

Interest rate corridors, liquidity and credit frictions

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Monetary policy implementation has evolved since the Great Moderation

Expanded toolkit – balance sheet policies, more prominent role for forward guidance, credit easing policies etc

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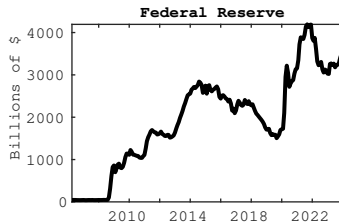
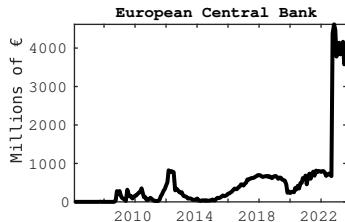
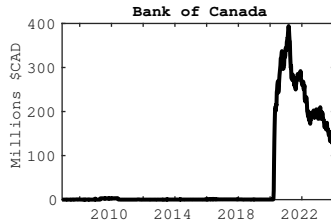
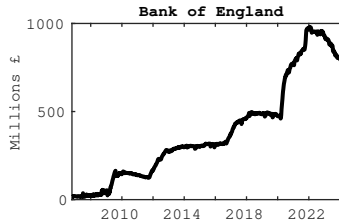
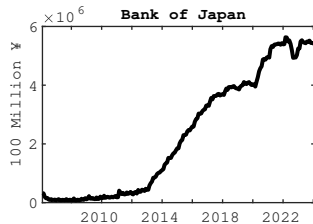
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Implementation of ‘conventional’ monetary policy also shifted, e.g.:

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These policies contributed to a big increase in banking sector excess reserves

Banking sector reserves



This paper

- ▶ I seek to build a model with endogenous excess reserves
- ▶ To study the interaction between QE, policy corridors, and lending conditions
- ▶ To study the important trade-offs in a structural model
- ▶ To study the impact of the ZLB and the role of negative interest rates
- ▶ To explore the role of QE on bank lending
- ▶ To study optimal policy

Corridor system 1/2

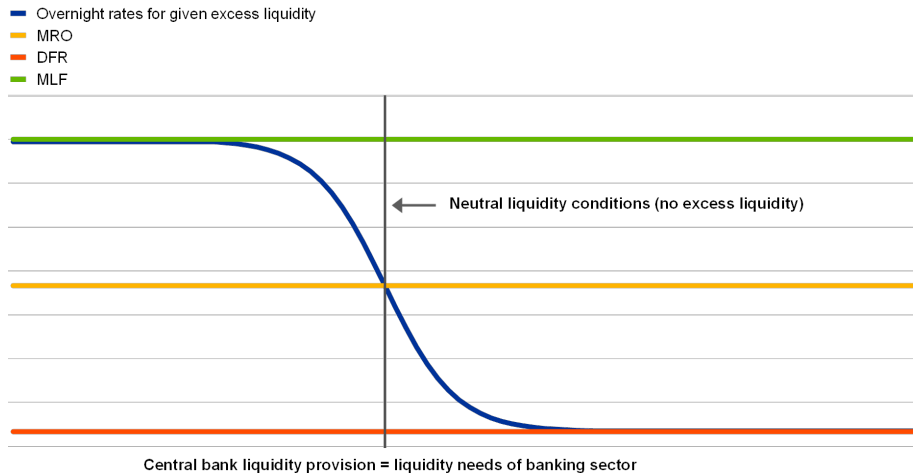
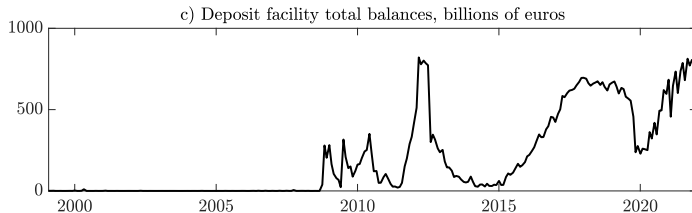
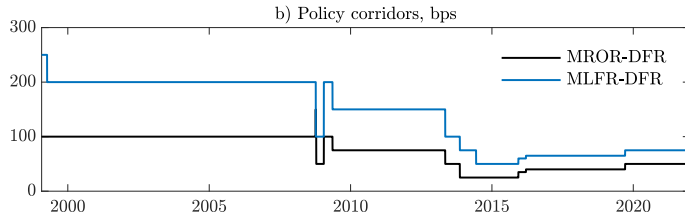
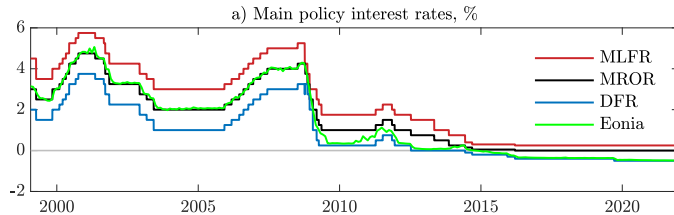


Figure: From [Eisenschmidt, Kedan & Tietz \(2018\)](#) (ECB Economic Bulletin 2018(5))

ECB interest rates



Corridor system 2/2

- ▶ Width of interest rate corridor to manage the volatility of overnight rate ([Bindseil & Jablecki 2011](#))
 - ▶ Narrow corridor → low volatility
 - ▶ Wide corridor → high interbank market volumes
- ▶ High reserve balances → floor becomes more important
 - ▶ Floor (CB deposit rate) becomes main policy interest rate
 - ▶ Deposit rate lowered to incentivize increased lending to real economy
 - ▶ [Draghi \(2015\)](#): “cuts in the rate on the deposit facility vastly improve the transmission of our monetary policy”

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It is very early stage – comments very welcome!

Snapshot of results: model and credit friction

New Keynesian model with:

- ▶ risky bank lending with adverse selection and credit rationing
- ▶ bank liquidity risk (not shown today)

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Main mechanism:

- ▶ Central bank deposit facility is an outside option for banks
- ▶ When adverse selection is bad (e.g., high risk), banks can ration credit
- ▶ CB deposit rate (IoR) affects incentives
- ▶ If IoR relatively high, banks ration credit more

Snapshot of results: initial results

Provisional results:

- ▶ If ZLB squeezes corridor → more credit rationing
 - ▶ additional cost of ZLB
 - ▶ importance of negative rates
- ▶ QE can be used as an additional tool
 - ▶ Can shift monetary policy towards a floor system
- ▶ Away from ZLB, two main channels:
 - ▶ lowers overnight rate compared to main policy target rate – usual demand channel **expansion** ↑
 - ▶ increases incentive to ration credit **contraction** ↓
 - ▶ Which effect dominates depends on financial conditions (firm risk)
- ▶ At the ZLB, I find QE can always help

Model Overview

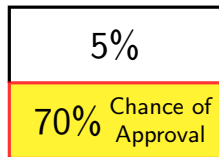
New Keynesian (Calvo) model frictional bank lending:

- ▶ Follow [Swarbrick \(2023\)](#) – [Stiglitz & Weiss \(1981\)](#) information problem (see also, e.g., [Ikeda 2020](#))
- ▶ 'Small firms' and 'large firms' (proportion exogenous, firm type random)
- ▶ Small firms all same size (need 1 unit of external finance)
- ▶ Each period draw either risky/safe projects, project type private information
- ▶ Banks can separate borrowers using loan approval
 - ▶ Loan terms are repayment rate and approval rate

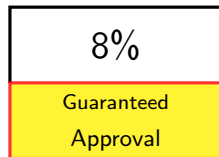
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Loan 1

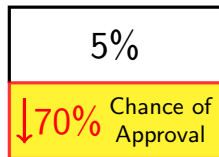


Loan 2

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- ▶ Banks can separate borrowers using loan approval
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- ▶ When risk is high, banks can ration credit and hold excess reserves (paying CB deposit rate)



Loan 1



Loan 2

Banks

Using central banks liquidity and HH deposits:

- ▶ banks post loan contracts specifying **interest rate** τ_t^i and **approval probability** x_t^i

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Using central banks liquidity and HH deposits:

- ▶ banks post loan contracts specifying **interest rate** τ_t^i and **approval probability** x_t^i
- ▶ τ_t^i and x_t^i chosen solve:

$$\max_{\substack{x_t^s, x_t^r \\ \tau_t^s, \tau_t^r}} \mathbb{E}_t \left[\frac{\Lambda_{t,t+1}}{\Pi_{t,t+1}} \left(\lambda x_t^s \left(\tau_t^s - R_t^* \right) + (1 - \lambda) x_t^r \left(p_{t+1}^r \tau_t^r - R_t^* \right) \right) \right] \quad (1)$$

$$\text{s.t. IC \& IR constraints} \quad (2)$$

$$\lambda x_t^s + (1 - \lambda) x_t^r \leq \bar{x}_t \quad (3)$$

$$0 \leq x_t^s \leq x_t^r \leq 1 \quad (4)$$

- ▶ IR constraint binds for safe firms (no expected profits)
- ▶ IC constraint binds for risky firms (earn expected profits to reveal type)
- ▶ IC, IR also $\Rightarrow \tau_t^r \geq \tau_t^s, x_t^r \geq x_t^s$
- ▶ R_t^* is opportunity cost of funds (e.g., interest on reserve balances)

Monetary policy

Standard Taylor rule

$$r_t^{mro} = \bar{r} + \gamma_\pi (\pi_{t-1,t} - \pi^*) + \gamma_y (y_t - \bar{y}) \quad (5)$$

- ▶ Think of this as the central bank setting the main refinancing rate at regular full -allotment auctions
- ▶ Interest rate on HH deposits $R_t = R_t^{mro}$ in equilibrium

Central bank also has two standing facilities

- ▶ Deposit facility paying R_t^{df} (excess reserves)
- ▶ Lending facility charging R_t^{lf}

We also allow the bank to conduct QE through purchasing assets from HHs — more on this if time

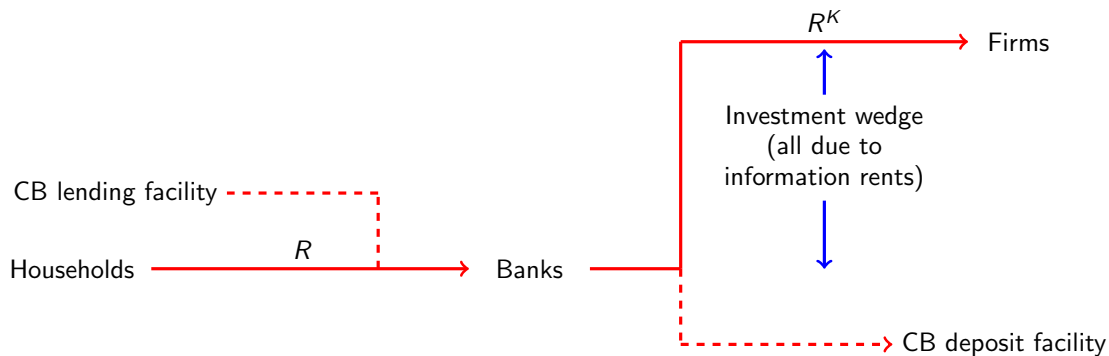
Interest rates

Benchmark – efficient financial markets



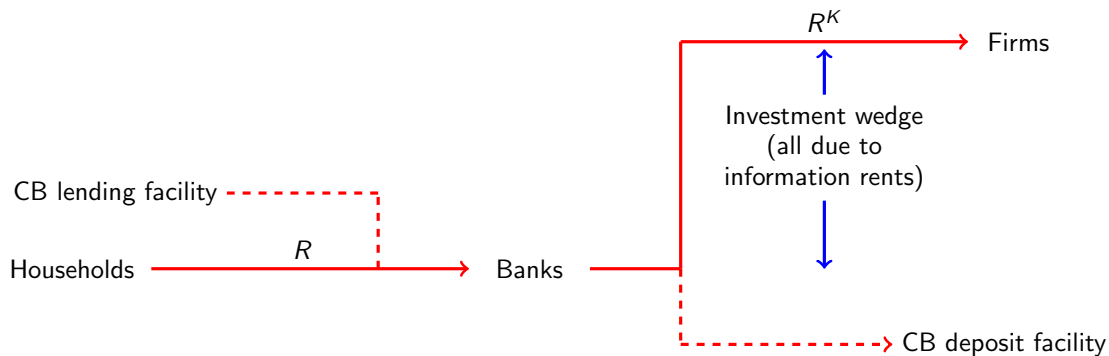
Interest rates

Benchmark – credit frictions, no excess liquidity



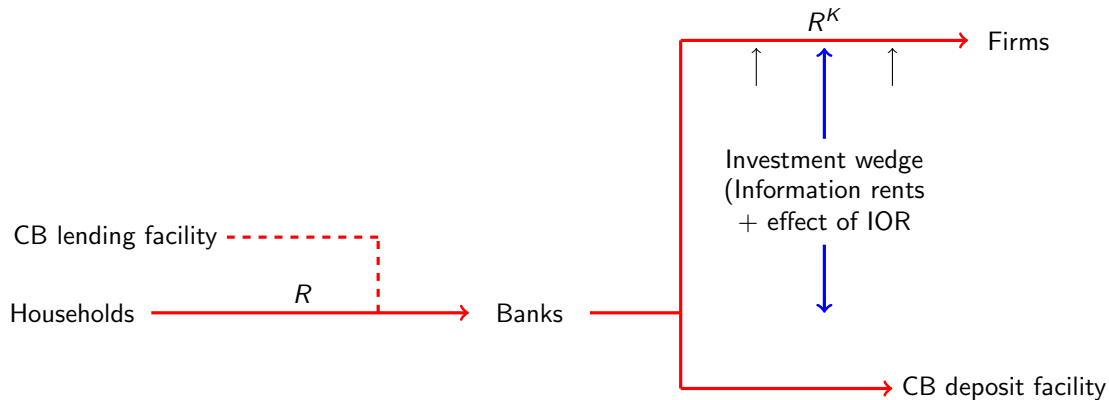
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Interest rates

Benchmark – credit frictions, with excess liquidity

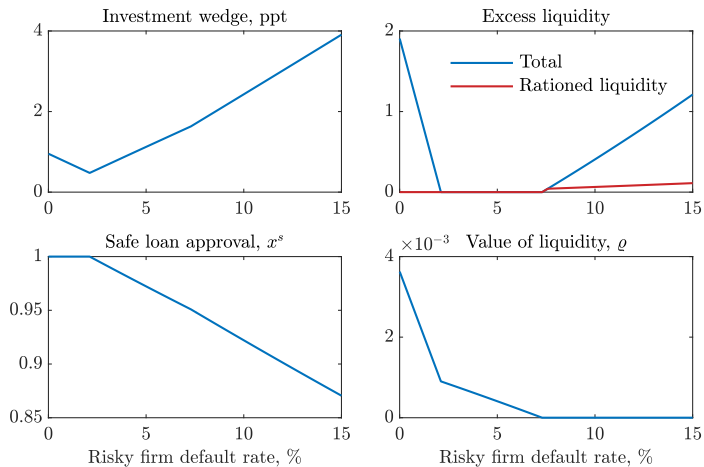


Note: interest rate corridor only matters when banks hold excess reserves

Excess liquidity can arise from two sources

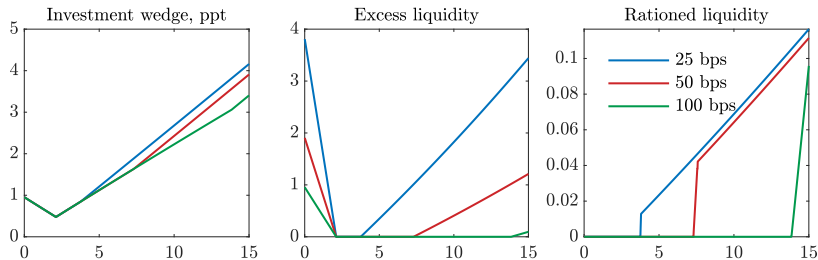
1. More liquidity available than firms looking for loans at equilibrium interest rates
 - ▶ Depends on risk and entry costs
 - ▶ Lower risk \rightarrow lower firm profits
 - ▶ Low profits + high entry costs = few firms
 - ▶ Fewer firms \rightarrow less investment \rightarrow higher marginal return on capital
 - ▶ Excess liquidity in banking sector and positive spread
2. Banks ration credit due to high level of risk
 - ▶ To raise risky loan interest rates, banks must lower approval of safe loans
 - ▶ I.e., cannot only tighten standards on high-interest rate loans
 - ▶ Safe borrowers rationed
 - ▶ Banks hold excess reserves instead

Comparative statics – effect of risk



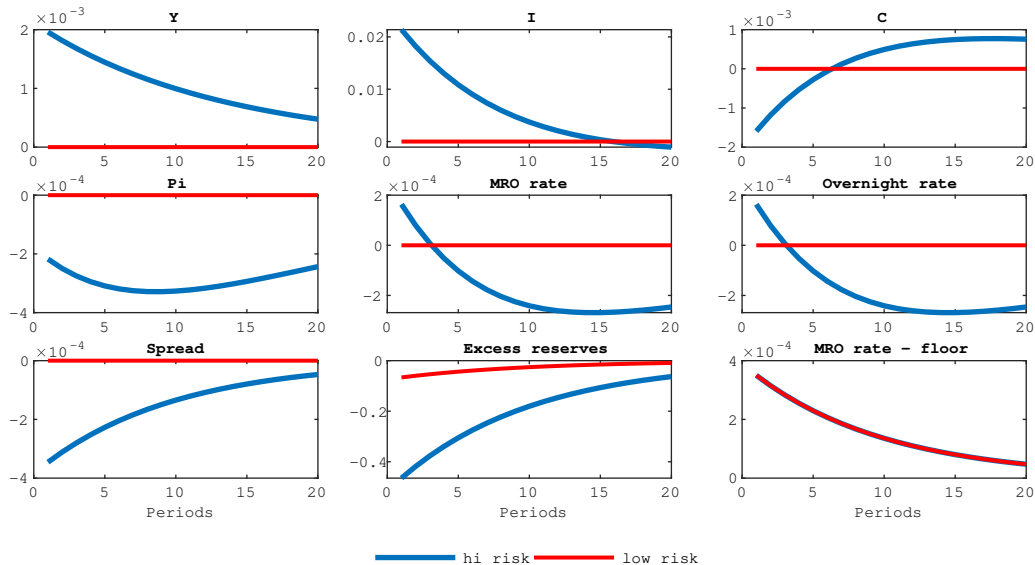
Result: large region with no excess reserves – the interest rate corridor has no role

Comparative statics – role of corridor



Result: changes in deposit rate only affect economy through the effect on credit rationing.

Temporary widening of corridor



Note: shows deviations from SS % or ppt (inflation/interest rates). Excess reserves are reserves/loans ratio

Quantitative Easing

The equilibrium interest rate depends on the volume of banking sector liquidity

- ▶ Suppose the CB purchases assets from HHs or injects bank liquidity directly
- ▶ Banks will take liquidity as long as expected return = expected funding cost
- ▶ Expected bank return (L_t is loans, S_t is Assets = loans + reserves):

$$1 = \mathbb{E}_t \left[\frac{\Lambda_{t,t+1}}{\Pi_{t,t+1}} \left(\underbrace{\left[\lambda x_t^s + (1 - \lambda) (1 - (1 - p_{t+1}) x_t^s) \right] R_t^s \frac{L_t}{S_t}}_{\text{Return on lending}} + \underbrace{\left(1 - (\lambda x_t^s + (1 - \lambda) \frac{L_t}{S_t}) \right) R_t^*}_{\text{Return on reserves}} \right) \right]$$

- ▶ This lowers average bank return, so will only clear at lower interest rate

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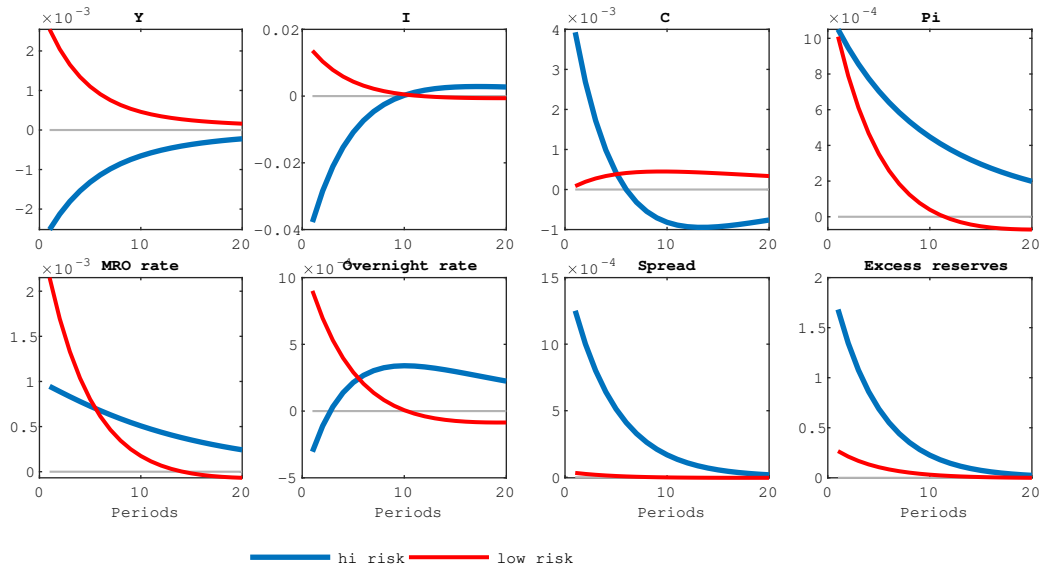
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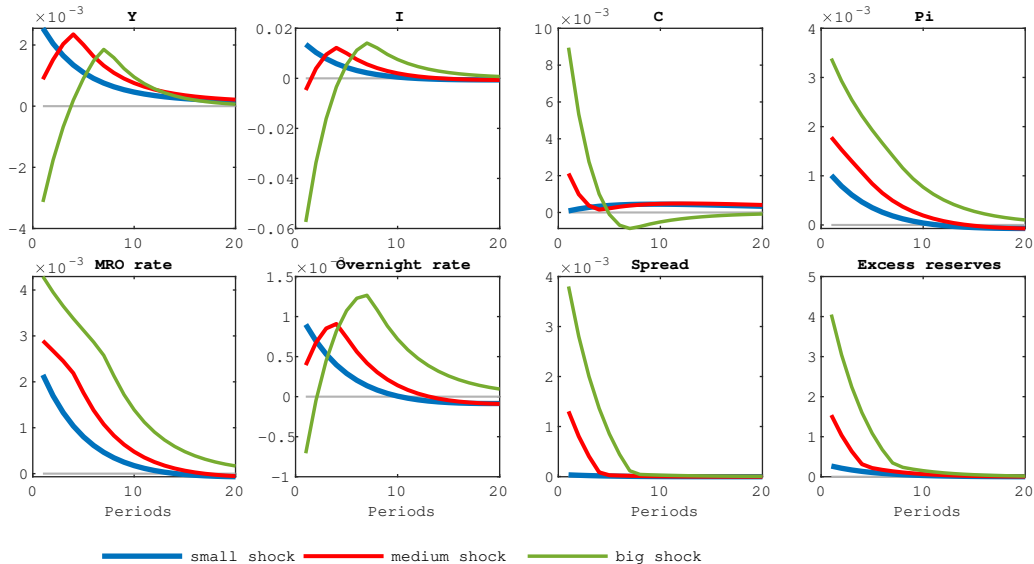
Two competing effects

- ▶ With lower interest rates, banks pass on to more favourable lending conditions: **lending** \uparrow
- ▶ As equilibrium interest rate \downarrow but CB deposit rate unchanged, incentive to ration credit: **lending** \downarrow

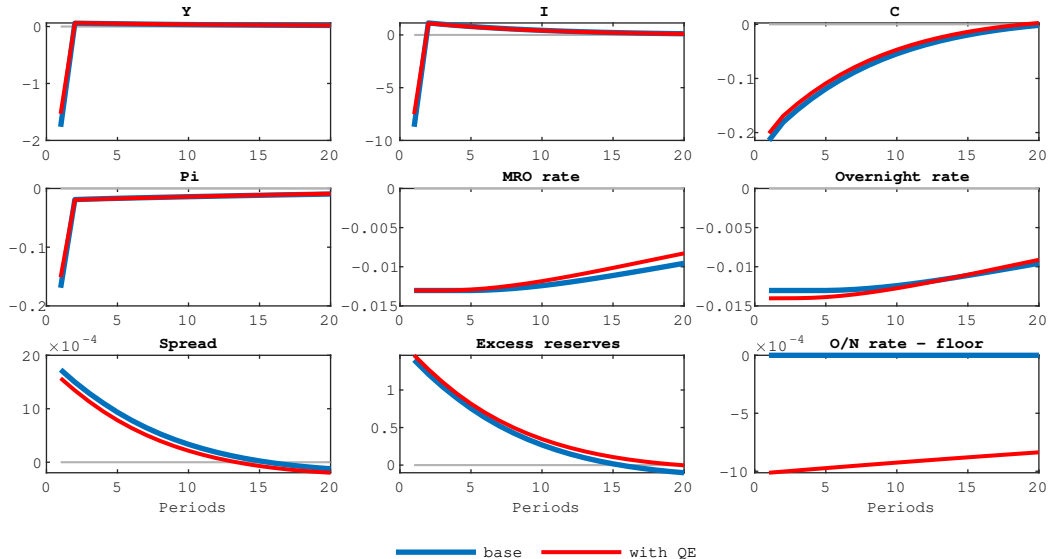
QE programme -- high risk vs. low risk economy



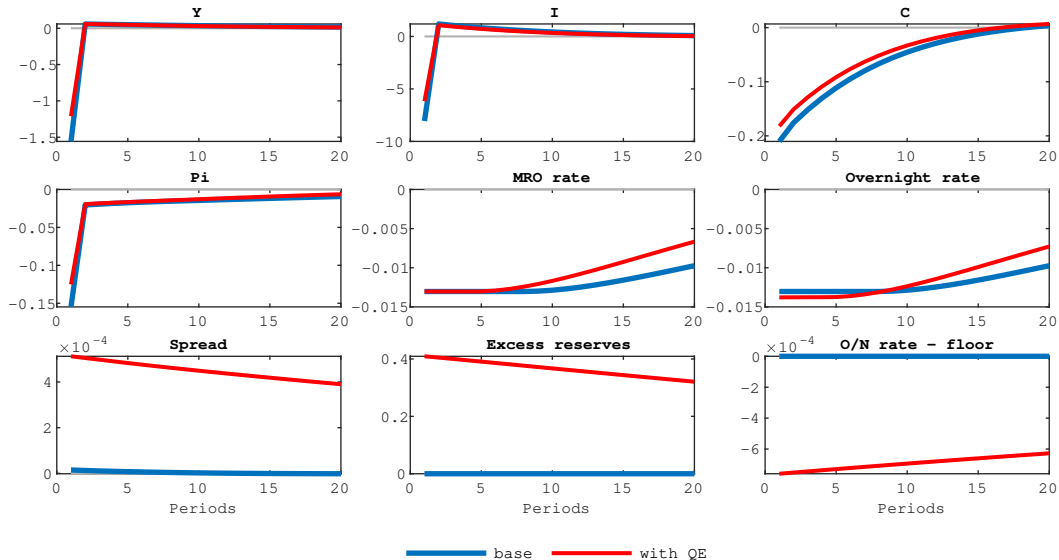
QE -- low risk economy, programme size effect



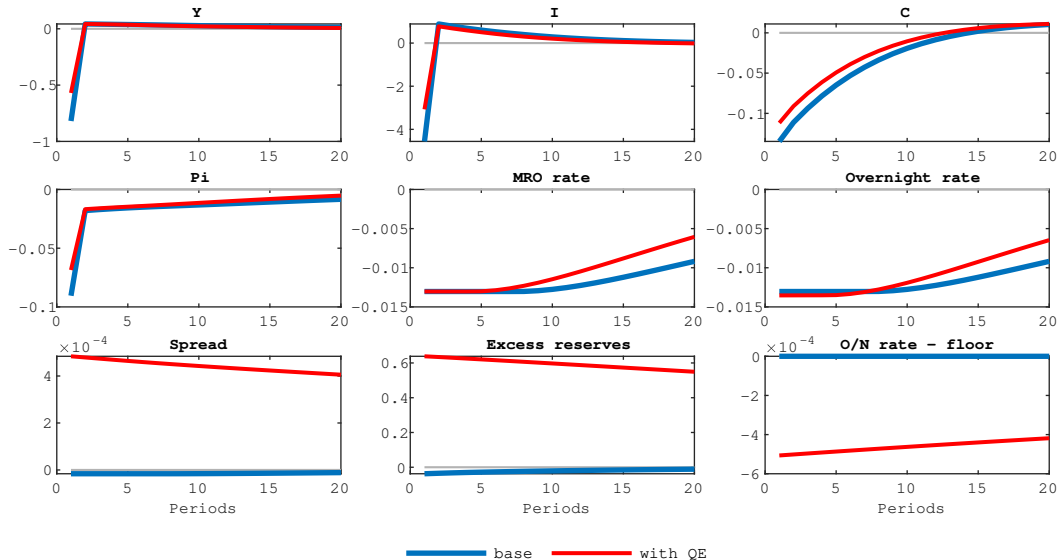
Demand shock with/without QE -- low risk economy



Demand shock with/without QE -- medium risk economy



Demand shock with/without QE -- high risk economy



References I

- Bindseil, U. & Jablecki, J. (2011), The optimal width of the central bank standing facilities corridor and banks' day-to-day liquidity management, Working Paper Series 1350, European Central Bank.
- Draghi, M. (2015), 'Introductory statement to the press conference (with Q&A)'. 3 December 2015, European Central Bank, Frankfurt am Main.
URL: <https://www.ecb.europa.eu/press/pressconf/2015/html/is151203.en.html>
- Eisenschmidt, J., Kedan, D. & Tietz, R. (2018), Measuring fragmentation in the euro area unsecured overnight interbank money market: a monetary policy transmission approach, Economic Bulletin (2018), Issue 5, Frankfurt am Main.
- Ikeda, D. (2020), 'Adverse selection, lemons shocks and business cycles', *Journal of Monetary Economics* **115**, 94–112.
URL: <https://www.sciencedirect.com/science/article/pii/S0304393219300947>
- Stiglitz, J. E. & Weiss, A. (1981), 'Credit Rationing in Markets with Imperfect Information', *American Economic Review* **71**(3), 393–410.
- Swarbrick, J. (2023), 'Lending standards, productivity, and credit crunches', *Macroeconomic Dynamics* **27**(2), 456–481.

Firms: large and small firms

- ▶ Differentiate between large (observable projects) and small (unobservable projects) firms
- ▶ Every period, firms draw their type (large/small) and a project (risky/safe):
 1. λ are **safe** – known return, no risk of default
 2. $1 - \lambda$ are **risky** – uncertain return, risk of default
- ▶ Project type doesn't matter for large firms as we'll assume equal NPV
- ▶ Entry costs – new firms raise equity finance to enter \implies claim on future profits
- ▶ Firms must raise outside finance for ongoing investment

Small firms

Firms raise k units of outside finance (loans)

- ▶ convert to $\omega_t^i k$ units of capital, $i \in \{s, r\}$
- ▶ succeed with probability p_{t+1}^i , otherwise yield zero
- ▶ $\omega_t^s = p_t^s = \omega_t^r p_t^r = 1$, $\omega_t^r > 1$, $p_t^r < 1$

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If funded, choose labour demand to maximise period profits:

$$V_t^i = \max_{h_t(\omega_t^i)} \left\{ \frac{P_t^W}{P_t} y_t(\omega_t^i) - \frac{W_t}{P_t} h_t(\omega_t^i) - \left(\frac{\tau_{t-1}^i}{\Pi_{t-1,t}} q_{t-1} - (1 - \delta) \omega_t^i q_t \right) k + V_t \right\} \quad (6)$$

where

$$y_t(\omega_t^i) = z_t \left[\omega_t^i k \right]^\alpha \left[h_t(\omega_t^i) \right]^{1-\alpha}$$

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Investment wedge and credit rationing

The investment wedge stems the information rents

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If the risk increases enough, banks will ration credit

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An important identity will by value of liquidity $\varrho_t \geq 0$ (ψ is multiplier on $x_t^r \geq x_t^s$ constraint):

$$\text{Liquidity value} = \varrho_t = \mathbb{E}_t \left[\frac{\Lambda_{t,t+1}}{\Pi_{t,t+1}} \left(\left(1 - \frac{1-\lambda}{\lambda} (1 - p_{t+1}) \right) R_{t+1}^s - R_t^* \right) \right] - \psi_t \quad (7)$$

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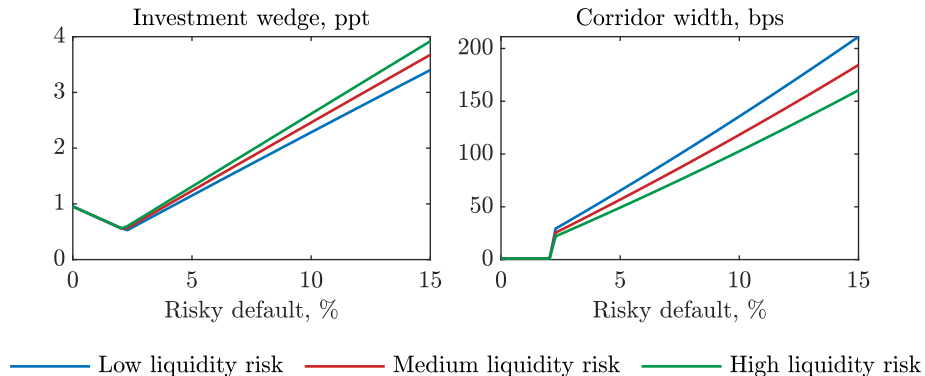
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Optimal corridor



Monetary policy shock

