Systemic Credit Freezes in Financial Lending Networks

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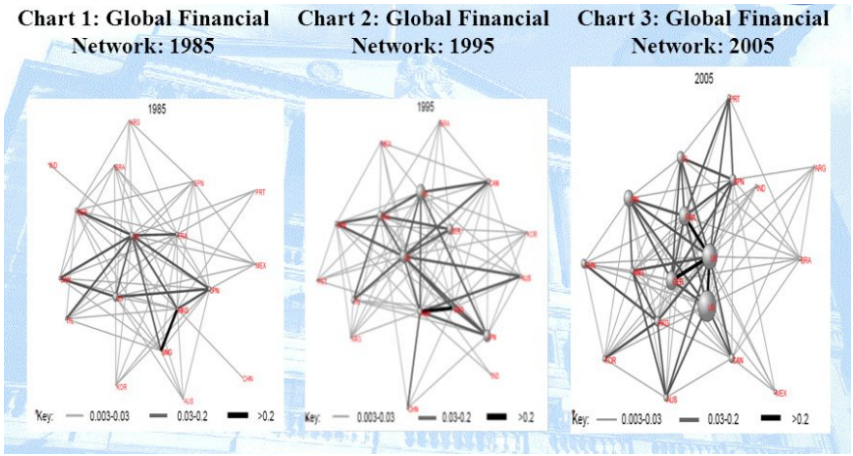
Motivation

- By the onset of the financial crisis of 2008, the US financial system had become increasingly more interconnected.
  - Complex lending relations: interbank and overnight lending, securitized lending such as repo market.
- Failure of an institution triggers financial distress for its counterparties or those holding its shares.
- Lenders need to also assess creditworthiness of borrowers of the borrower, and so on.



- Collapse of Lehman Brothers in September 2008 causes many institutions to lose access to credit (credit freeze).

Ex-Ante vs. Ex-Post

- Ex-Post Contagion: the failure of one institution can cause other institutions to fail.
- Ex-Ante Considerations: credit freezes induced by the fear future liquidity or profitability of borrowers might be compromised because of ex-post effects.

"You have a neighbor, who smokes in bed...Suppose he sets fire to his house. You might say to yourself...'I'm not gonna call the fire department. Let his house burn down. It's fine with me.' But then, of course, what if your house is made of wood? And it's right next door to his house? What if the whole town is made of wood?"

Ben Bernanke
Chair of Federal Reserve Bank
during the 2008 financial crisis

Institutions such as Goldman Sachs, Credit Suisse and Deutsche Bank had "little or no interest to renew repos [for Bear Stearns] in the face of concerns over the dealer bank's solvency."

Darrell Duffie
How Big Banks Fail and What to do About It
March 27, 2010

"If we start taking novations [credit contracts for Bear Stearns], people pull their business, they pull their collateral, you're out of business."

Gary Cohn
Co-President
Goldman Sachs
March 11, 2008

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- Introduce risk shifts that increase a bank's probability of default.
- Characterize the subgame perfect equilibria of lending interactions to motivate policy intervention.

Related Literature

- Empirical evidence of credit freezes in interbank lending
  - Adrian et al. (2013); Alfonso, Kovner and Schoar (2010); Brunnermeier (2009)
- Endogenous network formation
  - Leitner (2004); Babus (2006); Blume et al. (2011)
- Single bank or pair of banks accessing credit market
  - Gorton and Metrik (2012); Diamond and Rajan (2011); Caballero and Simsek (2013)
- Ex-ante fears captured through global coordination game
  - Allen and Babus (2009); Anand et al. (2012); building off global games literature of Shin and Morris (2001)
  - No ex-post trigger (see Acemoglu, Ozdaglar and Tahbaz-Salehi (2015), Cabrales, Gale and Gottardi (2015), Elliott, Golub and Jackson (2014), Gai and Kapadia (2010), Jorian and Zhang (2010))

Banks, Depositors, and Entrepreneurs

1. Entrepreneur ($\mathcal{E}$): Non-financial project with funding level x and unit capacity has production technology:

$$f(x) = \begin{cases} r^*, \text{ if } x \geqslant 1 \\ 0, \text{ otherwise} \end{cases}$$

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3. Bank ($\mathcal{B}$): Intermediaries between depositors and clients (and each other).

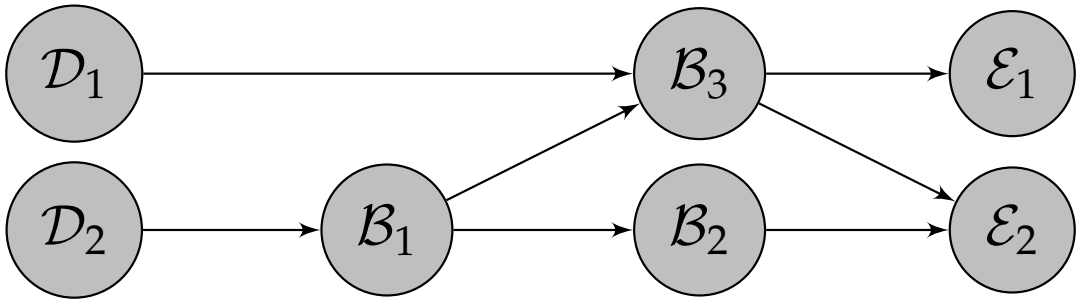

Figure: Opportunity Network $\mathbf{G}$.

Stages of Lending Model

- Take directed, opportunity network $\mathbf{G}$ as given. Let $\mathcal{N}_{in}(i)$ and $\mathcal{N}_{out}(i)$ denote the in and out-neighborhood of i, respectively.

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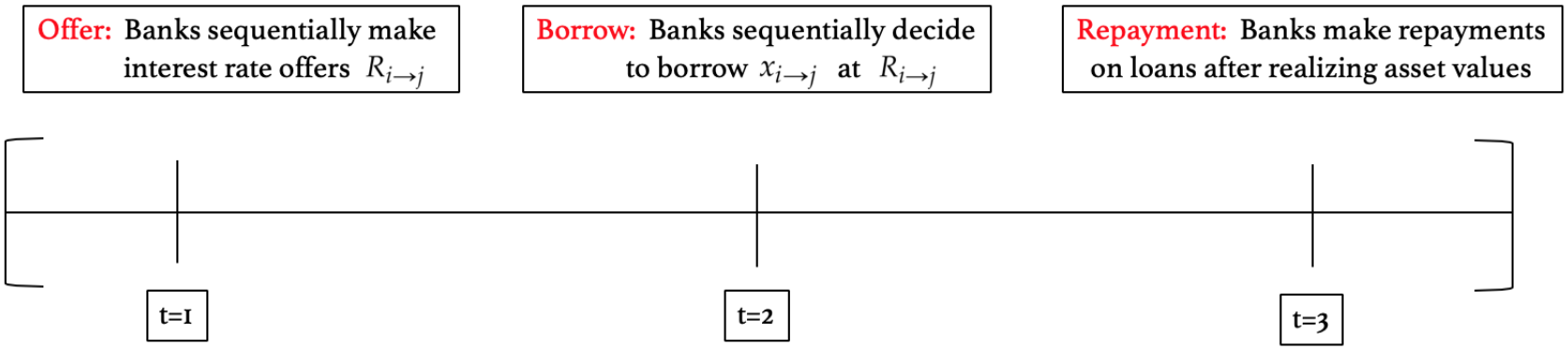
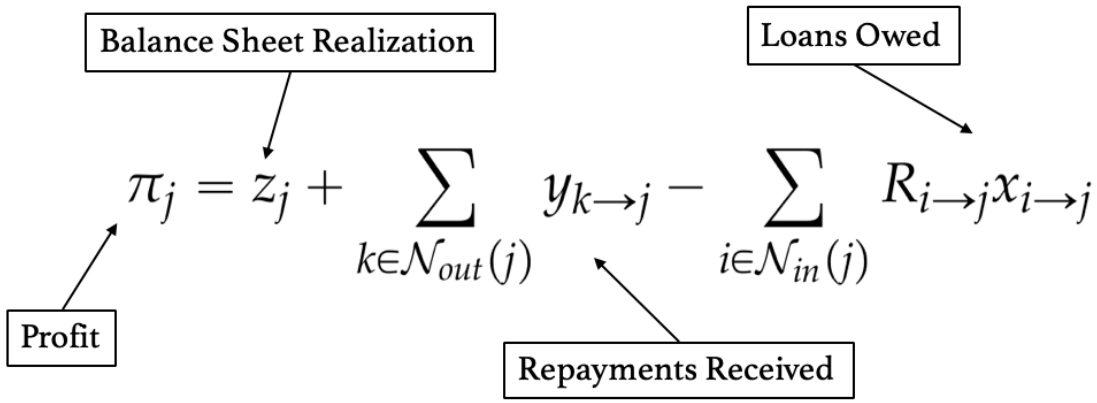
- Lending model consists of three stages:



Repayment Equilibrium

- Take financial network $\mathbf{G}_* = (\mathbf{R}, \mathbf{x})$ as given.
- The (realized) profit of bank j is



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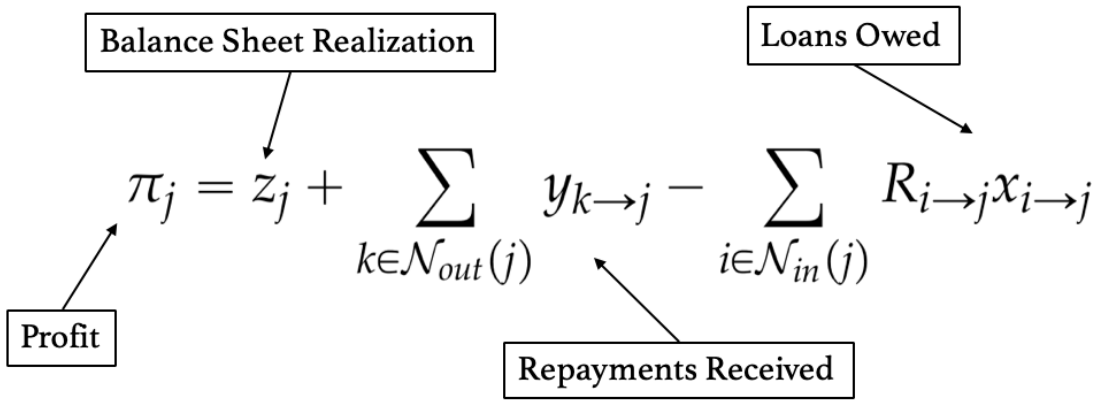

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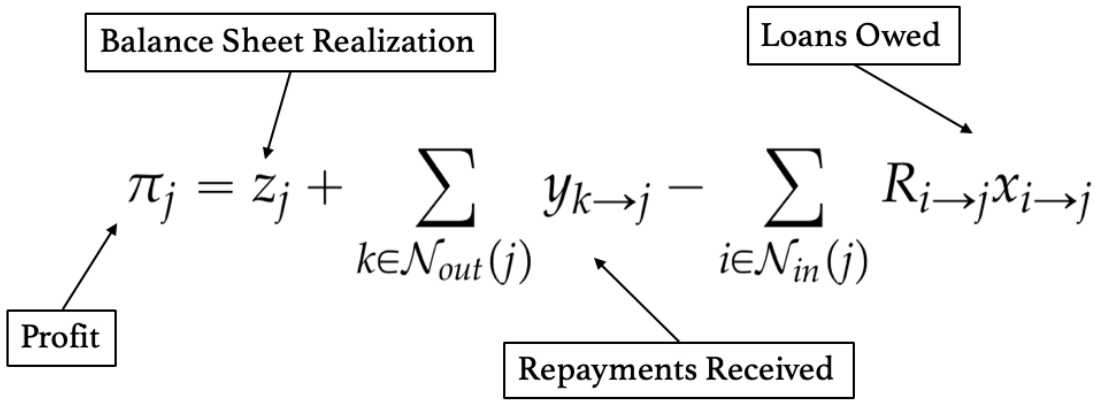

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- If a bank defaults, it repays nothing. This is known as the total failure model, where bankruptcy liquidation proceeds are zero.

Lending Equilibrium

- Every bank j maximizes expected upside profit minus a default cost ($F \geqslant 0$) from bankruptcy, $\mathbb{E}[(\pi_j)_+ - F \cdot d_j]$, subject to the borrowing constraint.

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- Strong solution concept: refine subgame perfection to eliminate indifferences; trembling-hand perfect equilibrium for interest rate offers.
- Essential uniqueness: two financial networks $\mathbf{G}_*, \mathbf{G}'_*$ are equivalent if $\mathbf{x} = \mathbf{x}'$ and $R_{i\to j} = R'_{i\to j}$ agree wherever $x_{i\to j} > 0$.

Strong Equilibrium Properties

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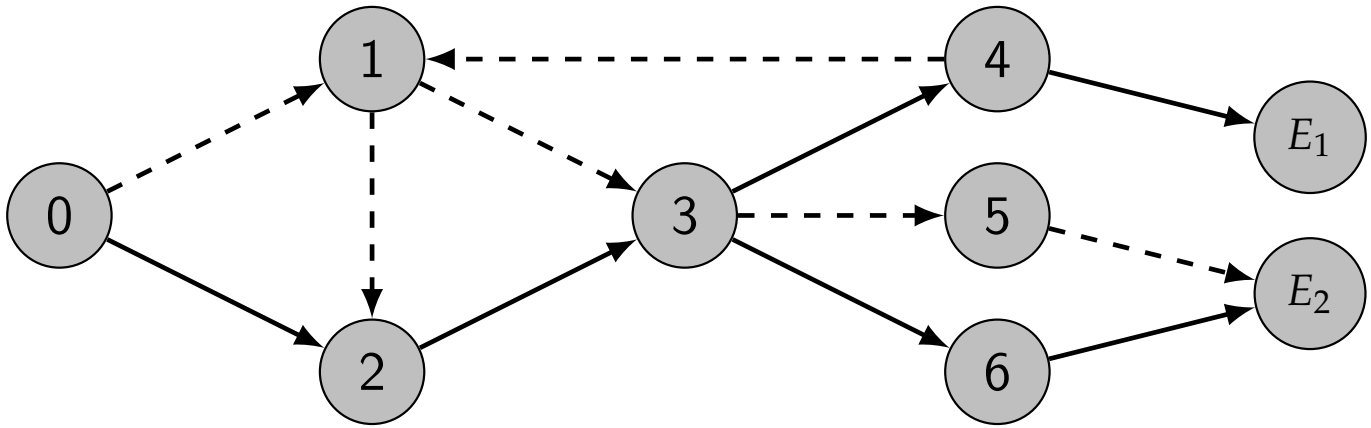

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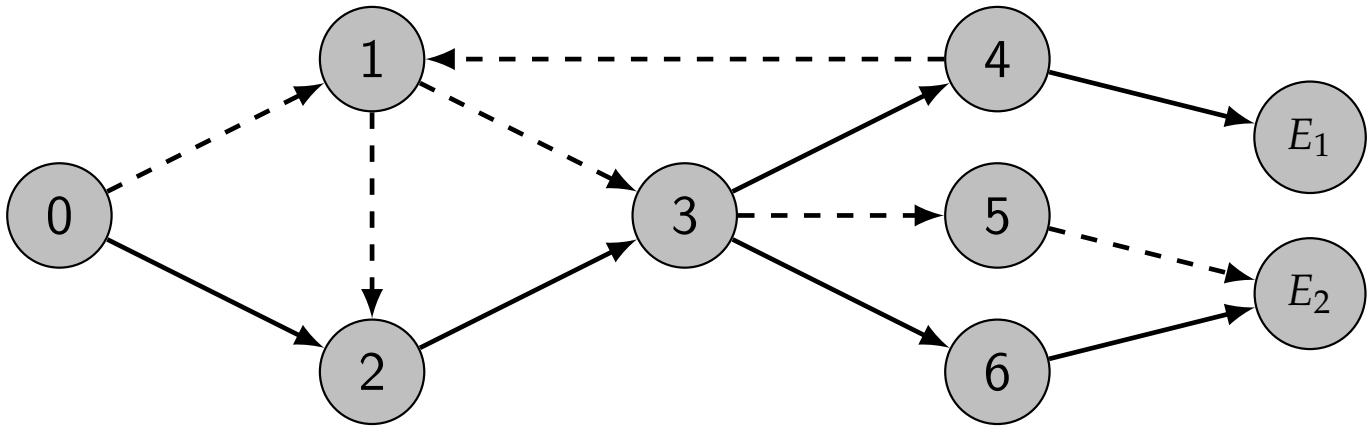

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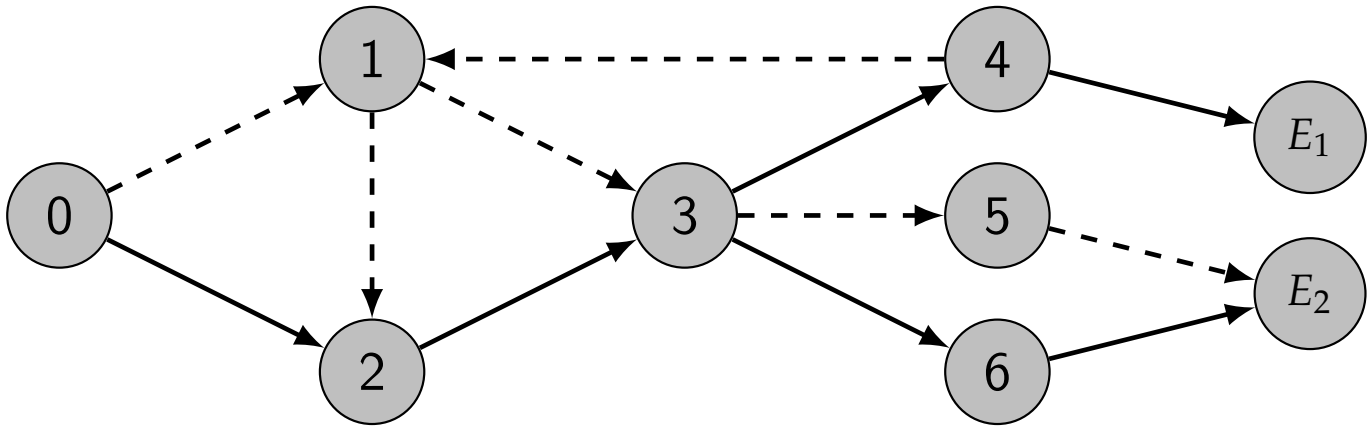
- Financial network is a *directed-tree*.



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Simple Freezes in Trees

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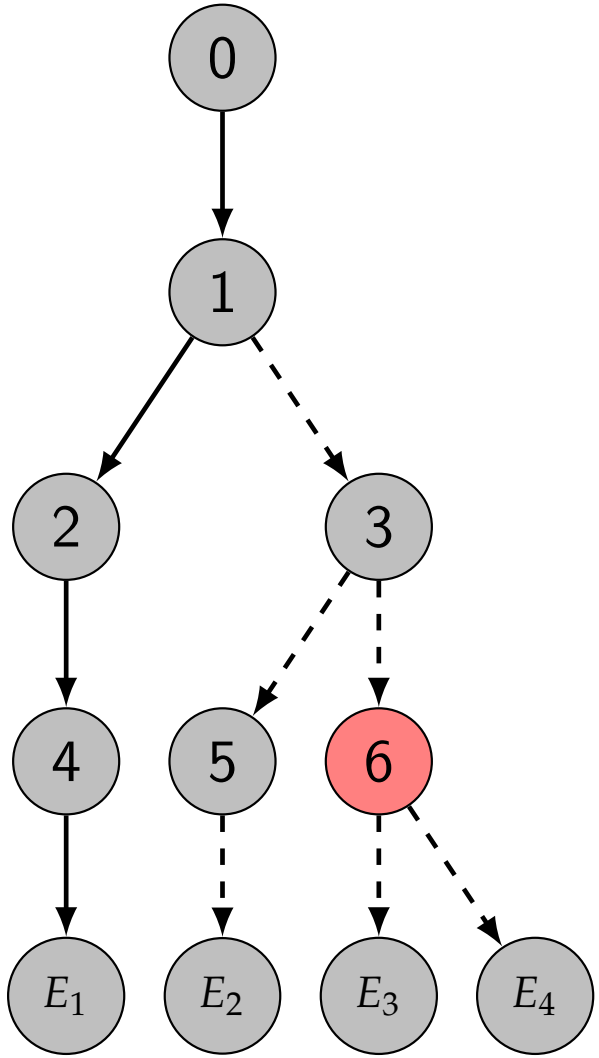

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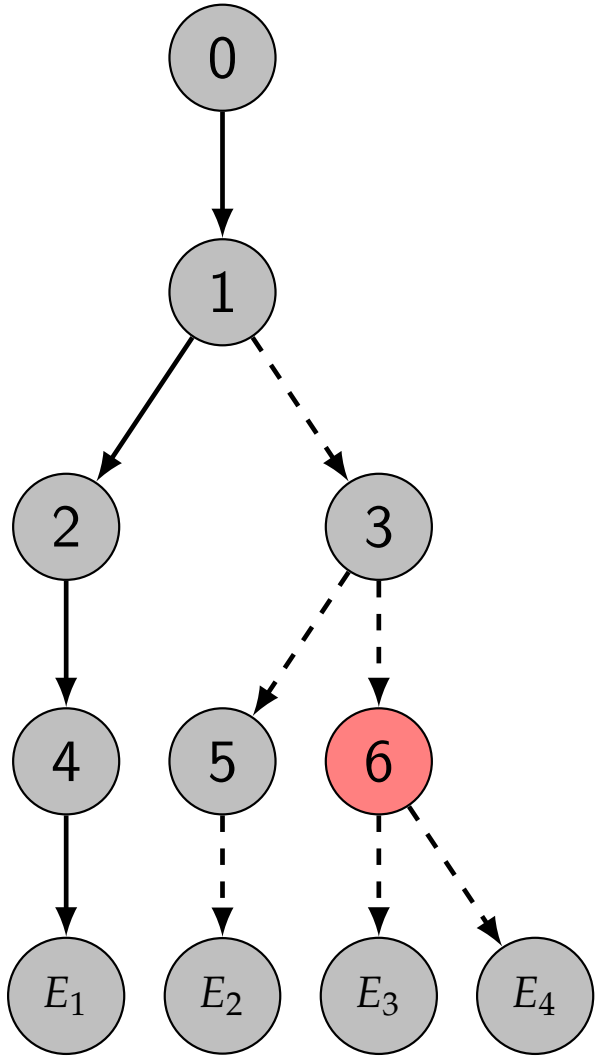

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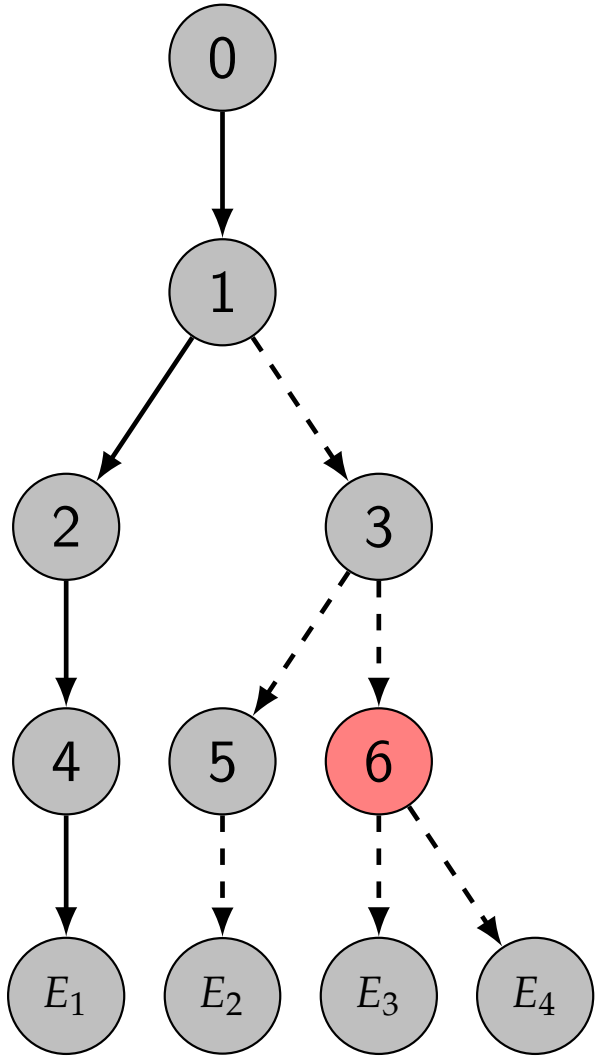
- If $\mathbf{G}$ is a directed tree, and assets are independently distributed, then any risk shift induces only simple freezes.



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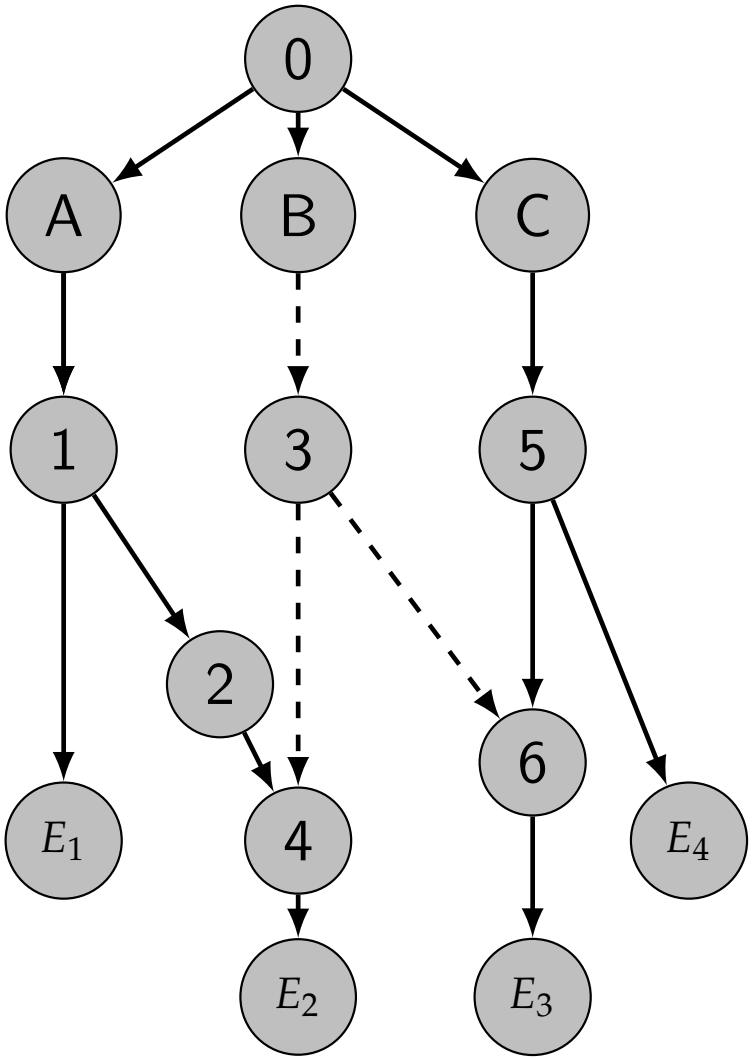

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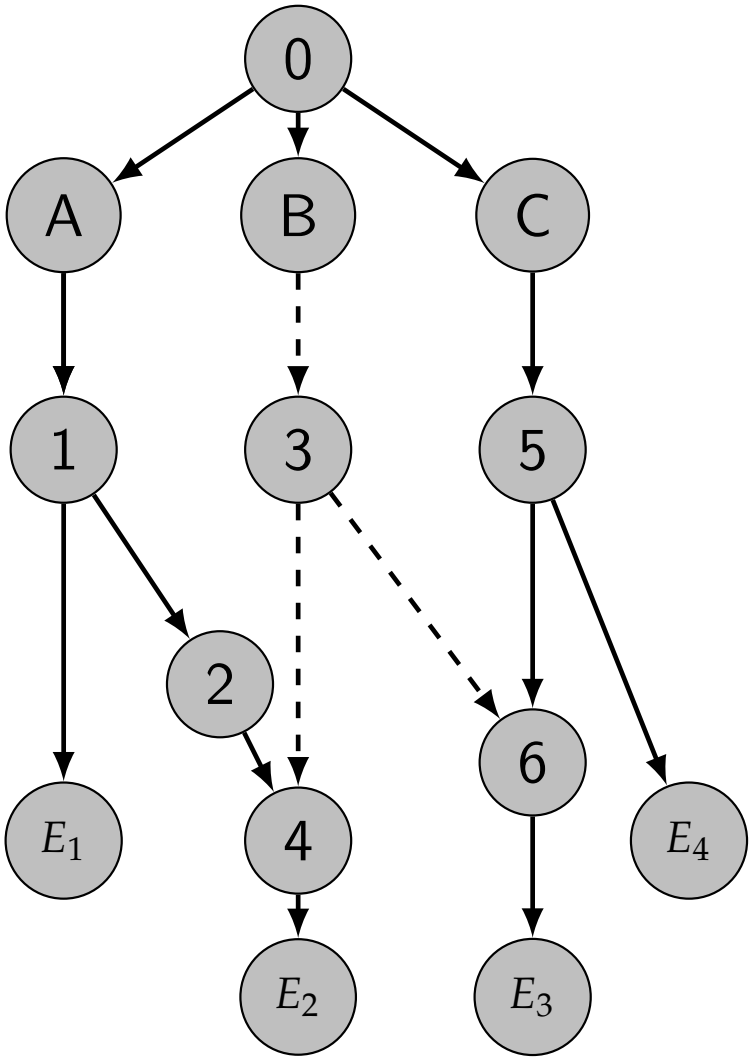

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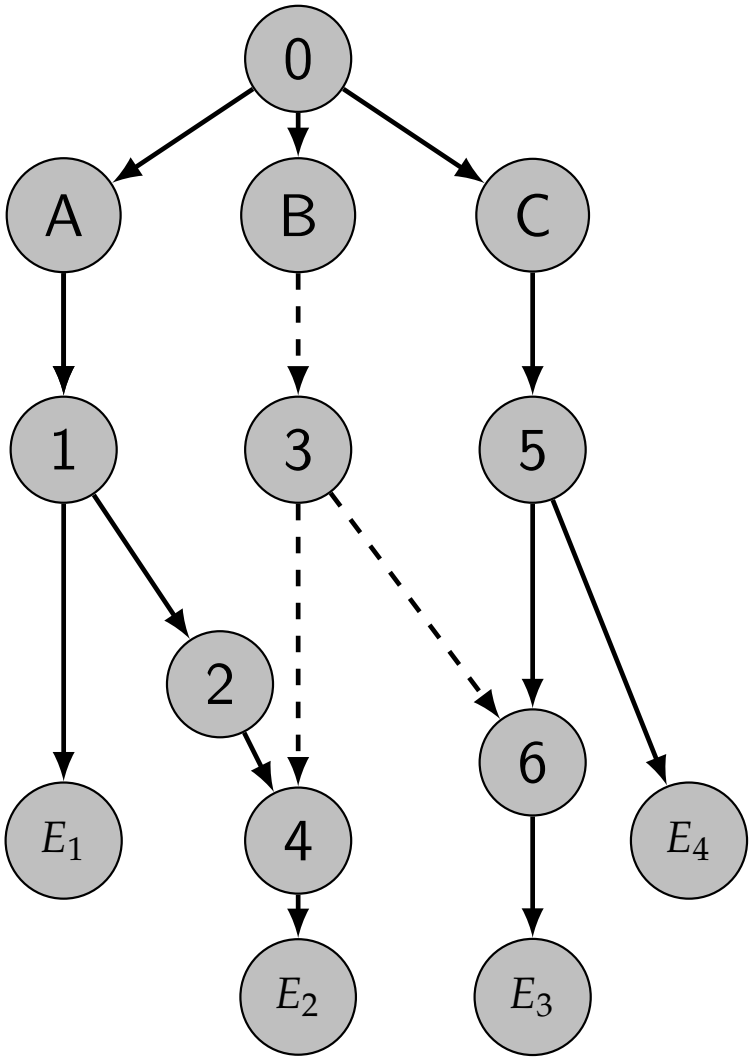

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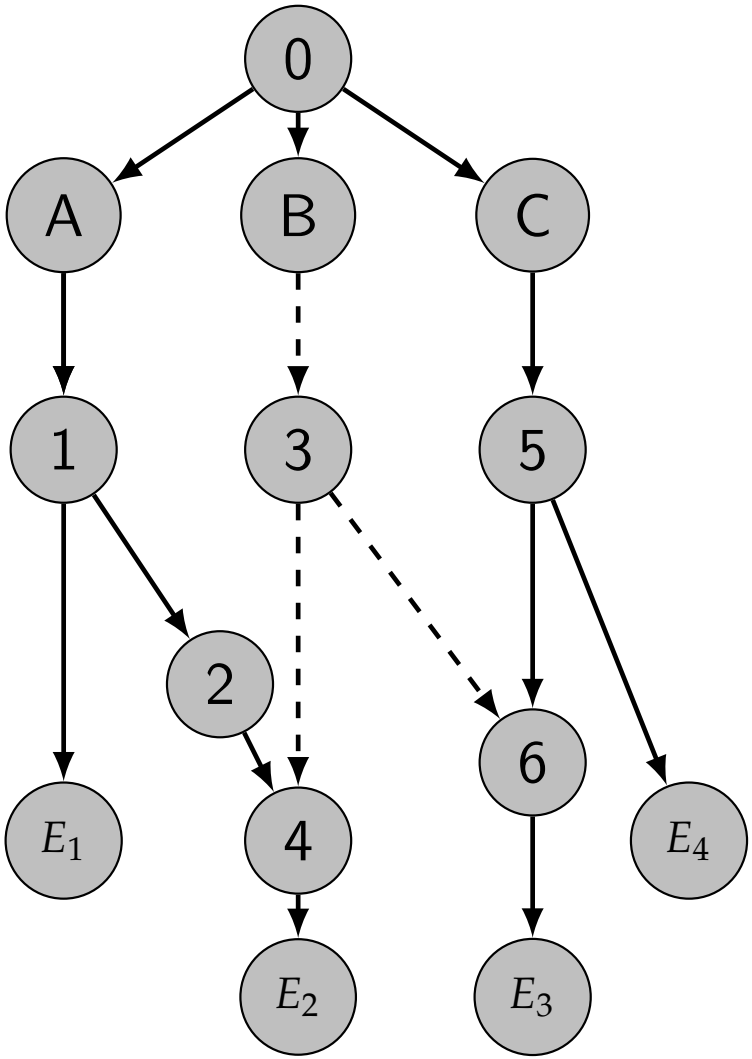

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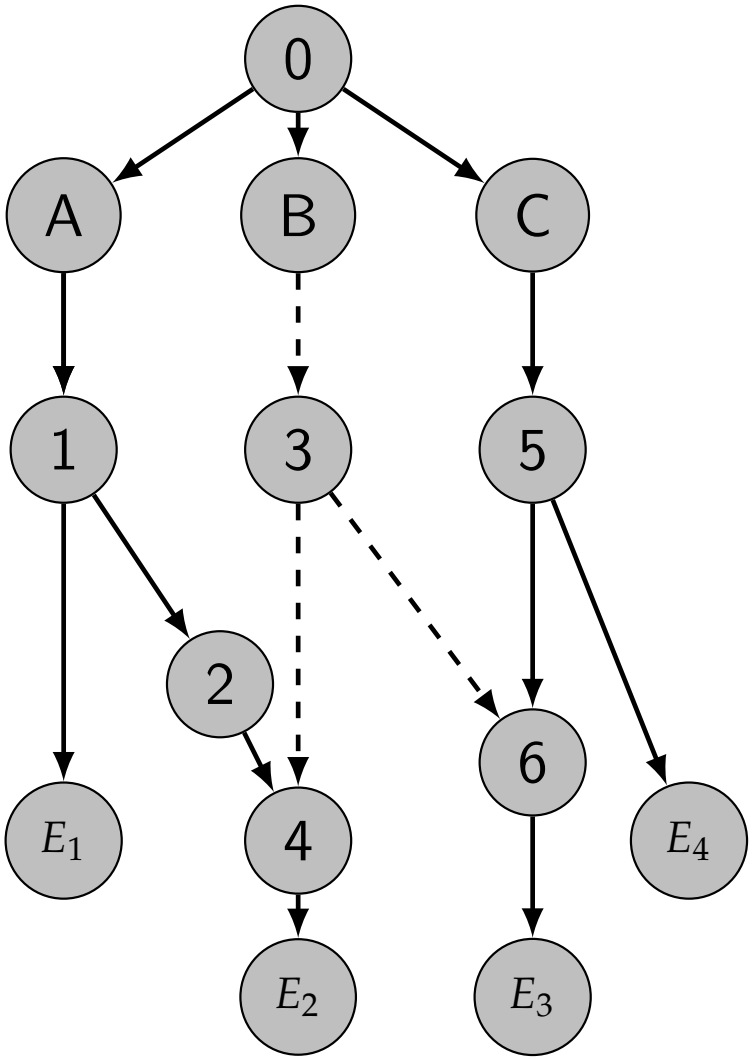

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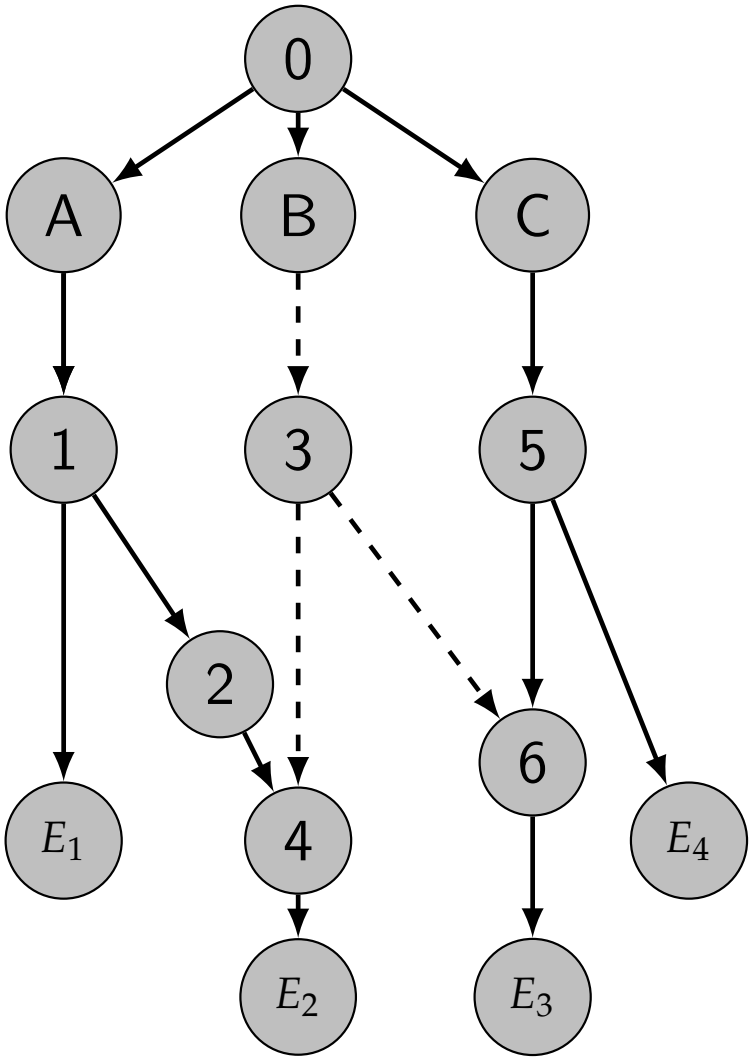

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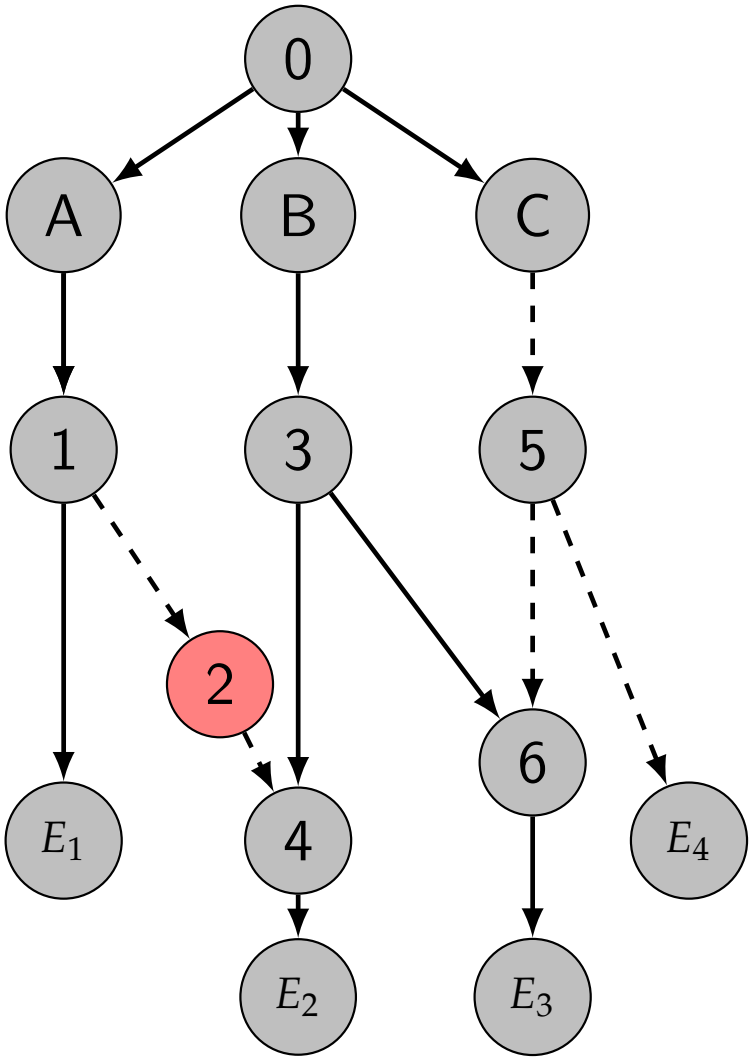
- Branch C has two clients as opposed to one, so branch C can compete with branch B over E_3.

Complex Freezes: After Risk Shift



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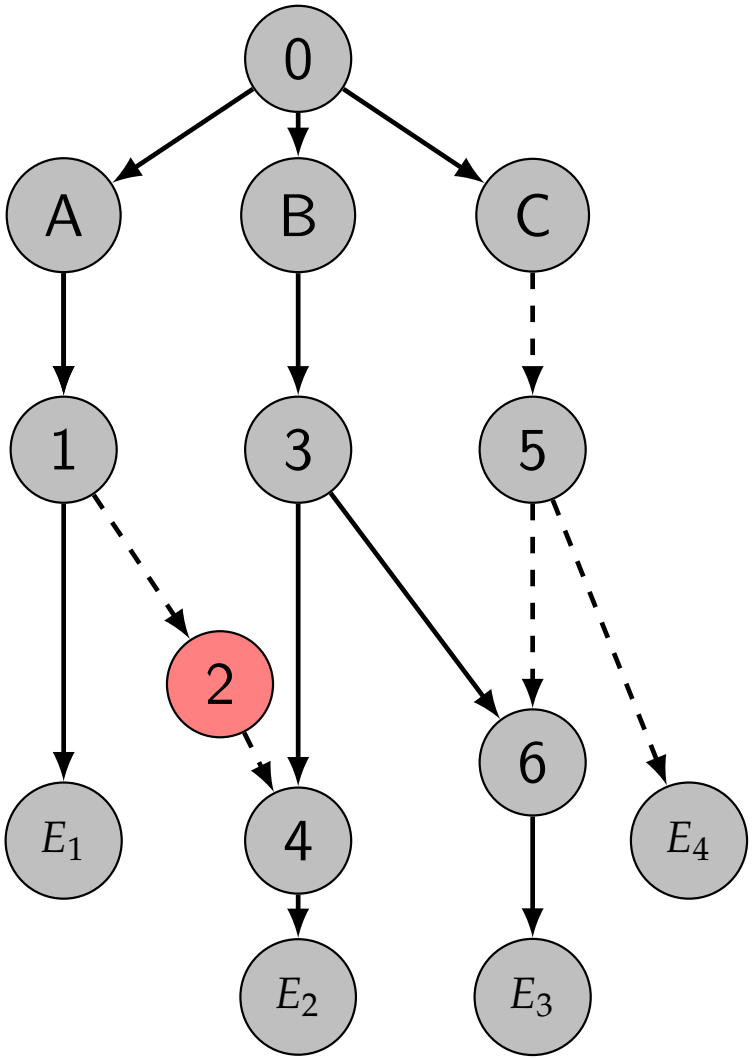

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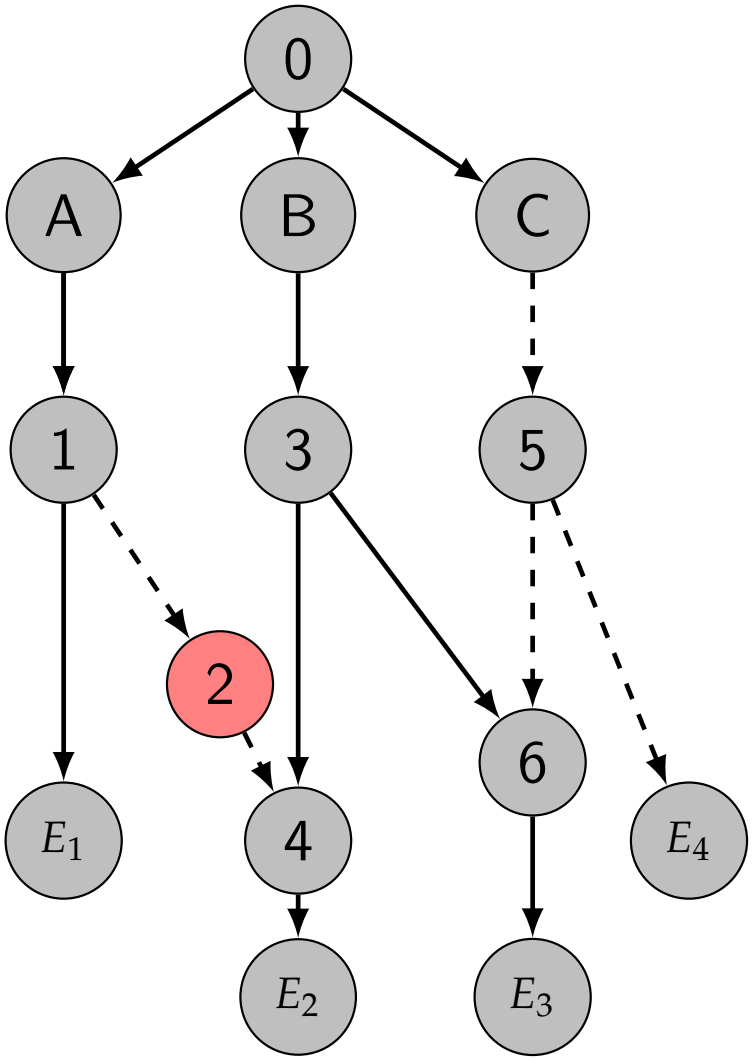

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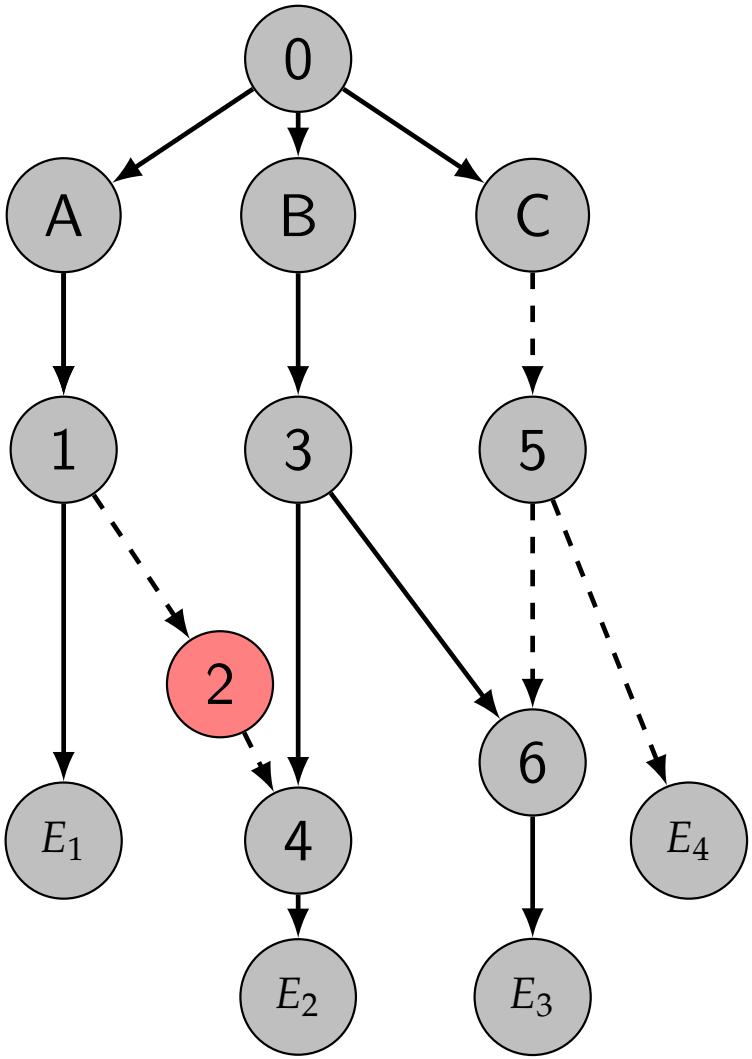

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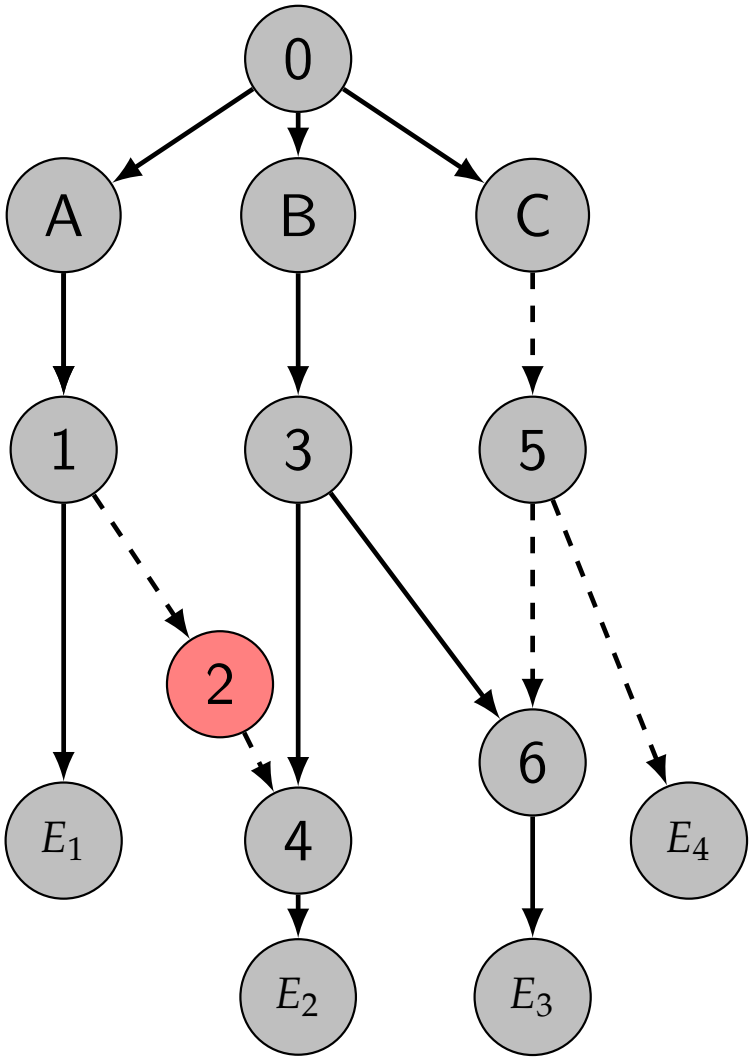

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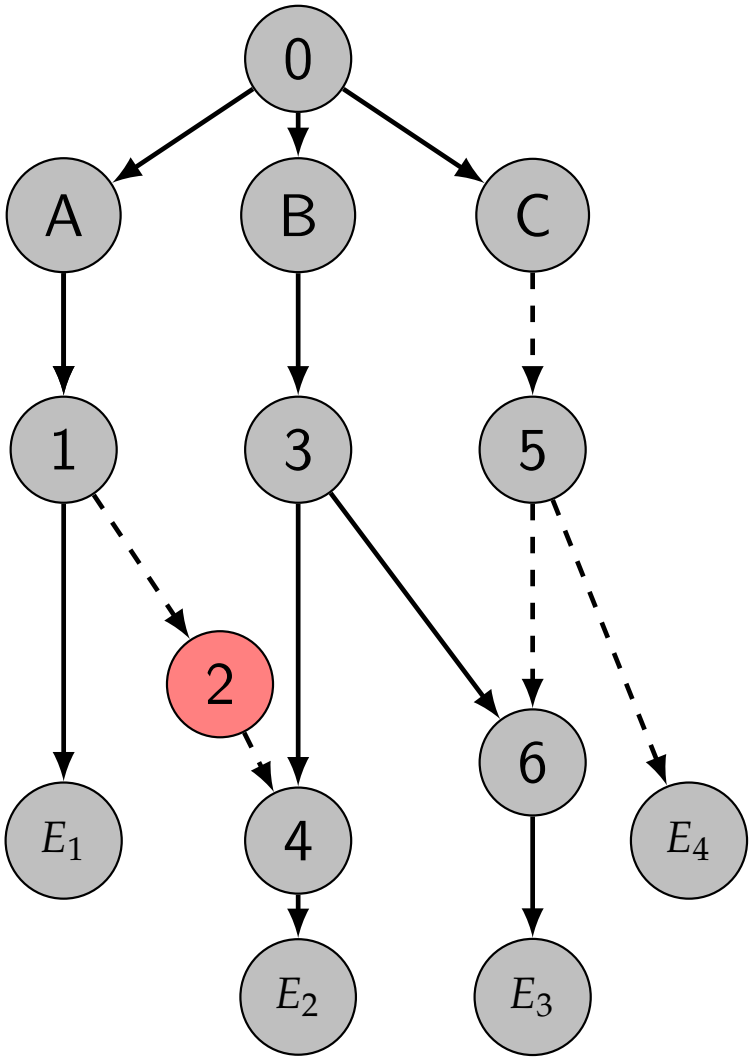

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- Profits from client E_4 not sufficient to compensate for bank 5's risk.

Central Bank Policy

- Central bank has a budget B and can implement asset purchases (positive risk shifts) or discount window (lender-of-last-resort) policies.
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- Optimal policy: maximize total lending to entrepreneurs.

Main Policy Findings

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- After a shock, we see total lending decrease by $\Delta > 0$ from a simple freeze; want to implement an inexpensive policy to restore lending:
  - Always set $\epsilon_i = 0$ and $B_i = 0$ if bank i did not lose credit.
  - This policy is relatively cheap (i.e., $B \leqslant \Delta$) and strictly cheaper than untargeted policy (if not in the chain).

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- For freezes in the chain, an untargeted policy does no worse than a targeted policy.
  - Lending in the chain is cooperative, use the interest rates to redistribute liquidity in a way that makes everyone content to borrow/lend.
- After a shock, we see total lending decrease by $\Delta > 0$ from a simple freeze; want to implement an inexpensive policy to restore lending:
  - Always set $\epsilon_i = 0$ and $B_i = 0$ if bank i did not lose credit.
  - This policy is relatively cheap (i.e., $B \leqslant \Delta$) and strictly cheaper than untargeted policy (if not in the chain).
- When the freeze is complex, may be better to target banks unaffected by freezes.

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- If policymakers are misinformed of the financial network, targeting policies can exacerbate the problem.
- Evidence for a policy of decreasing some asset prices, which could lower interest rates.

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- Future work: investigate credit freezes in repo or interbank lending market, can we characterize optimal policy?