The Macroeconomic Impact of Money Market Disruptions

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Motivation

- Unsecured money markets (MMs) key for the transmission of monetary policy
- Secular decline in the relative share of unsecured to secured transactions in the euro area
  - started before the Financial Crisis Secured vs unsecured funding
- In secured markets, haircut increases for some bonds during the Sovereign Debt Crisis ECB vs private haircuts
- Increased recourse to central bank (CB) funding during the Financial and Sovereign Debt Crises Eurosystem funding

Research questions

- What is the macroeconomic impact of the decline in unsecured market transactions?
- What are the implications of the disruptions in secured markets?
- Build a DSGE model of bank liquidity management with secured and unsecured MMs, and collateralized CB funding
  - calibrate the model to the euro area data
  - investigate different types of CB policies

Preview of results

- Drop in share of unsecured to secured transactions from 42% to 24%:
  - output contracts by 0.5%
  - key mitigating factor: substitution towards secured MM
- Increase in private haircuts from 3% to 40%:
  - output contracts by 2% if no CB operations
  - CB policies that replace bonds with money on bank balance sheets reduce output contractions significantly
  - e.g., under "QE"-type policy, output contracts only 0.2%
- Policy response needs to worry about origins of disruptions

Outline

1. Model set-up
2. Some analytics
3. Calibration
4. Numerical experiments and CB policies

1. Model set-up

Model overview

Households

hold deposits D
and money M,
consume and work

Firms

produce output y
and capital k

Government

issues bonds B,
taxes and spends

Banks

hold capital k, bonds B, money M
take deposits D, CB loans F
manage liquidity in MMs

Foreigners

hold bonds B

Central Bank

holds bonds B,
loans F to banks,
issues money M

Banks: timing

- Morning:
  - idiosyncratic type shock: with prob ξ_t, a bank is "**C**onnected", else "**U**nconnected"
  - given type, choice of assets (capital $k_{t,l}$, bonds $B_{t,l}$, money $M_{t,l}$, and dividends $\phi N_{t,l}$) and liabilities (deposits $D_{t,l}$, CB loans $F_{t,l}$, and net worth $N_{t,l}$)

- Afternoon (liquidity management):
  - iid liquidity shock $\omega_{lt} \leq \omega^{\max}$ (deposit reshuffle)
  - **C** banks: raise liquidity in unsecured MM
  - **U** banks: borrow in secured MM up to $\widetilde{\eta}_t Q_t (B_{t,l} - B^F_{t,l})$

- End of period:
  - reverse liquidity shock occurs, loans are repaid
  - all banks return earnings to mother bank, which allocates net worth equally to all banks in $t+1$

Banks: Key constraints

- Gertler-Kiyotaki-Karadi leverage constraint:

$$\mu^{\mathbf{RA}}_{\mathbf{c,t}},\ \mu^{\mathbf{RA}}_{\mathbf{u,t}}: \qquad V_{t,l} \geq \lambda \left(P_t k_{t,l} + Q_t B_{t,l} + M_{t,l}\right)$$

- Afternoon withdrawal constraint for **U**-banks:

$$\mu_{\mathbf{u,t}}: \quad \omega^{\max} D_{t,u} \leq M_{t,u} + \widetilde{\eta}_t Q_t \left(B_{t,u} - B^F_{t,u}\right)$$

- Collateral constraint at CB in the morning:

$$\mu^{\mathbf{C}}_{\mathbf{u,t}}: \qquad B^F_{t,l} \leq B_{t,l}$$

- Short-sale constraints:

$$\begin{aligned} \mu^{\mathbf{M}}_{\mathbf{u,t}}: \qquad & M_{t,l} \geq 0 \\ \mu^{\mathbf{F}}_{\mathbf{u,t}}: \qquad & F_{t,l} \geq 0 \end{aligned}$$

Banks: "morning" problem

- Maximize end-of-period bank value

$$\tilde{V}_{t,l} = \tilde{\psi}_{t,k} P_t k_{t,l} + \tilde{\psi}_{t,B} B_{t,l} + \tilde{\psi}_{t,M} M_{t,l} - \tilde{\psi}_{t,D} D_{t,l} - \tilde{\psi}_{t,F} F_{t,l} \quad \text{s.t.}$$

$$P_t k_{t,l} + Q_t B_{t,l} + \phi N_t = D_{t,l} + Q_t^F F_{t,l} + N_t$$
$$D_{t,l} \geq 0,\ k_{t,l} \geq 0,\ B_{t,l} \geq 0$$
plus the **key constraints** from above

- A bunch of inequality constraints: steady-state, comparative static analysis only

2. Steady-state analysis: Some analytics

Some analytics

- Case: **C** banks get funded through deposits, not the CB. Optimality requires:

$$\mu_u = \left(1 + \mu_u^{RA}\right)\left(\tilde{\psi}_k - \frac{\tilde{\psi}_b}{Q}\right)\frac{1}{\widetilde{\eta}}$$

- If afternoon constraint binds, $\mu_u > 0$ and $\tilde{\psi}_k > \frac{\tilde{\psi}_b}{Q}$
  - **C** banks do not hold bonds
  - **U** banks may hold bonds for their collateral value; bonds command a collateral premium

- **U** banks borrow from CB if private haircuts or expected withdrawals high, and CB funding conditions favourable
  - **U** banks hold money to relax the afternoon constraint (self-insurance)

3. Calibration

Calibration

- Model calibrated to euro area data pre-crisis
- Key parameters:
  - fraction of **U** banks, $1-\xi$=0.58 (Euro Area Money Market Survey, pre-2008 average)
  - private and CB haircuts, $1-\widetilde{\eta}=1-\eta$=0.03 (LCH Clearnet and ECB data for 2010)
  - max withdrawals as share of deposits, $\omega^{\max}$=0.1 (EBA data on Liquidity Coverage Ratio: HQLA to cover 30-days liquidity needs under stress over total assets)

- Six free parameters: ϕ, λ, χ, g, B^C, $\overline{B}^*$. Set to match model predictions on six variables with empirical pre-2008 counterparts

Variable	**Data**	**Model**
Debt/GDP	0.57	0.61
Bank leverage	6.00	5.81
Loan spread (annual)	0.021	0.021
Share bonds held by banks	0.23	0.23
Share bonds foreign sector	0.64	0.61
Inflation (annual)	0.020	0.021

- List all parameter values

4. Steady-state analysis: Numerical experiments

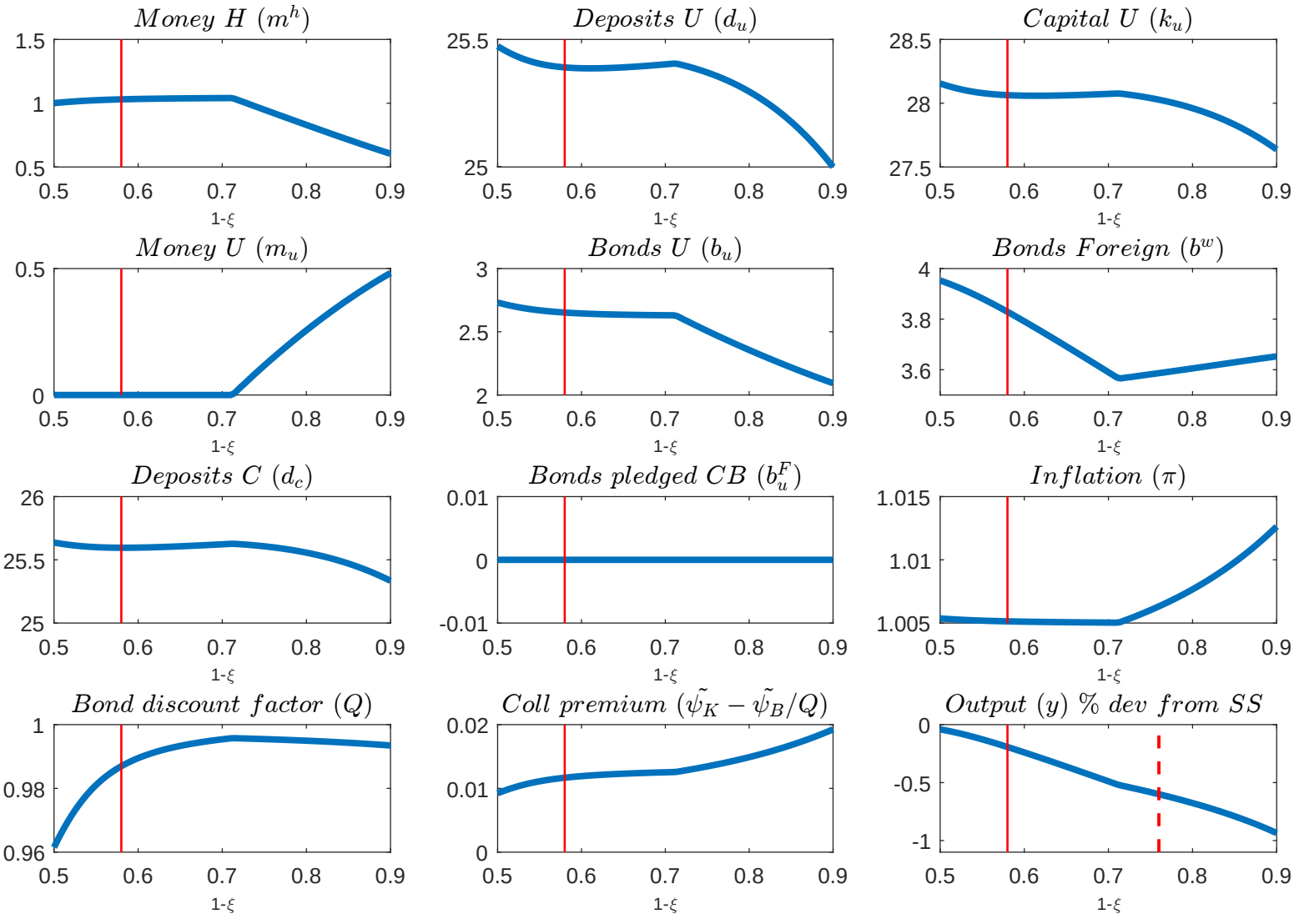
Experiments and CB policies

- Comparative static exercises:
  - Disruptions in the unsecured MM
  - Disruptions in the secured MM
  - Other experiments (not today): e.g., larger potential withdrawals
- Alternative central bank policies:
  - No CB intervention: no CB funding, constant instruments
  - Constant bond holdings, collateralized funding ("FRFA")
  - Bond purchases to maintain constant inflation ("QE")
  - Other policies (not today): constant bond prices ("OMT"); enlarging collateral set

Unsecured MM disruptions

- Comparative statics: increase in share $1-\xi$ of **U** banks
- CB policy: constant CB instruments, incl. bond holdings
- Mechanisms: As the share of **U** banks increases,
  - bonds become progressively more expensive
  - **U** banks start holding money (key constraint 1)
  - **U** banks reduce deposits and capital
  - aggregate output contracts

Unsecured MM disruptions



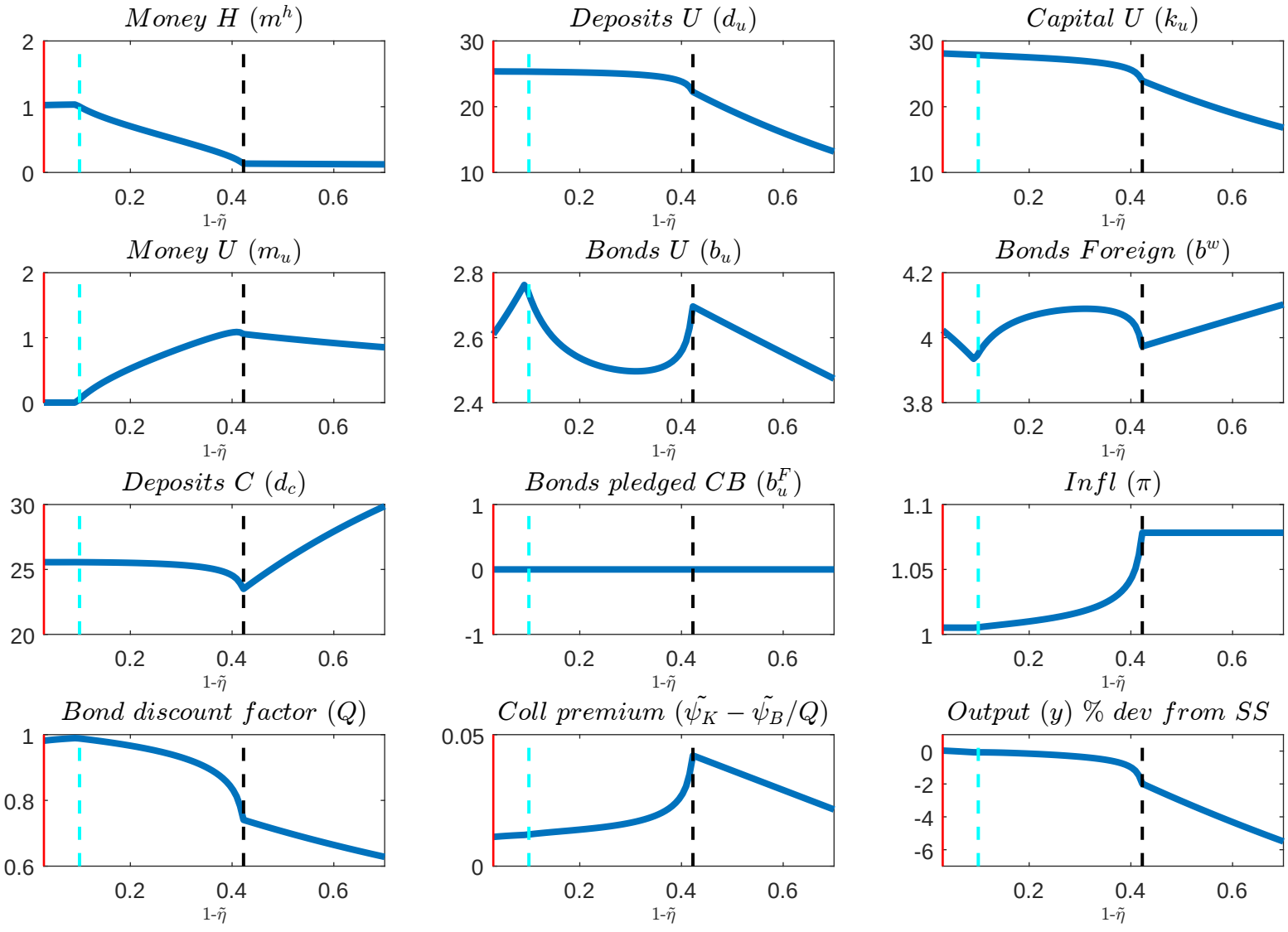
Unsecured MM disruptions

- Increase in $1-\xi$ from 58% (pre-2008 average) to 76% (post-2008 average): output contracts 0.5%
- No role for CB funding: if secured MM functions smoothly, always preferred for short-term liquidity management
- In this example, "QE"-type policy would work similarly
  - but if $\omega^{\max}$=0.2, output contracts 4% under constant instruments policy, only 0.5% under "QE" policy

Secured MM disruptions

- Comparative statics: increase in haircut $1 - \widetilde{\eta}$
- CB policy: no CB intervention (CB haircut $1 - \eta$=0.99)
- Mechanisms: As the private haircut $1 - \widetilde{\eta}$ increases,
  - bonds less valuable as collateral in the private market
  - **U** banks start holding money (key constraint 1)
  - **U** banks severely constrained in the afternoon: bond collateral value low, money scarce
  - leverage constraint turns slack (key constraint 2) $\rightarrow$ **U** banks dramatically reduce deposits and capital
  - **C** banks take on some deposits but output contracts

Secured MM disruptions, no CB operations



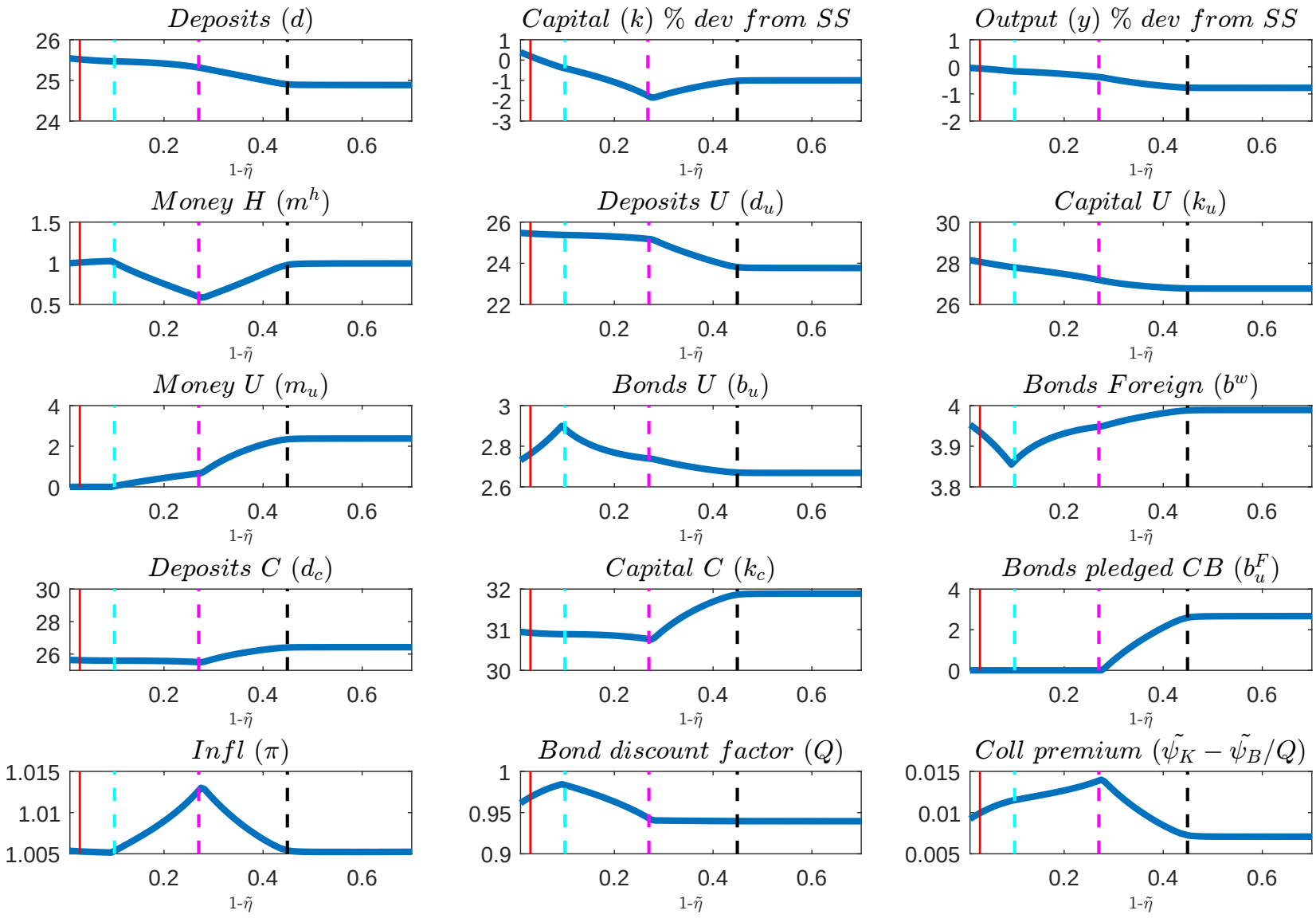
Secured MM disruptions, no CB operations

- Large output contractions:
  - Increase in private haircuts from 3% to 40%: output contracts 2%
  - Increase from 3% to 70%: output contracts 5.4%
- What if CB intervenes? Two CB policies:
  1. Constant bond holdings, collateralized CB funding ("FRFA")
  2. Bond purchases to maintain constant inflation ("QE")

1. Secured MM disruptions, CB funding

- Comparative statics: increase in haircut $1 - \widetilde{\eta}$
- CB provides funding against bond collateral: "FRFA"
- Mechanisms: As the private haircut $1 - \widetilde{\eta}$ increases,
  - bonds less valuable as collateral in the private market
  - **U** banks start holding money (key constraint 1)
  - **U** banks access CB funding (key constraint 2)
  - **U** pledge all their collateral to the CB (key constraint 3)
- CB funding $\rightarrow$ floor to output reduction
  - increase in private haircuts from 3% to 40%: output contracts just 0.6%

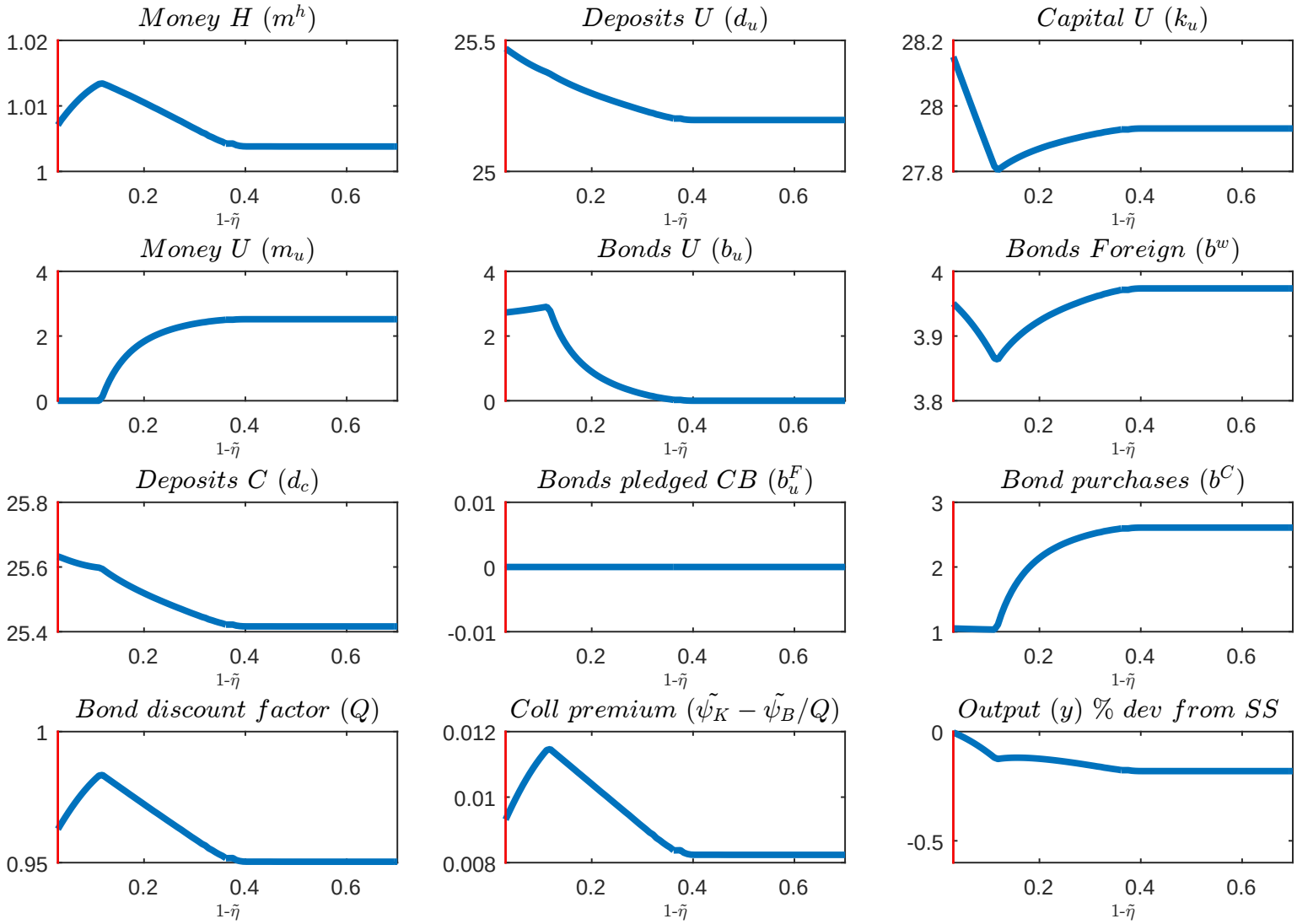
1. Secured MM disruptions, CB funding



2. Secured MM disruptions, bond purchases

- Comparative statics: increase in haircut $1 - \widetilde{\eta}$
- CB maintain π constant by changing bond holdings: "QE"
- Mechanisms: As the private haircut $1 - \widetilde{\eta}$ increases,
  - bonds less valuable as collateral in the private market
  - **U** banks start holding money (key constraint 1)
  - **U** sell all bonds, mostly to the CB (key constraint 2)
- CB substitutes bonds with low collateral value for money on bank balance sheets $\rightarrow$ floor to output reduction
  - increase in private haircuts from 3% to 40%: output contracts just 0.2%

2. Secured MM disruptions, bond purchases

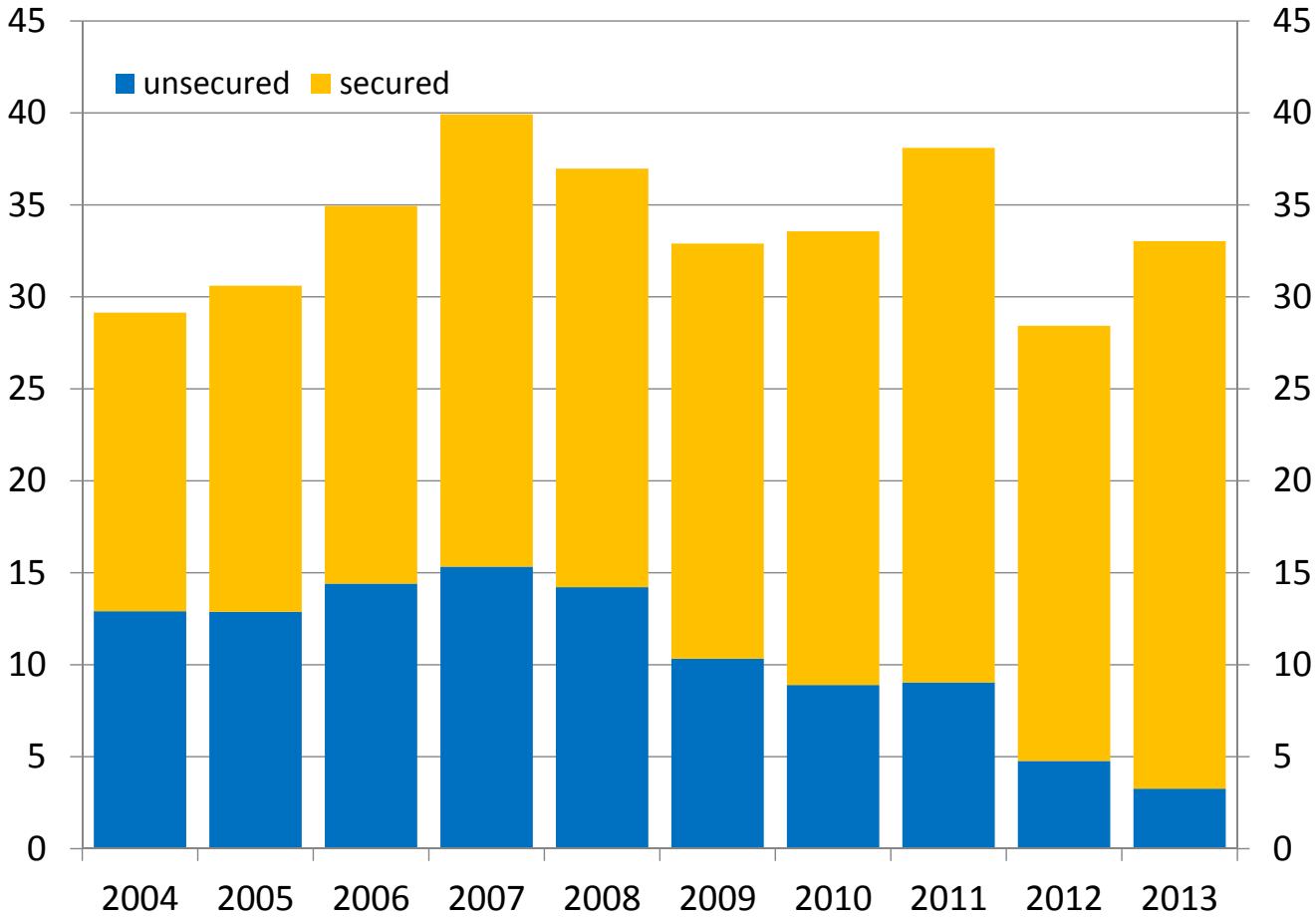


Conclusions

- Calibrated DSGE model of bank liquidity management to assess the macroeconomic impact of MM disruptions
  - to assess unsecured market frictions, key to consider secured markets
  - to assess secured market frictions, key to consider CB operations
- Output contractions can be sizeable: more than 5% in some examples
- Policy response needs to worry about origins of disruptions and which of the key constraints are likely to bind

Thank you!

Quarterly turnover in the euro money market



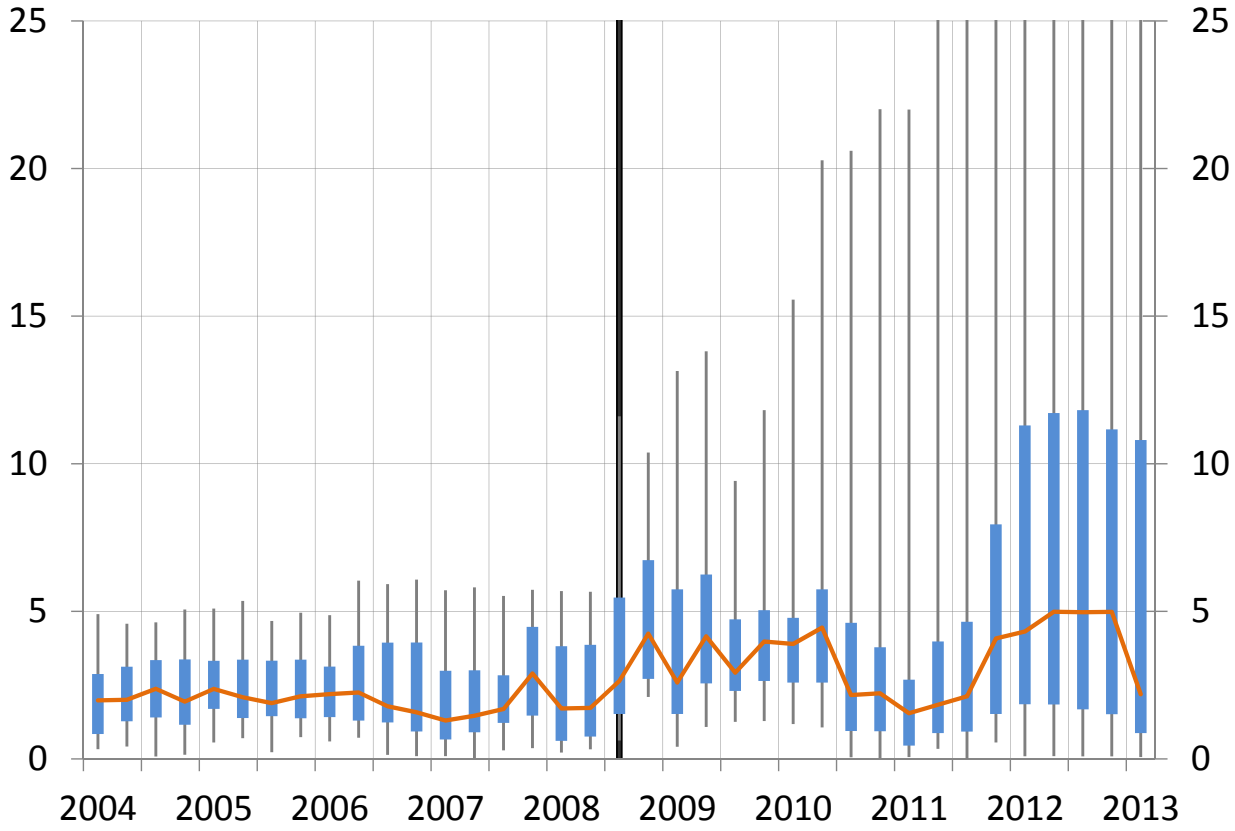
Source: Euro Area Money Market Survey. Cumulative quarterly turnover in the euro money market (EUR trillion).The panel comprised 98 euro area credit institutions.

ECB vs private haircuts on sovereign bonds

	ECB		Private	
	CQS1-2	CQS3	Germany	Portugal
2010	2.8	7.8	2.7	8.1
2011	2.8	7.8	3.0	10.1
2012	2.8	7.8	3.0	80.0
2013	2.8	7.8	3.0	80.0

Source: ECB and LCH Clearnet.

Eurosystem funding in total deposit liabilities



Source: ECB.

List of all parameter values

Parameter	Description	Value
θ	Capital share	0.33
δ	Depreciation rate	0.02
β	Discount rate H	0.995
χ	Coeff money in utility	0.0063
g	Government spending	0.4416
κ^{-1}	Aver maturity bonds (Q)	9
ϕ	Fraction net worth as dividends	0.0306
ξ	Fraction 'connected' banks	0.42
$\widetilde{\eta}$	Private haircut on bonds	0.97
η	CB haircut on bonds	0.97
λ	Run-away coefficient	0.1532
$\omega^{\max}$	Max withdrawal as share of deposits	0.1
B_C	Bonds held by central bank	1.0455
ϱ	Parameter foreign bond demand	0.1
$\bar{B}^*$	Stock of debt	6.5825
Q	Bond price	0.9616
$\bar{B}^{for}$	Stock of foreign debt	8.0297

Selected related literature

- Interbank market frictions (partial EQ):
  - E.g., asymmetric information (Heider, Hoerova and Holthausen, 2015); multiplicity of Pareto-ranked equilibria (Freixas, Martin and Skeie, 2011) ...
- GE models with interbank markets:
  - OTC models of interbank market trade (Afonso and Lagos, 2015; Atkeson, Eisfeldt, and Weill, 2015)
  - Implementation of monetary policy through the unsecured money market (Bianchi and Bigio, 2016)
  - Macro impact of unsecured money market freezes (Bruche and Suarez, 2009)
  - Models of bank runs (Gertler, Kiyotaki and Prestipino, 2016)
  - Determination of payments, credit, and asset prices in a monetary economy (Piazzesi and Schneider, 2017)

The central bank

- Holds discount bonds issued by govt, B_t^C, with fixed repayment rate, κ, and price Q_t
- Provides collateralized cash loans to bank l, at haircut η_t:

$$F_{t,l} \leq \eta_t \; Q_t B_{t,l}^F$$

- Issues money and transfers seigniorage to govt
- CB balance sheet at t:

Assets	**Liabilities**
$Q_t^F \overline{F}_t$ (loans to banks)	$\overline{M}_t$ (currency in circulation)
$Q_t B_t^C$ (govt bond holdings)	S_t(seigniorage)

- CB chooses B_t^C, Q_t^F, and η_t

Foreigners

- Foreign demand for domestic bonds: zero, if nominal rate is below zero; otherwise, constant elasticity wrt to real interest rate

$$B_t^W = \left(\varkappa - \frac{1}{\varrho} \log Q_t \pi_t \right) P_t * 1_{Q_t \leq 1}$$

  (Actually, we used arctan(...) instead of indicator function, for smoothness)

- We allow short-sales by foreigners