

## STSM REPORT: EXPLORING THE BITCOIN AND CRYPTOCURRENCIES NETWORKS

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**Host: Jörg Osterrieder<sup>2</sup>**

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*Dear Prof. Myers, it is my great pleasure to approve below report. It was a great honour to host Dr. Saralees Nadarajah at our university. It was a very intense week of work, we have accomplished far more than what we originally intended due to the hard work of everyone involved. We managed to finish a paper, which by now has made into several top ten lists of SSRN. Furthermore this paper was submitted to an academic journal, it was accepted and we are currently in the final stages of revising it before it gets published.*

*Jörg Osterrieder*

**Dated: April 21, 2017**

### **Background/ motivation for the visit**

Cryptocurrencies have captured the interests of academics, and those in industry (i.e. Bank of England). With a recent surge in interest in adapting cryptocurrencies for updating systems in industry, we believe that now is the time to start studying cryptocurrencies as key pieces of financial technology.

The Short- term scientific mission grant has supported my visit to see Dr. Jörg Osterrieder in the Institute of Data Analysis and Process Design at the Zurich University of Applied Sciences, Switzerland, for a period of one week in April 2017. During the stay, we collaborated, presented a talk at the regular institute seminar series (Zurich University of Applied Sciences), and conducted research on a joint project with Dr Jörg Osterrieder which involves modelling cryptocurrencies and extending its applications for the financial industry. The goal was to extend our research, write-up the results and submit them for publication in an academic journal. Furthermore, we wanted to deepen the industry collaborations that ZHAW already has and meet with the Fintech/banking industry to discuss our results and apply them in a practical setting. With this research visit, we also wanted to lay the ground-work for dissemination of the results at industrial mathematics conferences. Most prominently, we have the 2nd European COST Conference on Mathematics for Industry, being held in Switzerland in September 2017, in mind. We believe that our proposed work has a positive benefit for academics and the Cryptocurrency community (miners and industry).

### **Description of work undertaken during the visit and main results (if appropriate, include pictures)**

A summary of the activities undertaken during the visit include:

- We furthered our joint work in fitting parametric distributions and performing forecasts and predictions to cryptocurrencies (Bitcoin, Ripple, Litecoin, Monero, Dash, MaidSafeCoin, and Dogecoin) that represent 90% of the market capitalization. We finalised this work into a paper entitled “The Statistical Analysis of Cryptocurrencies” and submitted the paper to the Journal of Risk and Financial Management. The abstract

for the paper is “We show the statistical properties of the most important cryptocurrencies, of which Bitcoin is the most prominent example. We characterize their exchange rates versus the US Dollar by fitting parametric distributions to them. It is shown that returns are clearly non-normal, however, no single distribution fits well jointly to all the cryptocurrencies analysed. We find that for the most popular currencies, such as Bitcoin and Litecoin, the Generalized hyperbolic distribution gives the best fit, whilst for the smaller cryptocurrencies (determined by market capitalization) the Normal inverse Gaussian distribution, Generalized t distribution, and Laplace distributions give good fits. The results are important for investment and risk management purposes”. The following is a link to a copy of the submitted paper [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2948315](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2948315) .

- We presented a talk focusing on the statistical analysis and modelling of Bitcoin at the institute seminar series at the Zurich University of Applied Sciences (ZHAW University). It was attended by a wide range of industrial and academic professors in the faculty. The presentation provided a lot of useful discussions, networking and further research direction in which statistics and finance can be applied to assist in the development of cryptocurrencies.
- We attended the 2017 ZHAW International Day – evening event on the 3<sup>rd</sup> April, hosted by ZHAW University at the Casinotheater, Winterthur. The keynote speech of the evening was on the topic of “The Role of Philanthropy in Higher Education” which was given by Claudia Frittelli. Ms Frittelli is a Program Officer of Higher Education and Research in Africa in the International Program at Carnegie Corporation of New York. In her speech, she gave us an understanding of the historical context of philanthropy in higher education and presented some examples of impactful higher education philanthropists. A further focal point of her presentation was dedicated to the drivers and opportunities of international collaboration in the 21st century context. Finally, she shared with us her ideas on how and why ZHAW might consider philanthropic opportunities for international collaboration. The event provided us with time to network with other faculty members at ZHAW.
- Dr. Osterrieder had students who were undergoing their bachelor projects sponsored by financial institutions on creating shiny apps – a user friendly app created on R, which simplifies calculations and predictions on financial assets and products. The bachelor students provided us with a presentation illustrating how their app worked and can be used by financial institutions. This introduction of a shiny app was very beneficial as we thought of expanding our published R packages entitled “*VaRES*” (Computes Value at risk and expected shortfall, two most popular measures of financial risk, for over one hundred parametric distributions, including all commonly known distributions. Also computed are the corresponding probability density function and cumulative distribution function.) as a shiny app making it more user friendly and efficient for researchers and industry to use our R package. We are currently in the preliminary stages of developing the app.
- Finalised the outline and submission of a joint workshop grant with Dr Osterrieder on the theme “Mathematics for Industry”, with a focus on the growing area of blockchain and cryptocurrencies. This workshop is intended to be located next year at the University of Manchester, UK.
- We discussed with Professor Kickmaier Wolfgang, Head of International Relations at ZHAW and Professor Dirk Wilhelm about further collaboration on research and on student exchange programmes that can bridge and strengthen the network between the University of Manchester and ZHAW.
- Prepared some joint applications with Dr Osterrieder for funding our research in Cryptocurrencies and to strengthen our network with the Fintech sectors.

### **Plans for future collaboration.**

We plan to further strengthen our collaboration with Dr Osterrieder and ZHAW University by working on a new research idea through analysing the distribution of the Bitcoin network - distribution of degrees, transaction frequency, transaction sizes, costs, scalability, etc; and investigating fraudulent transactions

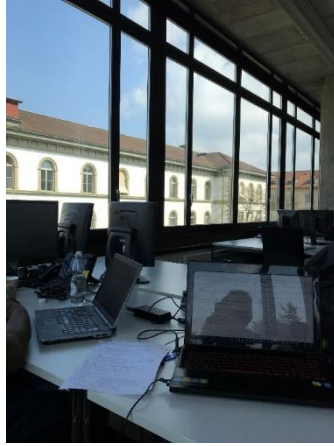
and anomalies in the network, by examining characteristics of cryptocurrency addresses. The analysis of these factors will assist and provide beneficial uses for the Bank of England to adapt blockchain technology to their current system.

### **How the STSM funding aided the research process**

Overall, we like to say thank you very much to the STSM committee for providing us with this STSM fund. Without this funding, it would not have been possible for the research and other activities mentioned above to be accomplished so efficiently and successfully.



**Left: International day event  
Centre: Presenting at the Internal Seminar  
Right: ZHAW University campus**



My office room at ZHAW University