Money Market Funds Intermediation, Bank Instability and Contagion

Marco Cipriani, Antoine Martin, Bruno M. Parigi

Prepared for seminar at the Banque de France, Paris, December 2012

Preliminary and incomplete

- The views expressed in this paper are solely those of the authors and do not necessarily represent those of the Federal Reserve Bank of New York or of the Federal Reserve System.

Money Market Funds

Over the last decade, U.S. banks have increasingly relied on funds from intermediaries, especially Money Market Mutual Funds (MMFs)

- MMFs are a class a mutual funds who invest in “safe” financial assets, with a short maturity:
  - They collect deposits, mainly from large institutional investors who are not covered by deposit insurance
  - They lend them, especially to banks and other financial institutions
- To limit exposure to a single institution, MMFs diversify their investment across institutions

Economic Function of MMFs

- Cash management tools for firms (and the government)

- MMFs allow investors to reap a positive yield on their cash holdings
- Since MMFs diversify their investment, they are perceived as safer than uninsured bank deposits

- Very popular financial instrument: assets under management grew from approx. $2tn in 2005, $3tn end of 2008, $2.6tn in 2012
- 21% of U.S. Mutual Fund Assets

MMFs as a Source of Short-term Funding

- MMFs are key providers of short-term funding, especially to the financial sector.

- Among the largest investors in some asset classes:

Percentage of MMF Investment by Asset Classes (6/12)				
Nonfinancial CP	Financial CP	Asset-backed commercial paper (ABCP)	Certificates of Deposit	Repurchase Agreements
43%	43%	38%	29%	33%
75bn	207bn	117bn	434bn	591bn

MMF Vulnerability

- ✓ MMFs do invest in instruments with credit, interest and liquidity risk

- ✓ Highly risk-averse investors

- ✓ In the US, they offer demandable deposits (shares) redeemable at par: fixed Net Asset Value (NAV)
  - *Breaking the buck*: when the Net Asset Value (i.e., the value of the asset per share) falls below 0.95, the MMF is forced by SEC regulation to re-price all its shares
  - Even small losses can start a run

  ⇒Investors have an incentive to redeem <u>before</u> the MMF breaks the buck

The Run of 2008

- In 2008, a MMF (Reserve Primary) broke the buck
- Stampede of withdrawals across the sector
- To stem the panic, both the Fed and the Treasury stepped in

➢ Active policy debate in US on the MMF industry:

1. Should the design of MMFs be reformed?

   NY Fed Staff Report: Minimum Balance at Risk

2. Does MMF intermediation increase financial system (banking) fragility?

$\Rightarrow$ Runnable financial institutions (Banks) rely for funds on institutions (MMFs) that are themselves runnable

Outline

- A two-bank, stochastic return Diamond and Dybvig (1983) model
  - Direct Finance (DF)
  - Money Market Funds Intermediation (MMF-I)

- The Effect of an Investors' Run (unexpected withdrawal of funds)

- Contagion (if time allows)

The Model

- Economy à la Diamond and Dybvig (1983)

- Three periods: 0, 1, 2

- 2 regions (A and B) and 2 Banks (*A* and *B*), and (with MMF intermediation) 2 MMFs (A and B)

- In each region, a continuum of wholesale (uninsured) investors of mass M

The Model

- Each investor has one unit of a good, which he deposits in one or both of the two banks, or (under MMF intermediation) in one of the two MMFs

- At time 0, each Bank can invest the good in:

  $\Rightarrow$ a stochastic long-run technology

  $\Rightarrow$ a storage technology

- Investing in the two banks allows investors and MMFs to decrease risk through diversification

Stochastic Long-Run Technology

- Banks have access to a stochastic long-run technology, paying a positive return at time 2
- Two states of the world
- Returns at date 2 of the two banks per unit invested in the long-run technology:

	Return: Bank *A*	**Return: Bank *B***
Probability 1/2	$R^H = \alpha R$	$R^L = R$
Probability 1/2	$R^L = R$	$R^H = \alpha R$

$R>0$, $\alpha>1$, $\Rightarrow R^H > R^L$

Stochastic Long-Run Technology

- Since the states of the world are equally likely, the net present value of a unit of investment in the long-run technology is the same for the two banks:

$$R(\alpha + 1)/2$$

- Assume $R(\alpha + 1)/2 > 1$
  - Long-run technology has a (gross) expected return greater than one
- Assumption: the long-run technology can be liquidated at the rate $r<R$
- The return of the storage technology is one

Preferences of Investors

- A fraction π of investors is impatient and consume at date 1.
- A fraction (1- π) is patient and consume at date 2
- The date 0 expected utility of investors:

$$\pi \log(c_1) + (1 - \pi) \log(c_2)$$

c_1, c_2 consumption at date 1, date 2, per unit invested

Direct Finance vs. MMF Intermediation

We compare two setups:

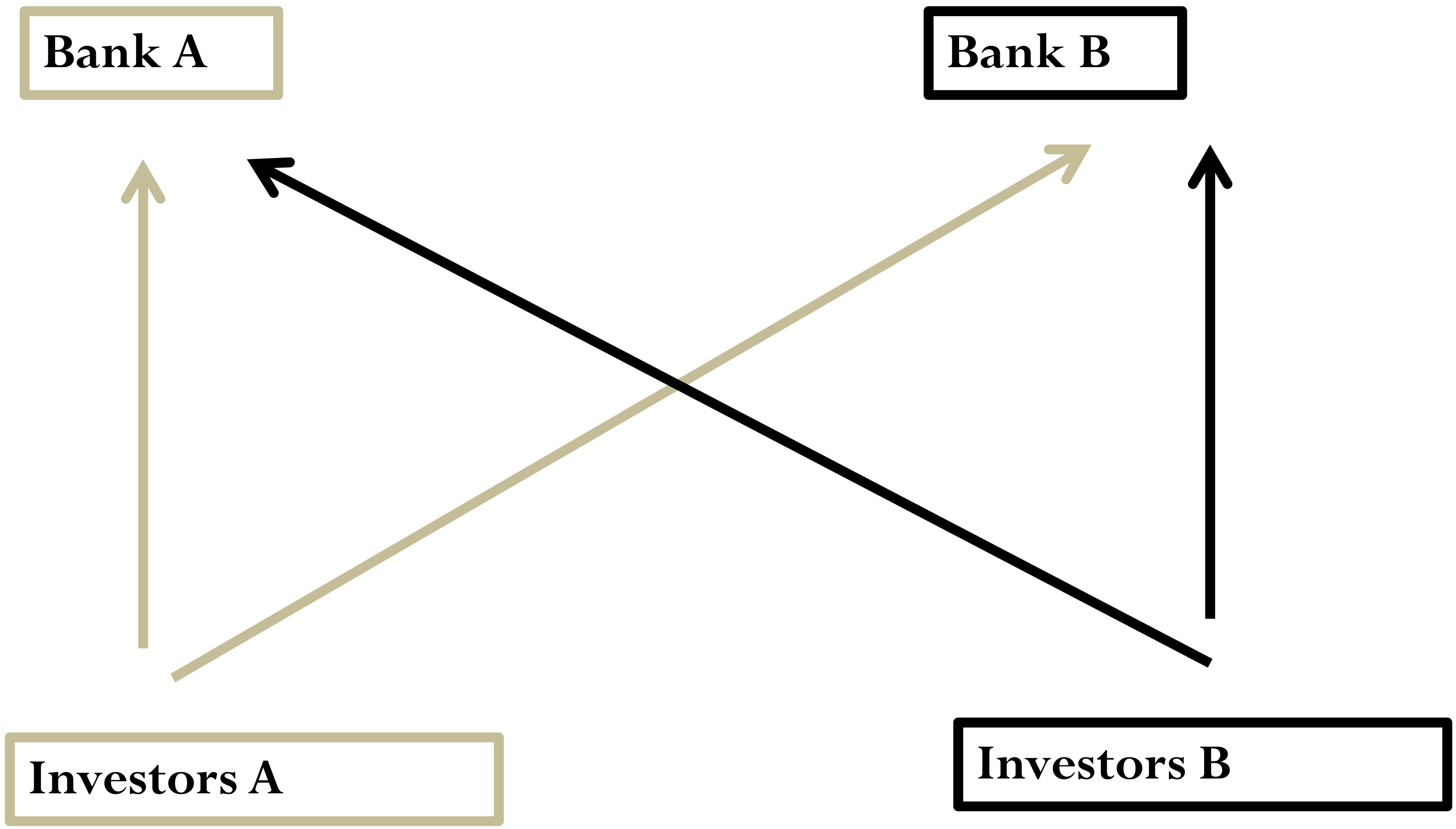
⇒ Direct finance (DF): investors invest directly in the two banks

⇒ MMF intermediation (MMF-I): investors invest in the two banks through an MMF

We study which one of the two setup is more "fragile"

✓ Note: **MMF intermediation allows to save monitoring costs (as in Diamond 1984)**

The Economy with Direct Finance (DF)



The Banks' Problem with DF

- Banks: zero expected profits

- (All analysis is per unit of deposit)

- Banks choose c_1, c_2, i (investment in the long-term technology per unit of deposit) to max expected utility of depositors subject to their feasibility constraints.

- Solution:

$$c_1 = 1 \text{ and } i = 1 - \pi$$

$$c_2^H = \alpha R \text{ and } c_2^L = R$$

The Payoff at Time 2 with DF

- Optimal contract:

$$c_2^H = \alpha R \text{ and } c_2^L = R$$

- Although c_1 is stochastic, by investing in both banks the same amount, investors obtain a deterministic date 2 payoff:

$$\frac{c_2^H + c_2^L}{2} = \frac{R(\alpha + 1)}{2}$$

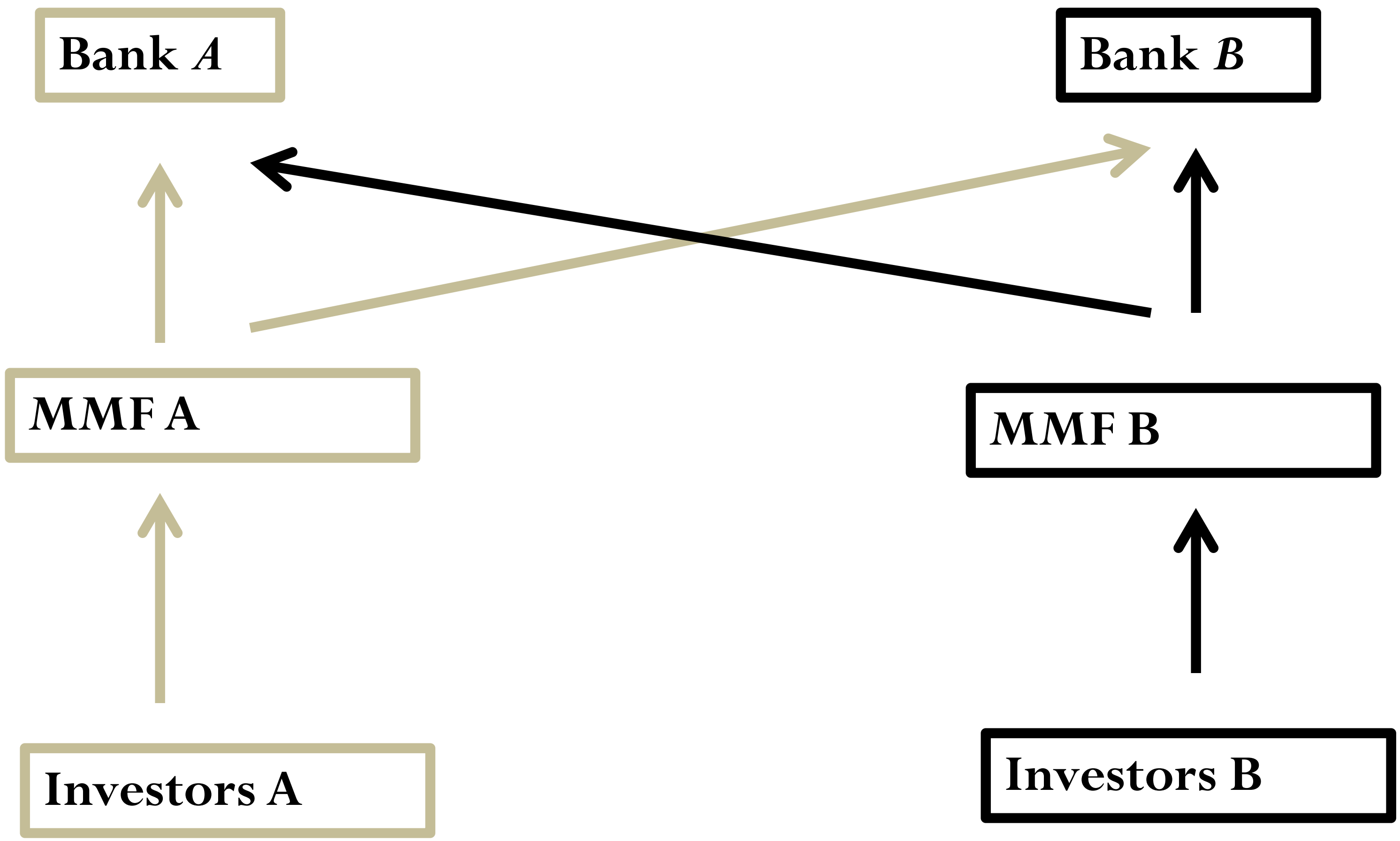
MMF Intermediation (MMF-I)

In each region there is an MMF

$\Rightarrow$ channels regional deposits to the two Banks

$\Rightarrow$ maximizes the expected utility of its investors

The Economy with MMF Intermediation (MMF-I)



MMF Intermediation (MMF-I)

- Optimal contracts offered by banks to each MMF are the same as those offered to investors under DF
- Each MMF simply aggregates the payouts coming from the two banks
- Thus contract per unit of deposit offered by the MMF to its investors is:

$$c_1^{MMF} = 1, \quad c_2^{MMF} = \frac{R(1+\alpha)}{2}$$

Outline

- A two-bank, stochastic return Diamond and Dybvig (1983) model
  - Direct Finance (DF)
  - Money Market Funds Intermediation (MMF-I)
- The Effect of an Investors' Run (an unexpected withdrawal of funds)
- Contagion (if time allows)

The Run: an Unexpected Withdrawal of Funds

- We study the effect of an investors' run in both DF and MMF-I
- Run: a positive measure of patient investors, q, unexpectedly withdraws early from region A.
- Under DF, they withdraw from Bank *A;* under MMF-I, from MMF A

The Unexpected Withdrawal of Funds

Unanticipated shock, similarly to Allen and Gale (2000)

$\Rightarrow$ since it is unanticipated, it does not change the allocation at date 0

$\Rightarrow$ motivation: runs on MMFs have been rare, unexpected events

- With an investors' run, the overall withdrawal from region *A* becomes:

$$\underbrace{\pi}_{\text{impatient dep.}} + \underbrace{(1-\pi)q}_{\text{patient dep.}}$$

- Assumption: distribution of q is uniform on [0, 1]

Information versus Liquidity Runs

- A run q can be due either:

  $\Rightarrow$ private information: return of Bank A is low

  $\Rightarrow$ a liquidity shock: a fraction of late depositors in region A becomes impatient

- Assumption: The higher the size of run q, the more likely it happens for information reasons

Information and Run Size

The larger the run, the higher the probability that it conveys information on Bank *A*

$$Pr(\text{Informational Run}) = f(q) \text{ where } f'(q) > 0$$

- WLOG: assume $Pr(\text{Informational Run}) = q$

Probability Updating

Bank A (under DF) and MMF A (under MMF-I) see the run on themselves and update the joint probabilities on Banks A and B:

$$\Pr(R_A^H, R_B^H \mid q) = 0(q) + 0(1-q) = 0,$$

$$\Pr(R_A^H, R_B^L \mid q) = 0 \underbrace{(q)}_{\text{Pr. run inform.}} + 0.5(1-q) = 0.5(1-q) < 0.5,$$

$$\Pr(R_A^L, R_B^L \mid q) = 0.5(q) + 0(1-q) = 0.5q,$$

$$\Pr(R_A^L, R_B^H \mid q) = 0.5(q) + 0.5(1-q) = 0.5.$$

✓ Note: the information is only on the return of Bank A, not of Bank B

The Run and Bankruptcy

- The run q may cause bank bankruptcy in the economy

- Bankruptcy is <u>not the result of a sunspot</u>, a wave of pessimism, but stems from the excess withdrawal q by patient investors and, in the MMF-intermediated economy, from the information that such withdrawal conveys to the MMF

Bankruptcy Rules

- Sequential service constraint
- Informed investors and MMFs (because they react to informed investors withdrawing) withdraw at the beginning of the line (since they have received information)

Runs under DF

- A run on Bank *A* under DF will push it into bankruptcy if *q:*

$$(\pi + \frac{(1-\pi)}{2} q) c_1 > 1 - i + ri$$

- Using optimal contracts:

$$(\pi + \frac{(1-\pi)}{2} q) 1 > \pi + r(1-\pi)$$

- Bank *A* goes bankrupt iff $q > 2r$

- We focus our analysis on $q \leq 2r$, the set of realizations such that a run *does not* cause bankruptcy under DF

Runs under DF

- Remember that $r \leq R$
- That is, the liquidation rate is lower than the return in the low state.
- *Therefore, the Bank will never liquidate its long-run investment in excess of what is needed to satisfy "running" investors*

The Run under MMF-I

- If after suffering a run, MMF A believes that Bank *A*'s return is low with high enough probability it withdraws ALL its deposits

- Why? Because this maximizes the utility of its investors, who benefit by jumping ahead of the queue

- Key amplification mechanism that makes the MMF-intermediated structure more unstable than direct finance

Bankruptcy under MMF-I

If MMF A runs on Bank *A*, it bankrupts the Bank as long as:

$$(\pi + \frac{(1-\pi)}{2})c_1 > 1 - i + ri$$

with the optimal contract, this becomes:

$$(\pi + \frac{(1-\pi)}{2})1 > \pi + r(1-\pi)$$

which is always true as long as $r < 0.5$.

The Choice for the MMF

1. Liquidating only the minimum *from both banks* to satisfy excess early withdrawals q

$$EU^{\text{MMF Does Not Run}}(\hat{c}^{H}_{2,A}, \hat{c}^{L}_{2,A}, \hat{c}^{H}_{2,B}, \hat{c}^{L}_{2,B}; q)$$

Where

$$\hat{c}^{H}_{2,A}, \hat{c}^{L}_{2,A}, \hat{c}^{H}_{2,B}, \hat{c}^{L}_{2,B}$$

are the payoffs at date 2 to the remaining (1-q) late investors.

The payoffs result of the (optimal) choice of MMF A at date 1 from which bank to withdraw

…OR…

2. Running from Bank *A* and trigger its bankruptcy

$$EU^{\text{MMF Runs}}(\hat{c}_1, c_{2,A}^{H}, c_{2,B}^{L}; q)$$

Where $\hat{c}_1$ is what MMF investors obtain at time 1 if the MMF forces Bank *A* to liquidate all its asset at date 1

Proposition 1

If

$$\pi > \frac{0.5 - r}{1 - r}$$

there is an interval of realizations of q for which bankruptcy occurs with MMF-I intermediation because

$$EU^{MMF \text{ Runs}} > EU^{MMF \text{ Does Not Run}}$$

<u>but not</u> with DF.

Comments on Proposition 1

An MMF-intermediated system is more fragile than direct finance:

- MMFs give investors demandable liabilities to satisfy liquidity needs, which makes MMFs runnable
- When the MMF is subject to a run, the MMF may run on the Bank to protect *all* its own investors and not just those initiating the run
- This amplifies the initial run

Comments on Proposition 1

- The need for MMF to run stems from the fact that the initial run contains negative information

- Because of banks' fixed promise at date 1, the MMF, receiving negative information on the bank's asset, obtains (in expected value) a higher payoff for its investors if it runs than if it does not

- Nevertheless, since the initial run may be due to liquidity as opposed to informative reasons, bank bankruptcy under MMF intermediation <u>causes inefficient liquidation</u> of the long-term investment

Proposition 2

If $\pi > \frac{0.5 - r}{1 - r}$,

there is a threshold

$$q^* \leq \tilde{q} \equiv \frac{\log\left(\frac{(\alpha R + 1)(R + 1)}{(\alpha R + R)^2}\right)}{\log\left(\frac{2}{(\alpha + 1)}\right)},$$

such that any realization of $q > q^*$ leads to bankruptcy under MMF intermediation.

Probability of Bankruptcy under MMF-I

The probability of bankruptcy under MMF intermediation is:

$$\Pr(bankruptcy) \geq 1 - q^* \equiv 1 - \log \frac{(\alpha R + 1)(R+1)}{(\alpha R + R)^2} / \log(\frac{2}{(\alpha + 1)})$$

Comparative Statics

The higher the long-term technology return, the lower the probability of bankruptcy after a run

$$\frac{\partial \tilde{q}}{\partial R} > 0, \quad \frac{\partial \tilde{q}}{\partial \alpha} > 0$$

Outline

- A two-bank, stochastic return Diamond and Dybvig (1983) model
  - Direct Finance (DF)
  - Money Market Funds Intermediation (MMF-I)
- The Effect of an Investors' Run (unexpected withdrawal of funds)
- Contagion (if time allows)

Proposition 3, Contagion

If $$\alpha < \frac{3-R}{R(1+R)},$$

bankruptcy of Bank *A* triggers bankruptcy of Bank *B*.

- If one bank is run on, it is optimal to run on the other as well even if no new information is available on it
- Why? A bank is not viable alone given the contract it offers. Diversification opportunities that arise from investing in both banks may turn into a source of fragility

Comments on Contagion

- Contagion stems from the loss of diversification that the liquidation of one bank entails for the depositors of the other.

- This is different from the interbank diversification channel of contagion of Allen and Gale (2000), because it relies on the increase in riskiness of one bank due to the collapse of the other, rather than on a direct loss of funds because of interbank deposits

Conclusion

- MMFs intermediation allows depositors to limit their exposure to a banking institutions and reap the gains from diversification (while saving on monitoring costs)

- However, a banking system intermediated through MMFs is more unstable than one in which investors interact directly with banks since MMFs are themselves subjects to runs from their own investors

Conclusion

- Instability arises through the release of information on bank assets, which is aggregated by MMFs and may lead them to withdraw en masse from a bank

- Finally, MMF intermediation is itself a channel of contagion among banking institutions

Thanks!