The Maturity Structure of Inside Money

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Motivation

- Banks engage in maturity transformation
- Diamond and Dybvig (1983) banking theory implies banks do too much maturity transformation
  - Too much bank run or panic risk
  - Suggests need for policies to limit banks' maturity transformation
- Since 2007, such policies have been implemented
  - Liquidity Coverage Ratio and Net Stable Funding Ratio in Basel III
  - Policies intended to immunize banks to bank runs or panics
- Our question: How do such policies impact usefulness of bank deposits as medium of exchange?

Motivation

- Conjecture:
  - Immunizing banks to panics should make their liabilities safer and more useful in exchange

- We:
  - Develop theory to study link between maturity transformation and usefulness of bank liabilities as medium of exchange
  - Find policies that limit maturity transformation likely to *reduce* usefulness of bank liabilities as medium of exchange
  - In ongoing work, document suggestive evidence:
    - Basel III liquidity requirements had this negative effect
    - Find increases in liquid asset holdings associated with policy changes reduced velocity of bank liabilities

Our Theory

- Develop theory of optimal maturity/risk structure in equilibrium model where bank liabilities act as inside money
- Efficient for banks to issue claims with smooth payoffs
  - Effectively, banks provide aggregate liquidity insurance
- If productive assets sufficiently risky and banks face limited commitment, efficient for banks to transform maturity
- Eq'm maturity transformation less than socially efficient
  - Optimal policy ensures banks make large enough short-term payouts
    - Policy opposite of liquidity coverage ratios in Basel III
    - Suggests considering means of payment role of banks important in calibrating policy

Our Mechanism

- Claims to bank cash flows serve as inside money
  - Partially backed by productive assets with aggregate risk
  - Partially backed by bank's equity

- Households use bank claims to relieve liquidity constraints

- Liquidity constraints introduce additional curvature in private and social value functions
  - Implies role for banks to provide aggregate liquidity insurance

- Limited bank commitment impedes provision of insurance
  - Banks cannot fully commit to transfer equity in low-return states
  - Maturity transformation relaxes commitment problem

- Pecuniary externality associated with bank liabilities
  $\Rightarrow$ *too little* transformation

Our Evidence

- Use (U.S.) geographic variation in banks' liquid asset holdings and deposit velocity
  - Estimate changes in liquidity coverage and deposit velocity for each Metro. Statistical Area
  - Sample from 2002-2015
- Find increases in liquid asset holdings associated with decreases in deposit velocity
- Suggestive of main mechanism of our model:
  - Liquid asset holdings $\uparrow$, maturity transformation $\downarrow$, velocity $\downarrow$
  - Policies enacted over sample, such as LCR $\uparrow$, intended to increase bank liquidity may have impacted velocity

Related Literature

- Inside Money and Distortions to Productive Assets
  - Lagos and Rocheteau (2008), Aruoba, Waller, and Wright (2011), Geromichalos, Herrenbrueck, and Salyer (2015), and many others...
- Bankers' Role as Providers of Inside Money
  - Cavalcanti and Wallace (1999), Monnet and Sanches (2012), Gu, Mattesini, Monnet, and Wright (2013)
- Bankers' Role as Providers of Insurance with Traded Liabilities
  - Jacklin (1987), Farhi, Golosov and Tsyvinski (2009)
- Information Insensitivity of Bank Claims
  - Hirschleifer (1971), Andolfatto (2010), Dang, Gorton, Holmstrom (2015), Dang, Gorton, Holmstrom, Ordonez (2014)

Environment

Key Ingredients

- Banks:
  - Issue claims subject to limited commitment
  - Use proceeds and endowments to purchase capital
  - Capital subject to risk and costly liquidation
    - Only source of *aggregate* risk
- Households:
  - Periodically trade in frictional markets (Lagos and Wright (2005))
  - Use bank claims to relieve liquidity constraints in frictional markets

Environment

- Adapts standard monetary economy to finite horizon: $t = 0, 1, 2$
- Agents: Households (buyers/sellers) and Banks
- Decentralized, or *frictional* Market (`DM`) in $t = 1, 2$
  - Trade specialized good, q_t
  - Random, pairwise matching; buyer meets seller with pr. $\alpha(n)$
  - Trade requires medium of exchange, subject to bargaining
- Centralized Market (`CM`) in $t = 0, 1, 2$
  - Trade general good x_t, production y_t, trade in any assets
  - Market is competitive

Environment: Households

- Preferences:
  - Buyers, measure 1:

$$\underbrace{v(x_0) - y_0}_{\texttt{CM}} + \sum_{t=1,2} [\underbrace{u(q_t)}_{\texttt{DM}} + \underbrace{v(x_t) - y_t}_{\texttt{CM}}]$$

  - Sellers, measure n:

$$\underbrace{v(x_0) - y_0}_{\texttt{CM}} + \sum_{t=1,2} [\underbrace{-c(q_t)}_{\texttt{DM}} + \underbrace{v(x_t) - y_t}_{\texttt{CM}}]$$

  - No risk over over buyer/seller type not critical

- Efficient DM trade: $u'(q^*) = c'(q^*)$

- Endowed with $k^i, i = b, s$ capital goods ($K^H = k^b + nk^s$)

Environment: Banks

- Representative bank; only participates in centralized markets
- Preferences: $\sum_{t=1,2} c_t^B$
- Endowed with K^B capital goods

Environment: Banks

- Invest I in $\mathtt{CM}_0$
- Info about returns realized in $\mathtt{DM}_1$:
  - $\omega \in \{\omega_l, \omega_h\}$ w. prob $\gamma(\omega)$
  - Period 2 rate of return $z(\omega)$ with $z(\omega_h) > z(\omega_l)$
- Plan to *liquidate* $L(\omega) \in [0, 1]$ in period $\mathtt{CM}_1$ with $\kappa < 1$
- Realized Output:

$$\begin{aligned} \mathtt{CM}_1: &\quad \kappa L(\omega) I z(\omega) \\ \mathtt{CM}_2: &\quad (1 - L(\omega)) I z(\omega) \end{aligned}$$

- Moral Hazard: abscond with $\xi \leqslant 1$ per unit of capital after $\mathtt{CM}_1$

$$\mathtt{CM}_2 \text{ payoff}: \quad (1 - L(\omega)) I z(\omega) \xi$$

Interpret as an asset management cost

Environment: Bank Claims

- Banks issue claims with coupon payments $d_t(\omega) \geqslant 0$,

$$D = \{D(\omega_l), D(\omega_h)\} = \{d_1(\omega_l), d_2(\omega_l), d_1(\omega_h), d_2(\omega_h)\}$$

- Function $p_0(D)$: price of claim with coupon D
  - More on $p_0(D)$ later...

- Households purchase claims in period 0; trade claims in future `DM` and `CMs`
  - No "early redemption" at bank

- Notation: $p_t(D(\omega))$ is ex-coupon claim price in $\mathtt{CM}_t$, state ω

Asset Transformation

- Allocations may feature bank balance sheet transformation

Risk Transformation

$$z(\omega_l)K^H < d_1(\omega_l) + d_2(\omega_l) \leqslant d_1(\omega_h) + d_2(\omega_h) < z(\omega_h)K^H$$

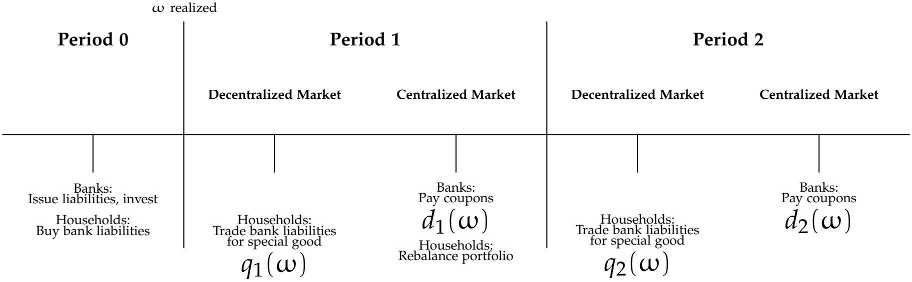
Maturity Transformation

$$d_1(\omega) > 0, \text{or equivalently } L(\omega) > 0 \text{ some } \omega$$

- Pass-through claim:

$$D : d_1(\omega) = 0, \quad d_2(\omega) = z(\omega)K^H$$

Timing



ω realized
Period 0
Period 1
Period 2
Decentralized Market
Centralized Market
Decentralized Market
Centralized Market
Banks:
Issue liabilities, invest
Households:
Buy bank liabilities
Households:
Trade bank liabilities
for special good
$q_1(\omega)$
Banks:
Pay coupons
$d_1(\omega)$
Households:
Rebalance portfolio
Households:
Trade bank liabilities
for special good
$q_2(\omega)$
Banks:
Pay coupons
$d_2(\omega)$

Bank's Problem

- Representative bank solves

$$\max_{I,L,D,c^B \geqslant 0} \sum_{\omega \in \Omega} \gamma(\omega) \left[c_1^B(\omega) + c_2^B(\omega) \right]$$

subject to

$$\begin{aligned}
p_0^k I &\leqslant p_0^k K^B + p_0(D) \\
c_1^B(\omega) + d_1(\omega) &= L(\omega) \kappa I z(\omega) \\
c_2^B(\omega) + d_2(\omega) &= [1 - L(\omega)] I z(\omega) \\
c_2^B(\omega) &\geqslant [1 - L(\omega)] I z(\omega) \xi \\
\sum_{\omega \in \Omega} \gamma(\omega) \left[c_1^B(\omega) + c_2^B(\omega) \right] &\geqslant K^B \sum_{\omega \in \Omega} \gamma(\omega) z(\omega)
\end{aligned}$$

  - Limited commitment from period 0 to 1 irrelevant if bank well capitalized

Households' Problem

- In non-frictional market (CM), Value for $i \in \{\text{buyer}, \text{seller}\}$:

$$W_t^i(a; D(\omega)) = \max_{x,y,a'} v(x) - y + V_{t+1}^i(a'; D(\omega))$$

subject to

$$x + a' p_t(D(\omega)) \leqslant y + [p_t(D(\omega)) + d_t(\omega)]a$$

- For a buyer,

$$V_{t+1}^b(a', D(\omega)) = (1 - \alpha(n))\, W_{t+1}^b(a'; D(\omega)) \\ + \alpha(n) \int_{a^s} \left\{ u[q_{t+1}(a', a^s; D(\omega))] + W_{t+1}^b(a' - m_{t+1}(a', a^s; D(\omega)); D(\omega)) \right\} d\Psi_{t+1}^s(a^s)$$

where q_{t+1} and m_{t+1} are terms of decentralized trade

- Similar value function for seller

Decentralized Terms of Trade

- Assume matched buyers and sellers in decentralized market engage in proportional bargaining

- Implies $q_t(a^b, a^s; D(\omega)), m_t(a^b, a^s; D(\omega))$ determined as solution to

$$\max_{q_t, m_t} u(q_t) + W_t^b(a^b - m_t; D(\omega)) - W_t^b(a^b; D(\omega))$$

subject to

$$u(q_t) + W_t^b(a^b - m_t; D(\omega)) - W_t^b(a^b; D(\omega))$$
$$= \frac{\eta}{1-\eta}\left[-c(q_t) + W_t^s(a^s + m_t; D(\omega)) - W_t^s(a^s; D(\omega))\right]$$
$$\underbrace{m_t \leqslant a^b}_{\text{key liquidity constraint}}$$

Competitive and Market Equilibrium

- *Competitive Equilibrium* is standard
- We define a *Market Equilibrium* as competitive equilibrium given an exogenous claim issue
  - Useful to define implementability constraints for planning problem
- *Constrained Efficient* allocation maximizes ex ante welfare of households
  - Choosing allocations that satisfy bank's constraints...
  - and allocations that constitute market equilibrium values

Constrained Efficient Liquidation

Determining Decentralized Terms of Trade

- From quasi-linearity of preferences, CM-Value functions simplify

$$W_t^i(a; D(\omega)) = [p_t(D(\omega)) + d_t(\omega)]a + \bar{v} + \max_{a'} -a' p_t(D(\omega)) + V_{t+1}^i(a'; D(\omega))$$

- CM-Value functions are linear in assets; buyers marginal pricers

- Degenerate end-of-$\mathtt{CM}_t$ asset holdings

- Bargaining condition simplifies to

$$\max_{q_t} u(q_t) - c(q_t)$$

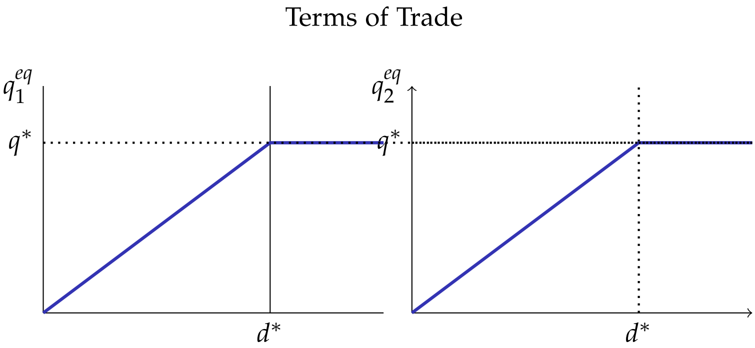
subject to

$$(1-\eta)u(q_t) + \eta c(q_t) \leqslant (p_t(D(\omega)) + d_t(\omega))a_t^b$$

$\Rightarrow$ *Value* of buyer's assets determines decentralized terms of trade

Asset Values and Terms of Trade

- Decentralized terms of trade is a function of value of bank claims



$t = 1$ Claim Value: $p_1(D(\omega)) + d_1(\omega)$ $t = 2$ Claim Value: $d_2(\omega)$

- $d^* \equiv$ value of 1 unit of claims for slack bargaining constraint

Period 1 Asset Prices

Period 1 Asset Prices

$$p_1(D(\omega)) = d_2(\omega)\left[1+\alpha(n)\eta\frac{u'(q_2^{eq}(D(\omega)))-c'(q_2^{eq}(D(\omega)))}{(1-\eta)u'(q_2^{eq}(D(\omega)))+\eta c'(q_2^{eq}(D(\omega)))}\right]$$

- If liquidity scarce in period 2, period 1 asset price incorporates liquidity premium
- Period 1 price increasing in d_2
  - d_2 increases asset price directly through increasing dividends
  - d_2 decreases asset price by decreasing liquidity premium ($q_2^{eq} \Uparrow$)
    - This effect is dominated
  - Backloaded coupons provide "early" value (raise q_1)
- Can define period 0 prices analogously

$$p_0(D) = \sum_{\omega}\sum_{t}\gamma(\omega)[1+LP_t(\omega;D(\omega))]d_t(\omega)$$

Welfare Objective

- Planner's objective equivalent to

$$W_0^P(D) = (1+n)\bar{v} + \sum_{\omega} \gamma(\omega) \sum_{t} d_t(\omega) + \alpha(n) \sum_{\omega} \sum_{t} \left[u(q_t^{eq}(D(\omega))) - c(q_t^{eq}(D(\omega))) \right]$$

- Efficient coupons balance:
  - Maximization of expected PDV of cash flows
  - Smoothing of expected inter-temporal liquidity distortions

Bank Capitalization

Assumption (Minimum Bank Capital)

Endowments K^h, K^B and absconding parameter, ξ satisfy

$$\frac{K^B}{K^H + K^B} \geqslant \xi$$

- Implies a pass-through claim ($d_2(\omega) = z(\omega)K^H$) is commitment-feasible
- If $z(\omega_l)$ large, then banks only serve as pass-through entity
- Assumption ensures limited commitment *alone* not a cause of maturity transformation

Constrained Efficient Maturity Transformation

Proposition (Efficient Maturity Transformation)

There exists a region of κ, ξ and threshold $\underline{z} < d^*/K^H$ such that if $z(\omega_l) < \underline{z}$, then efficient allocations feature both risk and maturity transformation $(d_1(\omega_l), L(\omega_l) > 0$.

Proof:

- $z(\omega_l)$ low $\Rightarrow$ $\mathtt{DM}_t$ trade distorted, commitment constraint binds
- *MB* of liquidation in ω_l:
  - Increase $d_1(\omega_l)$
  - Increase $\mathtt{DM}_1$ trade ($q_1(\omega_l) \Uparrow$) in liq. scarce state
- *MC* of $L(\omega_l)$: decrease....
  - $d_2(\omega_l)$
  - $\mathtt{DM}_2$ trade ($q_2(\omega_l) \Downarrow$)
  - $\mathtt{DM}_1$ trade ($q_1(\omega_l) \Downarrow$ since $p_1(D(\omega)) \Downarrow$)
  - $\mathtt{CM}_2$ coupons ($d_2(\omega_h) \Downarrow$) in liq. excess state

Constrained Efficient Maturity Transformation

Proposition (Efficient Maturity Transformation)

There exists a region of κ, ξ and threshold $\underline{z} < d^*/K^H$ such that if $z(\omega_l) < \underline{z}$, then efficient allocations feature both risk and maturity transformation $(d_1(\omega_l), L(\omega_l) > 0$.

Proof:

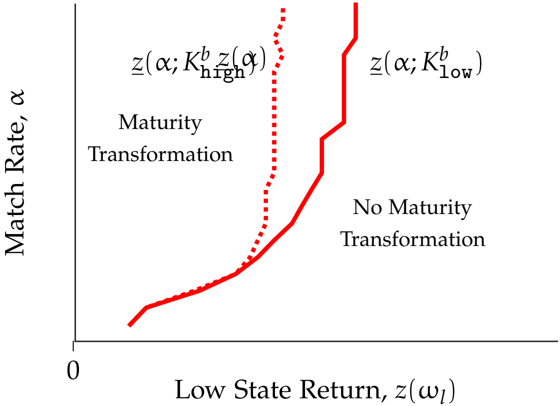
- Net benefit of liquidation proportional to

$$\kappa \times \left[1 + \frac{d\,\texttt{DM Utility}_1}{dd_1(\omega_l)}\right] - (1-\xi) \times \left[1 + \frac{d\,(\texttt{DM Utility}_1 + \texttt{DM Utility}_2)}{dd_2(\omega_l)}\right] - \xi$$

- When κ and ξ large, exogenous and endogenous costs of liquidation are low
- Exist $\xi < K^B/(K^H + K^B)$ and $\kappa < 1$ so that benefit higher than cost

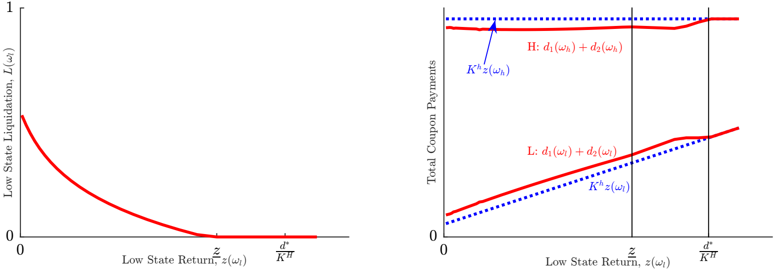
▸ Details

Constrained Efficient Transformation: Summary



- Maturity transformation if and only if high α, low $z(\omega_l)$
- Maturity transformation more likely when bank capital low

Constrained Efficient Transformation: Summary



- Risk Transformation as soon as $z(\omega_l) < d^*/K^H$
- Maturity Transformation only when $z(\omega_l)$ sufficiently low
- Maturity Transformation allows for more risk transformation
  - (not shown, but) efficient coupons smoother than best allocations with no liquidation

Necessity of Risk and Limited Committment

- No maturity transformation in absence of risk
  - Within a given state, shortening maturity necessarily costly
  - Implies in absence of risk, if liquidation has direct costs, efficiency features no liquidation

- No maturity transformation with full commitment
  - Backloading of payments desirable
    - Implied by forward looking asset prices
  - Liquidation only desirable when limited commitment impedes risk transformation

Equilibrium Risk and Maturity Transformation

Constructing Claim Prices

- Consider market eq'm when banks issue symmetric claims, D^*
- Implies period 0 claim price

$$p_0(D^*;D^*) = \sum_{\omega}\sum_{t} \gamma(\omega)[1 + LP_t(\omega; D^*(\omega))]d_t^*(\omega)$$

- Define $\pi_t(\omega; D^*) = \gamma(\omega)[1 + LP_t(\omega; D^*(\omega)]$
- For alternative claim D, assume

$$p_0(D;D^*) = \sum_{\omega}\sum_{t} \pi_t(\omega; D^*)d_t(\omega)$$

- Interpretation:
  - Banks cannot impact aggregate liquidity, liquidity premia

Equilibrium with Liquidation

- We look for an equilibrium with:
  - No liquidity premium in high state: $\pi_t(\omega_h; D^*) = \gamma(\omega_h)$
  - Liquidity premium in low state: $\pi_t(\omega_l; D^*) > \gamma(\omega_l)$
- In such an equilibrium,
  - Bank has no period 1 consumption
  - Bank commitment constraint binds in low state

Decentralized Equilibrium Liquidation

Proposition (*Inefficient Liquidation*)

If constrained efficient allocation satisfies $L(\omega_l) \in (0,1)$, then the equilibrium allocation features strictly less maturity transformation (lower $L(\omega_l)$) and is therefore, constrained inefficient.

- Banks do not internalize own impact on liquidity premia
- Banks free ride on high implied liquidity premium associated with efficient allocation
    - Issue claims with larger than efficient period 2 coupons
    - Engage in too *little* liquidation
- Externality associated with “wrong” price of bank *liabilities*

Decentralized Equilibrium Liquidation

Proposition (*Inefficient Liquidation*)

If constrained efficient allocation satisfies $L(\omega_l) \in (0,1)$, then the equilibrium allocation features strictly less maturity transformation (lower $L(\omega_l)$) and is therefore, constrained inefficient.

- Proof:
    - Bank optimality for $L(\omega_l) > 0$ requires

$$\kappa\pi_1(\omega_l; D^*) - (1-\xi)\pi_2(\omega_l; D^*) - \xi\gamma(\omega_l) \geqslant 0$$

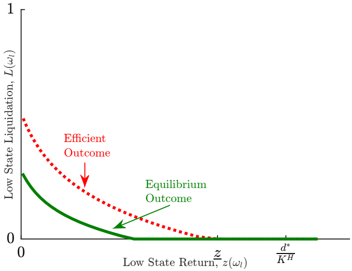
    - Bank optimality evaluated at planning solution

$$\kappa\pi_1(\omega_l; D^*) - (1-\xi)\pi_2(\omega_l; D^*) - \xi\gamma(\omega_l) = \underbrace{-\gamma(\omega_l)(1-\eta)(1-\kappa)}_{\texttt{Bargaining}} - \underbrace{\bar{B}\frac{d\pi_2(\omega_l; D^*)}{dq_2^{eq}}}_{\texttt{Pecuniary}}$$

    with $\bar{B} > 0$

    - `MB` of liquidation larger for planner
        - Bargaining inefficiency
        - Pecuniary externality

Decentralized Equilibrium Liquidation



- Planner chooses $L(\omega_l) > 0$ when $z(\omega_l) < \underline{z}$
  - For these $z(\omega_l)$'s, equilibrium $L(\omega_l)$ strictly lower
- Planner chooses $L(\omega_l) = 0$ when $z(\omega_l) \geqslant \underline{z}$
  - For these $z(\omega_l)$'s, equilibrium $L(\omega_l)$ coincides
    - Banks wants less $L(\omega_l)$ then planner; cannot have $L(\omega_l) < 0$
    - Straightforward to show rest of equilibrium also coincides
    - For these $z(\omega_l)$'s, equilibrium is (constrained) efficient

Optimal Policy

- Previous proposition shows
  - Banks undertake less maturity transformation than efficient
  - Resulting claim issues riskier than efficient
- Role for Policy:
  - Efficiency attained with *liquidation floor* ($L(\omega_l) \geqslant \underline{L}$)
  - Liquidation floor ensures banks attain minimal level of maturity transformation

Policy Interpretation

- Banks must be required to make sufficient short-term payouts
  - Depending on implementation, policy may resemble:
    - Minimum short-term debt or Minimum bank run risk
  - Policies based on Diamond and Dybvig bank intended to reduce short-term payouts by banks
    - E.g. liquidity coverage ratio: banks hold sufficient short-term assets to reduce likelihood of early withdrawals/panics
  - Inefficiency associated with "mis-pricing" of bank liabilities
    - Diamond-Dybvig inefficiencies associated with mis-pricing of assets
- Suggests need for lower liquidity coverage ratios than those calibrated without considering role of banks in creating means of payment

Ongoing Empirical Work:

How is Bank Liquidity Related to Velocity of Bank Liabilities?

Model Implications for Data

- Model uncovers new tradeoff for associated with maturity transformation
  - More maturity transformation allows same stock of bank liabilities to facilitate more decentralized trade
  - Implies increase in velocity of bank liabilities
- In data, pre- and post-crisis policies require banks to manage maturity transformation
  - Liquidity Coverage Ratio: require banks to hold more liquid assets relative to short-term liabilities
  - Such policies reduce maturity transformation done by banks
- Empirical question: How is bank liquidity related to velocity of bank liabilities?
  - Use geographic variation in changes in bank liquidity and bank note velocity to uncover relationship
  - Evidence: FDIC Call Report and Summary of Deposits Information and macro data from BEA from 2002-2015

Measurement

- The liquidity coverage ratio for bank i in year t is

$$\texttt{LCR}_{i,t} = \frac{\texttt{Liquid Assets}_{i,t}}{\texttt{Outflow}_{i,t} - \texttt{Inflow}_{i,t}} \times 100$$

  - `Liquid Assets` $\equiv$ (risk-)weighted sum of US Treasuries, US Agencies, Cash and Balances Due, and Other Securities
  - `Outflow` $\equiv$ (risk-)weighted sum of Deposits, Unused Commitments, Trade Liabilities, Other Debt and Liabilities, Derivatives, and Fed Funds Repos
  - `Inflow` $\equiv$ (risk-)weighted sum of Interest Bearing Balances, Securities, Net Loans and Leases, Trade Assets, Fed Funds Reverse Repo

Measurement

- Bank i's deposit market market share in region r in year t is

$$s_{i,r,t} = \frac{\texttt{Deposits}_{i,r,t}}{\sum_i \texttt{Deposits}_{i,r,t}}$$

- Define bank liquidity in region r in year t as

$$\texttt{LCR}_{r,t} = \sum_i \left(s_{i,r,t} \times \texttt{LCR}_{i,t} \right)$$

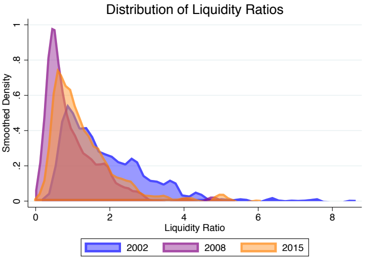
- Velocity in region r in year t:

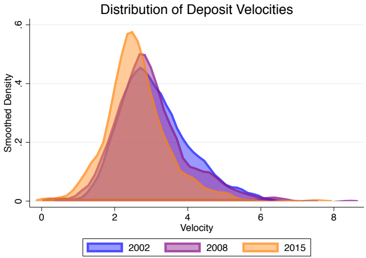
$$V_{r,t} = \frac{Y_{r,t}}{\sum_i \texttt{Deposits}_{i,r,t}}$$

where $Y_{r,t}$ is nominal GDP or consumption in region r in year t

Evolution of Liquidity and Velocity Since the Crisis

- How have liquidity and bank deposit velocity evolved before and after 2008?





- Liquidity: Decline before 2008; increase after 2008
- Velocity: No change before 2008; decline after 2008

Empirical Specification

- How is liquidity growth related to velocity growth?

$$\Delta V_{r,t} = \beta_0 + \beta_1 \Delta \texttt{LCR}_{r,t} + \beta_X X_r + \epsilon_r$$

- Identification: regions with larger growth in liquidity coverage ratio *more* impacted by LCR policy change

OLS

$$\Delta V_{r,t} = \beta_0 + \beta_1 \Delta \texttt{LCR}_{r,t} + \beta_X X_r + \epsilon_r$$

	(1)	(2)	(3)	(4)
ΔLCR	-0.0364***	-0.0385*	-0.0195	-0.0216
	(0.00842)	(0.0166)	(0.0170)	(0.0182)
State FE	No	Yes	No	Yes
Time FE	No	No	Yes	Yes
Observations	5329	5329	5329	5329
R2	0.00350	0.0161	0.0711	0.0835
Adjusted R2	0.00331	0.00678	0.0686	0.0724
Within R2		0.00391	0.000930	0.00115

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

- Banks that acquire more liquidity see larger declines in velocity

▸ IV using Lagged LCR

Conclusions

- Developed theory of bank balance sheet transformation arising from liquidity provision and aggregate risk
- Find if assets are risky and yield insufficient liquidity in some states, efficient for banks to transform risk
- If assets sufficiently risky to cause limited commitment constraints to bind, efficient for banks to transform maturity
- When equilibrium features maturity transformation, banks under-provide maturity and risk transformation
- Need more lax policy than suggested by theories that ignore provision of stable means of payment

Appendix

Constrained Efficient Maturity Transformation

Formally

- Marginal impact of perturbation proportional to

$$\gamma(\omega_l)\left\{U^P_{1,1_l}\kappa - \left(U^P_{1,2_l} + U^P_{2,2_l}\right)(1-\xi)\right\} - \gamma(\omega_h)\,\xi\frac{\gamma(\omega_l)}{\gamma(\omega_h)}\left\{U^P_{1,2_h} + U^P_{2,2_h}\right\}$$
$$= \gamma(\omega_l)\left[U^P_{1,1_l}\kappa - \left(U^P_{1,2_l} + U^P_{2,2_l}\right)(1-\xi) - \xi\right]$$

  (equality follows from excess liquidity in high state ($U^P_{1,2_h} + U^P_{2,2_h} = 1$)

- As $z(\omega_l) \to 0$, term in brackets tends to

$$\kappa\left[1 + \frac{\alpha(n)}{1-\eta}\right] - (1-\xi)\left[1 + \frac{\alpha(n)}{1-\eta} + \frac{\alpha(n)}{1-\eta}\left(1 + \frac{\alpha(n)\eta}{1-\eta}\right)\right] - \xi$$

Back

Using lagged LCR as IV

	(1)	(2)	(3)	(4)
ΔLCR	-0.193	-0.388**	-0.194	-0.387**
	(0.105)	(0.122)	(0.118)	(0.120)
First Stage				
LCR_{2002}	-0.0258***	-0.0209***	-0.0260***	-0.0211***
	(0.00426)	(0.00538)	(0.00396)	(0.00500)
State FE	No	Yes	No	Yes
Time FE	No	No	Yes	Yes
Observations	5329	5329	5329	5329
1st Stage F-Stat	36.65	15.05	43.31	17.92

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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