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Repository of BDA research papers

The University of Pavia and the Humboldt University of Berlin , with the support of all the project partners, has developed the repository of papers related to Big Data Analytics. The repository all research papers outputted regarding big data analytics. 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The papers have been presented at various academic conferences and have been published in Open Access Journals or have been archived by the authors to maintain an open access copy in an Open Access Repository e.g. Arxiv, SSRN.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

Fintech Risk Management: A Research Challenge for Artificial Intelligence in Finance

Authors

Paolo Giudici

Extract

The Financial Stability Board (2017b) defines FINancial TECHnology as "technologically enabled financial innovations that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions and on the provision of financial services."

While innovation in finance is not a new concept, the focus on technological innovations and its pace have increased significantly. Fintech solutions that make use of big data analytics, artificial intelligence and blockchain technologies are currently introduced at an unprecedented rate. These new technologies are changing the nature of the financial industry, creating many opportunities that offer a more inclusive access to financial services. The advantages notwithstanding, FinTech solutions leave the door open to many risks, that may hamper consumer protection and financial stability. Relevant examples of such risks are underestimation of creditworthiness, market risk uncompliance, fraud detection, and cyber-attacks. Indeed fintech risk management represent a central point of interest for regulatory authorities, and require research and development of novel measurements.

Partners

- University of Pavia

Journal

Frontiers in Artificial Intelligence

Data

27 November 2018

Link

https://doi.org/10.3389/frai.2018.00001

Title

Latent factor models for credit scoring in P2P systems

Authors

Daniel Felix Ahelegbey, Paolo Giudici and Branka Hadji-Misheva

Abstract

Peer-to-Peer (P2P) FinTech platforms allow cost reduction and service improvement in credit lending. However, these improvements may come at the price of a worse credit risk measurement, and this can hamper lenders and endanger the stability of a financial system. We approach the problem of credit risk for Peer-to-Peer (P2P) systems by presenting a latent factor-based classification technique to divide the population into major network communities in order to estimate a more efficient logistic model. Given a number of attributes that capture firm performances in a financial system, we adopt a latent position model which allow us to distinguish between communities of connected and not-connected firms based on the spatial position of the latent factors. We show through empirical illustration that incorporating the latent factor-based classification of firms is particularly suitable as it improves the predictive performance of P2P scoring models.

Partners

- University of Pavia

Journal

Physica A: Statistical Mechanics and its Applications

Data

10 February 2019

Link

https://doi.org/10.1016/j.physa.2019.01.130

Title

Spatial Regression Models to Improve P2P Credit Risk Management

Authors

Arianna Agosto, Paolo Giudici and Tom Leach

Abstract

Calabrese et al. (2017) have shown how binary spatial regression models can be exploited to measure contagion effects in credit risk arising from bank failures. To illustrate their methodology, the authors have employed the Bank for International Settlements' data on flows between country banking systems. Here we apply a binary spatial regression model to measure contagion effects arising from corporate failures. To derive interconnectedness measures, we use the World Input-Output Trade (WIOT) statistics between economic sectors. Our application is based on a sample of 1,185 Italian companies. We provide evidence of high levels of contagion risk, which increases the individual credit risk of each company.

Partners

- University of Pavia

Journal

Frontiers in Artificial Intelligence

Data

16 May 2019

Link

https://doi.org/10.3389/frai.2019.00006

Title

Network Based Scoring Models to Improve Credit Risk Management in Peer to Peer Lending Platforms

Authors

Paolo Giudici, Branka Hadji-Misheva and Alessandro Spelta

Abstract

Financial intermediation has changed extensively over the course of the last two decades. One of the most significant change has been the emergence of FinTech. In the context of credit services, fintech peer to peer lenders have introduced many opportunities, among which improved speed, better customer experience, and reduced costs. However, peer-to-peer lending platforms lead to higher risks, among which higher credit risk: not owned by the lenders, and systemic risks: due to the high interconnectedness among borrowers generated by the platform. This calls for new and more accurate credit risk models to protect consumers and preserve financial stability. In this paper we propose to enhance credit risk accuracy of peer-to-peer platforms by leveraging topological information embedded into similarity networks, derived from borrowers' financial information. Topological coefficients describing borrowers' importance and community structures are employed as additional explanatory variables, leading to an improved predictive performance of credit scoring models.

Partners

- University of Pavia
- Zurich University of Applied Sciences

Journal

Frontiers in Artificial Intelligence

Data

24 May 2019

Link

https://doi.org/10.3389/frai.2019.00003

Title

Factorial Network Models to Improve P2P Credit Risk Management

Authors

Daniel Felix Ahelegbey, Paolo Giudici and Branka Hadji-Misheva

Abstract

This paper investigates how to improve statistical-based credit scoring of SMEs involved in P2P lending. The methodology discussed in the paper is a factor network-based segmentation for credit score modeling. The approach first constructs a network of SMEs where links emerge from comovement of latent factors, which allows us to segment the heterogeneous population into clusters. We then build a credit score model for each cluster via lasso-type regularization logistic regression. We compare our approach with the conventional logistic model by analyzing the credit score of over 1,5000 SMEs engaged in P2P lending services across Europe. The result reveals that credit risk modeling using our network-based segmentation achieves higher predictive performance than the conventional model.

Partners

- University of Pavia
- Zurich University of Applied Sciences

Journal

Frontiers in Artificial Intelligence

Data

04 June 2019

Link

https://doi.org/10.3389/frai.2019.00008

Title

Network based credit risk models

Authors

Paolo Giudici, Branka Hadji-Misheva, Alessandro Spelta

Abstract

Peer-to-Peer lending platforms may lead to cost reduction, and to an improved user experience. These improvements may come at the price of inaccurate credit risk measurements, which can hamper lenders and endanger the stability of a financial system. In the article, we propose how to improve credit risk accuracy of peer to peer platforms and, specifically, of those who lend to small and medium enterprises. To achieve this goal, we propose to augment traditional credit scoring methods with "alternative data" that consist of centrality measures derived from similarity networks among borrowers, deduced from their financial ratios. Our empirical findings suggest that the proposed approach improves predictive accuracy as well as model explainability.

Partners

- University of Pavia
- Zurich University of Applied Sciences

Journal

Quality Engineering

Data

01 Nov 2019

Link

https://doi.org/10.1080/08982112.2019.1655159

Title

Editorial: AI and Financial Technology

Authors

Paolo Giudici, Ronald Hochreiter, Jörg Osterrieder, Jochen Papenbrock and Peter Schwendner

Extract

The Financial Stability Board defines FINancial TECHnology as "technologically enabled financial innovation that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions and the provision of financial services." While innovation in Finance is not a new concept, the focus on technological innovations and its pace have increased significantly. Fintech solutions that make use of Big Data analytics, Artificial Intelligence, and Blockchain technologies are currently introduced at an unprecedented rate. These new technologies are changing the nature of the financial industry, creating opportunities for Fintechs startups to offer more inclusive access to financial services. The advantages notwithstanding, Fintech solutions leave the door open for many challenges such as underestimation of creditworthiness, market volatility, cyber attacks, fraud and money laundering which represent central points of interest for regulators and supervisory bodies.

Partners

- University of Pavia
- WU Vienna
- Firamis

Journal

Frontiers in Artificial Intelligence

Data

15 November 2019

Link

https://doi.org/10.3389/frai.2019.00025

Title

Lorenz Model Selection

Authors

Paolo Giudici and Emanuela Raffinetti

Abstract

In the paper, we introduce novel model selection measures based on Lorenz zonoids which, differently from measures based on correlations, are based on a mutual notion of variability and are more robust to the presence of outlying observations. By means of Lorenz zonoids, which in the univariate case correspond to the Gini coefficient, the contribution of each explanatory variable to the predictive power of a linear model can be measured more accurately. Exploiting Lorenz zonoids, we develop a Marginal Gini Contribution measure that allows to measure the absolute explanatory power of any covariate, and a Partial Gini Contribution measure that allows to measure the additional contribution of a new covariate to an existing model.

Partners

- University of Pavia

Journal

Journal of Classification

Date of Publication

08 January 2020

Link

https://doi.org/10.1007/s00357-019-09358-w

Title

Tree networks to assess financial contagion

Authors

Arianna Agosto, Daniel Felix Ahelegbey, Paolo Giudici

Abstract

We propose a two-layered tree network model that decomposes financial contagion into a global component, composed of inter-country contagion effects, and a local component, made up of inter-institutional contagion channels. The model is effectively applied to a database containing time series of daily CDS spreads of major European financial institutions (banks and insurance companies), and reveals the importance of monitoring both channels to assess financial contagion. Our empirical application reveals evidence of a high inter-country and inter-institutional vulnerability at the onset of the global financial crisis in 2008 and during the sovereign crisis in 2011. The results identify France as central to the inter-country contagion in the Euro area during the financial crisis, while Italy dominates during the sovereign crisis. The application of the model to detect contagion between sectors of the European economy reveals similar findings, and identifies the manufacturing sector as the most central, while, at the company level, financial institutions dominate during the 2008 crisis.

Partners

- University of Pavia

Journal

Economic Modelling

Date of Publication

February 2020

Link

https://doi.org/10.1016/j.econmod.2019.11.005

Title

The Leaders, the Laggers, and the "Vulnerables"

Authors

Veni Arakelian, Shatha Qamhieh Hashem

Abstract

We examine the lead-lag effect between the large and the small capitalization financial institutions by constructing two global weekly rebalanced indices. We focus on the 10% of stocks that "survived" all the rebalancings by remaining constituents of the indices. We sort them according to their systemic importance using the marginal expected shortfall (MES), which measures the individual institutions' vulnerability over the market, the network based MES, which captures the vulnerability of the risks generated by institutions' interrelations, and the Bayesian network based MES, which takes into account different network structures among institutions' interrelations. We also check if the lead-lag effect holds in terms of systemic risk implying systemic risk transmission from the large to the small capitalization, concluding a mixed behavior compared to the index returns. Additionally, we find that all the systemic risk indicators increase their magnitude during the financial crisis

Partners

- Panteion University

Journal

Risks

Data

12 March 2020

Link

https://doi.org/10.3390/risks8010026

Title

On the Improvement of Default Forecast Through Textual Analysis

Authors

Paola Cerchiello and Roberta Scaramozzino

Abstract

Textual analysis is a widely used methodology in several research areas. In this paper we apply textual analysis to augment the conventional set of account defaults drivers with new text based variables. Through the employment of ad hoc dictionaries and distance measures we are able to classify each account transaction into qualitative macro-categories. The aim is to classify bank account users into different client profiles and verify whether they can act as effective predictors of default through supervised classification models.

Partners

- University of Pavia

Journal

Frontiers in Artificial Intelligence

Data

07 April 2020

Link

https://doi.org/10.3389/frai.2020.00016

Title

Using clustering ensemble to identify banking business models

Authors

Bernardo P. Marques, Carlos F. Alves

Abstract

The business models of banks are often seen as the result of a variety of simultaneously determined managerial choices, such as those regarding the types of activities, funding sources, level of diversification, and size. Moreover, owing to the fuzziness of data and the possibility that some banks may combine features of different business models, the use of hard clustering methods has often led to poorly identified business models. In this paper we propose a framework to deal with these challenges based on an ensemble of three unsupervised clustering methods to identify banking business models: fuzzy c-means (which allows us to handle fuzzy clustering), self-organizing maps (which yield intuitive visual representations of the clusters), and partitioning around medoids (which circumvents the presence of data outliers). We set up our analysis in the context of the European banking sector, which has seen its regulators increasingly focused on examining the business models of supervised entities in the aftermath of the twin financial crises. In our empirical application, we find evidence of four distinct banking business models and further distinguish between banks with a clearly defined business model (core banks) and others (non-core banks), as well as banks with a stable business model over time (persistent banks) and others (non-persistent banks). Our proposed framework performs well under several robustness checks related with the sample, clustering methods, and variables used.

Partners

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Journal

Intelligent Systems in Accounting, Finance and Management

Data

28 April 2020

Link

https://doi.org/10.1002/isaf.1471
SSRN: https://ssrn.com/abstract=3593311

Title

COVID-19 contagion and digital finance

Authors

Arianna Agosto & Paolo Giudici

Abstract

Digital finance is going to be heavily affected by the COVID-19 outbreak. We present a statistical model which can be employed to understand the contagion dynamics of the COVID-19, so that its impact on finance can possibly be anticipated, and digitally monitored. The model is a Poisson autoregression of the daily new observed cases, and considers both short-term and long-term dependence in the infections counts. Model results are presented for the observed time series of China, the first affected country, but can be easily reproduced for all countries.

Partners

- University of Pavia

Journal

Digital Finance

Date of Publication

11 May 2020

Link

https://doi.org/10.1007/s42521-020-00021-3

Title

Peer-to-peer loan acceptance and default prediction with artificial intelligence

Authors

J. D. Turiel and T. Aste

Abstract

Logistic regression (LR) and support vector machine algorithms, together with linear and nonlinear deep neural networks (DNNs), are applied to lending data in order to replicate lender acceptance of loans and predict the likelihood of default of issued loans. A two-phase model is proposed; the first phase predicts loan rejection, while the second one predicts default risk for approved loans. LR was found to be the best performer for the first phase, with test set recall macro score of 77.4%. DNNs were applied to the second phase only, where they achieved best performance, with test set recall score of 72%, for defaults. This shows that artificial intelligence can improve current credit risk models reducing the default risk of issued loans by as much as 70%. The models were also applied to loans taken for small businesses alone. The first phase of the model performs significantly better when trained on the whole dataset. Instead, the second phase performs significantly better when trained on the small business subset. This suggests a potential discrepancy between how these loans are screened and how they should be analysed in terms of default prediction.

Partners

- University College London

Journal

Royal Society Open Science

Date of Publication

10 June 2020

Link

https://doi.org/10.1098/rsos.191649

Title

Default count-based network models for credit contagion

Authors

Arianna Agosto Daniel Felix Ahelegbey

Abstract

Interconnectedness between economic institution and sectors, already recognised as a trigger of the great financial crisis in 2008–2009, is assuming growing importance in financial systems. In this article, we study contagion effects between corporate sectors using financial network models, in which the significant links are identified through conditional independence testing. While the existing financial network literature is mostly focused on Gaussian processes, our approach is based on discrete data. We indeed test dependence in the conditional mean (and volatility) of default counts in different economic sector estimated from Poisson autoregressive models, and in their shocks. Our empirical application to Italian corporate defaults in the 1996–2018 period reveals evidence of a high inter-sector vulnerability, especially at the onset of the global financial crisis in 2008 and in the following years. Many contagion effects between corporate sectors are indeed found in the shock component of the default count dynamics.

Partners

- University of Pavia

Journal

Journal of the Operational Research Society

Date of Publication

22 June 2020

Link

https://doi.org/10.1080/01605682.2020.1776169

Title

Financial contagion through space-time point processes

Authors

Giada Adelfio, Arianna Agosto, Marcello Chiodi, Paolo Giudici

Abstract

We propose to study the dynamics of financial contagion by means of a class of point process models employed in the modeling of seismic contagion. The proposal extends network models, recently introduced to model financial contagion, in a space-time point process perspective. The extension helps to improve the assessment of credit risk of an institution, taking into account contagion spillover effects.

Partners

- University of Pavia

Journal

Statistical Methods & Applications

Data

08 July 2020

Link

https://doi.org/10.1007/s10260-020-00538-2

Title

A Poisson Autoregressive Model to Understand COVID-19 Contagion Dynamics

Authors

Arianna Agosto and Paolo Giudici

Abstract

We present a statistical model which can be employed to understand the contagion dynamics of the COVID-19, which can heavily impact health, economics and finance. The model is a Poisson autoregression of the daily new observed cases, and can reveal whether contagion has a trend, and where is each country on that trend. Model results are exemplified from some observed series.

Partners

- University of Pavia

Journal

Risks

Date of Publication

16 July 2020

Link

https://doi.org/10.3390/risks8030077

Title

Monitoring Covid-19 Policy Interventions

Authors

Paolo Giudici and Emanuela Raffinetti

Abstract

A very key point in the process of the Covid-19 contagion control is the introduction of effective policy measures, whose results have to be continuously monitored through accurate statistical analysis. To this aim we propose an innovative statistical tool, based on the Gini-Lorenz concentration approach, which can reveal how well a country is doing in reducing the growth of contagion, and its speed.

Partners

- University of Pavia

Journal

Frontiers in Public Health

Date of Publication

26 August 2020

Link

https://doi.org/10.3389/fpubh.2020.00438

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

Information Network Modeling for U.S. Banking Systemic Risk

Authors

Giancarlo Nicola, Paola Cerchiello, and Tomaso Aste

Abstract

In this work we investigate whether information theory measures like mutual information and transfer entropy, extracted from a bank network, Granger cause financial stress indexes like LIBOR-OIS (London Interbank Offered Rate-Overnight Index Swap) spread, STLFSI (St. Louis Fed Financial Stress Index) and USD/CHF (USA Dollar/Swiss Franc) exchange rate. The information theory measures are extracted from a Gaussian Graphical Model constructed from daily stock time series of the top 74 listed US banks. The graphical model is calculated with a recently developed algorithm (LoGo) which provides very fast inference model that allows us to update the graphical model each market day. We therefore can generate daily time series of mutual information and transfer entropy for each bank of the network. The Granger causality between the bank related measures and the financial stress indexes is investigated with both standard Granger-causality and Partial Granger-causality conditioned on control measures representative of the general economy conditions.

Partners

- University of Pavia
- University College London

Journal

Entropy

Date of Publication

23 November 2020

Link

https://doi.org/10.3390/e22111331

Title

Network VAR models to measure financial contagion

Authors

Daniel Felix Ahelegbeya, Paolo Giudici, Shatha Qamhieh Hashem

Abstract

Financial contagion among countries can arise from different channels, the most important of which are financial markets and bank lending. The paper aims to build an econometric network approach to understand the extent to which contagion spillovers (from one country to another) aris from financial markets, from bank lending, or from both. To achieve this aim we consider a model specification strategy which combines Vector Autoregressive models with network models. The paper contributes to the contagion literature with a model that can consider bank exposures and financial market prices, jointly and not only separately. From an empirical viewpoint, our results show that both bilateral exposures and market prices act as contagion channels in the transmission of shocks arising from a country to other countries.

Partners

- University of Pavia

Journal

The North American Journal of Economics and Finance

Date of Publication

January 2021

Link

https://doi.org/10.1016/j.najef.2020.101318

Title

Comparing Performance of Machine Learning Algorithms for Default Risk Prediction in Peer to Peer Lending

Authors

Yanka Aleksandrova

Abstract

The purpose of this research is to evaluate several popular machine learning algorithms for credit scoring for peer to peer lending. The dataset to fit the models is extracted from the official site of Lending Club. Several models have been implemented, including single classifiers (logistic regression, decision tree, multilayer perceptron), homogeneous ensembles (XGBoost, GBM, Random Forest) and heterogeneous ensemble classifiers like Stacked Ensembles. Results show that ensemble classifiers outperform single ones with Stacked Ensemble and XGBoost being the leaders.

Partners

University of Economics - Varna

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Journal

TEM Journal

Date of Publication

16 February 2021

Link

https://doi.org/10.1016/j.najef.2020.101318

Title

Improvements in PD Models: A Case-Study Approach

Authors

Raluca Caplescu; Simona Cojocea; Daniel Traian Pele; Vasile Alecsandru Strat

Abstract

Logistic regression (LR) and support vector machine algorithms, together with linear and nonlinear deep neural networks (DNNs), are applied to lending data in order to replicate lender acceptance of loans and predict the likelihood of default of issued loans. A two-phase model is proposed; the first phase predicts loan rejection, while the second one predicts default risk for approved loans. LR was found to be the best performer for the first phase, with test set recall macro score of 77.4%. DNNs were applied to the second phase only, where they achieved best performance, with test set recall score of 72%, for defaults. This shows that artificial intelligence can improve current credit risk models reducing the default risk of issued loans by as much as 70%. The models were also applied to loans taken for small businesses alone. The first phase of the model performs significantly better when trained on the whole dataset. Instead, the second phase performs significantly better when trained on the small business subset. This suggests a potential discrepancy between how these loans are screened and how they should be analysed in terms of default prediction.

Partners

- The Bucharest University of Economic Studies

Journal

Proceedings of the 15th International Conference on Business Excellence 2021

Date of Publication

20 Aprol 2021

Link

`https://ssrn.com/abstract=3821829`

Title

Food Prices, Ethics and Forms of Speculation

Authors

Don Bredin; Valerio Potì; Enrique Salvador

Abstract

This paper examines the role of speculative motives in the determination of commodity prices and specifically food related commodity prices. The motivation for this study is the considerable flow of funds into commodities, the widespread view that the process of financialization has led to greater levels of speculation and that speculation is the primary cause of regular spikes in food prices since the turn of the century. We consider two forms of short-term trading, a biasing influence (Manipulators) and a correcting influence (Speculators), relative to the fundamental price. While both forms of short-term trading are relevant, they are small in terms of their influence on overall prices. We do however find some evidence of an increased role being played by Manipulators during the period most associated with financialization.

Partners

- University College Dublin

Journal

Journal of Business Ethics

Date of Publication

23 May 2021

Link

https://link.springer.com/article/10.1007/s10551-021-04842-z#Ack1

Title

Nonparametric Tests for Superior Predictive Ability

Authors

Stelios Arvanitis; Selcuk Karabati; Thierry Post; Valerio Potì

Abstract

A nonparametric method for comparing multiple forecast models is developed and implemented. The hypothesis of Optimal Predictive Ability generalizes the Superior Predictive Ability hypothesis from a single given loss function to an entire class of loss functions. Distinction is drawn between General Loss functions, Convex Loss functions and Symmetric Convex Loss functions. The research hypothesis is formulated in terms of moment inequality conditions. The empirical moment conditions are reduced to an exact and finite system of linear inequalities based on piecewise-linear loss functions. The hypothesis can be tested in a statistically consistent way using a blockwise Empirical Likelihood Ratio test statistic. A computationally feasible test procedure computes the test statistic using Convex Optimization methods, and estimates conservative, data-dependent critical values using a majorizing chi-square limit distribution and a moment selection method. An empirical application to inflation forecasting reveals that a very large majority of thousands of forecast models are redundant, leaving predominantly Phillips Curve type models, when convexity and symmetry are assumed.

Partners

- University College Dublin

Journal

International Journal of Forecasting

Date of Publication

April 2021

Link

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3251944

Title

Shall the winning last? A study of recent bubbles and persistence

Authors

Akanksha Jalana; Roman Matkovskyya; ValerioPotì

Abstract

In this study, we analyze stock market performance of 43 firms that show very large price rises in COVID-19 times for the period 21/11/2019 – 20/1/2021. These cover 6 industries - work-from-home companies, stay-at-home companies, Cryptocurrency companies, Bitcoin companies, Coronavirus Vaccine companies and Coronavirus therapeutics companies. Our results demonstrate the presence of bubbles and persistence patterns.

Partners

- University College Dublin

Journal

Financial Research Letters

Date of Publication

25 May 2021

Link

https://doi.org/10.1016/j.frl.2021.102162
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3800819