

Banks, Money and the Zero Lower Bound on Deposit Rates

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³The views expressed herein are those of the authors and should not be attributed to the Bank of England

Outline



① Motivation

② Related Literature

③ The Model

④ Simulations

⑤ Conclusion

Motivation



- ▶ 2007-2009 Financial Crisis : macro-finance implication of banks' balance sheet transformation for credit and liquidity provision.
- ▶ The need to break the dichotomy between price stability and money & banking, and model banks explicitly (see, e.g. [Woodford 2010](#), [Gu et al. 2016](#)).
- ▶ Problem: recent models use the **intermediation of loanable funds** theory.
 - ▶ Banks are intermediaries between savers and borrowers of goods and physical capital
 - ▶ Nonfinancial models.
 - ▶ Banks are warehouses of goods.
 - ▶ Commodity money and barter.
 - ▶ Limited scope for the role of credit in liquidity provision (see discussions in [Piazzesi and Schneider 2018](#), [Bianchi and Bigio 2018](#)).

Motivation

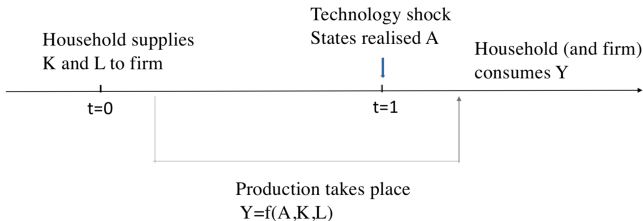


- ▶ Solution: Use **financing through money creation** models.
 - ▶ Banks are creators and intermediaries of money.
 - ▶ Every transaction corresponds to banks' liability ledger entries.
 - ▶ Support from papers by central banks and policy institutes: [BoE \(2014, 2018\)](#), [Bundesbank \(2017\)](#), [BIS \(2011, 2015\)](#), [RBA \(2018\)](#), [IMF\(2014a, b\)](#), [CBI \(2017\)](#), [Norges Bank \(2017\)](#), [PBoC \(2018\)](#) .
 - ▶ Support from historical and anthropological evidence: [David Graeber \(2012\)](#).
 - ▶ Proponent: [Jakab and Kumhof \(2015\)](#), [Gersbach and Faure \(2018\)](#).

The Big Picture



- ▶ Standard decentralised neoclassical model in a nutshell.



- ▶ What is missing?
 - ▶ What does the firm use to buy L and K?
 - ▶ Implicitly involves **contracts & credit risks** (household VS firm).
 - ▶ Firm issues bonds and equity to the household; household holds claims (**Finance, security design**).
 - ▶ However, with multiple goods, security design is not straightforward.
 - ▶ Hence, financing via intermediation: "commercial banks as creators of money" à la **Tobin (1963)**.

Claiming Niche



- ▶ What does this paper do?
 - ⇒ DSGE + inside money + nominal rigidities (New Keynesian Financing Model)
 - ⇒ Both **credit supply** and **credit demand**
 - ⇒ Shed light on the post-crisis debate on monetary policy effectiveness at the low interest environment (see [Brunnermeier and Koby 2019](#))

ZLB: deposit rate ZLB ⇒ constrains policy rate from falling as much as desired

- ▶ Among the first try to incorporate credit and inside money provision in a dynamic general equilibrium.
- ▶ Points to the possibility of contractionary policy rate reduction at the ZLB.
- ▶ A banking/financial explanation for the flattening of the Phillips curve at the ZLB.

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Literature - credit and inside money



- ▶ Money as a financing outcome of credit
 - ▶ **Early wisdom:** Macleod (1866), Wicksell (1906), Hahn (1920), Hawtrey (1919), Schumpeter (1934, 1954), Keynes (1931), and Tobin (1963).
 - ▶ **Early formalisation in general equilibrium theory:** Shubik and Wilson (1977), Dubey and Geanakoplos (1992, 2003, 2006), Shubik and Tsomocos (1992), Tsomocos (2003), Bloise and Polemarchakis (2006), Goodhart et al. (2006).
 - ▶ **Post-crisis:** Gu et al. (2016), Bianchi and Bigio (2018), Donaldson et al. (2018), Bigio and Weill (2016), Brunnermeier and Sannikov (2016), Lagos et al. (2017), Piazzesi and Schneider (2018), McMahon et al. (2018), Tsomocos and Wang (2019), Lagos and Zhang (2019).

Literature



- ▶ Income, credit and purchasing power:
 - ▶ Post-Keynesian literature: [Minsky\(1977\)](#), [Moore \(1979\)](#), [Lavoie \(2014\)](#), [Keen \(2014, 2015\)](#).
- ▶ Contractionary monetary easing near ZLB:
 - ▶ Theory: [Brunnermeier and Koby \(2018\)](#), [Eggertsson et al. \(2017\)](#)
 - ▶ Empirical: [Landier et al. \(2013\)](#), [Heider et al. \(2017\)](#), many others.
- ▶ Flatter Philips curves near ZLB:
 - ▶ Anchoring of inflation expectations: [Blanchard et al. \(2015\)](#), [Blanchard \(2016\)](#), [Kiley \(2015\)](#), [Ball and Mazumder. \(2011\)](#).
 - ▶ Real shocks: [Leduc and Wilson \(2017\)](#), [Laseen/Sanjani \(2016\)](#).
 - ▶ Structural change: [Gordon \(2013\)](#), [Christiano et al. \(2015\)](#), many others.
 - ▶ Financial frictions: [Gilchrist et al. \(2017\)](#), focusing on high spreads during crisis.

Outline



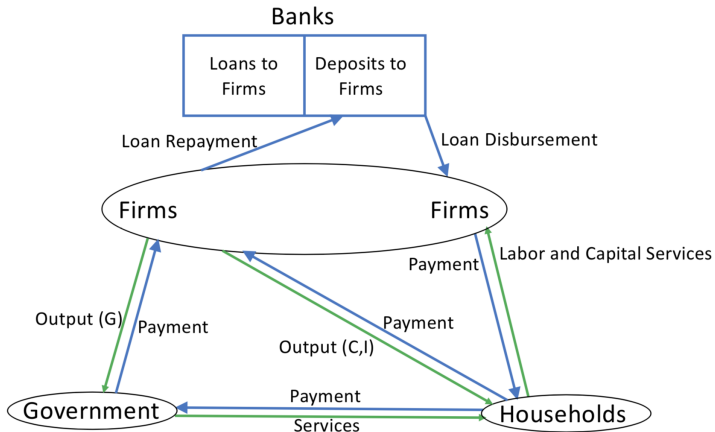
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Model Overview

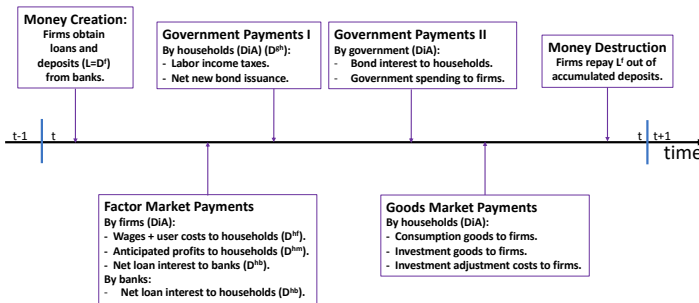


- ▶ Agents: banks, firms, households, government.
- ▶ Intertemporal linkages:
 - ▶ Government bonds.
 - ▶ Physical capital.
- ▶ Intratemporal linkages:
 - ▶ Sequence of deposits-in-advance constraints (\neq budget constraints).
 - ▶ Deposits first created for firms (= borrowers).
 - ▶ Firms pay deposits to households for inputs.
 - ▶ Households pay some deposits to government.
 - ▶ Households and government spend all deposits on firm output.
 - ▶ Firms repay loans in full
- ▶ No commodity money
- ▶ Price level determinacy:
 - ▶ Price theory of money à la [Calvo \(2012, 2016\)](#).
 - ▶ Alternatives: outside money à la [Dubey and Geanakoplos \(1992, 2003, 2006\)](#), default à la [Lin et al. \(2016\)](#), fiscal theory of price level determinacy à la [Sims, Cochrane](#).

Model Overview



Model Overview



Banks



- ▶ Banks alone can commit to repay.
- ▶ Banks's profits = lending spread - cost of lending.
- ▶ Lending spread (charged to firms):

$$R(L_t) = (i_t - i_t^d) L_t$$

- ▶ i_t = lending rate = arbitrated with policy rate.
- ▶ i_t^d = deposit rate: Flexible away from ZLB. Stuck at 1 at the ZLB.
- ▶ Cost of lending:

$$C(L_t) = \frac{1 - \beta}{1 + \frac{1}{\xi}} P_t \ell_t^{tgt} \left(\frac{L_t}{P_t \ell_t^{tgt}} \right)^{1 + \frac{1}{\xi}} \Rightarrow \ell_t = \ell_t^{tgt} \left(\frac{i_t - i_t^d}{1 - \beta} \right)^{\xi}$$

- ▶ Upward-sloping loan supply curve.
- ▶ Not constrained when i_t^d can adjust.
- ▶ Highly constrained when $i_t^d = 1$ (ZLB).
- ▶ At ZLB, lowering i_t directly reduces bank lending.

Empirics for banks



- ▶ Data and Methodology:
 - ▶ Dependent variable: Log of US real C&I loans.
 - ▶ Explanatory variable: Spread on C&I loans net of smoothed charge-offs.
FISIM methodology (Hood (2013)).
 - ▶ Instruments (2SLS):
 - ▶ Lagged % of banks reporting stronger loan demand.
 - ▶ Two alternative instruments yield similar results.
 - ▶ Controls: GDP growth, bank liquidity, tightening bank loan standards.
- ▶ Result: **1 pp increase in spread associated with 10% increase in loans.**
- ▶ Stylised facts post-GFC:
 - ▶ C&I loan rates dropped with policy rate.
 - ▶ Deposit rates dropped more slowly and then hit ZLB.
 - ▶ Result: Significant spread compression for around 2 years.

Firms



- ▶ Technology (standard Cobb-Douglas):

$$y_t(j) = S_t^a h_t(j)^{1-\alpha} K_t(j)^\alpha$$

- ▶ Sticky goods price inflation $G_{P,t}(j)$
- ▶ Deposits-in-advance
 - ▶ Profits (loan spread = cost)

$$\Pi_t^F(j) = P_t(j)y_t(j) - W_t h_t(j) - R_t^k K_t(j) - L_t(j)(i_t - i_t^d) - P_t G_{P,t}(j)$$

- ▶ Deposits-in-advance:

$$L_t(j) \geq L_t(j)(i_t - 1) + W_t h_t(j) + R_t^k K_t(j) + \Pi_t^F(j)$$

Firms



► Lagrangean:

$$\begin{aligned}
 \text{Max } E_0 \sum_{t=0}^{\infty} \beta^t \Lambda_t^h & \left[(P_t(j))^{1-\theta} (P_t)^\theta y_t - W_t h_t(j) - R_t^k K_t(j) \right. \\
 & - L_t(j) (i_t - i_t^d) - \frac{\phi_P}{2} P_t y_t \left(\frac{P_t(j)}{P_{t-1}(j)} - 1 \right)^2 \\
 & - MC_t \left((P_t(j))^{-\theta} (P_t)^\theta y_t - S_t^a h_t(j)^{1-\alpha} K_t(j)^\alpha \right) \\
 & + \eta_t^f \left(L_t(j) - (P_t(j))^{1-\theta} (P_t)^\theta y_t + \frac{\phi_P}{2} P_t y_t \left(\frac{P_t(j)}{P_{t-1}(j)} - 1 \right)^2 \right) \\
 & \left. - \eta_t^b \left(L_t(j) - P_t \ell_t^{t,gt} \left(\frac{i_t - i_t^d}{1 - \beta} \right)^\xi \right) \right]
 \end{aligned}$$

Firms



► Non-standard optimality conditions:

► Phillips curve:

$$\frac{\mu mc_t}{(1 - \eta_t^f)} - 1 = f\left(\frac{\pi_t}{\pi_{t-1}}\right) - M_t \frac{y_{t+1}}{y_t} \frac{(1 - \eta_{t+1}^f)}{(1 - \eta_t^f)} f\left(\frac{\pi_{t+1}}{\pi_t}\right) = 0$$

► Loans FOC:

$$i_t - i_t^d = \eta_t^f - \eta_t^b$$

- Away from the ZLB: $1 - \eta_t^f = 1 - i_t + i_t^d$. Deposit rate enters.
- At the ZLB: $1 - \eta_t^f = 2 - i_t - \eta_t^b$. Credit rationing multiplier enters.

The household



- ▶ Standard household problem with a twist.
- ▶ Lifetime utility:

$$\text{Max}_{\{c_t(i), h_t(i), I_t(i), k_t(i), B_t(i)\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t [S_t^c (1 - v)^{\frac{1}{\epsilon}} \frac{(c_t(i) - v c_{t-1})^{1 - \frac{1}{\epsilon}}}{1 - \frac{1}{\epsilon}} - \frac{\chi}{2} h_t(i)^2]$$

- ▶ Capital accumulation:

$$k_t = (1 - \delta) k_{t-1} + I_t$$

- ▶ Budget constraint:

$$B_{t-1}(i) + W_t h_t(i) (1 - \tau_{L,t}) + R_t^k k_{t-1}(i) + D_t^{hb} + D_t^{hm} + B_t(i) (i_t - 1) \geq P_t c_t(i) + P_t I_t(i) + P_t G_{I,t}(i) + B_t(i)$$

- ▶ Twist: This budget constraint can be shown to be an intra-period deposits-in-advance constraint, and deposits are not endowed.

Government



- ▶ Budget constraint:

$$B_t = B_{t-1} + B_t (i_t - 1) + P_t g_t - \tau_{L,t} W_t h_t$$

- ▶ Fiscal rule:

$$\tau_{L,t} - \bar{\tau}_L = f_b \left(\frac{b_t}{4y_t} - \frac{b_{SS}}{4y_{SS}} \right)$$

- ▶ Monetary policy rule:

$$i_t = ((2 - \beta) \bar{\pi}) \left(\frac{\pi_t}{\bar{\pi}} \right)^{m_\pi}$$

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Figure 1: Calibration

Description	Calibration	Parameter	ZLB-Constrained	Unconstrained
	Target		Value	Value
Real Policy Interest Rate (p.a.)	3%	β	0.9925	0.9925
Real Deposit Interest Rate (p.a.)	0% / 1%	κ	0.0100	0.0050
Credit Supply Elasticity	10	ξ	0.3988	0.1988
Intertemporal El. of Substitution		ϵ	0.5	0.5
Consumption Habit		v	0.75	0.75
Labor Supply Elasticity			1.0	1.0
Labor Supply	1	χ	0.3123	0.2669
Labor Income Share	60%	α	0.3242	0.3367
Investment/GDP	20%	δ	0.0171	0.0144
Government Spending/GDP	18%	\bar{g}	0.5849	0.6845
Government Debt/GDP	100%	$\bar{\tau}_L$	0.3498	0.3498
Investment Adjustment Cost		ϕ_I	2.5	2.5
Steady State Price Mark-up	10%	μ	1.1	1.1
Inflation Adjustment Cost		ϕ_π	200	200
Fiscal Debt Gap Feedback		f_b	0.1	0.1
Policy Rate Inflation Feedback		m_π	3.0	3.0
Policy Rate Loans Feedback		m_ℓ	0	0
Shock Persistence: S_i^c		ρ_c	0.70	0.70
Shock Persistence: S_i^n		ρ_n	0.95	0.95
Shock Persistence: ℓ_t^{tgt}		ρ_ℓ	0.90	0.90
Shock Persistence: S_i^{int}		ρ_{int}	0.90	0.90

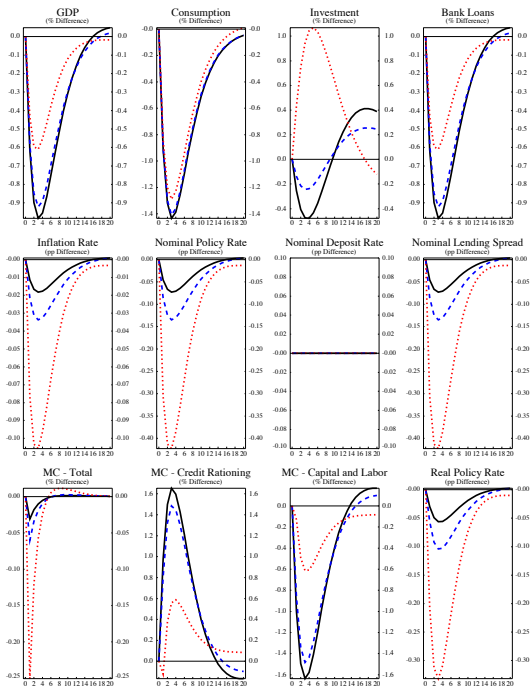


Figure 2: CD shock Policy Rate Contraction, semi-elasticities: solid=10, dashed =5, dotted =1

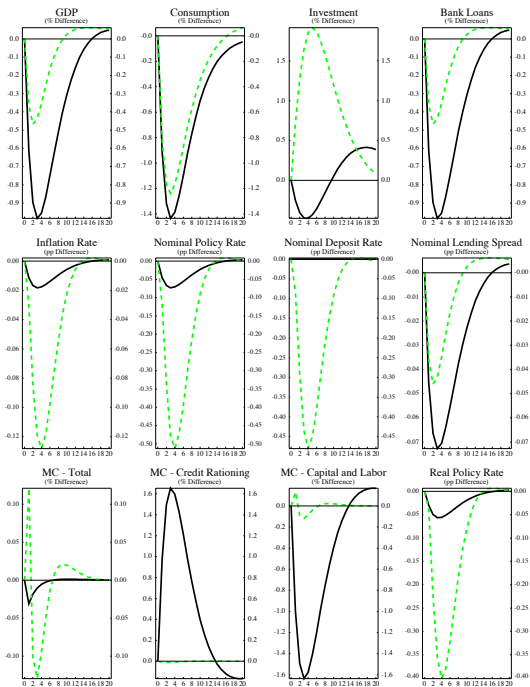


Figure 3: CD Shock - Flat Phillips Curve, ZLB constrained (dashed) versus unconstrained (dotted)

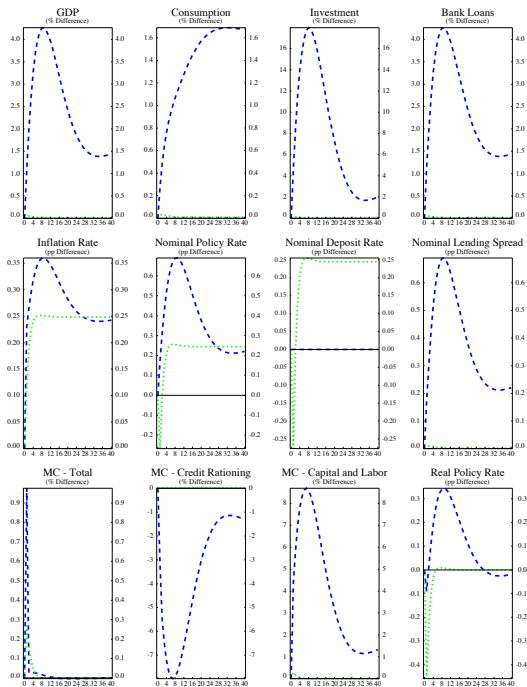


Figure 4: CD Shock - piebar, ZLB constrained (solid) versus unconstrained (dashed)

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Conclusion



- ▶ Results
 - ▶ Infinite-horizon model of endogenous money creation by banks.
 - ▶ Bank deposits = only money in the economy (no outside money).
 - ▶ Bank deposits created through book entries and exit via loan repayment.
 - ▶ ZLB prevents banks from elastically supplying money.
 - ▶ Phillips curve turns out flatter at the ZLB due to the credit constraint.
- ▶ A broader role
 - ▶ An attempt to bridge the gap between money and banking and the real business cycle literature.
 - ▶ Ties money and liquidity with credit and opens the avenue for financial stability analysis.
- ▶ Future avenues
 - ▶ Explicitly model credit risks via strategic default.
 - ▶ Interact money and price stability with financial stability risks (see [Tsomocos and Wang 2019](#) and [Goodhart et al. 2019](#)).
 - ▶ Flexible prices, value for money, seigniorage and default.