

## When panic makes you blind: a chaotic route to systemic risk

F. Lillo

Scuola Normale Superiore, Pisa, Italy

We present an analytical dynamical model of financial systemic risk to investigate the effects of microprudential changes on macroprudential outcomes. Specifically, we study the consequence of the introduction of a financial innovation that allows reducing the cost of portfolio diversification in a financial system populated by financial institutions having capital requirements in the form of Value at Risk (VaR) constraint and following standard mark-to-market and risk-management rules. We provide a full analytical quantification of the multivariate feedback effects between investment prices and bank behavior induced by portfolio rebalancing in presence of asset illiquidity and show how changes in the constraints of the bank portfolio optimization endogenously drive the dynamics of the balance sheet aggregate of financial institutions and, thereby, the availability of bank liquidity to the economic system and systemic risk. The model shows that when financial innovation reduces the cost of diversification below a given threshold, the strength (because of higher leverage) and coordination (because of similarity of bank portfolios) of feedback effects increase, triggering a transition from a stationary dynamics of price returns to a nonstationary one characterized by steep growths (bubbles) and plunges (bursts) of market prices. We then introduce a slow-fast random dynamical system to study the role of expectation feedbacks on systemic stability of financial markets. We then study how the expectations of risk by financial institutions play a central role in determining the systemic stability of the financial system and how wrong risk expectations may create panic-induced reduction or over-optimistic expansion of the balance sheets. The fixed point equilibrium of the system breaks into leverage cycles when institutions do not have enough memory of the past history in estimating the risk of their portfolios. When they become more and more myopic, a bifurcation cascade leading to chaos follows. We study the role of the financial policy for the expectation feedback system and we also discuss the effects of some market frictions as the cost of diversification and the Tobin tax. Finally we present some empirical evidences of the dynamics of bipartite network of US bank portfolios and investment classes showing that before the crisis the similarity of portfolios has significantly increased and that systemic risk measures based on portfolio overlaps can be used as

[1] F. Corsi, S. Marmi, F. Lillo, *Operations Research* **64**, 1073 (2016).

[2] D. Di Gangi, F. Lillo, D. Pirin, [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2611111](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2611111). (2015).

[3] P. Mazzarisi, F. Lillo, S. Mar, in preparation (2017).