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 \( \rightarrow p_s \text{MRS}_s \) 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 \((DGP)\)
Course on continuous time macro

1. Introduction: Liquidity, Run-up, Crisis-Amplification, Recovery

**Real Macro-Finance Models with Heterogeneous Agents**

2. A Simple Model

3. General Solution Technique

4. International Macro-Finance Model with Sudden Stops/Runs

**Money Models**

5. A Simple Money Model

6. General Solution Technique

7. The I Theory of Money

8. Welfare Analysis & Optimal Policy
   - Monetary and Macroprudential Policy

9. International Financial Architecture*

10. Robust Computational Methods – Comparing Nonlinear Models

11. Calibration and Empirical Implications
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
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
The 2 Components of Systemic Risk

1. Systemic risk build-up during (credit) bubble ... and materializes in a crisis \(-\text{time-series}\)
   - "Volatility Paradox" \(\rightarrow\) contemp. measures inappropriate
   - Vulnerability-focus instead of timing-focus
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
  - Local thinking “neglect of tail risk” ≈ VaR

- **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
  \[
  \frac{\partial \partial u^i}{\partial x^i} \frac{\partial x^i}{\partial x^{-i}}
  \]
  - 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

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

\[ \text{others' average actions} \]

Positive externality
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 $\frac{\partial^2 u^i}{\partial x^i \partial x^{-i}} = \frac{\partial}{\partial x^i} \frac{\partial u^i}{\partial x^{-i}} = \frac{\partial}{\partial x^{-i}} \frac{\partial u^i}{\partial x^i}$

  - can be independent of each other

  - ...but note: if $\frac{\partial u^i}{\partial x^{-i}} = 0$, then $\frac{\partial^2 u^i}{\partial x^i \partial x^{-i}} = 0$

- 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
Shock prior to run-up of imbalances

Shock by 10, but equilibrium declines only by 9

$i$’s best response

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

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 ...)

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

Run-up

i’s best response

others’ average actions
Shock after run-up

Shock by 10
Leads to equilibrium effect of 30
2nd, 3rd round effects: Amplification

Initial fundamental shock/trigger is amplified
Amplification of Fundamental Shock

Multiplicity: without Fundamental Shock
2nd, 3rd round effects: Amplification Multiplicity

- i’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

Run-up

Amplification

Shock

Multiplicity

Jump

Others’ average actions
Multiplicity – Crisis vulnerability without shock

If others were to respond less, you also respond less.

Even stronger (slope >1)
Drop without fundamental shock

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

Strategic complementarities

Run-up

$i$’s best response

others’ average actions
Overview: Financial Crises

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3. Persistence/Slow recovery

Diagram:
- Shock to capital
- Loss of net worth
- Precaution + tighter margins
- Fire sales
- Volatility price

Nonlinearity

Crisis management

Preventive
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
  - Collateralized

- 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)
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)
    \[ Rb_t \leq q_{t+1} k_t \]
  - Next periods volatility (VaR)

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: \( \Pr(-(p_{t+1} - p_t) \geq m) = 1\% = \pi \)

- 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
  - Multiple equilibria
  - Counterparty bank run
Leverage with Margin Funding

- action/holdings of “expert traders”

- residual supply $S(p)$

Higher holding, $\Rightarrow$ higher price
Leverage with Margin Funding

- action/holdings of “expert traders”

- residual supply $S(p)$

\[ S(p) \]

- $i$’s best response

\[ \text{others' average actions} \]

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

- **action/holdings of “expert traders”**

- **residual supply** $S(p)$

- $i$’s best response

- **expert traders forced to sell**

- **Others sell** → **price drops**

- **higher holding, ⇒ higher price**

Graph showing:
- Vertical axis: $i$’s best response
- Horizontal axis: others’ average actions
- $S(p)$ curve
- $p(\cdot)$
- Others sell
- Price drops
- Higher holding
Leverage with Margin Funding

- action/holdings of “expert traders”

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

- Others sell
  - price drops
  - (1) ⇒ losses
  - (2) ⇒ volatility/VaR estimate ⇒ margins

- expert traders forced to sell
Leverage with Margin Funding

- action/holdings of “expert traders”

\[ i' \text{’s best response} \]

expert traders forced to sell

Others sell

⇒ price drops

(1) ⇒ losses

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

- Loss Spiral
- Margin Spiral

1. **Shock to capital** → **Loss of net worth**
2. **Precaution + tighter margins** → **volatility price**
3. **volatility price** → **Fire sales**

*nonlinearity*
Amplification/Destabilizing after Large Shock

- After a large (fundamental) shock

"large shock amplifier"
Stabilizing after Small Shocks

- After a small (fundamental shock)

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

"small shock absorber"
DeStabilizing after Large Shock

- After a large (fundamental) shock

![Diagram showing the concept of 'small shock absorber' and '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 $\Rightarrow$ 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
    ⇒ Countercyclical leverage
  - 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 ⇒ Procyclical
- Geanakoplos-Pedersen (2014): **New vs. old leverage**
  - Margins spike in crisis ⇒ Procyclical
- 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 counterparty (Lehman)
      ▪ Diamond-Dybvig run
   b. select collateral (private label MBS/ABS)
      ▪ Brunnermeier-Pedersen run
Gorton & Metrick (2011)

- Bilateral repo data (private date by Gorton)
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.
Bilateral and Tri-party Haircuts/Margins?

Differences in Median Haircuts

Source: FRBNY Calculations
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 showing the amount of ABCP and Non-ABCP outstanding from January 2004 to January 2009.](image-url)
ABCP: Composition

- Non-U.S. Residential Mortgages
- Student Loans
- Credit Cards
- Autos
- Commercial Real Estate
- Home Equity (Subprime)

$ Billions

Mar-00 Sep-00 Mar-01 Sep-01 Mar-02 Sep-02 Mar-03 Sep-03 Mar-04 Sep-04 Mar-05 Sep-05 Mar-06 Sep-06 Mar-07 Sep-07 Mar-08 Sep-08

[Graph showing the composition of ABCP with different categories and their values over time.]
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**

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

 Depends on strategic substitutability/complementarity
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*

- $VaR_q^j$ is defined as quantile

  $$\Pr(X^j \leq VaR_q^j) = q$$

- $CoVaR_q^{j|x^i}$ is the conditional quantile

  $$\Pr\left(X^j \leq CoVaR_q^{j|x^i}|C(X^i)\right) = q$$

- The contribution

  $$\Delta CoVaR_q^{j|i} = CoVaR_q^{j|x^i=VaR_q^i} - CoVaR_q^{j|x^i=VaR_{50}^i}$$

- *In dollars*

  $$\Delta^\$ CoVaR_q^{j|i} = Size^i \times \Delta CoVaR_q^{j|i}$$
\( \triangle \text{CoVaR} \) 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)
  - $VaR_{system}^i | \text{institution } i \text{ in distress}$

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

- 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

- “Micro-prudence” of bank is “macro-imprudent”
- 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

⇒ Lower inflation

BruSan “The I Theory of Money”
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: **CoVaR**
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  - Fire-sales
  - Spillovers

- Recovery phase
  - Persistence vs. Resilience
  - Dynamic Amplification
  - Volatility Dynamics/Volatility Paradox
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 $t + 2, \ldots$

- 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
Bernanke, Gertler & Gilchrist (BGG)

- BGG assume separate investment sector
  - This separates entrepreneurs’ capital decisions from adjustment costs

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

- 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
  - Backward
  
  grow networth via retained earnings
  
  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
“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)
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
Extra Slides