Financial fragility and economic performance

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March 4, 2008

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The main question

Given tastes and productive technologies, can general financial conditions have an independent effect on the economy?

General description

- Two-period general equilibrium model
  - Saving period (t_1)
  - Consumption period (t_2)
- Two production technologies:
  - Storage technology
  - Investment technology

Agents

- Countable infinity of individuals
  - Fraction μ is entrepreneur; $1 - \mu$ is nonentrepreneur
  - Risk neutral
- Competitive financial intermediaries
  - Make zero profits
  - Goal is risk diversification
  - Waste no resources in intermediation process

Timing and endowments

- Start of t_1: Each individual gets w_i of the input good
- Endowment can be stored or invested
- Output of either process is consumption at t_2

Storage technology

Storage technology has gross return of r per unit invested

Investment technology

- Infinite number of potential investment projects
- All projects are ex-ante identical
- Two-step investment process:
  - Evaluation
  - Implementation

Investment technology: Evaluation

- Any project can be evaluated; only entrepreneurs can evaluate
- Cost of evaluation: e units of effort
- Evaluation outcome: Probability p of success
- p independent across projects; c.d.f. $H(p)$
- Project cannot succeed unless evaluated

Investment technology: Implementation

- Knowing p, entrepreneur decides to take project or not
- Taking project requires one unit of endowment
  - If $w_i < 1$, need external financing
  - Success: Return is $R > r$ units of consumption good
  - Failure: Zero return
- Declining project has zero endowment cost
  - Can store or lend endowment to others
  - Effort cost of evaluation is sunk

Investment technology: Some remarks

- Nonentrepreneurs can undertake projects; however:
  - Project fails for sure
  - Never an equilibrium outcome
- Assume a policy of undertaking *all* evaluated projects gives negative expected return

Information

- Endowment is public information
- Outcome of project is public information
- $H(p)$ is publicly known; p is private information
- Evaluation is a private action

Utility maximization

All individuals maximize expected t_2 consumption

- Entrepreneurs' decisions
  - Evaluate or not
  - If evaluated, take project or not
- Nonentrepreneurs decide to store or to invest

Notation

- $\bar{w}$: Per-capita endowment
  - Assume $\bar{w} > \mu$: Feasible to fund all projects
- m: Fraction of individuals who evaluate projects
- p^*: Reservation success probability
- $H(p^*)$: Fraction of rejected projects

Notation

- $\hat{p}$: Probability of success, conditional on taking the project

$$\hat{p}(p^*) = \mathbb{E}(p|p \geq p^*) = \frac{\int_{p^*}^{1} p \, dH}{1 - H(p^*)}$$

- $\hat{p}R$: Average expected return per unit of investment

The planner's problem

Planner solves

$$\max_{p^*,m} \quad r\left[\bar{w} - m(1 - H(p^*))\right] + m\left[(1 - H(p^*))\hat{p}R - e\right] \quad (1)$$

$$\text{s.t.} \quad m \leq \mu \quad (2)$$

- Maximize expected return on storage and investment
- Restriction: Need an entrepreneur to evaluate

First-best solution

$$p^*_{fb} = \frac{r}{R} \tag{3}$$

$$m_{fb} = \begin{cases} \mu & \text{if } (1 - H(p^*_{fb}))(\hat{p}_{fb}R - r) - e > 0 \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

General description

- Assume $w_i < 1$ for most individuals
  - Most likely entrepreneurs need external financing
- Competitive intermediaries waste no resources in operation
- Want to find optimal credit contract

The arrangement

- The entrepreneur
  - Signs a contract with intermediary at start of t_1
  - Evaluates project, finds p
  - If he takes project, receives loan from intermediary
  - Otherwise, stores or lends endowment
- The intermediary
  - If entrepreneur takes project, lends $1 - w_i$
  - Obtains (contingent) payment from entrepreneur in t_2

The arrangement

Table: Entrepreneur's transfers (to intermediary) and profits

	Transfers	Profits
Takes project: Success	Z_s	$R - Z_s$
Takes project: Failure	Z_u	$-Z_u$
Declines project	Z_0	$rw - Z_0$

The arrangement

The intermediary:

- Has opportunity cost r
- Can distinguish all contingencies
- Cannot observe *everything*
  - Cannot see project's quality (p)
  - Cannot tell whether entrepreneur evaluated project

Assumptions

- Assume the individual's type is not observable
- Assume evaluation is profitable
  - Can find parameters where expected profits are greater than rw

The optimal contract

The optimal contract solves

$$\max_{Z_s, Z_u, Z_0} \quad [(1 - H(p^*))\hat{p}R + H(p^*)rw - e] - [(1 - H(p^*))(\hat{p}Z_s + (1 - \hat{p})Z_u) + H(p^*)Z_0] \quad (5)$$

The optimal contract

Subject to

$$(1 - H(p^*))(\hat{p}Z_s + (1 - \hat{p})Z_u) + H(p^*)Z_0 \geq (1 - H(p^*))r(1 - w) \quad (6)$$

$$p^*(Z_s, Z_u, Z_0) = \arg\max\{[1 - H(p^*))\hat{p}R + H(p^*)rw - e] - [(1 - H(p^*))(\hat{p}Z_s + (1 - \hat{p})Z_u) + H(p^*)Z_0]\} \quad (7)$$

$$Z_0 \geq 0 \quad (8)$$

The optimal contract

- Equation (7) is an IC constraint
  - Entrepreneur chooses p^* that maximizes his utility
- Differentiate wrt p^* to get

$$rw - Z_0 = p^*(R - Z_s) - (1 - p^*)Z_u \tag{9}$$

- The second-order condition of (9) is

$$R - Z_s \geq -Z_u \tag{10}$$

- Will use (9) and (10) to substitute for (7)

The optimal contract

Lemma (1)

If expected profits are nonnegative, equation (10) is nonbinding, so

$$R - Z_s > -Z_u;$$

also, equation (6) binds:

$$(1 - H(p^*))(\hat{p}Z_s + (1 - \hat{p})Z_u) + H(p^*)Z_0 = (1 - H(p^*))r(1 - w)$$

The optimal contract

- The *limited liability* constraints are

$$0 \geq Z_u \tag{11}$$
$$rw \geq Z_0 \tag{12}$$

- Equation (12) never binds
  - Suppose it does
  - By (9) – (11), $p^* = 0$
  - Expected profits are negative, which is suboptimal

Characterizing the optimal contract

Proposition (1)

If $w \geq 1$ *then* $p^* = r/R = p^*_{fb}$.

- A 100% stake gives incentives to maximize expected profits
- Clearly $p^* = p^*_{fb}$

Characterizing the optimal contract

Proposition (2)

If $w < 1$

1. *In the optimal contract,*

$$Z_s = \frac{r(1-w)}{\hat{p}}, \quad Z_u = 0, \quad Z_0 = 0$$

2. $p^* < p^*_{fb} = r/R$
3. $\partial p^* / \partial w > 0$

Characterizing the optimal contract

- If $w < 1$ individual borrows, so agency problems appear
- Entrepreneur has incentive to take projects with $p^* < r/R$
- Higher w increases opportunity cost of proceeding:
  - Entrepreneur is more selective
  - Expected project surplus increases
- Inverse relation between borrower net worth and agency costs

Characterizing the optimal contract

- Intermediary would like to
  - Reward selective entrepreneurs ($rw - Z_0$ large)
  - Punish careless entrepreneurs (Z_u large)
- IC and limited liability require $Z_u = Z_0 = 0$

Characterizing the optimal contract

- Contract is a "credit line"
  - Entrepreneur draws funds as needed
  - Repays if successful
- Individual completely endures agency cost of financing
  - As $\partial p^* / \partial w > 0$, intermediary asks for higher Z_s

Entrepreneur's utility and internal funds premium

- Individual's maximized expected utility is given by

$$V = (1 - H(p^*))(\hat{p}R - r) + rw - e$$

- If $w < 1$ then $r > p^* R$ and $\partial p^* / \partial w > 0$, so

$$\frac{\partial V}{\partial w} = \left[(r - p^* R) \frac{\partial p^*}{\partial w} + r \right] > r$$

- Expected return to internal funds ($\partial V / \partial w$) exceeds expected return to external funds (r)

Entrepreneur's utility and internal funds premium

Proposition (3)

1. *There is a* $w_\ell > 0$ *such that the entrepreneur does not evaluate if* $w < w_\ell$
2. w_ℓ *and* p_ℓ^* *satisfy*

$$p_\ell^* R - r\left[w_\ell + \left(\frac{p_\ell^*}{\hat{p}_\ell}\right)(1 - w_\ell)\right] = 0 \quad (13)$$

$$(1 - H(p^*))(\hat{p}_\ell R - r) - e = 0 \quad (14)$$

Entrepreneur's utility and internal funds premium

- If borrower net worth is low enough, agency costs are large
- There is no contract for which evaluation is profitable

Description of equilibrium

Given a pair (r, R)

- Market riskless rate is r
  - Follows as storage is positive in equilibrium
- Entrepreneurs solve (5) and
  - Entrepreneurs with $w \geq w_\ell$ evaluate
  - Entrepreneurs with $w < w_\ell$ become lenders
- Individuals with $p < p^*(w)$ become lenders (or store)
  - Nonentrepreneurs lend to intermediaries

Output and welfare

Welfare depends on distribution and level of w

- $F(w)$ c.d.f, $f(w)$ p.d.f. of initial endowment of entrepreneurs
- Output q is given by

$$\begin{aligned} q &= r\bar{w} + \mu \int_{w_\ell}^{1} [1 - H(p^*(w))] (\hat{p}(w)R - r) f(w) dw \\ &\quad + \mu(1 - F(1))(1 - H(p^*_{fb}))(\hat{p}_{fb}R - r) \qquad (15) \\ &< r\bar{w} + \mu(1 - H(p^*))(\hat{p}_{fb}R - r) \\ &= q_{fb} \end{aligned}$$

Output and welfare

- Welfare also depends on distribution and level of w
- Per capita welfare v is given by

$$\begin{aligned} v &= q - me \\ &< q_{fb} - \mu e \\ &= v_{fb} \end{aligned} \tag{16}$$

- The number of evaluated projects, m, is

$$m = \mu(1 - F(w_\ell)) < \mu \tag{17}$$

Output and welfare

v and q are less than v_{fb} and q_{fb} since

1. Not all entrepreneurs evaluate $(m < \mu)$ as "poor" entrepreneurs with $w < w_\ell$ drop off the market
2. "Middle-class" entrepreneurs produce a lower surplus compared to first-best, given their lower p^*

Financial fragility

- If many entrepreneurs have low wealth (relative to project size), we have *financial fragility*
  - Potential borrowers are not creditworthy
  - Agency costs are too high
  - Fundamentals are good; investment and average return are low
- Full investment collapse possible if $w < w_\ell$ for everybody

Observable types

- Assume intermediary can distinguish among types
- IC constraint is loosened since
  - Intermediary can make payments to entrepreneurs that evaluate but decline
  - No risk of nonentrepreneurs pretending to be entrepreneurs
- Z_0 can be negative

IC constraint

The IC constraint is now given by

$$\begin{aligned} &[(1-H(p^*))\hat{p}R + H(p^*)rw - e] \\ -&[(1-H(p^*))(\hat{p}Z_s + (1-\hat{p})Z_u) + H(p^*)Z_0] \\ &\geq rw - Z_0 \end{aligned} \tag{18}$$

IC constraint

Since (6) always binds (Lemma 1), add (6) and (18) to get

$$(1 - H(p^*))(\hat{p}R - r) - e \geq -Z_0 \tag{19}$$

Transfers may be positive but are bounded

Optimal contract

- Intermediary can set Z_u at maximum and Z_0 at minimum
- Can show that

$$Z_u = 0, \quad Z_0 = -\left[(1 - H(p^*))(\hat{p}R - r) - e\right] < 0 \qquad (20)$$

- Optimal p^* is defined implicitly by

$$p^* R - r\left[w + \left(\frac{p^*}{\hat{p}}\right)(1 - w)\right] = \phi(p^*), \quad \phi(p^*) > 0 \qquad (21)$$

- If multiple values of p^* solve (21), optimum is largest value

Optimal contract

Proposition (4)

If borrower types are observable

1. *There is a* $w_u < 1$ *such that if* $w > w_u$*, then* $p^* = r/R$
2. *If* $w < w_u$*, then* $p^* < r/R$ *and* $\partial p^*/\partial w > 0$
3. *There may exist a* $w > 0$ *below which no one evaluates projects*
   - *If it exists, then its value is less than or equal to* w_ℓ

Optimal contract

- Contract is more efficient: Can achieve first-best with $w < 1$
- If there is a w at which investment collapses, then $w \leq w_\ell$
- Qualitatively, outcome is similar: Investment may still collapse
- Unless external finance is small ($w > w_u$), this contract cannot eliminate financial fragility

Policy implications

- All derived market equilibria are Pareto optimal
- Even with financial fragility, no unanimous policy can be supported
- Policy intervention *can* increase welfare, returns, and output

Non-observable types

Optimal policy: Tax successful investment projects and distribute proceeds among nonentrepreneurs

- Solves problem: Too many evaluated projects
- Tax on successful projects makes entrepreneurs more selective
- Tax may reduce the (already) small number of evaluations
- Final effect is ambiguous

Observable types

Planner can *always* achieve first-best via lump-sum taxation

- Tax nonentrepreneurs
- Distribute proceeds among entrepreneurs so $w > w_u$ for all

Observable types: Policy

- Policy may be interpreted as *debtor bailout*
  - Attacks source of problems: Low borrower net worth
- Example: Roosevelt's financial rehabilitation in New Deal
  - Target: Debt burden of farmers, businesses, banks ...
  - Policy normalized credit markets
  - Outcome: Increased output and investment

Final remarks

- Model is not without flaws
- No dynamics: Cannot capture moral hazard from bailouts
  - Incentive for excessive risk-taking
  - Borrowers behave inefficiently
- Solution: Bailout policy only under aggregate shocks ...

Final remarks

- Can we distinguish aggregate and idiosyncratic shocks?
  - If large borrower fails, bailout policy is preferred to no bailout
  - Example of time-inconsistent policy
- Solutions:
  - "Bail out the institution but not the management"
  - Don't bail out the institution: Protect rest of borrowers

Our remarks

- How is this related to the current situation?
  - Sub-prime mortgage problems
  - Net worth of financial institutions is low
  - Fundamentals are good, investment and average return are low
- Is this an aggregate or idiosyncratic shock?
- Is Fed policy standing up to the paper's recommendations?
  - Resource injections in August 2007: Increase net worth?
  - Interest rate going down: Reduce opportunity cost?