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Repository of papers in blockchain

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The papers have been presented at various academic conferences and have been published in Open Access Journals or have been archived by the authors to maintain an open access copy in an Open Access Repository e.g. Arxiv, SSRN.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)

Highlights

Financial technology (FinTech) solutions that employ the Blockchain are spreading rapidly, particularly in payment tools such as crypto coins and stable coins, which are also being used as financial assets. While the application of the Blockchain to payments may reduce transaction fees and improve financial inclusion, it may also increase operational risks, such as cyber risk and fraud risk, and increase financial risks, when coins are used as financial assets, in consideration of their high volatility.

The measurement of the additional types of risk that derive from the application of the blockchain are of key interest to regulators and supervisors. The EU-funded FINTECH has developed research aimed at measuring this risk. Seventeen papers have been selected for inclusion in the project's Blockchain research repository; six of them have been selected as use cases to be shared with regulators, supervisors, banks and fintechs. Among them, the paper "Initial Coin Offerings: risk or opportunity" has received the best feedback.

The main contribution of the paper is the proposition of a methodology based on natural language processing, sentiment analysis and regression models, aimed at understanding from telegram chats and other web based information which initial coin offerings are likely to be fraudolent. The use case and the feedback from the project's stakeholder reveal that the proposed method is, both predictively accurate and interpretable. It can thus be suggested as a standard risk measurement practice to measure risks deriving from the application of the blockchain to finance. Another possible standard is suggested from another paper in the repository which shows how to measure cyber risk, in the realistic situation of data available only at the ordinal level, for non disclosure issues.

The impact of the blockchain on financial services much depends on its regulation, which is evolving and, therefore, determine changes in research priorities. For this reason the papers in the blockchain repository cover different topics. The most investigated one concerns the measurement of financial risk that derives from considering crypto coins as assets and, in particular, the measurement of the contagion risk between coin prices (two papers) or between exchange markets (three papers). Another important stream of research has concerned the impact of news and sentiment on crypto prices (three papers). A different paper proposes a classification model to understand whether crypto coins can indeed be considered as alternative assets. Two papers have considered how to build optimal portfolio allocations for crypto coins considered as financial assets. Another one suggests the construction of a stable coin based on a basket of currencies, based on similar portfolio allocation considerations. While most papers deal with the application of the blockchain to crypto coins, three are more general and concern the operations of a blockchain. One paper estimates the duration of bitcoin mining, putting it in relation with the cost of energy. Other two papers consider the topic of designing a blockchain application that respects privacy and preserves digital identity.

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

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 Bittrexs act 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

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

Crypto price discovery through correlation networks

Authors

Paolo Giudici, Gloria Polinesi

Abstract

We aim to understand the dynamics of crypto asset prices and, specifically, how price information is transmitted among different bitcoin market exchanges, and between bitcoin markets and traditional ones. To this aim, we hierarchically cluster bitcoin prices from different exchanges, as well as classic assets, by enriching the correlation based minimum spanning tree method with a preliminary filtering method based on the random matrix approach. Our main empirical findings are that: (i) bitcoin exchange prices are positively related with each other and, among them, the largest exchanges, such as Bitstamp, drive the prices; (ii) bitcoin exchange prices are not affected by classic asset prices, but their volatilities are, with a negative and lagged effect.

Partners

- University of Pavia

Journal

Annals of Operations Research

Date of Publication

29 May 2019

Link

https://doi.org/10.1007/s10479-019-03282-3

Title

Cryptocurrency market structure: connecting emotions and economics

Authors

Tomaso Aste

Abstract

I study the dependency and causality structure of the cryptocurrency market investigating collective movements of both prices and social sentiment related to almost two thousand cryptocurrencies traded during the first six months of 2018. This is the first study of the whole cryptocurrency market structure. It introduces several rigorous innovative methodologies applicable to this and to several other complex systems where a large number of variables interact in a non-linear way, which is a distinctive feature of the digital economy. The analysis of the dependency structure reveals that prices are significantly correlated with sentiment. The major, most capitalised cryptocurrencies, such as bitcoin, have a central role in the price correlation network but only a marginal role in the sentiment network and in the network describing the interactions between the two. The study of the causality structure reveals a causality network that is consistently related with the correlation structures and shows that both prices cause sentiment and sentiment cause prices across currencies with the latter being stronger in size but smaller in number of significative interactions. Overall this study uncovers a complex and rich structure of interrelations where prices and sentiment influence each other both instantaneously and with lead–lag causal relations. A major finding is that minor currencies, with small capitalisation, play a crucial role in shaping the overall dependency and causality structure. Despite the high level of noise and the short time-series I verified that these networks are significant with all links statistically validated and with a structural organisation consistently reproduced across all networks.

Partners

- University College London

Journal

Digital Finance

Date of Publication

24 April 2019

Link

https://doi.org/10.1007/s42521-019-00008-9

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

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

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

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 or 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 Pagnottoni

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 turbolent 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.frl.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 Bitsane 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 LIBRO 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

Information-theoretic measures for nonlinear causality detection: application to social media sentiment and cryptocurrency prices

Authors

Z. Keskin and T. Aste

Abstract

Information transfer between time series is calculated using the asymmetric information-theoretic measure known as transfer entropy. Geweke's autoregressive formulation of Granger causality is used to compute linear transfer entropy, and Schreiber's general, non-parametric, information-theoretic formulation is used to quantify nonlinear transfer entropy. We first validate these measures against synthetic data. Then we apply these measures to detect statistical causality between social sentiment changes and cryptocurrency returns. We validate results by performing permutation tests by shuffling the time series, and calculate the Z-score. We also investigate different approaches for partitioning in non-parametric density estimation which can improve the significance. Using these techniques on sentiment and price data over a 48-month period to August 2018, for four major cryptocurrencies, namely bitcoin (BTC), ripple (XRP), litecoin (LTC) and ethereum (ETH), we detect significant information transfer, on hourly timescales, with greater net information transfer from sentiment to price for XRP and LTC, and instead from price to sentiment for BTC and ETH. We report the scale of nonlinear statistical causality to be an order of magnitude larger than the linear case.

Partners

- University College London

Journal

Royal Society Open Science

Date of Publication

16 September 2020

Link

https://doi.org/10.1098/rsos.200863

Title

Are cryptos becoming alternative assets?

Authors

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

Abstract

This research provides insights for the separation of cryptocurrencies from other assets. Using dimensionality reduction techniques, we show that most of the variation among cryptocurrencies, stocks, exchange rates, commodities, bonds, and real estate indexes can be explained by the tail, memory and moment factors of their log-returns. By applying various classification methods, cryptocurrencies are categorized as a separate asset class, mainly due to the tail factor. The main result is the complete separation of cryptocurrencies from the other asset types, using the Maximum Variance Components Split method. Additionally, we show that cryptocurrencies tend to exhibit similar characteristics over time and become more distinguished from other asset classes (synchronic evolution).

Partners

- Humboldt University Berlin
- ASE Bucharest

Journal

The European Journal of Finance

Date of Publication

21 August 2021

Link

https://doi.org/10.1080/1351847X.2021.1960403

Title

Network Models to Enhance Automated Cryptocurrency Portfolio Management

Authors

Paolo Giudici, Gloria Polinesi, Paolo Pagnottoni

Abstract

The usage of cryptocurrencies, together with that of financial automated consultancy, is widely spreading in the last few years. However, automated consultancy services are not yet exploiting the potentiality of this nascent market, which represents a class of innovative financial products that can be proposed by robo-advisors. For this reason, we propose a novel approach to build efficient portfolio allocation strategies involving volatile financial instruments, such as cryptocurrencies. In other words, we develop an extension of the traditional Markowitz model which combines Random Matrix Theory and network measures, in order to achieve portfolio weights enhancing portfolios' risk-return profiles. The results show that overall our model overperforms several competing alternatives, maintaining a relatively low level of risk.

Partners

- University of Pavia

Journal

Artificial Intelligence in Finance

Date of Publication

24 April 2020

Link

https://doi.org/10.3389/frai.2020.00022

Annex - List of publications

Title	Authors	Journal	Keywords
Can Cryptocurrencies Preserve Privacy and Comply With Regulations?	Geoff Goodell, Tomaso Aste	Frontiers in Blockchain	Crypto assets, Privacy, Regulation
Lead Behaviour in Bitcoin Markets	Ying Chen, Paolo Giudici, Branka Hadji Misheva, Simon Trimborn	Risks	Crypto prices, Lead-lag models, Clustering
High Frequency Price Change Spillovers in Bitcoin Markets	Paolo Giudici, Paolo Pagnottoni	Risks	Crytpocurrency exchanges, High frequency prices, Spillover models
A Decentralised Digital Identity Architecture	Goodell Geoff; Aste Tomaso	Frontiers in Blockchain	Blockchain architecture, Privacy, digital identity
Cryptocurrency market structure: connecting emotions and economics	Tomaso Aste	Digital Finance	Cryptocurrency markets, Sentiment analysis, Behavioral economics
Crypto price discovery through correlation networks	Paolo Giudici, Gloria Polinesi	Annals of Operations Research	Crypto exchanges, Correlation network models, Clustering
Analysing Social Media Forums to Discover Potential Causes of Phasic Shifts in Cryptocurrency Price Series	Andrew Burnie, Emine Yilmaz, Tomaso Aste	Frontiers in Blockchain	Crypto prices, Sentiment analysis, Cryptocurrency markets
Initial Coin Offerings: Risk or Opportunity?	Anca Mirela Toma, Paola Cerchiello	Frontiers in Artificial Intelligence	Fraud risk, initial coin offerings, alternative funding
Are cryptos becoming alternative assets?	Pele, D.T., Wesselhöfft, N., Härdle, W.K., Kolossiatis, M., Yatracos, Y.	Journal of Empirical Finance	Crypto assets, classification models, factor models
Network Models to Enhance Automated Cryptocurrency Portfolio Management	Paolo Giudici, Paolo Pagnottoni, Gloria Polinesi	Frontiers in Artificial Intelligence	Crypto assets, portfolio allocation, Correlation network models
Information-theoretic measures for nonlinear causality detection: application to social media sentiment and cryptocurrency prices	Z. Keskin, Tomaso Aste	Royal Society Open Science	Crypto prices, Information theoretic models, sentiment analysis

Cyber risk ordering with rank-based statistical models	Paolo Giudici, Emanuela Raffinetti	AStA Advances in Statistical Analysis	Cyber risk, Ordinal models, Stochastic dominance
The Cost of Bitcoin Mining Has Never Really Increased	Yo-Der Song, Tomaso Aste	Frontiers in Blockchain	Bitcoin mining, energy costs, bitcoin pricing
Key Roles of Crypto-Exchanges in Generating Arbitrage Opportunities	Audrius Kabašinskas, Kristina Šutienė	Entropy	Crypto exchanges, arbitrage models, network models
Libra or Librae? Basket based stablecoins to mitigate foreign exchange volatility spillovers	Paolo Giudici, Thomas Leach, Paolo Pagnottoni	Finance Research Letters	Stable coins, Portfolio allocation, Basket based coins
Investing with cryptocurrencies – evaluating their potential for portfolio allocation strategies	Alla Petukhina, Simon Trimborn, Wolfgang Karl Härdle, Hermann Elendner	Quantitative Finance	Crypto assets, Portfolio allocation, Crypto indexes
Rise of the machines? Intraday high-frequency trading patterns of cryptocurrencies	Alla A. Petukhina, Raphael C. G. Reule, Wolfgang Karl Härdle	The European Journal of Finance	Algorithmic trading, High-frequency trading, volatility models