Advanced Corporate Finance

FBE 631a

Giorgia Piacentino

PRESENTATIONS

1. Maturity Rat Race

   Brunnermeier and Oehmke, JF 2013

2. Sequential Banking

   Bizer and DeMarzo, JPE 1992

3. Banks as Liquidity Providers: An Explanation for the Coexistence of Lending and Deposit-Taking

   Kashyap, Rajan, and Stein, JF 02

4. The Effect of Credit Market Competition on Lending Relationships

   Petersen and Rajan, QJE 1995

5. The Leverage Ratchet Effect

   Admati, DeMarzo, Hellwig, and Pfleiderer, JF 2018

6. Competition in Loan Contracts

   Parlour and Rajan, AER 2001

7. Rollover Risk and Credit Risk

   He and Xiong, JF 2012

LECTURE 4: DEMANDABLE DEBT

WHY DO BANKS USE DEMANDABLE DEBT?

Demand-deposit contract seems to be not ideal in Diamond-Dybvig

- Markets seem to achieve FB

But we observe banks issuing demandable debt

So, why are bank loans financed by deposits?

Do we have a theory of banking and demandable debt?

- Calomiris–Kahn 91, Diamond–Rajan 01, Donaldson-Piacentino 21

TODAY'S QUESTION

Why do banks fund themselves with demandable debt?

Demandable debt increases debt capacity

It disciplines: Diamond–Rajan 01

It preempts: Calomiris–Kahn 91

It increases secondary market prices: Donaldson–Piacentino 21

DIAMOND–RAJAN 01

DIAMOND–RAJAN 01: IN A NUTSHELL

Entrepreneurs have projects but can't commit to operate them

- So entrepreneurs' projects are illiquid

Banks can reduce illiquidity of loans

- They can operate projects but also cannot commit

Bank can commit by borrowing with demand deposits

- If bank threatens not to operate the project, depositors run
- This reduces bank's rent, so it doesn't want to do it

MODEL

Two dates: $t = 0, 1$

Three types of risk-neutral players:

- Entrepreneur
- Consumer (depositor)
- Specialist (bank)

Storage technology pays 1 at $t = 1$ if invest 1 at $t = 0$

ENTREPRENEUR

Has zero personal wealth

Has one project that costs I at $t = 0$

The project pays off:

- Y if the entrepreneur operates it (first-best user)
- Project can be liquidated early

LENDERS

Consumer

Has positive endowment

Cannot operate the project

Can liquidate it for βX, where $\beta \in (0,1)$ (third-best user)

Specialist

Has no endowment so has to borrow from consumer

Specialist can operate project

Can liquidate it for $X < Y$ (second-best user)

TWO POTENTIAL AGENCY PROBLEMS

<u>Limited commitment of entrepreneur</u>

Entrepreneur can't commit to operate project

This leads to hold-up problem between entrepreneur and lender

<u>Limited commitment of specialist</u>

The specialist cant commit to operate project

So there is a hold-up between him and his own creditor

TIMING

$\underline{t=0}$: Entrepreneur borrows from specialist

Specialist borrows from consumer

$\underline{t=1}$: Entrepreneur makes specialist take-it-or-leave-it offer P_1

If specialist accepts, he gets P_1

If he rejects, he seizes the project and gets liquidation value

Specialist makes consumer take-it-or-leave-it offer P_2

If consumer accepts, he gets P_2

If he rejects, he seizes the project and gets liquidation value

RESULTS

BENCHMARK: ONE CONSUMER

BENCHMARK: ONE CONSUMER

Entrepreneur cannot borrow more than βX

A larger amount is not *renegotiation proof*

In fact there are two possible arrangements:

1. Entrepreneur borrows directly from consumer a max of βX
2. Entrepreneur borrows via a specialist/bank

    In theory he could borrow X from bank

    But bank cannot borrow more than βX from consumer

    Because it would renegotiate it down to βX

RESULT 1: MULTIPLE CONSUMERS

MULTIPLE CONSUMERS

Suppose that there are multiple consumers/depositors

Suppose that bank funds itself with demand-deposit structure

- It satisfies sequential service constraint

Then it can *commit* to repay X

- Any attempt to renegotiate down repayment would trigger "run"

BANK RUN DISCIPLINES

Suppose that bank raises X with deposit contract from 2 guys

This contract gives the right to withdraw $d/2 = X/2$ at any t

- As long as bank has assets left

Early withdrawal leads consumer to seize and liquidate project

- Guys who withdrawal get randomly assigned place in queue
- The guy who arrives first can seize assets until gets $d/2$
- The guy who arrives second gets what's left $\beta X - d/2$

BANK RUN DISCIPLINES

If bank tries to renegotiate by reducing repayment by ε

Leaves 2 depositors facing following game:

	Withdraw	$\neg$ Withdraw
Withdraw	$\frac{\beta X}{2}, \quad \frac{\beta X}{2}$	$\frac{d}{2}, \quad \beta X - \frac{d}{2}$
$\neg$ Withdraw	$\beta X - \frac{d}{2}, \quad \frac{d}{2}$	$\frac{d}{2} - \varepsilon, \quad \frac{d}{2} - \varepsilon$

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Liquidation is the equilibrium outcome of renegotiation

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Liquidation is the equilibrium outcome of renegotiation

NB: If $\varepsilon = 0$, there are two equilibria; withdrawing is weakly dominant

DIAMOND–RAJAN: TAKE-AWAY

Fragility allows bank to borrow against full value of loan

Demandable debt expands debt capacity

So can lend without demanding premium for illiquidity

<u>Financial fragility allows liquidity creation</u>

DIAMOND–RAJAN: COMMENTS

In eq. $\varepsilon = 0$ and two equilibria; withdrawing is weakly dominant

Here markets cannot achieve what banks achieve

Banks have expertise that consumers don't have

Is this about banks?

Why doesn't entrepreneur offer demand deposit?

Is the "run" similar to the Diamond–Dybvig run?

What happens with deposit insurance?

CALOMIRIS-KAHN 91

CALOMIRIS-KAHN 91 IN A NUTSHELL

Demandable debt seems inferior to equity

But they show it has an advantage

- Allows depositors to “vote with their feet”
- So they have incentive to monitor the banker

MODEL

PLAYERS

Penniless risk-neutral banker B

Deep-pocketed risk-neutral competitive depositor D

SIMPLIFIED MODEL

TIMING

$t = 0$: B borrows \$1 from D with promise to repay P and invests

$t = 1/2$: Perfect signal of B's investment

$t = 1$: D can liquidate investment, destroying proportion L of payoff

Call M max that can be paid to depositor in liquidation

$t = 2$: If not liquidated, it pays off V_G w.p. γ and $V_B < V_G$ w.p. $1 - \gamma$

B can abscond with $(1 - A)V_i$, destroying proportion A

DEPOSITOR

Has \$1, which if invested in the market yields S

If he deposits \$1 to B, his promised repayment is:

P at $t = 2$ if B doesn't abscond

0 at $t = 2$ if B absconds

M at $t = 1$ if liquidation

By paying I, D receives signal σ at $t = 1/2$:

$$\mathbb{P}[\sigma = g \,|\, V_G] = \mathbb{P}[\sigma = b \,|\, V_B] = 1$$

ASSUMPTIONS

What can be guaranteed to D in liquidating contract > than what can be guaranteed in non-liquidating contract

$$M > AV_B$$

Deadweight losses from liquidating are > than from absconding

$$L > A$$

POSSIBLE CONTRACTS

Simple debt (liquidating or non-liquidating)

- Repayments P

Contingent debt

- Repayments P_g, P_b contingent on the signal

Demandable debt

- Repayments P_g, P_b contingent on the signal
- Option to liquidate

PROPOSITION

If signal is sufficiently cheap

For $S \leq AV_B$ simple safe debt is optimal

For $S \in (AV_B, S^*]$ contingent debt is optimal

For $S \in (S^*, \hat{S}]$ demandable debt optimal

OPTIMALITY OF SAFE SIMPLE DEBT: PROOF

B always prefers to repay than abscond if

$$(1 - A)V_B \leq V_B - P \iff P \leq AV_B$$

D's break-even condition is

$$S = P$$

D's maximum expected repayment is

$$AV_B$$

So, if $S \leq AV_B$ borrowing with simple debt optimal

No liquidation, not abscondance, no cost to acquire signal

B chooses it because it implements FB and he gets rents

If $S > AV_B$, can't borrow w/ simple debt; what about contingent?

OPTIMALITY OF CONTINGENT DEBT: PROOF

B always prefers to repay than abscond if

$$(1-A)V_i \leq V_i - P_\sigma \implies P_\sigma \leq AV_i$$

D's break-even condition is

$$S = \gamma P_g + (1-\gamma)P_b$$

D's maximum expected repayment is

$$S^* = \gamma AV_g + (1-\gamma)AV_b$$

So, if $S \leq S^*$ contingent debt is optimal

No liquidation, not abscondance; cheap to acquire info

But if $S > S^*$ need to increase P_σ and B absconds sometimes

DEMANDABLE DEBT: D LIQUIDATES IF $\sigma = b$

If $\sigma = g$, D does not liquidate

If $\sigma = b$, D liquidates

OPTIMALITY OF DEMANDABLE DEBT: PROOF

If $P_b > AV_B$: B absconds when $V_i = V_B$

But D observes $\sigma = b$, can liquidate and get $M > AV_B$

D's break-even condition is

$$S = \gamma P + (1 - \gamma)M$$

D's maximum expected repayment is

$$\hat{S} = \gamma AV_G + (1 - \gamma)M$$

CALOMIRIS–KAHN: TAKE-AWAY

Giving D option to redeem increases debt capacity: $\hat{S} > S^*$

- Allowing for efficient investment

- Even though it induces inefficient liquidation on equilibrium path

Contingent contract is ex post more efficient

- But it does not allow for efficient investment

FULL MODEL: IMPERFECT SIGNAL

FULL MODEL: IMPERFECT SIGNAL

Everything the same as above, but signal is imperfect

By paying I, D receives signal σ at $t = 1/2$:

$$\mathbb{P}[\sigma = g \,|\, V_G] = \mathbb{P}[\sigma = b \,|\, V_B] = \rho > 1/2$$

POSSIBLE CONTRACTS

Simple contract (liquidating or non-liquidating)

"Nuisance" contract:

Repayments P_g, P_b can be contingent on the signal

Demandable-debt contract:

Repayments P_g, P_b can be contingent on the signal

Option to liquidate

If feasible, nuisance contract dominates demandable debt contract

PROPOSITION

If the signal is sufficiently cheap and accurate then

For $S \leq AV_B$ simple non-liquidating contract is optimal

For $S \in (AV_B, S^*]$ the "nuisance contract" is optimal

For $S \in (S^*, \hat{S}]$ the demandable debt contract is optimal

OPTIMALITY OF SIMPLE DEBT: PROOF

B always prefers to repay than abscond if

$$(1-A)V_B \leq V_B - P \implies P \leq AV_B$$

Debt is risk free and D's break-even condition: $S = P$

And D does not invest in learning the signal

So, if $S \leq AV_B$ can borrow with simple debt

But if $S > AV_B$ can't

OPTIMALITY OF NUISANCE CONTRACT: PROOF

Suppose $\sigma = g$ and $V_i = V_G$, B prefers not to abscond if

$$(1 - A)V_G \leq V_G - P_g \implies P_g \leq AV_G$$

Suppose $\sigma = g$ and $V_i = V_B$, B prefers to abscond if

$$(1 - A)V_B > V_B - P_g \implies P_g > AV_B$$

Suppose $\sigma = b$ and $V_i = V_B$, B prefers not to abscond if

$$(1 - A)V_B \leq V_B - P_b \implies P_b \leq AV_B$$

OPTIMALITY OF NUISANCE CONTRACT: PROOF

Given P_b is low, B doesn't abscond and D doesn't liquidate

Ds' break-even condition is

$$S = \gamma\rho P_g + \gamma(1-\rho)P_b + (1-\gamma)(1-\rho)\cdot 0 + (1-\gamma)\rho P_b$$

or

$$S = \gamma\rho P_g + \Big(\gamma(1-\rho) + (1-\gamma)\rho\Big)P_b$$

Ds' maximum expected repayment is

$$S^* = \gamma\rho AV_G + \Big(\gamma(1-\rho) + (1-\gamma)\rho\Big)AV_B$$

If $S > S^*$, then cannot borrow with nuisance contract

OPTIMALITY OF DEMANDABLE DEBT: PROOF

Suppose $\sigma = g$ and $V_i = V_G$, B prefers not to abscond if

$$(1 - AV_G) \leq V_G - P_g \implies P_g \leq AV_G$$

Suppose $\sigma = b$ and $V_i = V_G$, B prefers not to abscond if

$$(1 - AV_G) \leq V_G - P_b \implies P_b \leq AV_G$$

Suppose $\sigma = g$ and $V_i = V_B$, B prefers to abscond if

$$(1 - AV_B) \leq V_B - P_g \implies P_g > AV_B$$

Suppose $\sigma = b$ and $V_i = V_B$, B prefers to abscond if

$$(1 - AV_B) > V_B - P_b \implies P_b > AV_B$$

DEMANDABLE DEBT: D LIQUIDATES IF $\sigma = b$

If $\sigma = g$, D does not liquidate

If $\sigma = b$, D liquidates

OPTIMALITY OF DEMANDABLE DEBT: PROOF

Given P_b is high, B likely to abscond, so D liquidates

Ds' break-even condition is

$$S = \gamma\rho P_g + \gamma(1-\rho)M + (1-\gamma)(1-\rho)\cdot 0 + (1-\gamma)\rho M$$

Ds' maximum repayment is

$$\hat{S} = \gamma\rho A V_G + \Big(\gamma(1-\rho) + (1-\gamma)\rho\Big)M$$

DONALDSON–PIACENTINO 21

DONALDSON–PIACENTINO 21

What is a bank?

- Makes loans
- Takes deposits
- Creates "money" (BoE estimates 97% of money)

Bank debt is something you use to make payments

Bank debt is financial security banks use to raise funds

- Banks choose to make it redeemable on demand

DONALDSON–PIACENTINO 21 IN A NUTSHELL

Banks *must* raise funds with demandable debt

- Increases *secondary market price* of debt, increasing debt capacity
- If I know I can trade debt at high price, willing to lend more

Banks necessarily expose themselves to a new type of run—money run

New rationale for demandable debt, runs, banking

- Endogenous pooling, maturity/liq. transformation, fragility

MODEL OVERVIEW

Discrete time infinite horizon $t \in \{0, 1, 2, ...\}$, no discounting

Two types risk-neutral players: borrower B, creditors C_0, C_1, ...

B has investment, creditors have wealth

Assumption 1: Horizon mismatch

Creditors may need liquidity before investment payoff

Assumption 2: Decentralized trade

Bank debt traded bilaterally OTC in secondary market

BORROWER AND CREDITORS

Borrower B is penniless but has a positive NPV investment

Costs c and pays off y at random maturity, arrival rate ρ

$$\text{NPV} = y - c > 0$$

Can be liquidated early for $\ell < c/2$

Creditors C_0, C_1,...

Deep-pocketed

Liquidity shock at random time, arrival rate θ

BORROWING INSTRUMENTS

B borrows c via debt with face value $R \leq y$ at maturity

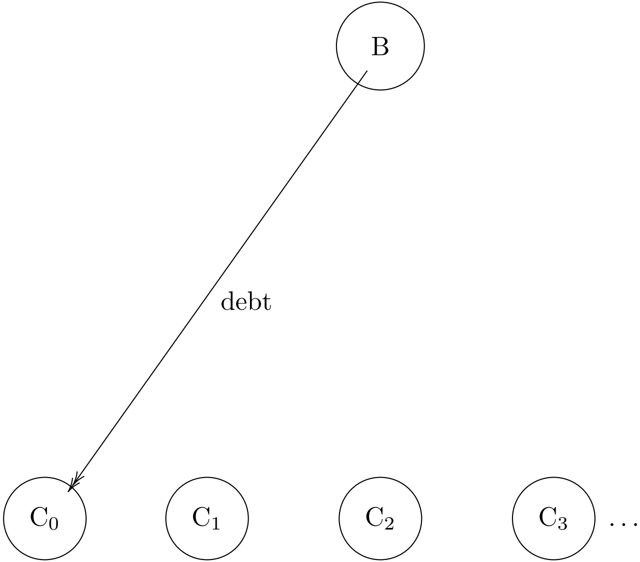
Long term or demandable

Tradeable or non-tradeable

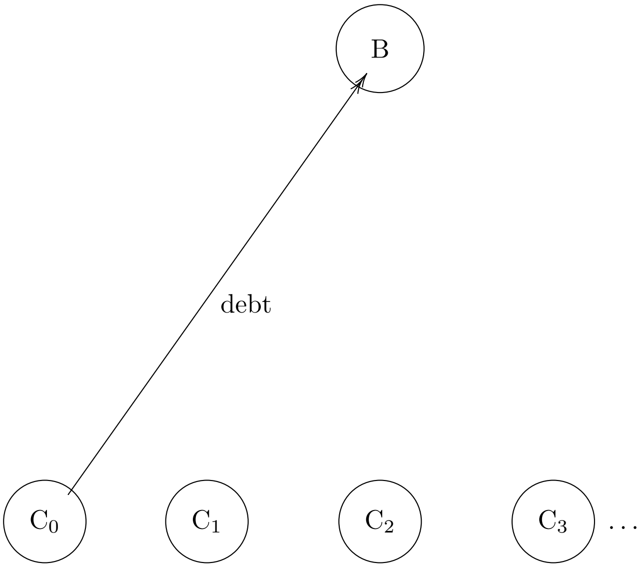
v_t denotes value of debt to not-shocked creditor

p_t denotes its secondary market price

DEMANDABLE DEBT



DEMANDABLE DEBT



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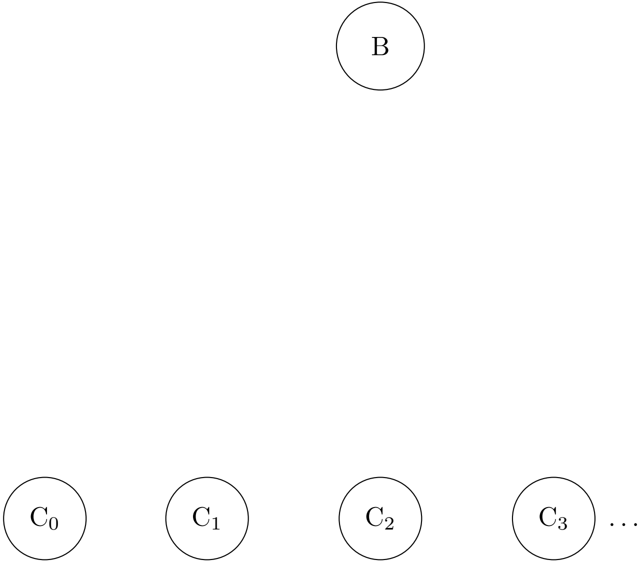

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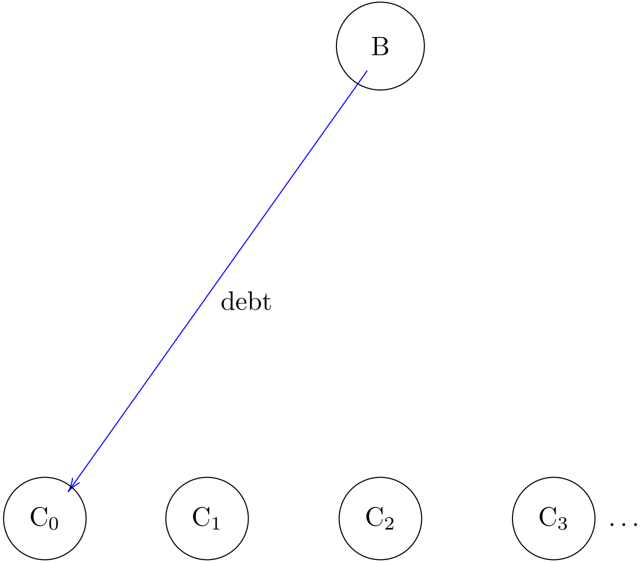

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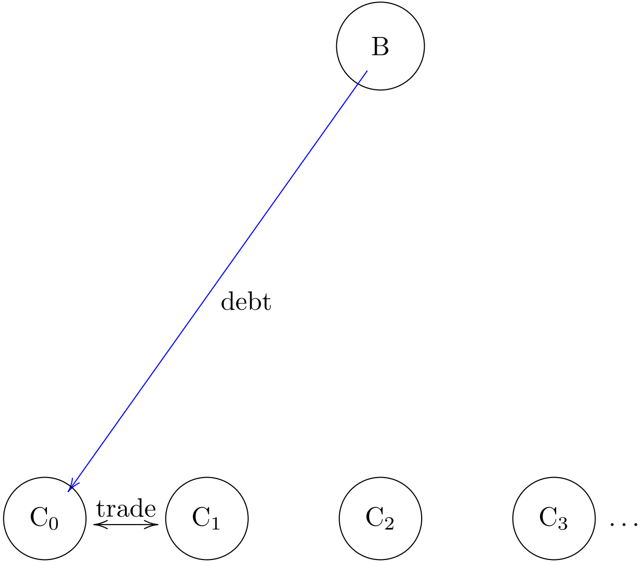

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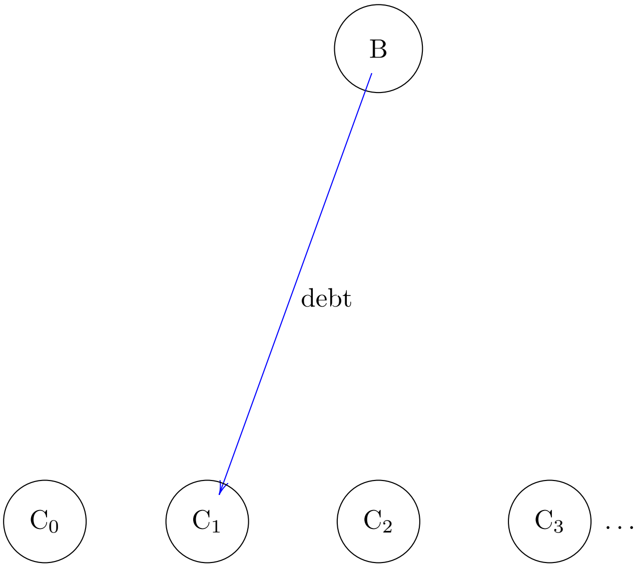

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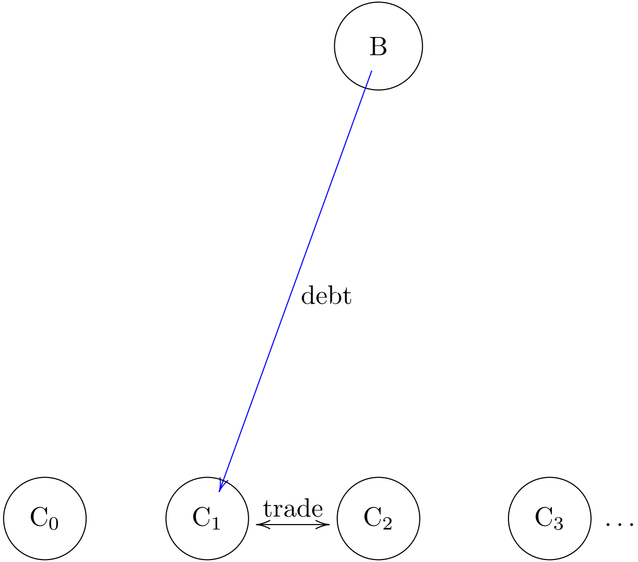

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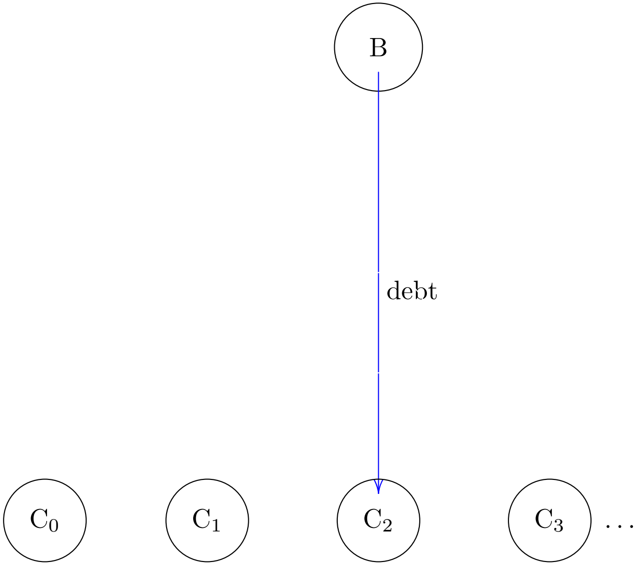

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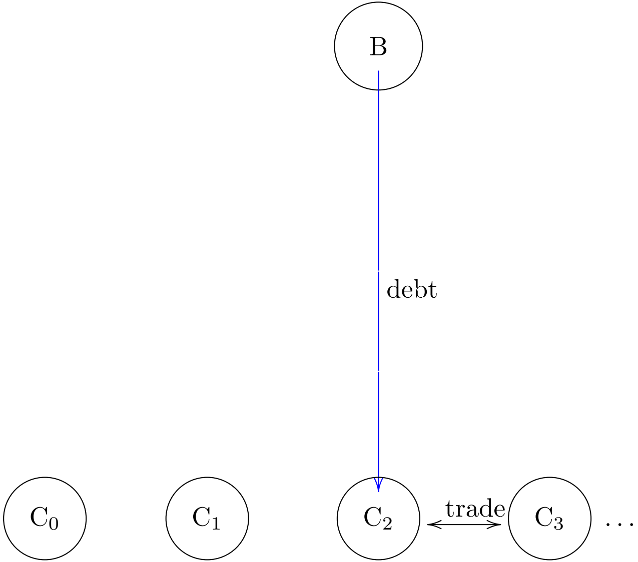

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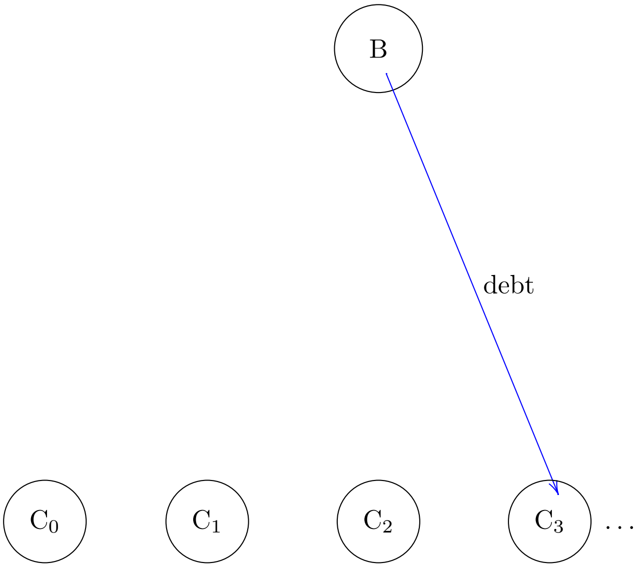

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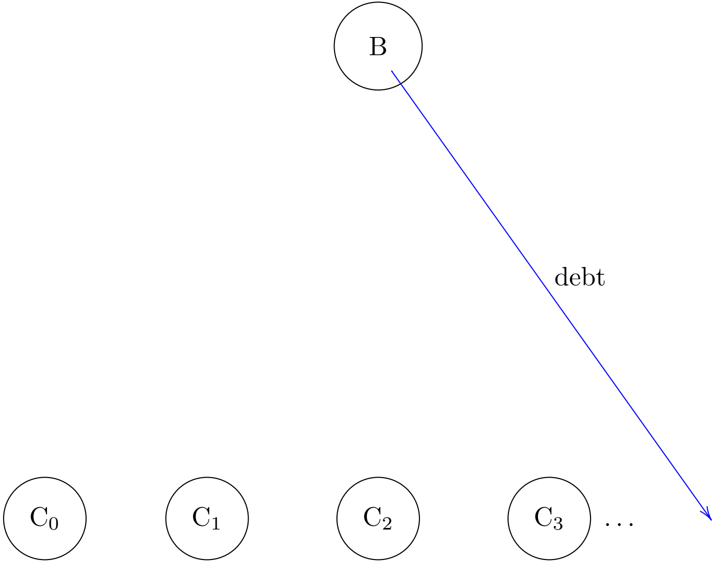


TIMELINE

Date 0

B borrows from C_0 and invests or does not

Date $t > 0$: if B's investment pays off

B repays R

Date $t > 0$: if B's investment does not pay off

Secondary debt market entry, bargaining, settlement

TRADEABILITY AND DEMANDABILITY

Entry	Bargaining	Settlement
Counterparty C_t can enter at cost k	Debtholder and C_t determine price p_t 50-50 Nash bargaining	Debt traded or demanded

Date t Date $t+1$

EQUILIBRIUM CONCEPT

Subgame perfect equilibrium

At Date 0, C_0 lends to B or does not

At Date $t > 0$, C_t enters with probability σ_t

σ_t is C_t's best response to others' strategies $\sigma_{\neg t}$

R and p_t outcomes of Nash bargaining

(Assume wlog C_t can enter iff debtholder has liquidity shock)

Focus on stationary equilibria: $\sigma_t = \sigma$ for all t

$\sigma = 1$ is circulating debt; $\sigma = 0$ is non-circulating debt

POSSIBLE INSTRUMENTS

	long-term	demandable
non-tradeable	"loan"	"puttable loan"
tradeable	"bond"	"banknote"

WHICH INSTRUMENT WILL B CHOOSE?

B chooses instrument to maximize payoff

s.t. borrowing constraint $v_0 \geq c$

Let's compute v_0 for each instrument in turn

NON-TRADEABLE INSTRUMENTS: VALUES

Value v of loan solves

$$v = \rho R + (1-\rho)\left(\theta \times 0 + (1-\theta)v\right)$$

So

$$v = \frac{\rho R}{\rho + (1-\rho)\theta}$$

Value v of puttable loan solves

$$v = \rho R + (1-\rho)\left(\theta \ell + (1-\theta)v\right)$$

So

$$v = \frac{\rho R + (1-\rho)\theta\ell}{\rho + (1-\rho)\theta}$$

TRADEABLE INSTRUMENTS: PRICES

Bond/Banknote traded OTC, price p_t from 50-50 Nash bargaining

Debtholder bargains with C_t to get

$$p_t = \text{ outside option } + \frac{1}{2} \times \text{ gains from trade}$$

<u>Bond</u>: outside option zero (not demandable), gains from trade v_t

Thus $p_t = v_t/2$

<u>Banknote</u>: outside option ℓ (demandable), gains from trade $v_t - \ell$

Thus $p_t = \ell + \frac{1}{2}\big(v_t - \ell\big) = \dfrac{v_t + \ell}{2}$

TRADEABLE INSTRUMENTS: VALUES

Value v of bond solves

$$v = \rho R + (1-\rho)\Bigg(\theta\Big(\sigma p + (1-\sigma)\times 0\Big) + (1-\theta)v\Bigg)$$

So

$$v = \frac{\rho R}{\rho + (1-\rho)\theta(1-\sigma/2)}$$

Value v of banknote solves

$$v = \rho R + (1-\rho)\Bigg(\theta\Big(\sigma p + (1-\sigma)\ell\Big) + (1-\theta)v\Bigg)$$

So

$$v = \frac{\rho R + (1-\rho)\theta(1-\sigma/2)\ell}{\rho + (1-\rho)\theta(1-\sigma/2)}$$

INSTRUMENT VALUES

	long-term	demandable
non-tradeable	$v_{\text{loan}} = \dfrac{\rho R}{\rho + (1-\rho)\theta}$	$v_{\text{putt.}} = \dfrac{\rho R + (1-\rho)\theta\ell}{\rho + (1-\rho)\theta}$
tradeable	$v_{\text{bond}} = \dfrac{\rho R}{\rho + (1-\rho)\theta\big(1-\frac{\sigma}{2}\big)}$	$v_{\text{note}} = \dfrac{\rho R + (1-\rho)\theta\big(1-\frac{\sigma}{2}\big)\ell}{\rho + (1-\rho)\theta\big(1-\frac{\sigma}{2}\big)}$

R and σ endogenous, cannot compare values directly

But can compare debt capacities, $v\big|_{R=y,\sigma=1} =: \text{DC}$

INSTRUMENT DEBT CAPACITIES, DC $:= v\Big|_{R=y,\sigma=1}$

	long-term	demandable
non-tradeable	$\mathrm{DC}_{\mathrm{loan}} = \dfrac{\rho y}{\rho + (1-\rho)\theta}$	$\mathrm{DC}_{\mathrm{putt.}} = \dfrac{\rho y + (1-\rho)\theta\ell}{\rho + (1-\rho)\theta}$
tradeable	$\mathrm{DC}_{\mathrm{bond}} = \dfrac{\rho y}{\rho + (1-\rho)\theta/2}$	$\mathrm{DC}_{\mathrm{note}} = \dfrac{\rho y + (1-\rho)\theta\ell/2}{\rho + (1-\rho)\theta/2}$

B can borrow only if debt capacity exceeds cost, DC $\geq c$

BRIGHT SIDE OF DEMANDABLE DEBT

If ℓ not too small and horizon mismatch severe, i.e.

$$\frac{1}{\rho} > \frac{1}{\theta} \cdot \frac{2\big(y - c\big)}{c(1-\rho)} \qquad (\star)$$

B can borrow <u>only</u> with banknote

$$\mathrm{DC}_{\text{note}} > c > \mathrm{DC}_{\text{loan/putt./bond}}$$

Interpretation of $(\star)$: B does maturity transformation, so B is bank

NEW RATIONALE FOR DEMANDABLE DEBT

Demandable debt increases secondary market price

Improves bargaining position of debtholder

Demandable debt increases primary market price

Higher secondary price leads to higher primary price

Demandable debt increases B's debt capacity

DARK SIDE OF DEMANDABLE DEBT

If C_t doubts future liquidity, won't enter

Debtholder needs liquidity but can't trade in secondary market

Debtholder redeems note on demand, B must liquidate

Bank run—or money run

MONEY RUNS AS MULTIPLE EQUILIBRIA

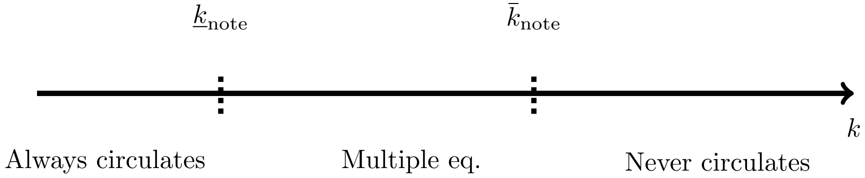
σ is best-response to σ for both $\sigma = 0$ and $\sigma = 1$

$$v - p \,\Big|_{\sigma=0} \;\leq\; k \;\leq\; v - p \,\Big|_{\sigma=1}$$

or

$$\frac{\rho(R-\ell)}{2\big(\rho + (1-\rho)\theta\big)} \;\leq\; k \;\leq\; \frac{\rho(R-\ell)}{2\rho + (1-\rho)\theta}$$

MULTIPLE EQUILIBRIA FOR $k \in [\,\underline{k}_{\text{note}}\,,\,\bar{k}_{\text{note}}\,]$



MONEY RUNS ARE NECESSARY EVIL

If $(\star)$, must borrow via demandable debt to fund investment

Necessarily exposed to money runs and inefficient liquidation

Contrasts with Diamond–Rajan where run exposure is good

DEMANDABILITY AND TRADEABILITY

Jacklin (1987) says demandability and tradeability are substitutes

You don't need option to demand debt if can trade it

Tradeable debt gets efficiency without risk of runs

We say demandability and tradeability are complements

Your option to demand debt increases the price you trade at

Need demandable debt for efficiency despite risk of runs

MONEY RUN VS. DIAMOND-DYBVIG RUN

Money run

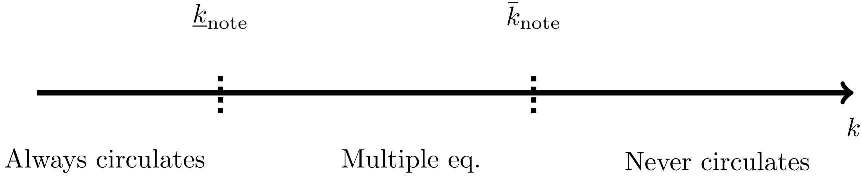
- Dynamic coordination problem in secondary market
- "Self-fulfilling liquidity dry-up" leads to redemption

Diamond-Dybvig run

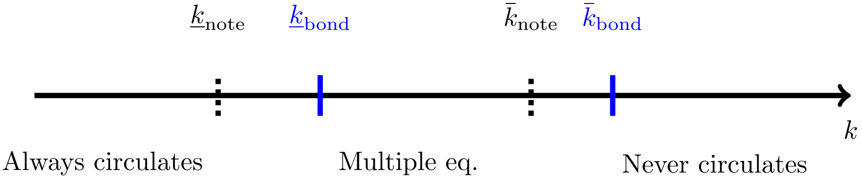
- Static coordination problem among depositors

OPTIMAL BOND BORROWING

BOND VS. BANKNOTE



BOND VS. BANKNOTE



For same face value R, bond circulates better than banknote

Since bond has lower p

BOND VS. BANKNOTE

For same face value R, bond circulates better than banknote

Since bond has lower p

Even with equilibrium R, bond circulates better than banknote

Since bond has higher R

BOND VS. BANKNOTE

Suppose $(\star)$ violated

If $k \in \left(\bar{k}_{\text{note}} \,, \bar{k}_{\text{bond}} \right]$: only bond feasible; banknote illiquid

If $k \leq \bar{k}_{\text{note}}$: bond socially optimal; liquid, not run-prone

BUT B MAY STILL CHOOSE BANKNOTE

For $k \leq \bar{k}_{\text{note}}$, B may choose banknote (inefficiently)

- If B borrows from C_0 via banknote, externality on C_1
- Weakens C_1's bargaining position, benefiting C_0 and B

Rent from C_1 can outweigh deadweight cost of runs (liquidation)

TWO SIDES OF DEMANDABILITY

Banknote makes Date-0 efficiency easier

C_0 pays c, since sells at high price later

But banknote makes Date-t efficiency harder

C_t won't pay k, since must buy at high price

Thing that allows B to fund itself is thing that exposes it to runs

INTERMEDIATION

WHAT IF DIRECT FINANCE IMPOSSIBLE?

So far, if ($\star$) and ℓ not too small, B raises c directly via banknote

B looks like a bank because it does maturity transformation

Now suppose ($\star$) and ℓ small

B cannot raise c directly, even via banknote

Bilateral finance impossible, but what about something else?

SUPPOSE $\mathrm{B}^1, ..., \mathrm{B}^N$ FORM BANK

N parallel, identical (perfectly correlated) versions of model

Borrowers $\mathrm{B}^1, ..., \mathrm{B}^N$, creditors $\mathrm{C}_t^1, ..., \mathrm{C}_t^N$ at each Date t

Borrowers $\mathrm{B}^1, ..., \mathrm{B}^N$ form a bank

Issue N banknotes, each backed by whole asset pool (not $1/N$ of it)

When notes circulate, no one redeems

If creditor deviates, he is only one redeeming, paid in full

Can set redemption value $r > \ell$ as long as creditors willing to enter

OPTIMAL $r = r^*$ MAKES ENTRY COND. BIND

$$\mathrm{C}_t^i\text{'s payoff } = v - p\Big|_{r=r^*} = k$$

which gives

$$r^* = R - \frac{2}{\rho}\Big(\rho + (1-\rho)\theta/2\Big)k$$

B'S BORROWING CONSTRAINT WITH $r = r^*$

$$c \leq \mathrm{DC}_{\text{note}}\Big|_{r=r^*} = y - \frac{(1-\rho)\theta}{\rho}k$$

or

$$c \leq \mathrm{PV} - \mathbb{E}[\,\text{entry costs}\,]$$

I.e. can <u>do all and only efficient investments if fund via banknotes</u>

But must set r so large that is very vulnerable to runs

LOOKS LIKE REAL-WORLD BANK

Maturity transformation: Borrows demandable, invests long-term

Liquidity transformation: Liquid liabilities, illiquid assets

Asset pooling: Reuse liquidation value w/o diversification

Dispersed creditors: each can redeem against same assets

Fragility: demandable debt fragile medium of exchange

DEMANDABLE DEBT FRAGILE STORE OF VALUE

With N creditors, there is a common pool problem

All creditors debt backed by the same assets

Money-creation rationale for why banks exposed to D–D runs