Motivation

- **Aim:** Bridge the gap between
  - Macro/monetary research
  - Finance research

- **Financial sector helps to**
  - overcome financing frictions and
  - channels resources
  - creates money

... but
- Credit crunch due to adverse feedback loops & liquidity spirals
  - Non-linear dynamics

- **New insights to monetary and international economics**
- Price stability
  Monetary policy

- Financial stability
  Macroprudential policy

- Fiscal debt sustainability
  Fiscal policy

- Short-term interest
- Policy rule (terms structure)

- Reserve requirements
- Capital/liquidity requirements
- Collateral policy
- Margins/haircuts
- Capital controls
Methodology

- **Verbal Reasoning** *(qualitative)*
  - Fisher, Keynes, ...

### Macro
- Growth theory
  - *Dynamic (cts. time)*
  - *Deterministic*
- Introduce stochastic
  - *Discrete time*
  - Brock-Mirman, Stokey-Lucas
  - DSGE models
- Cts. time macro with financial frictions

### Finance
- Portfolio theory
  - *Static*
  - *Stochastic*
- Introduce dynamics
  - *Continuous time*
  - Options Black Scholes
  - Term structure CIR
  - Agency theory Sannikov
Pre-crisis Macro

- Price/wage rigidities

- Expectations of
  - cash flow
  - “the” short-term interest rate

\[ \Delta \text{price} = f(\Delta E[\text{future cash flows}], \Delta \text{risk premia}) \]

- Expectation hypothesis
- Credit spread = expected default

- Euler equation
  - Substitution effects

Post-crisis Macro & Finance

- Financial frictions

- Endogenous risk/volatility
  - e.g. runs, sudden stops, ...

- Risk premia time varying

- Term risk premia
- Credit risk premia

- Wealth redistribution
  - Income/wealth effect
Heterogeneous Agents & Frictions

- Lending-borrowing/insuring since agents are different

  - Poor-rich
  - Productive
  - Less patient
  - Less risk averse
  - More optimistic

  - Rich-poor
  - Less productive
  - More patient
  - More risk averse
  - More pessimistic

- Friction $\rightarrow$ $p_s MRS_s$ different even after transactions

- Wealth distribution matters! (net worth of subgroups)
- Financial sector is not a veil
Types of Distortions

- Belief distortions
  - Match “belief surveys”  \((BGS)\)

- Incomplete markets
  - “natural” leverage constraint \((BruSan)\)
  - Costly state verification \((BGG)\)

- Leverage constraints
  (no “liquidity creation”)
  - Exogenous limit \((Bewley/Ayagari)\)

- Collateral constraints
  - Next period’s price \((KM)\)
    \[ Rb_t \leq q_{t+1}k_t \]
  - Next periods volatility \((VaR, JG)\)
  - Current price

- Search Friction \((DGP)\)
Overview: Financial Crises

- Run-up phase
  - Distorted Beliefs
  - Concentration of Risk
  - Maturity Shortening

- Crash phase
  - Fire-sales
  - Paradox of Prudence
  - Spillovers

- Recovery phase
  - Persistence vs. Resilience
  - Dynamic Amplification
  - Volatility Dynamics/Volatility Paradox

Externalities

Strategic Complements/Substitutes
The 2 Components of Systemic Risk

1. Systemic risk build-up during (credit) bubble... and materializes in a crisis
   - “Volatility Paradox” → contemp. measures inappropriate
   - Vulnerability focus instead of timing focus

2. Spillovers/contagion
   - Direct contractual: domino effect – network
   - Indirect: price effect (fire-sale externalities), credit crunch, liquidity spirals

3. Persistence/Slow recovery

[Diagram showing the process from shock to capital, loss of net worth, precaution and tighter margins, and fire sales, volatility, and nonlinearity, leading to persistence and slow recovery]
The 2 Components of Systemic Risk

1. Systemic risk build-up during (credit) bubble
   ... and materializes in a crisis
   - time-series
   - “Volatility Paradox” → contemp. measures inappropriate
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2. Spillovers/contagion
   - Direct contractual: domino effect – network
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3. Persistence/Slow recovery

preventive

crisis management
Run-up 1: Bubbles due to Beliefs “Distortions”

- **Extrapolative Expectations**
  - Representativeness heuristic
  - Overestimate of productivity after good shock
  - Bubbles/overinvestment driven by *level of beliefs* a la Miller (1977)
    - AS: Surveys consistent with each other, mutual fund flows

- **Heterogeneous beliefs**: optimists and pessimists
  - + limited commitment ⇒ Leverage cycle
  - “Marginal buyer” vary with shocks

- **Surveys elicit “consensus beliefs” ≠ marginal buyer’s beliefs**

- **Switching** heterogeneous beliefs ⇒ Speculation
  (Resale option a la Harrison-Kreps/Scheinkman-Xiong):
    - optimist/pessimist “switching” + short-sale constraint
    - ⇒ Bubbles, volatility, and transaction volume
Run-up 2: Concentration of Risk

- Financial frictions models:
  - “Experts” hold most of aggregate risk in good times
  - Low volatility, but risk builds up in background
  - Credit cycle: (BGG/KM/BruSan)

- Leverage cycle: (JG/BruPed) extreme leverage in cts. time limit
Run-up 3: Maturity Mismatch

- Brunnermeier-Oehmke: Maturity “rat race”
  - Incentive to dilute creditors
- Diamond-Dybvig: Demand for liquidity
- Calomiris-Kahn: Discipline for banker
Run-up 3: Maturity Mismatch

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Run-up 4: Build-up of Interlinkages

- Kopytov (2018)
Run-up 5: Build-up Strategic Complementarity

- In payoffs: externalities
  \[ \frac{\partial u_i}{\partial x^{-i}} \]
  - If others sell, I suffer a negative shock
  - Pecuniary externalities
    - Incomplete markets setting
    - Price affects collateral constraint
  - Normative theory (welfare implications)

- In response: strategic substitutes/complements
  \[ \frac{\partial \partial u_i}{\partial x^i \partial x^{-i}} \]
  - If others sell, it is more profitable for me to also sell
  - Descriptive/positive theory
Run-up 5: Build-up Strategic Complementarity

- A “strategic-substitute-externality”
  
  *(we Germans like long words 😊)*

- Externality:
  individual ignores that his action leads to a build-up of strategic complementarities
  - With potential large price swings/fire sales

- Pecuniary externality: e.g. fire-sale externality
Externality: negative

\[ i\text{'s best response} \]

\[ \text{negative externality} \]
Externality: positive

Positive externality

\( i \)'s best response

others' average actions
Strategic substitutability

If others respond less, (price goes down)
You respond more         (buy more)

“Respond like a maverick”
Strategic Complementarity

If others respond less, (price goes down)
You respond less  (buy less)
Externalities vs. Strategic Complementarities

- Externalities (payoff spillovers) \( \frac{\partial u^i}{\partial x^{-i}} \)

and

- Strategic Complementarity/Substitutability \( \frac{\partial \frac{\partial u^i}{\partial x^i}}{\partial x^{-i}} = \frac{\partial \frac{\partial u^i}{\partial x^{-i}}}{\partial x^i} \)

  - can be independent of each other
  - ...but note: if \( \frac{\partial u^i}{\partial x^{-i}} = 0 \), then \( \frac{\partial \frac{\partial u^i}{\partial x^i}}{\partial x^{-i}} = 0 \)

- Connection:
  - Due to strategic complementarities \( x^{-i} \) changes a lot
  - Which causes large externality (spillover)
Shock prior to run-up of imbalances

Strategic substitutability

If others respond less, (price goes down)
You respond more  (buy more)

Shock absorber

$i$’s best response

others’ average actions
Shock prior to run-up of imbalances

Shock by 10, but equilibrium declines only by 9
Run up of imbalances

Strategic complementarities

If others were to respond less, (price goes down) you also respond less (buy less/sell)

Shock amplifier

Only off equilibrium changes (price is still high, but ...)

i’s best response

Run-up

others’ average actions
Run up of imbalances

Strategic complementarities

If others were to respond less, (price goes down)
you also respond less (buy less/sell)

Shock amplifier

Only off equilibrium changes
(price is still high, but ...)

i’s best response

Traders lever up by paying out dividend
(more constrained after negative shock)

Example: Run-up

others’ average actions
Shock after run-up

Shock by 10
Leads to equilibrium effect of 30

i’s best response

Run-up

Shocks

Others’ average actions
2nd, 3rd round effects: Amplification

Initial fundamental shock/trigger is amplified
Amplification of Fundamental Shock

Multiplicity: without Fundamental Shock

"Remember that hurricane a thousand miles away? That was me!"
2\textsuperscript{nd}, 3\textsuperscript{rd} round effects: Amplification

Multiplicity

\(i\text{’s best response}\)

Run-up

Shock

Multiplicity

Jump

Amplification

Others’ average actions
2\textsuperscript{nd}, 3\textsuperscript{rd} round effects: Amplification

Multiplicity

$i$’s best response

 multiplicities

 Run-up

 shock

 jump

 amplification

 others’ average actions
**Multiplicity – Crisis vulnerability** without shock

- Only off equilibrium changes (price is still high, but ...)

**Strategic complementarities**

- If others were to respond less, You also respond less

- Even stronger (slope >1)
  - Drop without fundamental shock

---

Graph:

- i’s best response
- Run-up
- Others’ average actions
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3. Persistence/Slow recovery

- preventive
- crisis management
- nonlinearity
- time-series
- cross sectional
- network
- liquidity
Traditional vs. modern banks

- Bank run 
a la Diamond-Dybvig
  - ... but inertia
    also due to demand deposit insurance

- Whole sale funding liq. risk like in Brunnermeier-Pedersen
  - Short-term
  - No inertia
    \[\text{Essentially senior}\]

- Fire-sales of tradable assets
- Risk shifting towards depositors (insurance)
Bank Runs

+ Silent bank run (via internet)
Example: Bank Run – Multiple Equilibria

- Best response of agents at \( t = 1 \) who learned that they are “late consumers”

If bank issues extra equity to purchase liquid asset
Traditional vs. modern banks

- **Bank run a la Diamond-Dybvig**
  - Demand deposit
    - FDIC insurance -- inertia
  - Illiquid loans

- **Whole sale funding liq. risk like in Brunnermeier-Pedersen**
  - Short-term
  - No inertia
  - Collateralized

- **Fire-sales of tradable assets**

- **Risk shifting towards depositors (insurance)**

- **Essentially senior**
Financial Frictions

- Incomplete markets
  - E.g. only debt contracts due to adverse selection

- Leverage constraints
  - Exogenous limit (Bewley/Ayagari)

- Collateral constraints
  - (Current price)
  - Next period’s price (KM)
    \[ R_b_t \leq q_{t+1} k_t \]
  - Next periods volatility (VaR)

The debt limit can depend on prices/volatility.
Liquidity Concepts

- Financial instability arises from the fragility of liquidity

**Market liquidity**
- Specificity of capital
  - Price impact of capital sale

**Funding liquidity**
- Maturity structure of debt
  - Can’t roll over short term debt
- Sensitivity of margins
  - Margin-funding is recalled

- *Liquidity mismatch* determines severity of amplification, (sunspot) runs, ... “strategic complementarities”
Margins/Haircuts Spirals

- How are margins set by brokers/exchanges?
  - Value at Risk: \( \text{Pr}(- (p_{t+1} - p_t) \geq m) = 1\% = \pi \)

- For collateralized lending, debt constraints are directly linked to the volatility of collateral
  - Constraints are more binding in volatile environments
  - Feedback effect between volatility and constraints

- Margin spiral force agents to delever in times of crisis
  - Collateral runs counterparty bank run
  - Multiple equilibria
Leverage with Margin Funding

- action/holdings of “expert traders”
  - residual supply $S(p)$
  - $i$’s best response
  - higher holding, $\Rightarrow$ higher price
Leverage with Margin Funding

- action/holdings of "expert traders"

- residual supply $S(p)$

\[ S(p) \]

\[ i \text{'s best response} \]

\[ \Rightarrow \text{higher holding, } \Rightarrow \text{higher price} \]
Leverage with Margin Funding

- action/holdings of “expert traders”
  - residual supply $S(p)$
  - expert traders forced to sell
    - Others sell ⇒ price drops
    - higher holding, ⇒ higher price

Graphical representation showing the interaction between expert traders and the residual supply function $S(p)$, indicating how increased holdings can drive prices down due to forced selling by expert traders.
Leverage with Margin Funding

- action/holdings of “expert traders”

- expert traders forced to sell

- Others sell

  ⇒ price drops

  (1) ⇒ losses

  (2) ⇒ volatility/VaR estimate ⇒ margins
Leverage with Margin Funding

- action/holdings of “expert traders”

\[ i \text{’s best response} \]

expert traders forced to sell

⇒ others’ average actions

⇒ others sell

⇒ price drops

(1) ⇒ losses

(2) ⇒ volatility/VaR estimate ⇒ margins
Liquidity Spirals – Amplification effects

- Loss Spiral
- Margin Spiral

- Shock to capital ➔ Loss of net worth ➔ Precaution + tighter margins ➔ Fire sales ➔ nonlinearity ➔ volatility price

- Loss Spiral:
  - Loss of net worth ➔ Precaution + tighter margins

- Margin Spiral:
  - Precaution + tighter margins ➔ Fire sales ➔ nonlinearity ➔ volatility price

- Nonlinearity:
  - Fire sales ➔ nonlinearity
  - Volatility price ➔ nonlinearity

- Shock to capital ➔ Loss of net worth

- Precaution + tighter margins ➔ Fire sales ➔ nonlinearity ➔ volatility price

Amplification/Destabilizing after Large Shock

- After a large (fundamental) shock

```
i’s best response

“large shock amplifier”
```
Stabilizing after Small Shocks

- After a small (fundamental shock)

"small shock absorber"
DeStabilizing after Large Shock

- After a large (fundamental) shock

\[ i's \ best \ response \]

"small shock absorber"

"large shock amplifier"
Crash 2: Endogenous Fat Tails

- Initial shock is normally distributed
- Return distribution due to strategic complementarities
Impact of Higher Leverage due to Stock Repurchase

- Starting point

If firm *repurchases equity* paid with liquid asset
⇒ lower capital ratio
⇒ even smaller shocks lead to sharp drops
⇒ fat tails
Impact of More Liquidity Mismatch

- Starting point

If firm sells liquid safe asset and buys less liquid risky (long-maturity) asset.
Impact of More Liquidity Mismatch

- Higher leverage

If firm sells liquid safe asset and buys less liquid risky (long-maturity) asset
⇒ lower (risk-weighted) capital ratio
⇒ more liquidity mismatch
Impact of More Liquidity Mismatch

- Margin spiral ⇒ more strategic complementarity

If firm sells liquid safe asset and buys less liquid (long-maturity) asset
Leverage Dynamics

- **Credit cycle:** *(Loss spiral)*
  - Constant volatility exog. shocks
  - Underinvestment (second best user problem)

- **Leverage cycle:** *(Margin spiral/Repo run)*
  - Exogenously time-varying volatility
    - ARCH/Scary bad news ⇒ Destabilizing Margins
    - ⇒ Pro-cyclical leverage

- **Evidence:** Pro- vs. countercyclical leverage depends on
  - investor type, book vs. market, new issuance vs. overall
Pro- vs. Counter-cyclical Leverage

- **Adrian-Shin (2014): Book vs. market leverage**
  - Intermediaries finance new assets with debt ⇒ Pro-cyclical

- **Geanakoplos-Pedersen (2014): New vs. old leverage**
  - Margins spike in crisis ⇒ Pro-cyclical

- **He, Kelly, Manela (2017): Different constraints**
  - “Equity constraint”: BGG/BruSan, countercyclical leverage
  - “Debt constraint”: Leverage cycle, procyclical leverage
  - Book/market leverage positively correlated for dealers
  - Evidence from HFs in Ang et al. (2011)
    - HFs procyclical, investment banks countercyclical
Run on Repo or not?

1. Not system-wide

2. Tri-party and bilateral repo markets behaved very differently

3. In tri-party market, runs on
   a. select **counterparties** (Lehman)
      - Diamond-Dybvig run
   b. select **collateral** (private label MBS/ABS)
      - Brunnermeier-Pedersen run
US Repo Run? 2008/9

- Margins on **collateral assets**
  - **very stable** in tri-party repo market
    - Copeland, Martin, Walker (2011)
    - Opposing view: Gorton, Metrick (2011)
  - Not stable on **private MBS/ABS**
    - but small relative to overall MBS/ABS market (3%)  
    - ABCP was a much bigger part...
    - Krishnamurthy, Nagel, Orlov (2011)
- Margin jump/run on selected **counterparties**
  - Bear Stearns (anecdotally)
  - Lehman (in data)
  - Not in Krishnamurthy et al.
ABCP collapse – rollover risk

- ABCP dries up
  - no rollover, esp. by money market funds ("Break the Buck" Rule 2a-7)
- SIVs draw on credit lines of sponsoring bank
- Banking Crisis: IKB, SachsenLB, Northern Rock, IndyMac, ...

![Graph](https://via.placeholder.com/150)
ABCP: Composition
Crash 3: Spillover across Institutions

- Financial Contagion

- Broadly, two types:
  - Contractual linkages: (Direct) cross-exposures
  - General equilibrium linkages: (Indirect) price effects.
Absorbers vs. amplifier

- **Shock absorber**
- **Shock amplifier**

- Depends on strategic substitutability/complementarity

### Table: Distribution of Exogenous vs. Endogenous

<table>
<thead>
<tr>
<th>Direct</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractual links</td>
<td>“Virtual links”</td>
</tr>
<tr>
<td>Loss through bankruptcy/default</td>
<td>Similar exposure than other levered players</td>
</tr>
<tr>
<td>Position data</td>
<td>Response indicator</td>
</tr>
<tr>
<td></td>
<td>- expectations/constraints</td>
</tr>
</tbody>
</table>

**Diagram:**
- **Fat tail**
- **Distribution:** exogenous, endogenous
Market Connectedness and Contagion

- Connected Interbank market

- Not fully connected market

- The more connected the larger is the scope for contagion

- Trade-off: Spillover/contagion vs. diversification!
Systemic Risk Measure: $\Delta CoVaR$

- **In returns**
  - $\text{VaR}_q^j$ is defined as quantile
    \[ \text{Pr}(X^j \leq \text{VaR}_q^j) = q \]
  - $\text{CoVaR}_q^{j|c(X^i)}$ is the conditional quantile
    \[ \text{Pr}(X^j \leq \text{CoVaR}_q^{j|c(X^i)} | c(X^i)) = q \]
  - The contribution
    \[ \Delta \text{CoVaR}_q^{j|i} = \text{CoVaR}_q^{j|X^i=\text{VaR}_q^i} - \text{CoVaR}_q^{j|X^i=\text{VaR}_{50}^i} \]
  - **In dollars**
    \[ \Delta \text{VaR}_q^{j|i} = \text{Size}_i \times \Delta \text{CoVaR}_q^{j|i} \]
\[ \Delta \text{CoVaR} \ vs. \ \text{VaR} \]

- Probability of a tree catching fire
- Probability of a tree on fire spilling over to forest
Various conditionings

- $\Delta CoVaR$
  - Q1: Which institutions move system (in a non-causal sense)
  - $VaR_{system}^i$ | institution $i$ in distress

- Exposure $\Delta CoVaR$
  - Q2: Which institutions are most exposed if there is a systemic crisis?
  - $VaR_i^i$ | system in distress

- Network $\Delta CoVaR$
  - VaR of institution $j$ conditional on $i$

- Asset by asset $\Delta CoVaR$
Crash 3: Paradox of Prudence

- “Micro-prudence” of bank is “macro-imprudent”
- Two “spirals” amplify
  - Liquidity spiral (price of capital)
  - Disinflationary spiral (price of money)
Crash 3: Paradox of Prudence

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- Two "spirals" amplify
  - Liquidity spiral (price of capital)
  - Disinflationary spiral (price of money)
    - Banks issue less inside money (& diversify less risk risk)
    - HH demand more money

BruSan "The I Theory of Money"

\[ \begin{align*}
\text{HH Net worth} & \quad \text{Inside equity} \\
\text{Money} & \quad \text{Risky Claim} \\
\end{align*} \]

Like Keynes' Paradox of Thrift, but in risk-space

\[ \Rightarrow \text{Lower inflation} \]
Crash 4: Spillovers Across Assets

- **Net worth channel:**
  - Expert net worth affects all assets  
  - Leverage cycle: Spillovers from “crossover” investors JG
    - Margins spike in one market
    ⇒ Crossover investors transfer capital from other markets
- **BruPed:** Multiple equilibria:
  - Joint jump in price across assets
    - Even assets with uncorrelated payoffs jump together
    - Could also be integrated in a DD-model

- Measurement: \textit{CoVaR}
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  - Fire-sales
  - Spillovers

- **Recovery phase**
  - Persistence vs. Resilience
  - Dynamic Amplification
  - Volatility Dynamics/Volatility Paradox
Dynamic Amplification

- **Static** amplification occurs because fire-sales of capital from productive sector to less productive sector depress asset prices
  - Importance of *market liquidity* of physical capital
- **Dynamic** amplification occurs because a temporary shock translates into a persistent decline in output and asset prices
  - Forward
  - Backward

- Forward: grow net worth via retained earnings
- Backward: asset pricing
“Single Shock Critique”

- Critique: After the shock all agents in the economy know that the economy will deterministically return to the steady state.
  - Length of slump is deterministic (and commonly known)
    - No safety cushion needed
  - In reality an adverse shock may be followed by additional adverse shocks
    - Build-up extra safety cushion for an additional shock in a crisis

- Impulse response vs. volatility dynamics
Endogenous Volatility & Volatility Paradox

- Endogenous Risk/Volatility Dynamics in BruSan
  - Beyond Impulse responses
  - Input: constant volatility
  - Output: endogenous risk time-varying volatility

⇒ Precautionary savings
  - Role for money/safe asset

⇒ Nonlinearities in crisis ⇒ endogenous fat tails, skewness

- Volatility Paradox
  - Low exogenous (measured) volatility leads to high build-up of (hidden) endogenous volatility (Minsky)
Speed of Recovery

- Speed of Recovery
  - KM: deterministic
  - BruSan: Length of recession is stochastic
    $\Rightarrow$ precautionary savings
Persistence

- Even in standard real business cycle models, temporary adverse shocks can have long-lasting effects.
- Due to feedback effects, persistence is much stronger in models with financial frictions:
  - Bernanke & Gertler (1989)
  - Carlstrom & Fuerst (1997)
- Negative shocks to net worth exacerbate frictions and lead to lower capital, investment and net worth in future periods.
CF: Persistence & Dampening

- Negative shock in period $t$ decreases $N_t$
  - This increases financial friction and decreases $I_t$
- Decrease in capital supply leads to
  - Lower capital: $K_{t+1}$
  - Lower output: $Y_{t+1}$
  - Lower net worth: $N_{t+1}$
  - Feedback effects in future periods $t + 2, ...$
- Decrease in capital supply also leads to
  - Increased price of capital $q_t$
  - Dampening effect on propagation of net worth shock
Persistence ⇒ Dynamic Amplification

- Bernanke, Gertler and Gilchrist (1999) introduce *technological illiquidity* in the form of nonlinear adjustment costs to capital.

- Negative shock in period $t$ decreases $N_t$
  - This increases financial friction and decreases $I_t$.

- In contrast to the dampening mechanism present in CF, now decrease in capital demand (not supply) leads to:
  - Decreased price of capital due to adjustment costs.
  - *Amplification* effect on propagation of net worth shock.
BGG assume separate investment sector
- This separates entrepreneurs’ capital decisions from adjustment costs

Φ(·) represents *technological illiquidity*
- Increasing and concave with Φ(0) = 0
- $K_{t+1} = \Phi \left( \frac{I_t}{K_t} \right) K_t + (1 - \delta)K_t$

FOC of investment sector
- \[\max_{I_t} \{q_t K_{t+1} - I_t\} \Rightarrow q_t = 1/\Phi' \left( \frac{I_t}{K_t} \right)\]
Kiyotaki & Moore (KM) ’97

- Kiyotaki, Moore (1997) adopt a collateral constraint, $Rb_t \leq q_{t+1}k_t$, instead of CSV market illiquidity – second best use of capital

- Output is produced in two sectors, differ in productivity

- Aggregate capital is fixed, resulting in extreme technological illiquidity
  - Investment is completely irreversible

- Durable asset has two roles:
  - Collateral for borrowing
  - Input for production
KM Amplification

- **Static** amplification occurs because fire-sales of capital from productive sector to less productive sector depress asset prices
  - Importance of *market liquidity* of physical capital
- **Dynamic** amplification occurs because a temporary shock translates into a persistent decline in output and asset prices
  - Forward: grow networth via retained earnings
  - Backward: asset pricing
“Kocherlakota Critique”

- Amplification for negative shocks differs from positive shocks
  - In Kocherlakota (2000) optimal scale of production (positive shock does not lead to expansion)
- Amplification is quantitatively too small
  - Capital share is only 1/3 and hence GDP is too small

- Cordoba and Ripoll (2004)
  - Needs sizeable capital share plus
  - Low intertemporal substitution
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    - Output: endogenous risk time-varying volatility

⇒ Precautionary savings
  - Role for money/safe asset

⇒ Nonlinearities in crisis ⇒ endogenous falt tails, skewness

- Volatility Paradox
  - Low exogenous (measured) volatility leads to high build-up of (hidden) endogenous volatility (Minsky)
Conclusion

- “Run-up”, “Crisis”, and “Recovery”-mechanisms
  - Belief-focused (representative + heterogeneous)
  - Friction-focused, where risk is central
- Risk concentration, fire-sales, spillovers, ...
- Paradox of Prudence
- Volatility Paradox
  - Mean-Amplification, Exog. ARCH, Endog. Volatility Dynamics

- Macro/Monetary models with financial sector should include
  - physical investment
  - inside money creation