

Institution: University of Bristol		
Unit of Assessment: 17 Business and Management		
Title of case study: University of Bristol research for the Bank of England mitigates systemic financial risk and improves usability of Financial Stability Report		
Period when the underpinning research was undertaken: 2015-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): Prof. Evarist Stoja	Role(s) (e.g. job title): Professor of Finance	Period(s) employed by submitting HEI: 09/2008-present
Period when the claimed impact occurred: 2015-2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact

The financial crisis of 2007-2009 crystallised the urgent need for both a better understanding of volatility, turbulence and rare extreme events in the global economy, and of how financial institutions can better withstand the stress caused by these events.

Research by Evarist Stoja of the University of Bristol has improved understanding of the causes and antecedents, predictors and consequences of volatility in global financial markets. This work has enabled the Bank of England – the Central Bank and financial regulator in the UK – to revise how it models and responds to financial market turbulence in a way that mitigates systemic risk. Stoja's research further informs how the Bank manages its portfolio of risky assets to help promote financial stability.

Stoja's research has also contributed to changes in how the Bank of England writes its flagship Financial Stability Report to be more usable for financial practitioners and, thus, better support the Bank in pursuing its ultimate goal of a healthy British economy.

2. Underpinning research

The global financial crisis of 2007-2009 was the first time since the Great Depression that the world's financial markets had experienced so much turbulence. With the global economy now much more complex and interconnected than before, financial institutions and regulators were dangerously unprepared for the crisis, with no central banks able to predict or readily mitigate its impact.

Stoja's research assesses the antecedents, causes, and consequences of financial volatility and extreme events, such as the 2007-2009 financial crisis. Such events happen only rarely but can have devastating outcomes. His work has a practical focus, looking at what financial institutions, regulators, and especially central banks can do to predict, minimise the likelihood of, and mitigate the impact of economic disasters. To ensure that his research is well-informed by real practice, Stoja's research partners have included collaborators in a variety of different financial institutions, such as banks and investment companies, as well as academics. His work has deepened understanding of volatility, and how risk is managed, in the following ways:

1. Recognising limits to risk mitigation

Stoja's research with Harris and Shen (Exeter) has found that there are clear limits on how much influence or insulation any given company's preventive action can have against risks in financial markets [3.1]. This paper recommended that users of hedging models (i.e. companies) should not invest excessive time and resources in trying to insulate themselves from volatile events.

2. Improved risk management model

Stoja and collaborator Polanski (Queens University Belfast) evaluated the risk measurement framework widely used by companies in the financial services sector to model and manage rare extreme events [3.2]. Despite its widespread use, the model had fundamental shortcomings which were not widely recognised by the financial services industry. Stoja and Polanski reconceptualised the model to overcome its shortcomings and support more effective risk management by making it more representative of the economic reality and, hence, more accurate.

3. Better prediction of volatility

Working with Harris (University of Exeter) and Yilmaz (of the investment company SLJ Macro Partners), Stoja proposed a new modelling approach to forecast volatility and turbulence in foreign exchange markets using techniques that can easily be applied to other markets, such as stock, bond and commodity markets [3.3]. In practical situations that require either timely forecasts (such as for intraday options trading) or recursive estimation (such as for back-testing risk management systems), the model provides a more straightforward way of incorporating the properties of turbulence in volatility forecasting than offered by competing models.

4. New models simplify financial analysis

Stoja and Polanski demonstrated that financial risk that leads to rare extreme events is multifaceted and originates from multiple sources – often simultaneously. Therefore, any attempt to model various aspects in isolation is uninformative and often misleading [3.4]. This means that trade-offs must be found between conflicting objectives. Stoja proposed two simple methods for addressing this problem when modelling economic variables. This research also identified how different classes of assets – foreign exchange, bonds, commodities, stocks – experience turbulence and rare extreme events at the same time, and built a considerably simpler and more accurate model to explain and predict the co-movement and so better support risk management.

Bank of England fellowship and advisory role

Since 2015, Stoja has worked directly with the Bank of England where he has built upon his existing research to help the Bank explain and predict volatility, rare extreme events, and their impact on financial systems. This work was first conducted during 2015 on a secondment at the Bank of England as a recipient of the prestigious Norman-Houblon and George Fellowship [a]. Stoja worked in the Bank's Stress Testing Strategy Division which was set up to assess the financial system emerging from the financial crisis of 2007-2009. At the end of the Fellowship, the ESRC [b] and the Bank of England funded Stoja to continue this work part-time with the Bank as an Academic Adviser.

The Fellowship and Advisory role have led to seven published papers in the Bank of England Working Paper Series. Two of these directly fed into Stoja's impact on the Bank of England's working practices:

i. Distinguishing between fundamental and transitory volatility

Collaborating with Chiu and Chin of the Bank of England and Harris, Stoja distinguished between two forms of volatility in the financial markets: *fundamental* and *transitory* [3.5]. *Fundamental* volatility is macroeconomic and requires intervention by central banks to support the financial system and the wider economy; *transitory* volatility comes and goes within a number of days, is caused by emotional reactions from “jumpy or spooked” investors and does not require intervention from the central bank, other than perhaps reassurance.

ii. Responses to the Bank of England's Financial Stability Report

Collaborating again with Harris alongside Bank of England staff Karadotchev and Sowerbutts, Stoja showed that financial markets routinely fail to react to the publication of the Bank of England's Financial Stability Report, which outlines recent developments in financial markets [3.6]. The Bank is one of only two regulators in the world with hard powers to address problems over specific financial stability areas. This means that information contained in the Bank of England's Financial Stability Report goes beyond ‘signalling’ and, in theory, can be translated into actual

Impact case study (REF3)

actions to support the UK's financial stability, and so has important implications for the financial sector. This finding was contrary to expectations [text removed for publication]. Stoja thus advised that the report should be shorter and written in simpler language.

3. References to the research

- 3.1** Harris, R.D.F., Shen, J., and **Stoja, E.** (2010) 'The Limits to Minimum Variance Hedging.' *Journal of Business Finance and Accounting*, 37, 737–761, <https://doi.org/10.1111/j.1468-5957.2009.02170.x>
- 3.2** Polanski, A. and **Stoja, E.** (2012) 'Efficient Evaluation of Multidimensional Time-Varying Density Forecasts with Applications to Risk Management.' *International Journal of Forecasting*, 28, 343-352 <https://doi.org/10.1016/j.ijforecast.2010.10.007>
- 3.3** Harris, R.D.F., **Stoja, E.** and Yilmaz, F. (2011) 'A Cyclical Model of Exchange Rate Volatility.' *Journal of Banking and Finance*, 35, 3055-3064; <https://doi.org/10.1016/j.jbankfin.2011.04.007>
- 3.4** Polanski, A. and **Stoja, E.** (2014) 'Co-Dependence of Extreme Events in High Frequency FX Returns.' *Journal of International Money and Finance*, 44, 164-178; <https://doi.org/10.1016/j.jimonfin.2014.02.001>
- 3.5** Chiu, C-W, Harris R.D.F., **Stoja, E.**, and Chin, M. (2016) 'Financial Market Volatility, Macroeconomic Fundamentals and Investor Sentiment', *Journal of Banking and Finance*, 92, 130-145; <https://doi.org/10.1016/j.jbankfin.2018.05.003>
- 3.6** Karadotchev, V., Harris R.D.F., Sowerbutts, R., and **Stoja, E.** (2019) 'Have FSRs got news for you? Evidence from the impact of Financial Stability Reports on market activity.', Bank of England WPS792, <https://www.bankofengland.co.uk/working-paper/2019/have-fsrs-got-news-for-you>

Grant information

- a. Stoja, E.** *Norman-Houblon and George Fellowship*, Bank of England, 1 January 2015–30 September 2015, GBP46,000.
- b. Stoja, E.** *Financial Market Volatility and the Macroeconomic Environment*, ESRC Impact Acceleration Account, 1 January 2016–31 December 2017, GBP17,000.

4. Details of the impact

Stoja's research has advanced the way that the Bank of England understands, models and responds to volatility [3.1; 3.3; 3.5] and extreme events [3.2; 3.4] and how it communicates financial information [3.6]. These benefits to the Bank, translate into benefits for the UK financial markets through effective Bank regulation. These markets are global and anyone who relies on them for savings, mortgages, pensions or investments, stands to benefit from the Bank's improved response to volatility.

His fellowship and advisory role (2015-onwards) have allowed him access to highly influential stakeholders in the Bank of England. His research findings have been presented to the Board of Governors of the Bank. Stoja's work was commissioned and presented to the Head of the Research Hub at the Bank, the Head of the Stress Testing Strategy Division, and the Head of the Macro-Finance Analysis Division. It has also been discussed in meetings and presentations involving the Bank's policymakers who include members of the very influential Monetary Policy Committee and Financial Policy Committee.

Stoja's work has also reached a broad professional and practitioner audience. Aspects of his work are summarised in *Bank of England Policy Blog posts* (published 2015-2019) [5.1-5.3]. These led to articles in the eminent *Wall Street Journal* (2017) [5.4] and *Central Banking* (2017) [5.5]. Stoja's research and these professional articles have influenced the planning and policy of the Bank [5.6], leading to three key impacts.

1. When – and when not – to respond to volatility

Stoja's distinction between fundamental and transitory volatility in financial markets helped to determine that not all volatility in financial markets has consequences. As a result, it is now clearer to the Bank of England that it does not need to intervene in every instance of turbulence.

This new finding is now one of the body of arguments the Bank uses to guide when and how to react to specific types of turbulence and volatility. As an example, in the Bank of England Policy Blog based on one of his internal studies (2017) [5.2], Stoja discusses the clear turbulence and distress caused by Brexit on small and medium-sized companies. However, large companies appeared unaffected. The rationale was that the latter are more insulated due to their international focus whereas the former are more exposed due to their focus mainly on the UK economy. However, the turbulence of the small and medium-sized companies was mainly transitory and the Bank understood that there was no need to intervene, other than to offer reassurance. This avoided unnecessary action on the Bank's part.

The distinction between fundamental and transitory volatility has also informed the Bank's own analyses and practices in broader ways. Their Head of the Stress Testing Strategy Division has said of Stoja's research: "*These findings have important policy implications ... since the core volatility is related to macroeconomic fundamentals while transitory volatility is associated with investor sentiment, policy makers are better served by using core volatility rather than total volatility in calibrating the adverse scenarios, especially for the Bank's annual stress testing exercise and, more generally, for macro-financial analysis.*" [5.6].

A senior economist at the Bank has further commented: "*the decomposition of volatility into fundamental and transitory volatility is highly useful and informative to the Bank and has enabled researchers and policy-makers to distinguish between the two ... very different forms of turbulence... and were recognised as making a material impact regarding macro-prudential policies and annual stress-testing exercise. Moreover ... the paper continues to create impact across directorates ... the results that volatilities improve the forecasting performance of macroeconomic variables have directly led to the development of a forecasting model... used by the Monetary Policy Committee every quarter*" [5.7]. This new forecasting model helps the Bank fulfil its mandate of maintaining price stability through monetary policy measures, the use of which depends on reliable macroeconomic forecasts and timely monitoring of volatility [5.7].

2. Improving the Financial Stability Report for practitioners

The Bank of England has made changes to how it presents its Financial Stability Report in response to Stoja's finding [text removed for publication] [3.6]. The Report is one of the Bank's flagship publications. It involves hundreds of analysts and costs hundreds of thousands of pounds to produce. To enhance the Report's utility and circulation among practitioners, Stoja advised that it should be shorter and written in simpler language. The Bank of England has understood the findings and their implications and has "*engaged extensively with the writers of the Financial Stability Reports, to exchange views and provide input for the future issues*" (Senior Economist, Bank of England) [5.8].

Another Senior Economist at the Bank commented: "*these important findings and conclusions were widely distributed inside the BoE during 2018 and 2019. In line with this recommendation, the Bank has recently started to complement its Financial Stability Report with visual summaries to make it more digestible and reach a wider audience ... Overall, the impact of this work has been a much improved and deeper understanding of the challenges ... that the Bank faces in its ... communications and the concrete steps necessary to address those challenges which the Bank has accepted and has started to implement and will continue to do so in the medium to long term...as it pursues its core objective of financial stability and ultimately a healthy British economy.*" [5.8].

3. Improved models for stress testing and portfolio management

Stoja's work has contributed to how the Bank builds its models of stress tests and how it interprets the results. Stress tests, conducted every year, are hypothetical scenarios of stress on financial institutions. These could explore, for example, the combined effects of falling house prices, increased unemployment and increases in interest rates; or EU economies doing well but China and the U.S. experiencing a recession. The tests' results influence capital requirements for financial institutions that do not fare well in the tests. Stoja – together with Bank staff – developed,

Impact case study (REF3)

for the first time [3.5], a “*framework for analysing the dynamic relationships between financial market volatility, macroeconomic fundamentals and investor sentiment ... These findings have important policy implications, especially for the Bank’s annual stress testing exercise.*” (Head of Stress Testing Division, Bank of England) [5.6].

The Bank’s new Agenda for research [5.10] continues to prioritise a deeper understanding of market stress with three Priority Topics for 2021 in this area: “*What features are needed in models that can be used to assess the costs and benefits of prudential policy responses to specific shocks? How can the interactions between the different parts of the financial system and the real economy be modelled to assess the economy’s response to large shocks?*” and “*What are the implications of deployment of machine learning and artificial intelligence by firms for the financial system?*” with a particular focus on whether AI can be used to game stress tests.

One way that the Bank of England maintained stability during the financial crisis was to buy financial assets. This intervention introduced a large and strong buyer in a market which increased and maintained liquidity, the lifeblood of a well-functioning market. However, the Bank also increased very substantially its balance sheet, the amount of assets that it bought and now holds on its books. These are relatively risky assets designed for profit-seeking investors. Thus, the Bank is currently exploring ways to reduce its balance sheet by selling these assets. For these assets to be offloaded from the Bank’s balance sheet, many financial institutions would need to buy. However, the quantity these financial institutions would buy is uncertain. For this purpose, “*the Bank of England benefited greatly from the Dynamic Black-Litterman model*” developed by Stoja in a Bank of England Working Paper, No. 596, published April 2016 [5.9]. This model proposes a general framework for portfolio management that “*better reflects the conditions and developments in the markets*” and “*is suitable for sophisticated investors and offers a number of advantages over existing models, especially in regard to incorporating extreme events*” [5.9]. It benefited the Bank as an “*important part of the plans that were being formulated ... as it explored strategies that could eventually be used to reduce [the Bank’s] balance sheet in a way that would be consistent with its policy objectives, including supporting the British economy.*” (Former Research Manager, Bank of England) [5.9].

5. Sources to corroborate the impact

- 5.1 Karadotchev, V., Harris R.D.F., Sowerbutts, R., and Stoja, E. (2019) ‘[Have FSRs got news for you?](#)’, Bank of England Policy Blog,
 - 5.2 Chiu, J. Harris, R., and Stoja, E. (2017) ‘[Do core and transitory volatilities matter for the economy?](#)’ Bank of England Policy Blog,
 - 5.3 Chavaz, M., Chiu, J., and Stoja, E. (2015) ‘[The “question” or the “answer”? Market reaction to UK stress tests.](#)’ Bank of England Policy Blog
 - 5.4 Chiu, J. Harris, R., and Stoja, E. (2017). ‘[Core Volatility and the Economy](#)’, *Wall Street Journal Pro*,
 - 5.5 Polanski, A., and Stoja, E. (2017). ‘[BoE paper tackles multidimensional tail risk forecasting](#)’ Central Banking
 - 5.6 Bank of England (2017) Supporting statement – Head of Stress Testing Strategy Division
 - 5.7 Bank of England (2019a) Supporting statement – Senior Economist
 - 5.8 Bank of England (2019b) Supporting statement – Senior Economist
 - 5.9 Harris R.D.F., Stoja, E., and Tan, L. (2016) ‘[The Dynamic Black-Litterman Approach to Asset Allocation.](#)’ Bank of England WPS, 563; World Federation of Exchanges (2020) Supporting statement – Former Research Manager, Bank of England
 - 5.10 Bank of England (2020) [Bank of England Agenda for Research](#)
-