Discussion: Asset Pricing Implications of Systemic Risk in Network Economies

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Aggregation

- The economy is not part of nature. It was created by humans to meet their needs.
- Humans produce goods to meet their needs. Often do this with other humans within the organisational structure known as firm.
- Aggregate economy is the sum of its parts.
- Traditional focus has been on the sum (aggregate economy) as opposed to parts.
- But some firms are more important than others. Where would the SP500 be without tech firms? There is **systemic risk**

Aggregation

Need to think about aggregation of individual firms to understand aggregate economy

Interconnections

- Need to think about more than just adding up output across firms.
- The connection between the Taiwan Semiconductor Manufacturing Company and Apple is clearly not the same as the connection between Honda and Apple

Interconnections

Need to think about how individual firms are interconnected

Aggregation and Interconnections

- Aggregate economy composed of sectors, which contain firms, which themselves contain small divisions, etc
- To understand where aggregate shocks come from need to look at building blocks of the aggregate economy
  - sectors
  - firms
  - parts of firms
  - individual workers and the production processes they design, build and run
- And understand the interconnections between sectors, firms, etc
  - Sectors, firms, etc. exist as part of a network

This paper

1. Aggregation: how do firm-level shocks aggregate to create aggregate shocks?
2. Interconnectedness: What happens when negative firm-specific shocks cluster across firms because of their network structure?
3. Asset Pricing: derive SDF and use aggregate shocks to infer cross-sectional risk premia

Model

- Infinite horizon economy, N Lucas Trees with CRRA rep agent (RRA: γ, time discount rate: δ) (Orchard, Martin (2013))

$$X_{i,t} = Y_t x_t^n, \; n \in \{1, \ldots, N\} \tag{1}$$

  - common shock

$$\frac{dY_t}{Y_t} = \mu dt + \sigma dW_t \tag{2}$$

$$\tag{3}$$

  - firm-specific shocks

$$x_t^n \in \{x^n(0), x^n(1)\} \tag{4}$$

    - x_t^n follows a 2 state Markov chain, the chain is independent across firms.
    - $0 \le x^n(0) < x^n(1)$, $x^n(0)$ is the distress state for firm n.

Aggregation I

- Aggregate consumption is given by

$$C_t = Y_t X_t^{(N)}, \tag{5}$$

where

$$X_t^{(N)} = \sum_{n=1}^{N} x_t^n, \tag{6}$$

- Need to understand $dX_t^{(N)}$

$$dX_t^{(N)} = \sum_{n=1}^{N} dx_t^n, \tag{7}$$

Aggregation II

- Define indicator function H_t^n for firm n's distress state

$$H_t^n = I_{\{x_t^n = x^n(0)\}} \tag{8}$$

$$dx_t^n|_{H_{t-}^n=0} = -[x^n(1) - x^n(0)] \cdot \overbrace{dN_{t,+}^n}^{\text{Poisson process jumps up when enter distress state, intensity } \lambda_{t-}^n} \tag{9}$$

$$dx_t^n|_{H_{t-}^n=1} = [x^n(1) - x^n(0)] \cdot \underbrace{dN_{t,-}^n}_{\text{Poisson process jumps up when leave distress state, intensity } \eta^n} \tag{10}$$

$$dx_t^n = -[x^n(1) - x^n(0)] \left((1 - H_{t-}^n)dN_{t,+}^n - H_{t-}^n dN_{t,-}^n\right) \tag{11}$$

Aggregation III

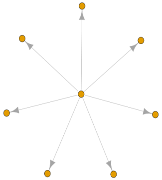
- When do firm-specific jumps create aggregate jumps?

$$dX_t^{(N)} = -\sum_{n=1}^{N}[x^n(1) - x^n(0)]\left((1 - H_{t-}^n)dN_{t,+}^n - H_{t-}^n dN_{t,-}^n\right) \tag{12}$$

- If enough firms jump in the same direction at the same time, firm-specific jumps will create an aggregate jump
- If we make the transition intensity into the distress state stochastic and make it high when other firms are in distress, we can have **distress clustering**

Interconnected I

- Specify **network** structure of firms: strength of connection of firm i to firm j (not j to i) is given by $\Delta_{ij} > 0$. This gives N by N matrix – adjacency matrix for directed (means direction matters) network
- Example: suppose $N = 8$ and $\Delta_{21} = \Delta_{23} = \ldots = \Delta_{28} = 1$, all other elements of Δ are zero



$$\Delta^{SN} = \alpha^{\mathcal{G}} \left(\nu^R\right)^T \cdot \nu^L = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\alpha^{\mathcal{G}} = 1, \quad \nu^L = [1, 0, ..., 0], \quad \nu^R = [0, 1, ..., 1],$$

Interconnected II

- Network structure impacts transition intensity into distress state

$$\lambda_t^n = \lambda^n + \lambda \sum_{j=1}^{N} \Delta_{ij} H_{j,t} \tag{13}$$

  - stochastic transition intensity, λ_t^n
  - suppose a firm goes into distress – transition intensity into distress for connected firms goes up
  - If transition intensities into distress are sufficiently high relative to transtion intensity out of distress, then firm-specific risks contribute to aggregate risk

Critical Value

If $\lambda/\eta >$ critical value, then firm-specific risks contribute to aggregate risk

Networks and Distress Clustering

- The critical value depends on the characteristics of the network.
- Intuition: if enough firms can be in the distress state at the same time there is **distress clustering** – a cascade of distress through the network

Switching into the Distress Clustering Regime

- At the moment, you have distress clustering or you do not.
- If you made either λ or η stochastic via dependence on some aggregate state variable, you would have distress clustering in bad states and no distress clustering in good states.

Introduce a Measure of Systemic Risk

Developing measures of systemic risk is important and still work in progress [Hansen (2013)]
You have a measure of systemic risk.
Just use the reciprocal of the critical value in $\lambda/\eta >$ critical value $\rightarrow$ distress clustering
When systemic risk is high, the critical value for distress clusterin is low

Other papers already have default clustering

- Bhamra, Kuehn and Strebulaev (2011a,b) and Chen (2011)
- This is obtained endogenously via an aggregate shock which raises the default boundary for all firms, creating a cluster of defaults.
- In this paper there is a full quantitative analysis of distress clustering (not in above papers), which is tractable precisely because the dynamics driving distress clustering is specified exogenously – a reduced form model

Asset Pricing

- Could this be left out and developed into another paper with Epstein-Zin-Weil preferences?
- It may be enough to enrich the model via regime shifts between default clustering and no default clustering and focus the paper on systemic risk, aggregate shocks and interconnectedness.

Conclusion

- Good model for studying aggregation of shocks inside a network of firms.
  - Make one change – enrich the model via regime shifts between distress clustering and no distress clustering
  - Distinguish model from Acemoglu, Ozdaglar, and Tahbaz-Salehi (2015) – you could see it as a reduced form model of default (as opposed to distress) clustering and connect with credit risk literature. Your model is dynamic.
- Focus on one idea, perhaps systemic risk
  - Firm-level default risk has aggregate effects creating systemic risk in bad states via default clustering
- Perhaps develop asset pricing model with EZW preferences in another paper