New Measures for a New Normal in Finance and Risk Management

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One of the lessons learnt from the global financial crisis experienced in the first two decades of the new century is that the macro-financial system is a complex system whose dynamics is characterized by nonlinearities, tipping points, adaptation and feedback loops. These phenomena are difficult to explain without taking into account the interconnectedness and interdependences of its parts and the interactions of its heterogeneous players. This recognition has generated a deep disenchantment with economic theory and the related models, also adopted in finance, which are based on the conjecture that representative agents are driven by market fundamentals and their actions are fully rational. A more pluralistic approach, benefiting from the contamination of different scientific experiences, has been advocated as a more promising pathway to research that is policy relevant and disruptive rather than incremental (Andre and Falk, 2021).
In particular, the repeated economic and financial crises, and the Covid-19 pandemic, have brough forcibly to the attention of practitioners and policy makers the need for new approaches to understand risks (old and new ones) and innovative methods to measure them. Risk has matured into an even more important factor in decision-making, in its many components, including for portfolio optimization and asset pricing. The very concept of risk-free rate has changed while new risk factors have manifested themselves in ways that are sometimes immediate and with unforeseen impacts. We have observed negative rates, when for years we had strived to rule out this scenario from asset pricing models. Serious mispricing phenomena have been recorded and continue to characterise some markets for sophisticated financial products, such as credit derivatives (Arping, 2004), which are still far from being fully understood and resolved.

Since 1996, the Workshops on Economics with Heterogeneous Interactive Agents (WEHIA) has provided a venue for scholars of different disciplines- economics, psychology, sociology, computer science, engineering, physics- to examine how aggregate properties of economic and financial systems arise from the actions and interactions of heterogeneous agents within the framework of complexity theory (Gallegati and Kirman, 2019). In June 2019, the 24th Workshop on Economic Science with Heterogeneous Interacting Agents (WEHIA) was held at City, University of London, UK. This special issue, focused on “Novel approaches to understand, forecast and mitigate financial risks" includes the main contributions presented at the workshop which were focused specifically on novel approaches to understand the dynamics and governance of financial crises, the refinement of pricing models and the construction of financial portfolios.
To complement more traditional methods, Agent Based Model (ABM) simulations, network analysis and laboratory experiments feature prominently in the selected papers as novel approaches to understand and quantify risks.

ABMs are computational model which can simulate the actions and interactions of individuals and organisations, in complex and realistic ways. Agents can range from passive automatons with no cognitive function to active data-gathering decision makers with sophisticated learning capabilities, adapting and reacting to the external environment they themselves help shaping. Thanks to the

possibility to model complex spatial interaction and subtle interdependencies between prices and actions, driven by learning and feedback mechanisms, these models are particularly well suited to explore emergent properties in economic systems such as bubble and crashes in financial markets or systemic risk in credit markets.
Network analysis is a set of techniques, contributed by different disciplines, to represent and analyze the structures that emerge from the recurrence of relationships among agents. The onset of the financial crisis has triggered an enormous interest in applying networks concepts and tools to assess the impact of interconnections between financial agents on financial stability and to understand the dynamic of distress contagion among assets or financial intermediaries.
Controlled laboratory experiments with human subjects are increasingly used in behavioural economics. In contrast with the paradigm of perfect rationality, experimental economics has shown that the heterogeneity of human subjects, their different degrees of bounded rationality and their individual cognitive capabilities strongly influence their decisions. Despite their simplicity, controlled laboratory experiments, as well as ABMs, allow for the collection of data that in the real world are not available and offer invaluable opportunities to explore the effect of policies under what-if scenarios.

One area which continues to attract the attention of academics and investors alike, is the prediction of volatility in investment returns, reflecting its importance in stock valuation, risk management and monetary policy. When volatility is interpreted as a measure of risk and uncertainty, it becomes a key input for many investment decisions and portfolio creation because investors and portfolio managers have certain levels of risk that they can bear (Poon and Granger, 2003). Therefore, a good forecast of asset price volatility over the investment period is a good starting point for assessing investment risk. Moreover, volatility is the most important variable in pricing derivative securities, the volume of which has quadrupled in recent years. Despite its non-observability, volatility has become a tradable and manageable entity. Today financial traders can buy derivatives that are written on volatility itself and good prediction of volatility from the time the option is entered till it expires are necessary to price these contracts.

To understand the role of traders' interactions on volatility dynamics we suggest to read two important contributions which use Agent Based simulations to explore how the actions of bounded rational traders, who either imitate each other via herding or try and learn from a common signal, may lead to bubbles and crashes and excess volatility.

In the model of *Schmitt, Schwartz and Westerhoff (2022)* every speculator bets on his heterogeneous trading signals (technical and fundamental). However, the heterogeneity of speculators occasionally vanishes, e.g. due to them reacting to the same trading signals or by panic-induced herd behaviour, caused for example by sharp stock price changes. The model produces sustained regimes with high volatility originating from the fact that speculators extract stronger trading signals from past stock price movements when stock prices fluctuate strongly. Simulations also suggest that circuit breakers can be an effective tool to combat financial market turbulence.

Gao and Ladley (2022) re-exams the relationship between heterogeneous beliefs and market stability in a market comprising noise traders and informed traders who learn and develop skills from trading. Noise traders are often thought to be detrimental to market stability, increasing volatility and the risk of bubbles and crashes. However, the authors show that an increase in the quantity of noise traders paradoxically makes the market more resilient to shocks because, by pushing price away from fundamentals, noise traders create incentives for informed traders to learn, increasing the proportion of informed traders who possess high levels of trading skill. Thus the heterogeneity of agents may increase market resilience particularly in newly developing markets where fewer skilled traders may be operating.

Kumar, Bansal and Chakrabarti (2022) take the challenge of measuring volatility a step forward, by focusing on volatilities spill over across a large number of stocks. The authors argue that asset returns exhibit collective dynamics and that disentangling the effect of each individual return series on its own dynamics from the impacts of other assets' dynamics is particularly acute when there is a large number of assets traded simultaneously at high frequency. They use the Lasso estimator to first identify the maximally connected component of the network defined by the correlation matrix and then proceed to quantify the spill over effects through estimation of a vector autoregression model. They show that the centrality measure based on dominant eigenvector of the observed return correlation matrix provides an intuitive and robust identification strategy to observe the ripple effects originating from a particular epicentre in the stock network and to quantify the corresponding magnitude of fluctuations.

Besides volatility, the estimation of co-movement between stocks is an another key ingredient for portfolio management. One of the aspects that the financial crisis has altered is the assumption of the stability of factors necessary for portfolio optimisation, in particular the structure of volatilities and correlations. In this respect, *Raddant and Wagner (2022)* address the problem of estimating dynamic correlations in large asset markets. The model is based on a decomposition of the conditional covariance matrix based in two dynamic factors, which describe the market volatility and other explanatory elements of the overall variance. This approach makes it possible to estimate equity beta more consistently and to introduce more robust portfolios.
Still with reference to the problem of estimating the covariance matrix, *Bongiorno and Challet (2022)* propose a covariance cleaning method that works well in the very high dimensional regime, i.e. when there are many more assets than data points per asset. Increasing the recursion order k of the filtering procedures reduces the localization of the non-zero elements of the eigenvectors associated with the smallest eigenvalues, which is crucial for portfolio allocation (higher localization yields portfolios with fewer assets). The method is found to work best for medium to large values of k and when tested against traditional approaches, it outperforms them by improving the risk-adjusted performance (as measured by the Sharpe index net of transaction costs) of the optimised portfolios. Working with shorter calibration windows it allows the construction of more reactive portfolios to changing market condition even though it requires larger turnover.

The central role played by variance covariance matrices in financial economics is the consequence of financial asset returns having traditionally been modelled as Wiener processes. However, stylized facts such fat tails, volatility clustering and multi-scaling are incompatible with such description. Multiscaling in particular, whose signature is the non-linearity of the scaling exponents of the q-order moments of the absolute value of log-returns, has been explained in terms of the superimposition of the distinct strategies and investment horizons of the different market players and is better described by multifractal processes. *Brandi and Di Matteo (2022)* propose a novel statistical procedure to provide a robust estimation and tests for the multiscaling property. Their results show that the use of proper scaling and multiscaling can improve the estimation of risk measures such as Value at Risk. Moreover, the authors propose a VaR measure which is consistent with the multifractality of financial time series using Monte Carlo Multifractal Random Walk simulations calibrated to the real data.

The financial crisis has also called into question the stability of the banking system, and its implication for the macro economy, together with the effectiveness of regulation, both with micro criteria and new macro-prudential instruments. Three papers explore the limitations of the current regulatory framework particularly when shocks to the real or financial sectors can percolate from one sector to the other and be amplified by the interconnections between firms and banks.

Vozzella and Gabbi (2022) look at the risk of pro-cyclicality of banking regulation, especially the one constraining lending on the basis of the rating quality of borrowers. Specifically, they criticize the existing regulatory assumptions of negative relationship between asset correlation and default probability and positive relationship between asset correlations and company's size to compute risk-weighted assets and capital requirements for credit risk. Empirical results show that the relationship between asset correlation and default probability is in fact positive during upturns and the one between asset correlation and company's size is not linear and changes with the business cycle. A risk-weighted asset calculated according to existing regulatory assumptions would not generate the required capital relief during a recession, when banks would have to free up credit resources to support business resilience. The authors propose transforming the regulatory approach in order to account for the pro-cyclical problems that still remain during upturns and downturns.

Gurgone and Iori (2022) focus on the interplay between bank heterogeneity and interconnectedness to assess the effectiveness of macroprudential measures to mitigate systemic risk. Adopting an agent based approach, describing an artificial economy with households, firms and banks, in which occasional liquidity crises emerge, the authors conduct counterfactual policy experiments generating alternative scenarios for the level of concentration of the credit market. The research show that there is no first-best policy valid for all types of banking networks. Under high heterogeneity, it is preferable to apply systemic capital surcharges to the largest banks, while under low heterogeneity it is more effective to target the most interconnected ones. Moreover, while the economy becomes more stable and efficient when systemic capital buffers are applied to heterogeneous banks, it becomes more stable but slightly less efficient when buffers are applied to more homogeneous banks.

Traditional risk models have been caught off guard by the deployment of COVID-19. While trying to understand what went wrong, investors can develop a more forward-looking risk management strategy to consider a wider range of scenarios in a highly uncertain market environment. Although risk models have become much more sophisticated since the global financial crisis, most of them, based primarily on historical data, have found it difficult to deal with the unprecedented effects of the COVID-19 pandemic. These included the sudden disruption of global supply chains, the closure of cities around the world, and the alteration of previously reliable correlations between economic sectors. No model had been designed to handle all these circumstances simultaneously. A first solution is provided *by Delli Gatti and Grugni (2022)* who explore the macro-financial consequences of a supply chain disruption in an agent-based framework characterised by two networks, a credit network connecting banks and firms and a production network connecting upstream and downstream firms. Two scenarios of supply chain disruption are considered in the paper. In the first one, due to the lockdown all upstream firms are forced to cut production. This generates a deep recession due to the indirect effects of the shock. In the second scenario, only upstream firms located in the "red zone" are forced to contract production. In this localized lockdown case the recession is milder and the recovery starts earlier thanks to the endogenous reorganization of production interlinkages among downstream and upstream firms. The experiments shed light on the trade-off between lean production and resilience to shocks in Global Value Chains.

The financial crisis has also called into question the benefits of financial innovation and the agenda of regulators has since been driven by retail client's protection and increased financial markets transparency. One of the most relevant aspects is the observation of excessive risk-taking by financial intermediaries and individuals during the crisis. In particular concerns have been voiced in regard to the over complexity and lack of transparency of structured products that, while allow investors to gain exposure to a broader range of risk factors, and to receive the associated risk premia, can easily be misunderstood and mispriced exposing less sophisticated investors to financial exploitation by financial institutions. Two papers explore these issues.

Mengel and Peeters (2022) ask whether market interactions encourage excessive and unsustainable risk-taking by some agents. They measure the extent of risk-taking by comparing the premium participants in laboratory experiments, with market and non-market interactions, require to incur risks. Both the market and the non-market treatments were run with and without social comparison information (i.e. information about others' buying and asking prices). The result of the research may appear surprising: markets actually decrease the willingness of participants to take risks when social comparison information is available. This result can be explained in terms of reference-dependent preferences, i.e. participants evaluate their outcomes relative to the outcomes of others and highlight the need of transparent and measurable indicators for social comparison in the presence of negatively correlated risks. This aspect is related to some recent phenomena such as online platforms (also involved in the GameStop case) where individual investors can observe the performance of other market participants and may even decide to imitate their strategies.

Fusai, Longo and Zanotti (2022) propose a way to measure the value added of structure products, specifically interest rate linked products, to retail investors by adding them to the efficient frontier and to the risk–return profile. The analysis is conducted by simulating the term structure according to a no-arbitrage multifactor interest rate model, that allows for a non-perfect correlation between changes of rates of different tenors, and by comparing the performance of a portfolio composed of core products (zero-coupon bonds, coupon bonds and floating rate notes) with a portfolio containing more sophisticated exotic products (such as constant maturity swaps, collars, spreads and volatility notes). The results show that capital-protected structured products allow investors to improve the risk-return trade-off. However, when taking into account the high fees charged for these products, the diversification benefits fade away and the investment in these products becomes negligible or null. The authors thus note that the role of regulators to keep high standard on costs disclosure and to limit inducements is crucial to drive financial markets toward higher efficiency.

Another issue that has recently been at the centre of the policy agenda is the effective disclosure of information by regulatory institutions in order to manage the expectations of economic agents when conducting monetary policy and to reduce the dependence of the financial system from rating agencies. *Ruiz-Buforn, Alfarano, Camacho-Cuena and Morone (2022)* assess what types of information disclosure are most effective to promote market efficiency and reduce the financial risk of market overreliance on public information. Specifically, the authors compare the effects of disclosing public information as a unique imperfect signal versus multiple imperfect signal with different relative precision. Through laboratory experiments, the paper shows that the release of public information crowds out the demand for costly private information if a single signal is disclosed, while it promotes the acquisition of private information when multiple disclosures are enacted. However, multiple disclosures do not eliminate the adverse effect of market overreaction to public information, which remains a potential source of fragility for the financial system.

The numerous (and heterogeneous) methodologies presented at the WEHIA 2019 conference and presented here in a number of contributions oriented towards solving financial problems, highlight how this debate offers great stimulus to find an answer to the crisis of confidence that has emerged over the last two decades on the more traditional and mainstream metrics in finance.
The new challenges posed by financial, social, and environmental crisis require methodological flexibility and a more realistic set of assumptions than traditional models. The methods proposed in this special issue originate from within the financial world but also from different scientific fields, where analogous problems and models have been successfully tested.
By refining these new metrics and apply them to explore current and future financial problems, we believe that it will be possible to make significant progress to minimise the risk of instability and achieve the different and possibly conflicting goals of the many networked stakeholders that populate the economic and financial system.

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