NLB: Negative (No) Lower Bound as a monetary policy instrument

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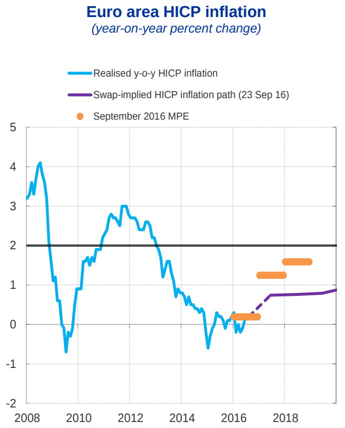
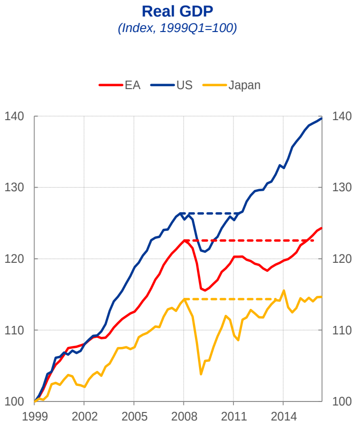
Work in progress (actually just started)

Backdrop: sluggish recovery and weak inflation outlook



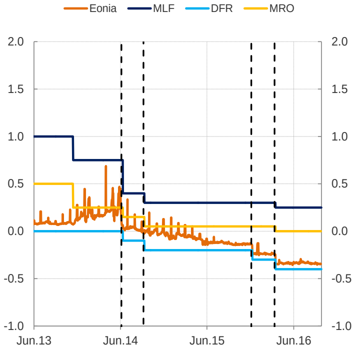
Sources: Thomson Reuters, Eurostat, ECB calculations.
Latest observation: August 2016 for HICP and June 2020 for swap-implied inflation path.



Sources: Eurostat, BEA, Cabinet Office, ECB calculations.
Notes: horizontal dotted lines represent pre-crisis peak real GDP level.
Latest observation: 2016 Q2.

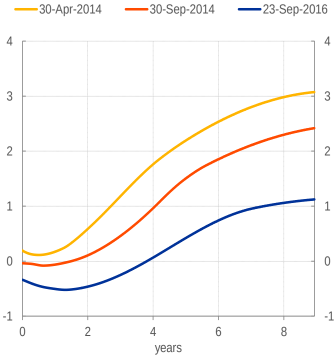
Deposit facility rate goes negative, 'risk-free' curve as well

ECB policy rates and overnight money market rates June 2014 – September 2016
(percent)



Sources: ECB and Reuters.
Latest observation: 23 September 2016.

EONIA forward curve
(percent)



Source: ECB.
Notes: the x-axis shows the number of years between the cut-off date of each curve and the contract date.
Latest observation: 23 September 2016.

Scope of the paper

- ECB as first large central bank with negative rate policy (NIRP) - unchartered policy territory
- Use a stylized macro model to illustrate:
  - ZLB-induced impediment to monetary policy accommodation
  - Term structure impact of shifting the LB from 0 to negative
  - Transmission to inflation and real activity
- Current discussion about detrimental effects of NIRP on and via banks

⇒ Expand model with simple banking sector, providing loans financed by deposits and capital to study impact on banks'
  - loan rates and volumes
  - net interest margin
  - profitability and capital
- ... and to capture feedback from banks to macroeconomy
- Calibrate/estimate model to the euro area

Related literature

- Effect of ZLB on term structure
  - Ruge-Murcia (2006)
  - Bauer and Rudebusch (2016)
  - Nakata and Tanaka (2016)
- ZLB and macro stabilisation policy
  - Eggertsson and Woodford (2003)
  - Jung, Teranishi and Watanabe (2005)
  - Nakov (2008)
  - Nakata and Schmidt (2015), etc.
- Relaxing the ZLB: NIRP
  - Lemke and Vladu (2016)
  - Demiralp, Eisenschmidt and Vlassopoulos (2016)
  - Heider, Saidi and Schepens (2016)
  - Brunnermeier and Koby (2016)

PRELIMINARY results

- ZLB constrains interest rates; it induces an upward bias on short-rate expectations and long rates
- This leads to asymmetric monetary policy accommodation and macroeconomic outcomes: too low inflation and output gap
- NIRP reduces current and expected policy rates. It makes policy and macro outcomes less asymmetric.
- The macroeconomic effect of relaxing the LB is still positive, when banks are important in transmission.
- Yet the effect is muted as banks face their own *zero* lower bound on re-financing (here: deposit) rates ...
- ...so that NIRP contributes to lowering net interest margins, profits and bank capital ...
- ... which decelerates the fall in loan rates and can in turn dampen the positive effect on the macro-economy

Outline

A simple macroeconomic model...

- Dynamic macro model a la Rudebusch/Svensson (1999), Holston/Laubach/Williams (2016)
- Phillips curve
$$\pi_t = c^\pi + \alpha\pi_{t-1} + \beta x_{t-1} + \epsilon_t^\pi \quad (1)$$
- IS curve
$$x_t = c^x + \gamma x_{t-1} + \lambda\left(i_{t-1} - E_{t-1}[\pi_t]\right) + \epsilon_t^x \quad (2)$$
- Taylor rule
$$i_t = c^i + a\pi_t + bx_t + \theta i_{t-1} + \epsilon_t^i \quad (3)$$

... modified with feedback from *long* rate and (Z)LB

- Phillips curve

$$\pi_t = c^\pi + \alpha\pi_{t-1} + \beta x_{t-1} + \epsilon_t^\pi \tag{4}$$

- IS curve

$$x_t = c^x + \gamma x_{t-1} + \lambda \underbrace{\left(y_{t-1}^2 - E_{t-1}\left[\frac{1}{2}\pi_t + \frac{1}{2}\pi_{t+1}\right]\right)}_{\text{Long-term real rate}} + \epsilon_t^x \tag{5}$$

- Taylor rule

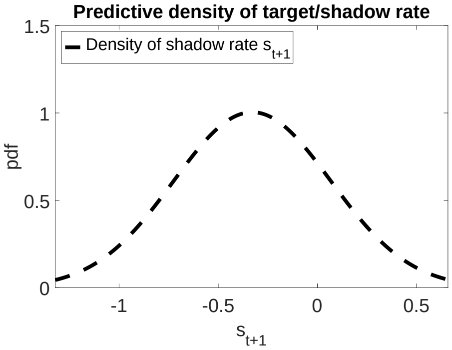
$$s_t = c^s + a\pi_t + bx_t + \theta s_{t-1} + \epsilon_t^s \tag{6}$$

$$i_t = \max\{s_t, LB\} \tag{7}$$

- Long (=2-period) rate

$$y_t^2 = \frac{1}{2} i_t + \frac{1}{2} E_t(i_{t+1}) + \underbrace{\frac{1}{2} QVar_t(i_{t+1})}_{\text{Term premium}} \tag{8}$$

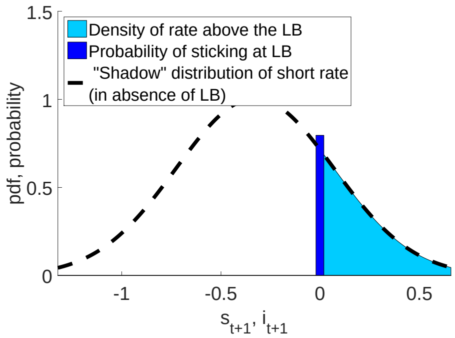
Predictive density of *target/shadow rate* is normal



$E_t(s_{t+1}) = -0.33$

- $s_{t+1}|\mathcal{F}_t \sim N(\mu_{s,t}, \sigma^2_{s,t})$, where $\mu_{s,t} = c^s + aE_t(\pi_{t+1}) + bE_t(x_{t+1}) + \theta s_t$ and $\sigma^2_{s,t} = a^2\sigma^2_\pi + b^2\sigma^2_x + \sigma^2_s$

... but distribution of actual short rate is censored



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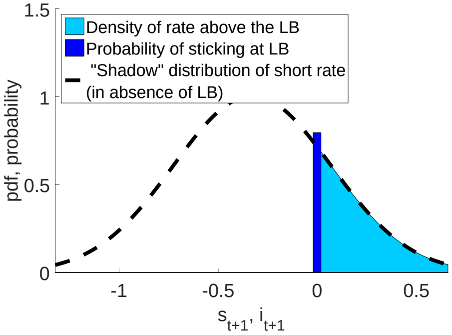
- $i_{t+1} = max\{s_{t+1}, LB\}|\mathcal{F}_t$ is distributed as censored normal with $Prob_t(i_{t+1}) = LB > 0$

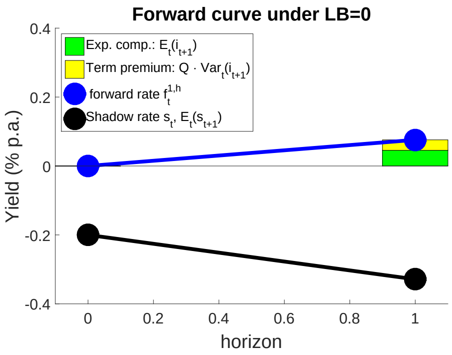
... biasing upwards expected short rates



$E_t(s_{t+1}) = -0.33$
$E_t(i_{t+1}) = 0.05$
$Median_t(i_{t+1}) = 0.0$

- $s_{t+1}|\mathcal{F}_t \sim N(\mu_{s,t}, \sigma^2_{s,t})$, where $\mu_{s,t} = c^s + aE_t(\pi_{t+1}) + bE_t(x_{t+1}) + \theta s_t$ and $\sigma^2_{s,t} = a^2\sigma^2_\pi + b^2\sigma^2_x + \sigma^2_s$
- $i_{t+1} = max\{s_{t+1}, LB\}|\mathcal{F}_t$ is distributed as censored normal with $Prob_t(i_{t+1}) = LB > 0$
- $E_t(i_{t+1})$ is biased upwards:
  - If LB binding: $E_t(s_{t+1}) < LB = med_t(i_{t+1}) < E_t(i_{t+1})$
  - Even if LB not binding: $LB < E_t(s_{t+1}) < E_t(i_{t+1})$

... elevating forward (and spot) rates



- $s_{t+1}|\mathcal{F}_t \sim N(\mu_{s,t}, \sigma^2_{s,t})$, where $\mu_{s,t} = c^s + aE_t(\pi_{t+1}) + bE_t(x_{t+1}) + \theta s_t$ and $\sigma^2_{s,t} = a^2\sigma^2_\pi + b^2\sigma^2_x + \sigma^2_s$
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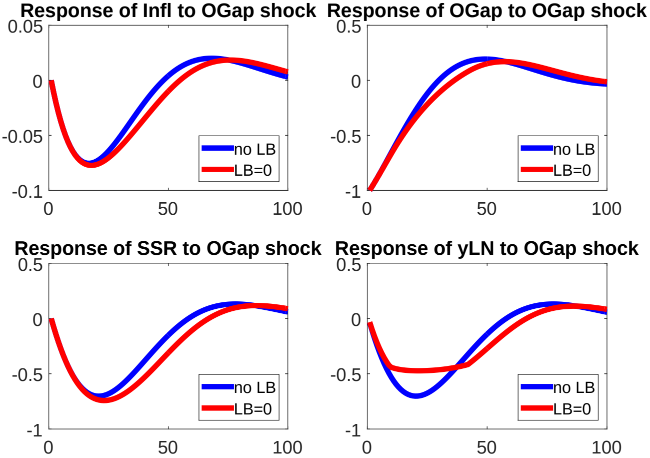
  - Even if LB not binding: $LB < E_t(s_{t+1}) < E_t(i_{t+1})$
- ... which affects forward rate $f_t^{1,1} = E_t(i_{t+1}) + Q \cdot Var_t(i_{t+1})$
- and spot rate $y_t^2 = \frac{1}{2} i_t + \frac{1}{2} f_t^{1,1}$

Monetary policy response less effective at ZLB

$\pi_t = 2\%$, $x_t = 0.0\%$, $s_t = 0.5\%$, shock to x_t of -1 percentage point



Macro outcomes are biased

- Expectations of variables under no LB vs $LB = 0$:

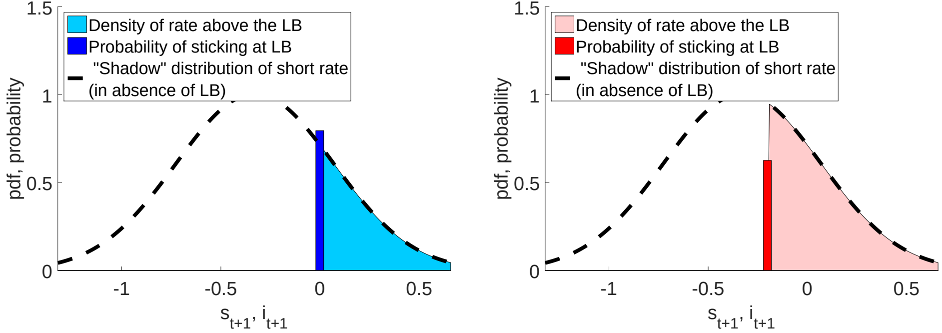
	π	x	s	y^2
no LB	2.00	0.00	2.00	2.00
$LB = 0$	1.95	-0.25	1.31	2.17

- Negative bias in inflation π and output gap x.
- Negative bias in shadow rate s. It needs to visit negative territory more often in order to 'at least' achieve $y^2 = 0$ (as negative rates are excluded)
- Positive bias in long rate y^2
- These (and all other macro) results to be re-visited under more careful calibration.

Outline

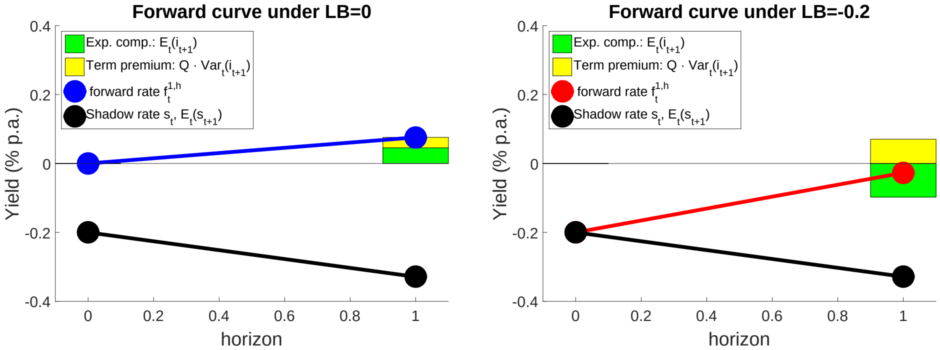
1. Motivation and stylized facts
2. The ZLB as a constraint on monetary policy
3. Lower bound as policy parameter
4. Feedback through the banking sector
5. Conclusion and next steps

Shift in LB decreases rate expectations...



- Decrease in lower bound shifts probability to formerly infeasible region
- Expected rate decreases unambiguously:
  $-\frac{\partial E_t(i_{t+1})}{\partial LB} = \Phi\left(\frac{E_t(s_{t+1})-LB}{\sigma_s}\right) - 1 < 0,$
- Stronger effect the more *LB* binding, see Lemke/Vladu (2016)

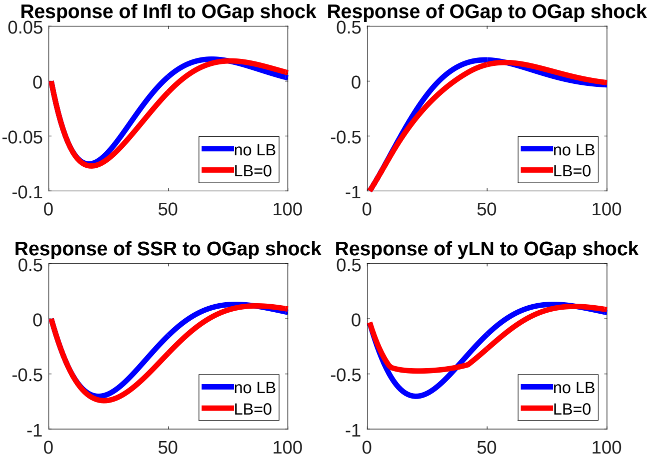
… while term premium may rise due to higher variance



- But $Var_t(i_{t+1})$ increases $\Rightarrow$ term premium $Q \cdot Var_t(i_{t+1})$ rises
- Overall impact on forward $E_t(i_{t+1}) + Q \cdot Var_t(i_{t+1})$ rate ambiguous,
- … but need to study general equilibrium effect.
- $Var_t(i_{t+1}) \uparrow$ raises QE 'lever' $\Rightarrow$ can re-adjust term premium

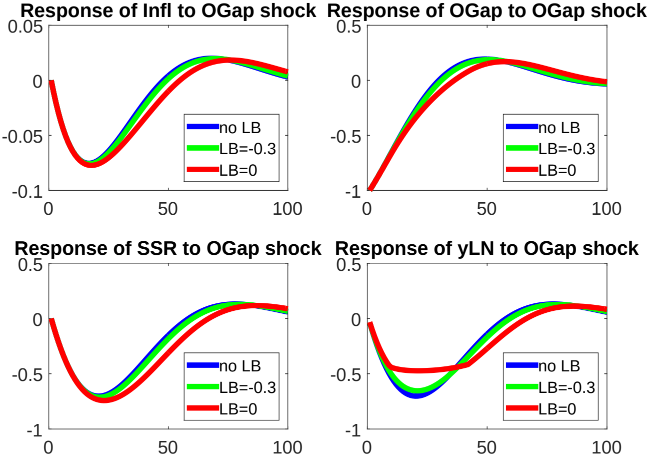
Recall problem at ZLB (and for now assume $Q = 0$)

$\pi_t = 2\%$, $x_t = 0.0\%$, $s_t = 0.5\%$, shock to x_t of -1 percentage point

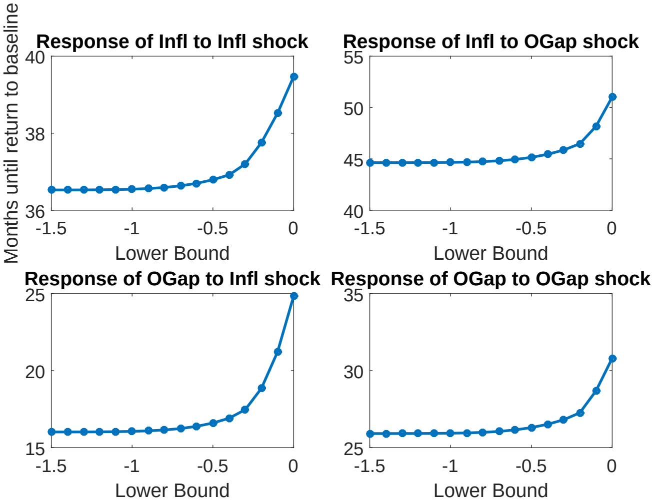


Relaxing LB ⇒ lower market rates ⇒ macro stabilization

$\pi_t = 2\%$, $x_t = 0.0\%$, $s_t = 0.5\%$, shock to x_t of -1 percentage point



Decreasing $LB \Rightarrow$ faster closing of inflation and output gap



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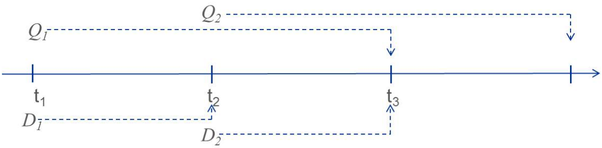
Sketching out a stylised banking sector

- So far analysis has not pointed to any costs of NIRP
- But NIRP for long may weigh on bank profits as banks' re-financing does not go down 1:1 with market short rate.
- Compare also Brunnermeier and Koby, 2016

⇒ To meaningfully consider trade-offs we need to introduce banks into our laboratory

A highly stylised bank balance sheet

Assets	Liabilities
Loans Q	Capital K
	Deposits D



The pricing of deposits

Assets	Liabilities
Loans Q	Capital K
	Deposits D

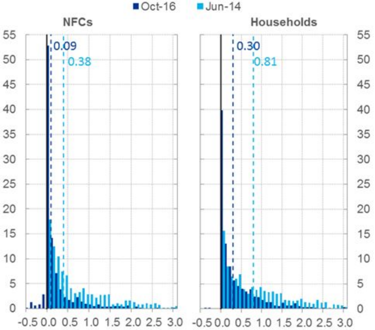
Deposits priced by applying a mark-down (α) on the short term rate (i_t) but are subject to a *zero* lower bound:

$$d_t = \max\left(i_t - \alpha, 0\right)$$

$\Rightarrow$ there is also a second, bank-specific lower bound ($LB_{Bank} = 0 \geq LB$)

Distribution of deposit rates to households and NFCs

(x-axis: deposit rates in percentages per annum, y-axis: frequencies in percentages)



Source: ECB.
Note: Deposit rates on new business as reported by individual banks for each of the available product categories. The dotted lines show the weighted average deposit rates in Jun-14 and Oct-16.

The pricing of loans

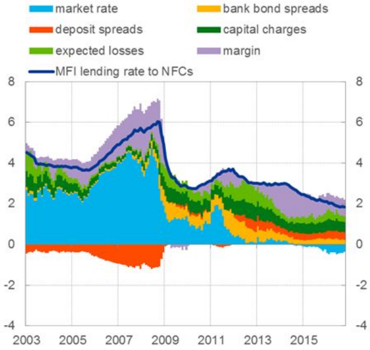
Assets	Liabilities
Loans Q	Capital K
	Deposits D

Loans are 2-period assets, so they are priced off the 2-period 'risk-free' rate (y_t^2) plus a spread that reflects the cost of equity and depends on the initial leverage position:

$$l_t^2 = y_t^2 + f\left(\frac{K_{t-1}}{Q_{t-1}}\right)$$

Decomposition of bank lending rate on loans to NFCs in the euro area

(percentages per annum)



Sources: ECB and ECB calculations.

Capital and bank profits

Assets	Liabilities
Loans Q	Capital K
	Deposits D

Law of motion of bank capital:

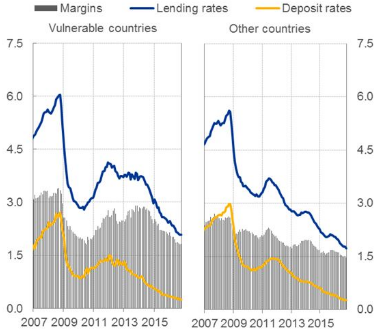
$$K_t = K_{t-1} + \Pi_t$$

Bank profits:

$$\Pi_t = \sum_{j=0}^{1} (l^2_{t-j} Q_{t-j}) - d_t \left[\sum_{j=0}^{1} (Q_{t-j}) - K_t \right]$$

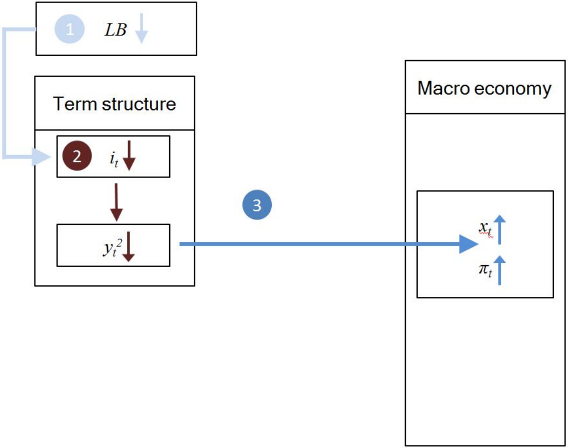
Loan-deposit margins for euro area banks

(percentages per annum)



Source: ECB.
Note: Loan and deposit composite rates on NFCs and households calculated using the corresponding outstanding amount volumes as weights.

A schematic representation of the feedback loop



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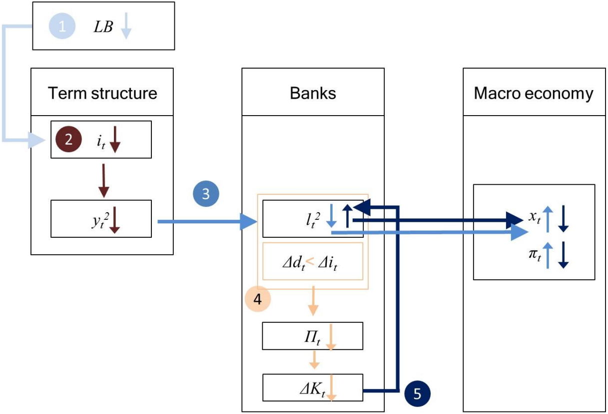


The model with feedback from *long lending* rate, ...

- Phillips curve

$$\pi_t = c^\pi + \alpha\pi_{t-1} + \beta x_{t-1} + \epsilon_t^\pi \tag{9}$$

- IS curve

$$x_t = c^x + \gamma x_{t-1} + \lambda \underbrace{\left(l_{t-1}^2 - E_{t-1}\left[\frac{1}{2}\pi_t + \frac{1}{2}\pi_{t+1}\right]\right)}_{\text{Long-term real \textit{lending} rate}} + \epsilon_t^x \tag{10}$$

- Taylor rule

$$s_t = c^s + a\pi_t + bx_t + \theta s_{t-1} + \epsilon_t^s \tag{11}$$

$$i_t = \max\{s_t, LB\} \tag{12}$$

- Long (=2-period) rate

$$y_t^2 = \frac{1}{2}i_t + \frac{1}{2}E_t(i_{t+1}) + \underbrace{\frac{1}{2}QVar_t(i_{t+1})}_{\text{Term premium}} \tag{13}$$

The banking module

- Deposit pricing

$$d_t = \max\left(i_t - \alpha, 0\right) \tag{14}$$

- Loan pricing

$$l_t^2 = y_t^2 + f\left(\frac{K_{t-1}}{Q_{t-1}}\right) \tag{15}$$

- Loan quantities determined by demand

$$Q_t = g\left(l_t^2, x_t\right) \tag{16}$$

- Deposit quantities determined endogenously via balance sheet identity

$$D_t = \sum_{j=0}^{1}(Q_{t-j}) - K_{t-1} \tag{17}$$

The banking module (continued)

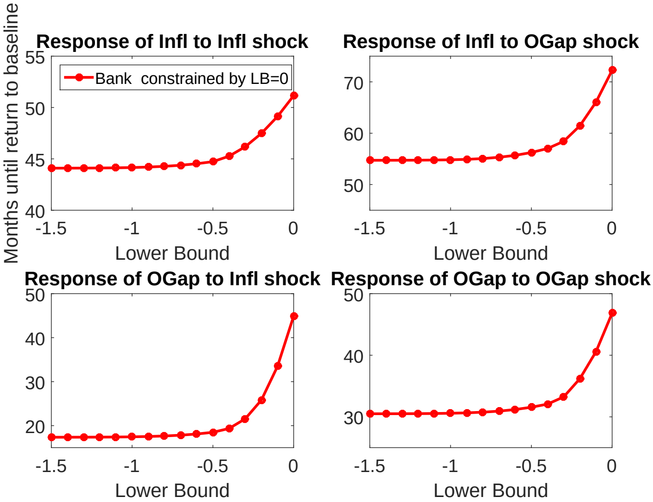
- Law of motion of capital

$$K_t = K_{t-1} + \Pi_t \tag{18}$$

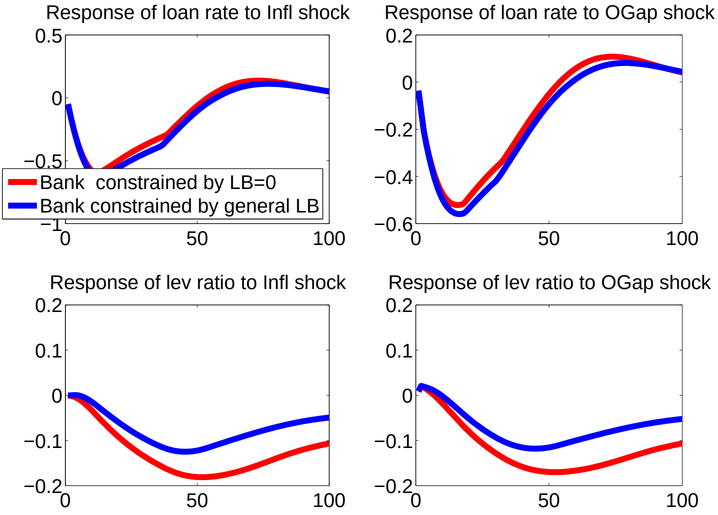
- Bank profits

$$\Pi_t = \sum_{j=0}^{1} (l^2_{t-j} Q_{t-j}) - d_t D_t \tag{19}$$

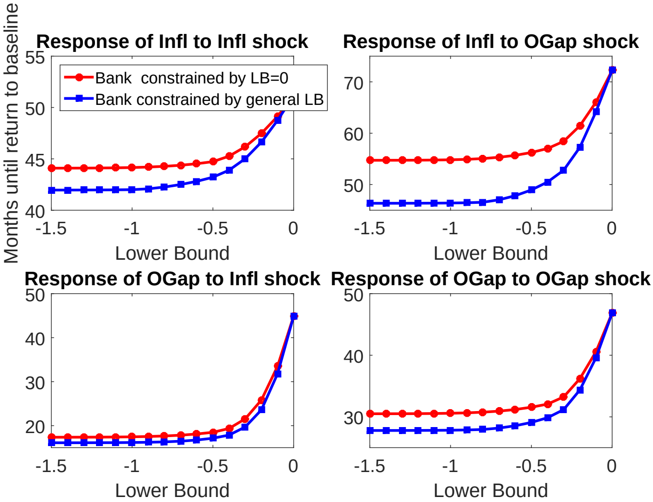
LB decrease beneficial also in bank economy



...but deposit rate rigidity squeezes profits ($LB = -0.3$)



... in turn dampening the benefit



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- ...so that NIRP contributes to lowering net interest margins, profits and bank capital ...
- ... which decelerates the fall in loan rates and can in turn dampen the positive effect on the macro-economy

Next steps

- Role of term premia
- Interaction with QE
- Refine calibration/estimation
- Replace 2-period bond by consol with flexible duration: stay closed-form?
- Sensible comparison of NIRP with forward guidance
- In-depth analysis of banking-sector transmission
- Modifications and extensions to the banking module:
  - Occasionally binding capital constraints (a la Brunnermeier and Koby (2016))
  - Richer balance sheet structure (assets and funding)
  - Endogenous loan default