Information Contagion and Systemic Risk[1]

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FDIC 12th Annual Bank Research Conference
Arlington, VA, 11 October 2012

[1] Joint work with Toni Ahnert, Financial Markets Group, London School of Economics and Political Science. A previous version of this paper was circulated under the title *"Stabilizing Information Contagion"*

What this paper is about

Setting the stage

- Our notion of systemic risk: joint default probability of financial intermediaries (banks, mmmf, etc.)
- Information about other banks can be valuable for (at least) two reasons: counterparty risk and common exposures
- Information contagion is the spill-over of information about the health of one bank, adversely affecting other banks

Our main research question

- What is the effect of ex-post information contagion on banks' ex-ante optimal portfolio choice?
- What is the welfare loss implied by information contagion due to joint default?

Key result: information contagion can reduce systemic risk

Sneak preview: our results

- When banks are subject to counterparty risk, anticipated information contagion can **reduce** systemic risk
- Unanticipated information contagion will always increase systemic risk
- When banks are subject to common exposures, information contagion increases systemic risk

Intuition for our main result

- Banks are more prudent when they anticipate information spillover

Motivation

- Systemic risk comes with large social costs: BIS estimates the cost of systemic bank crises ranging from 3% GDP (US savings and loans) to 30% GDP (Chile 81-87)
- After Lehman insolvency only the Reserve Primary Fund "broke the buck". However, Dumontaux and Pop (2012) show that NBFIs were most affected
- When investors are sensitive to the health of the financial system, information contagion can be a major source of systemic risk
- Two reasons why information about other banks can be useful: **counterparty risk** and **common exposures**
- Information contagion is a major source of systemic risk

Relation to the literature

- Acharya and Yorulmazer (2008b): interlinkages through correlated portfolio holdings; information contagion creates incentive for correlated investments;
  $\Rightarrow$ **our paper**: exogenous asset correlation, but endogenous portfolio choice (liquidity, interbank insurance, demand deposits)

- Allen, Babus, and Carletti (2012): interaction of asset commonality and funding maturity; portfolio overlap created by network formation model; bad news about aggregate state adversely affect debt roll-over
  $\Rightarrow$ **our paper**: liability diversification; risky and risk-free assets; bank-specific information spillovers

- Allen and Gale (2000): financial contagion in unanticipated aggregate liquidity shock
  $\Rightarrow$ **our paper**: solvency shocks with positive probability; optimal portfolio choice

Model: Timing, agents, and investment opportunities

- Three dates $t = 0, 1, 2$
- Two regions $k = A, B$
- Agents (in each region):
  - Continuum of depositors
  - A representative bank (e.g. investment bank, money market fund)
- Two investment opportunities
  - Storage: risk-free, matures after one period
  - Long-term investment project: risky, matures after two periods, yields (regional) return R_k:

$$R_k = \begin{cases} R & \text{w.p. } \theta_k \\ 0 & \text{w.p. } 1 - \theta_k \end{cases}$$

    where θ_k is a solvency shock to region k
  - Costly liquidation: $\beta \in [0, 1)$

Model: Depositors

- Liquidity preferences as in Diamond and Dybvig (1983)
  - Uncertainty about liquidity preference at date $t = 0$
  - Uncertainty resolved at the beginning of $t = 1$
  - Early despositors of mass λ, late depositors of mass $1 - \lambda$
- Risk averse depositors:

$$U(c_1, c_2) = \begin{cases} u(c_1) & \text{w.p.} \quad \lambda \\ u(c_2) & \text{w.p.} \quad 1 - \lambda \end{cases}$$

- Unit endowment
- Store or deposit at bank

Model: Banks

- Collects deposits by offering a demand deposit contract (d_1, d_2) at $t = 0$
  - insurance against idiosyncratic liquidity risk for risk-averse depositors
- Choice of interbank insurance $b \geq 0$ and liquidity y at $t = 0$
- Free entry $\Rightarrow$ maximize depositors expected utility
  - deposit in full at bank
- Distributes proceeds equally at $t = 2$ (mutual bank)
- Focus on essential bank-runs $\rightarrow$ no co-ordination failure

Model: Information structure

- All prior distributions are common knowledge
- Depositors receive independent public signals about returns in both regions which are perfectly revealing with probability q_k
- Information about the other region can be valuable for two reasons: counterparty risk and common exposures
- Information contagion occurs if information about the other region's fundamentals is payoff-relevant in your region

Model: Timeline

Date 0	Date 1	Date 2
1. Endowed depositors invest or deposit at regional bank	1. Regional liquidity shocks are publicly observed	1. Investment projects mature
2. Banks choose portfolio and initiate interbank deposits	2. Banks settle date-1 interbank claims	2. Banks settle date-2 interbank claims
	3. Depositors privately observe liquidity preference	3. Banks service remaining withdrawals
	4. Depositors observe regional solvency signals	
	5. Depositors decide whether to withdraw	

Equilibrium: Outline

Outline

- Depositors compare payoffs from withdrawing and not withdrawing, using regional signals
- Essential bank-runs take place if $\theta < \overline{\theta}$
- Compute expected utility from thresholds
- Two reasons why an **analytical solution** of this problem is **infeasible**:
  1. corner solutions
  2. response of thresholds with respect to liquidity is non-monotonic
- Globally optimize expected utility w.r.t. (d_1, y, b) **numerically**

Results: Resilience effect

	cr only $(EU,\ d_1^*,\ y^*,\ b^*)$ $(\overline{\theta}_{\mathrm{H}},\ \overline{\theta}_{1,\mathrm{L}}\ ,\ A_1)$	cr + ic $(EU,\ d_1^*,\ y^*,\ b^*)$ $(\overline{\theta}_{\mathrm{H}},\ \overline{\theta}^N_{2,\mathrm{L}}\ ,\ \overline{\theta}^D_{2,\mathrm{L}},\ A_2)$
cr only	(**0.172**,0.88,0.73,0.08) (0.423,0.23,**0.048**)	(**0.096**,0.88,0.73,0.08) (0.423,0.212,0.252,**0.052**)
cr + ic		(0.107,0.94,0.8,0.02) (0.379,0.211,0.222,0.041)

Table: Parameters: β=0.7, R=5.0, ϕ=1.0, λ=0.5, η=0.25, ρ=1.0, q_H=0.7

Results: Resilience effect

	cr only $(EU,\ d_1^*,\ y^*,\ b^*)$ $(\overline{\theta}_{\mathrm{H}},\ \overline{\theta}_{1,\mathrm{L}}\ ,\ A_1)$	cr + ic $(EU,\ d_1^*,\ y^*,\ b^*)$ $(\overline{\theta}_{\mathrm{H}},\ \overline{\theta}^N_{2,\mathrm{L}}\ ,\ \overline{\theta}^D_{2,\mathrm{L}},\ A_2)$
cr only	(**0.172**,0.88,0.73,0.08) (0.423,0.23,**0.048**)	(0.096,0.88,0.73,0.08) (0.423,0.212,0.268,0.052)
cr + ic		(**0.107**,0.94,0.8,0.02) (0.379,0.211,0.226,**0.042**)

Table: Parameters: β=0.7, R=5.0, ϕ=1.0, λ=0.5, η=0.25, ρ=1.0, q_H=0.7

Results: Instability effect

	pure ce $(EU,\ d_1^*,\ y^*,\ b^*)$ $(\overline{\theta},\ A_5)$	ce + ic $(EU,\ d_1^*,\ y^*,\ b^*)$ $(\overline{\theta},\ A_6)$
ce only	(**0.13**,1.0,0.77,0.0) (0.328,**0.161**)	(0.137,1.0,0.77,0.0) (0.328,0.161)
ce + ic		(**0.137**,1.01,0.76,0.0) (0.344,**0.168**)

Table: Parameters: β=0.7, R=5.0, ϕ=1.0, λ=0.5, η=0.25, ρ=1.0, q_H=0.7

Results: Summary

Result 1+2

If information spillovers are unanticipated, information contagion due to counterparty risk **and** common exposures unambiguously increases systemic risk.

Result 3: Resilience Effect

In the setup with counterparty risk, anticipating information contagion reduces systemic risk and expected utility.

For **common exposures**, however:

Result 4: Instability Effect

In the setup with common exposures, anticipating information contagion increases systemic risk and expected utility.

Robustness of Results

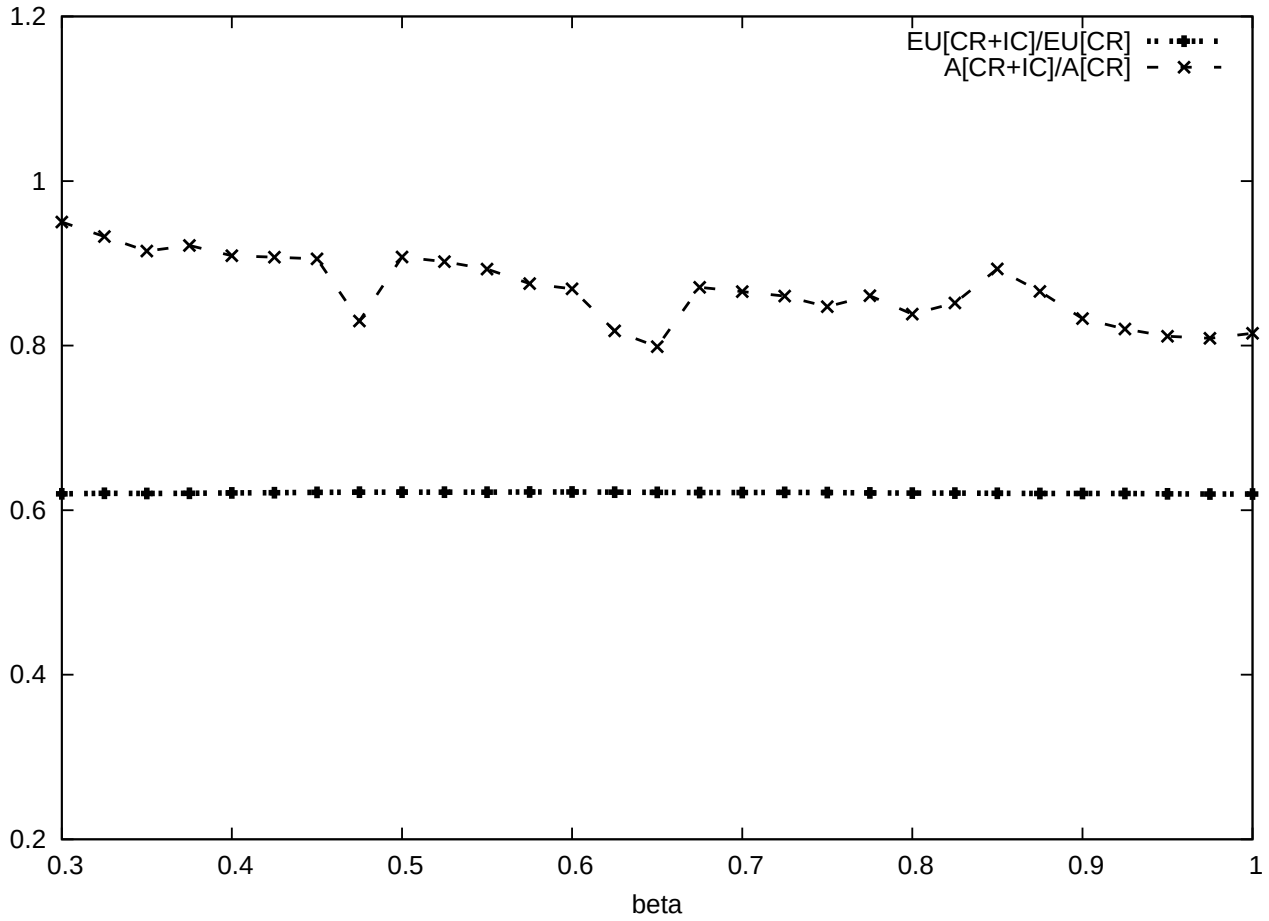

Figure: Robustness check for the resilience effect for a variation of β.

Robustness of Results

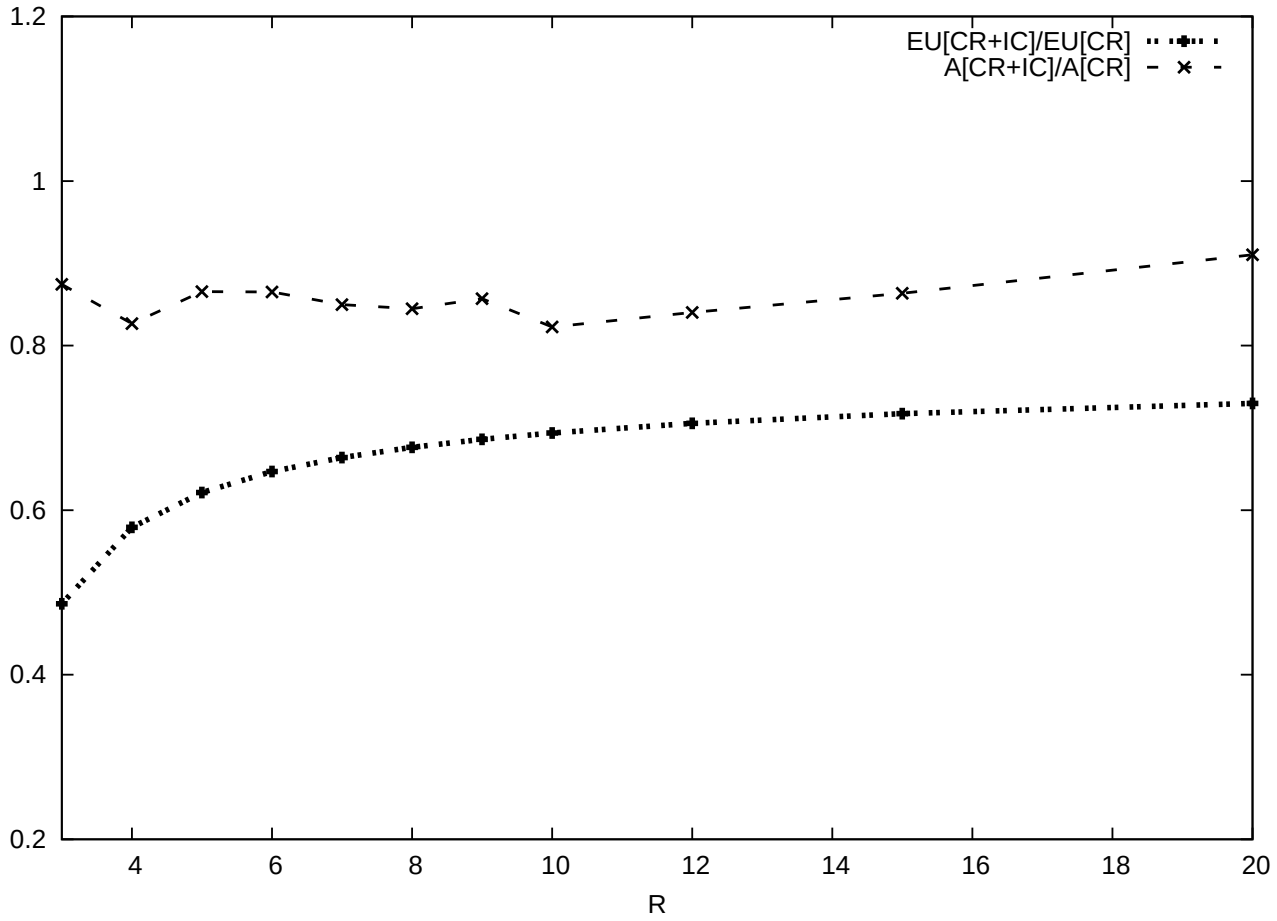

Figure: Robustness check for the resilience effect for a variation of R.

Robustness of Results

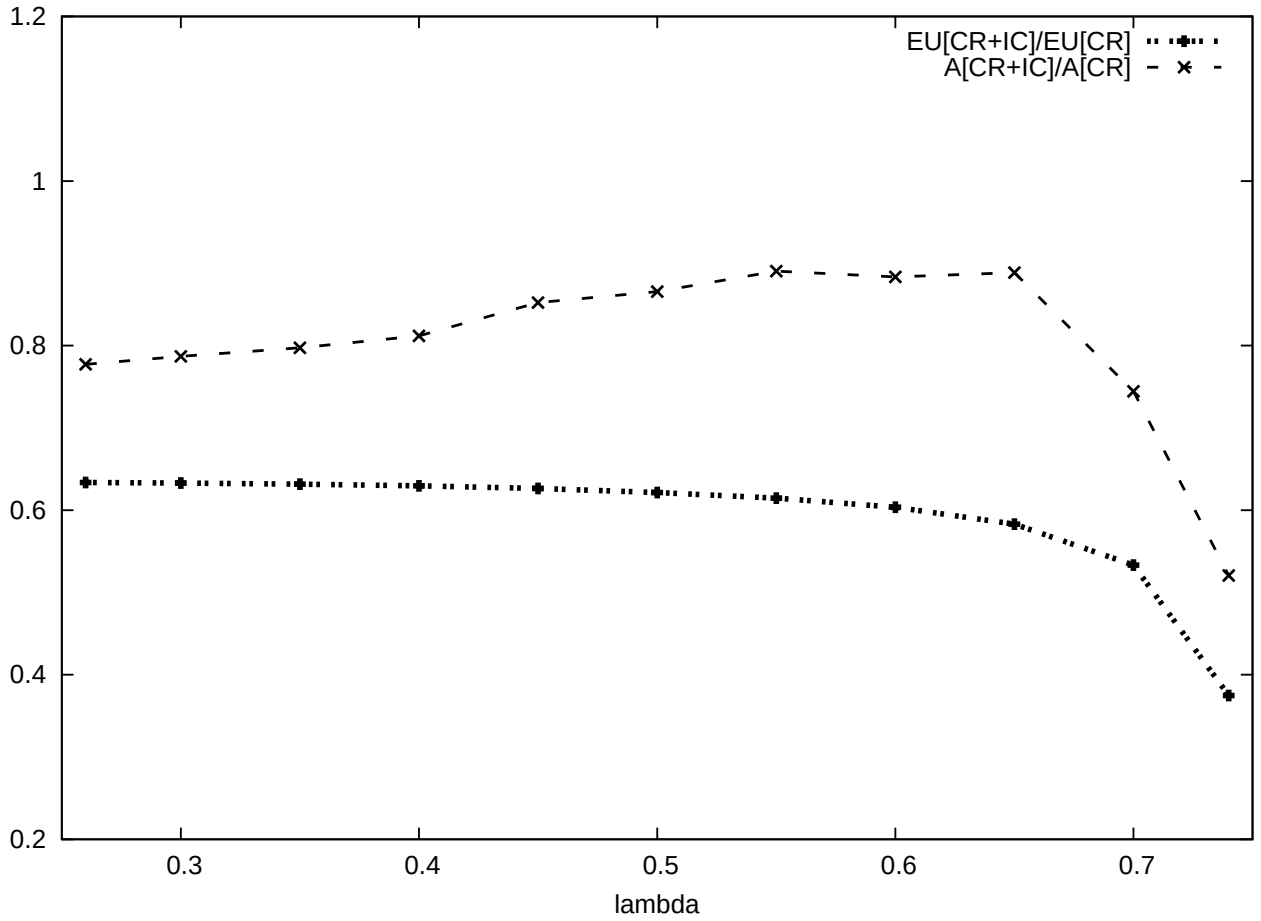

Figure: Robustness check for the resilience effect for a variation of λ.

Robustness of Results

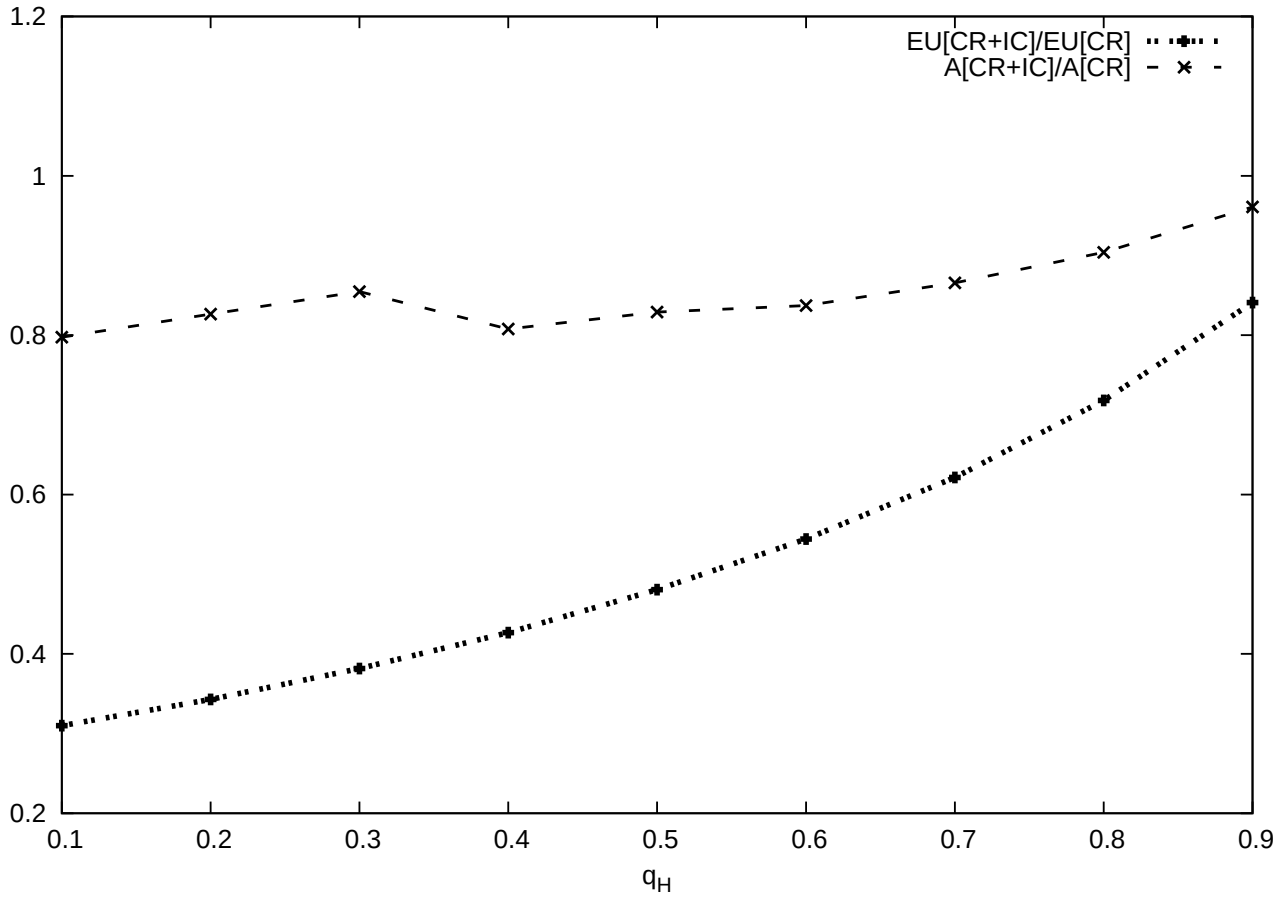

Figure: Robustness check for the resilience effect for a variation of q_H.

Robustness of Results

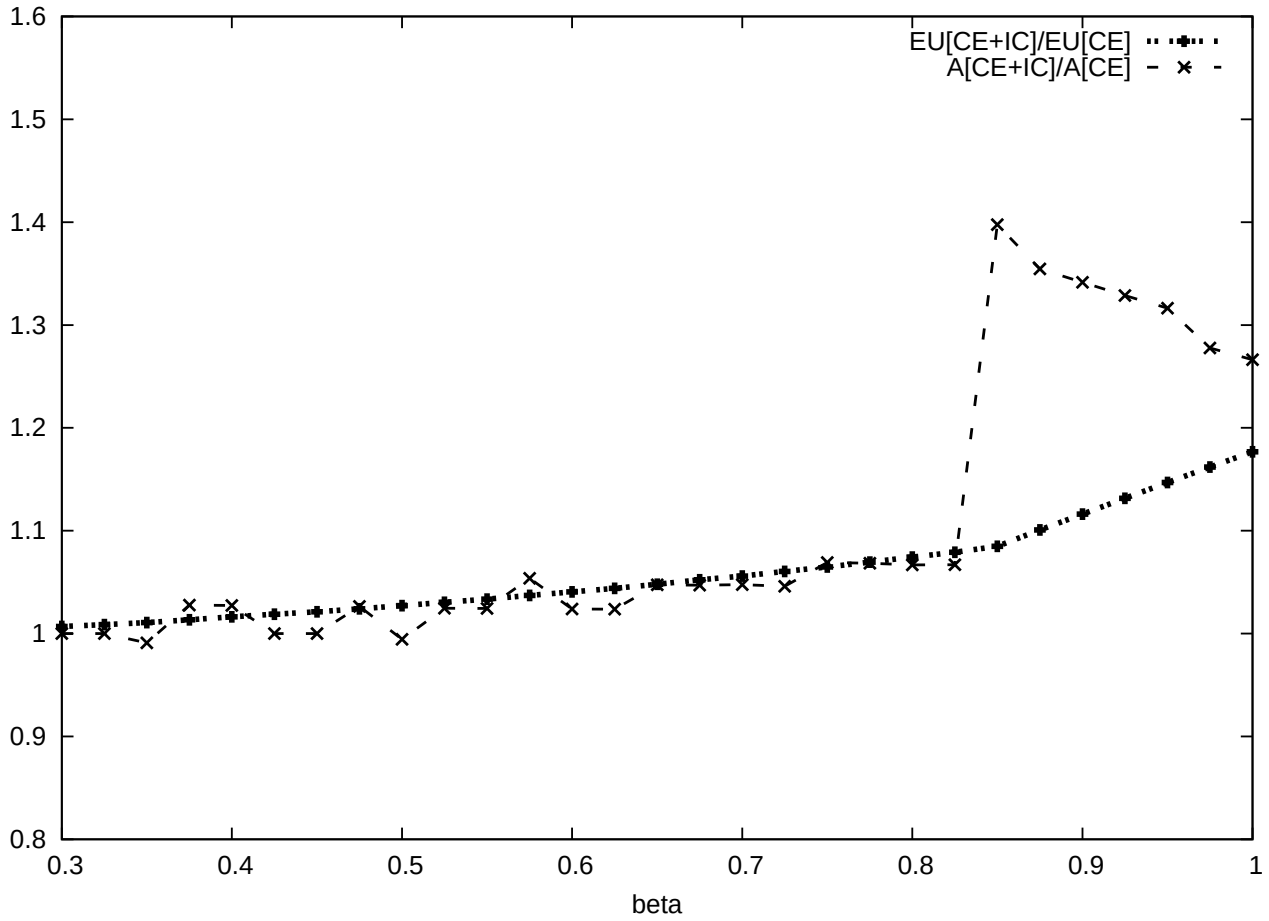

Figure: Robustness check for the instability effect for a variation of β.

Robustness of Results

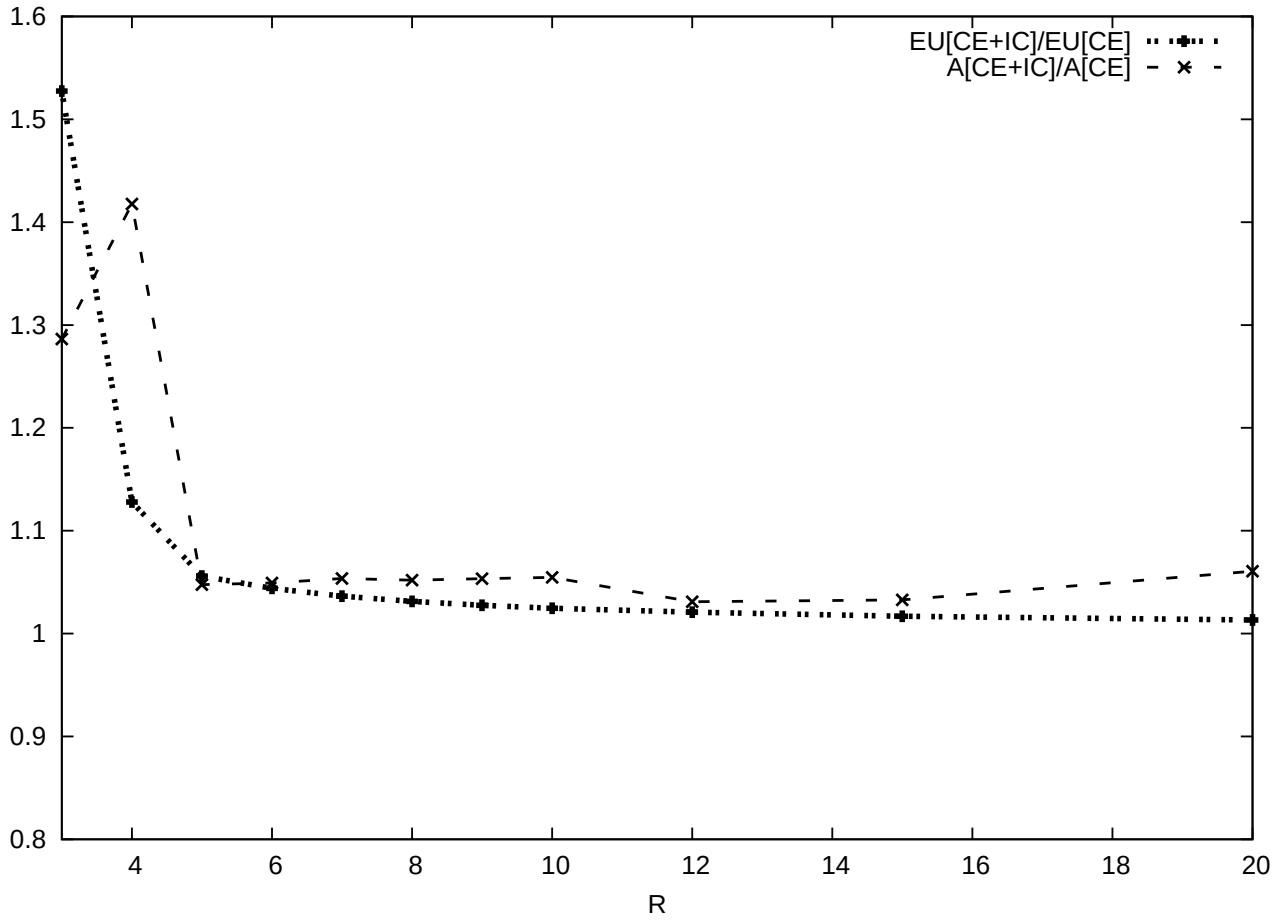

Figure: Robustness check for the instability effect for a variation of R.

Robustness of Results

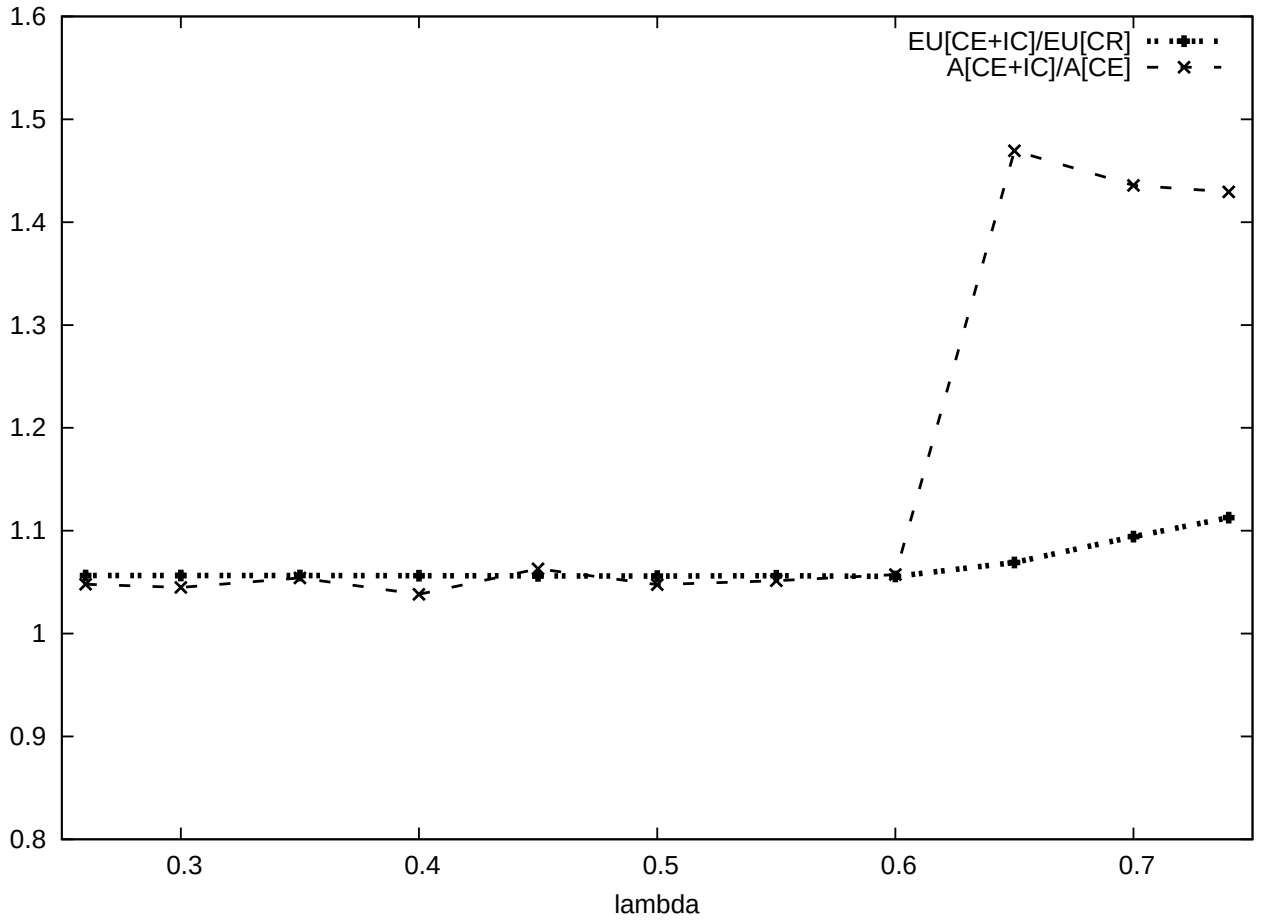

Figure: Robustness check for the instability effect for a variation of λ.

Robustness of Results

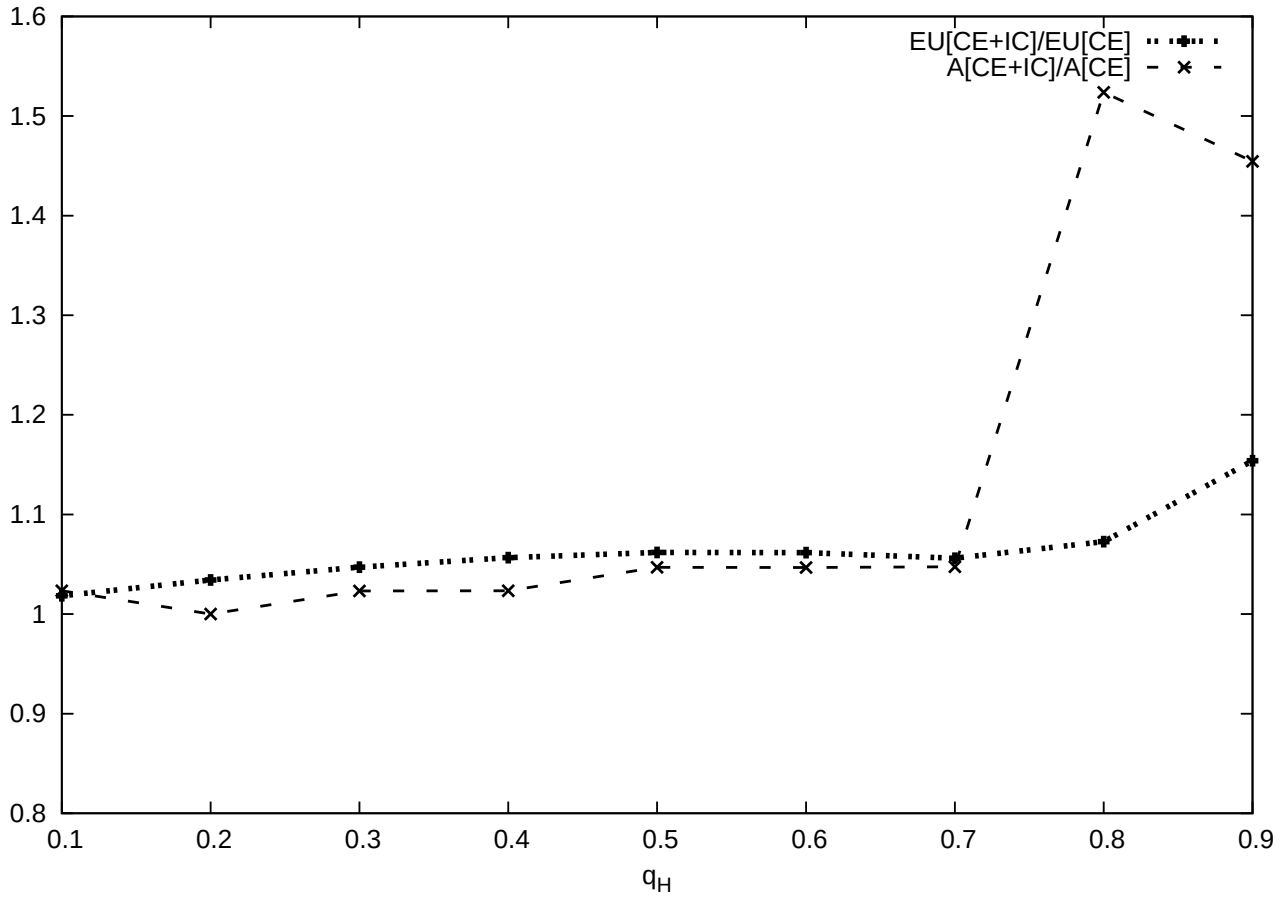

Figure: Robustness check for the instability effect for a variation of q_H.

A broader perspective: applying our model to microfinance

- Microfinance institutions (MFIs) serve over 205 million customers (Microcredit Summit Campaign (2012))
- Group lending is an agreement in which lender grants loan to a **group** of borrowers who jointly guarantee repayment $\rightarrow$ **counterparty risk!**
- Group liability is attributed as main driver of growth in the microfinance industry
- Theory behind the idea of group lending (e.g. Stiglitz (1990), Varian (1990)): overcome informational asymmetries through peer monitoring

A broader perspective: applying our model to microfinance

- Two entrepreneurs $k = A, B$ jointly take a group loan from a MFI
- Safe storage technology (cash, durable goods), risky investment project R_k (buying an ox to plow a field, dwelling a well to sell the water, etc.)
- Regions in this interpretation are sectors of the economy
- Project pays with regional probability θ_k (alternatively: there is a probability of alternative use of funds by entrepreneur, e.g. sickness of family member)
- Entrepreneurs receive signal about regional return of other entrepreneur with probability q
- Entrepreneurs decide whether to default on group loan

A broader perspective: applying our model to microfinance

Date 0	**Date 1**	**Date 2**
1. Microfinance institution (MFI) decides on group loan	1. Group loan institutionalizes counterparty risk	1. Investment projects mature
2. Entrepeneurs choose their portfolio	2. Entrepeneurs observe regional solvency signals	2. Group of entrepreneurs repays MFI
	3. Depositors decide whether to default	

Table: Timeline of the microfinance model application.

A broader perspective: applying our model to microfinance

Resilience effect predicts two things:

1. Lower default rates of group loans $\rightarrow$ Gine et al. (2009): loan repayment rates are higher in joint-liability games (0.88) than in individual-liability games (0.68)

2. Group borrowers hold more liquid assets $\rightarrow$ Banerjee et al. (2010): randomized experiment in India shows households with existing business will hold more durable goods

$\Rightarrow$ Resilience effect in line with existing empirical literature

Conclusion

- This paper analyzes the impact of ex-post information contagion on the ex-ante portfolio choice of banks
- Information about another bank reveals valuable information due to common exposures and counterparty risk
- Information contagion unambiguously increases systemic risk in the presence of common shocks or when unanticipated
- **However**, in the presence of counterparty risk anticipated information contagion can **reduce** systemic risk

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Thank you!