Institutional Finance,…
Princeton: Department-wide Seminar

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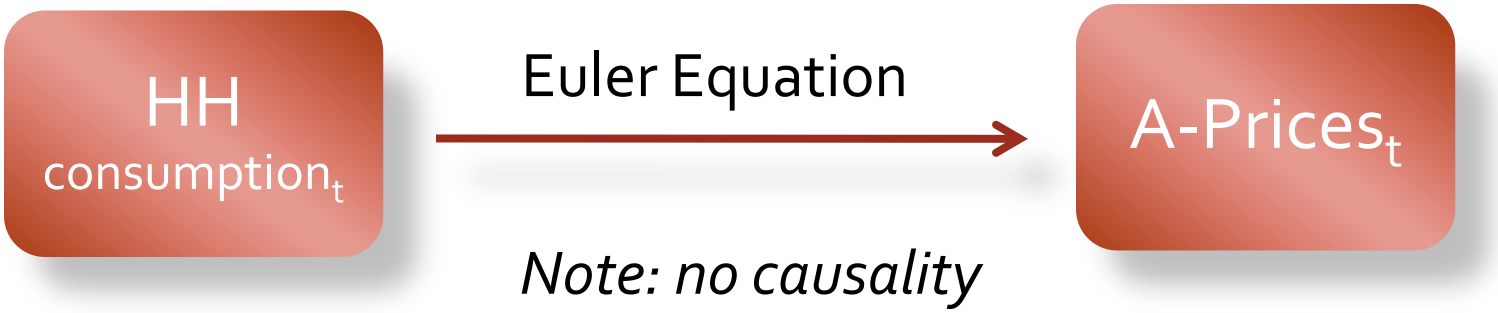
Represent. Agent "Euler Equation Finance"

- No (funding) friction ⇒ Financial sector is a veil
  - Starting with Lucas …
  - Perfect aggregation

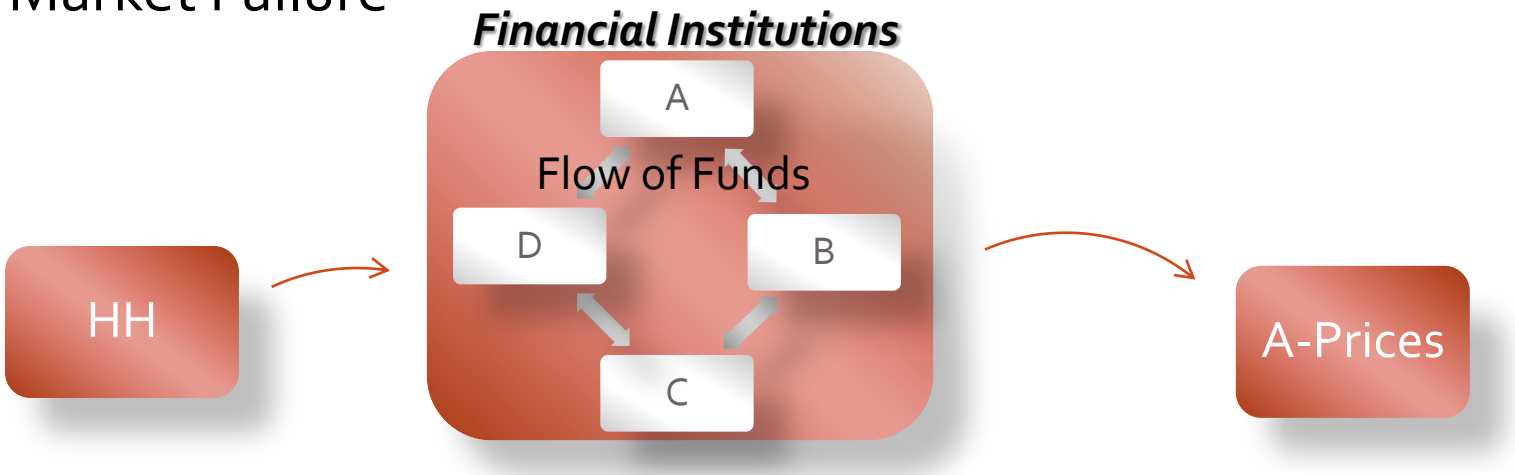


⇒ Pricing kernel = MRS of representative household

- Modeling: exotic preferences/utility functions + beliefs
- Data source: Consumption

"Institutional Finance"

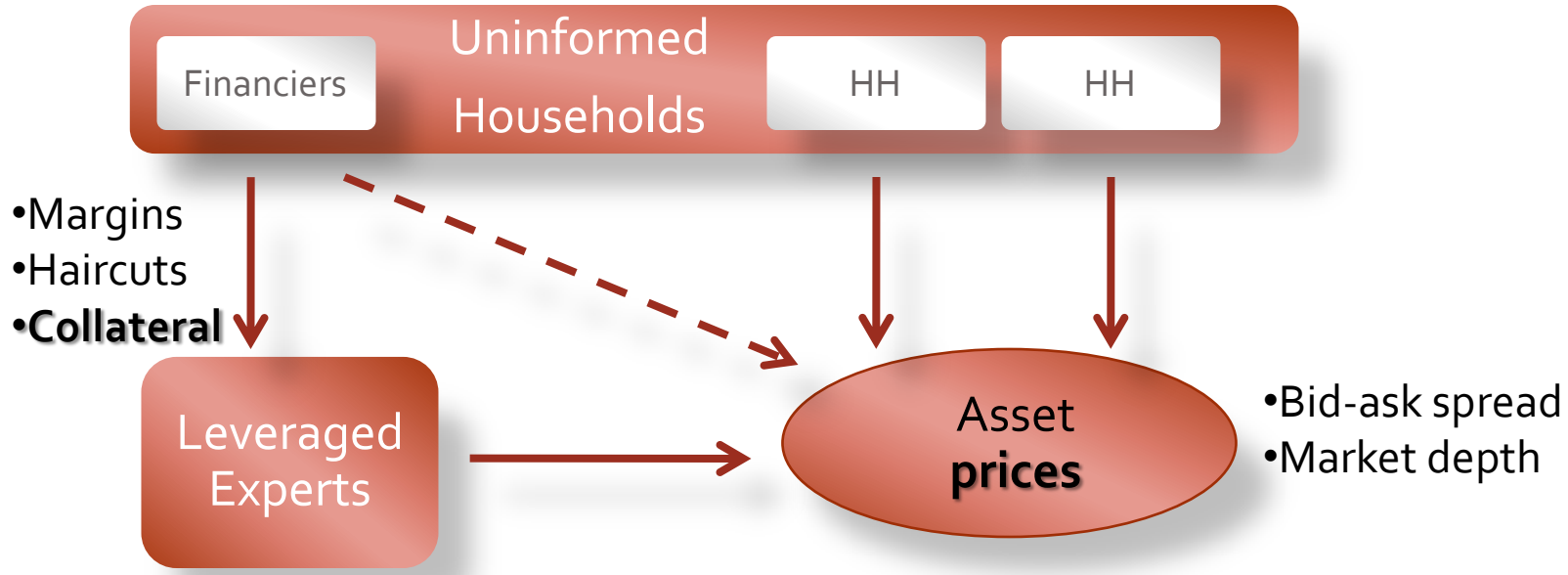
- Funding frictions are at the center
  investors with expertise rely on funding w/o expertise
  - No aggregation
  - Market Failure



→ Pricing Kernel = Shadow cost of funding (liquidity)

- Modeling: institutional frictions
- Data source: Flow of funds

Funding and Market Liquidity (with Lasse Pedersen)

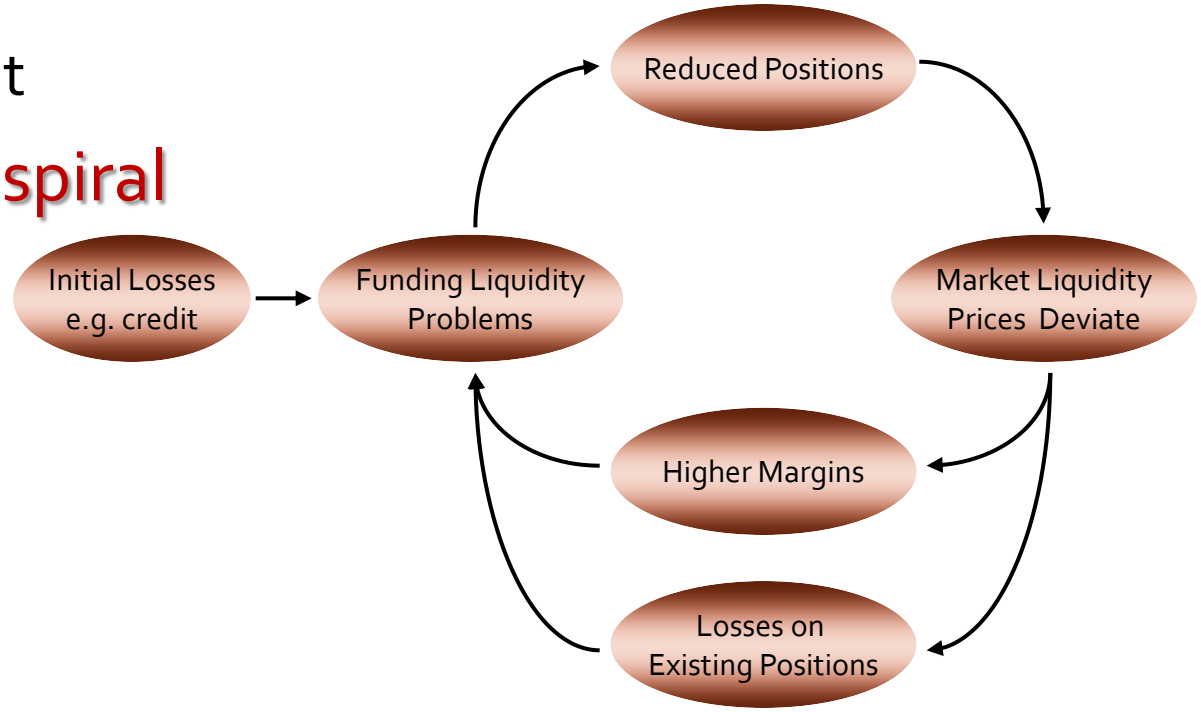


- **Funding Liquidity**
  - Ease … raise funds by using asset as collateral
  - $m^+ x^+ + m^- x^- \leq W$
  - Lagrange multiplier
  - Margins/haircuts can be changed every day
    - Short-term lending

- **Market Liquidity**
  - Ease with which one can raise funds by selling asset
  - Asset price
    - pricing kernel

Liquidity spirals

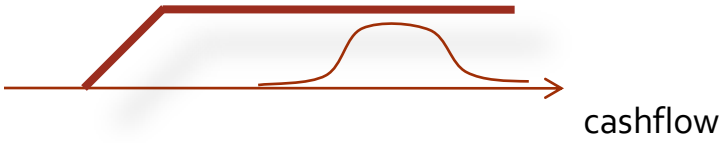
- Loss spiral
  - same leverage
    - mark-to-market
- Margin/haircut spiral
  - delever!
    - mark-to-model



Brunnermeier-Pedersen (2009)

Margin/haircut spiral - Procyclicality

- Margins/haircut increase in times of crisis ⇒ delever
  margin = f(risk measure)
- Two Reasons
  1. Backward-looking estimation of risk measure
     - Use forward looking measures
     - Use long enough data series
  2. Adverse selection
     - Debt becomes more information sensitive (not so much out of the money anymore)



- Credit bubbles
  - whose bursting undermines financial system

⇒ Countercyclical regulation

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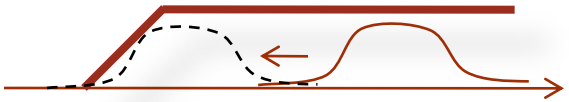
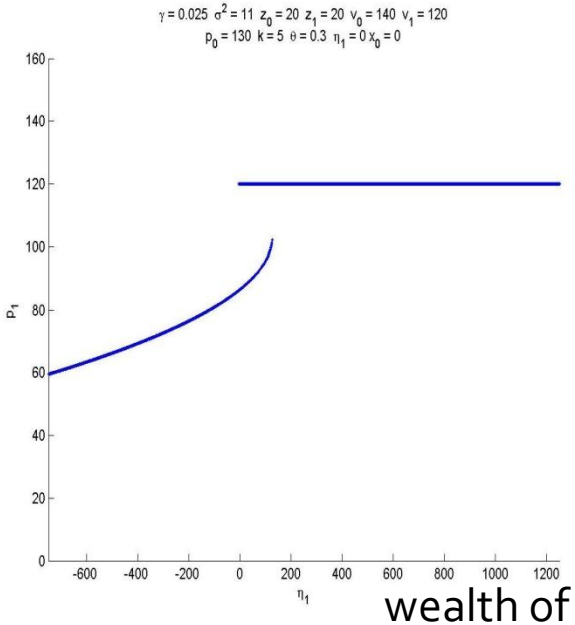


- Credit bubbles
  - whose bursting undermines financial system

⇒ Countercyclical regulation

Fire-sale externality

- Liquidity Spiral
  - Amplification
  - Fragility
  - Multiple Equilibria
    Systemic risk is endogenous



wealth of experts

- Precuniary externality + incomplete markets
  - Take on too much leverage/maturity mismatch
  - take fire-sale price as given
  - also in Stiglitz (1982), Geanakoplos-Polemarchakis (1986)

Fire-sales depress price also for others

Other Externalities/Financing Frictions

1. Hoarding
   - Micro-prudent
     - SIV might draw on credit line
     - At the same time interbank market is closed
   - Macro-prudent?
2. Runs – dynamic co-opetition
3. Network Externality
   - Hiding own's commitment ⇨ uncertainty for counterparties

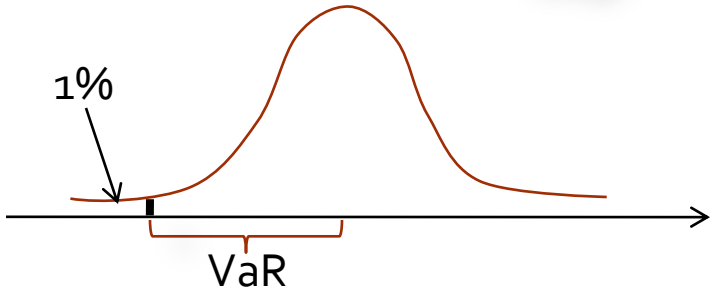
See JEP article

Overview

- Institutional Finance
  - Liquidity Spiral: Amplification, Fragility, Multiplicity – with Lasse Pedersen
  - Procyclicality
  - Fire-sale Externality
- Implications for Financial Regulation
  - CoVaR – with Tobias Adrian
- Implications for Monetary Economics – with Arvind Krishnamurthy
  - Role of financial institutions
  - Maturity Rat Race – with Martin Oehmke

Current bank regulation

1. Risk of each bank in isolation ⇒ Value at Risk



2. Focus on asset side of the balance sheet matter
   - Asset side
     - Asset by asset – risk weighted ⇒ diversify in off-balance SPV
     - Value at Risk (VaR)
   - Liability side – maturity mismatch gets little attention

Two challenges ….

1. Focus on externalities – systemic risk contribution
   - What are the externalities?
   - How to measure contribution to systemic risk?
     - CoVaR influences
       - Who should be regulated? (AIG, …)
       - What is the optimal
         - capital charge (cap),
         - Pigouvian tax
         - Private insurance scheme?
2. Countercyclical regulation
   - How to avoid procyclicality?

+ incorporate liquidity risk – asset-liability interaction

Macro-prudential regulation

1. Externality:
   - Measure contribution of institution to systemic risk: CoVaR
   - Response to current regulation
     "hang on to others and take positions that drag others down when you are in trouble" (maximize bailout probability)
     - become big
     - become interconnected

2. Procyclicality:
   - Lean against "credit bubbles" – laddered response
     - Bubble + maturity mismatch impair financial system (vs. NASDAQ bubble)
   - Impose Capital requirements/Pigouvian tax/Private insurance scheme
     - not directly on ΔCoVaR, but on
     - frequently observed factors, like maturity mismatch, leverage, B/M, *crowdedness* of trades/credit, …

Overview

- Institutional Finance
- Implications for Financial Regulation
  - contribution vs. exposure CoVaR
  - Quantile Regressions
  - Addressing Procyclicality
  - Market variables
- Implications for Monetary Economics
  - Maturity Rat Race – with Martin Oehmke

CoVaR

- CoVaR = VaR conditional on
  institute *i* (index) is in distress (at it's VaR level)

- Exposure CoVaR
  - Q1: Which institutions are most exposed if there is a systemic crisis?

  ⇒ $VaR^{i} \mid$ system in distress

- Contribution CoVaR
  - Q2: Which institutions contribute (in a non-causal sense)

  ⇒ $VaR^{system} \mid$ institution *i* in distress

Cover both types	Institutions
Risk spillovers	"individually systemic"
Tail risk correlations	"systemic as part of a herd"

  - Non-causal, can be driven by common factor

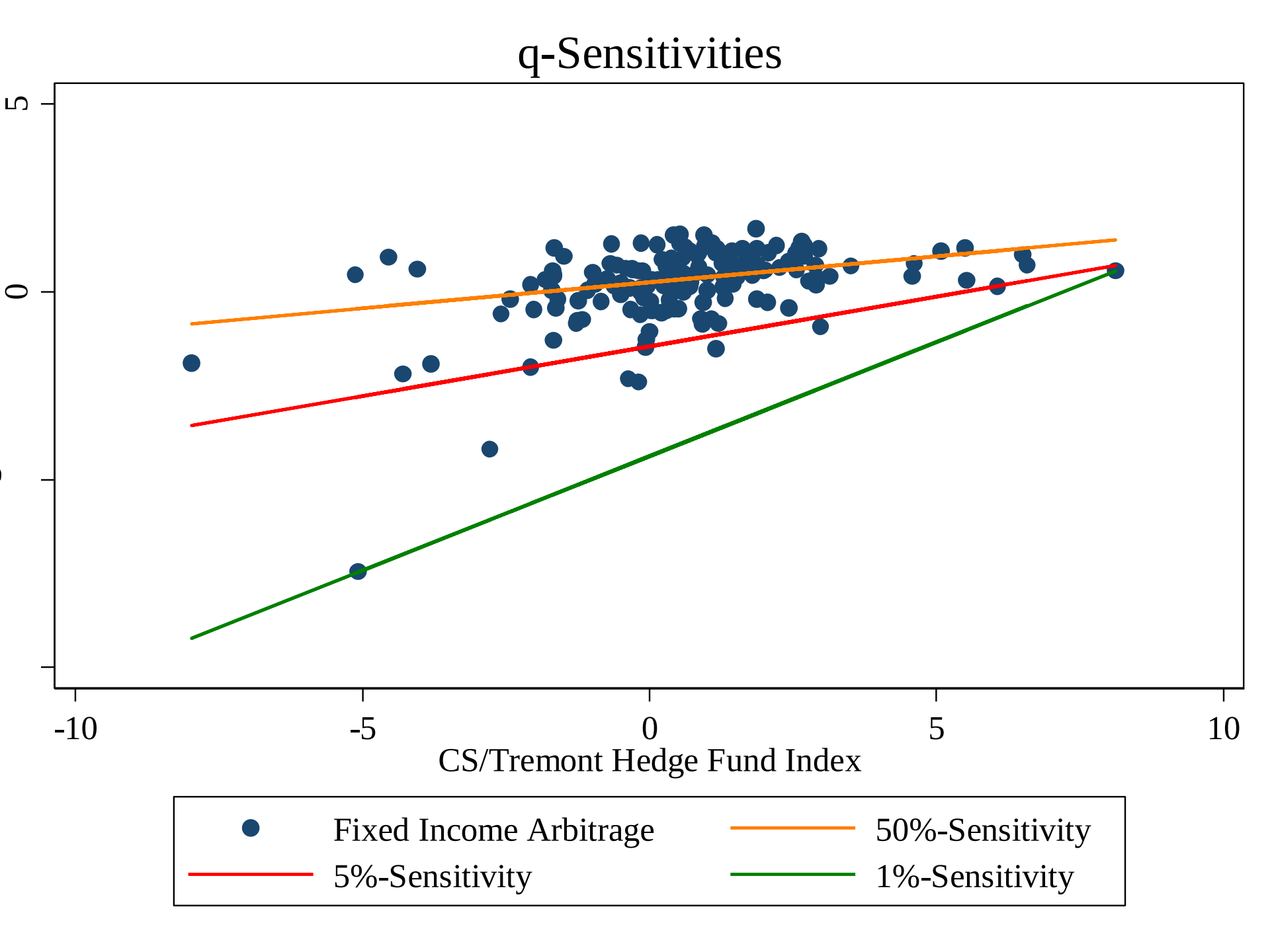
Quantile Regressions: A Refresher

- OLS Regression: min sum of squared residuals

$$\beta^{OLS} = \arg\min_{\beta} \Sigma_t \quad y_t - \alpha - \beta x_t \quad ^2$$

- Quantile Regression: min weighted absolute values

$$\beta^q = \arg\min_{\beta} \Sigma_t \begin{cases} q\left|y_t - \alpha - \beta x_t\right| & \text{if} \quad y_t - \alpha - \beta x_t \geq 0 \\ 1-q \ \left|y_t - \alpha - \beta x_t\right| & \text{if} \quad y_t - \alpha - \beta x_t < 0 \end{cases}$$


q-Sensitivities
5
0
-10
-5
0
5
10
CS/Tremont Hedge Fund Index
Fixed Income Arbitrage
50%-Sensitivity
5%-Sensitivity
1%-Sensitivity

Quantiles = - Value-at-Risk

- Quantile regression:
  - Quantile *q* of *y* as a linear function of *x*

$$\hat{y}_q \mid x = F_y^{-1} \; q \mid x \; = \alpha_q + \beta_q x$$

where $F^{-1}(q|x)$ is the inverse CDF conditional on x

- Hence, $F^{-1}(q|x)$ = *q*% Value-at-Risk conditional on *x*.
  - Note out (non-traditional) sign convention!

CoVaR - using quantile regressions

$$CoVaR_q^{ij} = VaR_q^i \mid VaR_q^j = \alpha_q^{ij} + \beta_q^{ij} VaR_q^j$$

$$\Delta CoVaR_q^{ij} = CoVaR_q^{ij} - VaR_q^i$$

- Illustration:
  - Same individual VaR, but A's CoVaR > B's CoVaR
  - Analogy to Covariance in CAPM
- Various conditionings?
  1. *Exposure CoVaR:* Individual institution on financial index
     - Who is vulnerable/exposed to?
  2. *Contribution CoVaR:* Financial index on individual institution
     - Who contributes?
  3. *Risk Spillover:* Institution/strategy *i* on institution/strategy *j*

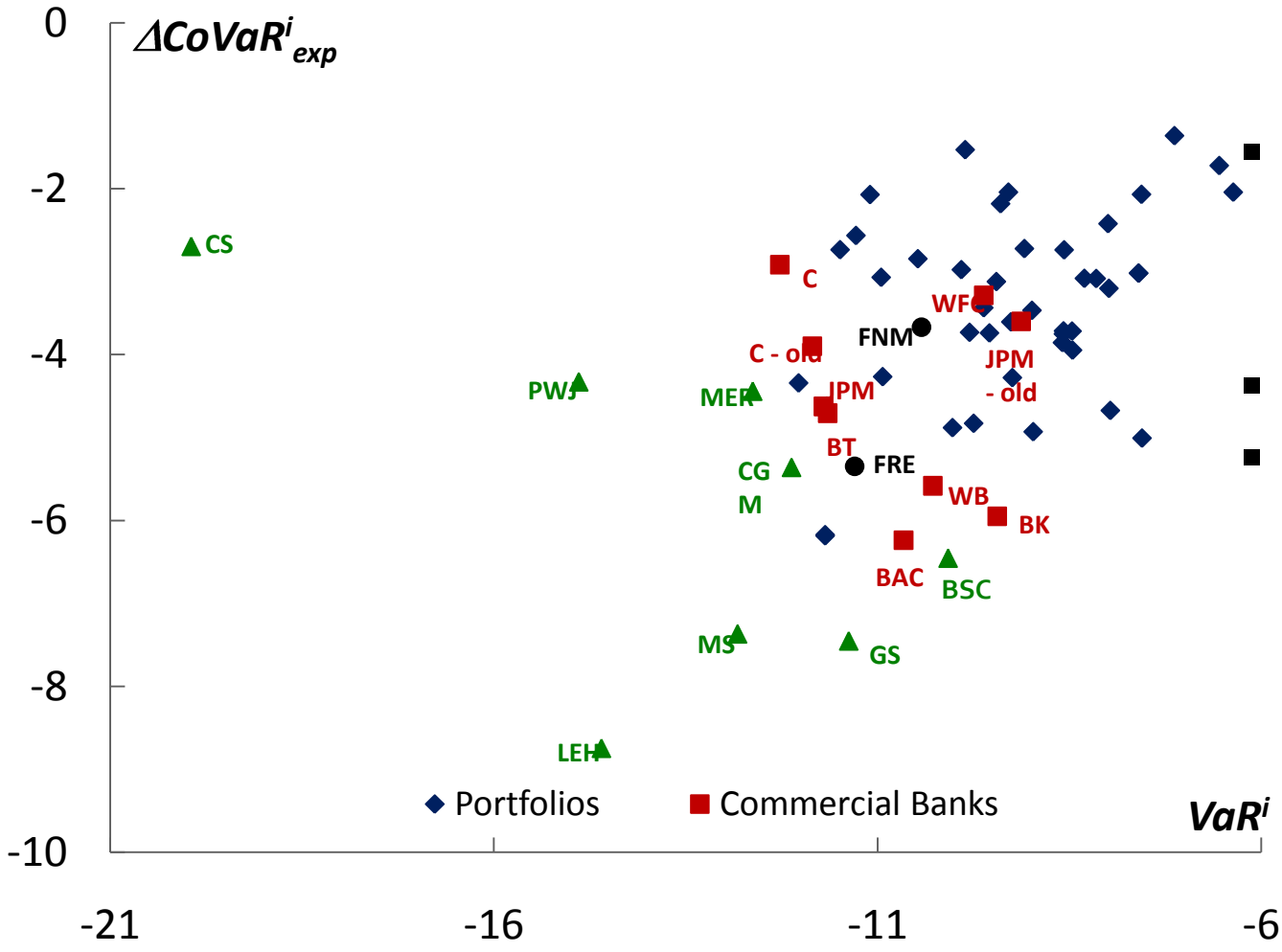
Data

- (Commercial bank and security broker dealer industry portfolios from Ken French 1926/07-2008/12)
- NYFed primary dealer (US) + GSE: CRSP returns 1986/01-2008/12 (weekly) [equity returns to also capture asset and liability]
  - Commercial banks
  - Investment banks
  - Portfolios sorted in quintiles based on
    - Maturity mismatch, liquidity, size, B/M, cash/asset, equity vol.
- CDS and option data of top 10 US banks, daily 2004-2008
- CSFB/Tremont hedge fund strategies 1994/1-2008/12 (monthly)
  - Long/Short Equity, Global Macro, Event Driven, Fixed Income Arbitrage, Multi-Strategy, Emerging Markets, Equity Market Neutral, Convertible Arbitrage, Managed Futures, Dedicated Short Bias

Overview

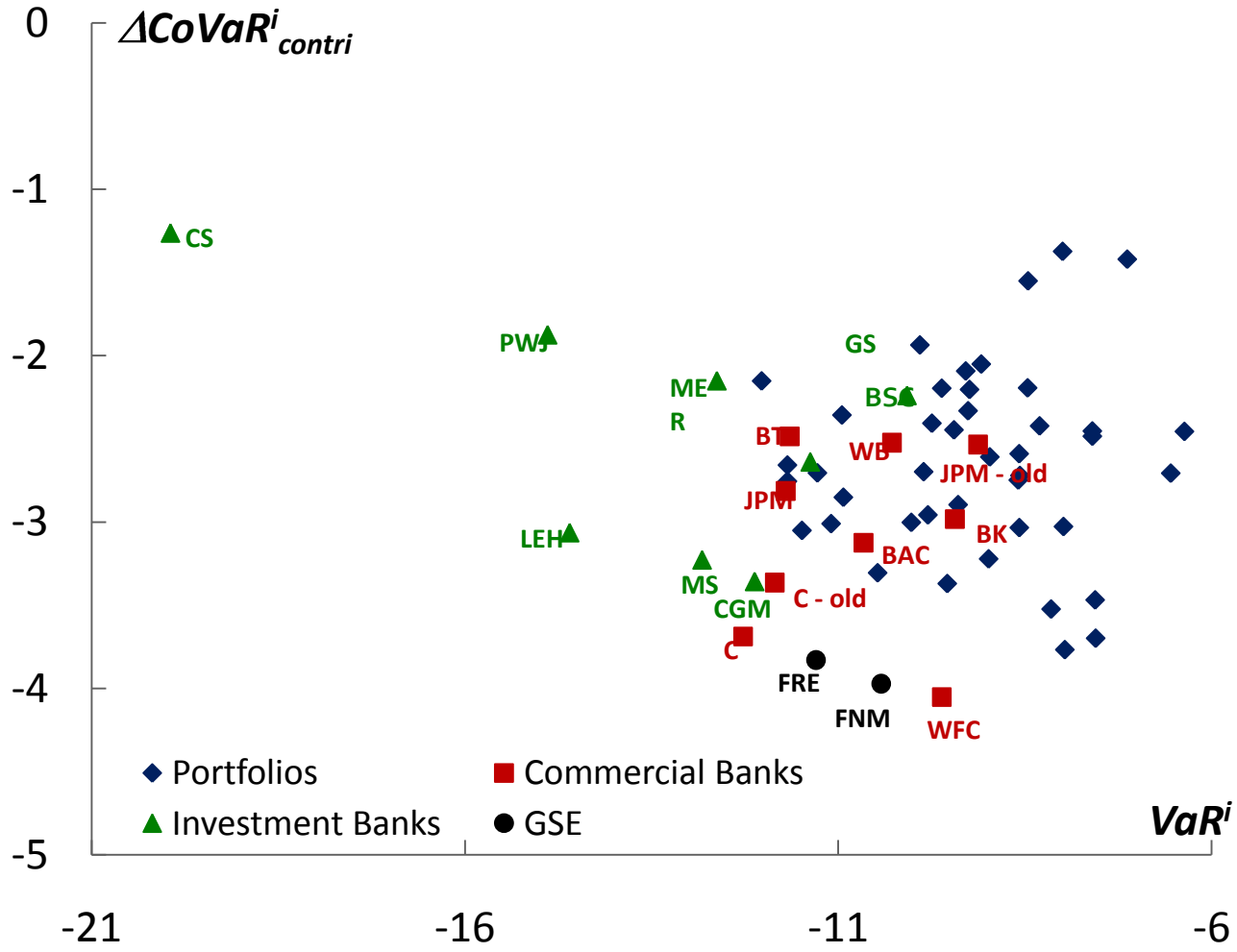
- Institutional Finance
- Implications for Financial Regulation
  - CoVaR contribution vs. exposure
  - Quantile Regressions
  - CoVaR versus VaR
  - Addressing Procyclicality
  - Market variables
- Implications for Monetary Economics
  - Maturity Rat Race – with Martin Oehmke

Q1: Who is in distress during systemic crisis?



- VaR and Δ CoVaR$_{exp}$ relationship is very weak
- Data up to 12/07
- Most vulnerable
  - Lehman
  - Morgan Stanley
  - Countrywide
  - Bank of America
  - Bear Stearns

Q2: Who "contributes" to systemic risk?



- VaR does not capture systemic risk contribution Δ CoVaR$_{contri}$
- Data up to 2007/12

Overview

- Institutional Finance
- Implications for Financial Regulation
  - contribution vs. exposure CoVaR
  - Quantile Regressions
  - Addressing Procyclicality
    - Time-varying CoVaRs
    - Link to characteristics
  - Market variables
- Implications for Monetary Economics
  - Maturity Rat Race – with Martin Oehmke

Time-varying CoVaR

- Relate to macro factors — interpretation
  - VIX Level — "Volatility"
  - 3 month yield
  - Repo – 3 month Treasury — "Flight to Liquidity"
  - Moody's BAA – 10 year Treasury — "Credit indicator"
  - 10Year – 3 month Treasury — "Business Cycle"
  - (House prices)
  - (Aggregate Credit growth/spread)
  - (Haircut/margins (LTC ratios))

… let's figure out what matters!

→ Obtain Panel data of CoVaR

- Next step: Relate to institution specific (panel) data

Average factor exposure

	INSTITUTIONS				PORTFOLIOS		
	VaR^{index}	VaR^{i}	$CoVaR^{i}_{contr}$	$CoVaR^{i}_{exp}$	VaR^{i}	$CoVaR^{i}_{contr}$	$CoVaR^{i}_{exp}$
VIX	-0.20	-0.28	-0.11	-0.15	-0.18	-0.14	-0.13
	(-2.04)	(-4.93)	(-3.56)	(-3.43)	(-1.33)	(-2.82)	(-2.52)
3 Month Yield	0.31	-0.24	-0.20	-0.74	-0.09	0.05	-0.24
	(1.41)	(-0.97)	(-3.93)	(-2.36)	(-0.53)	(0.32)	(-1.06)
Repo spread	-4.56	-3.30	-2.61	0.08	-4.65	-1.39	0.91
	(-1.80)	(0.31)	(-6.60)	(-0.03)	(-1.45)	(-1.14)	(0.46)
Credit spread	-0.86	-1.09	-0.86	-2.63	-2.89	-0.83	-1.38
	(-0.65)	(0.90)	(-3.61)	(-4.23)	(-1.91)	(-1.55)	(-2.12)
Term spread	0.15	-0.11	-0.21	-0.69	0.33	0.12	0.17
	(0.40)	(0.21)	(-2.80)	(-2.07)	(0.33)	(0.56)	(0.44)

Average t-stats in parenthesis

Avoid Procyclicality

- Regulatory charges on $\Delta CoVaR_{contri}$ may introduce procyclicality
  - Like VaR does in Basel II framework
- Way out:
  Link + ***predict*** $\Delta CoVaR_{contri}$ to frequently observed characteristics (use Panel data structure)
  - Maturity mismatch
  - Leverage
  - …. special data only bank supervisors have (e.g. crowdedness)
- Extra:
  - Show that these variable carry information beyond VaR

Predictive (1 year lag)

PANEL A: INSTITUTIONS

PANEL B: PORTFOLIOS

	$CoVaR^i_{contri}$		$CoVaR^i_{exp}$		$CoVaR^i_{contri}$		$CoVaR^i_{exp}$	
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	FE, TE	FE	FE, TE	FE	FE, TE	FE	FE, TE	FE
VaR (lag)	0.02**	0.05***	-0.06**	0.03*	0.20***	0.14***		-0.26***
Mat-Mism(lag)	-0.30	-0.30	-1.84**	-1.79**	1.20***	0.25		0.04
Leverage (lag)	-0.02***	-0.02***	-0.01	-0.02	-0.01***	-0.04***		-0.01*
B/M (lag)	-0.27**	-0.19**	-0.08	0.71***	-0.14	0.57***		-0.53***
Size (lag)	9.94	10.61	27.43*	-15.68	-0.52	-1.34		2.52
Constant	-0.35	-0.65**	-5.04***	-3.84***	-0.55**	-0.63***		-6.13***
Observations	1657	1657	1657	1657	2486	2486		2486
R-squared	0.66	0.40	0.62	0.48	0.72	0.38		0.71

Predicting with Market Variables

	ΔCoVaR_contrib				ΔCoVaR_exp			
COEFFICIENT	1 Quarter	1 Year	1 Quarter	1 Year	1 Quarter	1 Year	1 Quarter	1 Year
CDS_beta (lag)	-0.25***	-0.58**			-1.24***	-2.54***		
	(0.05)	(0.23)			(0.39)	(0.85)		
ΔCDS (lag)	0.05	0.06			1.39	-1.28		
	(0.17)	(0.68)			(1.10)	(2.20)		
IV_beta (lag)			-0.34***	-0.67***			-1.75***	-3.33**
			(0.11)	(0.18)			(0.30)	(1.39)
DIV (lag)			-0.05	-0.77***			0.63	-0.56
			(0.28)	(0.19)			(0.59)	(1.04)
Constant	-1.17***	-1.28***	-1.13***	-1.15***	-4.65***	-4.82***	-4.33***	-4.20***
	(0.04)	(0.07)	(0.07)	(0.08)	(0.15)	(0.24)	(0.17)	(0.52)
Observations	178	148	178	148	178	148	178	148
R-squared	0.59	0.54	0.55	0.55	0.71	0.68	0.72	0.65

1) beta w.r.t. first principal component on changes in CDS spreads within quarter
2) panel regression with FE – (no findings with FE+TE)

Shock Amplifier vs. Absorber

	INSTITUTIONS			
	VaR_index		VaR_index	
COEFFICIENT	1 Year	1.5 Years	1 Year	1.5 Years
Fitted CoVaR_contrib (lag)	4.46**	6.43***		
	(1.91)	(1.95)		
Resid CoVaR_contrib (lag)	0.50	0.52		
	(0.40)	(0.41)		
Fitted CoVaR_exp (lag)			0.75	0.51
			(1.42)	(1.34)
Resid CoVaR_exp (lag)			2.94***	3.95***
			(0.57)	(0.54)
VaR_index (lag)	0.30**	0.13	-1.25***	-1.96***
	(0.12)	(0.12)	(0.33)	(0.32)

Overview

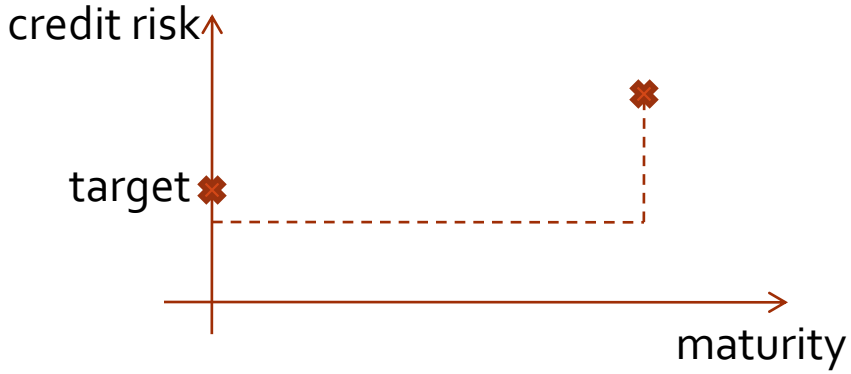
- Institutional Finance
- Implications for Financial Regulation – CoVaR
  - Macro-prudential regulation
    - Focus on externalities
    - Measure for systemic risk is needed, e.g. CoVaR
    - Maturity mismatch (+ Leverage) – encourage long-term funding
  - Countercyclical regulation
    - Find variables that predict average future CoVaR
    - Forward-looking measures, spreads, …
- Implications for Monetary Economics
  - Role of financial institutions
  - Maturity Rat Race

Implications for Monetary Economics

Objectives	Instruments
Price stability	Target rate (money supply)
Financial stability	Liquidity policy

Tinbergen

- Monetary Transmission
  - Target rate (short-term)
  - Effective rate (short-term)
  - Corporate lending rate



- Liquidity policy
  - *Narrow:* Hold short-term rate close to target
    - Reduce term risk premium
  - *Broad:* financial stability to ensure transmission
    - Reduce term and credit risk premium

Need to understand the role of financial institutions first

Role of Financial Institutions

- Project/asset selection
  - Informational advantage (Sharpe, Rajan)
- Create info-**in**sensitive securities (Gorton-Pennachi)
  - Pool and tranch in order to reduces lemon's problem
- Maturity transformation
  Why short-term (debt) funding?
  - Liquidity shock insurance (Diamond-Dybvig)
    - maturity tranformation is *good*, but bank run caveat
  - Incentivize management (Calomiris-Kahn)
    - Maturity mismatch is *good*
  - **Maturity rat race** (with MartinOehmke)
    - Maturity mismatch is *bad*

The Maturity Rat Race

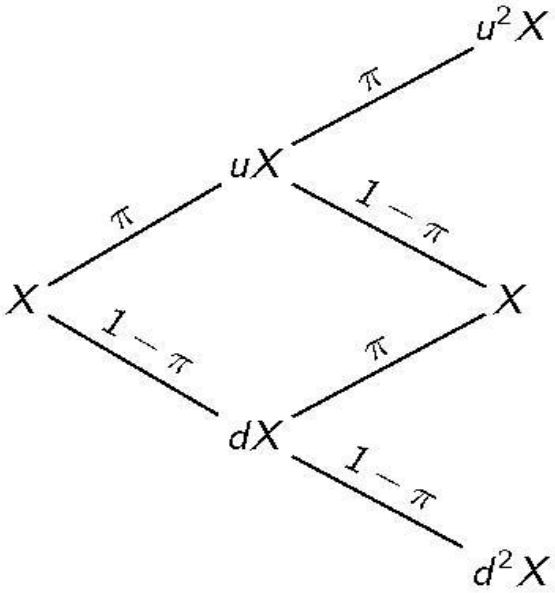
- Leads to a unraveling to short-term debt
- Friction with multiple creditors with differing maturities
- Mechanism:
  - Creditors with shorter maturity can adjust face value (reduce interest rate) since they can pull out in bad states
  - Part of cost in low state is borne not by borrower but by remaining long-term creditors
    (long-term debt holders are diluted)

Setup

- Financing can be
  - Long-term: two periods
  - Short-term: one period + rollover at t=1
- Borrower has to borrow from multiple lenders
  - Continuum of competitive lenders
  - Each has limited capital
- Priority in default
  - Proportional to face value of debt at time of default

Project Payoffs

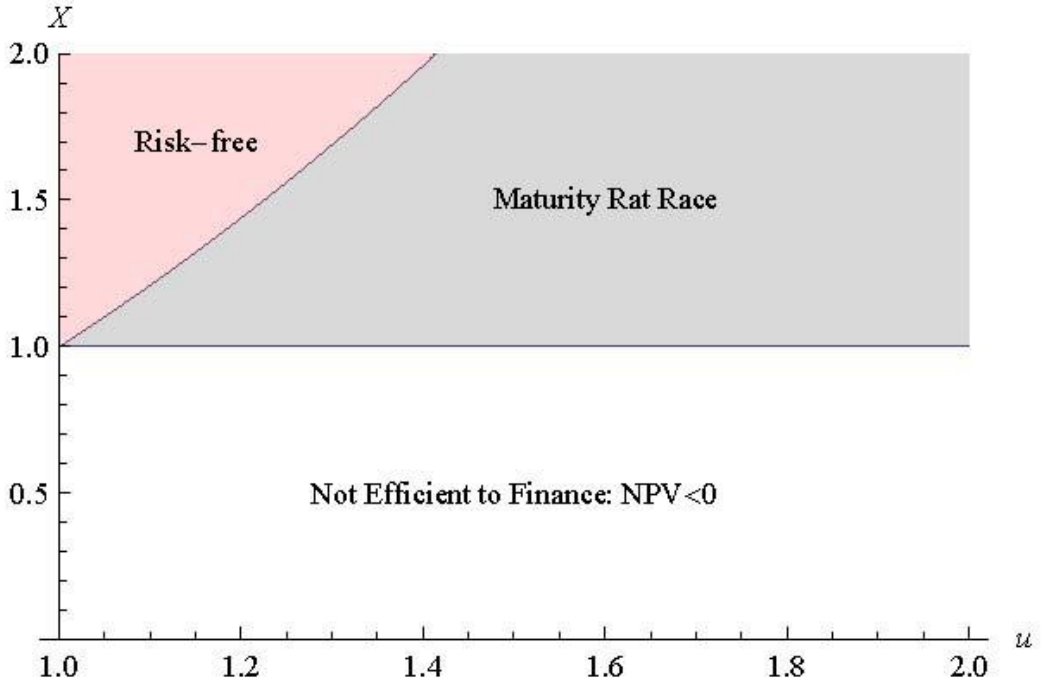
- Long-term project costs 1 at t=0, pays out at t=2
- Expected payoff moves along binominal tree, u=1/d



- Project can be liquidated prematurely at discount: fraction (1-δ) is lost

The Maturity Rat Race

- Hold everybody else's financing fixed, can borrower and one lender profitably deviate by moving to rollover financing?



When is the Rat Race Inefficient?

1. Inefficient (early) unwinding in down state

$$dX < 1 \Leftrightarrow X < u$$

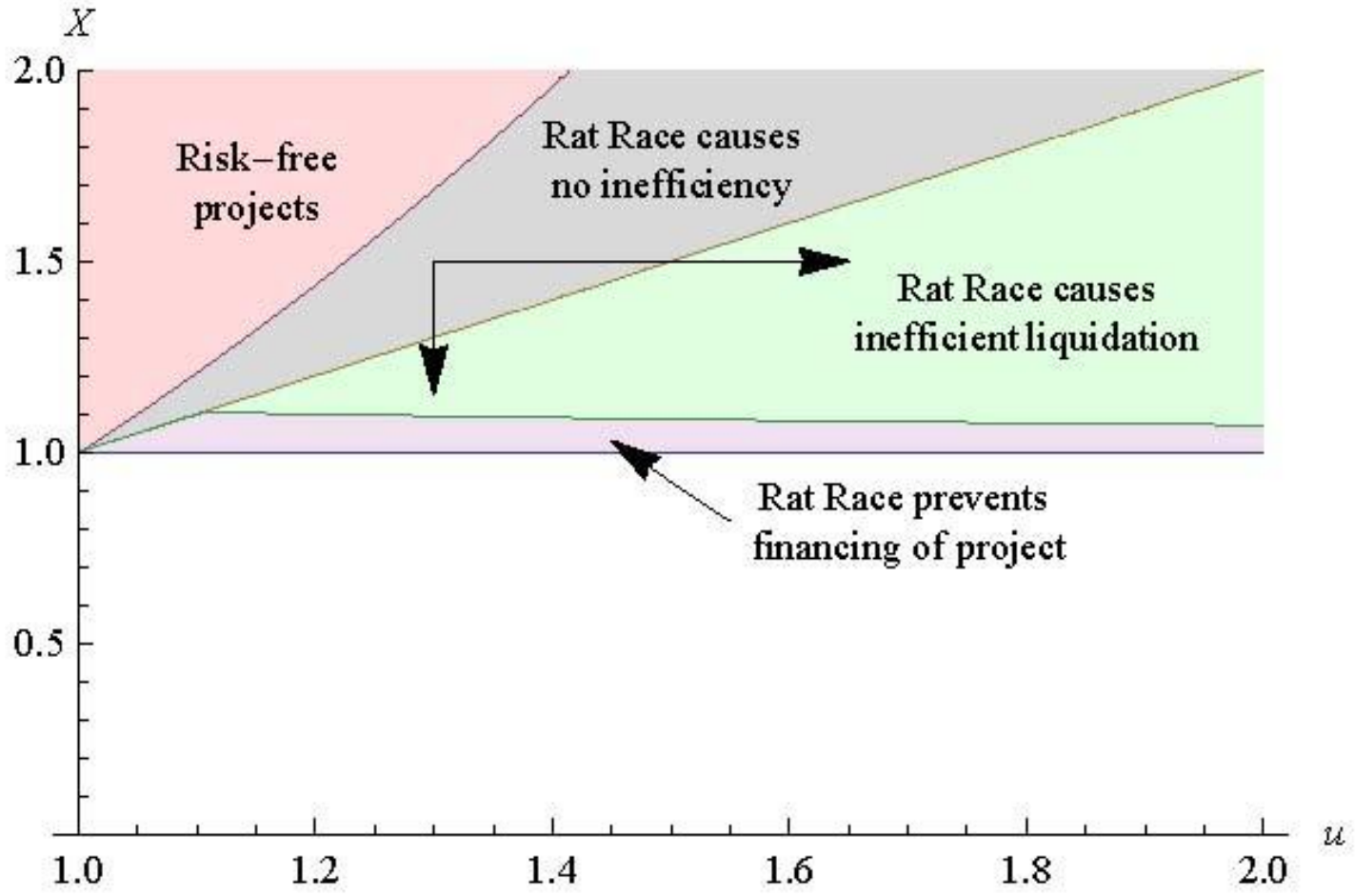
2. Project does not get off the ground (since long-term financing is not viable)

$$\pi u X + (1-\pi)\delta dX < 1$$

- When economy turns sour/risky

  ⇨ problem becomes more severe

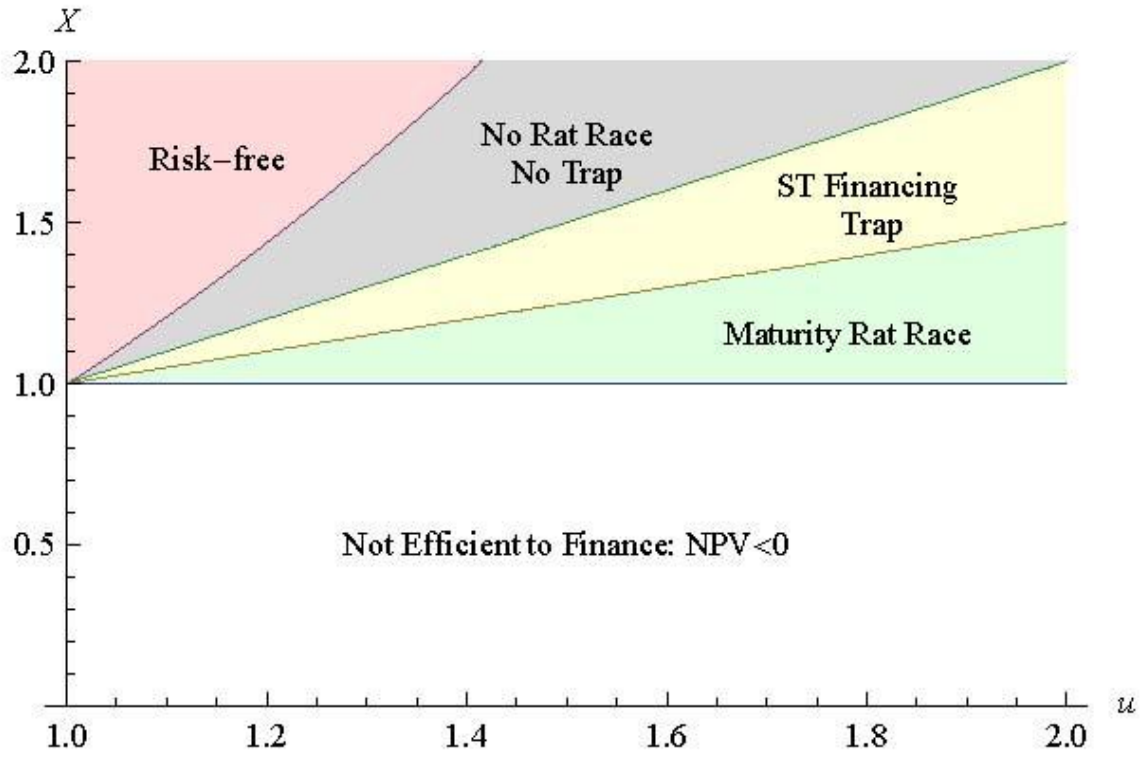
Inefficiencies



Covenants limit Rat Race

- Since
  - E.g. covenant restrict raising face value of new short-term debt at time t=1
  - Short-term debt holders always pull out in down state
- Short-term financing trap (multiplicity)
  - If all lenders go short-term + pull out in down state at t=1, then borrower does not want to switch to "expensive" long-term financing

Covenants – Short-term Financing Trap



Conclusion

- Institutional Finance
  - Financial institutions are not a veil
  - Moving away from representative agent models
- Financial Regulation
  - Macro-prudential has to focus on measuring contribution to systemic risk
  - Countercyclicality (to overcome margin/haircut spiral)
- Monetary/Liquidity Policy
  - Role of financial institutions – why short-term funding?
  - Avoid "credit bubbles" since they impair financial system