

Beliefs and Settlement Risk

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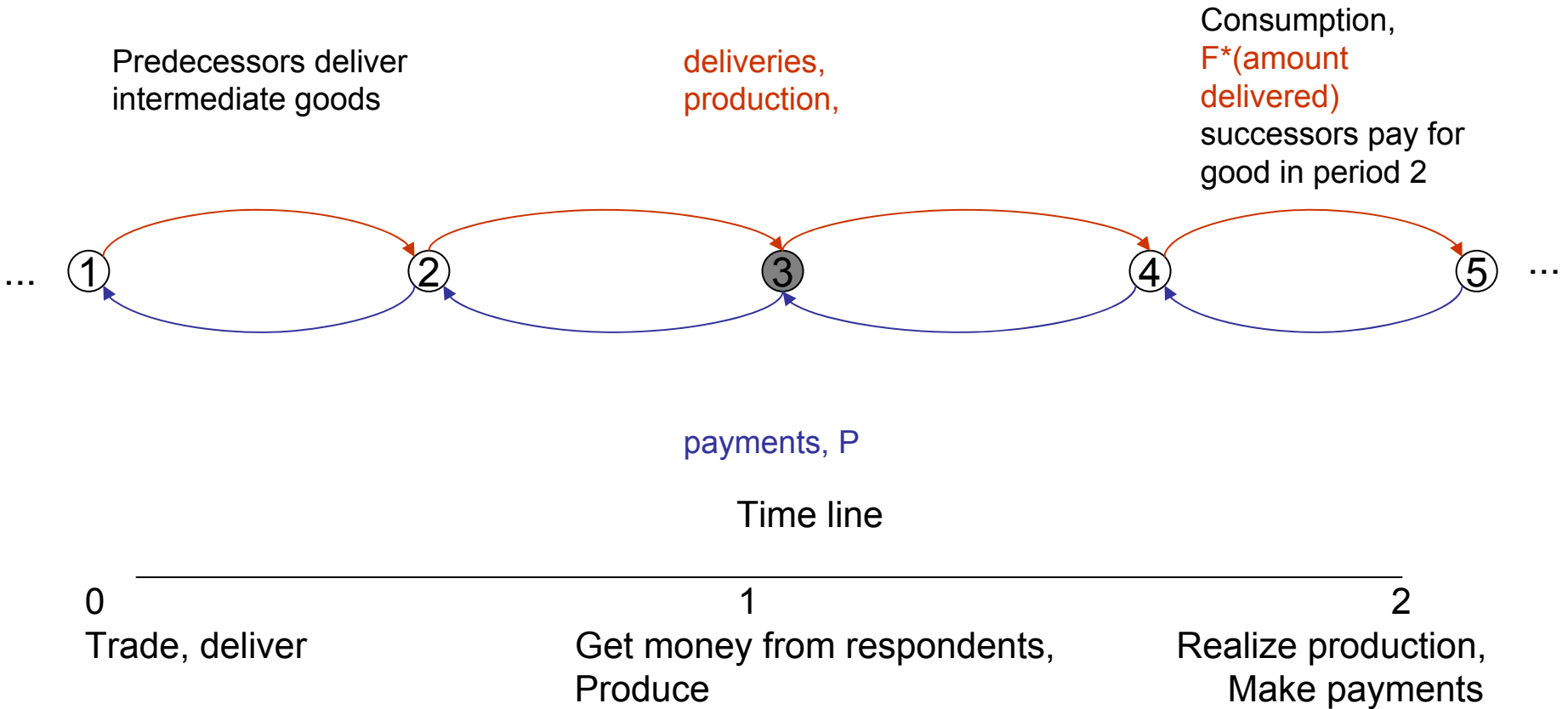
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Settlement Risk

- In an RTGS system, participants face the problem of *settlement risk*.
 - Failure of counterparty to settle as expected.
- Kahn, McAndrews, and Roberds (2003), and Mills and Nesmith (forthcoming) explore the issue.
- KMR examine a trading and settlement ring topology game.

Model components: Ring topology game



- Assets
 - Money (M)
 - Deliveries (F) from predecessors that settle
 - Payments (P) from successors that settle

Settlement game

- If agents deliver and settle, all is well, because
 - $F > P$, there is a positive gain from trade, and value from settling
- If default occurs, then parties must go to bankruptcy court.
 - Debtor gets to keep $\alpha > 0$ share of assets,
 - Creditor gets $\beta > 0$ share. $\alpha + \beta < 1$.
 - Defaulter can't go to bankruptcy court as creditor.

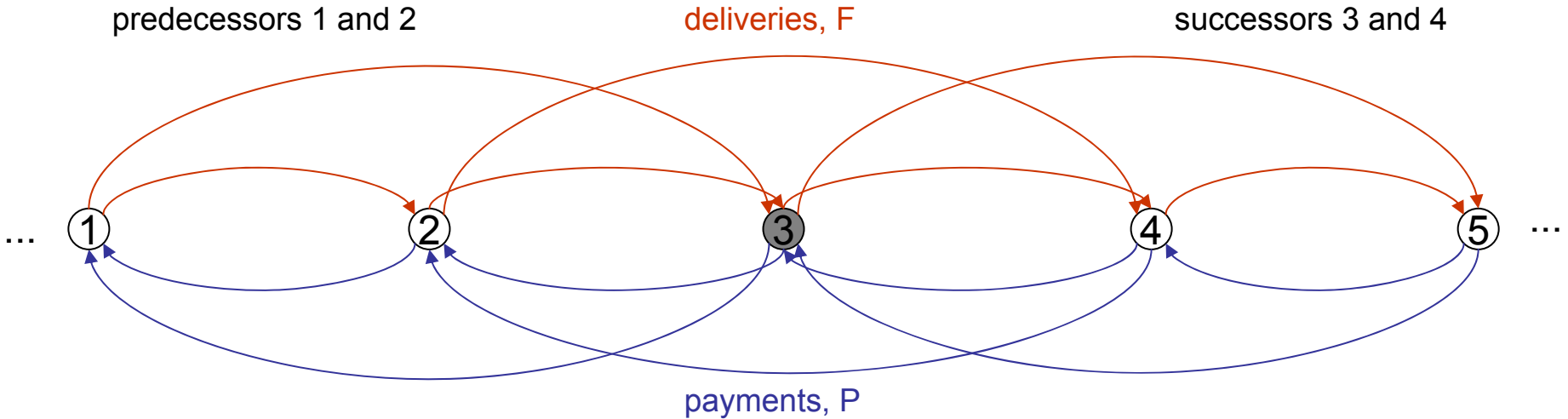
Ring topology game

- KMR show that for an open set of parameter values, there can be regions of *mutually assured default* and regions of *mutually assured settlement*, and these regions can overlap.
- High levels of money, M , assist in assuring settlement, as does collateral (shrink, or even eliminate region of mutually assured default).
- Here we interpret M to represent the behavior of a bank's respondent network.

Beliefs about Settlement Risk

- KMR assume agents adopt Nash equilibrium beliefs in a static environment.
- Here we adopt a dynamic fictitious-play-like procedure for agents to form beliefs that are consistent with the equilibrium actions of the agents.
 - Update beliefs based on observed actions
 - Recency weighting
 - Play until beliefs and actions are stable

Model components



- **Assets**
 - Money (M)
 - Deliveries (F) from predecessors that settle
 - Payments (P) from successors that settle

($F > P$, denoting positive value from settling)
- **Beliefs**
 - p_i^+ , probability that successor pays
 - p_i^- , probability that predecessor delivers

Decision making

- Banks settle if value of settlement > value of defaulting
- Value of settlement
 - + own assets
 - payments to all predecessors
 - + creditor's share (β) of defaulting successors' assets
- Value of defaulting
 - + defaulter's share (α) of own assets
- Assets are contingent on other bank's behavior. In order to decide whether to settle or default, banks must form beliefs about other banks behavior, and the behavior of their counterparts.

Decision making (cont'd)

- Value of settlement (S_i)

$$S_i = A_i - (P \cdot k_i^{in}) + (1 - p_i^{out}) \cdot \beta \cdot \sum_{j \in k_i^{out}} \left(\frac{A_j}{p_i^{in} \cdot (k_j^{in} - 1) + 1} \right)$$

$$A_i = M_i + p_i^{in} \cdot F \cdot k_i^{in} + p_i^{out} \cdot P \cdot k_i^{out}$$

$$A_j = M_j + \left(\frac{p_i^{in} \cdot (k_j^{in} - 1) + 1}{k_j^{in}} \right) \cdot F \cdot k_j^{in} + p_i^{out} \cdot P \cdot k_j^{out}$$

assets by successor

expected number of creditors
by the successor

- Value of defaulting (D_i)

$$D_i = \alpha \cdot A_i$$

Forming beliefs

- Banks update beliefs on the basis of experience.
- Recency-weighted update rule:

$$p_i^{in}(t + 1) = p_i^{in}(t) + \alpha \cdot (x^{in} - p_i^{in}(t))$$

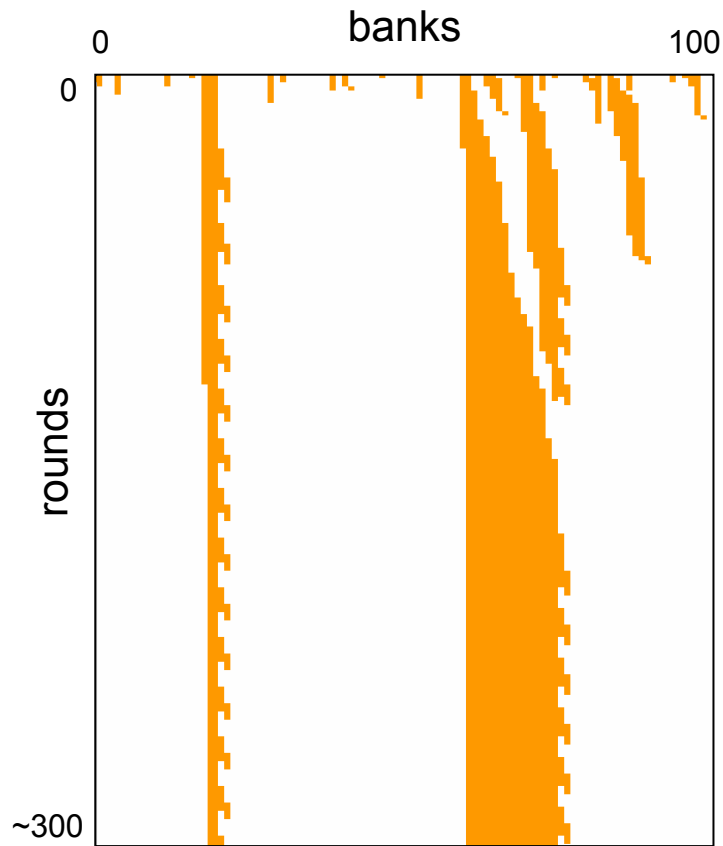
$$p_i^{out}(t + 1) = p_i^{out}(t) + \alpha \cdot (x^{out} - p_i^{out}(t))$$

$$x^{in}, x^{out} \in \{0, 1\} \text{ , 0=default, 1=settle}$$

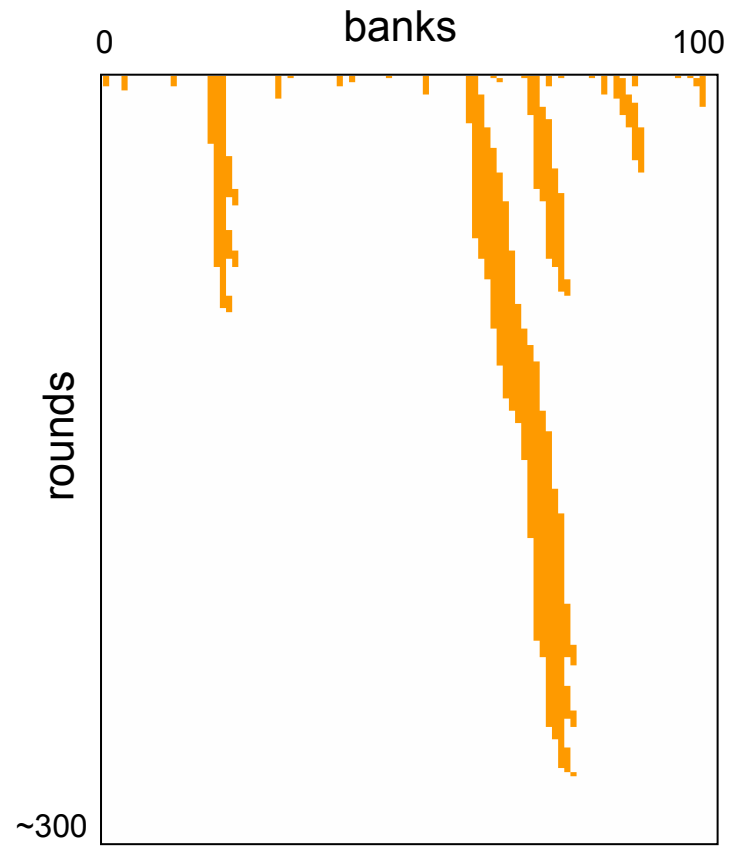
α = weight parameter (we use 0.1)

Convergence – example

white = settle, orange = default



no convergence

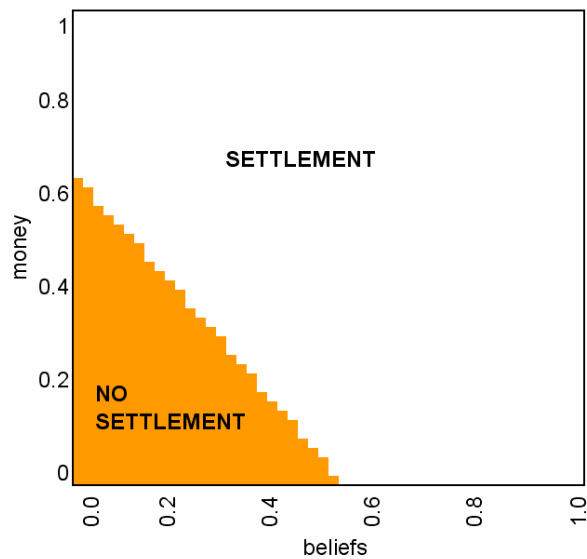


convergence “all settle“
equilibrium

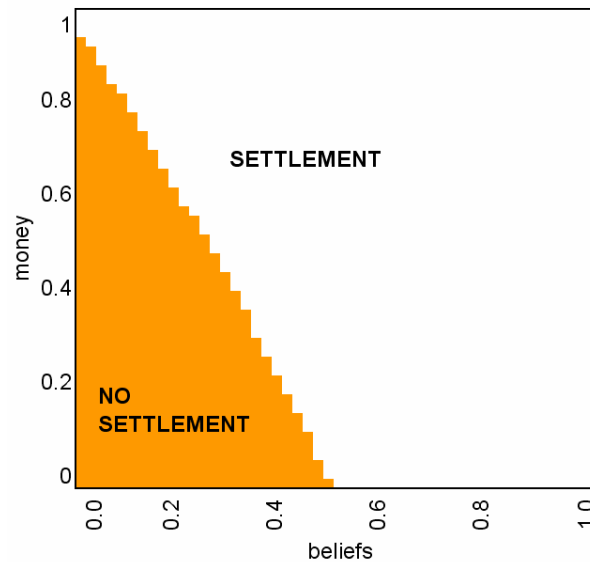
Money vs. network reach

- identical M_i
- identical initial beliefs and ring topology
- reach = number of outgoing/incoming links

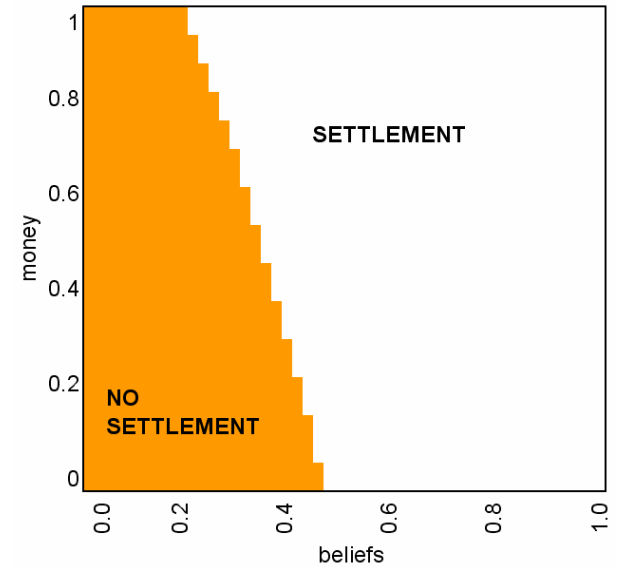
reach = 1



reach = 2

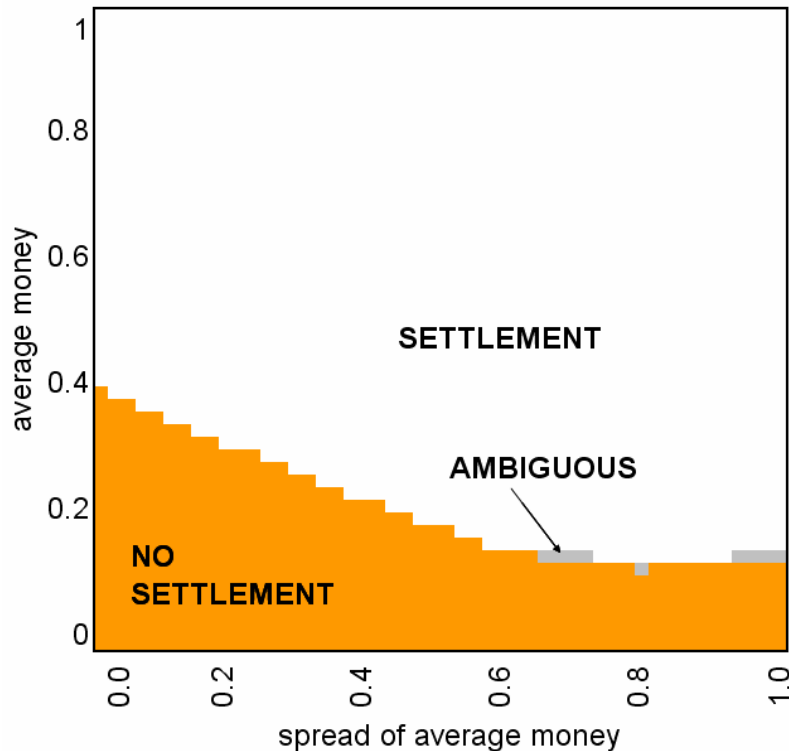
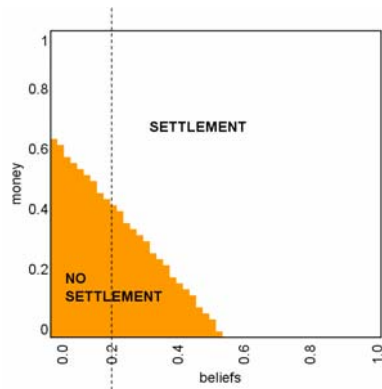


reach = 5



Degree of heterogeneity

- with given initial beliefs (here 0.2) and ring of reach 1
- we investigate alternative mean preserving spreads of M_i
- settlement equilibrium is possible with less money when money is distributed more unevenly

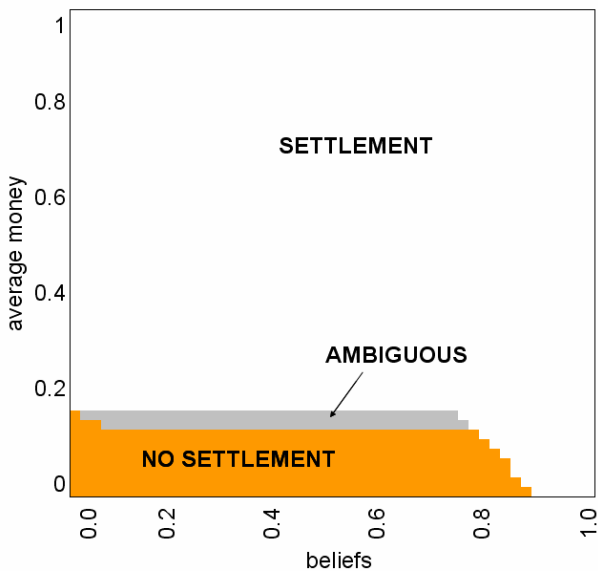


mixed refers to a cycle or to a partial settle/default equilibrium

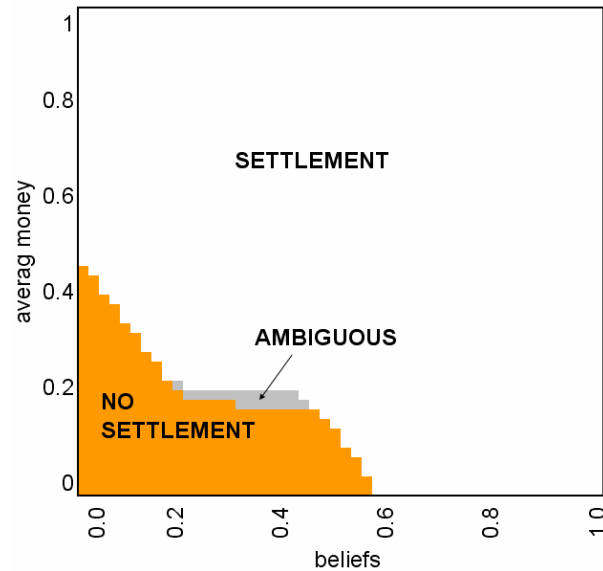
Heterogeneity and reach

- heterogeneous M_i (uniform, carrier = 1)
- identical initial beliefs and ring topology
- reach = number of outgoing/incoming links

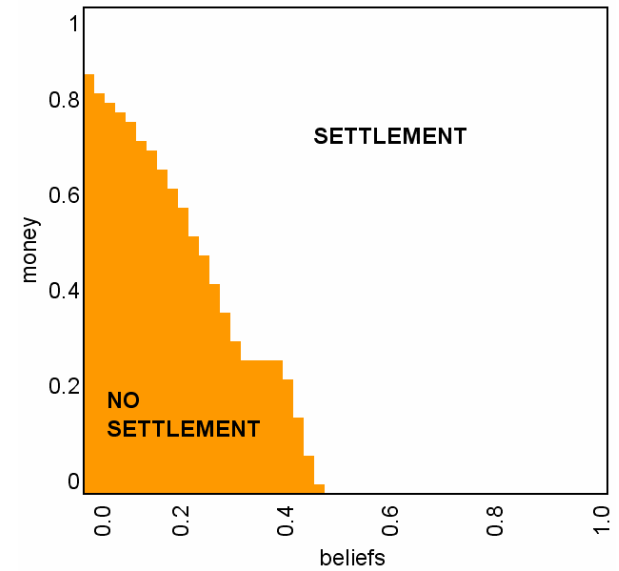
reach = 1



reach = 2



reach = 5



Conclusions

Our investigation of settlement risk has yielded three findings:

- increased money holdings, as in KMR, increase the likelihood of settlement
- heterogeneity of money holdings tends to improve outcomes—positive contagion (antibodies rather than viruses)
- Initial beliefs matter in the selection of settle or default equilibrium, when both equilibria exist.