journal

Quality and Reliability Engineering International

## Date of Publication

04 June 2020

## Link

<https://doi.org/10.1002/qre.2673>

## Title

Fin vs. tech: are trust and knowledge creation key ingredients in fintech start-up emergence and financing?

## Authors

Theodor Florian Cojoianu, Gordon L. Clark, Andreas G. F. Hoepner, Vladimir Pažitka & Dariusz Wójcik

## Abstract

We investigate how the emergence of fintech start-ups and their financing is shaped by regional knowledge creation and lack of trust in financial services incumbents across 21 OECD countries, 226 regions and over the 2007–2014 period. We find that knowledge generated in the IT sector is much more salient for fostering new fintech start-ups than knowledge generated in the financial services sector. Additionally, the importance of new knowledge created in the financial services sector (IT sector) increases (decreases) as fintech start-ups grow and seek financing. When the level of trust in financial services incumbents falls within a region, this is followed by an increase in the financing provided to fintech start-ups. Nevertheless, regions with historically low average levels of trust in financial services incumbents attract less fintech investment overall.

## Partners

- University College Dublin

## Journal

Small Business Economics

## Date of Publication

13 June 2020

## Link

<https://doi.org/10.1007/s11187-020-00367-3>

## Title

Vector error correction models to measure connectedness of Bitcoin exchange markets

## Authors

Paolo Giudici, Paolo Pagnottoni

## Abstract

Bitcoins are traded on various exchange platforms and, therefore, prices may differ across trading venues. We aim to investigate return connectedness across eight of the major exchanges of Bitcoin, both from a static and a dynamic viewpoint. To this end, we employ an extension of the order-invariant forecast error variance decomposition proposed by Diebold and Yilmaz (2012) to a generalized vector error correction framework. Our results suggest that there is strong connectedness among the exchanges, as expected, although some of them behave dissimilarly. We identify Bitfinex and Coinbase as leading exchanges during the considered period, while Kraken as a follower exchange. We also obtain that connectedness across exchanges is strongly dynamic, as it evolves over time.

## Partners

- University of Pavia

## Journal

Applied Stochastic models in Business and Industry

## Date of Publication

25 July 2019

## Link

<https://doi.org/10.1002/asmb.2478>

## Title

Rise of the machines? Intraday high-frequency trading patterns of cryptocurrencies

## Authors

Alla A. Petukhina, Raphael C. G. Reule & Wolfgang Karl Härdle

## Abstract

This research analyses high-frequency data of the cryptocurrency market in regards to intraday trading patterns related to algorithmic trading and its impact on the European cryptocurrency market. We study trading quantitatives such as returns, traded volumes, volatility periodicity, and provide summary statistics of return correlations to CRIX (CRyptocurrency IndeX), as well as respective overall high-frequency based market statistics with respect to temporal aspects. Our results provide mandatory insight into a market, where the grand scale employment of automated trading algorithms and the extremely rapid execution of trades might seem to be a standard based on media reports. Our findings on intraday momentum of trading patterns lead to a new quantitative view on approaching the predictability of economic value in this new digital market.

## Partners

- Humboldt-Universität zu Berlin

## Journal

The European Journal of Finance

## Date of Publication

27 July 2020

## Link

<https://doi.org/10.1080/1351847X.2020.1789684>

# Title

Fostering Customer Bargaining and E-Procurement Through a Decentralised Marketplace on the Blockchain

# Authors

João Martins; Manuel Parente; Mário Amorim-Lopes; Luís Amaral; Gonçalo Figueira; Pedro Rocha; Pedro Amorim

# Abstract

Firms have available many forms of collaboration, including cooperatives or joint ventures, in this way leveraging their market power. Customers, however, are atomic agents with few mechanisms for collaborating, leading to an unbalanced buyer-supplier relationship and economic surpluses that shift to producers. Some group buying websites helped alleviate the problem by offering bulk discounts, but more advancements can be made with the emergence of technologies, such as the blockchain. In this article, we propose a customer-push e-marketplace built on top of Ethereum, where customers can aggregate their proposals, and suppliers try to outcompete each other in reverse auction bids to fulfil the order. Furthermore, smart contracts make it possible to automate many operational activities, such as payment escrows/release upon delivery confirmation, increasing the efficiency along the supply chain. The implementation of this network is expected to improve market efficiency by reducing transaction costs, time delays, and information asymmetry. Furthermore, concepts such as increased bargaining power and economies of scale, and their effects in buyer-supplier relationships, are also explored.

# Partners

- INESC-TEC

# Journal

IEEE

# Date of Publication

21 September 2020



## Link

<https://doi.org/10.1109/TEM.2020.3021242>

## Title

The Cost of Bitcoin Mining Has Never Really Increased

## Authors

Yo-Der Song and Tomaso Aste

## Abstract

The Bitcoin network is burning a large amount of energy for mining. In this paper, we estimate the lower bound for the global mining energy cost for a period of 10 years from 2010 to 2020, taking into account changes in energy costs, improvements in hashing technologies and hashing activity. We estimate energy cost for Bitcoin mining using two methods: Brent Crude oil prices as a global standard and regional industrial electricity prices weighted by the share of hashing activity. Despite a 10-billion-fold increase in hashing activity and a 10-million-fold increase in total energy consumption, we find the cost relative to the volume of transactions has not increased nor decreased since 2010. This is consistent with the perspective that, in order to keep the Blockchain system secure from double spending attacks, the proof of work must cost a sizable fraction of the value that can be transferred through the network. We estimate that in the Bitcoin network this fraction is of the order of 1%.

## Partners

- University College London

## Journal

Frontiers in Blockchain

## Date of Publication

22 October 2020

## Link

<https://doi.org/10.3389/fbloc.2020.565497>

## Title

Cyber risk ordering with rank-based statistical models

## Authors

Paolo Giudici & Emanuela Raffinetti

## Abstract

In a world that is increasingly connected on-line, cyber risks become critical. Cyber risk management is very difficult, as cyber loss data are typically not disclosed. To mitigate the reputational risks associated with their disclosure, loss data may be collected in terms of ordered severity levels. However, to date, there are no risk models for ordinal cyber data. We fill the gap, proposing a rank-based statistical model aimed at predicting the severity levels of cyber risks. The application of our approach to a real-world case shows that the proposed models are, while statistically sound, simple to implement and interpret.

## Partners

- University of Pavia

## Journal

AStA Advances in Statistical Analysis

## Date of Publication

09 December 2020

## Link

<https://doi.org/10.1007/s10182-020-00387-0>

## Title

Libra or Librae? Basket based stablecoins to mitigate foreign exchange volatility spillovers

## Authors

Paolo Giudici, Thomas Leach, Paolo Pagnotoni

## Abstract

The paper aims to assess, from an empirical viewpoint, the advantages of a stablecoin whose value is derived from a basket of underlying currencies, against a stablecoin which is pegged to the value of one major currency, such as the dollar. To this aim, we first find the optimal weights of the currencies that can comprise our basket. We then employ volatility spillover decomposition methods to understand which foreign currency mostly drives the others. We then look at how the stability of either stablecoin is affected by currency shocks by means of spillover networks built on VAR models. Our empirical findings show that our basket based stablecoin is less volatile than all single currencies. This result is fundamental for policy making, and especially for emerging markets with a high level of remittances: a Librae (basket based stablecoin) can preserve their value during turbulent times better than a Libra (single currency based stablecoin).

## Partners

- University of Pavia

## Journal

Finance Research Letters

## Date of Publication

8 April 2021

## Link

<https://doi.org/10.1016/j.fr1.2021.102054>

## Title

Key Roles of Crypto-Exchanges in Generating Arbitrage Opportunities

## Authors

Audrius Kabašinskas and Kristina Šutienė

## Abstract

The evolving crypto-currency market is seen as dynamic, segmented, and inefficient, coupled with a lack of regulatory oversight, which together becomes conducive to observing the arbitrage. In this context, a crypto-network is designed using bid/ask data among 20 crypto-exchanges over a 2-year period. The graph theory technique is employed to describe the network and, more importantly, to determine the key roles of crypto-exchanges in generating arbitrage opportunities by estimating relevant network centrality measures. Based on the proposed arbitrage ratio, Gatecoin, Coinfloor, and Bit-sane are estimated as the best exchanges to initiate arbitrage, while EXMO and DSX are the best places to close it. Furthermore, by means of canonical correlation analysis, we revealed that higher volatility and the decreasing price of dominating crypto-currencies and CRIX index signal bring about a more likely arbitrage appearance in the market. The findings of research include pre-tax and after-tax arbitrage opportunities.

## Partners

- Kaunas University of Technology

## Journal

Entropy

## Date of Publication

12 April 2021

## Link

<https://doi.org/10.3390/e23040455>

# Title

Investing with cryptocurrencies – evaluating their potential for portfolio allocation strategies

# Authors

Alla Petukhina, Simon Trimborn, Wolfgang Karl Härdle & Hermann Elendner

# Abstract

Cryptocurrencies (CCs) have risen rapidly in market capitalization over the past years. Despite striking volatility, their high average returns and low correlations have established CCs as alternative investment assets for portfolio and risk management. We investigate the benefits of adding CCs to well-diversified portfolios of conventional financial assets for different types of investors, including risk-averse, return-maximizing and diversification-seeking investors who may trade at different frequencies, namely, daily, weekly or monthly. We calculate out-of-sample performance and diversification benefits for the most popular portfolio-construction rules, including mean-variance optimization, risk-parity, and maximum-diversification strategies, as well as combined strategies. Our results demonstrate that CCs can improve the risk-return profile of portfolios, but their benefit depends on investor objectives. In particular, diversification strategies (maximizing the portfolio diversification index or equating risk contributions) draw appreciably on CCs and show, in line with spanning tests, CCs to be non-redundant extensions of the investment universe. However, when we introduce liquidity constraints via the LI-BRO method to account for illiquidity of many CCs, out-of-sample performance drops considerably, while the diversification benefits persist. We conclude that the utility of CC investments strongly depends on investor characteristics.

# Partners

- Humboldt-Universität zu Berlin

# Journal

Quantitative Finance

# Date of Publication

13 April 2021

## Link

<https://doi.org/10.1080/14697688.2021.1880023>

## Title

Analysis of the cryptocurrency market applying different prototype-based clustering techniques

## Authors

Luis Lorenzo; Javier Arroyo

## Abstract

Since the appearance of Bitcoin, cryptocurrencies have experienced enormous growth not only in terms of capitalization but also in number. As a result, the cryptocurrency market can be an attractive arena for investors as it offers many possibilities, but a difficult one to understand as well. In this work, we aim to summarize and segment the whole cryptocurrency market in 2018 with the help of data analysis tools. We will use three different partitional clustering algorithms each of them using a different representation for cryptocurrencies, namely: yearly mean and standard deviation of the returns, distribution of returns, and time series of returns. Since each representation will provide a different and complementary perspective of the market, we will also explore the combination of the three clustering results to obtain a fine-grained analysis of the main trends of the market. Finally, we will analyze the association of the clustering results with other descriptive features of the cryptocurrencies, including the age, technological attributes, and financial ratios derived from them. This will help to enhance the profiling of the clusters with additional insights. As a result, this work offers a description of the market and a methodology that can be reproduced by investors that want to understand the main trends on the market.

## Partners

- Universidad Complutense de Madrid

## Journal

Financial Innovation

## Date of Publication

Forthcoming

## Link

Preprint:<https://eprints.ucm.es/id/eprint/63821/>



## Title

Some aspects of regulatory optimisations in the financial sector

## Authors

Stefan Vachkov, Nedyalko Valkanov

## Abstract

Since the appearance of Bitcoin, cryptocurrencies have experienced enormous growth not only in terms of capitalization but also in number. As a result, the cryptocurrency market can be an attractive arena for investors as it offers many possibilities, but a difficult one to understand as well. In this work, we aim to summarize and segment the whole cryptocurrency market in 2018 with the help of data analysis tools. We will use three different partitional clustering algorithms each of them using a different representation for cryptocurrencies, namely: yearly mean and standard deviation of the returns, distribution of returns, and time series of returns. Since each representation will provide a different and complementary perspective of the market, we will also explore the combination of the three clustering results to obtain a fine-grained analysis of the main trends of the market. Finally, we will analyze the association of the clustering results with other descriptive features of the cryptocurrencies, including the age, technological attributes, and financial ratios derived from them. This will help to enhance the profiling of the clusters with additional insights. As a result, this work offers a description of the market and a methodology that can be reproduced by investors that want to understand the main trends on the market.

## Partners

- University of Economics Varna

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