Does Financial Integration Eliminate the Diabolic Loop?

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Outline

1. Motivation
2. Environment
3. Benchmark Outcomes
4. CRISES
5. Policy Interventions
6. Repeated Game

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Motivation

- Diabolic Loop Interaction Magnifies Debt and Bank Fragility
  - Bad News about sovereign debt repayment (Debt Run)
  - Value of Sovereign Debt Falls
  - Banks' balance sheets deteriorate
  - Government chooses to bailout banks, issuing more sovereign debt
  - value of debt falls further
  - ...
- Central Question: With financial integration (Banking Union) is this interaction reduced?
- Tensions from resulting diversification of debt holdings
  - insurance: risk sharing gains
  - incentives: spillovers created

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Literature

- Diabolic Loop: Brunnermeier ... ... Cooper-Nikolov
- Sovereign Debt and Banks: Gennaioli, Martin and Rossi
- Banks and Reallocation: Boissay .... Boissay-Cooper
- Interbank Flows : architecture and magnitudes
- Folk Theorem : Aumann, Rubinstein, Friedman

Key Elements

- Financial Integration: IBM reallocates deposits
- Focus on bank bailouts not deposit insurance
- Bailout is a government choice
- Adverse news about repayment reduces value of government debt and sets diabolic loop in motion
- Cross holding of government debt.
  - basis for risk sharing
  - creates moral hazard: impacts bailout choice and default

Findings : Financial Integration

+ provides a mechanism for capital reallocation
+ provides a mechanism for sharing of fundamental risk
− excessive inefficient bailouts can arise
+ diversification through cross-border holding shares default risk

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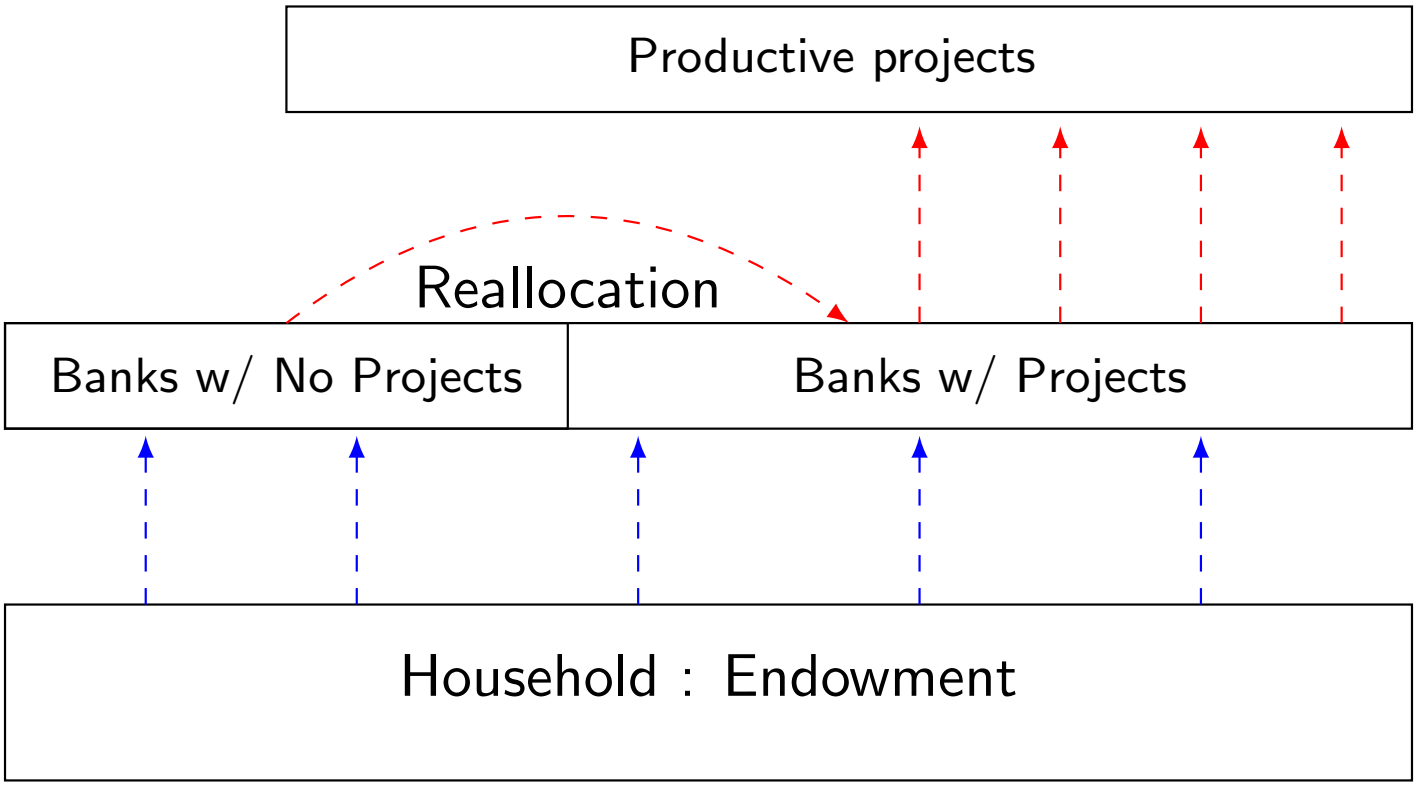
Flow of Funds : First Best



- Frictions
  - private information about bank opportunity
  - moral hazard by banks with loans
- Solutions
  - flows between banks in interbank market (IBM)
  - use government debt as collateral
  - equilibrium borrowing constraints in IBM
- leading to:
  - diabolic loop linking debt and intermediation
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Flow of Funds : Decentralized Single Country

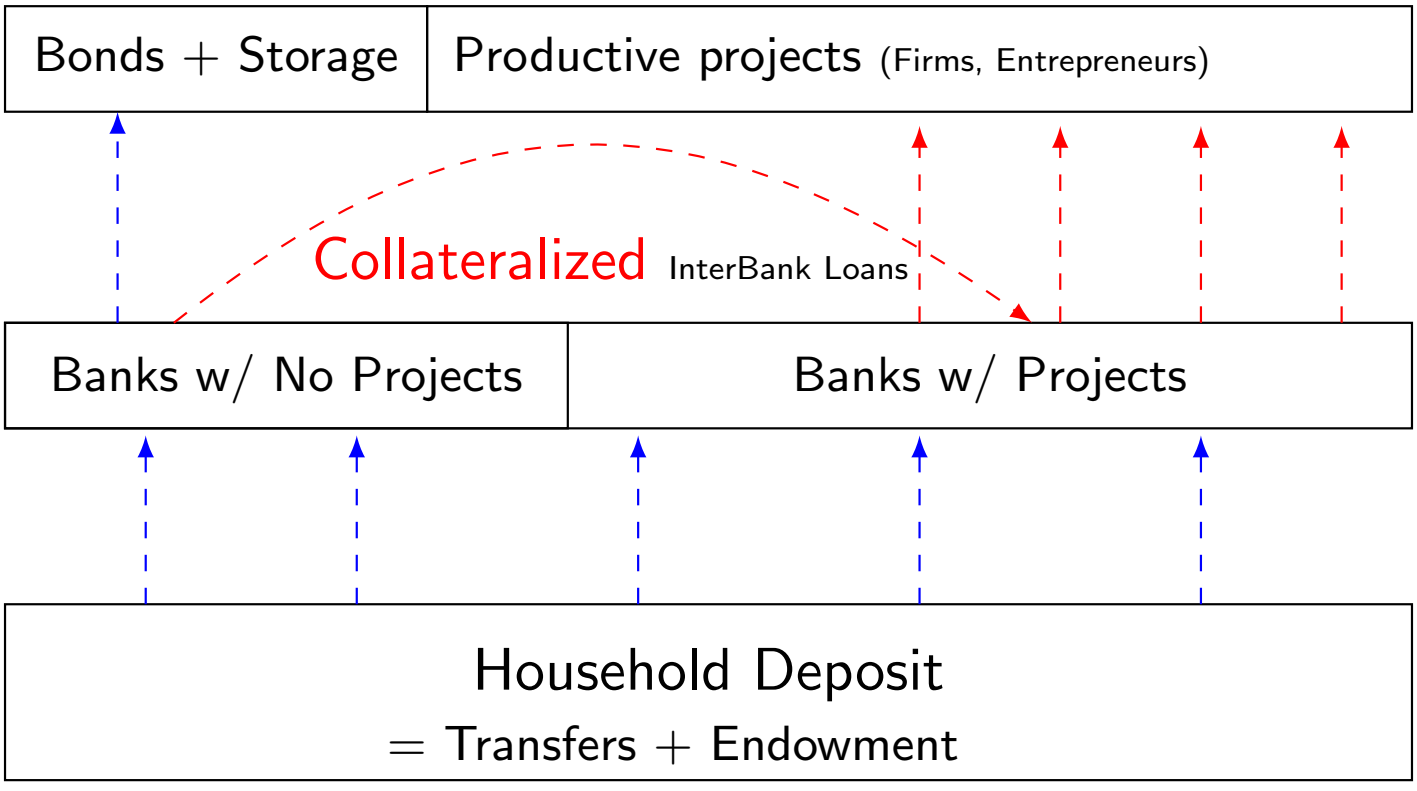
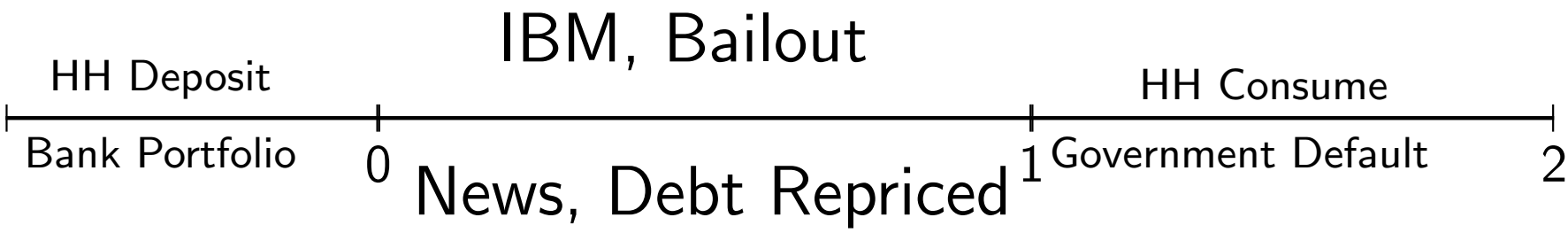


Figure: Timing of Choices



Actors

- Households
- Banks
- Government(s)

Households

- period 0 deposit endowment and government transfer into home "banks"
- Pay tax on government debt if no default in Period 2

Banks: Period 0

- take deposits, d_0, from households
- hold liquid assets: s_0
- hold bonds : b_0

$$d_0 = q_0 b_0 + s_0$$

- q_0 is a price

Banks: Period 1 CRITICAL

- π fraction have "investment opportunity"
- those with investment opportunity
  - borrow on IBM to obtain additional liquid assets: I
  - moral hazard (run away with funds)
  - equilibrium borrowing constraints
  - use valued government debt as collateral
  - government bailout $\tilde{B}$, initial debt of B_0
- IC in period 1:

$$I \leq \kappa \equiv \underbrace{q_1(B_0 + \tilde{B})}_{\text{price of debt}} \times \overbrace{(B_0 + \tilde{B})}^{\text{level of debt}}. \quad (1)$$

- those without investment opportunity lend, store or buy government debt : arbitrage is here

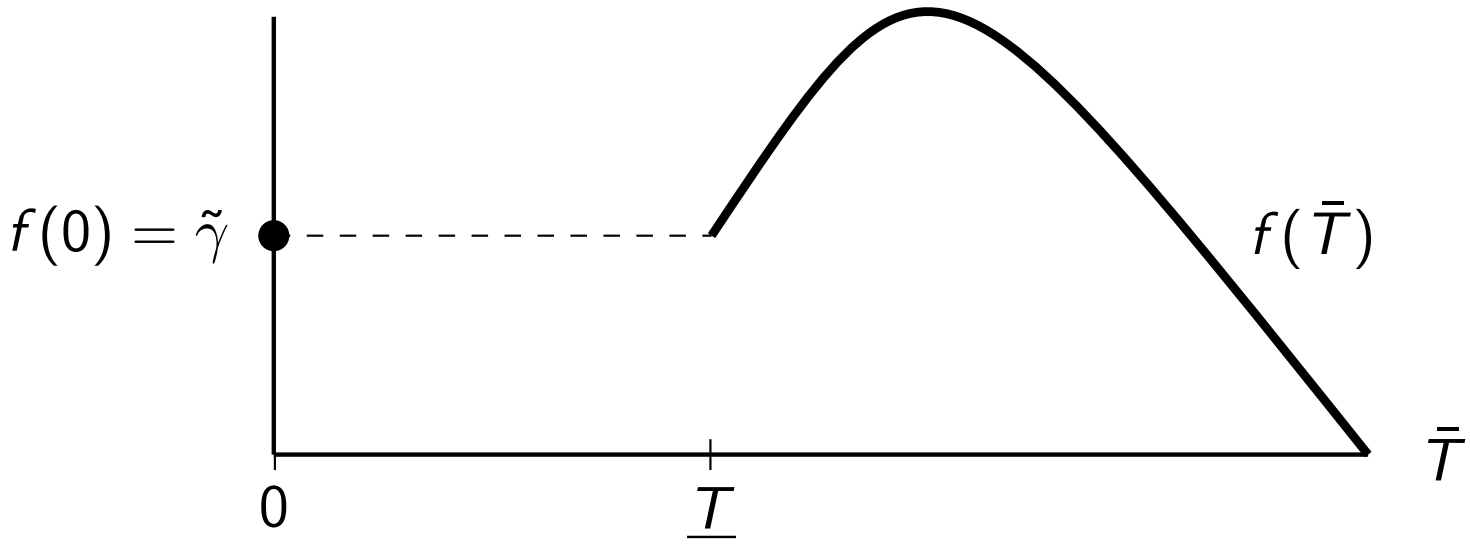
Government: Period 2

- Realize Tax Capacity
- Default iff Insufficient Tax Capacity
- if Default: incur a payoff loss of Γ
- if Repay: impose lump sum tax
- Endogenous Default : The Bailout Choice in Period 1 impacts the probability of Default

Government : Period 1

- receive news about probability of a zero tax capacity: $\tilde{\gamma} \in \{0, \gamma\}$
- choose bailout of banks in period 1

Figure: Maximal Lump Sum Tax: Distribution

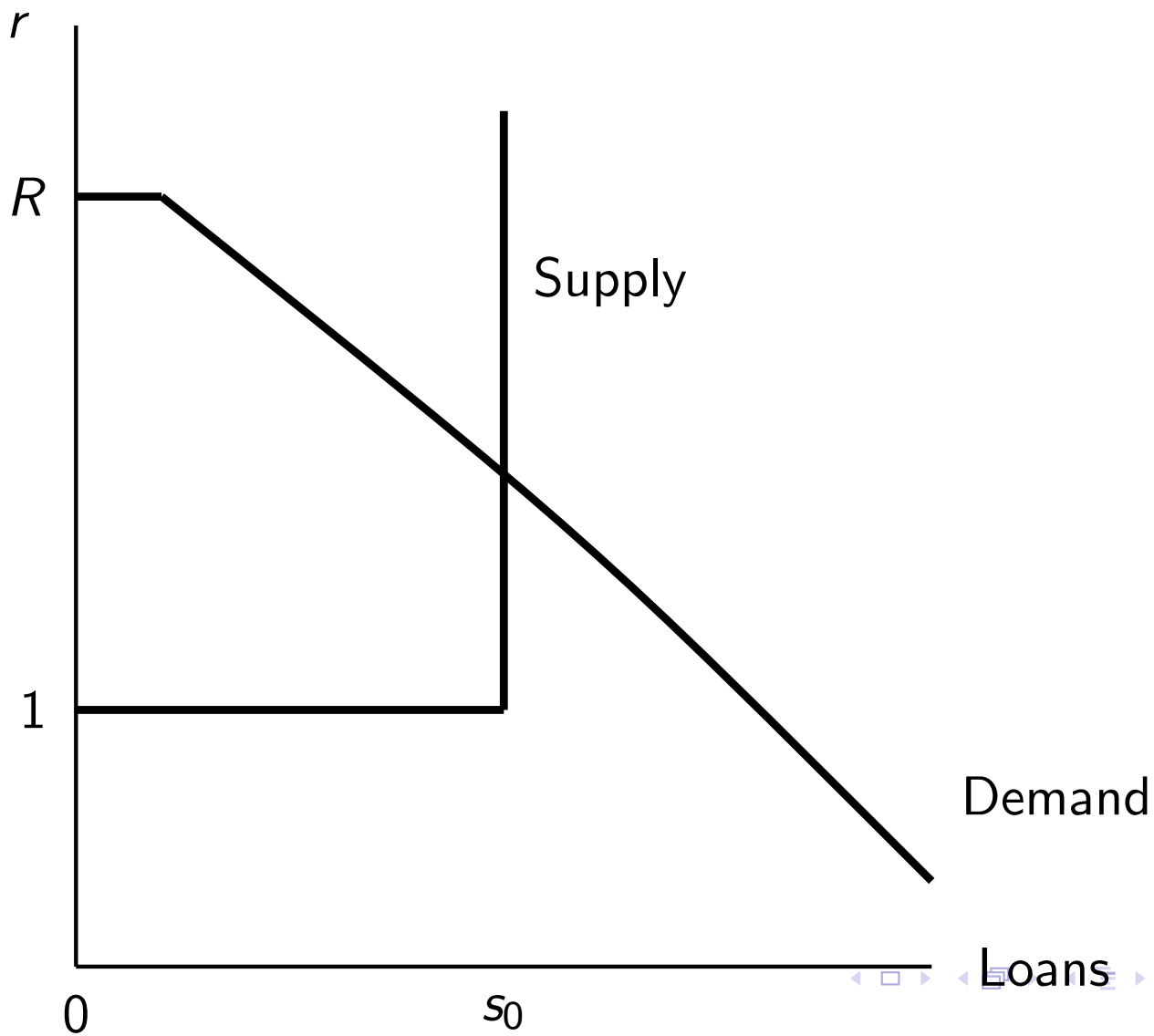


Single Country Bailout

Government is large and internalizes the impact of its bailout on:

- the price of its debt
- the IBM rate
- level of investment and flows between banks
- same power applies in multi-country setting

Figure: IBM equilibrium



Governments: Period 1

- Government maximizes expected consumption:

$$max_{\tilde{B}} \quad \underbrace{\pi R(s_0 + I)}_{Investment} + \overbrace{(1-\pi)s_1}^{storage} - [\tilde{\gamma} + (1-\tilde{\gamma})F(\overbrace{B_0 + \tilde{B}}^{B_1})]\Gamma. \quad (2)$$

- use bailout to minimize storage, maximize investment
- key is $I = \kappa = q_1(B_1) \times (B_1)$
- $q_1(B_1) = \frac{(1-\tilde{\gamma})(1-F(B_1))}{r}$
- bailout has adverse effects on q_1 by increasing default probability
- fiscal space: $\tilde{\gamma} = 0, B_0 + \tilde{B} \equiv B_1 < \underline{T}$

Mapping from Bailout to IBM outcome

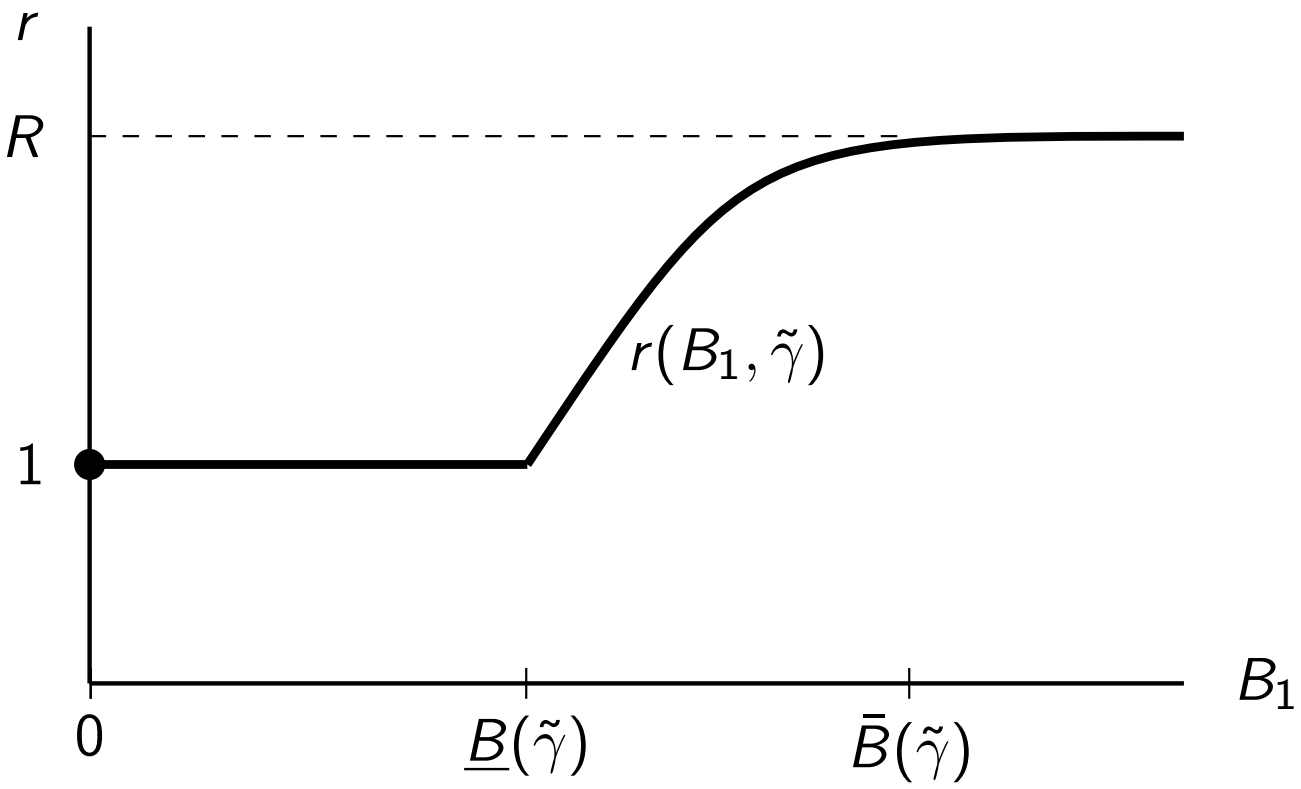
Lemma

There exists two critical levels of period 1 *debt, denoted* $\underline{B}_1(\tilde{\gamma})$ *and* $\overline{B}_1(\tilde{\gamma})$ *with* $\underline{B}_1(\tilde{\gamma}) < \overline{B}_1(\tilde{\gamma})$ *such that:*

1. *If* $B_1 \leq \underline{B}_1(\tilde{\gamma})$, *then: (i)* $r = 1$, *(ii)* $s_1 > 0$ *and (iii) an increase in* B_1 *is met by substitution from storage to lending;*
2. *If* $\underline{B}_1(\tilde{\gamma}) < B_1 < \overline{B}_1(\tilde{\gamma})$, *then : (i)* $1 < r < R$, *(ii)* $s_1 = 0$ *and (iii) an increase in* B_1 *is met by an increase in* r *such that lending is constant;*
3. *If* $B_1 \geq \overline{B}_1(\tilde{\gamma})$, *then: (i)* $r = R$, *(ii)* $s_1 = 0$ *and (iii) an increase in* B_1 *is held by banks;*

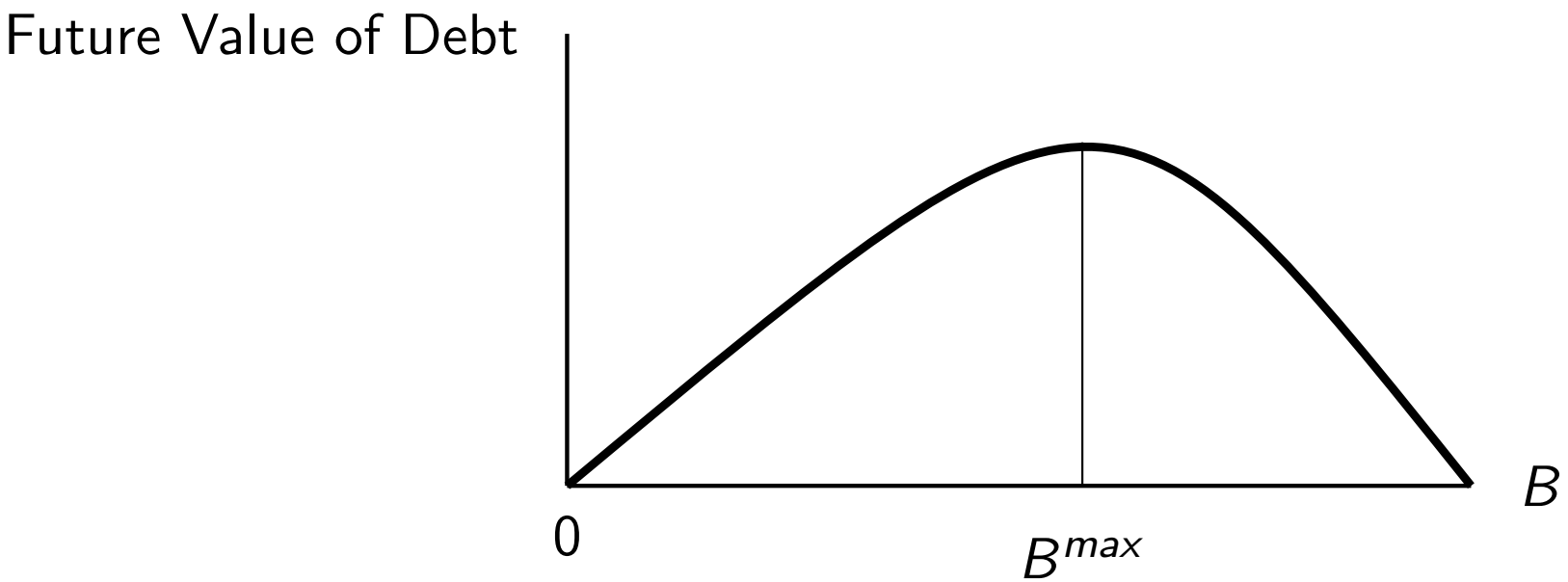
Further both $\underline{B}_1(\tilde{\gamma})$ *and* $\overline{B}_1(\tilde{\gamma})$ *are increasing in* $\tilde{\gamma}$.

Figure: Dependence of IBM rate on Debt



This figure shows the equilibrium rate in the IBM, r, given $\tilde{\gamma}$.

Figure: Revenue from Debt Issuance



Version with Multiple Countries

- Banks hold debt of both countries in period 0

$$\sum_k q_0^k b_0^{jk} + s_0^j = d_0^j$$

- Period 1 collateral becomes

$$\kappa^j = \sum_k q_1^k b_0^{jk} + q_1^j \tilde{b}^j \tag{3}$$

$k = 1, 2$ indexes the two countries, j is a particular country.

- Market Clearing Integrated IBM

$$\sum_k \pi^k I^k = \sum_k (1 - \pi^k) L^k. \tag{4}$$

- bailout game in middle period

Bailout Choice : For each government

- Expected Consumption

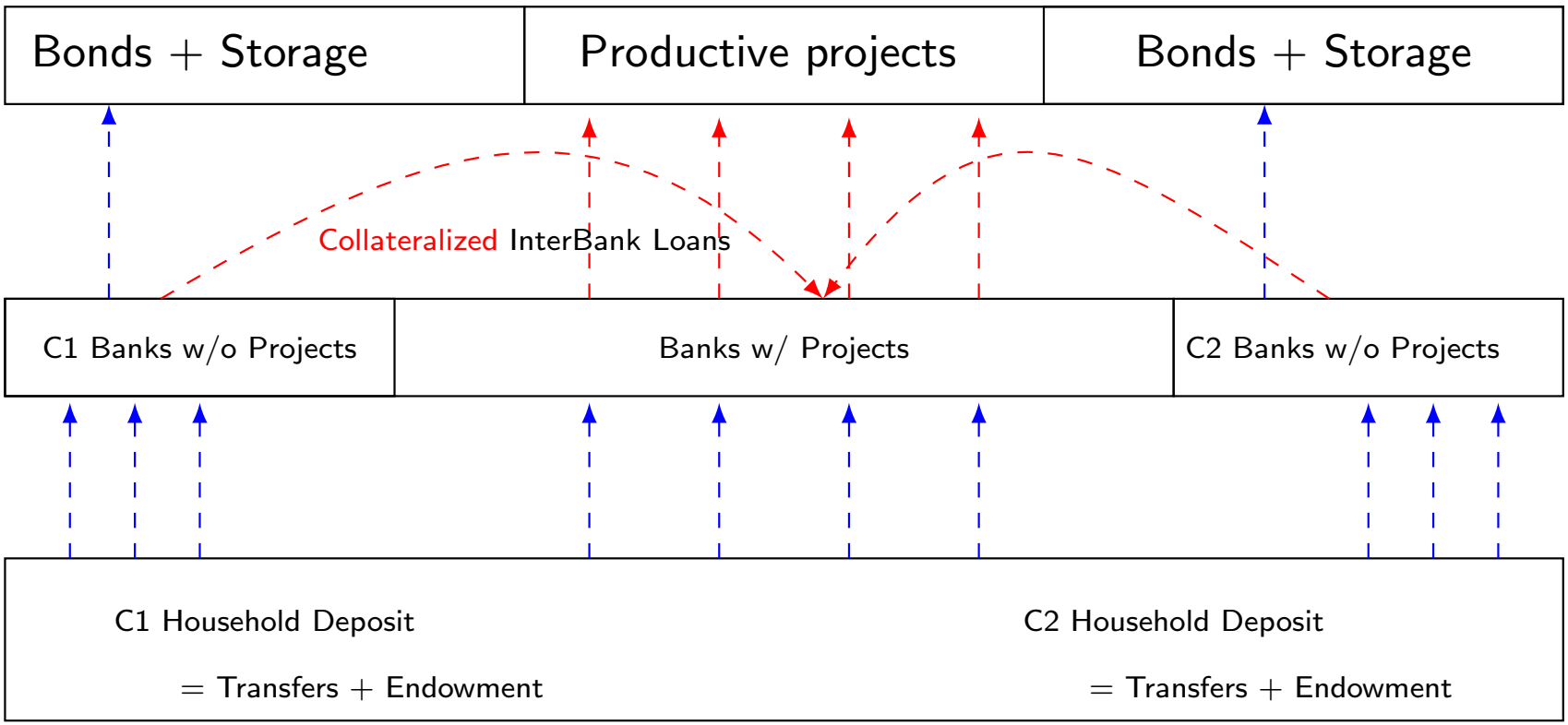
$$
\begin{aligned}
c^j &= \overbrace{\pi(R(s_0+I^j)-rI^j)+(1-\pi)[r(s_0-s_1^j)+s_1^j]}^{\text{bank flows}} \\
&+ \underbrace{(1-\theta^{-j})B_0^{-j}(1-\tilde{\gamma}^{-j})(1-F(B_1^{-j}))-(1-\theta^j)B_0^j(1-\tilde{\gamma}^j)(1-F(B_1^j))}_{\text{debt flows}} \\
&- \underbrace{[\tilde{\gamma}^j+(1-\tilde{\gamma}^j)F(B_1^j)]\Gamma}_{\text{default}}. \qquad (5)
\end{aligned}
$$

- Bailout FOC

$$
\begin{aligned}
&\pi(R-r)\frac{\partial I^j}{\partial \tilde{B}^j}-(1-\pi)(r-1)\frac{\partial s_1^j}{\partial \tilde{B}^j}+[(1-\pi)(s_0-s_1^j)-\pi I^j]\frac{\partial r}{\partial \tilde{B}^j} \\
&= (1-\gamma)f(B_0^*+\tilde{B}^j)\left(\Gamma-(1-\theta^*)B^*\right). \qquad (6)
\end{aligned}
$$

- Effects other country through both asset prices and IBM rate

Flow of Funds : Decentralized, Multi-Country



Equilibrium

- optimization by banks and government in all periods
- market clearing
  - period 0 market for government debt
  - period 1 IBM
  - period 1 market for government debt
- θ^k is the fraction of home debt held by country k banks in period 0
  - at bank level, indifference
  - matters for equilibrium outcomes

Definition of Equilibirum

Definition

In each state, $\mathcal{S}$, banks in both countries choose: (i) period 0 portfolio of liquid assets and bonds from both countries and (ii) period 1 decision, after learning type, of whether to be a lender or a borrower in the IBM and, if a borrower, whether to invest the borrowed funds or abscond. Governments independently choose: (i) period 0 debt and the (ii) period 1 level of bailout. An equilibrium consists of these optimizing choices along with market clearing of: (i) the period 0 bond market, (ii) the period 1 bond market and (iii) the period 1 IBM.

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First Best: No Moral Hazard

- liquidity moves to productive banks
  - between those with and without projects
  - across borders
- no storage
- $c = Ry_0$ implies W^*
- no role for government debt
- no crisis

Normal Times Equililbriurm

- no crisis : $\tilde{\gamma} = 0$ in both countries
- Fiscal Space

Assumption

$B^* \leq \underline{T}^j$.

- First Best Supported

Proposition

Under Assumption 1, then there exists an equilibrium without default with: (i) $l^* = \kappa^* = \frac{(1-\pi)s_0}{\pi}$*, (ii)* $R = r$*, (iii)* $s_1 = 0$ *and (iv)* $c = Ry_0$ *where* $B^* \equiv \frac{(1-\pi)s_0}{\pi}$*. There is no incentive for a bank bailout in period* 1*. The welfare level* W^* *is obtained.*

- $\theta = \theta^*$ irrelevant

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Evaluate Outcome by

- eliminate storage
- minimize default risk
- distribution of consumption

Symmetric Crisis

- $\tilde{\gamma} > 0$: strictly positive probability of default in both countries
- Small γ
  - news reduces value of government debt
  - demand for IBM loans falls
  - r falls but $r > 1$, so $q_1(B^*)$ increases
  - first best investment obtains: news absorbed in IBM rate to support collateral values
  - BUT $R > r$: both countries have an incentive to bailout to increase capital inflows (market share)
- Large γ
  - induces bailout by both governments
  - support first best investment iff sufficient fiscal space or Γ small

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Proposition

In a symmetric crisis, the lending is at the first-best level, i.e. $l = l^*$*, if either: (i) the probability of default is small enough that it is absorbed by a fall in the interest rate, or (ii) the cost of default,* Γ*, is sufficiently small. Else,* $l < l^*$*.*

Proposition

In a symmetric crisis, if governments bailout their banks the amount of bailout in each country exceeds the single-country level. Welfare, $W^s(\theta^*, \gamma)$, is below that obtained in the single country case if $\theta^* < 1$ and is increasing in θ^*.

- spillovers : welfare loss relative to single country case if $\theta^* < 1$
- without risk sharing gain, financial integration is not desired

Asymmetric Crisis : Suppose

- $c1$ has no bad news: $\tilde{\gamma} = 0$
- $c2$ has bad news : $\tilde{\gamma} = \gamma > 0$
- allow $\underline{T}^j$ to differ

Asymmetric Crisis : Approach

- do the countries together have enough fiscal space?
  - if yes: how share it
  - if no: how share default risk?
- Study some Extreme Cases
  - risk sharing through cross holding of debt: θ^* small
  - risk sharing through capital flows: θ^* near 1

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Cross Holding of Debt

Proposition

In the asymmetric crisis, if θ^* is sufficiently small and $\underline{T}^1$ is sufficiently large, then an increase in the probability of default has no effect on investment. The first best welfare level, W^*, is obtained.

- risk shifted to $c1$ through cross holding of debt: $\theta^* \leq \theta^{rs}$
- bailouts occur in both countries but stay within fiscal space
- support first best allocation
- a lower θ^* is needed for larger γ
- dominates outcome without union

Risk Sharing thru *Ex Post* Capital Flows

Proposition

Suppose $\theta^* = 1, \tilde{\gamma}^1 = 0, \tilde{\gamma}^2 = \gamma$. *If*

- γ *is sufficiently small, then the first-best allocation will be maintained through a bailout by country* 2 *of its banks.*
- *else, there will be a bailout of its banks by country 1, drawing capital from country* 2 *banks without an investment opportunity. The (aggregate) efficient level of investment will attain if country* 1 *has adequate fiscal space.*

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Policy Interventions

- limit bailout spillover and/or share risk
- Cooperative Solution
  - Internalize Spillovers
  - Efficiently use fiscal space
- Common Bonds : Can reproduce Cooperative Solution
- Limits on Cross Holdings : Desired if
  - shocks are common
  - no limits to *ex post* capital flows
- Policy acts on IBM rate to impact interactions through r

Cooperative Solution

- Objective

$$\begin{aligned} c^{agg} &= \max_{\tilde{B}^1,\tilde{B}^2} \pi \sum_{j=1,2} R(s_0 + I^j) + \sum_{j=1,2} ((1-\pi)s_0 - \pi I^j) \\ &- \sum_{j=1,2} [\tilde{\gamma}^j + (1-\tilde{\gamma}^j)F(B_0 + \tilde{B}^j)]\Gamma. \end{aligned} \tag{7}$$

- FOC

$$\pi(R-1)\frac{\partial I^j}{\partial \tilde{B}^j} = (1-\tilde{\gamma}^j)f(B_0^* + \tilde{B}^j)\Gamma. \tag{8}$$

where $f(B_0^* + \tilde{B}^j) = 0$ if $(B_0^* + \tilde{B}^j) \leq \underline{T}^j)$.

Proposition

If there is adequate fiscal space, the solution to (7) *entails issuing sufficient debt to support the first-best level of investment. Else, the solution to* (7) *entails equal bailouts in each country such that the marginal cost of bailout is independent of* $\tilde{\gamma}^j$.

-

Common Bonds

- issue B^* to each country in the initial period
- adequate to support first best allocation in normal times
- bailout FOC is the same as cooperative solution
- allocate debt obligation to equalize expected marginal cost of default

Proposition

The allocation with common bonds coincides with the cooperative solution.

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Risk Sharing Gains But ...

- exploiting simplicity of exogenous default
- low θ creates an incentive to default
- yet low θ generates risk sharing gains
- study incentives for repayment in dynamic game

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Infinitely Repeated PD

- C : cooperative payoff
- D : defection payoff
- A : Nash Equilibrium after defection
- Cooperation is supported iff

$$(D - C) \leq \frac{\beta}{1 - \beta}(C - A)$$

Our Version

- $C(\theta)$:
  - W^* if $\theta \leq \theta^{rs}$
  - increases as θ falls
- $D(\theta)$:
  - default on debt outstanding
  - defection payoff increases as θ falls
- A :
  - Single Country IBM post defection
  - lost risk sharing
  - $W^a < W^*$
- Cooperation is supported iff

$$(D(\theta) - C(\theta)) \leq \frac{\beta}{1-\beta}(C(\theta) - A)$$

Asymmetric Crisis

Debt Repayment

- Incentives for Repayment

Proposition

There exists a critical value of θ, denoted θ^{ic} such that debt will be repaid in all states if $\theta \geq \theta^{ic}$. Further, $\theta^{ic} < 1$.

- Equilibria of Infinitely Repeated Game

Proposition

If β is sufficiently high, the critical value θ^{rs} can be supported as an equilibrium without strategic debt default. That is $\theta^{rs} \geq \theta^{ic}$. In equilibrium, W^* obtains.

- Key, as always, is patience

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Conclusions

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- Strengthen it by excessive bailout
- policy interventions may be useful
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