

Systemic Risk and Market Crash: An AI Approach

Heqing Shi (PhD Student in Fintech)

Dr. Yi Cao (First Supervisor)

Dr. Zexun Chen (Second Supervisor)



THE UNIVERSITY
of EDINBURGH

Background

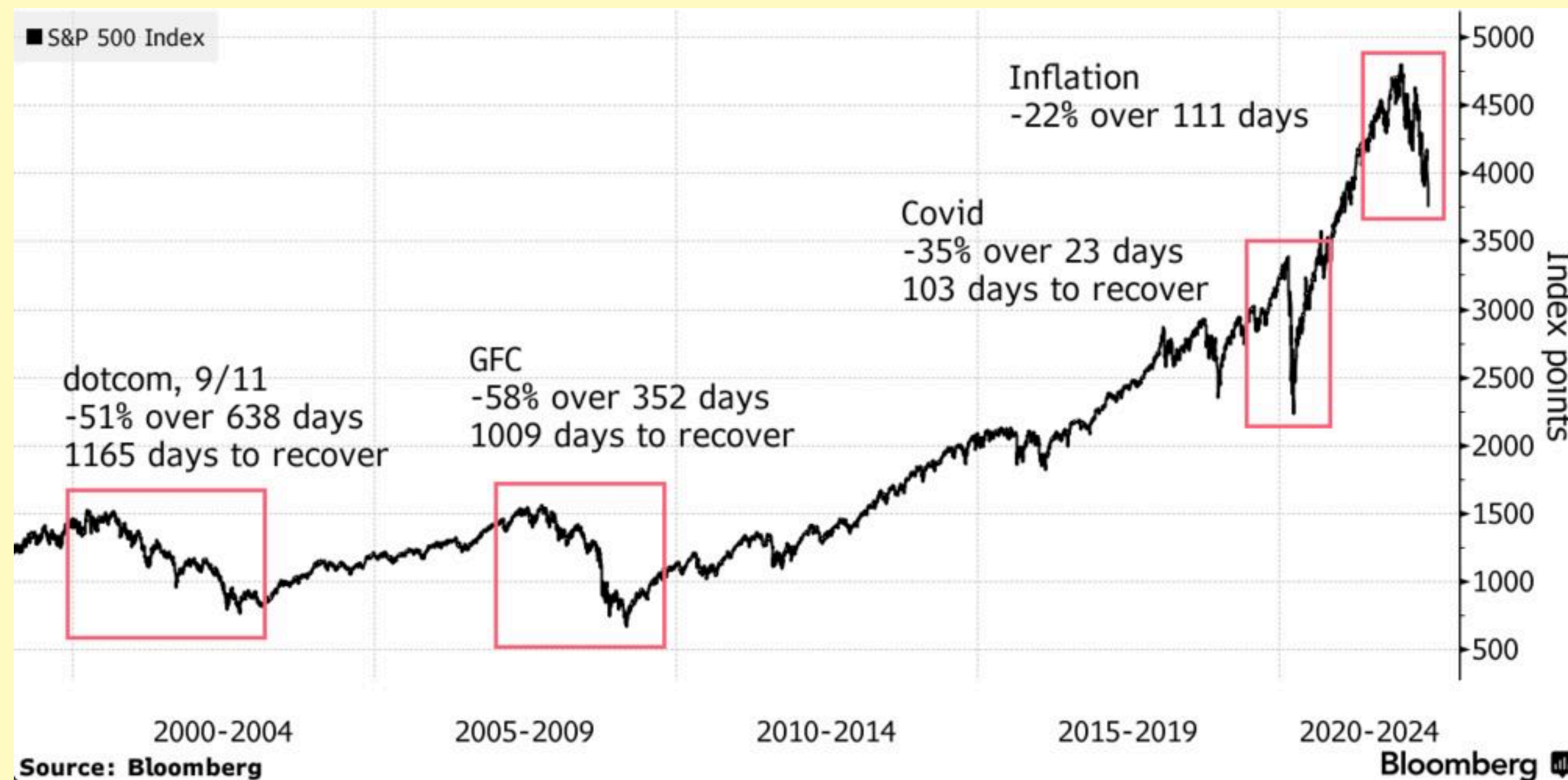


Figure: Price crashes of S&P 500 index in history

► Is financial instability really predictable? This is a long debated topic in finance. Some scholars hold the opinion that financial crashes are the thing that we know it when we saw it and hence unpredictable. However the recent studies suggest that financial instability is largely predictable as it is a consequence of credit expansions and asset price bubbles.

Research Gap & Our Objective

► Although econometricians have identified the linear relationship between some systemic risk measures and possible future macroeconomic downturns, further work still required in order to better understand how micro-level market crashes are developed by increasing risks in the financial sector:

- most of previous studies discuss how the systemic risk from financial institutions impact macroeconomic growth (lower-frequency, longer-horizon) instead of asset prices in secondary markets (higher-frequency, shorter-horizon);
- the underlying mapping from systemic risk measures to the probability of a realisation of crash might be non-linear;

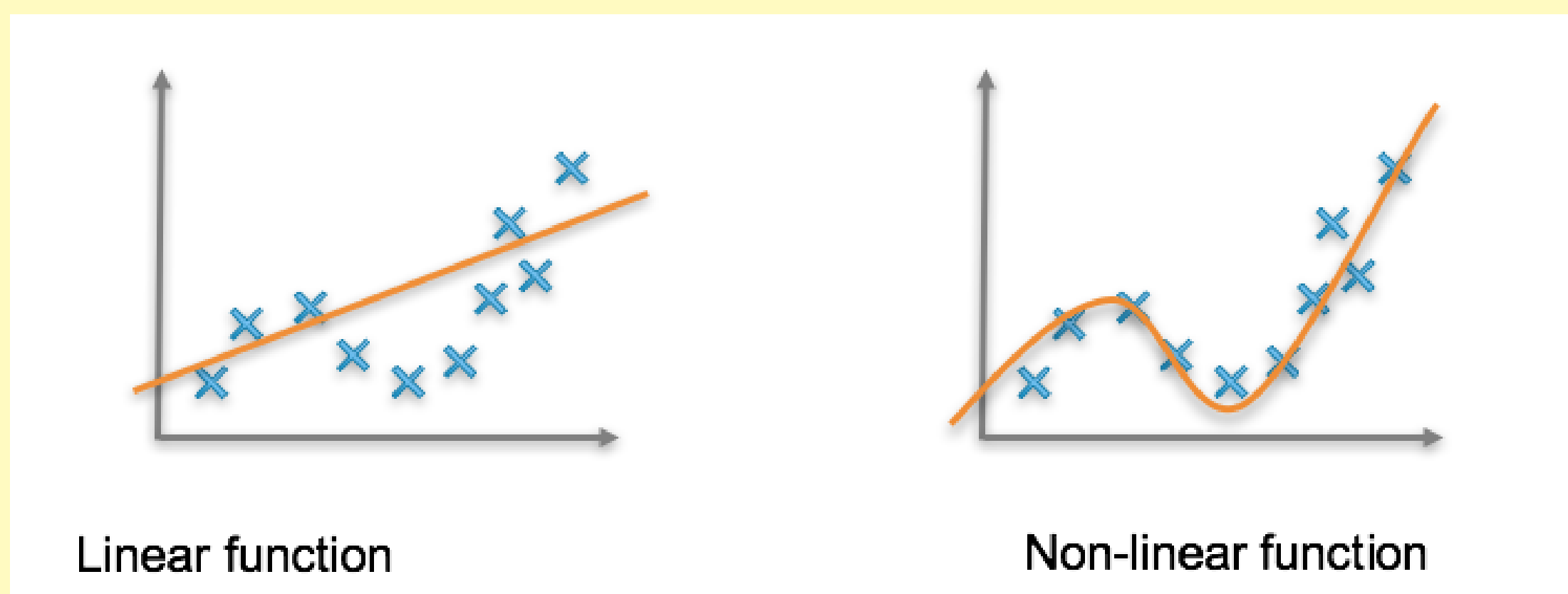


Figure: Machine learning models are known to be able to capture a non-linear mapping

► We aim to propose an improved systemic risk measure estimation and market crash forecasting methodology with Artificial Intelligence which has achieved great success in other areas e.g. speech recognition, image classification and recommendation.

Expected Methodology

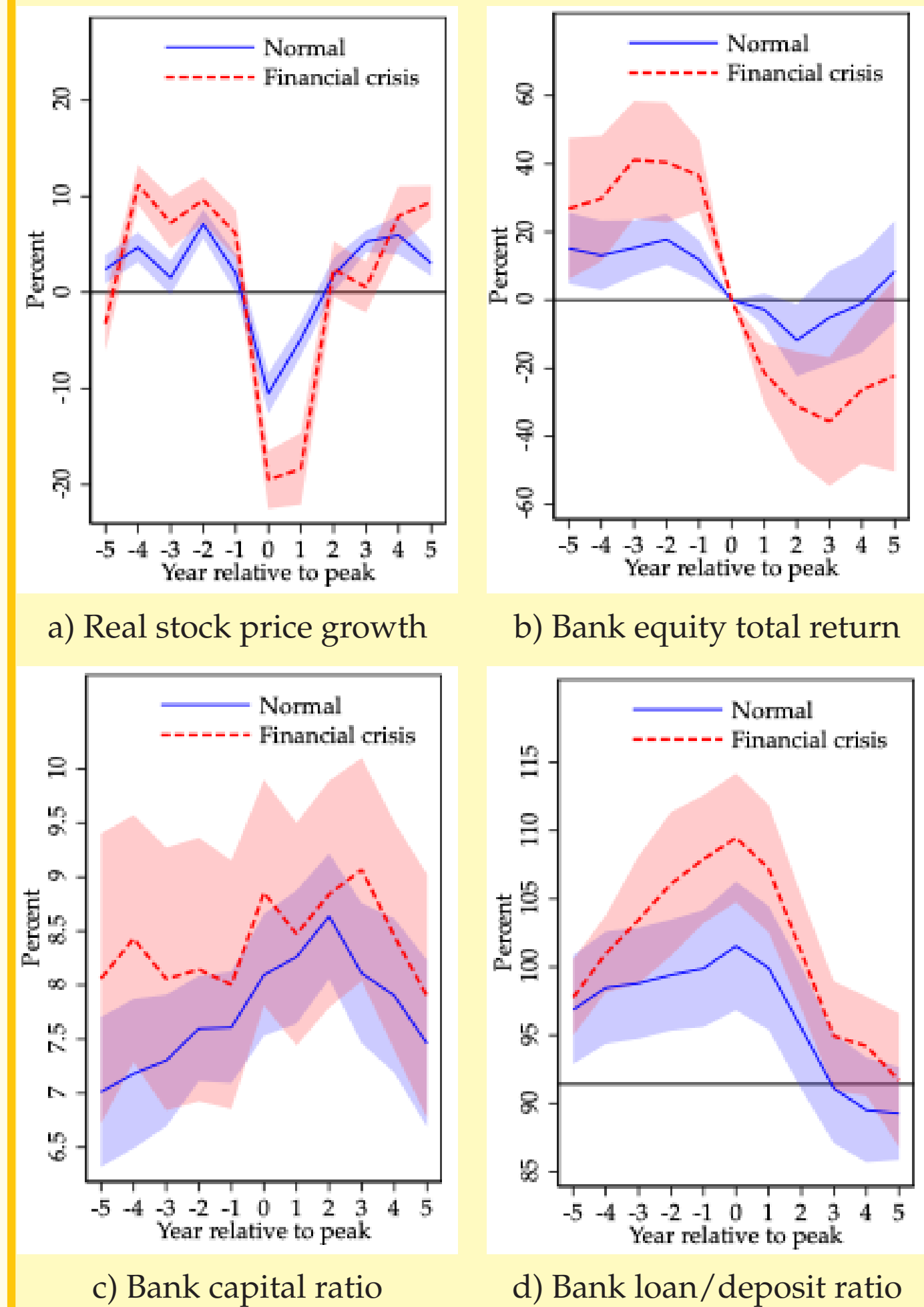
► Ex-ante Systemic Risk Measure Construction:

- Employ those well-established measures e.g. ΔCoVaR , SRISK which are also used by regulators as inputs;
- Infer forward-looking systemic risk information from derivatives e.g. put options;
- Aggregate them from individual institution level to the system level by using aggregation techniques such as Partial Least Squares (Microprudential \rightarrow Macroprudential);

► Training an AI-based Early Warning System:

- To capture the non-linearity between systemic risk measures with asset price crashes, a neural network with a tailored non-linear activation function $\sigma(\cdot)$ will be used;
- We also aim to construct the network under a Bayesian framework so that economically meaningful priors about systemic risk can be incorporated and the outputs will be interval predictions rather than just point predictions;
- The trained AI will then output an expected magnitude or expected probability of a potential market crash event;

Current Literature



► The above charts indicate that characteristics of banks such as equity return, capital ratio and loan-deposit ratio behave extremely differently before and during a financial crisis.

► Systemic risk from the banking sector contributes significantly to a crisis!

► Various definitions and measures of banks' systemic risk have been proposed and used by global regulators:

- CoVaR & ΔCoVaR
- MES
- SRISK
- CATFIN
- ...

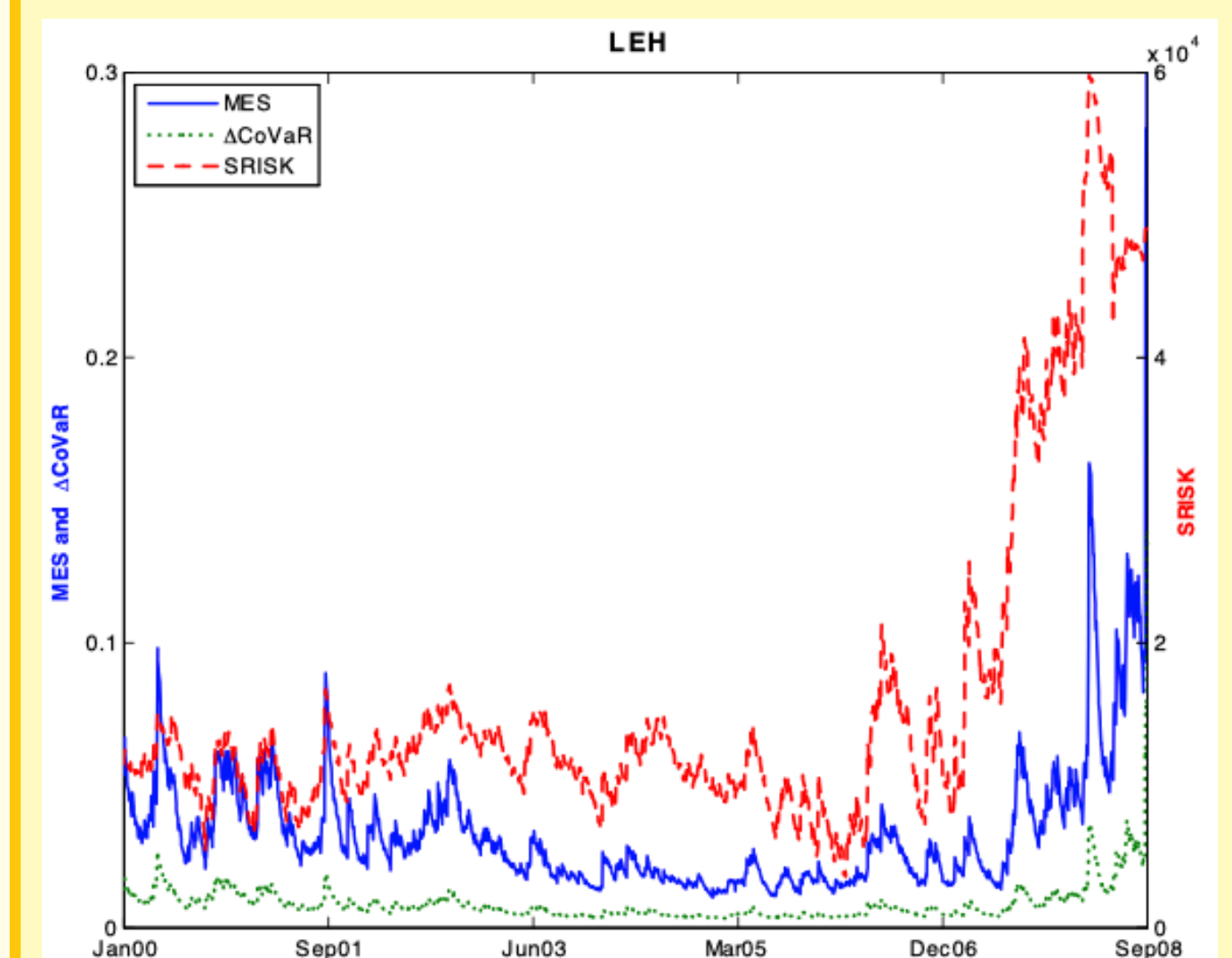


Figure: MES, ΔCoVaR and SRISK from Jan 2000 to Sep 2008

► The above figure shows that three widely-used systemic risk measures, MES, ΔCoVaR and SRISK spike before and during the Global Financial Crisis in 2008, implying that systemic risk from the financial sector contains predictive information about future crashes.

References

- [1] A. Sufi and A.M. Taylor. Financial Crises: A Survey In *National Bureau of Economic Research* 2021
- [2] M. Brunnermeier, S. Rother, I. Schnabel. Asset Price Bubbles and Systemic Risk In *The Review of Financial Studies* 2020