Dynamic Networks and Asset Pricing

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Research Question and Main Results

- How do firm cash flows linkages affect the cross-section of expected returns?

Main Results:
- Equilibrium risk premium is positively related to the extent that a firm is actively connected to the rest of the network.
  - Fundamental shocks to such firm lose soon their idiosyncratic nature and evolve into a systematic factor leading the business cycle.
- After controlling for market beta, size and book to market, centrality has a positive and significant price of risk.
  - A one standard deviation increase in centrality implies approx. a 0.4% increase in monthly risk premium.
- Network connectivity provides a rationale for cross-sectional momentum.
  - Past performance of connected peers has a positive price of risk limited to non central stocks.
Intuition behind the main idea

Symmetric Networks: fully disconnected in Figure 1a; fully connected in Figure 1b.

Asymmetric Networks: “Star” network in Figure 2a; \( \overline{n} \) connected “Stars” in Figure 2b.
Model (1)

- Pure exchange Lucas economy. A representative agent maximizes

\[
U_0 = E \left[ \int_0^\infty e^{-\delta s} \frac{C_s^{1-\gamma}}{1-\gamma} ds \right]
\]

(1)

- Investment opportunity set: (a) locally risk-less asset in zero net supply, (b) \(n\) risky securities in positive net supply: asset \(i\) pays a stochastic dividend at \(t\), \(D^i_t\)

- Prices satisfies market clearing condition, i.e. aggregate consumption, \(C_t = \sum_{i=1}^{n} D^i_t + L_t\) where \(L_t\) is labor income

- Each dividend is composed of a smooth lognormal dividend factor \(Y^i_t\) and a jump component \(x^i_t\) (independent of \(Y^i_t\))

\[
D^i_t = Y^i_t x^i_t, \quad i = \{1, \ldots n+1\}
\]

\[
\frac{dY^i_t}{Y^i_t} = \mu^i dt + \sigma^i dZ_t
\]

(2)
Model (2)

- $H^i_t$: is 1 if tree $i$ is in distress and 0 otherwise. $\lambda^i_t$: persistence intensity

- Connectivity in the network: Intensities depend on the state of distress of other trees, $H$, and on a business cycle factor, $S$:
  - Local connectivity: Dividend intensities are affected by the state of distress of directly connected trees. A highly central tree (say tree 1) satisfies:
    - its distress increases other firms distress intensities, i.e.
      \[ \lambda^i(H^1_t = 1) > \lambda^i(H^1_t = 0) \]
    - its distress intensity is insensitive to others distress, i.e.
      \[ \lambda^1(H^i_t = 1) \approx \lambda^1(H^i_t = 0) \]
  - Global connectivity: When $S$ is in recession, the distress events are more likely, i.e. $\lambda^i(1, H) > \lambda^i(0, H)$
Security Prices

- Let $P^i_i(H_t)$ be the price of a claim on tree $i$. Let $P^i_0(H_t)$ and $P^i_1(H_t)$ denote the price of a claim on tree $i$ when $S = 0$ and $S = 1$ respectively. Let $p^h_t = P(S_t = 0|\mathcal{F}_t)$ Then

$$\frac{P^i_i(H_t)}{D^i_t} = p^h_t \frac{P^i_0(H_t)}{D^i_t} + (1 - p^h_t) \frac{P^i_1(H_t)}{D^i_t}$$

- Intuition:
  - Suppose agent observe $S$ and there is no connectivity
    Distress event $\rightarrow$ future dividend $\uparrow$ $\rightarrow$ future consumption $\uparrow$ $\rightarrow$ I $\downarrow$
    Thus, all $P/D$ ratios decrease.
  - Add network structure back
    Distress event $\rightarrow$ future dividend of connected trees $\downarrow$
    $\rightarrow$ future consumption $\downarrow$ $\rightarrow$ price pro-cyclical trees $\downarrow$
    Thus, $P/D$ are smaller for well connected trees.
  - With incomplete information induces agents to update to a higher value their beliefs of a current recession
Failure Two Fund Separation

- If the network is symmetric, two fund separation holds as $n \to \infty$. If the network is asymmetrically connected, two fund separation does not hold.
- Intuition:

![Symmetric Network](image1)

*Figure 1a*
Symmetric Networks: fully disconnected in Figure 1a; fully connected in Figure 1b.

![Asymmetric Network](image2)

*Figure 2a*
Asymmetric Networks: “Star” network in Figure 2a; “Stars” in Figure 2b.
Empirical Findings

- **Data**: all firms listed on NYSE, AMEX and NASDAQ, with accounting data reported in COMPUSTAT from 1993 to 2007. They also use data on customer-supplier linkages among firms. Regulation SFAS N.131 requires firms to report the identity of customers representing more than 10% of their sales.

- **Results**:
  - After controlling for market beta, size and book to market, centrality has a positive and significant price of risk.
    - A one standard deviation increase in centrality implies approx. a 0.4% increase in monthly risk premium.
  - Network connectivity provides a rationale for cross-sectional momentum.
    - Past performance of connected peers has a positive price of risk limited to non central stocks.
Final Remarks

- Equilibrium risk premium is positively related to the extent that a firm is actively connected to the rest of the network
  - Fundamental shocks to such firm lose soon their idiosyncratic nature and evolve into a systematic factor leading the business cycle.

- Two fund separation might not hold

- Provided the model, it is hard to see what is the impact of a network on prices and trading (the assumption on related intensities might not be a unique feature of networks)