FinTech Tail Risk and Consumer Protection: Implications for UK Growth

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*****PRELIMINARY AND INCOMPLETE*****

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I. Introduction and Scope

The emergence of the UK FinTech sector as a global and national leader has brought to the forefront a series of challenges about the future, orientation and regulation of this rapidly evolving, lucrative industry. The large diversity in what constitutes FinTech, and how it differs from the rest of financial services providers or other nascent sectors, only adds to the ambiguity of the subject. What is not ambiguous is the large economic, financial and political importance of FinTech as a facilitator of economic growth generation of capital and innovation. The conditions that led to the expansion of FinTech (disillusionment with the ethos and services of mainstream financial institutions; IT innovation looking for lucrative outlets and applications, coupled with slow adoption rates from established providers; public need for flexible, tailored services and overall digitalisation; abundant investment capital during quantitative easing in search of high yields) create a complex framework for a regulatory authority, whose resilience and risks are difficult to assess and pre-empt. Given the recent political mandate for growth in the UK, and the country's flourishing sector, it is important to assess whether FinTech riskiness can have a wider impact on consumers and financial stability.

In this paper, we adopt an interdisciplinary perspective and combine insight from the areas of law and finance. Our first objective is to focus on rare, negative effects of large magnitude (tail events) and their impact and likelihood (tail risk), which may cause or signal financial distress for a firm and lead to default or other adverse results. Specifically, we examine whether they can have a negative impact on growth and overall credit, with particular focus on household/ consumer credit and credit of small and medium enterprises (SMEs). Until now, there are very few academic studies on FinTech risk and most focus on either its relationship with the traditional banking and financial sector or focus on various risk spillovers and firm connectedness. Although recent evidence suggests increased contagion within FinTech and between FinTech and traditional banking (e.g. Anwer et al, 2025), there is scant focus on tail risk. This is the empirical gap we intend to cover.

Our second objective is to provide an overview of the FinTech regulatory framework in the UK, with particular focus on financial stability, consumer protection and SME lending. We then evaluate the successes, dangers and limitations of the regulatory framework and provide tailored policy suggestions on regulatory capacity building, operational requirements, risk management and non-regulatory measures, with particular focus on fostering growth, ensuring resilience and protecting individual and SME borrowers. Specifically, we discuss from a legal and economic perspective whether FinTech regulation in its current form is fit for purpose and can counter the above. The conclusions of this section inform the empirical section on tail risk.

Low-income households and SMEs are a sizeable market for FinTech firms and use them to gain access to credit and various financial services that are costlier, cumbersome or outright inaccessible at larger, mainstream banks and financial firms. Two plausible scenarios are (i) distress in FinTech business and household lenders increasing repayment pressure and costs to clients that are already precarious conditions (ii) distress in FinTech investment platforms increasing costs or even leading to loss of investor capital. Tail risk, by its very nature difficult to observe and quantify, is a prime example of a microeconomic feature that transcends the

individual firm and can have a wide impact on the financial system. The increasing client base and penetration of FinTech firms makes this risk socially non-negligible at the very least. Therefore, FCA could benefit from a deeper understanding of the impact or distress in Fintech, especially since many of those firms are IT firms (e.g. Software-as-a-Service) or large technology firms that, crudely, happen to provide financial services.

The Kalifa review (2021) is an apt illustration of state and industry aspirations and collaboration for the past 5 years, whose suggestions have been widely adopted and lauded. In its view, the role of the regulator is to enable and foster growth by simplifying rules, supporting partnerships between firms and fostering innovation. It is telling that risk is framed as a growth-limiting factor for the industry (e.g. skilled labour supply) rather than an inherent, operational danger or a negative factor with wider impact. McNulty and Milne (2021) criticise that narrow scope of FinTech support, which lacks a wider consideration of their ability to solve the legacy challenges of the financial sector; although public support of startups is understandable, and FinTech can provide solutions, this support should not be to the detriment of other industries and those solutions should become more evident. One of their most notable points, which is key in this project, is systemic risk and the role of the regulator. Another argument, succinctly summarized by Omarova (2020), is that existing regulatory models focus on rigid product/ entity types, "which enables and rewards bureaucratic specialization, deep but narrow technical expertise, and minimally invasive regulatory targeting of specifically cognizable 'market failures' within the relevant agency's jurisdiction". This approach focuses on micro-level issues and solutions, ignoring the macro-level influence of FinTech.

Although we have taken into account FCA publications and consultations, our study does not discuss them in depth or beyond what is necessary, as they are already known to the FCA. Nonetheless, we have dedicated comments on the proposed FCA changes on the safeguarding regime for payments and e-money institutions,[3] which also consider some stakeholder responses. The regulatory part of our study focuses on observations and proposals found mainly in legal literature. Its primary aim is to provide a benchmark for a general evaluation of current FCA regulatory framework and enforcement practices. A concrete evaluation of specific regulations was not possible owing to the time constraints in the preparation of this report. We have not accounted for the particularities of de-centralised finance and crypto currency, as these pose some unique challenges, which the limited timeframe of our study did not enable us to analyse. The empirical section is unavoidably limited due time constraints and data availability. Our intention is to provide convincing grounds for further research on these areas rather than a complete set of results. We conduct robustness tests and use a variety of methods and measures for a thorough assessment of our main objectives, but cannot conduct an extensive data collection or address all possible shortcomings (e.g. endogeneity).

[3] FCA CP 24/20, September 2024, <https://www.fca.org.uk/publications/consultation-papers/cp24-20-changes-safeguarding-regime-payments-and-e-money-firms>.

II. Implications for consumers, SMEs and growth

The core consequences of tail risk for consumers are the same as the consequences of a struggling or failing FinTech firm. They can be categorised into individual, i.e. for the clients of that particular firm, and systemic. The materialization of tail risk at the micro-prudential level has the same effect with any ordinary situation that causes distress or insolvency to a FinTech firm. The manifestation and scope of those risks can vary depending on the exact services offered by a firm.

A. Risks for individual consumers

FinTech facilitates economic inclusion of weak consumers and SMEs. The materialization of tail risk may lead to economic, and thus social, exclusion of consumers and SMEs, which could impede economic growth. The relationship between traditional lenders (e.g. banks), non-regulated lenders and FinTech ranges from adversarial to complementary to substitutional. For instance, Ashton and Gregoriou (2025) find significantly higher numbers of alternative financial services providers being involved in financial misconduct in areas of high bank branch closure, with the most severe offending occurring within urban and deprived areas. Tang (2019) finds evidence in favour of coexistence rather than competition. FinTech firms react quicker to credit needs for reconstruction after natural disasters than established banks and increase supply elasticity more aggressively (Allen et al., 2023), a point that strengthens our aim to examine credit provisions to firms and individuals under distress.

The most comprehensive contributions on the issue are in World Bank publications by Boeddhu (2021) and Boeddhu (2022), partially summarised in this paragraph. Consumers may lose access to funds held or administered by a FinTech entity (Boeddu et al., 2021). Such loss may be provisional or permanent. In the case of Wirecard, the loss for UK clients was provisional and was restored relatively quickly. However, the fall out of Synapse led to much longer delays and there are still challenges for individual clients to access their funds. In commercial settings, where speed in transactions is paramount, long delay may have similar consequences as permanent loss of access. In any case, natural persons, especially financially vulnerable consumers, may be among those least able to bear losses, or even a temporary restriction on access to their money.

Fowler (2020) provides a comprehensive overview of such relationships and the consequences for investors and, most importantly for us, consumers. In case of insolvency of the FinTech company, consumers may lose part of their funds, because their claims usually enjoy no priority, particularly if the client funds have been intermingled with company funds and are treated as company assets. A consumer participating in P2PL as a lender/investor may risk losing their committed loan principal and/or interest, or repayments owed to them. Depending on the legal relationships between the parties, borrowers may also suffer loss of funds, when they are seeking to repay through the platform but fail to reach lenders/investors. Business interruption of such platforms may affect the proper administration of loans that remain viable, causing corresponding loss. In cases of investment-based crowdfunding platforms, investors could be deprived of services necessary for realizing the full value of their investments.

Buy Now, Pay Later (BNPL) lenders, such as Klarna, are a major area of FinTech growth with direct implications on consumer finance and debt. Although earlier literature is quite positive on business creation and performance (e.g. Agarwal et al., 2020), later evidence casts doubt on those claims. BNPL borrowers were, on average, much more likely to be highly indebted, revolve on or overuse their credit cards, have delinquencies in traditional credit products and lower credit scores (demonstrating access and use of traditional finance tools), and use high-interest financial services such as payday, pawn, and overdraft compared to non-BNPL borrowers (Shupe et al., 2023). In 2023, more than 3 million UK households owed £2.7bn of BNPL credit with 21% of debtors having fallen behind on payments and 47% of UK adults not realising than BNPL can cause indebtedness.[4] Recent plans by the US Consumer Financial Protection Bureau to treat BNPL similar to credit card regulations, emphasising disclosure requirements, do not account for role of merchants in driving the industry or the fact that consumers often do not even view BNPL as credit in the first place (Soni, 2023).

The last remark strongly highlights how critical financial literacy is for of BNPL exposure and adoption, especially among low-income consumers. Financial literacy reduces perceived BNPL benefits and that lower financial literacy is associated with more benefits and less risks (Gerrans et al., 2021). Charging BNPL to credit cards (i.e. a 0% form of debt to a 20%+ credit instrument with long amortization) is most prevalent among UK consumers that are young and those living in the most deprived areas (Guttman-Kenney et al., 2023). Greater BNPL usage is associated with lower subjective evaluations of consumers' overall well-being by increasing their current money management stress and decreasing their expected future financial security (Schomburgk and Hoffmann, 2023). BNPL products coupled with FinTech are disproportionately used by lower-income families, who are increasingly reliant on credit for everyday purchases. Afterpay, Klarna and Zip present themselves as more responsible than credit cards on loan cost and inclusivity grounds while framing consumer responsibility as timely repayment (hence being responsible towards the creditor) rather than prudent (responsible) in terms of own consumption, spending and management of personal finances (Aalders, 2023).

The framework proposed by Soni (2023) is worthy of special reference, as it addresses fundamental problems in consumer credit also present in the UK. It includes (i) regulating merchants, as well as lenders, as statutory covered service providers, since they are the first point of customer contact and can improve accountability and protect vulnerable customers (ii) explicit information and definition of provided BNPL schemes as loans, thus prohibiting abusive representations, providing safeguards and preventing misrepresentations of the credit provided. From an Australian perspective, allowing merchants to surcharge the costs of the BNPL service, as well as giving the Australian Securities and Investments Commission oversight of the Code of Practice, in conjunction with targeted regulatory action, can improve the currently inadequate consumer protection, foster competition and ensure growth (Rizk,

[4] The values are from a Kalgera article (https://www.kalgera.com/blog/buy-now-pay-later-bnpl-how-its-impacting-society-to-date) referring to a blog from Bank of England economists G. Gunner and J. Waddel (https://bankunderground.co.uk/2023/08/23/shining-light-on-shadow-credit-what-is-buy-now-pay-later-and-who-uses-it/). Fung (2024) for a US think tank commentary.

2021). In one of the earliest papers on BNPL regulation, BNPL arrangements in Singapore should not be subject to licensing or minimum income requirements (a suggestion often overridden in more contemporary literature) but be subject to maximum credit limits and reporting, interest rate, fees and total charge restrictions and standardised information disclosure requirements (Sng and Tan, 2022).

B. Risks for small and medium enterprises (SMEs)

Comprehensive literature reviews on FinTech and SMEs can be found in Sanga and Aziakpono (2023) and Verma et al (2023). Peer-to-peer (P2P) lending from FinTech firms is often found to improve SME access to finance (e.g. Abbasi et al., 2021). A thorough description of the £22bn funding gap and the financing issues SMEs face comes from Bank of England (2020), in its introduction of the Open Data Platform. SME equity finance is highly concentrated in London, while SME loans are concentrated in London and the South East. Non-bank finance was at about 15% of total SME lending in 2018. Since 2017, however, all of the net growth in SME lending has come from smaller banks or from alternative sources such as P2P lending, with the UK banking sector withdrawing. After the global financial crisis, the banking system did not cover SME credit needs, partly because SME finance was concentrated to a small number of banks with very similar models. This gap has been one of the prime mobilising forces behind P2P FinTech lending, which stepped in to fill the gap after the global financial crisis in the US and managed to increase its market share (Gopal and Schnabl, 2022). A similar phenomenon has been observed in the UK. A decline in SME funding by large high street banks after the crisis had led to a c.£95bn finance gap between 2015 and 2022, which had needed to be met by emerging challenger banks and alternative finance providers. The share of total lending to SMEs by these challenger and specialist banks rose to around 60% in 2023, whilst the five largest banks dropped to around 40%, compared to over 60% in 2012.[5]

FinTech serves high quality, creditworthy SMEs who already have access to bank credit, while firms access FinTech to obtain long-term unsecured loans and reduce their exposure to banks with less liquid assets, stable funds, and capital (Eca et al., 2021). This increases SME investment, employment, and sales growth. However, this comes at a cost. Fintech small-business loans charge rates 3% higher on average that consumer loans from the same lender and 4-7% higher than comparable loans from regulated banks (Palladino, 2020). This illustrates the need for regulatory clarity and additional supervision to protect this crucial market segment from predatory non-bank lenders.

Although business-to-business lending and the important role of FinTech in bridging the funding gap for SMEs are well-established, key issues remain on the impact of unsecured loans and information asymmetry for firms with low collateral or limited track record. For instance, Italian lenders cannot obtain soft information but only hard data through lending platforms (both bank and non-bank FinTech), which may prevent FinTech firms facing information asymmetry from securing loans and thus worsening asymmetry problems (Fasano and Kappa, 2022). Therefore, soft information gathered through traditional banking is still relevant but

[5] See the "SME Finance" House of Commons Committee report, Eighth Report of Session 2023–24 https://publications.parliament.uk/pa/cm5804/cmselect/cmtreasy/27/report.html#heading-4

excluded by the very nature of Fintech. To that end, machine learning algorithms analysing hard information held by banks can improve the efficiency of loan officers using both hard and soft information(Tantri, 2021). French firms experience a 13% increase in bank credit after receiving a FinTech loan, which occurs only when FinTech borrowers invest in new assets and are therefore able to pledge them as collateral to banks (Beaumont et al., 2022). Therefore, firms may use FinTech lending as a first step to acquire cheaper, safer bank credit via acquiring collateral, rather than rely primarily on FinTech lenders.

Another aspect is the business focus of FinTech lending to areas of high unemployment and firm failure (Cornelli et al., 2024b). Although the authors are cautiously optimistic about the ability of FinTech to improve financing conditions for excluded small firms, as well as loan performance, there is a very real and important issue of predatory, unregulated practices that target the most deprived social groups (Ashton and Gregoriou, 2025). In that context, improving credit risk tools is vital (Giudici et al., 2019). FinTech lenders do not improve their level of prudence when some borrowers report misleading information, reacting only to the most blatant cases, while screening via LendingClub information appears to have decreased recently (Gallo, 2021). Although this may or may not be a deliberate stance on behalf of lenders, loan collection performance may be lowered.

From a legal point, SME protection from FinTech lender malpractice falls under the existing legal provisions to traditional lenders and any law literature is is fragmented, case-based and often country specific, since the exact rules governing FinTech often differ among States (jurisdictions). A contribution comes from (Jagtiani et al., 2021). Unlike small business and unsecured consumers lending, fintech mortgage lenders do not have the same incentives or flexibility to use alternative data for credit decisions because of stringent mortgage origination requirements. Fintech loans are broadly similar to those made by traditional lenders, despite innovations in the marketing and the application process. However, compared to banks, non-banks market to consumers with weaker credit scores and fintech lenders have greater market shares in areas with lower credit scores and higher mortgage denial rates.

This could entail the need for reforms in corporate law. Although our paper does not focus on corporate law issues, some observations would be useful. An example is equity financing for SMEs, an area where FinTech has had an impact only very recently. Toniolo and Pederzini, (2020) find that equity-based crowdfunding needs a flexible bargaining and contracting regime for governance, minority protections and safeguards for retail investors, but must be accompanied by adequate SME organization, management and accounting structures leading to the creation of an SME equity market. Equity funding cannot be assessed independently of the law regulating the SME as a whole, and recent EU interventions adopt an unhelpful approach that treats SMEs as a homogeneous group of public (instead of private) limited companies. They argue that centralised regulation would not be desirable because it would inhibit regulatory competition and lack flexibility. Peng et al. (2023) observe that legal protection and the quality of legal enforcement matters less to the cost of fintech credit, compared to bank loans, because fintech credit provides better ex ante loan pre-screening and ex post loan monitoring and default recovery. Nonetheless, the rates of fintech credit are affected, in cases of (a) higher risk loans, (b) fintech platforms with fewer risk-sharing tools,

and (3) States where borrowers reside or are incorporated provide fewer information-sharing channels.

C. Systemic risks

Distress or collapse of FinTech companies due to tail risk may also have systemic consequences. Distress in an established FinTech firm, or a credit crunch in the sector, may cause contagion to other FinTech firms whose clientele, business models and credit providers overlap. The collapse of Silicon Valley Bank, which specialised in tech firms and experienced a mostly digital bank run, is a strong reminder of the speed of contagion and fund movement, that can trigger or exacerbate losses both for firms and financial institutions. FinTech platforms can be more susceptible to a bank run not only for reputational reasons but also due to high leverage and lack of liquid reserves (Ioannou et al., 2024). However, the relationship between FinTech and traditional banks and financial firms varies according to the period, the sample and the country in question, with the US and China being the two most popular choices due to data availability. The evidence on the relationship between FinTech and bank stability are mixed. Connectedness between large US FinTech firms increased during and after Covid, with the positive co-movement of default risk showing no diversification opportunities (Anwer et al., 2025). The focus on default risk makes this study the closest to ours. Haddad and Hornuf (2021) find a positive influence of FinTech on bank stability and performance, indicating a symbiotic rather than competitive relationship. On the other hand, on a US sample, risk spillovers from FinTech to traditional financial institutions is positively related to systemic risk and more intense in the bearish case (Li et al., 2020). This contradicts Henriques and Sadorsky (2025), who find that FinTech in the US is not a major source of systemic risk. For China FinTech, a major driver of systemic risk is the interaction between stock volatility and market volatility as well as market capitalisation (Chen et al., 2024).

Crucially, recent studies have both more complete datasets and examine a host of systemic risk features, to identify connectedness and the speed of spillovers as major concerns rather than simply the absolute or relative magnitude of distress. For Europe, Pacelli et al. (2022) find that the spillovers of cross-sector tail risk spillovers are more significant in the downside than the upside, and there is an asymmetric effect of extreme risk spillover to the real economy. The cross-border element becomes quite important. On a country basis, although FinTech as a whole improves financial stability, crowdfunding has a positive effect but consumer lending destabilises the financial system (Koranteng and You, 2024). This acts as further motivation for this study. The fact that FinTech companies often aim at financially vulnerable consumers and entities, which face challenges on their financing through traditional banking channels, may encourage precarious lending with significant systemic effects in case of a collapse (Jagtiani and Lemieux, 2018). This is exacerbated by the focus of FinTech companies, especially credit intermediaries on origination fees rather than interest margins, with direct reference to the securitisation of FinTech-generated mortgages, which involves higher-risk loans (Omarova, 2019).

Law and regulation literature appears more reserved on the systemic risk implications of FinTech than mainstream finance research, and has identified various areas of concern (e.g. Jackson, 2020). Due to their smaller size and focus on efficiency they are more vulnerable to

adverse economic shocks than large financial institutions (Magnuson, 2018). Those shocks are more likely to spread to other financial firms because there are more propagation mechanisms, such as cybersecurity vulnerabilities of the underlying technologies and use of automated decision-making systems, which allow investment decisions to be made very quickly without human intervention (high-speed algorithmic trading). In addition, information asymmetries may be high, when FinTech firms are not subject to disclosure duties, which enables them to transfer risks to third parties and encourages them, thus encouraging risky behaviour, e.g. precarious lending (Claessens et al., 2018). The growing market size of the FinTech industry increases systemic concerns. A comprehensive literature review can be found in Barroso and Laborda (2022).

Second, there are greater supervision challenges, because FinTech firms sometimes operate in opaque ways, such as relying on decentralised, dispersed networks of small actors and algorithmic decision-making (Anagnostopoulos, 2018). Cryptocurrencies are a prominent example in this regard. Thus, regulators may lack reliable information and understanding about the structure and operations of FinTech markets (Brummer and Yadav (2018)).

Third, market actors have fewer reputational incentives for rational cooperation to avoid or mitigate crises. The appropriate behaviour is still in development since traditional finance paradigms are disrupted; there are far more actors than in traditional finance; while the stakes for each firm are lower, compared to the concentrated banking sector. At the same time, the market for FinTech rewards quick growth and increased risk-taking, since early movers tend to win most (Magnuson, 2018) This is exacerbated by the inexperience of FinTech companies in risk management and compliance.

An oft-cited study by the Financial Stability Board (2017) had identified potential sources of systemic risk for FinTech at the micro and macro level. From a micro-financial perspective, maturity mismatch had been identified as a major risk source, while liquidity mismatch and leverage were not deemed to raise significant concerns at that time. Another element was governance and process control, related to the regulatory perimeter; cyber risks; reliance on highly-concentrated third-party service providers (e.g. cloud providers, data services); legal and regulatory risk given the often diverging and evolving national regulatory frameworks; business risk of critical financial markets infrastructures, which have the potential to impair the provision of critical services and interfere with recovery or an orderly wind down. From a macro-financial perspective, the most important risk was reputational contagion across the FinTech industry, especially where FinTech firms directly impacted households and businesses. Availability bias may exacerbate fears of consumers as to the reliability of FinTech firms and erode trust. Consumers tend to treat e-money the same, irrespective of the service provider. Moreover, FinTech companies are more prone to procyclicality and volatility as they are affected stronger by market sentiment and are designed to act fast.

A final element is the potential for large FinTech firms to be systemically important but fall, by definition, beyond the regulatory and support scope of the traditional banking sector. This lack of provision may not cause moral hazard concerns in the typical sense but increases instability, uncertainty and possible cascading effects in case of a downturn. The experience of FTX, Wirecard and Synapse has indicated that, despite the large regulatory impact and the losses to

investors, the collapse of a central FinTech company did not destabilise the wider financial system. There was a much larger political impact by the collapse of banks with primary clientele in the Tech/FinTech sectors (Silicon Valley Bank, Signature), which led to a considerable bailout that was disproportionate to those banks' size and led to complaints from EU regulators on violating the post-global financial crisis norms. Our first comment is that, as the experience around shadow banking has shown (a term that largely applies to FinTech), a relatively small firm by sector standards may lead to disproportionately large distress through contagion, if its connections are "right". Our second comment is that there can be distress outside the banking sector, namely among low-income consumers and SMEs, which can lead to large effects on income and welfare. Most of those concerns pertain today, although the current economic environment has changed massively after Covid. Consensus can be found on the need for tailored regulation and a better classification for FinTech firms.

III. Regulatory measures to protect consumers and promote growth and financial stability

A. Elements of robust regulation

Effective regulation is commonly proactive, dynamic and flexible, incorporating the views of all stakeholders and correspond to the systemic size and business model of each actor (e.g. Anagnostopoulos (2018)). In this section, we do not intend to provide an overview of the entire regulatory discussion, as it is already familiar to the FCA. Instead, we will first discuss the UK approach on FinTech regulation vis-à-vis proposals found in the legal and economic literature and accounting for approaches in other jurisdictions, and then identify the characteristics a regulator should have to achieve the dual objective of increasing growth without increasing fragility or jeopardising social welfare.

1) Regulation and growth

The current policy imperative in the UK is that regulation must promote growth, and the FinTech sector is key in that context. The most important recent policy document is the Kalifa review (2021), where regulation is seen as a mechanism that fosters growth by limiting business risk. The position of the review is that potentially high rates of firm failure are in the nature of innovative sectors and a regulator should ensure the resilience of the system rather than that of its components; individual firms, of any size and nature, should be able to fail non-disruptively and be substituted by new or existing firms as providers of financial services to customers. History, including recent events, demonstrates that unsafe forms of innovation, and failures of financial regulation and supervision, can have serious consequences for consumer, and investor confidence.

The Kalifa review's position on Schumpeterian "creative destruction" creates a regulatory conundrum: although a FinTech firm may not be "too big to fail", its influence in the sector and the reputational impact from a failure may be too large to ignore. We emphasise that a FinTech distress scenario can be distinctly different from the collapse of a systemically important financial institution which is bailed out because it may be difficult to identify a

“central” distressed institution. Also, the various stakeholders (startups, households, SMEs) may not have the loss tolerance or capacity to withstand a wider economic slowdown or credit crunch. The decentralisation of FinTech may be a source of weakness rather than resilience, while the reputational and credit spillovers may be substantial at a time when the centre of distress can be difficult to identify. The regulatory dilemma in such a case would be to support “everyone or no one” during flight to safety, especially since the within-FinTech networks highlighted in previous sections are quite widespread.

The second important element is that FinTech regulation may be fundamentally different from generic regulation on nascent industries or existing regulation of financial activities. It is not a matter for the regulator only to “keep up”, but also to adapt to a shifting regulation object undergoing self-discovery and with its own distinct characteristics (Ford, 2017). It is thus a matter of definition as well as upholding mandate.

The UK’s regulatory approach is insightfully contrasted with that of China in Langley and Leyshon (2023). If the FinTech sector is seen as a “political economy of platforms”, or ecosystem, the UK approach is to regulate with platforms in a cooperative manner while the Chinese approach is to regulate against them in an instrumental “means to an end” manner. UK FinTech consists of a relatively large number of start-up and early-career specialist firms augmented by a constellation of funders (angel investors, venture capitalists, large banking and tech firms), while China is dominated by BigTech ‘super apps’, reflecting social and political differences. This implies a more streamlined, easier to control and more obedient Chinese sector, whereas FCA would need to rely on a different mixture of incentives to foster growth as well as a balance between discretionary intervention and a rules-based, hands-off system. Two difficulties that arise are the social and fiscal cost of nurturing the FinTech sector (McNulty and Milne, 2021) and avoiding regulatory capture. As of now, the UK sandbox approach has been very successful in allowing young FinTech firms to raise capital and spur innovative activity (Cornelli et al., 2024), but the question on whether the framework is scaleable and can withstand economic downturns remains to be seen.

Comparing the UK with the German framework is even more revealing, as it emphasises the transformation of large FinTech firms to regulated bank entities, e.g. Revolut. In both countries, FinTech firms sought to operate within existing regulatory frameworks rather than operate in grey areas and be subject to penalties later (Hodson, 2021). Other similarities are the movement of German FinTech firms into the realm of bank licencing and regulation, a shift from regulatory entrepreneurship to regulatory innovation and a relationship with established banks that is more symbiotic than adversarial. However, the collapse of Wirecard and the resulting oversight failure, partially because of both excessive and fragmented regulation, cannot be ignored. Contrary to increased competition, change and innovation observed in Europe, the Latin America regulatory experience is one of amplifying already high market concentration and increasing cross-country barriers, since most FinTech relies on existing bank structures for its operation (Ioannou and Wójcik, 2022).

Overall, the UK framework has been well-positioned to foster growth in the FinTech sector and for the wider economy. Central in its approach are two characteristics often desired by FinTech representatives: adaptability and flexibility. More generally, a regulator should change

from being proactive to reactive, provide tailored policies and be continuously open and engaged in policy learning (Vogel, 2015). Therefore, regulators should be vigilant and stay informed, to be able to adjust to the changing market conditions. It is very helpful to engage with the supervised firms and learn from them what the economic impact of regulatory policies; however, caution is required to avoid becoming captive of business interests or even creating such impression, because the regulator's reputation and legitimacy would be undermined (Vogel, 2015). A less pronounced characteristic, which acts against risk-taking and regulatory arbitrage, is vigilance and data/ information gathering. This contradicts with the requests of lower bureaucratic requirements and raises concerns on being captive of business interests or even creating such impressions, because the regulator's reputation and legitimacy would be undermined. An open question, however, is resilience.

The open and flexible regulatory approach of the UK, despite its successes, has not been tested in a manner similar to the Wirecard collapse. In other words, it has not experienced a systemic event of low real or perceived probability, which could radically alter the position and mandate of the regulator. Due to the large interconnectedness and openness of the UK financial system, identifying such a key FinTech firm may be challenging. A further challenge is the influence of large technology firms, with huge data collection and processing capacity, that provide financial services but cannot be considered FinTech firms, which poses additional regulatory concerns beyond the narrow scope of this paper (Zetsche et al.,2017).

2) Flexibility, early intervention and compliance by design

An important argument by Fahy (2022) on UK regulation is that frontline interactions may play a more foundational role in fostering future collaboration with innovative firms than they do with firms in mature industries. Fintech startups were acutely reliant on cooperative regulatory staff to assist them in addressing inexperience, unproven products or resource constraints (regulatory staff acted as advocates for firms within the FCA and with incumbent institutions), but were also more malleable in a business and cultural sense. Cooperative and collaborative interactions were vital for the regulator and firms to agree on how products could be adjusted to be safely and legally commercialized, how regulation is perceived and what kind of relationship with the regulator was possible and desirable. However, Fahy (2022) does not find frontline interactions to affect the motivation to comply with regulation, indicating potential regulatory capture after a point of growth; firms are left motivated to continue their cozy relationship with the FCA, but not any more motivated to comply.

From a legal point of view, actor-specific, tailor-made interventions may be necessary, without the need to enact new rules of general application (Kaal, 2013). The post-crisis bank supervision approach of a pre-specified toolkit of bail-ins, bailouts and Basel III (e.g. Coffee Jr. 2011) may not be adequate or suitable for the FinTech sector, while its resistance to discretion may have been corroded by regulator actions in the collapse of Silicon Valley Bank and the UBS- Credit Suisse merger. Although a harmonised treatment of the same risk across institutions (and consistency in rules) is desirable, it would be important, all else being equal, to avoid this leading to excessive homogenisation of business models. Besides, it is unlikely that there is single identifiable "best practice" approach that should be applied to all duty holders "across the board." Rather, because different duty holders confront different external

pressures, and have different skills, capabilities, and motivations, what constitutes a best practice intervention strategy may vary with the context (Gunningham, 2017).

Such flexibility could be achieved through a shift in regulation from rules-based to principles-based, and regulatory sandboxes, such as those implemented by FCA, can be helpful in this regard (Fenwick et al., 2017). A key issue in the application of the sandbox is maintaining a level playing field between startups and established firms as well as firms licenced to participate in the sandbox and those that have not. The Australian sandbox variant, contrary to the application-based process of the FCA which allows it to exercise a measure of control in the process, makes certain startups automatically eligible for the industry licensing exemption. That exemption allows certain FinTech firms to engage with the sandbox without holding an Australian financial services licence. A thorough comparison, and a discussion of jurisdictions that mimicked the FCA can be found in Bromberg et al. (2017).

Nonetheless, neither principles nor rules usually function particularly successfully when independent from each other, while detailed rules can be quickly outdated and easily gamed (Black, 2017). On the other hand, principles-based regulation may create legal uncertainty as to the expectations of the regulator[6] and undermine effective enforcement, since it is easier for firms to dispute the findings of the regulator before the court.[7] A regulator's flexibility can be limited early by the choice to retain (build) on-premises supervisory structures or to deploy (buy) cloud-based software-as-a-service tools, but there should still be timely legal observation through legislative standards based on policy strategies (McCarthy, 2023). In that framework, express top-down guidance on how best to devise applicable standards, accompanied by discrete practical measures such as regulatory sandboxes, is preferable. Moreover, the regulatory success of the UK led to its framework being exported, which has positioned the regulator ideally for international engagement post-Brexit as well as allowing for the combination of domestic-led frameworks in order to develop an international regulatory nexus (Schilling de Carvalho, 2022).

Regulators should thus apply a combination of compliance and enforcement strategies, and maintaining flexibility is key. Each strategy alone has strengths and weaknesses, thereby compensating for the weaknesses of one strategy with the strengths of another, and prudently selecting the mixture of strategies, is key (Gunningham, 2017). In general, regulation-induced fear of legal sanctions, reputational risks, and peer pressure through voluntary commitments are sufficiently powerful to induce relatively high levels of regulatory compliance in many regulatory programmes and contexts (Gunningham, 2017). Finally, regulators should have the capacity for early intervention, when the technology is still under development. This could be achieved when new technologies are evaluated already during the licensing process, in order to have compliance by design in the new systems.

[6] See also Payment Services Association, 'Response to FCA Call for Input on Changes to the Safeguarding Regime for Payments and E-Money Firms Call for Input The Payments Association' (2024), 10 Institute of Chartered Accountants in England and Wales (ICAEW), 'CP24 / 20 Changes to the Safeguarding Regime for Payments and e-Money' (2024), 5;

[7] See FCA, 'Changes to the Safeguarding Regime for Payments and E-Money Firms Disclaimer' (2024)

4) Data-driven regulation

Data-driven regulation, namely rules based on relevant and timely information, facilitates regulators' predictions and anticipation of otherwise unforeseeable contingencies, making anticipatory action by regulators possible (Kaal, 2013). In line with earlier remarks, regulatory interventions should be well-thought, minimal, and with clear benefits to avoid increasing complexity of the financial system; regulation with only marginal benefits that increases complexity should be avoided (Allen, 2022). The regulator should step into action either when the risks posed by disruptive technology cross the threshold of systemic proportions and become materially destabilising or when there are individual company systemic status signal changes in terms of size, volume, and risk (Anagnostopoulos, 2018). Besides, the small size of many FinTech companies combined with the already sizeable barriers to finance dictate that the regulation should aim at imposing minimal administrative burdens on firms (Magnuson, 2018).

Regulators need to engage in adaptive learning and treat policies as experiments from which they can learn and which in turn can help shape future strategy. In particular, adaptive learning is heavily dependent on the depth and accuracy of an agency's statistical database and other information sources. Only with adequate data collection and interpretation, can a regulator know how effective or otherwise a particular regulatory strategy has been. An excellent regulator needs to be constantly self-evaluating, learning and adapting its approach, identifying emerging problems and acting promptly to solve them (Gunningham, 2017).

5) Legitimacy of regulatory actions and independence of regulators

Although the topic is not central to the paper, we find it useful to comment on regulatory legitimacy and independence for completeness. Legitimacy or political acceptability, including positive public perceptions of the regulator, is important. Maintaining legitimacy is important for regulators, even where this conflicts with what might otherwise be judged to be the most appropriate strategy, because proposals that cannot gain political acceptance are unlikely to be adopted (Gunningham, 2017). To the extent possible, regulators should avoid bowing to political pressure that results from short-term political considerations and influence from interest groups. Long-term risks (such as market stability, sustainable growth, trust in regulators, etc) may outweigh short-term benefits. In particular, the focus of elected officials and political appointees on the next election might be too short-termed to do the hard work needed to prevent crises that may occur many years in the future (Allen, 2022).

A final point is the relationship with regulators in other jurisdictions, since FinTech has a strong cross-border element that has relied (until recently) in an environment of ample liquidity and investment capital. As argued earlier, the export of the UK sandbox approach has put the country and the regulatory authority in a strong position, since other regulatory authorities have opted to adopt a similar framework. This can reduce frictions, improve coordination and reduce differences. In that vein, a "race to the bottom" of regulatory arbitrage and supervisory standards, to attract FinTech, might be countered by a global minimum standard, which would require all FinTech firms to mention, next to their name, the regulator responsible for their

oversight (Lehman, 2020). This would serve as a kind of quality mark for the supervised firm and incentivise improvement of oversight among regulators.

B. Specific measures proposed

In the legal and economic literature, a series of regulatory measures have been proposed to mitigate the risk for consumers of failing FinTech companies. These include measures to mitigate the systemic risk of FinTech companies, since the materialisation of such risk may affect the wider consumer trust and thus economic growth. Although the measures proposed do not specifically concern the UK regulatory landscape, they can serve as a benchmark for the evaluation of the UK regulations and useful suggestions for future changes.

1) Regulatory capacity building

i) Regulatory understanding of FinTech business models and underlying technologies.

Regulators should have a solid understanding of the business models and the technologies used by FinTech firms. If regulators do not understand how the system works, it is very hard to build in mechanisms either for managing risk or for ensuring the system's resilience when those risks crystallise (Black, 2012). Magnuson (2018) makes a series of suggestions, which we find fruitful. First, regulators should adopt a "regulation lite" model that incentivizes FinTech firms to provide information to regulators about their businesses and seek guidance on the applicability of current law. Second, FinTech regulation should aim at producing high-quality information in the most cost-effective way possible. Third, other measures include centralising the regulatory authority, creating targeted FinTech regulation, establishing simplified registration procedures. Regulatory sandboxes, accelerators, innovation hubs and other forms of communication between regulators and FinTech companies facilitates testing different technologies and their impact on regulation and have been very helpful and successful until now (FSB (2017), Twohig (2023)).

Technical expertise of regulators and enforcers has been identified as a key enabler of effective supervision and enforcement (Boeddu et al., 2022), since they ensure that they have the increasingly multidisciplinary capabilities needed to understand and deal with FinTech-related risks (Boeddu et al., 2021). Out of the many regulatory issues highlighted in the Wirecard collapse, two are particularly relevant. First, regulators should develop and acquire technological competences, to avoid losing sight of the true business model of the entities supervised; the expansion of the cadre of activities of Wirecard led to both excessive and lacking supervision (Navaretti et al. (2020), Langenbucher et al. (2020)). Second, differences between soft and hard regulatory capture can be vital. BaFin was not hard captured in the Wirecard case, as de facto influence cannot be proven, but de jure dependency vis-à-vis the Ministry of Finance (as implicitly endorsed by German law) might have contributed to soft regulatory capture – especially in the aspect of the short selling ban (Buttigieg et al., 2023). Therefore, coordination problems among different authorities may arise, especially in the BoE-FCA-PRA-Treasury constellation, which strengthens the point for regulatory consolidation up to a degree; beyond a certain point, monitoring large influential firms with multiple business activities becomes exponentially difficult. However, technical expertise is not enough:

humility, curiosity, and scepticism of conventional wisdom are also important, given the uncertainty surrounding the impact of new technologies on the financial system (Allen, 2022).

Financial stability regulators should also try to foster a culture of innovation that could generate out-of-the-box solutions to regulatory problems, apart from establishing new rules. Consolidation of technical experts in one agency would facilitate collaboration among them (Allen, 2022). Obliging FinTech companies to provide incident reporting, in case of serious disruptive events - "event" subject to regulatory definition - would be another potential measure (Allen, 2022). Moreover, stress tests and simulations on hypothetical scenaria could be conducted to explore the impact of potential technological failures to the system and help determine appropriate regulatory responses (Eickstädt and Horsch, 2021). These elements are directly related to our focus on tail risk.

A final remark is that regulatory sandboxes have been successful but are not harmless (e.g. Kelly, 2018) and have only been applied and tested in a period of low cost of borrowing and ample capital liquidity. Although successful and protective of consumers, sandboxes may also foster regulatory arbitrage, overdependence on state protection, support of poor business models, acting as advertising mechanisms or ignoring consumer protection (Ubrich (2020) for a summary from a business perspective). In some cases, it might be seen as preferential treatment and absorbing resources from other sectors that require support (McNulty and Milne, 2021). The earlier comparison with Australia is indicative of the debate around selective or inclusive sandboxes mechanisms and "regulatory race to the bottom" concerns. However, there is consensus that flexibility, adaptability and a safe operational environment for startups are instrumental for sector and wider economic growth.

ii) Technological tools for supervision (SupTech) and limitations of machine learning systems in risk management and oversight.

Supervisory technological tools are indispensable and enable regulators, through the increased use of information technology to become more vigilant and reflectively flexible in differentiating among various types of market players (i.e. size/volume and systemic risk, business practices, ethos and ethics etc) (Zeranski and Sancak, 2020). Better information also contributes to (a) continuous monitoring and potential update of the regulatory perimeter, (b) timely responses to changes in market conditions and practices, and (c) handling macrofinancial risks, since the collection of regulatory information allows the main pockets of vulnerability and contagion channels to be identified (FSB, 2017).

Supervised firms and regulators often use machine-learning systems (and, recently, the special category of AI-based systems) for risk managements. While such tools can offer valuable insights, caution is required in their use. Specifically on prediction of tail risk, the usefulness of machine-learning systems is limited because most training data comes from normal times when companies are not under stress. (Allen, 2022). This concerns not only the estimation of the likelihood or impact of a tail event, (by its nature ambiguous, and even more problematic if such risks and events are not contained in the data or are not considered as such), also the risk of increased coordination and herding during a tail event: if a large number of financial institutions rely on the same or similar machine learning algorithms and these algorithms are

exposed to the same or similar data, then their decisions may also be similar, leading to tech-based herding, flash-crashes or runs. Especially robo-investing platforms have the potential to coordinate investor behaviour on a scale that has never been seen before— if these platforms rely on technology that is unreliable during tail events, then tail events could have catastrophic outcomes (Allen, 2022). This overall lack of awareness and predictability can amplify the effect of tail events and pose a threat to the stability of the financial system.

As a result, machine-learning systems tend to underappreciate correlations among asset performance in times of distress. Two further risks are the rise of monopoly-like market forms in providing SupTech and RegTech tools, as well as improving the way such models detect previously unknown risks (Gaspari (2019), BIS (2019)). A less obvious limitation of machine-learning systems is the automation bias, i.e. the reluctance of most people to dispute the output of automated systems. Regulators might blindly defer decisions to machine output, since it may be impossible to evaluate the results or engage critically with the models' decision-making process (Allen, 2022). Danielsson et al (2022) push that argument even further. AI is most useful under clear rules and objectives and repeated related past observations ("known unknowns"), which allow it to work on a correlation basis and perform well on micro financial problems. On the contrary, during a crisis, rules and norms are violated, unknown unknowns take over and causal relationships (where AI is at its weakest) dominate, which make AI unsuitable for addressing macro financial issues. The use of AI in macroprudential supervision should be heavily scrutinized and rejected if any of these issues become pertinent, as it can lead to permanent dependence on that toolset. Hence, risk-management systems based on machine learning should be combined with further risk management methods.

Therefore, RegTech and SupTech tools are necessary to the regulator but only under very careful consideration of their capabilities, limitation and scope. Allowing them to automate regulation can lead to great problems, since they often operate as black boxes rather than tractable analytical tools. To mitigate such risks, human oversight is paramount, ideally by a senior manager leading an equipped team who understands both the technology and has a background in finance. The improvement of algorithm training and more clarity on algorithm operation and output are paramount for effective risk management. A principles-based regime should require that firms adopting machine learning models prioritize a focus on low probability but high consequence events, so that the models learn how to respond to the unexpected. This involves data scientists taking outliers and instability explicitly into account, and adjusting model training accordingly, rather than excluding, mislabeling or ignoring them (Allen (2022) for a more thorough discussion). As the use of machine learning in risk management becomes better understood, regulators might also decide to implement more concrete rules. One possibility is that regulation could require data scientists to emphasize tail events during the tuning process by mandating an asymmetric cost ratio that makes underestimates of losses in risk models far less common than overestimates.

The final point considers the institutional position and demands on the regulator. Despite technological advances, there is no silver bullet and a combination of experience, technical prowess and maintaining the onus on human rather than automated decision making seems like the most prudent way forward. It is clear, though, that FinTech regulation contains a lot of

uncertainty and resembles a balancing act, in which the regulator's reputation is largely at stake. Suggestions such as extending to regulators a 'permission to fail', since similar failures are recognized as a necessary part of the private sector innovation process (Allen, 2023) should be treated with caution, for they might hurt the credibility and consistency of the regulatory authority.

2) Operational requirements and risk management

i) Protection of client funds

Protection of client funds is paramount for maintaining client trust and mitigating the effects of tail risks. There should be trust that a minimum level of quality of services is maintained. Client funds held by the FinTech company should be promptly returned to clients and should be segregated from other funds held by the platform operators (Boeddu et al., 2022). There have been proposals about a possible expansion of bank-type deposit protection to at least certain FinTech firms, such as e-money institutions (Fowler, 2020, Boeddu et al., 2022). At the very least, there should be clear information of FinTech clients whether their funds enjoy deposit insurance or not (Fowler, 2020).

Nevertheless, there is a fundamental difference between credit institutions (banks) and non-credit institutions (including FinTech firms, mainly payment institutions and e-money institutions): the latter are not allowed to accept deposits. Since deposits are a debt of the credit institution to the client, credit institutions are subject to much more stringent requirements concerning capital adequacy, liquidity, governance etc, while they are covered by deposit protection schemes as an additional protective layer. Non-credit institutions are obliged to safeguard client funds, which from a functional perspective (through segregation requirements) or also from a legal perspective (in case of a trust) are considered property of the clients. A deposit protection scheme applicable to non-credit institutions would bypass the fundamental distinction between credit institutions and other financial institutions and would convert client funds to deposits. Thus, non credit institutions would become credit institutions, yet without the respective safeguards. This would have a series of unintended consequences in terms of competition, moral hazard, systemic stability, and consumer protection.

ii) Orderly business records

More stringent disclosure requirements related to a FinTech company's liquidity position and more detailed breakdown of a company's cash flows are regulatory initiatives that are often contested as "red tape" from FinTech firms. However, they are necessary. Lack of orderly record keeping is one of the major challenges faced by those affected by the Synapse collapse, and opaque business structures were one of the main reasons of the Greensill Capital fallout (Ellina and Milman, 2023). Provisions on such requirements would prevent information asymmetries, reflect accurately the financial health of FinTech firms to regulators and investors, and ensure the existence of effective mechanisms to manage liquidity crises (Twohig, 2023). FinTech companies should make subject to stricter disclosure requirements, so that regulators can better estimate their risk of default (Anwer et al., 2025).

iii) Contingency planning

Both FinTech companies and regulators should have contingency plans for cases of catastrophic risks. Contingency planning is essential to ensure that customers can access their funds, even during operational disruptions. It should include plans for cyber-attacks, as well as risk management of third-party services providers, such as cloud services and data services (FSB, 2017). The increase in total connectedness during global events such as the COVID-19 pandemic reveals a need for FinTech firms to enhance their preparedness for systemic shocks that impact multiple players simultaneously (Anwer et al., 2025). While Fintech consistently acts as a shock absorber in long-term scenarios, it becomes a shock transmitter during adverse economic conditions (Ha et al., 2024). Stronger safeguards are vital—not only to shield users from the fallout of platform failures but also to rebuild trust after events like the Synapse collapse (Mouka, 2024). Regulators should have their own contingency planning, which could include circuit-breakers to avoid the spread of the vulnerabilities across the system, and limiting exposures to certain entities or activities (Allen, 2022, Prasanna et al. 2019).

iv) Determine criteria for classifying FinTech companies as companies with systemic risk.

Similar to credit institutions (banks), there should be special rules for Systemically Important FinTechs, if not for the entire financial system then for the FinTech sector. Potential classification criteria could be the amount of cross-jurisdictional activity and the degree of interconnectedness (as e.g. represented by intra-financial assets, liabilities and securities, network-based risk assessment tools, financing sources, business-to-business credit provision and structure), the number of users, the complexity and entrepreneurial risk of supplied financial services, products and technologies, processes and algorithms used by the FinTech (some criteria discussed in Eickstädt and Horsch (2021)). Systemically important FinTech companies could be made subject to stricter rules regarding capital requirements, risk management, and reporting. A crucial first step is a FinTech Registry, where firms providing tech-based financial services could be registered along with a description of activities, assets, products and business relations (e.g. leveraging tech from other providers or developing novel products). This would also address the known weakness of classification and definition around FinTech.

3) Non-regulatory measures

i) Cross-border and cross-agency cooperation

The growing importance of FinTech activities and the interconnections across the financial system render useful the enhanced cooperation and communication among relevant supervisory authorities, to ensure preparedness (FSB, 2017). Regulators should work closely with their counterparts in foreign countries to design regulations that work on the global level. Since FinTech companies are often active in more than one country, regulatory decisions in one jurisdiction may both affect other jurisdictions, while regulators in different countries may possess useful firm-level information and knowledge on the effects of certain forms of regulation (Magnuson, 2018). Harmonisation could also reduce regulatory arbitrage, if a race to the bottom can be prevented. As mentioned earlier, the UK has an early advantage in that area due to pioneering and exporting the most widely adopted regulatory framework.

iii) Account for behavioural aspects

Behavioural aspects in the supervision and enforcement process are less salient but may have significant repercussions. Regarding supervisory authorities, home-country bias may lead national supervisors, acting in the context of economically competing nation states, to align their supervisory behaviour with political, i.e. national economic, considerations (Jakubeit, 2021). This has been illustrated in the *Wirecard* fallout, when the German regulator (BaFin) ignored warnings about financial misconduct of a supervised, national FinTech entity (Véron, 2020).

Concerning firms, optimism bias causes firms' directors to underestimate the likelihood and potential impact of adverse events (Lovahlo and Kahnemann, 2003), with direct consequences for their risk exposure. Specifically, availability bias drives directors' decisions based on the easiness of recalling instances of catastrophic events and the number of such events events (Ansari, 2023). Since such events are by definition rare, directors tend to ignore their likelihood of occurring. These biases explain, in part, the findings of the FCA on reduced compliance to the requirements of wind-down planning[8] and of segregation of client funds.

iv) Promote financial and digital literacy policies.

The importance of financial literacy of consumers in the context of FinTech is undisputed. FinTech clients may be subject to extremely targeted advertising, behavioural nudges, and face technology related barriers (Giorgiantionio and Rotondi, 2021). They may also be unaware of their risk exposure, such as counterparty risk, due to lax regulation, lack of knowledge of the firm's principal place of business (e.g. FinTech firms registered outside large jurisdictions) and may take important financial decisions in isolation, without consulting a professional (Locatelli and Tandra, 2021). Financial consumers should know that FinTech might be used as an alluring word to induce users to place money on technological solutions (Zeranski and Sancak, 2020). This point may be particularly important for low-income consumers, who may be unaware or ill-informed on the exact nature of credit or financial services they become involved in, and may expose them to illicit activities or exploitation (Ashton and Gregoriou, 2025).

IV. Comments on the proposed changes by the FCA to the safeguarding regime for payments and e-money firms

In this section, we add some of our own comments on the debate for the proposed changes to the safeguarding regime for payments and e-money firms[9], taking into account various stakeholder responses. We classify them according to each field and provide, where possible an appropriate reference[10].

1) External audits

[8] FCA, Observations on wind-down planning, TR22/1, April 2022, paras 1.3-1.4; FCA, Changes to the safeguarding regime for payments and e-money firms, CP 24/20, September 2020, para 1.3.
[9] FCA CP 24/20, September 2024, <https://www.fca.org.uk/publications/consultation-papers/cp24-20-changes-safeguarding-regime-payments-and-e-money-firms>.
[10] TPA, 6, 9; UK Finance, 19; COSEGIC, 41; ICAEW, 3.

Regular external audits on compliance with safeguarding requirements are very helpful in promoting compliance. Such audits could be conducted by special qualified and experienced professionals, not only by statutory auditors, which would likely reduce the cost for the firms. The FCA could develop a list of qualifications that such auditors should have. The introduction of an auditing standard under which safeguarding audits must be completed would ensure consistency and facilitate compliance and supervision.[11] Moreover, it would be helpful to have wind-down plans and resolution packs also audited, to ensure that they are regularly updated.

2) Reporting

The strengthening of reporting requirements, including the increase in frequency, is necessary to promote compliance and enrich the data available to the FCA. This is especially important for tail risk events, because their catastrophic impact may cause a firm to fail within a very short timeframe. Reporting of safeguarding returns will also be useful in managing sudden collapses of firms as a result of a tail event, because it would provide recent data and would facilitate prompt update of 'resolution packs' to aid the insolvency proceedings.

3) Small firms

Small firms, whether e-money institutions or authorised payment institutions,[12] should not be exempted from undergoing regular safeguarding audits. The absence of audits would increase risk for consumers, especially the vulnerable ones,[13] and would not promote public trust. Moreover, having small firms audited promotes a culture of compliance and risk management from an early stage, and mitigates the risk of inadequate systems and controls as these firms grow and handle increasingly larger volumes of relevant funds.[14] Nonetheless, to avoid creating disproportionate burdens and undesired market effects, less onerous requirements could be imposed on small e-money institutions, such as a simplified auditing standard and less frequent safeguarding returns (e.g. quarterly).[15]

Besides, to qualify as 'small', e-money institutions need to generate average outstanding electronic money of up €5 million immediately before registration; and over the period of 12 months preceding their application for registration, process a monthly average amount of payment transactions up to €3 million. Since these requirements refer to *average* amounts, it has been correctly observed that even small -money institutions may handle amounts higher than €5 million during *some days*.[16] If a tail event occurs and causes collapse on one such day, the amounts at stake may exceed €5 million and resemble those of ordinary e-money institutions. Hence, there is no justification for the exemption of small e-money institutions from the annual auditing requirements.

[11] ICAEW, 3.
[12] See also UK Finance, 17 (para. 5.2.1) and 47 (para. 8.6), which also advocated for equal treatment between EMIs and APIs.
[13] See Financial Services Consumer Panel, 2, which describes such risk as 'existential'.
[14] ICAEW, 4-5.
[15] See also Apockinas (response to consultation question 6), who suggests that the scope, frequency, and format of audits should be tailored to the firm's size, risk exposure, and compliance history; UK Finance, 21, which recommends that all firms should submit safeguarding returns on a quarterly basis.
[16] COSEGIC, 5.

It should be noted that although the failure of a single small firm may not have a significant impact on the market, a tail event might cause multiple small firms to fail at the same time. The aggregate effect could have systemic consequences.

4) Designated Safeguarding Accounts

Requiring firms to receive client funds into designated safeguarded accounts is correct and would enhance protection of client funds. However, further exemptions will probably be needed to accommodate the needs of firms operating multicurrency international business models (to the extent that these are not covered by the proposed exemption in the new CASS 15.5.5(2)R) as well as future, innovative business models.[17] The requirement that client funds should be received on the same day seems to create some serious operational challenges for many firms, especially regarding liquidity and speed of operations (Lafferty and Budd, 2025),[18] which could create significant compliance costs for firms.[19] It would be worth exploring alternatives to this requirement for some cases, e.g. to focus on the balance of the safeguarded account each day representing the acquirer's calculation of its liabilities, rather than placing scheme funds directly into the safeguarded account or to establish a waiver process if firms can prove equivalent protection of client funds via other means. [20]

5) Alternative means of safeguarding

Safeguarding by insurance or investment in low risk, liquid assets can be maintained, because it provides flexibility to firms, especially in cases where these encounter difficulties in finding a designating safeguard account. However, a more careful assessment is needed.

i) Safeguarding by insurance or guarantees

An advantage of safeguarding by insurance is that insurance companies could motivate firms to comply with the applicable regulatory requirements through appropriate terms in insurance contracts.[21] This would be a form of 'smart regulation' in the sense of engaging external actors in the compliance process (Gunningham, 2017). Nevertheless, consumers have expressed significant reservations on the use of insurance policies and comparable guarantees. These regard, among others, potential violations of the insurance policy by the firms, which could lead insurance companies to deny coverage.[22] A solution could be laying down a statutory rule comparable to section 148 of the Road Traffic Act 1988: insurance companies would not be able to deny payment to firms' clients for violation of the insurance policy by the firm (but would have a right of redress against the firm). Yet, if insurers paid the clients of a collapsed firm, despite the firm having breached the insurance policy's terms and conditions, and insurers had merely a right of redress against the firm, then insurers would become (unsecured) creditors in the firm's insolvency proceedings. This would significantly raise the risk for insurers,

[17] UK Finance, 29; TPA 7; COSEGIC, 7; Apockinas (response to consultation question 9).
[18] See UK Finance, 50, 53; COSEGIC, 6.
[19] See UK Finance, 33, which cites the case of one acquirer, who estimated that it would need £250 million debt funding, which at current interest rates and margin could cost up to four million pounds per annum.
[20] UK Finance, 26-27, 54.
[21] See also Kunreuther (2015), on the role of insurance in the management and financing of extreme events.
[22] Financial Services Consumer Panel, 7.

leading to reduced availability of relevant policies and higher premiums. In any case, insurance has the downside of potential litigation as to whether there was a violation of the policy or not. Hence, the use of insurance as an alternative to safeguarding may need to be reconsidered.

On the other hand, the use of insurance policies and comparable guaranties seems to be very limited in the market,[23] so the resulting actual risk for consumers is low. At the same time, the FCA may not wish to give the impression of depriving firms of flexibility. Taking into account the FCA's recent political mandate to focus on growth,[24] maintaining the current possibility might be a preferable option for the FCA. In any case, additional rules and/or guidance on the required financial health and reliability of the insurer or guarantor would be helpful, to mitigate the risks of insurer or guarantor insolvency.[25]

ii) Safeguarding through investment in low-risk, liquid assets

Investment returns could enhance the firms' financial position. As to whether an additional permission would be necessary for firms to invest client funds in low-risk, liquid assets, it has been correctly observed that this would be unnecessary and disproportionate, given (a) the limited and well-defined types of assets into which the investment is allowed and (b) that firms do not provide investment services to consumers, but manage safeguarding funds for liquidity and security purposes, which falls squarely under their existing safeguarding obligations.[26] Nonetheless, firms should only be allowed to hold the assets they invest in, if they have the necessary license to operate as an investment firm.

6) Resolution packs

Resolution packs will be extremely useful in an insolvency. The requirements to retain an up-to-date resolution pack should be firmly enforced.

7) Appointment of a single individual for compliance oversight

Appointing a single individual of sufficient skill and authority to be responsible for the firm's compliance with safeguarding requirements is a positive step, yet more detailed guidance is needed, such as necessary qualifications, whether this person needs to be a board member etc. It is submitted that the position of such person could combine elements from the position of Data Protection Officer (DPO) and of an Anti-Money Laundering (AML) officer. This means

[23] According to a survey of the European Banking Authority (EBA) among EU Member States, which was conducted in 2021, data gathered from 18 EU Member States indicated in only one State was insurance the prevalent safeguarding method – see 'Opinion of the European Banking Authority on the treatment of client funds under Deposit Guarantee Schemes', 27 October 2021, para. 28. https://www.eba.europa.eu/sites/default/files/document_library/Publications/Opinions/2021/1022906/EBA%20Opinion%20on%20the%20treatment%20of%20client%20funds%20under%20DGSD.pdf. See also 'What you need to know about safeguarding of accounts, assets and funds', https://www.wearefreemarket.com/blog/need-to-know-safeguarding-accounts-assets-funds, where it is stated that in the UK the segregation of funds is used universally, while for the insurance method the author of the post is unaware of any real-world use case.

[24] Letter from the Chancellor of the Exchequer to the Chief Executive of the Financial Conduct Authority (FCA) providing recommendations for the FCA, 14 November 2024, https://www.gov.uk/government/publications/recommendations-for-the-financial-conduct-authority-november-2024.

[25] Apockinas (response to consultation question 15).

[26] Apockinas (response to consultation question 12).

that this person should (a) have a detailed understanding and overview of the firm's safeguarding methods and procedures, in view of its exact business model and financial operations, (b) be able to oversee reconciliation procedures, (c) be responsible for preparing and updating resolution packs, and (d) advise senior management on related issues. Liability for a safeguarding failure should attach mainly to the firms' directors, since appropriate safeguarding procedures are a wider organisational aspect of a firm, while a single person should not be serving as a scapegoat in case of such a failure.

8) Statutory trust

Establishing a statutory trust on client funds would significantly enhance legal clarity and the consumer rights in case of insolvency. The definition of 'relevant funds' is also very helpful, as it overcomes ambiguities of the previous regime (Simpson et al., 2020). This does not overlook that a statutory trust cannot resolve all relevant challenges, such as where the relevant funds have been conveyed to a bona fide purchaser for value or where those funds have been dissipated,[27] or where the shortfall of funds has been caused by a third party, e.g. the account bank or insurance provider.[28] Nonetheless, it is a solution with more advantages and less disadvantages compared to the previous regime.

V. Implications for the FCA and recommendations

This section contains our first set of conclusions. The current FCA regulatory framework seems fit for purpose, concerning the provisions as such. The FCA oversight and enforcement practices, as laid down in its guidance and official documents, fulfil all requirements established in legal literature for a robust regulation. This is valid also for the majority of specific regulatory and non-regulatory measures proposed in the legal literature. Nonetheless, the FCA might wish to consider some recommendations.

We find it helpful for the FCA to account for behavioural parameters in its enforcement practice. Particularly regarding tail risks, the directors' optimism bias and availability bias are important challenges to be overcome. The proposed improvement in record keeping and enhancement of monitoring and reporting are steps in the right direction. External audits of safeguarding compliance could include auditing of wind-down plans. Potential personal liability of the company's directors in case of (negligent) non-compliance with safeguarding requirements would be useful to be reminded with every opportunity.

Reporting of serious incidents affecting the technical infrastructure of the firms or their safeguarding practices would enhance FCA's understanding of potential risks and help it proceed with appropriate action, when needed. Serious incidents could encompass 'near misses', i.e. situations were no harm or only limited harm occurred, but actual grave harm could easily have occurred under the circumstances. The first step would be to define a 'serious incident' in the applicable regulations and following a public consultation. Then, the FCA could

[27] UK Finance, 40 (para. 7.3).
[28] UK Finance, para. 7.4.3 (p 44).

mandate the establishment of an internal incident database in each firm, where (anonymised) data on serious incidents can be registered, alongside their causes and remedial actions. Such data could be registered in already existing databases, e.g. for cybersecurity purposes, to reduce compliance costs. At the same time, such data should be sent to the FCA, pursuant to a template, and registered in a central FCA database. The FCA could then process the data and issue recommendations and guidance - or even new rules, if necessary.

Valuable insights could be gained by conducting stress tests and simulations of adverse scenaria to explore the impact of potential tail events, including technological failures. These could be conducted during random audits, whose exact scope needs to be carefully delineated. On the one hand, given the interconnectedness of the financial system, it would be useful for such tests and simulations to be conducted irrespective of the firm's size. On the other hand, it could be argued that proportionality would require concentrating only on 'systemically important' firms. Such designation could follow specific criteria, such as volume of transactions, interconnectedness, and number of users.

Furthermore, the FCA could explore requirements for training data used in machine-learning software for risk management, to account for the possibility of tail events. As to the proposed safeguarding rules:

- External audits could be conducted by persons or entities who are not statutory auditors.
- Small firms should not be exempted from the auditing requirements. However, they could subject to a lighter regime for proportionality reasons.
- The requirement to receive client funds directly into designated safeguard accounts could be refined through addition of an exemption for firms with multi-currency operations and a special waiver process.
- Additional rules and/or guidance on the required financial health and reliability of the insurer or guarantor would be helpful, to mitigate the risks of insurer or guarantor insolvency.
- The requirements to retain an up-to-date resolution pack should be firmly enforced.
- further clarifications would be welcome on the necessary qualifications of the individual responsible for overseeing compliance with the safeguarding requirements. The FCA could combine elements from the position of DPOs and AML officers.

Overall, unintended consequences and regulatory failures, by their nature, will always occur (Black, 2012). Keeping an open mind and constantly striving for improvement, through internal and external feedback mechanisms, should be maintained as a priority for the FCA.

VI. Quantitative analysis of the impact of FinTech tail risk on economic growth, individual consumers and SMEs

The previous sections analysed the various economic and regulatory risks FinTech may pose for regulators and consumers. The economic literature has started to address such risks only recently and mainly by examining spillovers between FinTech and traditional banking. With few exceptions, such as Anwer et al. (2025), tail risk remains unexplored. A common selection issue is that the samples often include large tech firms that provide payment systems or support for financial services (Amazon, Apple, Google etc.) as well as FinTech firms. We avoid that caveat and focus on firms listed in the London Stock Exchange.

Some of the FinTech risks for individual consumers identified earlier were exposure to predatory practices from rogue credit providers, overreliance and excessive indebtedness, onerous borrowing and repayment terms, loss of funds (wealth, savings), lack of information on financial products and limited financial literacy leading to harmful investment decisions, misuse of existing tools. These are particularly relevant for low-income consumers and SMEs, which we explicitly discuss. Although FinTech is often regarded as having closed the financial gap for SMES, some of the risks on credit provisions are higher loan riskiness and costs for SMEs, exposure to riskier, unsecured debt by default for FinTech lenders leading to increased fragility, reliance on hard data only for lenders, lack of due diligence as well as misleading information from customers. The latter suggests both a precarious situation on behalf of small businesses as well as an unwillingness of FinTech lenders to exclude riskier customers and thus limit their growth and client base. SMEs often seek to acquire collateral via FinTech loans and then access cheaper mainstream credit. Fintech credit is often seen as a stepping stone for firms to acquire collateral and access cheaper, more reliable mainstream bank lending. Finally, some of the risks FinTech poses for economic growth are stronger cross-section tail risk spillovers on the downside than the upside, higher risk of loans, opacity, low incentives to abide by regulation, more volatility and procyclicality, low governance, quick reputational contagion and some evidence that FinTech consumer lending may actually have a destabilising effect to the financial system.

These findings inform both our focus on macro and credit control variables as well as the representation of tail risk as expected losses in stock prices for firms of sufficient clout as to be listed in the stock market.

A. Sample and data collection

We collect daily closing prices 60 firms listed in the London Stock Exchange between 1st January 2008 and 29th January 2025, with 30 listed in the All Shares index (AS) and 30 in the Alternative Investment Market (AIM) index. The list, classification and starting date of each stock's return series can be found in Table 1. We then calculate daily returns for the AS listed stocks and weekly returns for the AIM listed stocks, to account for the fact that AIM stocks are infrequently traded.

Our selection criteria are

1) Whether a firm is listed for more than 4 years

2) Whether a firm describes itself as a FinTech firm on its website or LSEG profile, or whether is perceived as such by the media, e.g. having participated in or sponsored FinTech events or featured in FinTech press.

3) Whether it is involved in providing financial services explicitly by using information technology as its core business. This excludes firms that use FinTech in an auxiliary manner (e.g. high street banks or insurers using online apps), firms that outsource FinTech products (e.g. strategic partnerships between a financial service provider and a FinTech firm on a segment of the former's activities) or IT firms not explicitly focused on financial services (e.g. System-as-a-Service firms supporting financial institutions). We do include investment vehicles whose main or explicit focus is the FinTech sector, such as Augmentum, but exclude firms whose main focus is not.

4) Whether the firm is regulated by the FCA.

Stock prices are collected from Thomson Reuters Eikon. All other data is available from the Bank of England database and the Office of National Statistics.

B. Methodology

We proxy tail risk by estimating the Expected Shortfall (ES) and Value-at-Risk (VaR) in the returns of each firm. If observed stock returns over a sample period are sorted from lowest to highest, and a threshold α is selected then the VaR is the return observed at that threshold α from the left. For instance, if α=5%, and the sample N is 100 daily returns, then the return at the lowest 5% (i.e. the 5^{th} lowest return, after ordering) is the VaR. The intuition is that there is an α=5% probability of losses equal to the Value-at-Risk to be realized. Alternatively, if returns are assumed to follow a normal distribution with a known mean and standard deviation (e.g. a standard normal), VaR is the observation that lies at α of that distribution. Although VaR and VaR-based approaches are common in risk measurement and management, one of its main weaknesses is that it is a point estimate that largely ignores tail probabilities. ES, as the average of all observations lower or equal to VaR, partially improves on that weakness. In the previous example, the Expected Shortfall would be the average of the five lowest returns in the sample (αN), or equivalently the area covered by the left tail of a normal distribution.

We follow three approaches to measure ES and VaR at a fixed 5% threshold. The first is using the historical sample of observed returns. The second is to rely on the normality assumption. The third is to simulate VaR and ES based on a model designed to capture jumps in asset returns. The last approach improves on a known problem with assuming normal returns, namely that empirically they are not; stock returns exhibit fat tails, which means that rare but very large negative returns are more likely than assumed under normality or having been observed in the past. To correct that weakness, we select the Stochastic Volatility with Correlated Jumps (SVCJ) model or Eraker et al. (2003), which can capture a wide array of stylised facts in asset returns, most crucially the rare negative events at the heart of the paper. The model belongs to the broad category of affine state-space models, where asset log returns dY are observed but volatility dV is a hidden, unobserved process. The model is specified as

$$dY_t = \mu\, dt + \sqrt{V_{t-}}\, dW_t^Y + \xi_t^Y\, dN_t$$
$$dV_t = (\kappa\theta - \kappa\, V_{t-})\, dt + \sigma_V \sqrt{V_{t-}}\, dW_t^V + \xi_t^V\, dN_t$$

The first two terms in the returns process form a diffusion process, i.e. the continuous time equivalent of a normal distribution, and represent returns under normal times. The third component is the term that allows for "jumps", or large upwards or downwards discontinuities in asset prices, of size ξ and is a drawing from a Poisson distribution with rate of events (jumps) λ. The structure of volatility is similar, with a diffusion and a jump term. However, volatility is allowed to revert back to its long-run average. The two diffusion processes are correlated, which allows the model to capture the leverage effect (the negative relationship between returns and volatility), jumps in returns and volatility are simultaneous and their sizes are also correlated. The various quantities (ignoring t subscripts for brevity) are log prices Y, variance V ,W^Y, W^V Brownian motions with correlation ρ, N a Poisson process with constant arrival intensity λ, diffusive mean returns μ, return and volatility jump sizes ξ^Y, ξ^V with correlation ρ_j, "volatility of volatility" parameter σ_V, κ is the speed of mean reversion and diffusive long-run volatility mean θ. Return jumps follow a normal distribution $N(\mu_Y + \rho_j\xi^V , \sigma_Y^2)$ and volatility jumps follow an exponential distribution $\exp(\mu_V)$. The parameters of interest are the mean of jump sizes μ_Y and the frequency of jumps λ. After discretising the model, it is estimated using Markov Chain Monte Carlo as described in Chondrogiannis et al. (2023).

For AS listed firms, we calculate Value-at-Risk (VaR) and Expected Shortfall (ES) at 5% level from daily returns based on (i) an expanding window of 250 trading days initially, and (ii) a rolling window of 250 trading days. The expanding windows (an initial window over which VaR or ES is calculated, then increasing by one step for the next estimate) and rolling windows (each estimate is calculated on the previous 250 days or 52 weeks, respectively) are used for estimates based on historical (empirical) and normal distributions. We use both historical and normal distributions for ES and VaR to take into account the fat tails of returns, as the assumption of normality underestimates extreme negative events. We stress that the positive estimates represent losses (negative returns and averages), not gains.

AIM firms are characterised by infrequent trading, which we partially mitigate by using weekly instead of daily returns and expanding/ rolling windows of 52 weeks. Since a non-negligible number of weeks with no price changes is present in the sample, we provide ES and VaR estimates for the entire return time series of each firm, i.e. the maximum expanding window. Rolling estimates proved to be sensitive to the number of zeros in the window, which affects the threshold value. Rolling results with non-trading days as blanks (estimates from 52 realised observations) and zeros are available upon request.

We complement the analysis, particularly for AIM firms, by constructing a set of FinTech indices for each dataset. The equally weighted (EW) index is a naive index that empirically captures the influence of smaller stocks to a larger degree. The market capitalisation (MCW) index is a common approach to gauge portfolio performance. We calculate ES and VaR estimates at 5% level at daily and weekly frequency for the AS index and weekly for the AIM index. We consider the AIM index to be more representative of the risk and performance of

entry-level and smaller non-listed FinTech startups of comparable size, while the AS index to better represent large established firms. The windows and approaches are the same as earlier. Due to the large difference in market capitalisation between AS and AIM firms, we do not consider a joint index since the former would overwhelm the latter in terms of influence. For each AS stock we estimate the model over 5 two-year periods (2019-20, 2020-21, 2021-22, 2022-23, 2023-24) using Markov Chain Monte Carlo. We opt for two, rather than 1 year, due to difficulties in fitting data from a single year.

We conduct fixed effects panel regressions, to account for firm heterogeneity in our sample. We construct two datasets, one monthly (2021-2024) and one annual (2020-2024) using the 30 AS listed firms. The annual dataset uses the jump sizes μ^Y and jump frequency λ as tail risk variables [We also intend to simulate VaR based on the parameters]. This creates a NxT panel of N=30 firms and T=5 years (150 observations) using annual observations. Due to the small number of years, the annual regression is contemporaneous. The monthly dataset uses end-of-month ES values as tail risk measure between December 2021 and December 2024 and construct a monthly NxM panel of N=30 firms and M=37 months (1110 observations). In the monthly regression, the independent variable is lagged by one period, since no contemporaneous relationship was identified. Due to the largely homogeneous results under VaR, we only report results using ES as tail risk measure. All our parameter choices for each regression take stationarity into account and are based on correlations and VIF tests, to avoid multicollinearity. For additional robustness, we examine whether statistical significance changes if a suspect variable is removed, and only report the result if there is minimal influence.

An inherent weakness of our measures is that they do not capture correlations or spillovers of tail risk. Two unreported correlation matrices show that correlations are positive but close to zero between larger AS firms, with a maximum around 20%, while for AIM firms they are moderate, with maximum values slightly below 50%.

C. Results

1. VaR and ES descriptive statistics

Table 3 presents the average, minimum and maximum ES (panel a) and VaR (panel b) for each AS listed firm over the entire time series of estimates. ES based on historical distributions is consistently higher by 0.5%-1% compared to ES based on the normal distribution for expanding estimation windows. However, for rolling annual (250 days) windows the two are quite similar. This illustrates how the assumption of normality can lead to underestimation of large downside risk for long horizons. A short-term investor might be prone to focus on estimates based on shorter horizons, while a regulator might be more interested in long-term behaviour. Aptitude Software (11.98%), Funding Circle (8.17%) and Kainos (7.91%) have the highest estimates, while half the firms have an expected shortfall between 5% and 10%. Plus500 has such high maximum estimates due to the collapse in its stock price in February 2019 due to collapsing revenues. For daily estimates, this is considerable and certainly non-negligible. VaR estimates in panel b largely follow the same pattern but are markedly lower than ES. This illustrates both the greater robustness of ES as measure and the longer tails, and hence tail risk, of the firms in our sample.

Table 3, panel c reports the sample estimates of VaR and ES. They are remarkably similar (note to reader: we checked multiple times, including manual calculations) and much higher than AS firms, after adjusting for frequency. Most firms exhibit expected shortfalls of about 60% and values-at-risk of 50%-55%. This illustrates not only the magnitude but the number of large negative observations in the sample.

Table 4 contains our results for two indices, market capitalisation weighted (MCW) and equally weighted (EW) for the universe of AS firms at weekly and daily frequency and AIM firms at weekly frequency. The estimates between the two indices are very similar for AS firms, with EW values slightly higher. This shows that larger firms do not dominate the performance of the index and it is still representative for smaller firms. Typically, naive indices are better at capturing the effect of smaller stocks in a portfolio, which is not the case here. Second, the AS index is much safer than the AIM index, which mirrors our earlier results. The AIM index demonstrates very large expected shortfall and value at risk estimates. Similar to the firm level estimates, there is evidence of fat tails in the indices, demonstrated by the differences between the historical and normal results. However, an important observation is that diversification is somewhat possible between FinTech firms. Both indices are considerably safer than the majority of stock averages. For AS firms, index ES is directly comparable to the safest firms in the sample, while for AIM firms it is nearly half of individual ES.

2. MCMC parameters

The full set of parameters is available upon request. Table 5 reports average jump sizes μ_Y (Panel a) and annualized jump frequency λ (i.e. absolute number of jump occurrences per period, Panel b) for the 5 two-year estimation periods per stock. 90 jump averages out of 145 are negative, which agrees with the empirical observation that stock return jumps are negative on average. A striking feature is that the negative jumps are numerous and sizeable; 35 are below -10% and 50 below 5%. This indicates the risk of FinTech stocks on an individual basis. The parameters in red denote cases where the standard deviation of jumps, σ_Y, is statistically significant but high. This most commonly happens in periods with large positive and negative jumps, which the algorithm finds difficult to fit. Although the standard errors of the parameters are small, and convergence was assured, we are compelled to note the feature as it relates directly to the riskiness of individual stocks. In Panel b, 2-4 jumps per year are expected but there are many cases with 5-6 jumps per year, or 10-12 over two years. This agrees with our earlier remarks. Based on each set of parameters, we also simulate 1000 sets of daily returns over two years (500 drawings in each run) and calculate the expected shortfall of each simulation. We then collect the average expected shortfall of the period and construct an ES panel similar to those earlier. The estimates are reported in the Appendix, as they represent the most accurate and recent estimates of tail risk.

3. Regression results

We examine the impact of tail risk on economic growth, proxied by the rate of real GDP, and on household/ consumer and SME credit. To proxy household debt, we rely on growth rates for credit card balances, unsecured loans, household credit and unsecured loans, plus the log level of the monthly change in consumer credit. For businesses we use the 12-month growth rate of

loans to SMEs and the 12-month growth rate of loans to non-financial firms. We control for year-on-year inflation, stock market performance, unemployment, 10-year government bond yields and wage growth. All rates are used as annual decimals rather than percentages, to avoid implausibly high parameters.

Table 6, panels a to d, summarise our results using monthly data. Panel (a) shows a clear negative relation between average tail risk losses and GDP growth[29]; the higher the losses in FinTech stocks, the lower GDP growth. Although all parameters are statistically significant at 1% level, the coefficient for the historical average ES (2008-2024) is twice as high as the others. To some extent, this illustrates issues with "memory", or how far back a regulator or manager should go in order to properly assess tail risk. In the expanding window case, the largest losses of the past will dominate the expected shortfall estimate. This does not happen in the rolling one-year window, which nevertheless exhibits the same result. We conclude that FinTech tail risk can have an impact on economic growth during and after Covid.

Panel (b) reports a similar set of results for the impact of FinTech tail risk on credit card debt. There is a statistically significant positive relationship between the two, which implies that when FinTech firms are under distress individual indebtedness increases. This observation is repeated for consumer credit (Panel c). This supports our initial hypothesis that distress in FinTech may worsen the finances of individuals and households, leading to increased debt. Although that may imply better access and higher spending, it may also imply a higher rate of debt turnover and overall indebtedness, quite possibly at higher rates. The finding implies more, not less credit for households, but provides no insight on the cost of servicing that debt. Since the correlation we find is between FinTech distress and household (unsecured) debt, we cautiously suggest a worsening of credit terms for households reflected in increased debt, or aggressive promotion and credit provisions from FinTech firms to households, leading to higher debt. Overall, there does not seem to be a hindrance in access due to tail risk. Finally, Panel (d) provides a similar argument for SMEs, where SME credit increases with tail risk. Contrary to our earlier results, however, the statistical significance is not only weaker but also highly dependent on controlling for unsecured loans – in the absence of the "loans" variable, statistical significance disappears. We treat the last set of results as merely indicative, as it appears to be more sensitive than the rest.

Table 7 reports our findings on the smaller annual panel on jump arrival frequency λ (panel a) and simulated expected shortfall from each period's SVCJ parameters (MCMC ES, panel b). We do not report results on average jump sizes as they were statistically insignificant. Due to the short sample and large multicollinearity, we can only control for inflation and annual FTSE100 returns. Jump frequency is negatively related to GDP and positively related to consumer credit, credit card debt, the debt-to-income ratio and unsecured loans. There is also a positive association with the rate of change of weekly wages, but the coefficient is practically zero. In panel (b), the effects of expected shortfall are more mixed. ES does not affect GDP but

[29] A reminder to the reader that monthly real GDP estimates, in the form of an index, are available by the UK Office for National Statistics here (series ECY2) and here, and we take first differences in log scale to turn the series into stationary. We use those time series, instead of quarterly data, for obvious frequency reasons.

negatively affects consumer credit and credit card debt. Table 8 reports the panel of average jump sizes and frequency for illustration.

Finally, Table 9 reports our results for the two FinTech indices, representing sector impact on the variables of interest. We only report the statistically significant results for the Expected Shortfall of the market capitalization weighted index, since the respective results for VaR and the equally weighted index were markedly similar. A key difference with the panel regressions is that ES was trend stationary so is differenced and not lagged. There is no impact of FinTech on GDP growth but there is a positive impact on credit card growth rate and a negative impact on SME credit. These are the opposite findings compared to our panel regressions. We are obliged to remark that the statistical significance of ES in the SME regression disappears when we control for unsecured loans, which makes the finding rather precarious. Finally, there was no statistical significance for any of the AIM indices and the results are thus omitted. A key element that differentiates the panel and the index results is the presence of fixed effects. Although the sector as a whole may not appear as influential to GDP and credit, or have a positive result, specific firm clusters or operations may create adverse effects on growth, consumer lending and household debt. This emphasises the need for granular, firm-level approaches rather than overarching aggregate methods.

VII. Conclusion

In the first part of the paper, we discuss whether the FinTech regulatory framework in the UK is fit for purpose. We argue that not only it has been a resounding success, but due to its international adoption and flexible nature it has secured a very strong position for the UK internationally. The main question is how and whether that framework can scale alongside a maturing FinTech sector. Selective regulatory sandboxes have been very successful in fostering firm growth and innovation but may create overreliance on state support to the detriment of other firms and sectors. This ambivalence is present in the development and support of all nascent industries, but the open, aggressive and rapidly changing nature of FinTech can make changes in support challenging to time. Premature alterations may expose the sector to risks, while overripe maintenance may foster regulatory arbitrage, firm complacency and loss of dynamism. Both the regulator and the academic literature seem to be aware of such issues while the regulatory authorities do not suffer from particular internal constraints; however, there is external pressure on premature liberation. We also find sufficient indications that tail risk is an important yet neglected component of the highly interconnected FinTech universe, with particular relevance for risky, highly indebted borrowers.

We consider the existing regulatory framework to be suitable and the FCA oversight and enforcement practices, as laid down in its guidance and official documents, to fulfil all requirements established in legal literature for a robust regulation. The challenges we identify relate to improvements and unforeseen evolutions (hence tail risk). These include the adequate adoption of machine learning and AI tools in a critical manner that prevents overreliance, simulation-based stress and external audits tests regardless of firm size, explicitly considering outliers and credit exposure in regulatory tools. We explicitly refer to a refinement of the

requirement to receive client funds directly into designated safeguard accounts, through addition of an exemption for firms with multi-currency operations and a special waiver process.

We emphasise that this framework has not been tested in difficult conditions and has been successful in a period of ample funding, with the possible exception of the last 2-3 years. Up to now, the decentralization of UK FinTech appears to be one of its strengths; although there are large established firms in the sector, there is not a small cadre of "systemically important" firms as in China, while innovation and performance are widely spread. This has both positive (the impact on traditional banking from a collapse may be manageable) and negative aspects (many smaller interconnected firms may simultaneously face a tail event, increasing the cost of support). In the current economic environment, the negative impact of FinTech on low-income households is the most socially precarious aspect. A worrying combination of high cost of living, low household savings, increasing cost of credit and low financial literacy has emerged, which calls for better protection on BNPL schemes. UK SMEs appear more flexible and better positioned to use FinTech to their advantage, although they are not exempt from credit crunches.

Our empirical analysis on tail risk shows that fat tails are a very real and important feature of FinTech stock returns. Rare, severe losses in large FinTech firms are negatively related to economic growth and positively related to increased household and SME credit. The increase applies to consumer credit, credit card debts and unsecured loans. A further interesting feature is that both the probability of tail risk and the magnitude of tail risk appear to be related to growth and credit. While the typical interpretation would be that of increased financial access, our use of a distress measure implies both increased loan provision from lenders under risk as well as increased credit undertaking on behalf of already indebted clients. This situation can only be described as precarious, especially in an environment of high cost of borrowing and living. There is a marked difference in the influence between firm-level panel regressions and time series regressions using FinTech indices, which implies that firm-level analysis may be governed by different characteristics than aggregate-level analysis. Although on aggregate the FinTech sector may have a benevolent influence (in our case, more prudent credit provision and use), specific activities and firm types may be related to severe enough adverse effects.

These findings agree with the FinTech risks identified in law and economic literature, and we expand that argument by providing evidence of a direct relationship between credit provision and firm distress, which relates to specific firm characteristics. They could, therefore, be a cause for regulatory concern, as they directly point out to hidden or unknown risks that are difficult to predict. The limitations of the econometric analysis lead to a series of suggestions, primarily on data collection. By default, our measure of distress relies only on listed firms and does not consider non-listed firms. Comprehensive research and data on FinTech firm failure for both listed and non-listed firms is therefore necessary, especially since established measures such as distance to default rely on comprehensive data. A first requirement would be a firm registry, and a second requirement would be clearer information on firm status leading to a merger and acquisition. While default is quite clear, a merger or acquisition may indicate both corporate success and corporate failure. A third recommendation would be better, more comprehensive, data provision, as most granular data is proprietary (e.g. CrunchBase). This

implies better monitoring and stress testing at a firm, rather than aggregate level, which we believe will be useful to the regulator. We stress, however, that our aim is not to provide a definite answer to the question via a thorough, complete research paper, but rather establish that the focus on tail risk is worthy of further examination. Our results should thus be viewed as preliminary evidence that can spur further research on the relationship between FinTech tail risk, growth and consumer credit. We consider that this objective has been fulfilled and acknowledge the various limitations that could not have been addressed in the framework of the project.

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03/01/2008	ADM	ADMIRAL GROUP	Property and Casualty Insurance
10/12/2018	AJB	AJ BELL	Investment Services
30/05/2017	ALFA	ALFA FINANCIAL SOFTWARE HOLDINGS	Software
10/04/2017	ALPH	ALPHA GROUP INTERNATIONAL	Investment Services
03/01/2008	APTD	APTITUDE SOFTWARE GROUP	Software
14/03/2018	AUGM	AUGMENTUM FINTECH	Asset Managers and Custodians
22/07/2021	BPT	BRIDGEPOINT GROUP	Asset Managers and Custodians
07/11/2018	CHRY	CHRYSALIS INVESTMENTS	Closed-ended investment funds
08/02/2016	CMCX	CMC MARKETS	Investment Services
03/01/2008	CPI	CAPITA	Professional Business Support Services
03/01/2008	EXPN	EXPERIAN	Professional Business Support Services
01/10/2018	FCH	FUNDING CIRCLE HOLDINGS	
17/06/2016	GROW	MOLTEN VENTURES	Closed-ended investment funds
03/01/2008	IGG	IG GROUP HOLDINGS	
28/02/2018	IHP	INTEGRAFIN HOLDINGS	
03/01/2008	IPF	INTERNATIONAL PERSONAL FINANCE	
13/07/2015	KNOS	KAINOS GROUP	
03/01/2008	MONY	MONY GROUP	Consumer Digital Services
08/03/2016	MTRO	METRO BANK HOLDINGS	Banks
03/01/2008	NCC	NCC GROUP	Computer Services
06/06/2014	OSB	OSB GROUP	
03/01/2008	PAG	PARAGON BANKING GROUP	
03/01/2008	PAY	PAYPOINT	Transaction Processing Services
22/04/2021	PBEE	PENSIONBEE GROUP	
02/07/2013	PCFT	POLAR CAPITAL GLOBAL FIN. TST	Closed-ended investment funds
25/07/2013	PLUS	PLUS500	
03/01/2008	SGE	SAGE GROUP	Software
11/08/2016	TBCG	TBC BANK GROUP	Banks
03/01/2008	VANQ	VANQUIS BANKING GROUP	Consumer Lending
18/03/2015	VSL	VPC SPECIALTY LENDING INVESTMENTS	Closed-ended investment funds

Table 1

Panel (a): FinTech firms listed in the FTSE All Shares index (hyperlinks)

04/01/2008	AFN	ADVFN	Financial Data Providers
28/06/2019	AGFX	ARGENTEX GROUP	Investment Services
04/01/2008	ALT	ALTITUDE GROUP	Computer Services
15/06/2018	AQX	AQUIS EXCHANGE	Investment Services
04/01/2008	BANK	FIINU	Consumer Lending
04/01/2008	BGO	BANGO	Consumer Digital Services
24/11/2017	BOKU	BOKU, INC	Transaction Processing Services
04/01/2008	BPM	B.P. MARSH & PARTNERS	Mortgage Finance
10/05/2019	DFCH	DISTRIBUTION FINANCE CAPITAL	Mortgage Finance
28/05/2021	DNM	DIANOMI	Publishing
17/12/2021	DSW	DSW CAPITAL	Asset Managers and Custodians
13/07/2012	DUKE	DUKE CAPITAL	Consumer Lending
04/01/2008	ECK	ECKOH	Software
08/08/2014	EQLS	EQUALS GROUP	Transaction Processing Services
04/01/2008	FDP	FD TECHNOLOGIES	Computer Services
09/04/2021	FIN	FINSETA	Transaction Processing Services
06/04/2018	FNTL	FINTEL	Professional Business Support Services
16/10/2020	FNX	FONIX	Transaction Processing Services
04/08/2017	GETB	GETBUSY	Software
04/01/2008	INSG	INSIG AI	Asset Managers and Custodians
04/01/2008	KWG	KINGSWOOD HOLDINGS	Asset Managers and Custodians
16/07/2021	LINV	LENDINVEST	Mortgage Finance
04/01/2008	MBO	MOBILITYONE	Transaction Processing Services
04/01/2008	PCIP	PCI-PAL	Software
04/01/2008	QBT	QUANTUM BLOCKCHAIN TECHNOLOGIES	Asset Managers and Custodians
07/07/2017	TAM	TATTON ASSET MANAGEMENT	Asset Managers and Custodians
04/01/2008	TAVI	TAVISTOCK INVESTMENTS	Diversified Financial Services
04/01/2008	TERN	TERN	Asset Managers and Custodians
23/02/2018	TRU	TRUFIN	Consumer Lending
04/01/2008	VNET	VIANET GROUP	Computer Services

Table 1

Panel (b): FinTech firms listed in the FTSE AIM index (hyperlinks)

Variable	Abbreviation	Obs	Mean	St. Dev
AS returns (D)		87991	0.010%	0.029
AIM returns (W)		17455	-0.121%	0.095
Real gross domestic product	GDP %	37	6.189%	0.395
YoY Inflation rate	Inf %	37	0.465%	0.489
End-of-month yield of 10Y government bonds	10Y Yld %	37	4.194%	11.801
Rate of unemployment	Unemp %	37	4.051%	0.240
12-month credit card growth rate	Ccard %	37	11.108%	0.022
Monthly rate of unsecured loans	Loans %	37	5.424%	0.015
12-mont loans to non-financial firms growth rate	Nfbus %	37	0.368%	0.015
12-month loans to SMEs growth rate	SME %	37	-4.216%	0.007
12- month aggregate household credit growth rate	HouseCred%	37	2.354%	0.015
Log of monthly change in consumer credit	ConsCred	37	7.101	0.307
Wage growth rate	Wage %	37	5.897%	1.191
FTSE100 return	FTSE100	37	0.396%	0.030
Annualised jump frequency	λ			
Average jump size (annual decimal)	ξV			
Value-at-Risk	VaR			
Expected Shortfall	ES			

Table 2

Descriptive statistics and abbreviations

Note: Abbreviation, number of observations (obs), mean and standard deviation (St. Dev) of the variables. Percentage (%) denotes first differences in log scale, i.e. growth rates.

AS	ES expanding hist			ES expanding Normal			ES 250D hist			ES 250D Normal		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
ADM	6.90%	7.53%	6.27%	6.52%	7.16%	5.95%	6.30%	8.17%	4.06%	6.04%	8.03%	4.40%
AJB	5.91%	6.79%	3.30%	5.38%	5.99%	3.37%	6.06%	8.63%	3.35%	6.01%	7.84%	3.30%
ALFA	5.09%	6.06%	3.90%	4.90%	5.84%	4.00%	4.86%	6.92%	3.25%	4.66%	6.55%	2.94%
ALPH	5.94%	6.82%	2.28%	5.61%	6.29%	1.88%	6.16%	8.32%	2.45%	6.08%	8.58%	1.93%
APTD	11.98%	15.59%	9.88%	11.09%	13.90%	9.13%	9.38%	17.61%	5.19%	9.81%	16.68%	5.64%
AUGM	4.01%	5.36%	0.76%	3.62%	4.63%	0.85%	4.50%	6.90%	0.80%	4.28%	6.80%	0.87%
BPT	3.99%	4.56%	3.24%	3.90%	4.17%	3.47%	4.24%	7.05%	2.52%	4.04%	5.83%	2.72%
CHRY	7.94%	9.34%	5.03%	7.24%	7.86%	4.20%	6.93%	11.66%	3.70%	6.73%	9.48%	3.91%
CMCX	5.21%	5.94%	3.79%	5.32%	5.87%	4.22%	5.41%	9.31%	3.17%	5.35%	8.54%	3.30%
CPI	4.73%	5.43%	3.42%	4.53%	5.08%	3.40%	5.31%	9.26%	3.33%	4.84%	7.75%	3.33%
EXPN	4.46%	6.12%	0.71%	3.97%	5.58%	0.82%	5.46%	8.78%	0.67%	5.32%	8.41%	0.71%
FCH	8.17%	10.47%	4.03%	7.00%	8.72%	3.66%	8.28%	18.01%	2.84%	7.53%	13.49%	2.67%
GROW	6.20%	8.55%	5.54%	5.71%	6.61%	5.01%	6.15%	10.28%	2.97%	5.94%	8.25%	3.38%
IGG	6.16%	8.09%	5.80%	5.76%	6.76%	5.09%	5.70%	8.09%	3.03%	5.69%	8.99%	3.33%
IHP	2.69%	3.46%	1.33%	2.20%	2.78%	1.27%	3.06%	6.03%	1.33%	2.58%	4.60%	1.23%
IPF	6.10%	7.70%	3.16%	5.68%	6.82%	3.92%	6.01%	10.68%	3.18%	5.47%	8.95%	2.85%
KNOS	7.91%	9.97%	6.66%	7.50%	9.68%	6.22%	6.39%	13.04%	2.35%	5.77%	10.31%	2.67%
MONY	2.63%	3.12%	1.74%	2.27%	2.65%	1.46%	2.86%	5.78%	1.41%	2.47%	4.75%	1.40%
MTRO	4.73%	7.70%	4.05%	4.48%	7.70%	3.74%	3.79%	7.70%	2.18%	3.45%	7.85%	2.25%
NCC	6.19%	11.56%	5.02%	5.56%	9.64%	4.46%	4.47%	12.40%	2.13%	4.01%	10.30%	2.24%
OSB	7.89%	11.19%	7.12%	7.71%	10.92%	6.84%	7.20%	14.02%	3.86%	6.83%	13.06%	3.49%
PAG	7.39%	13.81%	5.94%	7.15%	14.16%	5.45%	4.78%	13.81%	2.40%	4.55%	14.17%	2.43%
PAY	4.72%	6.79%	3.24%	4.19%	6.05%	2.95%	6.03%	17.44%	2.07%	5.32%	14.35%	2.06%
PBEE	4.21%	6.92%	3.56%	3.92%	6.97%	3.31%	3.31%	6.92%	2.02%	3.19%	6.97%	1.88%
PCFT	5.45%	7.36%	4.87%	5.39%	7.10%	4.63%	4.57%	9.13%	2.66%	4.40%	7.72%	2.61%
PLUS	4.04%	4.94%	3.25%	19.85%	46.66%	3.10%	4.54%	12.49%	1.27%	12.81%	148.07%	0.98%
SGE	6.36%	10.55%	5.37%	5.97%	10.12%	4.83%	4.72%	10.55%	2.46%	4.42%	10.24%	2.21%
TBCG	3.95%	5.53%	3.56%	3.62%	5.55%	3.26%	3.41%	6.06%	1.90%	3.16%	5.58%	2.13%
VANQ	4.95%	6.51%	3.72%	4.95%	6.41%	3.53%	5.82%	13.65%	2.08%	5.61%	14.68%	2.25%
VSL	4.85%	5.72%	4.32%	4.63%	4.97%	4.21%	5.03%	11.32%	3.09%	4.80%	8.41%	3.04%

Table 3

Panel (a): Expected Shortfall estimates for All Shares listed firms

	VaR expanding hist			VaR expanding Normal			VaR 250D hist			ES 250D Normal		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
ADM	4.75%	5.35%	4.27%	5.20%	5.71%	4.74%	4.47%	6.15%	3.14%	4.82%	6.40%	3.50%
AJB	3.59%	4.00%	2.59%	4.29%	4.77%	2.69%	4.31%	6.23%	2.59%	4.79%	6.25%	2.63%
ALFA	3.48%	3.87%	2.68%	3.90%	4.66%	3.19%	3.43%	4.33%	2.30%	3.71%	5.22%	2.35%
ALPH	3.55%	4.59%	0.85%	4.47%	5.02%	1.50%	4.19%	6.92%	1.33%	4.84%	6.84%	1.54%
APTD	7.26%	9.18%	6.58%	8.84%	11.08%	7.28%	6.56%	10.75%	3.79%	7.83%	13.30%	4.50%
AUGM	2.21%	3.30%	0.46%	2.89%	3.69%	0.67%	3.07%	5.13%	0.45%	3.41%	5.42%	0.69%
BPT	2.66%	2.99%	2.15%	3.11%	3.32%	2.76%	2.90%	3.99%	1.79%	3.22%	4.65%	2.17%
CHRY	4.81%	5.39%	3.06%	5.77%	6.27%	3.35%	4.38%	6.00%	2.22%	5.37%	7.56%	3.12%
CMCX	3.37%	3.81%	2.59%	4.24%	4.68%	3.36%	3.64%	4.88%	2.38%	4.26%	6.81%	2.63%
CPI	3.10%	3.29%	2.48%	3.62%	4.05%	2.71%	3.34%	4.70%	2.41%	3.86%	6.18%	2.65%
EXPN	2.87%	4.25%	0.42%	3.17%	4.45%	0.66%	3.82%	6.13%	0.42%	4.25%	6.71%	0.57%
FCH	4.41%	5.59%	2.27%	5.58%	6.95%	2.92%	4.89%	8.49%	1.95%	6.00%	10.76%	2.13%
GROW	3.18%	3.50%	2.54%	4.56%	5.27%	4.00%	3.41%	4.67%	2.09%	4.73%	6.58%	2.70%
IGG	3.81%	4.96%	3.20%	4.59%	5.39%	4.06%	3.72%	6.15%	2.05%	4.53%	7.17%	2.65%
IHP	1.67%	2.15%	0.97%	1.75%	2.22%	1.01%	2.12%	3.68%	0.97%	2.06%	3.66%	0.98%
IPF	3.60%	4.17%	2.36%	4.53%	5.44%	3.12%	3.63%	5.38%	1.98%	4.36%	7.13%	2.27%
KNOS	4.32%	5.43%	3.50%	5.98%	7.72%	4.96%	3.47%	5.82%	1.62%	4.60%	8.22%	2.13%
MONY	1.78%	2.03%	1.40%	1.81%	2.11%	1.17%	2.02%	3.77%	1.03%	1.97%	3.79%	1.11%
MTRO	2.93%	4.57%	2.50%	3.58%	6.14%	2.98%	2.36%	4.57%	1.57%	2.75%	6.26%	1.79%
NCC	3.42%	6.85%	2.68%	4.43%	7.69%	3.55%	2.65%	7.06%	1.56%	3.19%	8.21%	1.78%
OSB	4.81%	6.26%	4.37%	6.15%	8.71%	5.45%	4.49%	9.29%	2.27%	5.45%	10.41%	2.79%
PAG	4.63%	7.90%	3.56%	5.70%	11.30%	4.35%	3.23%	7.90%	1.89%	3.63%	11.30%	1.94%
PAY	2.72%	3.65%	2.07%	3.34%	4.82%	2.35%	3.56%	10.55%	1.37%	4.24%	11.44%	1.64%
PBEE	2.84%	4.97%	2.36%	3.13%	5.56%	2.64%	2.39%	4.97%	1.45%	2.54%	5.56%	1.50%
PCFT	3.89%	5.48%	3.26%	4.30%	5.66%	3.69%	3.20%	6.20%	2.05%	3.51%	6.16%	2.08%
PLUS	2.23%	2.70%	1.75%	15.83%	37.21%	2.47%	2.39%	4.35%	0.67%	10.22%	118.08%	0.78%
SGE	4.19%	7.08%	3.42%	4.76%	8.07%	3.85%	3.13%	7.08%	1.43%	3.53%	8.16%	1.76%
TBCG	2.79%	4.32%	2.40%	2.89%	4.43%	2.60%	2.32%	4.40%	1.34%	2.52%	4.45%	1.70%
VANQ	3.03%	4.35%	2.49%	3.95%	5.11%	2.81%	3.50%	8.46%	1.60%	4.48%	11.71%	1.80%
VSL	3.11%	3.57%	2.99%	3.69%	3.96%	3.36%	3.08%	4.31%	1.68%	3.82%	6.70%	2.42%

Table 3

Panel (b): Value-at-Risk estimates for All Shares listed firms

	ES hist	VaR hist	ES Norm	VaR Norm
DSW	60.67%	59.22%	109.15%	86.72%
LINV	59.51%	53.68%	88.26%	70.38%
DNM	60.63%	57.07%	108.33%	86.38%
FIN	62.03%	60.30%	100.77%	80.35%
FNX	57.93%	52.46%	108.76%	86.73%
AGFX	58.68%	54.74%	102.34%	81.61%
DFCH	57.89%	54.21%	104.05%	82.97%
AQX	56.78%	54.85%	114.89%	91.62%
FNTL	58.86%	53.55%	109.45%	87.28%
TRU	58.21%	54.08%	113.69%	90.66%
BOKU	56.67%	53.08%	110.07%	87.77%
GETB	58.61%	55.79%	109.55%	87.35%
TAM	56.53%	52.85%	104.15%	83.05%
EQLS	59.41%	57.07%	118.25%	94.30%
DUKE	60.81%	56.69%	120.66%	96.22%
QBT	60.73%	56.95%	108.40%	86.44%
TERN	62.22%	58.15%	107.43%	85.66%
INSG	59.46%	56.56%	109.33%	87.18%
BANK	60.45%	56.56%	106.03%	84.55%
MBO	59.52%	56.06%	117.95%	94.05%
ECK	58.63%	54.36%	109.40%	87.24%
AFN	60.22%	57.42%	106.80%	85.17%
ALT	60.01%	57.33%	107.65%	85.84%
BGO	58.39%	54.27%	105.35%	84.01%
PCIP	59.42%	54.92%	110.39%	88.02%
TAVI	61.19%	58.15%	110.41%	88.04%
VNET	59.31%	54.72%	109.09%	86.99%
BPM	55.49%	49.03%	99.08%	79.01%
FDP	59.05%	54.08%	113.80%	90.74%
KWG	59.42%	56.37%	102.73%	81.92%

Table 3

Panel (c): Expected Shortfall and Value-at-Risk sample estimates for AIM firms

AS stocks, 2008-2025

	Expanding window				Annual window (250 days)			
EW	ES hist	VaR hist	ES N	VaR N	ES hist	VaR hist	ES N	VaR N
Average	3.01%	1.94%	2.60%	2.07%	2.49%	1.65%	2.20%	1.75%
Max	4.46%	3.38%	4.13%	3.29%	5.22%	3.38%	4.13%	3.29%
Min	2.62%	1.63%	2.25%	1.80%	1.30%	0.90%	1.43%	1.14%
MCW								
Average	2.92%	1.96%	2.63%	2.10%	2.37%	1.68%	2.23%	1.78%
Max	4.65%	3.45%	4.40%	3.51%	4.65%	3.45%	4.40%	3.51%
Min	2.50%	1.64%	2.26%	1.80%	1.22%	0.90%	1.19%	0.95%

AIM stocks 2008-2025

	Expanding window				Annual window (52 weeks)			
EW	ES hist	VaR hist	ES N	VaR N	ES hist	VaR hist	ES N	VaR N
Average	31.14%	26.49%	34.46%	27.48%	27.43%	24.39%	30.06%	23.97%
Max	34.27%	29.96%	39.87%	31.80%	37.53%	34.23%	43.67%	34.82%
Min	28.90%	24.58%	30.82%	24.58%	18.21%	15.97%	20.42%	16.28%
MCW	ES hist	VaR hist	ES N	VaR N	ES hist	VaR hist	ES N	VaR N
Average	34.89%	28.39%	40.63%	32.40%	32.89%	28.96%	41.14%	32.80%
Max	37.56%	34.37%	46.86%	37.37%	44.45%	40.07%	70.45%	56.18%
Min	30.02%	24.83%	28.37%	22.63%	21.01%	15.89%	25.82%	20.59%

AS stocks, 2008-2025 weekly

	Expanding window				Annual window (52 weeks)			
EW	ES hist	VaR hist	ES N	Var N	ES hist	VaR hist	ES N	Var N
Average	7.22%	4.61%	6.08%	4.85%	5.60%	3.98%	5.07%	4.05%
Max	11.45%	9.83%	10.06%	8.02%	14.43%	9.83%	10.48%	8.36%
Min	6.05%	3.72%	5.15%	4.11%	2.15%	1.71%	2.95%	2.36%
MCW								
Average	6.13%	4.14%	5.59%	4.46%	5.12%	3.90%	4.85%	3.87%
Max	9.79%	6.73%	9.39%	7.49%	11.78%	7.06%	9.56%	7.62%
Min	5.23%	3.65%	4.72%	3.76%	2.06%	1.93%	2.76%	2.20%

Table 4

ES and VaR estimates for AS and AIM indices

ξY	24	23	22	21	20
BPT	-6.6638	-4.4834	5.1709		
PBEE	10.4084	13.3698	-10.0149		
AJB	8.7449	6.0425	-3.3498	3.1115	15.6379
CHRY	-12.5729	4.9593	-6.8962	1.9951	0.7276
FCH	33.0882	8.7276	10.3576	0.8976	-0.5362
AUGM	0.4992	-10.2634	6.4923	15.1670	
IHP	-10.4927	-9.5113	-15.8410	-9.5390	-0.5409
ALFA	-23.1801	-22.7935	5.9528	13.0265	2.1371
ALPH	-4.6832	-1.1282	-2.9631	-39.8015	-37.5403
TBCG	-9.9671	-8.8311	-8.7571	-15.7052	-17.6915
GROW	8.6361	6.7753	-3.8705	-10.1165	-9.1063
MTRO	1.0164	-22.0119	-0.0487	0.7609	-0.2048
CMCX	-1.7362	-18.0468	-15.2459	2.9342	3.2565
KNOS	-15.4838	-20.1482	13.2987	20.2674	16.7808
VSL	-13.5555	-0.2610	-0.7114	-7.1129	-1.7138
OSB	-21.4145	0.0474	-2.9893	-0.7433	1.2600
PLUS	-0.1741	1.0524	-0.9511	9.4832	-3.3203
PCFT	0.4491	-0.8064	-2.2241	-0.0319	-0.7947
ADM	-0.6559	-17.0243	-3.5977	-0.6668	-0.4149
IGG	-0.8102	-0.9270	-1.5872	-8.3845	7.7638
IPF	8.7732	7.9383	4.7101	-0.4065	0.0091
PAG	-0.4029	-2.8538	3.9333	-10.0180	-11.9804
CPI	-1.9930	-10.6548	-9.6501	-1.1791	-0.6598
EXPN	-9.1221	0.7598	-1.6985	-2.0359	-0.8875
PAY	0.3265	0.6547	-1.1576	-14.3687	-15.8032
APTD	-18.8127	-22.6497	-22.2750	1.2562	-24.8670
MONY	-1.8852	-0.0790	-7.0865	8.2417	-1.8973
SGE	2.7167	4.3743	0.0439	-7.3492	-8.5805
VANQ	-41.1490	-22.5934	-21.0208	-0.3444	0.4046
NCC	-26.2677	-35.4162	4.9020	2.0632	-30.6744

Panel (a): average jump size (daily percentage)

λ	24	23	22	21	20
BPT	9.8768	12.3855	15.0417		
PBEE	4.3860	3.0154	3.6654		
AJB	2.1471	4.0333	2.4458	5.1837	1.9170
CHRY	2.3143	16.5124	5.0914	9.9596	14.8474
FCH	1.7624	12.7646	7.7105	28.7952	38.3418
AUGM	7.8684	3.7026	4.6066	2.6831	
IHP	1.5344	1.9996	1.9870	2.0924	5.3608
ALFA	1.6399	1.6094	6.2637	4.5538	23.9522
ALPH	2.3775	9.4642	7.3779	1.3934	1.2337
TBCG	2.5258	3.6809	3.6398	2.1147	2.1512
GROW	4.6795	10.9466	5.6435	4.4922	4.6279
MTRO	7.4142	2.0383	10.7492	29.3716	44.0658
CMCX	8.1268	3.6080	3.9658	9.6218	8.5001
KNOS	2.5865	1.4046	2.4144	2.8205	2.9139
VSL	1.7758	7.1055	9.6718	2.2782	4.3032
OSB	2.2523	5.6859	6.6484	12.1857	16.9272
PLUS	12.5084	14.9515	12.1544	3.3240	8.3578
PCFT	9.4678	16.3719	12.4723	4.3376	3.6906
ADM	12.1489	1.9308	4.9181	13.3995	21.9693
IGG	14.7612	15.3758	4.2354	4.8469	2.3779
IPF	2.8474	7.5475	14.1028	42.1701	33.7099
PAG	14.8261	8.6235	3.2694	4.2511	2.9958
CPI	9.2434	3.3677	3.7781	26.1290	25.6697
EXPN	1.5292	5.3568	6.2405	3.7245	6.6038
PAY	4.3503	6.2592	9.2119	2.6780	2.4796
APTD	1.7834	1.8895	1.4050	20.9589	1.4086
MONY	11.0238	19.0354	2.1821	3.2556	9.5453
SGE	4.6001	3.3606	3.9182	2.4925	3.8778
VANQ	1.8126	1.8080	1.8474	19.9618	29.6045
NCC	1.7720	1.4141	6.2753	9.3771	1.4021

Panel (b): annualised jump frequency

Table 5

MCMC parameters for average returns jump size μ_Y (ξ_Y) and annualised jump frequency λ

Note: jump sizes are reported as daily percentages (divide by 100 to annualize). Jump frequency is reported annualized (divide by 252 for daily), i.e. BPT manifests almost 10 jumps in 23-24. Jump sizes in red denote cases where the parameter of the jumps' standard deviation is accurate but very high, i.e. due to large positive and negative jumps. The column headers are the ends of the two-year periods, e.g. 24 stands for the 23-24 period of estimation.

		GDP	GDP	GDP	GDP
ES (-1) HA	Empirical	-6.557			
		(1.752)***			
	Normal		-3.870		
			(1.670)**		
ES (-1) 1Y	Empirical			-3.838	
				(0.870)***	
	Normal				-3.889
					(0.959)***
Inflation		0.016	0.016	0.010	0.014
		(0.001)***	(0.000)***	(0.003)***	(0.002)***
10Y yield		0.007	0.007	0.007	0.007
		(0.000)***	(0.000)***	(0.000)***	(0.000)***
Consumer Credit		0.339	0.337	0.351	0.338
		(0.002)***	(0.001)***	(0.011)***	(0.008)***
ΔUnempRate		0.678	0.672	0.720	0.693
		(0.005)***	(0.003)***	(0.022)***	(0.017)***
Household Credit		-0.019	-0.019	-0.014	-0.017
		(0.005)***	(0.001)***	(0.004)***	(0.003)***
FTSE100		8.207	8.212	8.129	8.119
		(0.014)***	(0.008)***	(0.038)***	(0.037)***
Δwage		0.2346857	0.2350687	0.2351153	0.243
		(0.002)***	(0.002)***	(0.005)***	(0.005)***
Intercept		-2.009	-2.126	-2.280	-2.192
		(0.097)***	(0.104)***	(0.046)***	(0.036)***
R2 within		0.3804	0.3791	0.3881	0.3851
F statistic		6.36E+05	7.09E+06	125624	290183

Table 6

Panel (a) Effect of lagged Expected Shortfall (ES) on GDP, December 2021 – December 2024

Note: ES(-1) denotes lagged ES, HA denotes Expected Shortfall from all past daily returns, 1Y denotes Expected Shortfall from the last year, Empirical and Normal denote estimates based on the empirical and normal distributions respectively. All variables are used as annual decimals (not percentages).

		Ccard	Ccard	Ccard	Ccard
ES (-1) HA	Empirical	0.550			
		(0.240)**			
	Normal		0.350		
			(0.139)**		
ES (-1) 1Y	Empirical			0.316	
				(0.086)***	
	Normal				0.291
					(0.088)***
Inflation		0.001	0.001	0.001	0.001
		(0.000)***	(0.000)***	(0.000)***	(0.000)***
10Y yield		0.000	0.000	0.000	0.000
		(0.000)***	(0.000)***	(0.000)***	(0.000)***
gdp		-0.012	-0.012	-0.011	-0.011
		(0.000)***	(0.000)***	(0.001)***	(0.000)***
Consumer Credit		0.064	0.031	0.029	0.030
		(0.001)***	(0.000)***	(0.001)***	(0.001)***
ΔUnempRate		0.030	0.065	0.060	0.063
		(0.000)***	(0.000)***	(0.002)***	(0.002)***
Household Credit		0.490	0.490	0.447	0.480
		(0.014)***	(0.012)***	(0.031)***	(0.023)***
FTSE100		-0.013	-0.012	-0.015	-0.011
		(0.001)***	(0.001)***	(0.003)***	(0.002)***
Δwage		-0.014	-0.014	-0.0141825	-0.0146839
		(0.000)***	(0.000)***	(0.000)***	(0.000)***
Intercept		-0.144	-0.136	-0.119	-0.126
		(0.013)***	(0.008)***	(0.005)***	(0.003)***
R2 within		0.5323	0.5273	0.5634	0.5462
F statistic		78331	318125	4861	11425

Table 6

Panel (b) Effect of lagged Expected Shortfall (ES) on credit card debt, December 2021 – December 2024

Note: ES(-1) denotes lagged ES, HA denotes Expected Shortfall from all past daily returns, 1Y denotes Expected Shortfall from the last year, Empirical and Normal denote estimates based on the empirical and normal distributions respectively. All variables are used as annual decimals (not percentages).

		ConsCred	ConsCred	ConsCred	ConsCred
ES (-1) HA	Empirical	5.288			
		(2.413)**			
	Normal		4.239		
			(1.826)***		
ES (-1) 1Y	Empirical			2.690	
				(1.141)**	
	Normal				1.360
					[1.594]
Inflation		0.138	0.137	0.140	0.138
		(0.001)***	(0.000)***	(0.001)***	(0.001)***
10Y yield		-0.011	-0.011	-0.011	-0.011
		(0.000)***	(0.000)***	(0.000)***	(0.000)***
gdp		0.179	0.178	0.185	0.180
		(0.001)***	(0.001)***	(0.004)***	(0.004)***
ΔUnempRate		-0.912	-0.908	-0.936	-0.915
		(0.003)***	(0.002)***	(0.017)***	(0.012)***
Household Credit		-1.205	-1.223	-1.549	-1.218
		(0.148)***	(0.164)***	(0.312)***	(0.160)***
FTSE100		-2.494	-2.490	-2.484	-2.481
		(0.007)***	(0.006)***	(0.019)***	(0.012)***
Δwage		-0.110	-0.110	-0.111	-0.114
		(0.002)***	(0.002)***	(0.003)***	(0.003)***
Intercept		6.842	6.875	7.013	7.081
		(0.137)***	(0.116)***	(0.055)***	(0.077)***
R2 within		0.3283	0.3275	0.3353	0.327
F statistic		753363	4.34E+06	19784	291757

Table 6

Panel (c) Effect of lagged Expected Shortfall (ES) on consumer credit, December 2021 – December 2024

Note: ES(-1) denotes lagged ES, HA denotes Expected Shortfall from all past daily returns, 1Y denotes Expected Shortfall from the last year, Empirical and Normal denote estimates based on the empirical and normal distributions respectively. All variables are used as annual decimals (not percentages).

		SME	SME	SME	SME
ES (-1) HA	Empirical	0.1058347			
		(0.054)*			
	Normal		0.0583599		
			[0.056]		
ES (-1) 1Y	Empirical			0.0563214	
				(0.019)***	
	Normal				0.0890
					(0.021)***
Inflation		-0.002	-0.002	-0.002	-0.002
		(0.000)***	(0.000)***	(0.000)***	(0.000)***
gdp		0.000	0.000	0.000	0.000
		(0.000)***	(0.000)***	(0.000)***	(0.000)***
10Y yield		0.000	0.000	0.000	0.000
		(0.000)***	(0.000)***	(0.000)***	(0.000)***
loans		0.242	0.242	0.240	0.235
		(0.003)***	(0.001)***	(0.003)***	(0.005)***
nfbus		0.255	0.255	0.253	0.252
		(0.001)***	(0.001)***	(0.003)***	(0.003)***
ConsCred		0.000	0.000	0.000	0.000
		(0.000)***	(0.000)***	(0.000)***	(0.000)*
ΔUnempRate		0.000	0.000	0.000	0.000
		(0.000)***	(0.000)***	[0.000]	[0.000]
FTSE100		-0.019	-0.019	-0.020	-0.020
		(0.000)***	(0.000)***	(0.000)***	(0.000)***
Δwage		0.010	0.010	0.010	0.010
		(0.000)***	(0.000)***	(0.000)***	(0.000)***
Ccard		-0.241	-0.239	-0.252	-0.251
		(0.002)***	(0.001)***	(0.008)***	(0.007)***
Intercept		-0.032	-0.029	-0.028	-0.030
		(0.003)***	(0.004)***	(0.001)***	(0.001)***
R2 within		0.7211	0.7199	0.7255	0.7302
F statistic		6.62E-01	863806	18365	28146

Table 6

Panel (d) Effect of lagged Expected Shortfall (ES) on loans to SMEs, December 2021 – December 2024

Note: ES(-1) denotes lagged ES, HA denotes Expected Shortfall from all past daily returns, 1Y denotes Expected Shortfall from the last year, Empirical and Normal denote estimates based on the empirical and normal distributions respectively. All variables are used as annual decimals (not percentages).

	GDP	ConsCred	Ccard	Dtol	UnsecD	Wwage
λ	-0.001	0.001	0.002	-0.001	0.001	0.0001244
	(0.000)**	(0.000)**	(0.001)**	(0.000)***	(0.000)**	(0.000)**
Inflation	-0.001	0.015	0.030	-0.650	1.216	-0.0661711
	(0.009)***	(0.019)***	(0.0315)***	(0.012)***	(0.016)***	(0.002)***
FTSE100	0.585	0.298	0.013	-0.125	-0.036	0.0315689
	(0.004)***	(0.007)***	[0.012]	(0.005)***	(0.006)***	(.001)***
Intercept	0.007	-0.069	-0.152	0.009	-0.034	0.0559412
	(0.001)***	(0.003)***	(.005)***	(0.002)***	(0.003)***	(0.000)***
R2	0.9341	0.7628	0.704	0.6095	0.6155	0.5184
F statistic	27204	4920	3750	2611	2737	2043

Panel (a)

	GDP	ConsCred	Ccard	Dtol	UnsecD	Wwage
MCMC ES	0.261	-0.709	-1.191	0.346	-0.482	-0.062
	(0.171)	(0.343)**	(0.573)**	(0.230)	(0.301)	(0.037)
Inflation	-0.132	1.474	2.960	-0.652	1.219	-0.066
	(0.011)***	(0.029)***	(0.048)***	(0.014)***	(0.020)***	(0.002)***
FTSE100	0.580	0.306	0.028	-0.131	-0.028	0.032
	(0.002)***	(0.005)***	(0 .009)***	(0.002)***	(0.004)***	(0.001)***
Intercept	-0.011	-0.025	-0.077	-0.014	-0.002	0.033
	(0.009)	(0 .017)	(0.029)**	(0.012)	(0.015)	(0.002)***
R2	0.931	0.757	0.697	0.593	0.600	0.4987
F statistic	89110	5244	1414	3689	1359	5344

Panel (b)

Table 7

Annual regressions – Effect of jump frequency λ (panel a) on and expected shortfall from the SVCJ model (panel b) on GDP, consumer credit, credit card debt, Debt to Income ratio, household unsecured loans and change of weekly wages

ξY	24	23	22	21	20
BPT	-6.6638	-4.4834	5.1709		
PBEE	10.4084	13.3698	-10.0149		
AJB	8.7449	6.0425	-3.3498	3.1115	15.6379
CHRY	-12.5729	4.9593	-6.8962	1.9951	0.7276
FCH	33.0882	8.7276	10.3576	0.8976	-0.5362
AUGM	0.4992	-10.2634	6.4923	15.1670	
IHP	-10.4927	-9.5113	-15.8410	-9.5390	-0.5409
ALFA	-23.1801	-22.7935	5.9528	13.0265	2.1371
ALPH	-4.6832	-1.1282	-2.9631	-39.8015	-37.5403
TBCG	-9.9671	-8.8311	-8.7571	-15.7052	-17.6915
GROW	8.6361	6.7753	-3.8705	-10.1165	-9.1063
MTRO	1.0164	-22.0119	-0.0487	0.7609	-0.2048
CMCX	-1.7362	-18.0468	-15.2459	2.9342	3.2565
KNOS	-15.4838	-20.1482	13.2987	20.2674	16.7808
VSL	-13.5555	-0.2610	-0.7114	-7.1129	-1.7138
OSB	-21.4145	0.0474	-2.9893	-0.7433	1.2600
PLUS	-0.1741	1.0524	-0.9511	9.4832	-3.3203
PCFT	0.4491	-0.8064	-2.2241	-0.0319	-0.7947
ADM	-0.6559	-17.0243	-3.5977	-0.6668	-0.4149
IGG	-0.8102	-0.9270	-1.5872	-8.3845	7.7638
IPF	8.7732	7.9383	4.7101	-0.4065	0.0091
PAG	-0.4029	-2.8538	3.9333	-10.0180	-11.9804
CPI	-1.9930	-10.6548	-9.6501	-1.1791	-0.6598
EXPN	-9.1221	0.7598	-1.6985	-2.0359	-0.8875
PAY	0.3265	0.6547	-1.1576	-14.3687	-15.8032
APTD	-18.8127	-22.6497	-22.2750	1.2562	-24.8670
MONY	-1.8852	-0.0790	-7.0865	8.2417	-1.8973
SGE	2.7167	4.3743	0.0439	-7.3492	-8.5805
VANQ	-41.1490	-22.5934	-21.0208	-0.3444	0.4046
NCC	-26.2677	-35.4162	4.9020	2.0632	-30.6744

Panel (a): average jump size (daily percentage)

λ	24	23	22	21	20
BPT	9.8768	12.3855	15.0417		
PBEE	4.3860	3.0154	3.6654		
AJB	2.1471	4.0333	2.4458	5.1837	1.9170
CHRY	2.3143	16.5124	5.0914	9.9596	14.8474
FCH	1.7624	12.7646	7.7105	28.7952	38.3418
AUGM	7.8684	3.7026	4.6066	2.6831	
IHP	1.5344	1.9996	1.9870	2.0924	5.3608
ALFA	1.6399	1.6094	6.2637	4.5538	23.9522
ALPH	2.3775	9.4642	7.3779	1.3934	1.2337
TBCG	2.5258	3.6809	3.6398	2.1147	2.1512
GROW	4.6795	10.9466	5.6435	4.4922	4.6279
MTRO	7.4142	2.0383	10.7492	29.3716	44.0658
CMCX	8.1268	3.6080	3.9658	9.6218	8.5001
KNOS	2.5865	1.4046	2.4144	2.8205	2.9139
VSL	1.7758	7.1055	9.6718	2.2782	4.3032
OSB	2.2523	5.6859	6.6484	12.1857	16.9272
PLUS	12.5084	14.9515	12.1544	3.3240	8.3578
PCFT	9.4678	16.3719	12.4723	4.3376	3.6906
ADM	12.1489	1.9308	4.9181	13.3995	21.9693
IGG	14.7612	15.3758	4.2354	4.8469	2.3779
IPF	2.8474	7.5475	14.1028	42.1701	33.7099
PAG	14.8261	8.6235	3.2694	4.2511	2.9958
CPI	9.2434	3.3677	3.7781	26.1290	25.6697
EXPN	1.5292	5.3568	6.2405	3.7245	6.6038
PAY	4.3503	6.2592	9.2119	2.6780	2.4796
APTD	1.7834	1.8895	1.4050	20.9589	1.4086
MONY	11.0238	19.0354	2.1821	3.2556	9.5453
SGE	4.6001	3.3606	3.9182	2.4925	3.8778
VANQ	1.8126	1.8080	1.8474	19.9618	29.6045
NCC	1.7720	1.4141	6.2753	9.3771	1.4021

Panel (b): annualised jump frequency

Table 8

MCMC parameters for average returns jump size μ_Y and annualised jump frequency λ

Note: jump sizes are reported as daily percentages (divide by 100 to annualize). Jump frequency is reported annualized (divide by 252 for daily), i.e. BPT manifests almost 10 jumps in 23-24. Jump sizes in red denote cases where the parameter of the jump standard deviation is accurate but very high, i.e. due to large positive and negative jumps. The column headers are the two-year periods, e.g. 24 is the 23-24 period of estimation.

MCW index		Ccard	Ccard	Ccard	Ccard
ΔESind HA	Empirical	-0.936			
		(0.376)**			
	Normal		-0.836		
			(0.553)		
ΔESind 1Y	Empirical			-0.525	
				(0.013)***	
	Normal				-0.045
					(0.023)*
Inflation		-0.001	0.000	-0.001	0.001
		(0.006)	(0.006)	(0.005)	(0.006)
10Y yield		-0.000	-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
gdp		-0.013	-0.012	-0.011	-0.012
		(0.006)**	(0.006)*	(0.005)*	(0.006)*
Consumer Credit		0.030	0.031	0.027	0.028
		(0.007)***	(0.008)***	(0.007)***	(0.009)***
ΔUnempRate		0.062	0.062	0.058	0.061
		(0.020)***	(0.025)**	(0.017)***	(0.024)**
Household Credit		0.693	0.671	0.739	0.676
		(0.217)***	(0.252)**	(0.184)***	(0.235)***
FTSE100		-0.029	-0.017	-0.034	-0.006
		(0.092)	(0.098)	(0.082)	(0.095)
Δwage		-0.020	-0.016	-0.023	-0.017
		(0.010)*	(0.009)*	(0.008)***	(0.009)*
Intercept		-0.117	-0.120	-0.096	-0.101
		(0.056)**	(0.062)*	(0.055)*	(0.064)
R2		0.6160	0.5512	0.7019	0.5768
F statistic		4.02	2.55	6.13	2.75

		SME	SME	SME	SME
ES (-1) HA	Empirical	-0.361			
		(0.154)**			
	Normal		-0.660		
			(0.148)***		
ES (-1) 1Y	Empirical			-0.020	
				(0.006)***	
	Normal				-0.033
					(0.006)***
Inflation		-0.003	-0.003	-0.003	-0.002
		(0.002)	(0.002)	(0.002)*	(0.002)
gdp		-0.002	-0.001	-0.001	-0.001
		(0.003)	(0.003)	(0.003)	(0.002)
10Y yield		-0.000	-0.000	-0.000	-0.000
		(0.000)	(0.000)**	(0.000)**	(0.000)**
nfbus		0.193	0.251	0.226	0.276
		(0.058)***	(0.057)***	(0.054)***	(0.053)***
ΔUnempRate		0.008	0.003	0.009	0.004
		(0.006)	(0.005)	(0.006)	(0.006)***
FTSE100		-0.043	-0.036	-0.041	-0.026
		(0.035)	(0.027)	(0.030)	(0.028)
Δwage		0.007	0.008	0.006	0.006
		(0.003)**	(0.003)**	(0.003)**	(0.002)**
Ccard		-0.275	-0.239	-0.329	-0.275
		(0.076)***	(0.060)***	(0.062)***	(0.055)***
ConsCred		0.000	0.000	0.001	-0.000
		(0.003)	(0.003)	(0.003)	(0.003)
Intercept		-0.013	-0.016	-0.013	-0.008
		(0.021)	(0.019)	(0.021)	(0.018)
R2		0.701	0.7393	0.7437	0.7822
F statistic		5.75	6.84	8.44	12.47

Table 9

Regression results for market capitalization weighted indices

Note: Δ is first differences, HA is ES from all past daily returns, 1Y is ES from the last year, Empirical and Normal denote estimates based on the empirical and normal distributions respectively. All variables are used as annual decimals (not percentages).

APPENDIX

MCMC ES	24	23	22	21	20
BPT	-5.9185	-6.1615	-6.8516	-6.0000	-6.0000
PBEE	-6.3408	-6.4060	-5.8836	-6.0000	-6.0000
AJB	-5.3698	-5.5670	-7.2231	-5.5553	-5.1619
CHRY	-5.6895	-6.8330	-6.1440	-5.7511	-4.9089
FCH	-7.1779	-6.7656	-6.5527	-6.4323	-6.8470
AUGM	-5.2455	-5.8725	-5.6588	-5.6313	-6.0000
IHP	-4.8713	-5.5418	-4.9859	-4.0595	-4.0868
ALFA	-4.9518	-5.4871	-6.0155	-6.1498	-6.5552
ALPH	-5.6325	-5.9918	-6.2117	-5.8839	-5.1777
TBCG	-5.3228	-4.9831	-4.8084	-5.4744	-5.7690
GROW	-6.3788	-7.1130	-5.9997	-5.6418	-4.9541
MTRO	-6.0103	-6.3609	-5.9245	-6.1419	-6.4798
CMCX	-5.2201	-4.4368	-5.6036	-5.8196	-5.5722
KNOS	-5.5272	-5.6656	-5.3181	-5.5810	-6.0214
VSL	-4.0772	-3.1562	-2.4132	-4.7694	-6.6939
OSB	-5.4044	-5.3159	-4.3196	-4.9350	-5.2850
PLUS	-2.6126	-2.5180	-2.8578	-4.8485	-5.5803
PCFT	-1.5625	-2.1809	-2.4862	-6.8025	-6.1371
ADM	-2.7284	-4.3788	-5.9399	-2.8113	-2.3609
IGG	-2.0642	-2.4678	-5.3411	-3.1632	-4.4795
IPF	-5.0914	-5.9678	-6.1657	-5.7581	-6.2851
PAG	-3.1725	-4.4662	-4.6034	-5.2263	-5.6993
CPI	-5.8136	-6.6317	-6.1741	-6.3358	-5.3518
EXPN	-2.6243	-4.3794	-3.5004	-4.7781	-4.0460
PAY	-5.6030	-7.4907	-3.2475	-5.2421	-4.3576
APTD	-4.2199	-4.7958	-6.5389	-4.0179	-4.7300
MONY	-3.2944	-3.4531	-6.9520	-4.1327	-4.1783
SGE	-2.2483	-2.7856	-5.2535	-4.2853	-3.0477
VANQ	-9.9425	-6.2274	-5.4085	-7.4254	-5.4766
NCC	-5.4351	-5.8239	-4.4872	-5.8008	-5.8653

Table A.1

Expected Shortfall of AS firms from the SVCJ estimations

Average ES per firm and period from 1000 simulations of two-year returns (500 drawings). Reported as negative but used as positive in estimations. The column headers are the two-year periods, e.g. 24 is the 23-24 period of estimation.