Mean Field Theory of Default Cascades in Credit Networks

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Abstract

When firm *i* signs a contract to supply firm *j* with a product or a service, firm *j* agrees to a payment schedule before, during, and even after the final delivery. Both firms take note of this payment schedule when they make projections on their cash flows, and thus while the contract is in force, the balance sheets of the two firms are linked. If for one reason or another, firm *j* faces difficulty with its cash flow, and cannot keep to the payment schedule, the cash flow of firm *i* may also be jeopardized. In a robust economy, credit links like the one described above will continually be formed when firms enter into production or service contracts with each other. Most of these links will be discharged (the debtor completes all payments owed to the creditor) after some time and be removed. We therefore have a dynamic credit network where the links are changing with time. At any time, a small number of firms may default on their payments for their own idiosyncratic reasons. Creditors of these firms may themselves default as a result, and we end up with cascades of defaults through the credit network. Such default cascades can occur whether the economy is growing or contracting, but we expect they will be larger and leading to more bankruptcies during economic crises. Default cascades thus pose a systemic risk to the real economy.

In this talk, I will describe two credit network models, and their mean field theories. In the first credit network model (Yoshi Fujiwara), firms form directed links with other firms at a constant rate. A directed link from firm *i* to firm *j* means that firm *i* owes firm *j* money. These links are deleted at a different constant rate, when credit obligations are successfully discharged. At each time step, firms not linked to defaulted firms can default with a small probability p_0, whereas firms linked to defaulted firms can default with a larger probability p_1. For this model, we developed a mean field theory that tracks the growth of a giant cluster within the credit network, and the susceptible-infected (SI) dynamics of defaults within the giant cluster. I will discuss the implications of this mean field theory on systemic risk posed to the credit network. In the second credit network model (Yougui Wang), directed credit links are formed and deleted at constant rates, but a firm defaults only when its net debt obligation (number of outgoing links minus number of incoming links) exceeds a certain threshold. In this sense, a default cascade progresses deterministically in the second model, compared to probabilistic progression in the first model. I will describe the more involved mean field theory on systemic risk for this model, and discuss implications for fiscal interventions.

Biography

Dr Siew Ann Cheong graduated with a BSc (Hons) degree in physics from the National University of Singapore in 1997, and went on to obtain his PhD in theoretical condensed matter physics from Cornell University in 2006. He was a postdoctoral associate with the Cornell Theory Center for a year and a half, working on biological sequence segmentation, before joining the Nanyang Technological University as an Assistant Professor in Physics and Applied Physics in August 2007. He is currently Deputy Director of the Complexity Institute in the Nanyang Technological University. His main research interest is in developing data analysis methods and toy models for understanding the dynamics of complex systems such as biological macromolecules, the brain, earthquakes, financial markets, infectious diseases, and human society.