Evaluation of unconventional monetary policy in a small open economy

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Disclaimer

The usual disclaimer applies, meaning that the author alone is responsible for any errors that may remain and for the views expressed in the paper.

Outline

1. Motivation, Research Questions and Approach
   - Motivation
   - Research Questions and Approach
2. Model
   - Households
   - Financial sector
   - Intermediate goods producers
   - Capital goods producers
   - Retail firms
   - Foreign behavior
   - Government and central bank
3. Model analysis
   - Capital quality shock
   - Capital quality shock and the ZLB
   - Crisis experiment
   - Effects of LSAP
4. Summary

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Motivation

- Great Recession pushed several central banks to lower the nominal interest rates to the effective zero lower bound.
- But these banks did not run out of means to ease monetary conditions further.
- Unconventional monetary policy:
  - Large-Scale Asset Purchases (credit easing, quantitative easing).
  - Signaling e.g. forward guidance - time (US) or state (UK) dependent.
- Despite growing interest in the UMP tools, there is a gap in the literature concerning international facets of such policies.

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International Openness

- Why it is important to take into account international openness?

Table : International trade measured by Exports to GDP

Country	Imp. content of Exp.	Exp. to GDP	"Pure" Exp.
France	27%	27%	20%
Germany	27%	50%	37%
Italy	29%	27%	19%
Japan	15%	15%	13%
Sweden	33%	50%	33%
UK	21%	31%	24%
US	12%	13%	11%
EU	13%	44%	38%

Source: OECD, STAN Input-Output database, data for 2011.

- Using closed economy models might have detrimental consequences when assessing effectiveness of LSAP!

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Research Questions

Questions that need to be answered:

- Interplay between "leakages" of the policy actions and the degree of openness:
  - to the international trade,
  - to the foreign assets.
- Role of the exchange rate, if it is influenced by asset purchases and how these changes affect the economy.

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Models developed so far

Del Negro et al. (2010)

- Focus on the role of the illiquid secondary markets for the private securities.
- There is no agent who acts as a bank/financial intermediary.

Cúrdia and Woodford (2010)

- Analysis of the purchases of the private assets.
- No connection between the investment and the output capacity.

Gertler and Karadi (2013)

- Both government and private securities purchases are analyzed.
- Rich specification of financial sector.

Model used in this study is an amalgam of Gertler and Karadi (2013) and Galí and Monacelli (2005).

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Households - problem

$$\max_{C_t, L_t, D^H_{h,t}, D^F_{h,t}} u_t = E_t \sum_{i=0}^{\infty} \beta^i \left[ln\left(C_{t+i} - \bar{h}\, C_{t+i-1} \right) - \frac{\chi}{1+\varphi} L_{t+i}^{1+\varphi} \right] \tag{1}$$

subject to:

$$P_t C_t + D^H_{h,t} + e_t D^F_{h,t} + P_t X = W_t L_t + P_t \Pi_t +$$

$$+ P_t T + R_{t-1} D^H_{h,t-1} + R^*_{t-1} \Psi\left(e_t D^F_{h,t} \right) e_t D^F_{h,t-1} \tag{2}$$

Households - solution

$$u_{C,t} = \frac{1}{C_t - \bar{h}\, C_{t-1}} - \bar{h}\beta\, E_t \frac{1}{C_{t+1} - \bar{h}\, C_t} = P_t \lambda_t \tag{3}$$

$$u_{L,t} = \chi L_t^{\varphi} = \lambda_t W_t \tag{4}$$

$$E_t \Lambda_{t,t+1} R_t = 1 \tag{5}$$

$$E_t \Lambda_{t,t+1} \frac{e_{t+1}}{e_t} \Psi\left(e_t D_{h,t}^F\right) R_t^* = 1 \tag{6}$$

Last two give the UIP:

$$E_t \Lambda_{t,t+1} \frac{e_{t+1}}{e_t} = E_t \frac{R_t}{\Psi\left(e_t D_{h,t}^F\right) R_t^*}$$

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Financial sector - problem

$$\max_{S_{p,t},\, B^H_{p,t},\, D_t} V_t = E_t \sum_{i=1}^{\infty} (1-\sigma)\sigma^{i-1} \widetilde{\Lambda}_{t,t+1} N_{t+i} \tag{7}$$

subject to:

$$Q_t S_{p,t} + q_t B_{p,t} = N_t + D^H_{h,t} \tag{8}$$

$$N_t = R_{k,t} Q_{t-1} S_{p,t-1} + R_{b,t} q_{t-1} B_{p,t-1} - R_{t-1} D^H_{h,t-1} \tag{9}$$

$$V_t \geqslant \theta Q_t S_{p,t} + \Delta\theta q_t B_{p,t} \tag{10}$$

Financial sector - solution

$$E_t \widetilde{\Lambda}_{t,t+1} (R_{k,t+1} - R_t) = \frac{\lambda_t}{1+\lambda_t} \theta \tag{11}$$

$$E_t \widetilde{\Lambda}_{t,t+1} (R_{b,t+1} - R_t) = \frac{\lambda_t}{1+\lambda_t} \Delta\theta \tag{12}$$

So excess return on each type of asset depends on the tightness of the financial frictions.

$$Q_t S_{p,t} + \Delta q_t B_{p,t} \begin{cases} = \phi_t N_t & \text{if } \lambda_t > 0 \\ < \phi_t N_t & \text{if } \lambda_t = 0 \end{cases} \tag{13}$$

Which means bankers have limited ability to expand their assets. Leverage ratio is a function of embezzlement parameter θ and the interest rates:

$$\phi_t = \frac{E_t \widetilde{\Lambda}_{t,t+1} R_t}{\theta - E_t \widetilde{\Lambda}_{t,t+1} (R_{k,t+1} - R_t)} \tag{14}$$

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Intermediate goods producers

$$\max_{Y_t, L_t, K_t} P_{m,t} Y_t - W_t L_t - Z_t K_t$$

subject to:

$$Y_{m,t} = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{15}$$

yields:

$$W_t = P_{m,t}(1-\alpha)\frac{Y_{m,t}}{L_t} \tag{16}$$

$$Z_t = P_{m,t}\alpha\frac{Y_{m,t}}{K_t} \tag{17}$$

Capital law of motion:

$$K_{t+1} = \xi_{t+1}\left[I_t + (1-\delta)K_t\right] \tag{18}$$

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Capital goods producers

$$\max_{I_t} E_t \sum_{\tau=t}^{\infty} \Lambda_{t,\tau} \left\{ (Q_\tau - 1) I_\tau - f\left(\frac{I_\tau}{I_{\tau-1}}\right) I_\tau \right\} \tag{19}$$

yields:

$$Q_t = 1 + f\left(\frac{I_t}{I_{t-1}}\right) + \frac{I_t}{I_{t-1}} f'\left(\frac{I_t}{I_{t-1}}\right) - E_t \Lambda_{t,t+1} \left(\frac{I_{t+1}}{I_t}\right)^2 f'\left(\frac{I_{t+1}}{I_t}\right) \tag{20}$$

Note that the lower demand of investment goods provokes worse situation of financial intermediaries, which in order to satisfy (13) have to decrease leverage, hence the bankers' net worth.

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Retail firms

$$Y_{H,t} = \left[\int_0^1 Y_{H,f,t}^{\frac{\varepsilon-1}{\varepsilon}} df \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{21}$$

$$Y_{H,t}^{*} = \left[\int_0^1 Y_{H,f,t}^{*\frac{\varepsilon-1}{\varepsilon}} df \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{22}$$

From (21) and (22) we know that the demand for the intermediate goods is given by:

$$Y_{H,f,t} = \left(\frac{P_{H,f,t}}{P_{H,t}} \right)^{-\varepsilon} Y_{H,t} \tag{23}$$

$$Y_{H,f,t}^{*} = \left(\frac{e_t P_{H,f,t}^{*}}{e_t P_{H,t}^{*}} \right)^{-\varepsilon} Y_{H,t}^{*} \tag{24}$$

Retail firms

Assuming that the law of one price (LOOP) holds $P_{H,t} = e_t P^*_{H,t}$, we can rewrite (24) as:

$$Y^*_{H,f,t} = \left(\frac{P_{H,f,t}}{P_{H,t}} \right)^{-\varepsilon} Y^*_{H,t} \tag{25}$$

Retailers are also subject to nominal rigidities (Calvo, 1983) which after optimization gives:

$$E_t \sum_{i=0}^{\infty} \gamma^i \Lambda_{t,t+i} \left[\frac{P^{NEW}_{H,t}}{P_{H,t+i}} - \mu P_{m,t+i} \right] \left(Y_{H,f,t+i} + Y^*_{H,f,t+i} \right) = 0 \tag{26}$$

Retail firms

Price dispersion for the domestically used and exported goods:

$$\Delta_{p,t} = \int_0^1 \left(\frac{P_{H,f,t}}{P_{H,t}} \right)^{-\varepsilon} df = (1-\gamma) \left(\frac{P_{H,t}^{NEW}}{P_{H,t}} \right)^{-\varepsilon} + \gamma \left(\frac{P_{H,f,t}}{P_{H,t}} \right)^{-\varepsilon} \Delta_{p,t-1}$$

$$\Delta_{p,t}^{*} = \int_0^1 \left(\frac{e_t P_{H,f,t}^{*}}{e_t P_{H,t}^{*}} \right)^{-\varepsilon} df = (1-\gamma) \left(\frac{P_{H,t}^{*NEW}}{P_{H,t}^{*}} \right)^{-\varepsilon} + \gamma \left(\frac{e_t P_{H,f,t}^{*}}{e_t P_{H,t}^{*}} \right)^{-\varepsilon} \Delta_{p,t-1}^{*}$$

Note that assumption that LOOP holds implies $\Delta_{p,t} = \Delta_{p,t}^{*}$. Finally, aggregate domestic goods price index $P_{H,t}$ evolves according to:

$$P_{H,t} = \left[(1-\gamma) \left(P_{H,t}^{NEW} \right)^{1-\varepsilon} + \gamma (P_{H,t-1})^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \tag{27}$$

Retail firms

Retailers combine goods produced at home and imported.

$$\min_{Y_t, Y_{H,t}, Y_{F,t}} P_t Y_t = P_{H,t} Y_{H,t} + P_{F,t} Y_{F,t}$$

subject to:

$$Y_t \equiv \left[(1-\nu)^{\frac{1}{\omega}} Y_{H,t}^{\frac{\omega-1}{\omega}} + \nu^{\frac{1}{\omega}} Y_{F,t}^{\frac{\omega-1}{\omega}} \right]^{\frac{\omega}{\omega-1}} \tag{28}$$

Demand functions for the two types of goods:

$$Y_{H,t} = (1-\nu) \left(\frac{P_{H,t}}{P_t} \right)^{-\omega} Y_t \tag{29}$$

$$Y_{F,t} = \nu \left(\frac{P_{F,t}}{P_t} \right)^{-\omega} Y_t \tag{30}$$

where P_t is the consumer price index given by:

$$P_t \equiv \left[(1-\nu) P_{H,t}^{1-\omega} + \nu P_{F,t}^{1-\omega} \right]^{\frac{1}{1-\omega}} \tag{31}$$

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Foreign behavior

$$P_{F,t} = e_t P_t^* \tag{32}$$

Foreign demand for domestic goods is given by:

$$Y_{H,t}^* = \left[\left(\frac{P_{H,t}^*}{P_t^*} \right)^{-\iota} Y_t^* \right]^{\varpi} \left(Y_{H,t-1}^* \right)^{1-\varpi} \tag{33}$$

Having defined foreign demand on domestic goods, we can express net exports as:

$$NX_t = P_{H,t} Y_{H,t}^* - P_{F,t} Y_{F,t} \tag{34}$$

and the foreign deposits as:

$$e_t D_{h,t}^F = -NX_t + e_t R_{t-1}^* \left[\mathrm{e}^{\psi\left(\overline{e}\overline{D_h^F} - e_t D_{h,t}^F\right)} \right] D_{h,t-1}^F \tag{35}$$

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Government and central bank

$$P_t G_t + (R_{b,t-1} - 1)\bar{B} + \tau_s + \tau_b = P_t T + (R_{k,t} - R_{t-1} - \tau_s) Q_{t-1} S_{g,t-1} +$$

$$+ (R_{b,t} - R_{t-1} - \tau_b) q_{t-1} B_{g,t-1} \tag{36}$$

$$i_t = \max\left[1, \rho_{ir} i_{t-1} + (1-\rho_{ir})\left[\kappa_\pi \pi_t + \kappa_y \left(\log Y_t - \log Y_t^N\right)\right] + \varepsilon_t\right] \tag{37}$$

$$1 + i_t = R_{t+1} \frac{P_{t+1}}{P_t} \tag{38}$$

Central bank's balance sheet is given by:

$$Q_t S_{g,t} + q_t B_{g,t} = D_{g,t} \tag{39}$$

$$Q_t (S_t - S_{g,t}) - \Delta q_t (B_{g,t} - B_t) \leqslant \phi_t N_t \tag{40}$$

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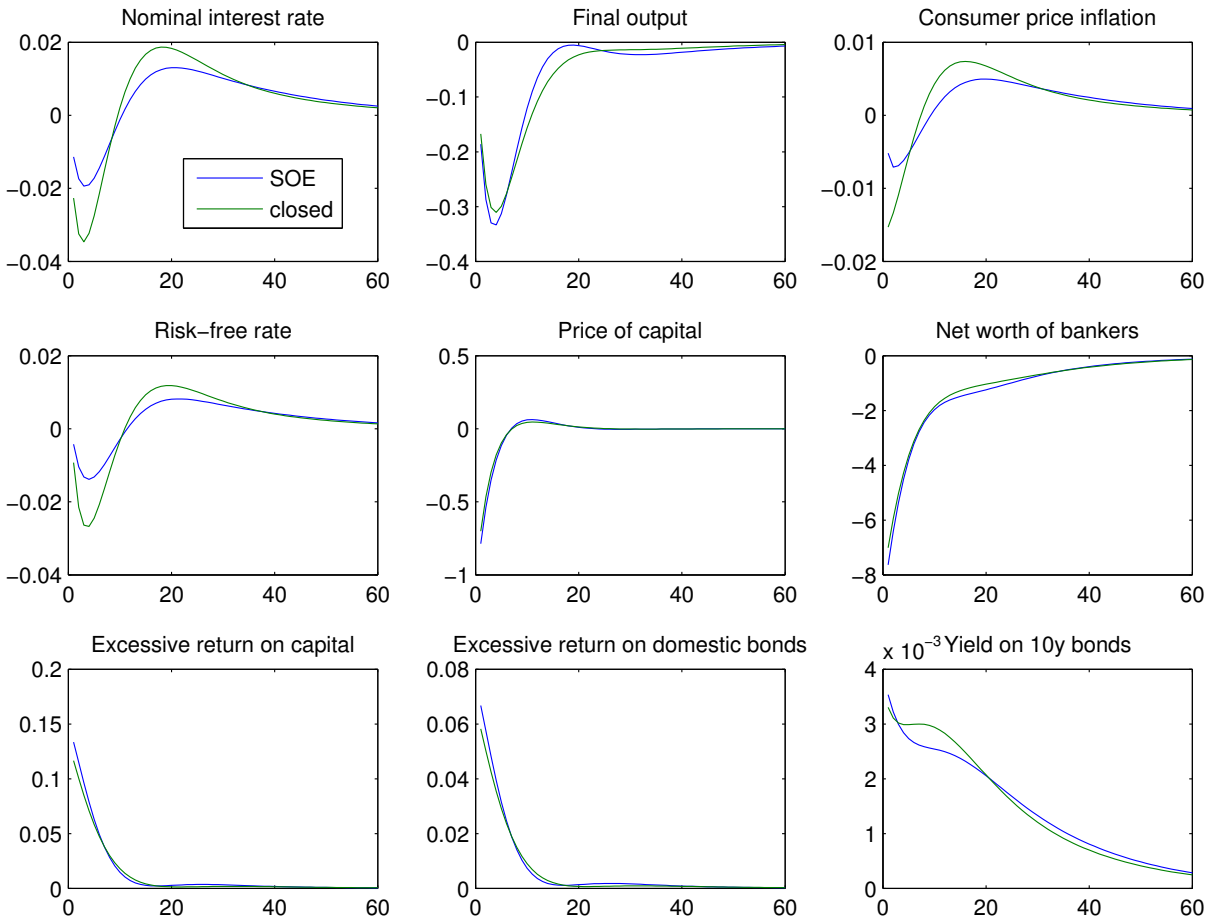
Capital quality shock

Figure : Capital quality shock



Note: Percentage point deviations from the steady-state.

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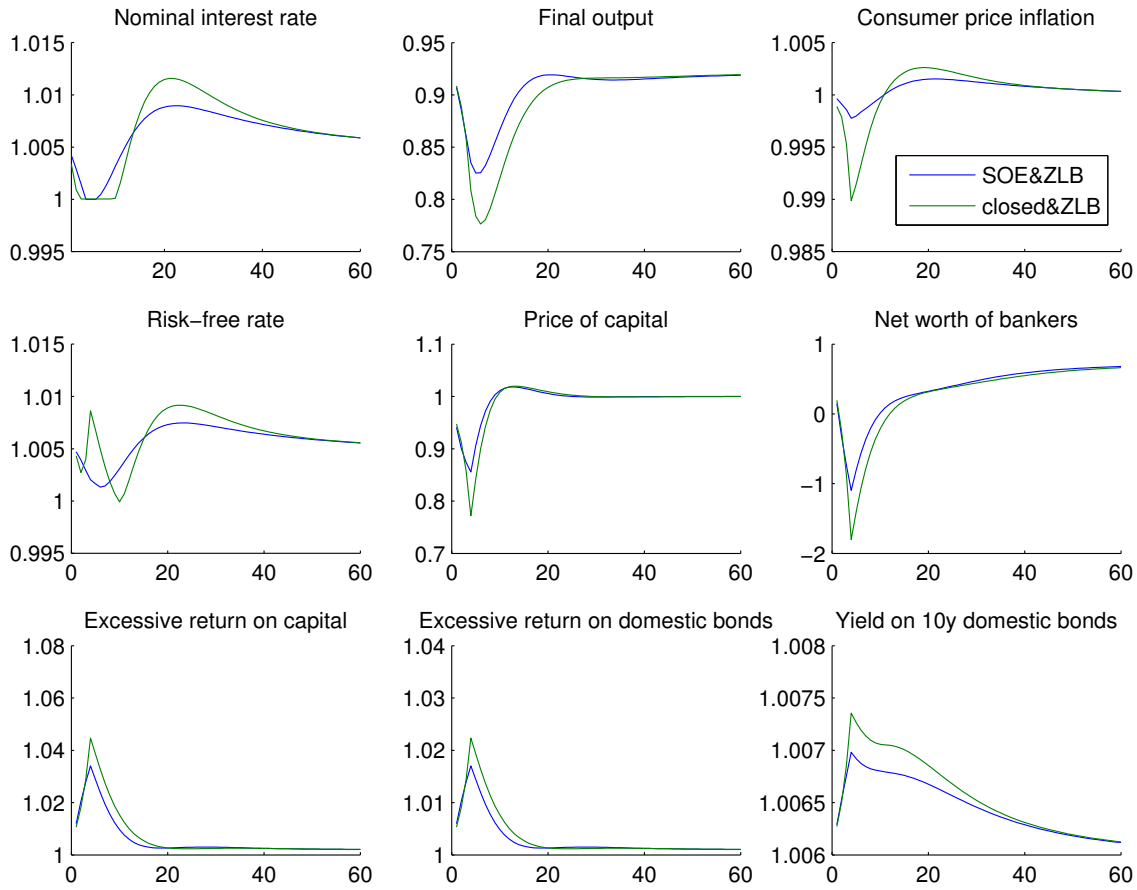
Capital quality shock and the ZLB

Figure : Capital quality shock and the ZLB



Note: IRFs are reported in levels.

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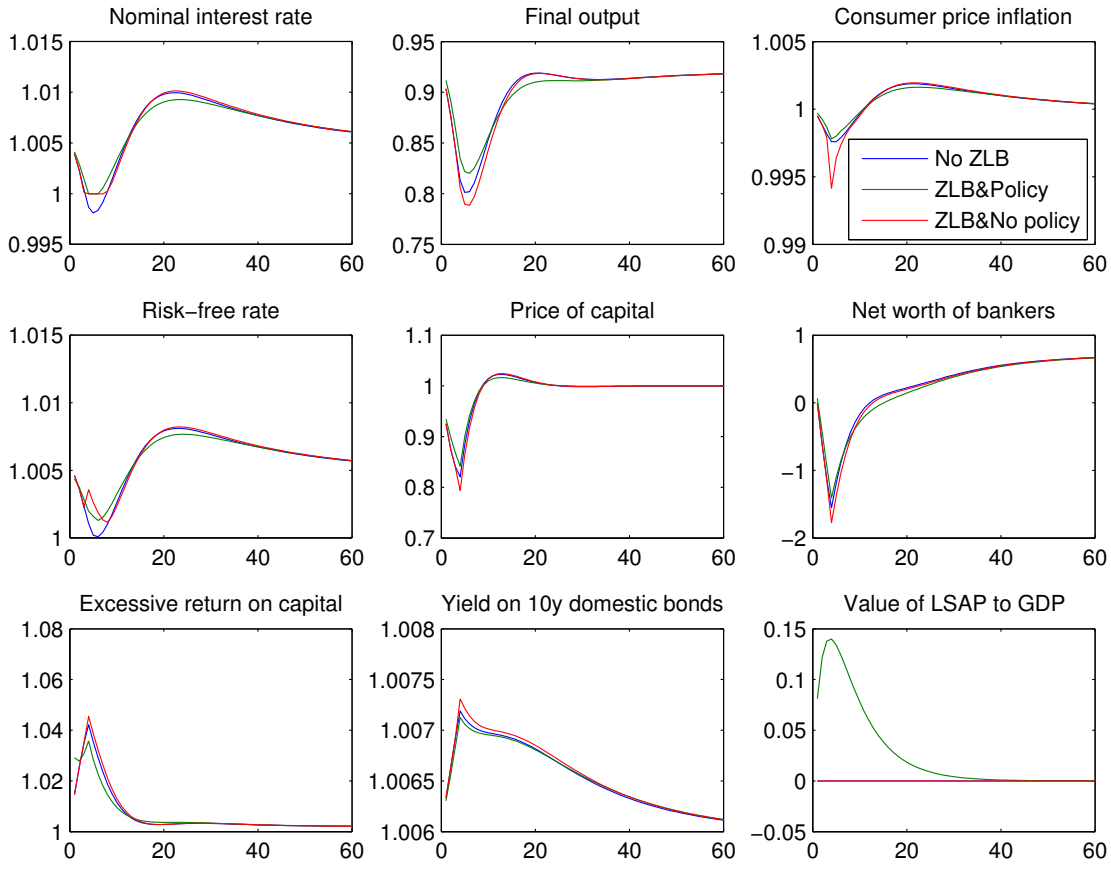
Crisis experiment

Figure : Crisis experiments in a SOE under three scenarios



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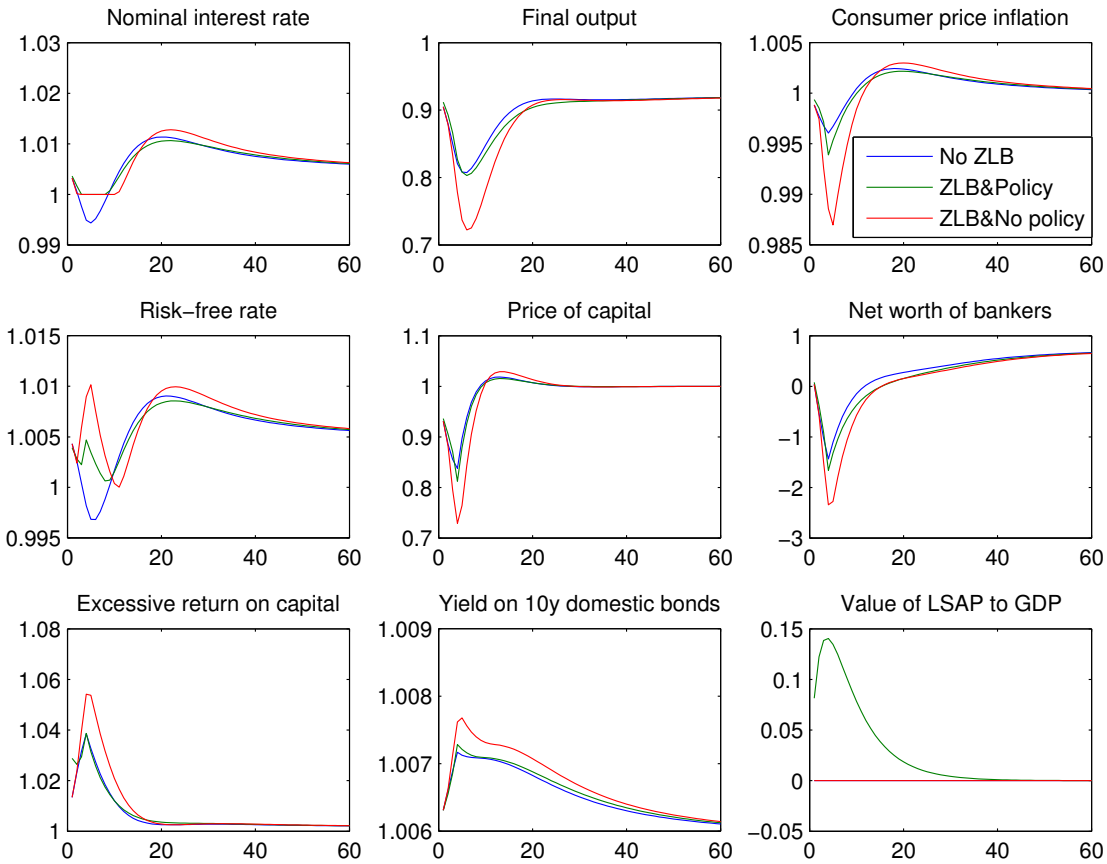
Crisis experiment

Figure : Crisis experiments in a closed economy



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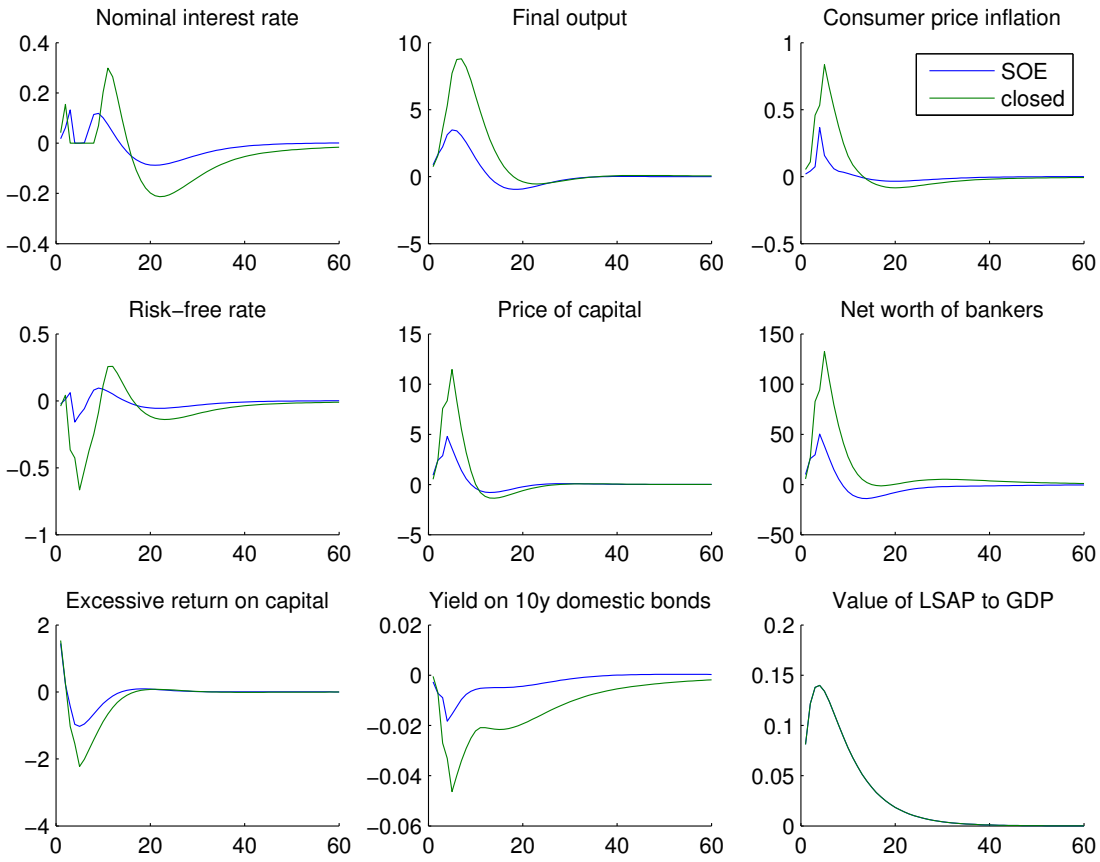
Effects of LSAP

Figure : Effectiveness of a LSAP in a SOE and a closed economy



Note: Differences between policy and no policy scenarios, both relative to the steady-state (in p.p.).

Summary

- Models developed so far ignored economic openness.
- Small open economy version of Gertler and Karadi (2013) model was designed to gauge the magnitude of "leakages".
- Effectiveness of a LSAP in both economies differs substantially.

- What has to be done?
  - Announcement effects.
  - Estimation of the share of a LSAP effects coming through the reak exchange rate compared to financial channels.