MONEY AND BANKING

Giorgia Piacentino

USC

WHAT IS A BANK?

To finance productive activities, banks:

- Take deposits
- Make loans, large share of which in the form of credit lines
- Create circulating liabilities = money

Banks are fragile

BANKS' LIABILITIES: DEPOSITS

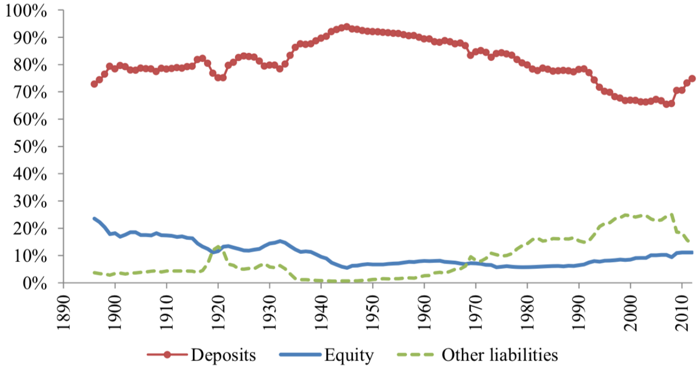


Figure: From Hansen, Shleifer, Stein, and Vishny (2015)

BANKS' ASSETS: LOANS

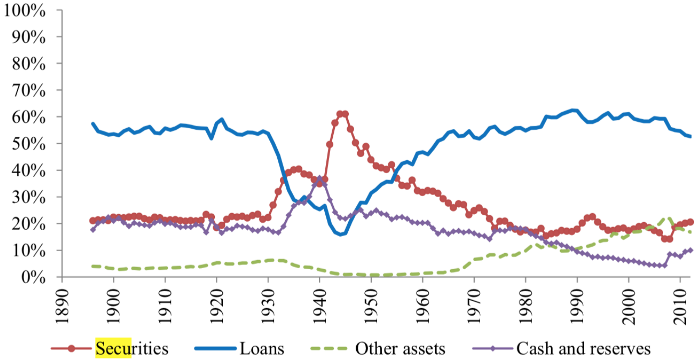


Figure: From Hansen, Shleifer, Stein, and Vishny (2015)

BANK RUNS

Figure: Run on American Union Bank in 1931

Laeven and Valencia (2018): 151 banking crises over 1970–2011

BANKS ARE SPECIAL

Banks hold a large proportion of wealth as deposits

- About 90% of U.S. households have deposit account

Banks make a large proportion of loans

- They do most of the consumer loans but also loans to businesses
- Loans to businesses bundled with credit lines (esp., for risky firms)

But we still struggle to say what a bank is or why it exists

QUESTIONS

1. Why do banks exist?

   Need theory where banks take deposits, make loans, create money

2. Why do banks issue demandable debt?

   Need theory where choose to issue contracts that exposes them to runs

3. Why are loans and credit lines (CLs) bundled together?

   Need theory where CLs used as a complement to term loans

PLAN

1. Warehouse Banking: Why do banks exist?
2. Money Runs: Why do banks issue demandable debt?
3. A New Theory of Credit Lines: Why bundle CLs with loans?

MOTIVATION

Banks take deposits, make loans, and create circulating liabilities

But we struggle to say what a bank is

To understand something go back to its origin....

Model consistent with facts and with origins of banking

WAREHOUSE BANKING

FACTS

The first banks evolved from ancient warehouses

Claims on deposited goods were used as means of payment

- I.e. warehouse receipts were early money

Warehouses made loans by printing new receipts

- I.e. not lending real deposited goods

"Warehousing" services are important for modern banks

- E.g., custody, deposit-taking, account-keeping

QUESTIONS

Why are warehousing and lending within the same institution?

How do banks that do warehousing and lending create liquidity?

THIS PAPER

Build a model based on the warehousing function of banks

Model is based on <u>two assumptions</u>

- Warehouses have an efficient storage technology
- Firms' output is not pledgeable

(No risk or asymmetric information)

RESULTS

Warehouses do the lending

Firms deposit in warehouses to access storage technology

Warehouses can seize firms' deposits

Circumvents non-pledgeability problem

Warehouses create liquidity when make loans

Not when they merely take in deposits

Loans are in "fake warehouse receipts"

Loans create deposits and not the other way around

REMINISCENT OF KEYNES (1931)

It is not unnatural to think of deposits of a bank as being created by the public through the deposits of cash

But the bulk of the deposits arise out of the action of the banks themselves

for by granting loans...a bank creates a credit in its books which is the equivalent of a deposit

NEW POLICY PRESCRIPTIONS

Our perspective in-line with history

But contrasts with most contemporary banking theory

Leads to new regulatory policy prescriptions

- Higher bank capital ratios increase liquidity
- "Tighter" monetary policy increases lending
- Liquidity requirements decrease liquidity, increase fragility

MODEL

MODEL OVERVIEW

Three dates: $t \in \{0, 1, 2\}$

Three types of risk-neutral player: farmers, laborers, warehouses

One good: "grain," a numeraire

Output is not pledgeable

Solution concept: Walrasian eq. s.t. IC from non-pledgeability

FARMERS

Endowment of grain e^f at Date 0

Short-term Leontief technology at Date 0

Takes grain investment i and labor ℓ with productivity $A > 2$

$$y = A \min\{\, i \,,\, \ell \,\}$$

Output is non-pledgeable

No labor, so must hire labor at Date 0

Consume at Date 2, so must save at Date 1

Storage technology lets grain depreciate at rate $\delta < 1/A$

LABORERS

No grain endowment, but labor at Date 0 at marginal cost one

Storage technology lets grain depreciate at rate δ

Consume at Date 2

WAREHOUSES

No endowment

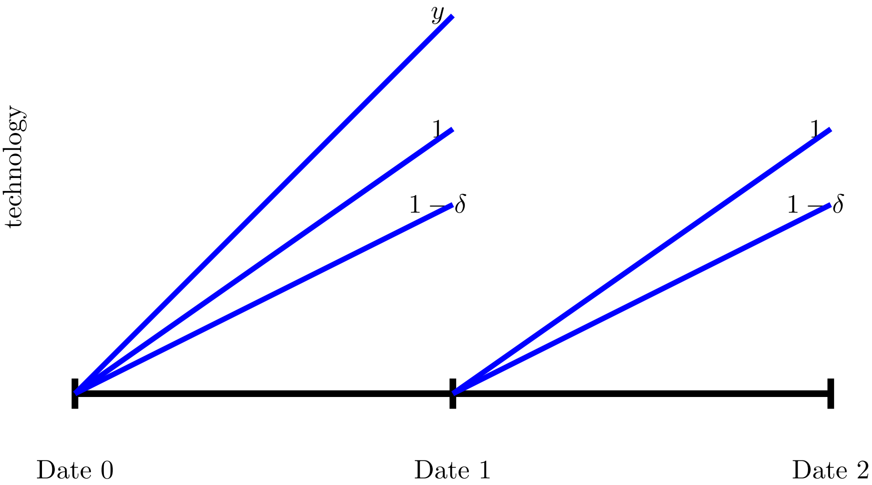
Storage technology that preserves grain, no depreciation

Can seize grain deposited in them

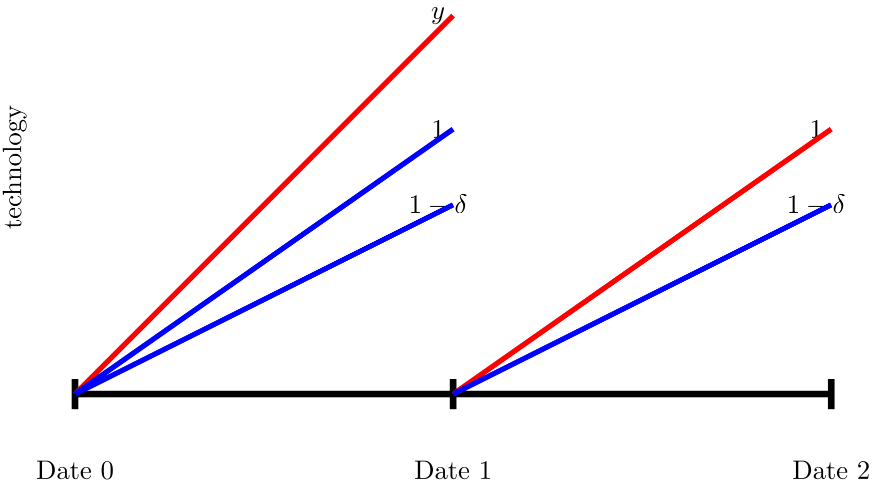
Stored grain is pledgeable

Consume at Date 2

TECHNOLOGIES



TECHNOLOGIES



CONTRACTS

Labor contracts at Date 0

Farmers pay laborers wage w per unit of labor invested

Deposit contracts at Date 0 and Date 1

Warehouses promise return R_t^D for deposits at Date t

Promises backed by warehoused grain

Lending contracts at Date 0

Warehouses lend L to farmers at Date 0 at rate R^L

They can lend in receipts or grain

TIMELINE

Date 0

Farmers borrow L, invest i in grain, pay laborers $w\ell$

Date 1

Farmers produce $y = A \min\{ i , \ell \}$

Farmers deposit and repay or divert and store privately

Date 2

Farmers, laborers, and warehouses consume

SOLUTION CONCEPT

Farmers, laborers, and warehouses maximize utility

subject to

budget constraints

promised repayments being incentive compatible

Markets for grain, labor, loans and deposits clear at each date

LIQUIDITY CREATION DEFINITION

LIQUIDITY CREATION DEFINITION

The liquidity multiplier is farmers' investment relative to endowment

$$\Lambda := \frac{i + w\ell}{e^f}$$

RESULTS

PRICES LEMMA

Interest rates and wages are all one:

$$R_0^D = R_1^D = R^L = w = 1$$

Deposit, lending, and labor markets are competitive

Warehouses' marginal cost of storage is one

Laborers' marginal cost of labor is one

BENCHMARKS

BM 1: First best allocation

BM 2: No fake receipts

Our model: Warehouses can lend in fake receipts

BM 1: FIRST BEST ALLOCATION

Farmers' technology Leontief, $y = A \min\{ i \, , \, \ell \}$

Thus $i = \ell$

Since output is pledgeable pay laborer on credit

So $i = e^f = \ell$

Liquidity creation is thus $\Lambda_{\text{fb}} = \dfrac{i + w\ell}{e^f} = \dfrac{2e^f}{e^f} = 2$

Efficient storage in the warehouse at Date 1

BM2: NO FAKE RECEIPTS

Farmers' technology Leontief, $y = A \min\{\, i \,, \, \ell \,\}$

Thus $i = \ell$

But output is not pledgeable so can't pay on credit

Warehouse can't lend: they have no grain or receipts

Budget constraint $i + w\ell = e^f$ implies $i = \ell = e^f/2$

Liquidity creation is thus $\Lambda_{\text{nr}} = \dfrac{i + w\ell}{e^f} = 1$

Deposit at Date 1 and avoid depreciation

WAREHOUSES LEND IN FAKE RECEIPTS

Suppose warehouses can write receipts when they lend

Circumvents non-pledgeability: pay laborer in receipts

But now pledgeability problem between farmer and warehouse

Repayment to warehouses must be incentive compatible

INCENTIVE CONSTRAINT

FARMERS' INCENTIVE CONSTRAINT

Farmers can borrow L at Date 0 only if IC to repay at Date 1 or

$$\text{repay, store at } R_1^D \ \succeq \ \text{divert, store at } 1-\delta$$

or, if a farmer has grain y at Date 1,

$$R_1^D\big(y - R^L L\big) \geq (1-\delta)y$$

or, since $R_1^D = R^L = 1$,

$$L \leq \delta y$$

<u>Proportion δ of output has now become pledgeable</u>

WHY NOT DEPOSIT IN ANOTHER WAREHOUSE?

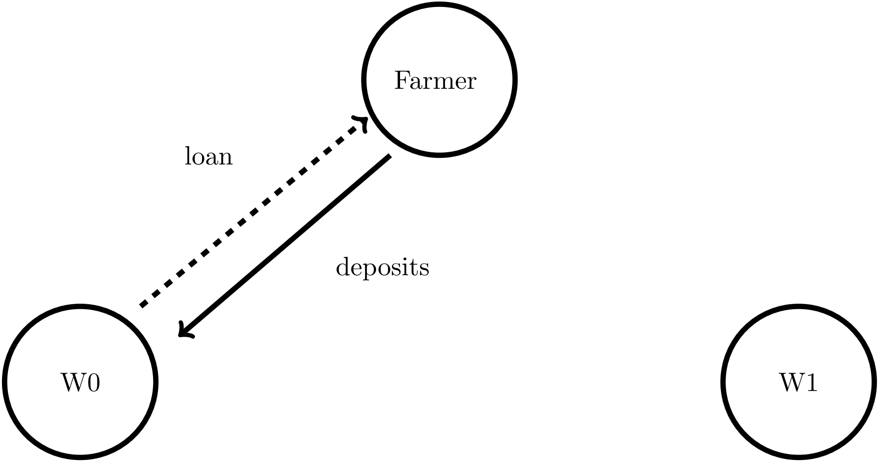
Farmer can borrow from one warehouse (W0) at Date 0

Divert output and deposit in another warehouse (W1) at Date 1

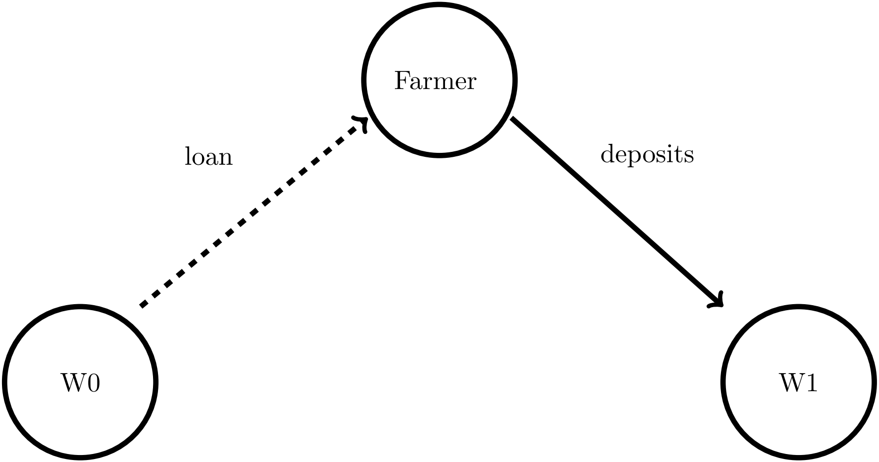
So farmer can avoid both repayment and depreciation

But this is not possible if there is an interbank market

DEPOSIT IN W0. W0 ENFORCES REPAYMENT

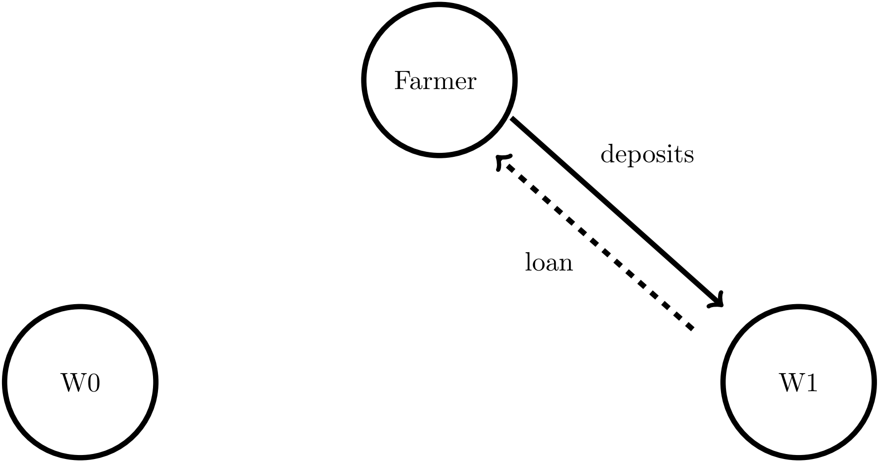


DEPOSIT IN W1? W0 CAN'T ENFORCE



INTERBANK TRADE: W1 BUYS LOAN FROM W0

INTERBANK MARKET PRESERVES IC



INTERBANK MARKET PRESERVES IC

Incentive compatibility preserved despite competing warehouses

One-period contracts implement two-period exclusive contract

Interbank market implements exclusive relationship

Successful warehouse banking systems had interbank clearing:

- E.g. Egyptian granaries, London goldsmiths

EQUILIBRIUM CHARACTERIZATION

EQUILIBRIUM CHARACTERIZATION

In equilibrium, loans L, labor ℓ, and investment i are

$$L = \frac{\delta A e^f}{2 - \delta A},$$
$$\ell = \frac{e^f}{2 - \delta A},$$
$$i = \frac{e^f}{2 - \delta A}.$$

EQUILIBRIUM CHARACTERIZATION: PROOF

1. Production function: $y = A\min\{i, \ell\}$
2. Optimal mix of inputs: $i = \ell$
3. Incentive constraint: $L = \delta y$
4. Budget constraint: $i + \ell = e^f + L$

So, from 2 and 4: $i + i = e^f + L$

Using into 1 and 3: $2i = e^f + \delta A i \implies i = \dfrac{e^f}{2 - \delta A}$

FAKE RECEIPTS CREATE LIQUIDITY

FAKE RECEIPTS CREATE LIQUIDITY

Fake receipts allow farmer to invest more

When warehouses lend in fake receipts, the liquidity multiplier is

$$\Lambda = \frac{2}{2 - \delta A} > 1$$

Farmer's investment exceeds total grain endowment

LIQUIDITY CREATION

The total amount of liquidity created is increasing in δ

The more desirable for farmers to store, the looser is IC

And warehouses are more willing to lend

LOANS CREATE DEPOSITS

DEPOSITS CREATE LOANS?

Balance sheet before lending

grain	deposits

$\xrightarrow{\text{lending}}$

Balance sheet after lending

grain − loan	deposits
loan	

LOANS CREATE DEPOSITS

Balance sheet before lending

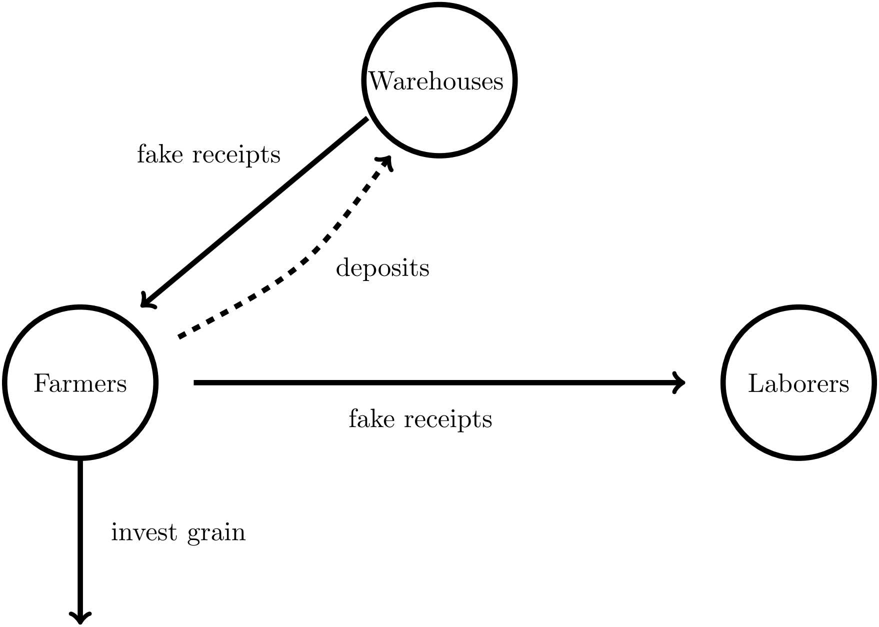
grain	deposits

$\xrightarrow{\text{liquidity creation}}$

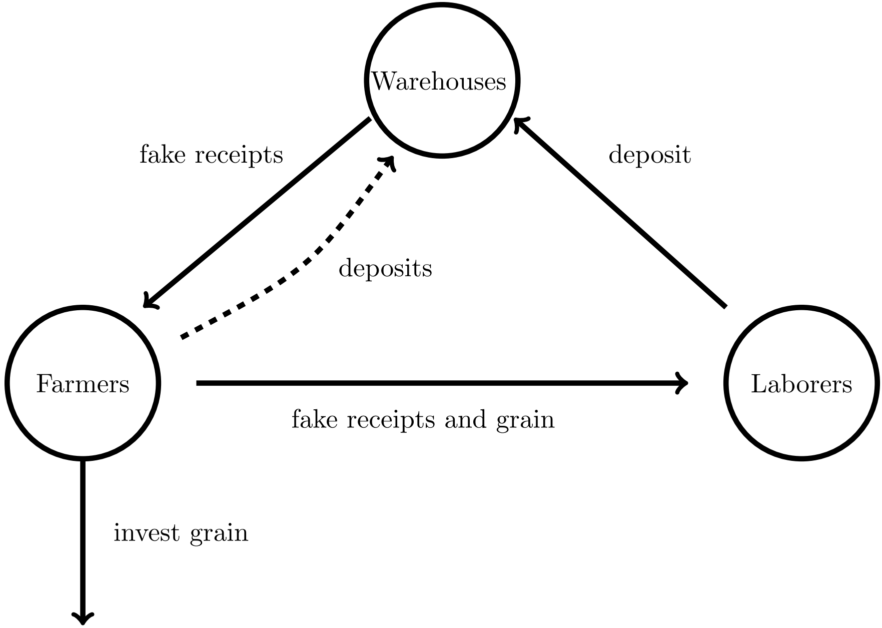
Balance sheet after lending

grain	old deposits
loan	new deposits

SUMMARY


Warehouses
fake receipts
deposits
Farmers
fake receipts
Laborers
invest grain

SUMMARY


Warehouses
fake receipts
deposit
deposits
Farmers
Laborers
fake receipts and grain
invest grain

ENDOGENOUS FRACTIONAL RESERVES

ENDOGENOUS FRACTIONAL RESERVES

Farmer's IC puts endogenous limit to amount it can borrow

Since L is max farmer can borrow, he could set $L = i$

And store $e^f - L$

But he can do better

- Can split $e^f - L$ between i and $w\ell$
- Laborer then stores $(e^f - L)/2$ in warehouse

WAREHOUSE-BANK EQUITY

EXTENSION: WAREHOUSE DIVERSION

Suppose warehouses can now divert grain

If divert store privately, but grain depreciates at δ

Suppose warehouses have endowment e^w at Date 1

WAREHOUSE INCENTIVE CONSTRAINT

Deposit-taking is IC at Date 1 if

$$\text{repayment and storage at } 1 \;\succeq\; \text{diversion and storage at } 1-\delta$$

or, for deposits D,

$$e^w + D - R_1^D D \geq (1-\delta)(e^w + D)$$

or, since $R_1^D = 1$,

$$\frac{e^w}{D} \geq \frac{1-\delta}{\delta}$$

LIQUIDITY DEPENDS ON WAREHOUSE EQUITY

The second-best is attained only if

$$e^w \geq \frac{1-\delta}{\delta}\,\frac{\alpha\big[1+(1-\delta)A\big]}{1+\alpha(1-\delta A)}\,e^f,$$

Otherwise warehouses constrain lending

Warehouse-banks need capital only at Date 1

No capital or initial deposits necessary at Date 0

WAREHOUSE'S IC BINDS

Warehouse's binding IC

$$D = \frac{\delta}{1-\delta} e^w$$

and market clearing

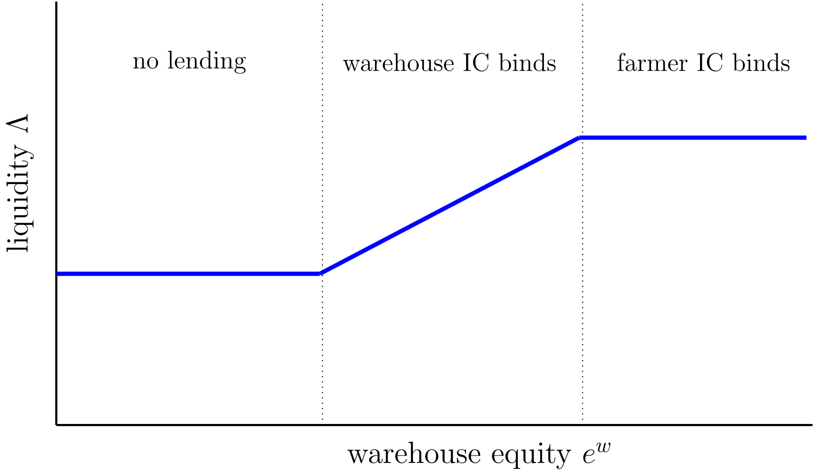
$$D = y + R_0^D \left(e^f - i\right) = Ai + e^f - i$$

give the liquidity multiplier

$$\Lambda = \frac{i + w\ell}{e^f} = \frac{2}{A-1} \left(\frac{\delta}{1-\delta} \frac{e^w}{e^f} - 1 \right)$$

LIQUIDITY & WAREHOUSE EQUITY

LIQUIDITY & WAREHOUSE EQUITY



CAPITAL INJECTIONS

Increasing capital increases lending only if warehouse IC binds

Only Date 1 capital matters

Increasing today's capital does not affect lending directly

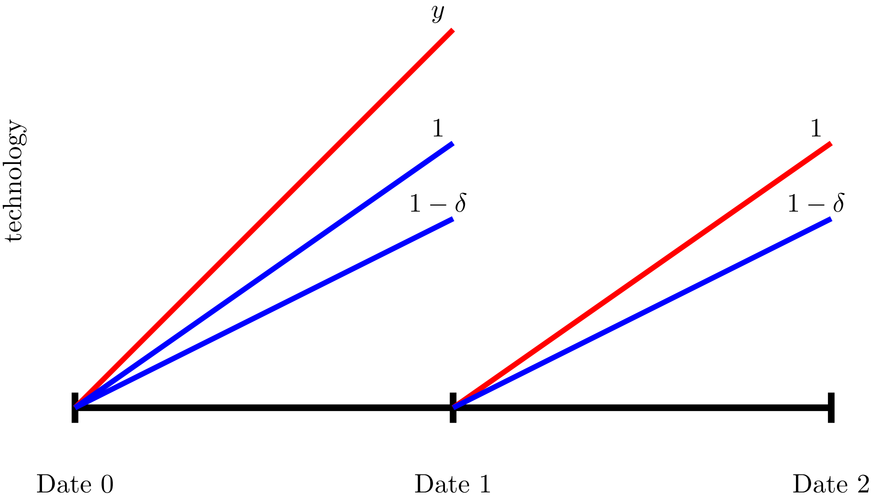
Casts light on why credit tight after crisis, despite intervention

MONETARY POLICY

MONETARY POLICY

Suppose warehouse can deposit in central bank at rate R^{CB}

TECHNOLGIES



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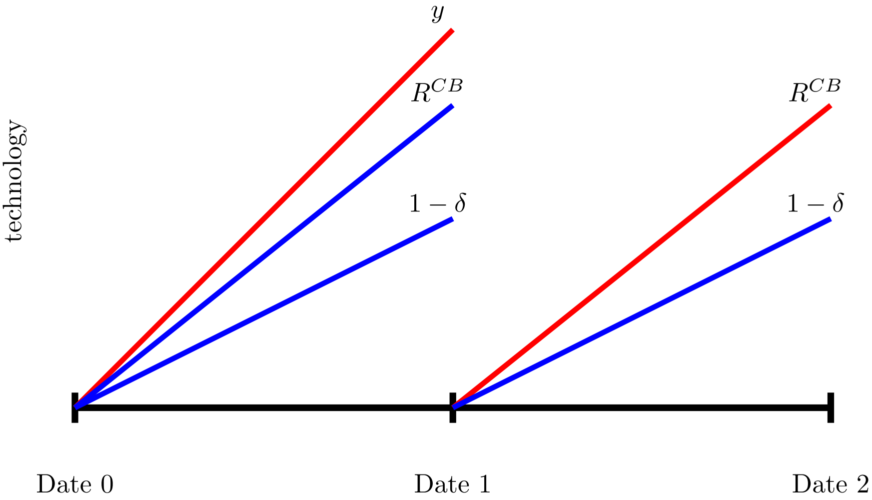


MONETARY POLICY: PRICES LEMMA

Interest rates are

$$R_0^D = R_1^D = R^L = R^{CB}$$

Wages

$$w = (R^{CB})^{-2}$$

MONETARY POLICY: FARMER'S IC

The IC becomes

$$R^{CB}(y - R^{CB}L) \geq (1 - \delta)y$$

or

$$L \leq \frac{1}{R^{CB}} \left(1 - \frac{1 - \delta}{R^{CB}}\right) y$$

Increasing R^{CB} can loosen IC

So tighter monetary policy can increase funding liquidity

LIQUIDITY REQUIREMENTS AND FINANCIAL FRAGILITY

LIQUIDITY REQUIREMENTS

Basel III requires that banks hold sufficient liquidity

$$\text{Liquidity Coverage Ratio} = \frac{\text{Liquid assets}}{\text{Total assets}} \geq \theta$$

Basically forces banks to invest some assets in cash

In our model this imposes a limit on loans it can make

In other words, a limit on fake receipts

Thus, hindering liquidity creation

LIQUIDITY REQUIREMENTS & FRAGILITY

Idea behind liq. requirements is that it reduces risk of runs

We show that liq. requirements *may* make banks fragile to runs

The higher are liq. requirements, the higher *may* be risk of runs

LIQUIDITY REQUIREMENTS & FRAGILITY

Add a Date 1/2 to our model

At Date 1/2 depositors may withdraw

Suppose warehouses have grain reserves θ at Date 0

Question: how does increasing θ affect the risk of a run?

LIQUIDITY REQUIREMENTS & RUNS

Call λ the proportion of grain that is withdrawn early

Call $g(\theta)$ the liquidation value of the warehouse's reserves

	$\lambda \leq \theta$	$\lambda > \theta$
Withdraw	$1 - \delta$	$\frac{(1-\delta)g(\theta)}{\lambda}$
$\neg$ Withdraw	1	0

Consider the choice of a depositor to withdraw 1 unit of grain

MULTIPLE EQUILIBRIA

	$\lambda \leq \theta$	$\lambda > \theta$
Withdraw	$1 - \delta$	$\frac{(1-\delta)g(\theta)}{\lambda}$
$\neg$ Withdraw	1	0

EQUILIBRIUM SELECTION

Use global games to select equilibrium

There is a "run" (everyone withdraws) when $\delta < \delta^*$

There is not a run (everyone does not withdraw) when $\delta > \delta^*$

So, $\mathbb{P}(\text{run}) = \mathbb{P}(\delta < \delta^*)$

Interpretation: δ^* measures financial fragility

Question: how do liquid reserves θ affect fragility δ^*?

EQUILIBRIUM SELECTION

The global games technique says that δ^* solves

$$\int_0^1 \text{don't withdraw payoff}\,(\delta)\,d\lambda = \int_0^1 \text{withdraw payoff}\,(\delta)\,d\lambda$$

i.e.

$$\int_0^1 \mathbb{1}_{\{\lambda \leq \theta\}} d\lambda = \int_0^1 \left[\mathbb{1}_{\{\lambda \leq \theta\}}(1-\delta) + \mathbb{1}_{\{\lambda > \theta\}} \frac{(1-\delta)g(\theta)}{\lambda} \right] d\lambda$$

or

$$\delta^* = \frac{g(\theta)\log(\theta)}{g(\theta)\log(\theta) - \theta}$$

DO RESERVES INCREASE FRAGILITY?

Recall that higher δ^* implies higher fragility

How does θ affect δ^*?

$$\frac{\partial \delta^*}{\partial \theta} > 0$$

if

$$g'(\theta) > \frac{g(\theta) + g(\theta)|\log \theta|}{\theta |\log \theta|};$$

higher reserve requirements lead to higher fragility

RESERVES INCREASE FRAGILITY: INTUITION I

Increase in θ has two effects

"Buffer effect": bank can withstand more withdrawals

"Incentive effect": higher expected payoff from withdrawing

RESERVES INCREASE FRAGILITY: INTUITION II

Consider a warehouse with no reserves, $\theta = 0$

	$\lambda \leq \theta$	$\lambda > \theta$
Withdraw	$1 - \delta$	0
$\neg$ Withdraw	1	0

No incentive to withdraw, since <u>always</u> get 0

High reserves increase withdraw payoff, making runs likely

NARROW BANKING

Narrow banks: banks should hold only liquid securities

Effectively, 100% reserves

Equivalent to BM in which warehouses can't issue fake receipts

And no liquidity being created

EXTENSION: CONSUMPTION AT DATE 1

WHAT IF FARMERS CONSUME AT DATE 1?

Seems that results are driven by timing of consumption

While true that farmers' need to save is driving results

Results robust to inclusion of farmer's consumption at $t = 1$

If farmers have decreasing marginal utility

WHAT IF FARMERS CONSUME AT DATE 1?

Does IC hold if farmer consumes at Date 1?

Suppose farmer has log utility $U = \log c_1 + \log c_2 = \log c_1 c_2$

RISK-AVERSE FARMER

Repayment is IC if

$$\text{depositing} \succeq \text{diversion}$$

where, payoff from depositing is maximum of

$$\begin{aligned}&u(c_1) + u(c_2)\\ &\text{s.t. } c_2 = R_D\,(y - R_L L - c_1)\end{aligned}$$

and payoff from diversion is maximum of

$$\begin{aligned}&u(c_1) + u(c_2)\\ &\text{s.t. } c_2 = (1-\delta)(y - c_1)\end{aligned}$$

RISK-AVERSE FARMER: IC

Solution to the deposit program is

$$c_1 = \frac{y - R_L L}{2}$$
$$c_2 = \frac{R_D(y - R_L L)}{2}$$

Solution to the diversion program is

$$c_1 = \frac{y}{2}$$
$$\text{s.t. } c_2 = \frac{(1-\delta)y}{2}$$

RISK-AVERSE FARMER: IC

Repayment is IC if

$$\log\left[\frac{y - R_L L}{2} \cdot \frac{R_D(y - R_L L)}{2}\right] > \log\left[\frac{y}{2} \cdot \frac{(1-\delta)y}{2}\right]$$

or

$$L < \frac{\sqrt{R_D} - \sqrt{1-\delta}}{\sqrt{R_D} R_L} y$$

Substituting for $R_D = R_L = 1$

$$L < \left(1 - \sqrt{1-\delta}\right) y \approx \frac{\delta y}{2}$$

LITERATURE

LITERATURE

Gu–Mattesini–Monnet–Wright 2013

Institutions that can keep promises better endogenously

1. Take deposits and make delegated investments

2. Their liabilities facilitate exchange

LITERATURE ON BANKING

In traditional models banks transfer from depositors to borrowers

But in reality banks lend by creating deposits

- Borrowers are simultaneously depositors

Papers that takes this view:

- Bianchi–Bigio 2015
- Jakab–Kumhof 2015

LITERATURE ON LIQUIDITY CREATION

Bryant 1980, Diamond–Dybvig 1983

Banks implement efficient risk sharing

Create liquidity by providing insurance, increasing loan value

Investment in illiquid projects $<$ initial liquidity endowment

Gorton–Ordoñez 2012, Dang–Gorton–Holmström–Ordoñez 2015

Banks create liquid assets by issuing info incentive claims

Liquidity created on right-hand side of banks' balance sheet

LITERATURE ON LIQUIDITY FROM LENDING

> We thus maintain—contrary to the entire literature on banking and credit—that the primary business of banks is not the liability business, especially the deposit business
>
> But in general and in each and every case an asset transaction of a bank must have previously taken place, in order to allow the possibility of a liability business and to cause it
>
> The liability business of banks is nothing but a reflex of prior credit extension....
>
> —Hahn (1920)

CONCLUSIONS

CONCLUSIONS

Warehouses are the natural banks

- Historical origin and raison d'être of banks
- Intermediation is endogenous
- Interbank emerges to support enforcement

Create private money ("fake receipts") when lending

- Provides liquidity and enhances investment efficiency
- Casts doubt on new regulatory proposals

MONEY RUNS

FACTS

Banks issue circulating demandable debt against pools of long-term assets

Banks are ipso facto fragile

QUESTIONS

Why do banks issue demandable debt despite being exposed to runs?

Why do banks combine activities that seem to exacerbate fragility?

1. Money creation
2. Liquidity transformation
3. Maturity transformation
4. Asset pooling

THIS PAPER

Develop theory based on role of bank debt as means of payment

Banknotes historically; electronic transfers today

Contrasts with other theories of demandable debt
(Calomiris-Kahn, Diamond-Rajan, Diamond-Dybvig)

But captures all features of banks above

Liq./mat. transformation, asset pooling, fragility arise endogenously

RESULTS

Demandable debt is optimal because it increases debt capacity

Increases secondary market price of debt, increasing debt capacity

If I know I can trade debt at high price, willing to lend more

Demandable debt exposes banks to a new type of run—money run

Secondary market circulation fragile (belief dependent)

If circulation dries up, need to redeem

Banks pool assets to "re-use" redemption value creating role for pooling

When debt circulates, redemption value "not rivalrous" $\Longrightarrow$

Can redeem for whole asset pool as long as others' redemption off eq.

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

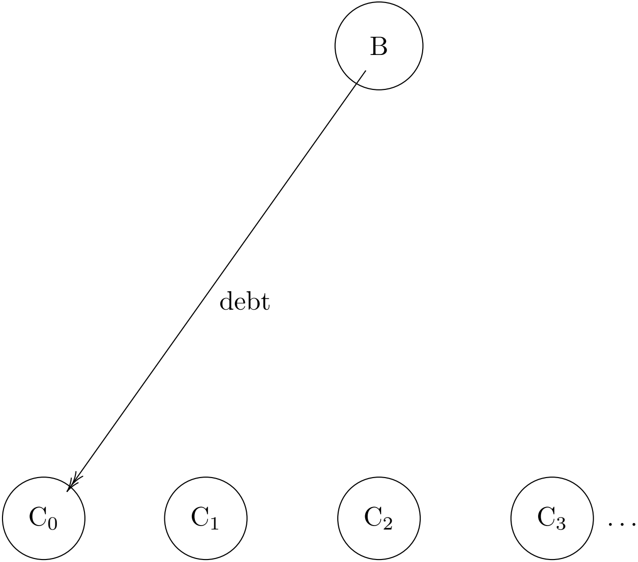
Long term or demandable

Tradeable or non-tradeable

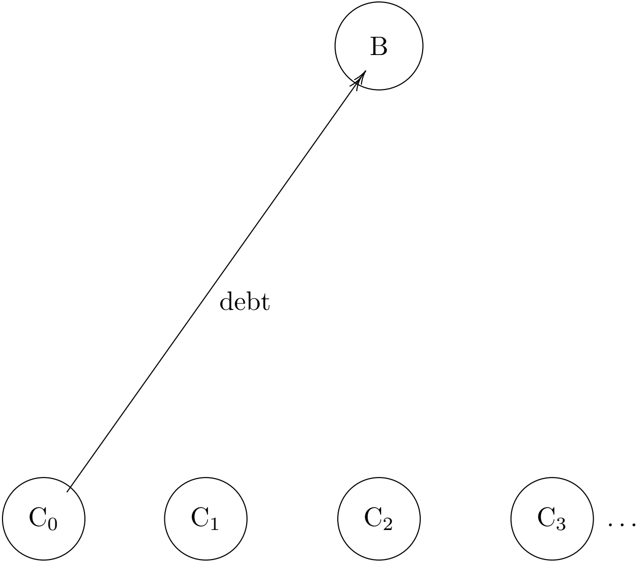
v_t denotes value of debt to not-shocked creditor

p_t denotes its secondary market price

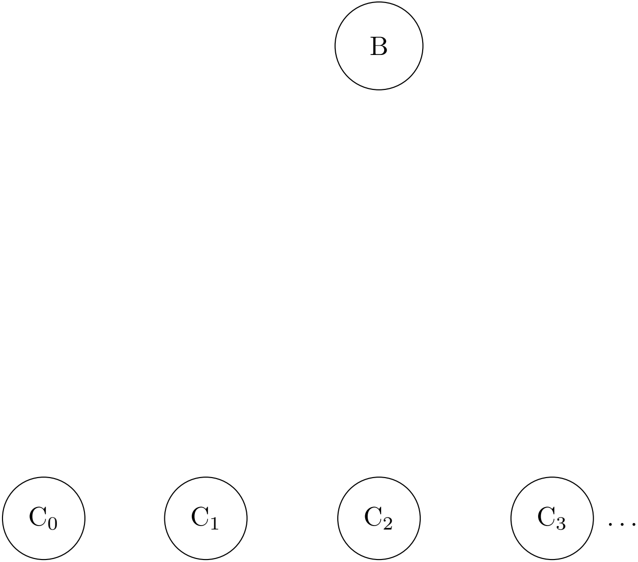
DEMANDABLE DEBT



DEMANDABLE DEBT



TRADEABLE DEBT



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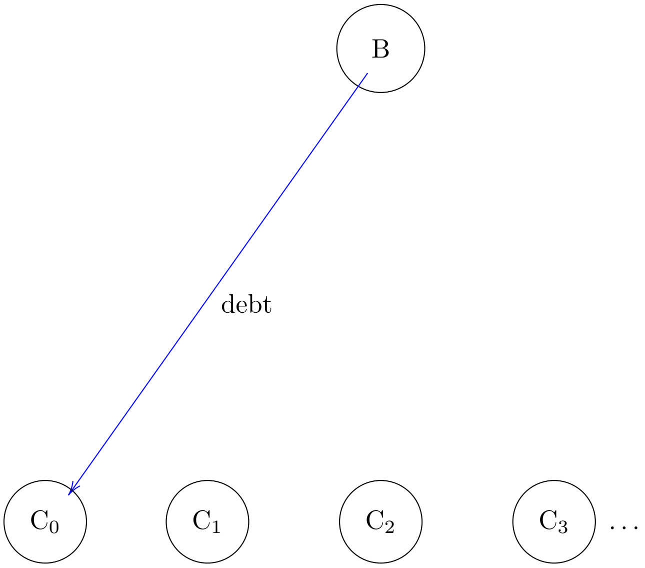
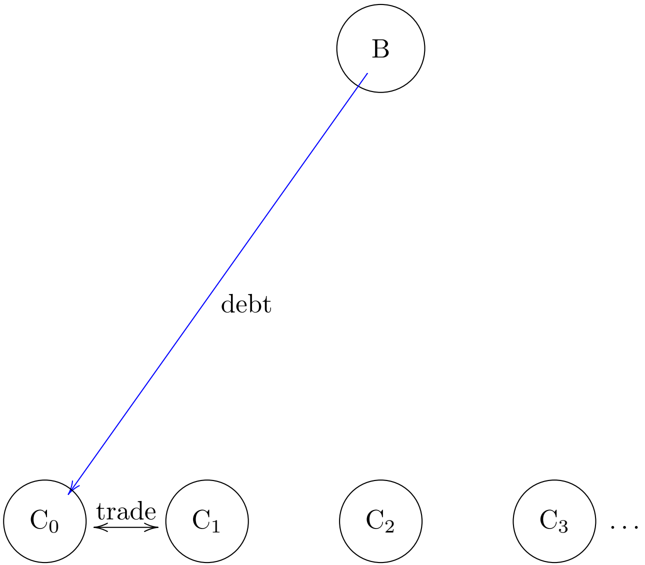
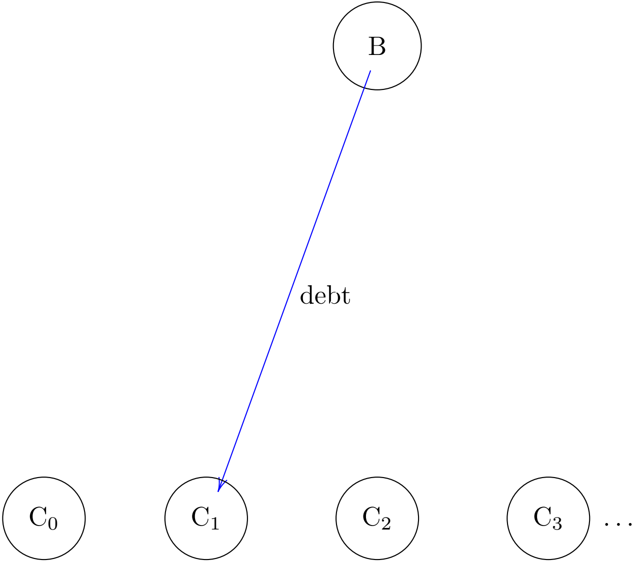


TRADEABLE DEBT



TRADEABLE DEBT



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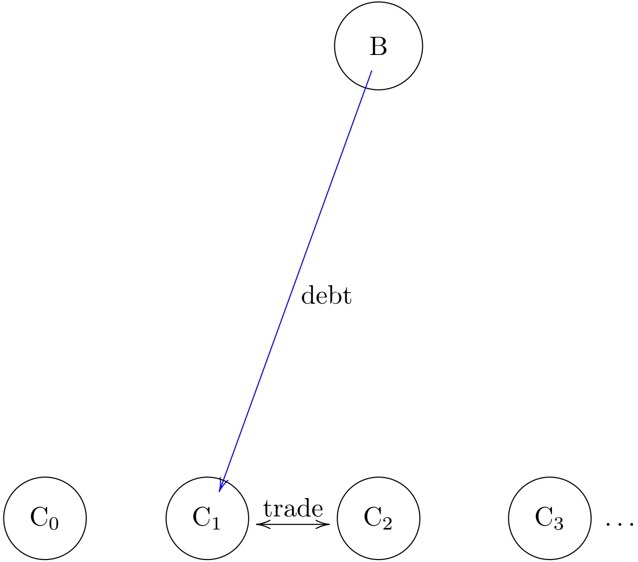

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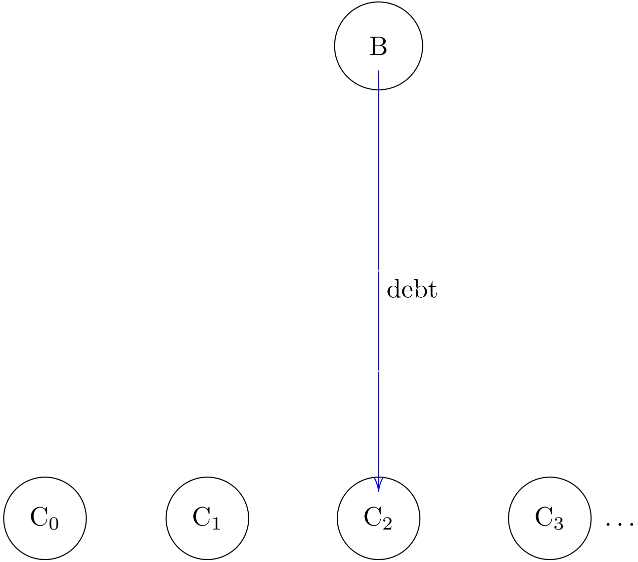

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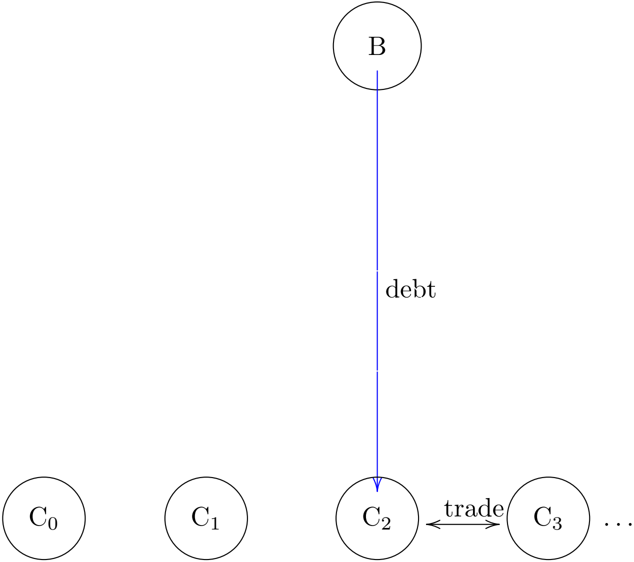

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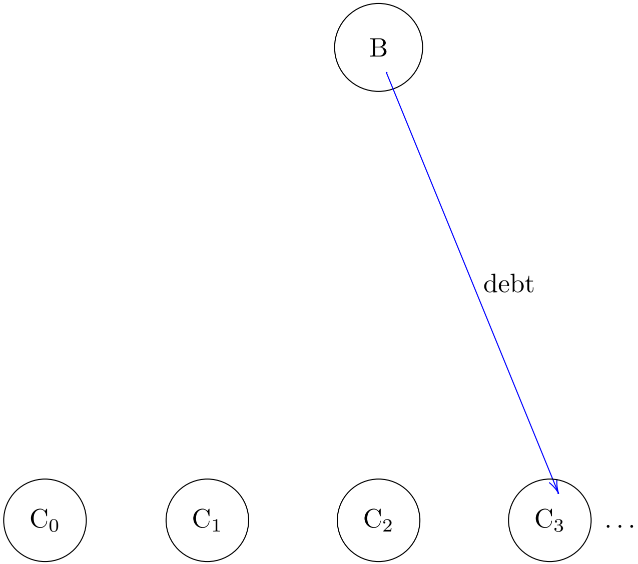

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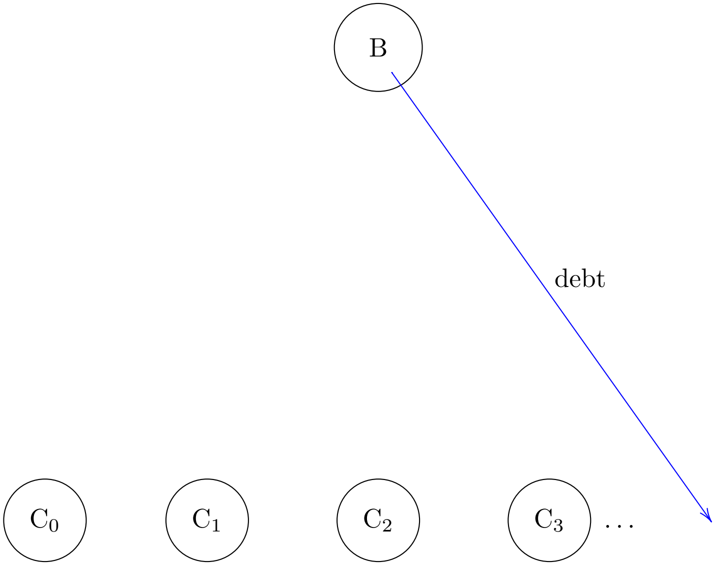


TIMELINE

Date 0

B borrows from C_0 and invests or does not

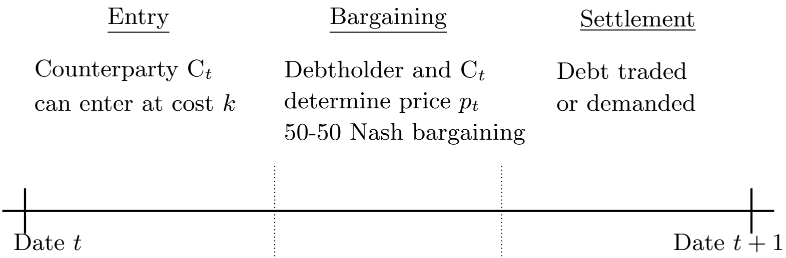
Date $t > 0$: if B's investment pays off

B repays R

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

Secondary debt market entry, bargaining, settlement

TRADEABILITY AND DEMANDABILITY



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

TRADEABLE INSTRUMENTS: VALUES

Value v of bond solves

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

So

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

Value v of banknote solves

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

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	$v_{\text{bond}} = \dfrac{\rho R}{\rho + (1-\rho)\theta\left(1-\frac{\sigma}{2}\right)}$	$v_{\text{note}} = \dfrac{\rho R + (1-\rho)\theta\left(1-\frac{\sigma}{2}\right)\ell}{\rho + (1-\rho)\theta\left(1-\frac{\sigma}{2}\right)}$

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 <u>secondary</u> market price

Improves bargaining position of debtholder

Demandable debt increases <u>primary</u> 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 <u>money run</u>

MONEY RUNS AS MULTIPLE EQUILIBRIA

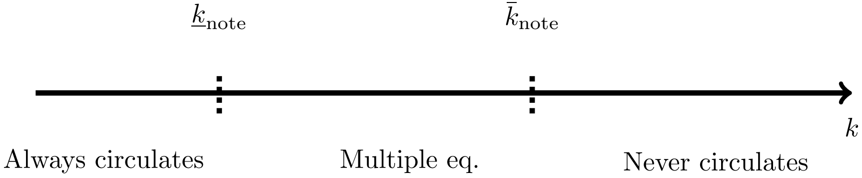
σ is best-response to σ for both $\sigma = 0$ and $\sigma = 1$

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

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

DEMANDABLE DEBT DESPITE RUNS

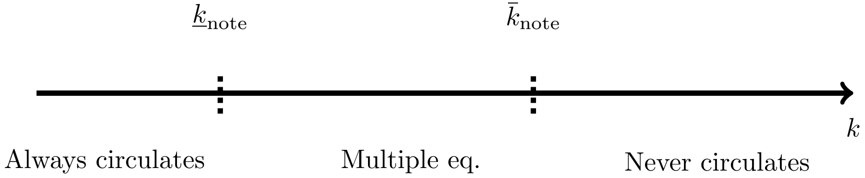
B could avoid runs by issuing a bond

May need to issue run-prone instrument to raise funds

Even in anticipation of runs occurring in equilibrium

OPTIMAL BOND BORROWING

BOND VS. BANKNOTE



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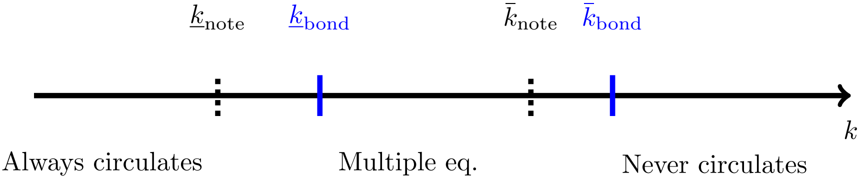

For same face value R, bond circulates better than banknote

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

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

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

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

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

<u>Maturity transformation</u>: Borrows demandable, invests long-term

<u>Liquidity transformation</u>: Liquid liabilities, illiquid assets

<u>Asset pooling</u>: Reuse liquidation value w/o diversification

<u>Dispersed creditors</u>: Each can redeem against same assets

<u>Fragility</u>: 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

A THEORY OF CREDIT LINES (WITH EVIDENCE)

FACTS

Credit lines make up c. \$2T of committed credit, bulk of bank credit (80%)
Berg–Saunders–Steffen 20, Greenwald–Krainer–Paul 21, Chodorow-Reich et al. 21, and Sufi 09

Credit lines are rarely drawn (16%) even in crises (24%)
Ivashina–Scharfstein 10, Greenwald 21

Credit lines are bundled with loans, especially to risky firms (80%)
See below

Credit lines are sometimes revoked by lenders
Falato–Chodorow-Reich 22

QUESTIONS

Q1. Why are credit lines so common, even if rarely used?

Q2. Why are credit lines bundled with loans?

Q3. How does the risk of revocation affect borrowing and welfare?

THIS PAPER

Dynamic model of borrower B issuing debt
Admati et al 17/DeMarzo–He 21

Friction: Non-exclusivity

After borrowing from one lender at t, borrows from another at $t + \mathrm{dt}$

Innovation: Allow for credit lines (CLs)

Options to borrow $\tilde{p}\mathrm{d}\tilde{Q}$ against face value $\mathrm{d}\tilde{Q}$

RESULTS

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BM1. Exclusive comp.: B acts as static monopolist (rations Q so $p >$ MC)

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R2. New role of bundling: Pairing loan with CL commits to optimal debt

R3. New role of lender commitment: Revocation $\uparrow$ borrower debt

T. New test of revocation risk: Increases borrowing (per R3)

MODEL

OVERVIEW

Infinite-horizon sequential borrowing: B borrows from one lender at each t

Credit line-debt bundle at date 0 and new debt afterward

B's cost of debt $c(Q_t)$ increasing and concave in stock of debt Q_t

Captures expected coupon payment $\downarrow$ as default prob. $\uparrow$ in Q

Universal risk-neutrality, deep pockets, and discounting at rate ρ

NB: No revocation; no risk; no CLs at $t > 0$

B's VALUE

B's flow payoff: $v_t \mathrm{d}t = y\mathrm{dt} + p_t \mathrm{d}Q_t - c(Q_t)\mathrm{d}t$, where

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$\mathrm{d}t$: time increment

$y\mathrm{d}t$: cash flow

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Q_t: stock of debt

B's value: $V_t = \int_0^\infty e^{-\rho s} v_{t+s} \mathrm{d}s$

LENDERS' VALUE

Lenders' flow payoff from unit debt given stock Q_t: expected coupon $\gamma(Q_t)$

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Value of stream of coupons on unit of debt: $\Gamma_t = \int_0^\infty e^{-\rho s}\gamma(Q_{t+s})\mathrm{d}s$

CONTRACTS

Loans $(p_t, \mathrm{d}Q_t)$: Borrow $p_t \mathrm{d}Q_t$ against face value $\mathrm{d}Q_t$

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Credit lines $(\tilde{p}, \mathrm{d}\tilde{Q})$: Option to borrow $\tilde{p}\mathrm{d}\tilde{Q}$ against face value $\mathrm{d}\tilde{Q}$

($\mathrm{d}\tilde{Q}$ put options on debt with strike $\tilde{p}$)

ASSUMPTIONS

A1: Dilution: expected coupons lower for higher debt: $\gamma' < 0$ & $\gamma(\infty) = 0$

A2: Gains from trade:

Positive at $Q = 0$: $\gamma(0) > c'(0)$

Negative as $Q \to \infty$: $\gamma(\infty) < c'(\infty)$

A3: Curvature: c and $\gamma(Q)Q - c(Q)$ concave

SOLUTION CONCEPT: MARKOV PERFECT EQ.

At each date, lenders offer bundles/loans and B chooses one offer s.t.

B and lenders max expected future lifetime utility given beliefs

Beliefs are consistent

B's balance sheet $\big(Q_t, (\tilde{p}, \mathrm{d}\tilde{Q})\big)$ is suff. stat. for history w.r.t. action

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NB: For a given CL, draw down is binary action

Notation: $\tilde{V}$ value function with credit line; V without (after draw down)

INTERPRETATION OF c

c flexible way to capture repayments and frictions

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Let π be default prob., δ coupon rate, τ_c corporate tax, $k > \delta$ default costs:

$$c(Q) = \underbrace{(1 - \pi(Q))\delta Q}_{\mathbb{E}[\text{coupons}] = \gamma(Q)Q} - \underbrace{\tau_c \delta Q}_{\text{tax shield}} + \underbrace{\pi(Q)Qk}_{\mathbb{E}[\text{default costs}]}$$

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Baseline assumptions easy to satisfy:

1. c increasing: $(\pi(Q)Q)' > -\dfrac{(1-\tau_c)\delta}{k-\delta}$
2. c concave: $(\pi(Q)Q)'' < 0$
3. c' bounded above zero: $\lim\limits_{Q\to\infty}(\pi(Q)Q)' > \dfrac{\bar{c}' - (1-\tau_c)\delta}{k-\delta}$

BENCHMARKS

BENCHMARK 1: EXCLUSIVE COMPETITION

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If B commits to one lender (of those competing at date 0) forever

B borrows at Date 0 and never again

<u>Price is above marginal cost</u>

EXCLUSIVE COMP: PROGRAM W/ COMMITMENT

Choose $(Q_t)_{t\geq 0}$ at $t=0$ to

$$\max \int_0^\infty e^{-\rho t}\big(y\mathrm{dt} + p_t \mathrm{d}Q_t - c(Q_t)\mathrm{dt}\big)$$

$$\text{s.t.}\;\; p_t \leq \int_0^\infty e^{-\rho s}\gamma(Q_{t+s})\mathrm{d}s$$

EXCLUSIVE COMP: PROOF

<u>Part 1: Optimal allocation $\implies$ no borrowing for $t > 0$</u>

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Impatience $\implies$ realize gains from trade now

Part 2: Optimal date-0 issuance

$$\text{Max } p_0 Q_0 - \frac{c(Q_0)}{\rho} \text{ s.t. } p_0 \leq \frac{\gamma(Q_0)}{\rho}$$

EXCLUSIVE COMP: PROOF

Part 1: Optimal allocation $\implies$ no borrowing for $t > 0$

Impatience $\implies$ realize gains from trade now

Part 2: Optimal date-0 issuance

Max $p_0 Q_0 - \dfrac{c(Q_0)}{\rho}$ s.t. $p_0 \leq \dfrac{\gamma(Q_0)}{\rho} \implies p_0 \equiv$

EXCLUSIVE COMP: PROOF

Part 1: Optimal allocation $\implies$ no borrowing for $t > 0$

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$$\text{Max } p_0 Q_0 - \frac{c(Q_0)}{\rho} \text{ s.t. } p_0 \leq \frac{\gamma(Q_0)}{\rho} \implies p_0 \equiv \frac{\gamma(Q_0)}{\rho} = \frac{c'(Q_0)}{\rho} - \frac{\gamma'(Q_0)Q_0}{\rho}$$

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Corporate finance intuition: Static trade-off theory

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Balance gains from trade (e.g. tax shield) with costs (e.g. distress)

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Durable goods monopolist intuition:

EXCLUSIVE COMP: INTUITION

Corporate finance intuition: Static trade-off theory

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BENCHMARK 2: NO CREDIT LINES

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Recall B can't commit to future debt issuance

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Absent credit lines, with dt $\rightarrow 0$

B issues more debt continuously

B captures no surplus

Price equals marginal cost

BENCHMARK 2: NO CREDIT LINES

Recall B can't commit to future debt issuance

Absent credit lines, with $dt \to 0$

- B issues more debt continuously
- B captures no surplus
- Price equals marginal cost

Cf. Leverage ratchet effect and Coase Conjecture
(Admati et al. 18, DeMarzo–He 21, Coase 72,...)

NO CLs: PROGRAM (W/O COMMITMENT)

Choose q_t at <u>each</u> t to

$$\max\ y\mathrm{d}t + p(Q_t + q_t\mathrm{d}t)q_t\mathrm{d}t - c(Q_t)\mathrm{d}t + e^{-\rho\mathrm{d}t}V(Q_t + q_t\mathrm{d}t)$$

$$\text{s.t.}\quad p_t \leq \int_0^\infty e^{-\rho s}\gamma(Q_{t+s})\mathrm{d}s$$

NO CREDIT LINES: PROOF

As $\mathrm{d}t \to 0$, HJB for B's value V: $\rho V(Q) = y + p(Q)q - c(Q) + V'(Q)q$

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NB: c concave $\implies$ V convex $(V'' = -c''/\rho > 0)$

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Corporate finance intuition: Costs of new debt born by existing debt

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Corporate finance intuition: Costs of new debt born by existing debt

Debt in place $\Longrightarrow$ new debt tempting $\Longrightarrow$ "ratchet effect" eats surplus

Durable goods monopolist intuition: Compete with future self

After selling monopoly Q to one lender, profit by selling more to another

RESULTS

LEMMA: RATCHET EFFECT FOR CREDIT LINES

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Suppose B has CL $(\tilde{p}, \mathrm{d}\tilde{Q})$ in place s.t. indifferent to drawing at Q_0:

$$\tilde{p}\mathrm{d}\tilde{Q} + V(Q_0 + \mathrm{d}\tilde{Q}) = \tilde{V}(Q_0) \iff \tilde{p} = -\frac{V(Q_0 + \mathrm{d}\tilde{Q}) - \tilde{V}(Q_0)}{\mathrm{d}\tilde{Q}}$$

B weakly prefers to draw for $Q > Q_0$

RATCHET: PROOF SKETCH FOR SMOOTH Q_t & $\tilde{V}$

Suppose (for contradiction) B strictly prefers not to draw at $Q_0^+ > Q_0$

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Near Q_0^+, $\tilde{V}$ satisfies HJB as if no CL $\implies \tilde{V} = V$

Sub into condition not to draw in terms of V:

$$
\begin{aligned}
\tilde{p} &< -\frac{V(Q_0^+ + \mathrm{d}\tilde{Q}) - \tilde{V}(Q_0^+)}{\mathrm{d}\tilde{Q}} && \text{(preference not to draw at } Q_0^+\text{)} \\
&= -\frac{V(Q_0^+ + \mathrm{d}\tilde{Q}) - V(Q_0^+)}{\mathrm{d}\tilde{Q}} && (\tilde{V}(Q_0^+) = V(Q_0^+) \text{ from above}) \\
&< -\frac{V(Q_0 + \mathrm{d}\tilde{Q}) - V(Q_0)}{\mathrm{d}\tilde{Q}} && \text{(convexity of } V \text{ from BM2)} \\
&= \tilde{p} && \text{(indifference at } Q_0\text{)}
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$$

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&= \tilde{p} && \text{(indifference at } Q_0\text{)}
\end{aligned}$$

I.e. $\tilde{p} < \tilde{p}$: $\Rightarrow\Leftarrow$

RATCHET EFFECT OF CLs: INTUITION

c concave $\implies$ more debt B has, less costly to have more

Idea: Higher $Q \implies$ lower repayment prob. $\implies$ lower cost of d$\tilde{Q}$

Akin to leverage ratchet effect:

Higher debt begets higher debt

R1: RATCHET-ANTI-RATCHET EFFECT

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Suppose B has debt Q_0 and CL $(\tilde{p}, \mathrm{d}\tilde{Q})$ in place s.t. indifferent to drawing

If $\mathrm{d}\tilde{Q}$ large enough, B doesn't take any new debt ($q_t \equiv 0$)

R1: RATCHET-ANTI-RATCHET EFFECT: PROOF

Step 1: Find price s.t. B prefers to borrow dQ at p (and thus draw CL)

Step 2: Find price s.t. lender willing to lend dQ at p

Step 3: Show price B willing to borrow > price lenders willing to lend

R1: STEP 1: FIND p S.T. B PREFERS TO BORROW

Issuing $\mathrm{d}Q$ at p (and drawing CL) $\succ$ not issuing (and $\sim$ drawing) if

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R1: STEP 2: FIND p S.T. LENDER LENDS

Lender knows B draws if lends, so lends $\mathrm{d}Q$ at p iff $p \leq \Gamma(Q_0 + \mathrm{d}Q + \mathrm{d}\tilde{Q})$

$\Gamma(Q_0 + \mathrm{d}Q + \mathrm{d}\tilde{Q}) \to 0$ as $\mathrm{d}\tilde{Q} \to \infty$ since $\gamma(Q) \to 0$ as $Q \to \infty$ by A2

R1: STEP 3 NO LENDING

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R1: RATCHET-ANTI-RATCHET: INTUITION

When B borrows from new lenders, draws on credit line diluting them

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$\implies$ credit lines implement exclusivity absent borrower commitment

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NB: Self-enforcing independent of who holds debt

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Price so low that B doesn't want to borrow

$\Longrightarrow$ credit lines implement exclusivity absent borrower commitment

NB: Self-enforcing independent of who holds debt

Debt can be traded, as in practice, unlike in monitoring-based theories

R1 RESONATES WITH PRACTICE

Credit line latent off-equilibrium threat

Explains low utilization: zero for 45% of firms; 16% for median

Credit line large so price falls enough after drawn

Explains large size of undrawn CLs: 80% of book equity, 1.7x term loan

R2: BUNDLING

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At date 0, B chooses a bundle of a loan (p, Q_0) and CL $(\tilde{p}, \mathrm{d}\tilde{Q})$ s.t.

(p, Q_0) coincides with outcome of exclusive competition

$(\tilde{p}, \mathrm{d}\tilde{Q})$ makes B indifferent to drawing at Q_0 with $\mathrm{d}\tilde{Q}$ "large"

R2: BUNDLING: PROOF

Recall that under candidate bundle

B never borrows again by R1

B's payoff maximized s.t. lenders break even by BM1

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B never borrows again by R1

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$\implies$ At any other bundle another lender can profitably enter

Can post candidate with price p replaced by $p + \epsilon$

R2: BUNDLING: INTUITION

Credit lines allow B to commit not to dilute by R1

Use credit lines to implement optimum without dilution (i.e. BM1)

R2 RESONATES WITH PRACTICE

Credit line bundled with loan as commitment device to curb dilution

Explains bundling, esp. for risky firms with high dilution risk

CLs OFFERED IN DEBT BUNDLES

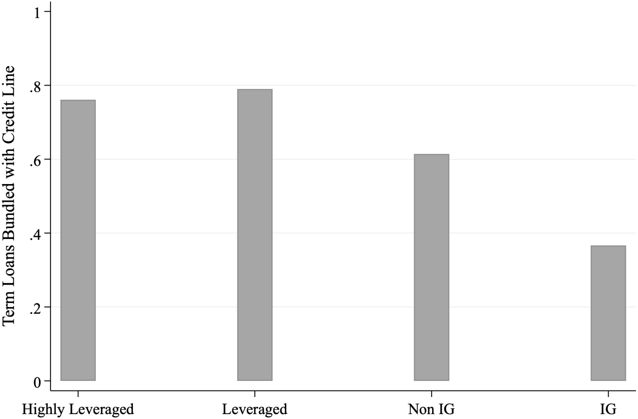

Figure: Bundling Propensity and Firm Riskiness

*This figure shows how the proportion of term loans that are bundled with a credit line vary by firm riskiness, as measured by Dealscan's classification of firms' market segments. The loans to the safest borrowers are Investment Grade ("IG"), then "Non-IG", "Leveraged", and "Highly Leveraged" respectively, where the distinction between the latter three categories depends on pricing thresholds. Data are from Dealscan, covering US C&I syndicated

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So far: Credit lines always honored if drawn

Now: Credit lines honored with prob. α (else disappear) if drawn

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$\implies$ Payoffs given drawing at Q_0 convex comb. of those at $Q_0 + \mathrm{d}\tilde{Q}$ and Q_0

R3: LENDER REVOCATION RISK INCREASES B's DEBT

R3: REVOCATION RISK

With revocation risk $1 - \alpha$, B can sustain price up to limit for dt $\to 0$:

$$p_0 - \frac{c'(Q_0)}{\rho} \leq \frac{\alpha}{1 - \alpha} \frac{c'(\infty)}{\rho}$$

R3: REVOCATION RISK: PROOF

Analogous to proof of R1:

Step 1: B borrows $\mathrm{d}Q$ at p iff $p \geq -\alpha V'(Q_0 + \mathrm{d}\tilde{Q}) - (1-\alpha)V'(Q_0)$

Step 2: Lenders lend $\mathrm{d}Q$ at p iff $p \leq \alpha\Gamma(Q_0 + \mathrm{d}\tilde{Q}) + (1-\alpha)\Gamma(Q_0)$

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Step 3: Using $-V' = c'/\rho$, show when both don't hold for $\mathrm{d}\tilde{Q} \to \infty$

R3: REVOCATION RISK: INTUITION

Credit line revocation risk makes new lenders willing to lend at higher p

Less worried about dilution by credit line if might not be there

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Credit line revocation risk makes new lenders willing to lend at higher p

Less worried about dilution by credit line if might not be there

$\implies$ harder to deter new debt

$\implies$ harder to commit not to dilute in the first place

PREDICTION

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Increased risk of borrower's credit line being revoked

$\Longrightarrow$ borrower takes on more debt

TESTS

TEST I

Based on fact that unhealthy lenders more likely to revoke credit lines (Chodorow-Reich–Falato 22)

Construct (neg) health shocks for borrowers' CL lenders and all lenders (following Chodorow-Reich 14 and Darmouni 20)

Shocks uncorrelated with borrower characteristics

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Findings

TEST I

Based on fact that unhealthy lenders more likely to revoke credit lines (Chodorow-Reich–Falato 22)

Construct (neg) health shocks for borrowers' CL lenders and all lenders (following Chodorow-Reich 14 and Darmouni 20)

Shocks uncorrelated with borrower characteristics

For borrower i, regress: $\text{new debt}_i = \alpha + \beta \text{shock CL}_i + \gamma \text{shock}_i + \delta X_i + \varepsilon_i$

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$\gamma < 0$: Shocks to all lenders decrease it (in line with literature)

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$\beta > 0$: Shocks to CLs increase borrowing (in line with our theory)

INCREASE DEBT AFTER SHOCKS TO CLs

	(1)	(2)	(3)	(4)
Shock	-0.16^{***}	-0.17^{***}	-0.17^{***}	-0.18^{***}
	(0.05)	(0.05)	(0.05)	(0.05)
Shock CL		0.03^{***}	0.02^{**}	0.03^{***}
		(0.01)	(0.01)	(0.01)
Number of Syndicates			0.03^{***}	0.04^{***}
			(0.01)	(0.01)
Pre CL Indic				-0.03^{**}
				(0.01)
Constant	0.20^{***}	0.19^{***}	0.19^{***}	0.18^{***}
	(0.04)	(0.04)	(0.04)	(0.04)
Observations	4883	4883	4883	4883
Adjusted R^2	0.002	0.003	0.009	0.010

TEST II

Exogenous increase in CL cost to some banks (due to 2018 SLR) $\Longrightarrow$

Affected firms borrow more in same year

EMPIRICAL RATES

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Rates on credit lines are relatively low ($\tilde{p}$ relatively high)

Median rate on the CL is equal to the rate on the associated term loan

Seems low given drawing increases leverage by 20%

Estimates in literature $\implies$ implied rate increase should be 5.4%

ROBUSTNESS

CREDIT LINE BUNDLES FOR $t > 0$

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So far: $t > 0$ lenders offer only debt, no new credit lines

Now: New lender can offer loan-CL bundle

R4: NO NEW CL LENDERS

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Suppose equilibrium with loan-credit line pair outstanding

No new lender offers bundle that B would accept

R4: NO NEW CL LENDERS: PROOF (SKETCH)

Same argument: Lender knows B will draw line in place (ratchet effect)

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Show by bounding payoff by commitment payoff

R5: WITH RISK, CONTINGENT CLs IMPLEMENT OPTIMUM

ADDING RISK

So far: No risk

Here: Allow for risk

How: Allow for additional Markov state s with debt Q_s contingent on s

Let Q_s^* be optimal debt at s

Let V_s and $\tilde{V}_s$ be value functions with and w/o CL

R5: CONTINGENT CLs IMPLEMENT OPTIMUM

Suppose V and $\tilde{V}$ exist, are convex, and monotone

Let $\tilde{p}_s = -\dfrac{V_s(Q_s^* + \mathrm{d}\tilde{Q}) - \tilde{V}_s(Q_s^*)}{\mathrm{d}\tilde{Q}}$ with $\mathrm{d}\tilde{Q}$ large

A contract with one lender with Q_s^* and $(\tilde{p}_s, \mathrm{d}\tilde{Q})$ implements optimum

R5: PROOF (SKETCH)

By definition, B indifferent to drawing at Q_s^* in state s

By ratchet, B draws if $Q > Q_s^*$

By $\mathrm{d}\tilde{Q}$ large, other lenders don't lend ($\Gamma(\mathrm{d}\tilde{Q}) \to 0$)

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Here: Commitment to take on less debt

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In lit.: Excessive debt and zero surplus

Here: Allowing for credit lines makes ratchet effect self-deterring

Latent contracts:

In lit.: Help lenders support collusive outcomes

Here: Help borrowers support monopolistic outcome

CONCLUSION

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Heretofore unexplored role of credit lines: commit not to dilute

- Curb competition with future self
- Implement monopoly outcome