Monetary and Fiscal Policy in a Financial Accelerator Model

Work in progress

Marko Ringmann

University of Potsdam, Germany

March 17, 2014

Outline

Background

- Until 2007 the ECB conducted monetary policy via interest rate changes
- The financial crisis led to deterioration of balance sheets of many financial intermediaries due to the subprime mortgage market collapse in the United States
- As a result, interbank-market trust dropped severely and the ECB jumped in and started to lend (in-)directly into private markets via:
  - Purchasing mortgage-backed securities (more intensively in the US)
  - Expanding the range of eligible collateral
  - Providing backstop funding
- Result: the ECBs balance sheet expanded severely

Background

Table 1: ECB Balance Sheet in bn. Euro (2007-2012)

	2007	2008	2009	2010	2011	2012
Claims from monetary policy operations against banks in the Euro zone	637	860	749	546	863	1,126
Securities issued by euro area residents	143	271	328	457	618	586
Total assets	1507	2075	1903	2002	2733	2962

Background

- Further, in December 2008, the European Commission decided on a "European Economic Recovery Plan"' (EERP) to boost economic activity
- Size of the fiscal support package was about 200 bn. Euro, of which 170 bn. Euro should be covered by the member states
- EERP targeted on many aspects, as e.g. the provision of credit and collateral, investments in infrastructure etc.
- According to calculations of the Cologne Institute for Economic Research (2010), overall fiscal stimuli accounted to average 1.5% of EU-27 GDP

$\rightarrow$ EU-27 countries spent approximately 360 bn. Euro in order to dampen the recession

Goal of the Paper

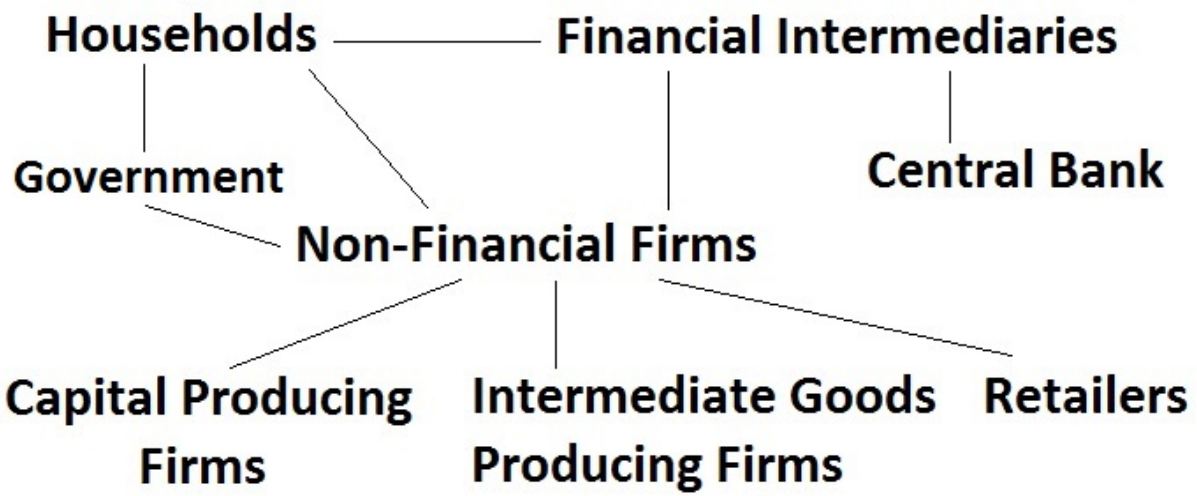
- Research objective is to built up a model which incorporates recent policy developments, i.e. the intervention of the ECB and the fiscal stimuli that were undertaken
- So far, both types of intervention in response to a (financial) crisis have been analyzed in great detail seperately
- However, the combination of both policies has not been investigated intensively
- I combine them by incorporating the possibility of central bank intervention on capital markets and by introducing fiscal policy rules
- This should give additional insights in the interaction of monetary and fiscal policy

Literature

- Overview regarding selective literature
- Gertler, Karadi (2011)
  - Introduced a leverage constraint for banks (financial intermediaries)
  - Asset value of banks dependent on equity
- Kirchner, van Wijnbergen (2012); van der Kwaak, van Wijnbergen (2013)
  - Extended version of Gertler, Karadi (2011)
  - Incorporated advanced balance sheet constraint of banks
  - Banks can either invest in capital or government bonds
- Coenen, Straub, Trabandt (2013)
  - Extended version of the ECB "New Area Wide Model"'
  - Richly specified fiscal sector

Overview

- Model contains different agents and institutions: households, financial intermediaries, non-financial goods producers, capital producers, retailers, and the central bank



Households

- Households consume goods and supply labor
- They invest money in financial intermediaries

Households' maximization yields standard FOCs:

Marginal Utility of Consumption:

$$\varrho_t = \frac{1}{1+\tau_t^c}\left[\epsilon_t^p \left(C_t - hC_{t-1}\right)^{-1} - \beta h \epsilon_{t+1}^p E_t \left(C_{t+1} - hC_t\right)^{-1}\right] \quad (1)$$

Intratemporal labor-Leisure Trade Off:

$$W_t = \frac{\epsilon_t^l \chi}{\varrho_t \left(1-\tau_t^l - \tau_t^{ssh}\right)} L_t^{\varphi} \quad (2)$$

Euler Equation:

$$\beta E_t\{\Lambda_{t,t+1} R_{dt+1}\} = 1. \quad (3)$$

Appendix

Intermediate Goods Firms

- Intermediate goods firms produce intermediate goods that are sold to retailers with the production technology $Y_t = A_t \left(U_t \xi_t K_{t-1}\right)^{\alpha} L_t^{1-\alpha}$
- Need capital for production which they buy at the end of period $t-1$ and then use for production in t
- Capital aquisition is financed via financial intermediaries by issuing claims on the amount of capital bought
- Claims pay an gross interest rate R_{kt} to the financial intermediary

Intermediate goods producers' maximization problem yields subsequent FOCs:

Intermediate Goods Firms

Optimal Capacity Utilization:

$$\alpha P_{mt} \frac{Y_t}{U_t} = Q_t \delta'(U_t) \xi_t K_{t-1} \tag{4}$$

Optimal Labor Demand:

$$W_t = \frac{(1-\alpha)}{\left(1+\tau_t^{ssf}\right)} P_{mt} \frac{Y_t}{L_t} \tag{5}$$

Return to Capital:

$$R_{kt} = \frac{\left(\alpha P_{mt} \frac{Y_t}{\xi_t K_{t-1}} + Q_t(1-\delta(U_t))\right) \xi_t}{Q_{t-1}} \tag{6}$$

Appendix

Capital Producing Firms

- Capital producers buy the remaining capital stock from intermediate goods producers at a price equal to one
- They use the depreciated capital and investment goods to build new capital which is sold at a price Q_t
- By assumption, there are no adjustment costs associated with refurbished capital, but with newly built capital
- This means, that investments in new capital do not transform one-to-one into new capital
- This is included as additional costs in the maximization problem of the firms

Capital producing firms' pin down the price of a unit of capital Q_t.

Appendix

Retail Firms

- Retail firms sell the final output Y_t
- Retailers simply re-package intermediate output and can adjust their prices in a Calvo-fashion
- Additionally, in between these periods firms can index its prices to lagged inflation

The price in $t+1$ therefore evolves according to the following rule

$$P_{t+1} = \begin{cases} P^*_{t+1}, & \text{with probability } (1-\gamma) \\ P_t(1+\pi_{t-1}), & \text{with probability } \gamma. \end{cases} \tag{7}$$

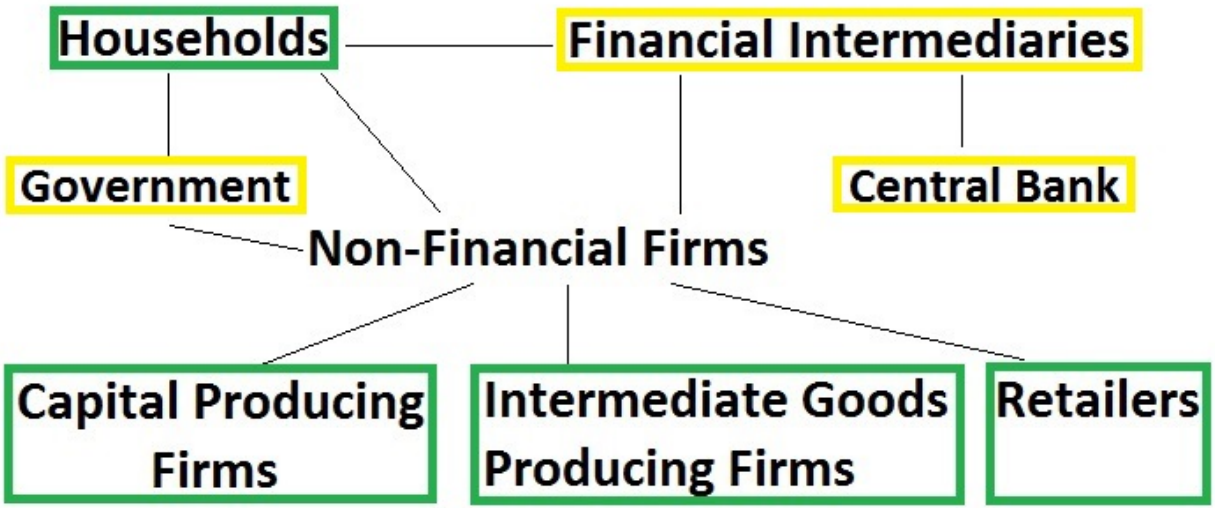
Hence, evolution of the aggregate price level is given by

$$P_t = \left[(1-\gamma)\left(P^*_t\right)^{1-\epsilon} + \gamma\left(\Pi_{t-1}P_{t-1}\right)^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}}. \tag{8}$$

Appendix

Overview

- Model contains different agents and institutions: households, financial intermediaries, non-financial goods producers, capital producers, retailers, and the central bank



Financial Intermediaries

- Financial intermediaries lend funds obtained by households to non-financial firms
- The amount a financial intermediary can lend is constrained by the deposits D_t it obtained from households and its net wealth ($\widehat{=}$ equity) N_t
- They invest in claims on capital issued by intermediate goods producers and in government bonds which sums up to portfolio P_t

Thus, the balance sheet is given by:

$$P_t = Q_t S_t + B_t = N_t + D_t \tag{9}$$

with S_t being the quantity of claims on non-financial firms and Q_t the relative price of a claim on one unit of capital.

Financial Intermediaries

- Net wealth evolves as the difference between earnings on assets and interest payments on liabilities, i.e.:

$$N_{t+1} = \underbrace{R_{kt+1} Q_t S_t + R_{bt+1} B_t}_{earnings} - \underbrace{R_{dt+1} D_t}_{liabilities}$$

Intermediaries maximize discounted terminal wealth V_t which is given by (note that a banker stays a banker with prob. $(1-\theta)$)

$$V_t = \max E_t \left\{ \sum_{i=0} (1-\theta)\, \theta^i \beta^i \Lambda_{t,t+1+i} \left(N_{t+1+i} \right) \right\}$$

Financial Intermediaries

- The intermediary is only willing to lend if the expected return of the assets is greater or equal to the interest it has to pay for borrowing (incentive to borrow infinitely)
- Moral hazard problem is solved by: banker can transfer assets to household of which he/she is a member and thus increase household income
- Then, only the fraction $(1 - \lambda)$ of the assets can be recovered from depositors
- So they would only continue to lend if the expected loss for the banker of diverting assets to his/her household is smaller than the gain from not doing so (diverted assets cannot create return for the banker)

$$\underbrace{V_t}_{loss} \geq \underbrace{\lambda(Q_t S_t + B_t)}_{gain} \tag{10}$$

Financial Intermediaries

I assume that the value function V_t evolves as follows

$$V_t = \underbrace{\nu_{kt}}_{\substack{\text{expected}\\ \text{marginal gain}\\ \text{of expanding}\\ \text{capital assets}}} \underbrace{Q_t S_t}_{\substack{\text{market}\\ \text{value}}} + \underbrace{\nu_{bt}}_{\substack{\text{expected}\\ \text{marginal gain}\\ \text{of expanding}\\ \text{bond assets}}} \underbrace{B_t}_{\substack{\text{market}\\ \text{value}}} + \underbrace{\eta_t}_{\substack{\text{expected}\\ \text{value of hav-}\\ \text{ing another}\\ \text{unity of } N_t}} \underbrace{N_t}_{\substack{\text{equity}}} .$$

Maximizing the V_t subject to the incentive constraint yields

$$P_t = \frac{1}{1-\psi_t}\phi_t N_t \tag{11}$$

with ψ_t being the share of assets that the government provides in times of a crisis ranging from $0 < \psi_t < 1$.

$\rightarrow$ Private sector is capital constrained

$\rightarrow$ Central bank can jump in and facilitate lending

Central Bank

Monetary policy (in "normal" times) is characterized by a Taylor rule:

$$i_t = (1-\rho)\left[i + \kappa_\pi \pi_t + \kappa_y \left(\log Y_t^* - \log Y_t\right)\right] + \rho i_{t-1} + \epsilon_t$$

In times of crisis, also credit policy is possible via the following feedback rule:

$$\psi_t = \psi + \nu\left[\left(R_{kt+1} - R_{t+1}\right) - \left(R_k - R\right)\right]$$

$\rightarrow$ Credit increases if the spread increases relative to its steady state value

Government

The government budget constraint is given by

$$T_t + B_t + R_{kt} S_{gt-1} = G_t + R_{bt} B_{t-1} + \tau S_{gt} + R_{bt} S_{gt-1}. \quad (12)$$

The government finances its expenditures by raising taxes. Tax income evolves as

$$T_t = \tau_t^c C_t + (\tau_t^l + \tau_t^{Wh} + \tau_t^{Wf}) W_t L_t. \quad (13)$$

Fiscal instruments both on the expenditure and revenue side are assumed to follow the prescriptions of simple feedback rules (taking the consumption tax rate as an example).

$$\tau_t^c = \tau_{t-1}^{c^{\rho_c}} \left[\tau^c \left(\frac{Y_t}{Y} \right)^{\theta_{CY}} \left(\frac{B_t}{B} \right)^{\theta_{CB}} \right]^{(1-\rho_c)} \varepsilon_{ct} \quad (14)$$

Data

- Model is calibrated and estimated for the Euro Zone from 1980 to 2011
- Data is taken from an updated version of the Area Wide Model (AWM) database and a fiscal database by Paredes et al.
- Observables: real GDP Y_t, real private consumption C_t, real government consumption G_t, total employment L_t, inflation π_t, real wages per head W_t, consumption tax τ_t^c, labor tax rate τ_t^l, social security contributions τ_t^{ssf} and τ_t^{ssh} from firms and households, lump-sum transfers Tr_t to households and aggregated government debt B_t
- We use the first log-difference minus the average growth rate in order to match the data to the model
- From social security contributions, tax rates and transfers we substract HP-trends

Priors and Posteriors

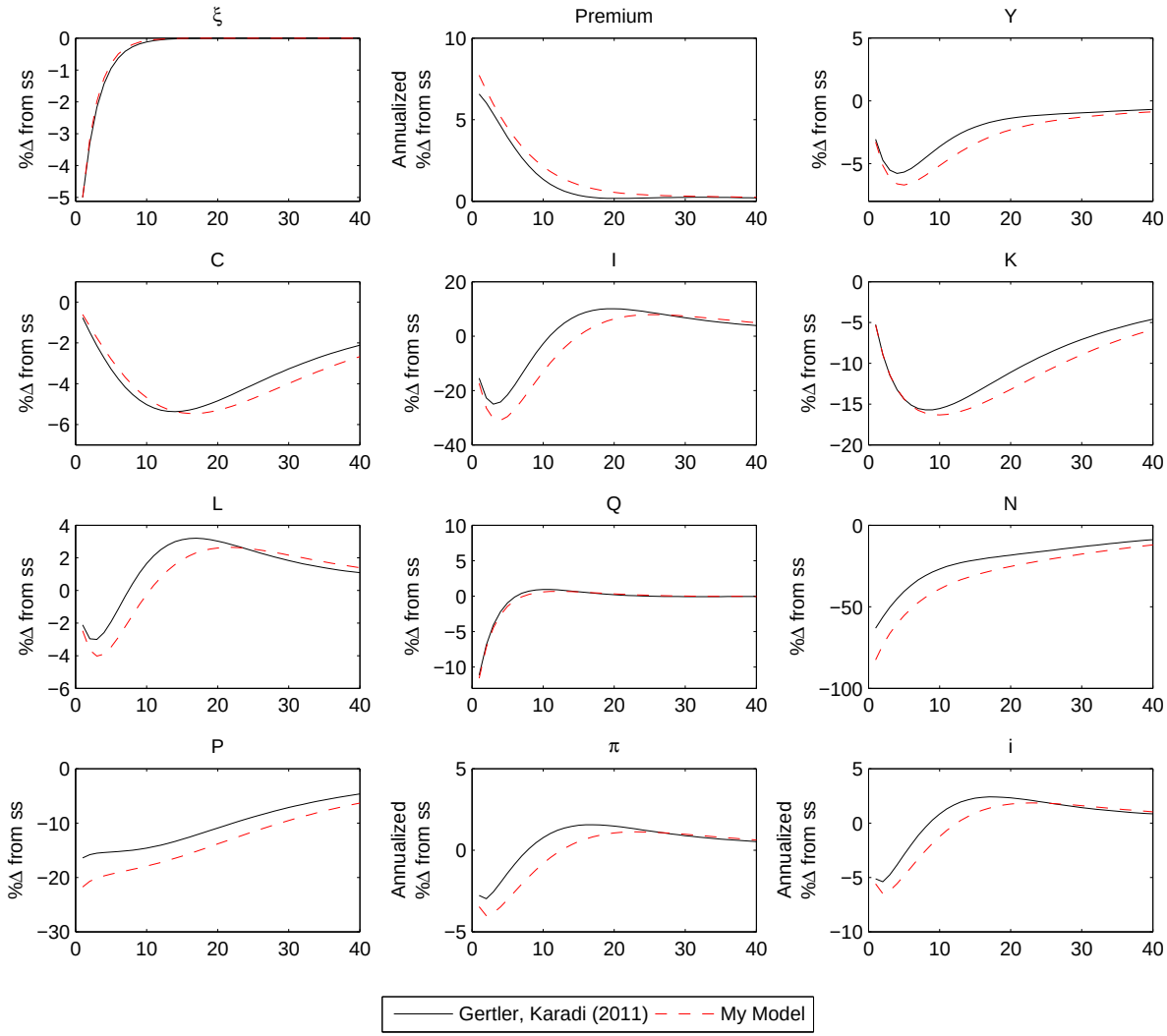
Parameter	Prior distribution	Posterior distribution Mode	Mean	5%	95%
Output feedback coefficients in fiscal rules					
θ_{cy}	$N(0,2)$	-0.7549	-0.7429	-0.9558	-0.5369
θ_{ly}	$N(0,2)$	0.3324	-0.2422	0.1572	0.3495
θ_{sshy}	$N(0,2)$	-0.1885	-0.0977	-0.2638	0.0392
θ_{ssfy}	$N(0,2)$	0.0534	0.0230	-0.2159	0.2476
θ_{try}	$N(0,2)$	0.2218	0.1015	0.0009	0.2298
θ_{gy}	$N(0,2)$	0.9809	0.9923	0.7424	1.2030
Debt feedback coefficients in fiscal rules					
θ_{cb}	$N(0,2)$	0.2486	0.2492	0.1385	0.3692
θ_{lb}	$N(0,2)$	0.0386	0.0661	0.0046	0.1245
θ_{sshb}	$N(0,2)$	-0.1833	-0.3181	-0.4898	-0.1405
θ_{ssfb}	$N(0,2)$	0.0636	0.0650	-0.0222	0.1550
θ_{trb}	$N(0,2)$	0.2645	0.3229	0.1378	0.4788
θ_{gb}	$N(0,2)$	-0.1730	-0.2193	-0.3664	-0.0765

Priors and Posteriors

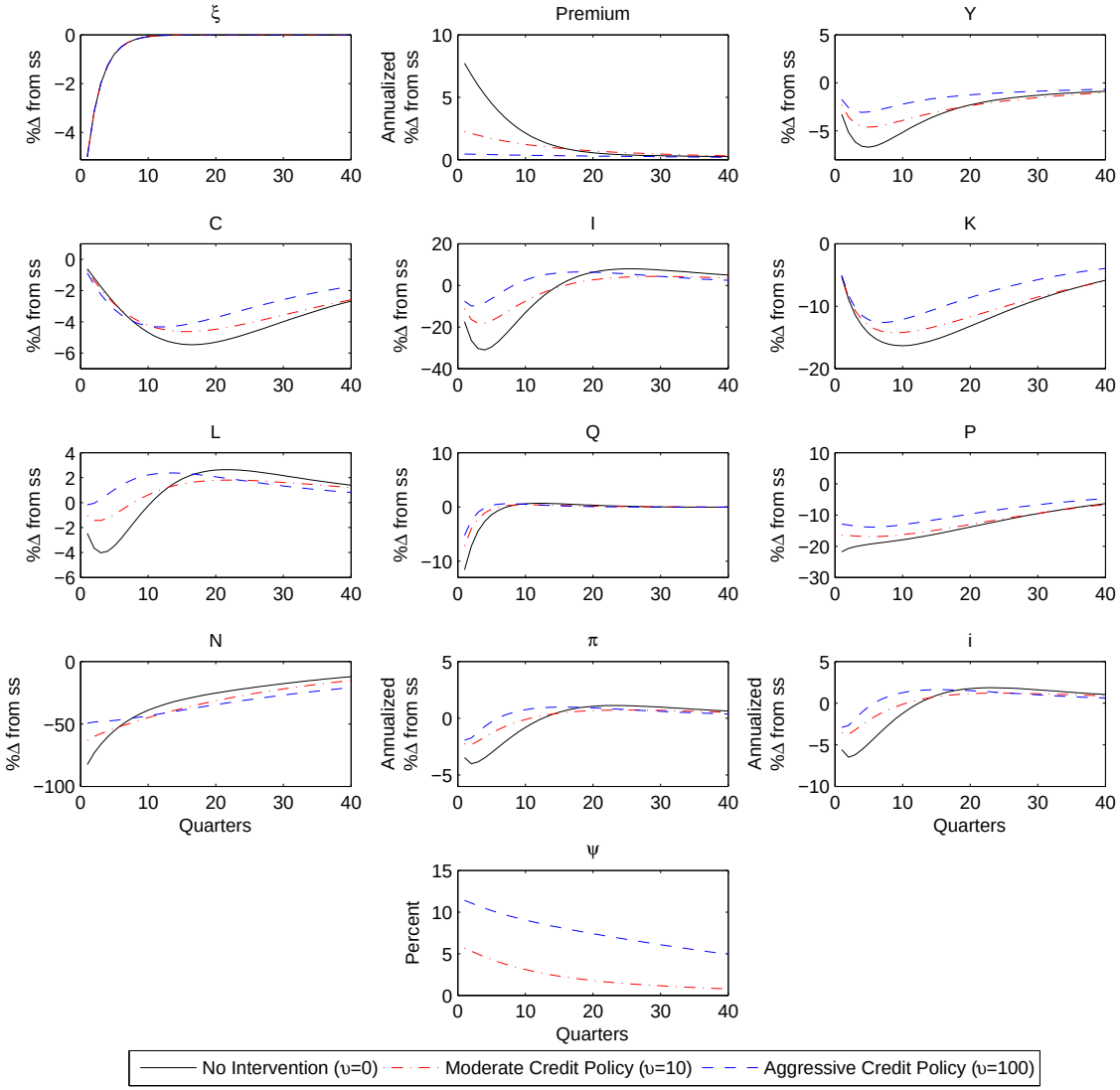
Parameter	Prior distribution	Posterior distribution Mode	Mean	5%	95%
Lagged dependent variable in fiscal rules					
ρ_c	$B(0.5, 0.2)$	0.9078	0.9044	0.8976	0.9102
ρ_I	$B(0.5, 0.2)$	0.8026	0.7860	0.7860	0.8074
ρ_{ssh}	$B(0.5, 0.2)$	0.9561	0.9586	0.9428	0.9722
ρ_{ssf}	$B(0.5, 0.2)$	0.9064	0.9041	0.9002	0.9079
ρ_{tr}	$B(0.5, 0.2)$	0.9348	0.9357	0.9346	0.9371
ρ_g	$B(0.5, 0.2)$	0.9610	0.9614	0.9602	0.9624
ρ_{tax}	$B(0.5, 0.2)$	0.8263	0.8235	0.8101	0.8387
Taylor Rule Parameters					
κ_π	$N(0, 2)$	1.6564	1.6477	1.6294	1.6601
κ_y	$N(0, 2)$	0.0227	0.0240	0.0213	0.0270

Note: The posterior distribution is obtained using the Metropolis-Hastings algorithm.

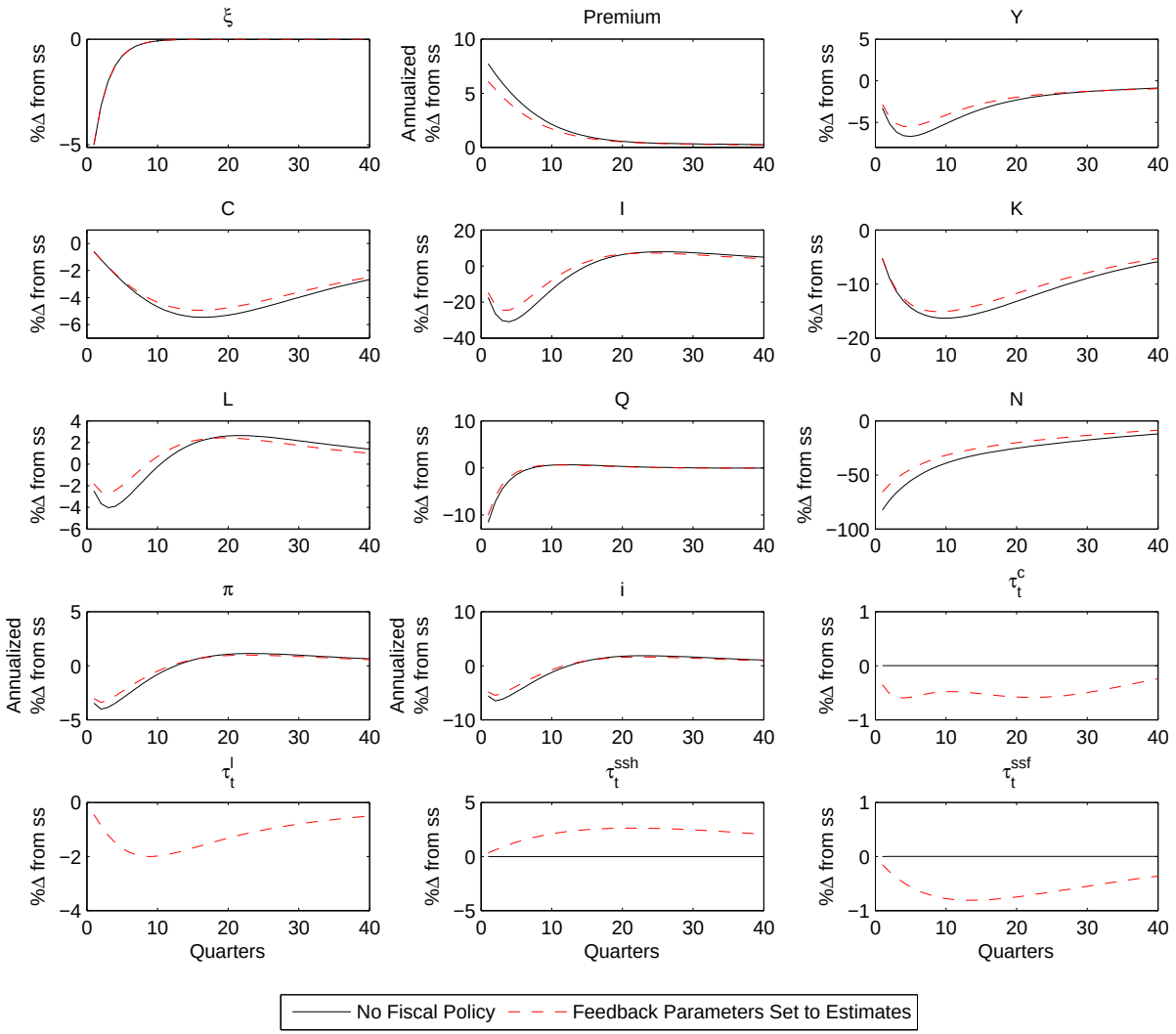
Responses to a Capital Quality Shock - Comparison



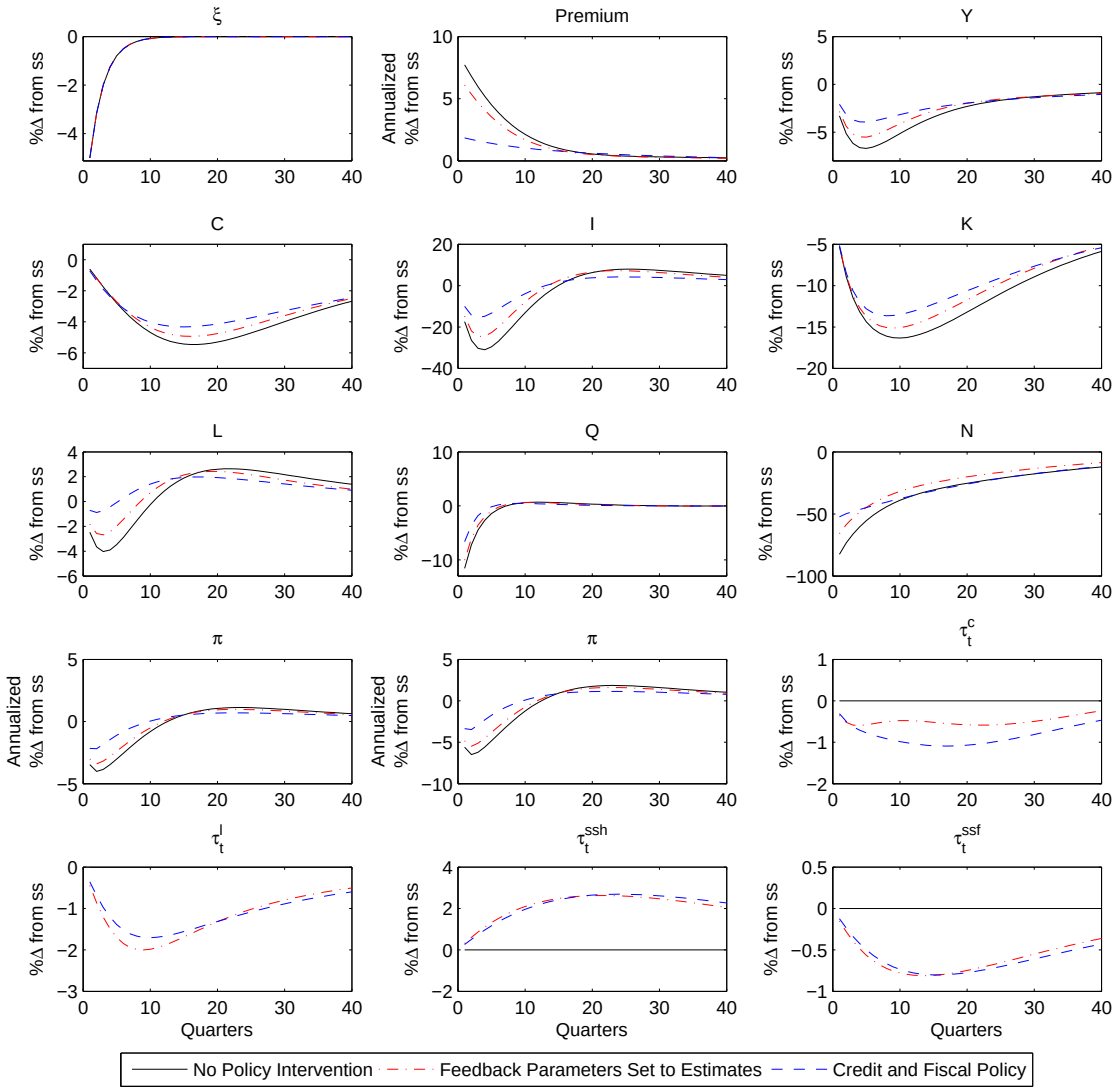
Responses to a Capital Quality Shock - Credit Policy



Responses to a Capital Quality Shock - Fiscal Policy



Responses to a Capital Quality Shock - Both Instruments



Conclusion

- Capital quality shock represents the downturn in assets after the financial crisis
- Incorporation of enhanced portfolio choice for financial intermediaries and an enlarged fiscal sector worsened the negative effects of a capital quality shock
- Balance sheet constraints of private intermediaries raise benefits of central bank intermediation
- Credit policy is welfare-enhancing in times of crisis
- Fiscal policy also seems to have an impact on the overall result (given my estimates for feedback parameters)
- Nevertheless, combination of credit and fiscal policy has most significant recession easing effect

Finally

Thank you for your attention!

Households

Households' maximization problem:

$$\max_{C_t, L_t, D_{t+1}} E_t \sum_{i=0}^{\infty} \beta^i \epsilon^p_{t+i} \left[ln\left(C_{t+i} - hC_{t+i-1}\right) - \frac{\chi}{1+\varphi} \epsilon^l_{t+i} L^{1+\varphi}_{t+i} \right]$$

s.t.

$$(1+\tau^c_t) C_t + D_{t+1} = (1-\tau^l_t - \tau^{ssh}_t) W_t L_t + \Pi_t + TR_t + R_{dt} D_t$$

with C_t being consumption, L_t labor supply, D_t intermediary deposits, R_{dt} the interest rate on intermediary deposits, $W_t L_t$ labor income, Π_t profits and TR_t lump-sum fiscal transfers and τ^c_t, τ^l_t and τ^{Wh}_t the corresponding tax rates

Back

Intermediate Goods Firms

The optimization problem of intermediate goods producing firms is given by

$$\max_{U_t, L_t, K_{t-1}} \; E_t \left[\sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+i} \Pi_{t+i} \right]$$

which is equal to

$$\max_{U_t, L_t, K_{t-1}} \; \Pi_{PV} = E_t \left\{ \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+i} \left[P_{mt+i} Y_{t+i} - Q_{t+i-1} R_{kt+i} K_{t-1+i} \right. \right.$$

$$\left. \left. + Q_{t+i} \left(1 - \delta(U_{t+i})\right) \xi_{t+i} K_{t-1+i} \left(1 + \tau_t^{ssf}\right) W_{t+i} L_{t+i} \right] \right\}$$

with $Y_t = A_t \left(U_t \xi_t K_{t-1}\right)^{\alpha} L_t^{1-\alpha}$ and $\delta(U_t) = \delta_c + \frac{b}{1+\zeta} U_t^{1+\zeta}$

Back

Capital Producing Firms

Capital producing firms' maximization problem:

$$\max_{I_{nt}} E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+i} \left\{ Q_{t+i} I_{nt+i} - I_{nt+i} - f\left(\frac{I_{nt+i} + I_{ss}}{I_{nt+i-1} + I_{ss}} \right) (I_{nt+i} + I_{ss}) \right\}$$

Back

Capital Producing Firms

Net investment evolves according to

$$I_{nt} = I_t - \delta(U_t)\xi_t K_t.$$

With $f\left(\frac{I_{nt+i}+I_{ss}}{I_{nt+i-1}+I_{ss}}\right) = \frac{\eta_i}{2}\left(\frac{I_{nt}+I_{ss}}{I_{nt-1}+I_{ss}} - 1\right)^2$ (by assumption), we get a solution for Q_t

$$Q_t = 1 + \frac{\eta_i}{2}\left(\frac{I_{nt}+I_{ss}}{I_{nt-1}+I_{ss}} - 1\right)^2 + \eta_i\left(\frac{I_{nt}+I_{ss}}{I_{nt-1}+I_{ss}} - 1\right)\frac{I_{nt}+I_{ss}}{I_{nt-1}+I_{ss}} - \eta_i E_t \beta \Lambda_{t,t+1}\left(\frac{I_{nt+1}+I_{ss}}{I_{nt}+I_{ss}} - 1\right)\left(\frac{I_{nt+1}+I_{ss}}{I_{nt}+I_{ss}}\right)^2.$$

This expression pins down the price of a unit of capital.

Back

Retail Firms

The retail firm maximizes the subsequent discounted profit function

$$\max_{Y_{ft},P_t^*} E_t \left\{ \sum_{i=0}^{\infty} (\gamma\beta)^i \Lambda_{t,t+i} \left[\frac{P_t^*}{P_{t+i}} \prod_{k=1}^{i} (1+\pi_{t+k-1})^{\gamma_p} - P_{mt+i} \right] Y_{ft+i} \right\}.$$

with β being the subjective discount factor with $0 < \beta < 1$, $\Lambda_{t,t+i}$ the stochastic discount factor, γ the probability of price change, γ_p the price indexation parameter, and π_t the inflation from $t-i$ to t.

Back

Credit Policy

- → Private sector is capital constrained
- → Central bank can jump in and facilitate lending via issuing government debt (involves efficiency costs τ per unit supplied)
- → Total value of intermediated assets changes to:

$$\underbrace{Q_t S_t}_{\text{total value of intermediated assets}} = \underbrace{Q_t S_{pt}}_{\text{privately intermediated assets}} + \underbrace{Q_t S_{gt}}_{\text{assets intermediated via government assistance}} \quad (15)$$

Central bank funds the fraction $S_{gt} = \psi_t S_t$, (15) changes to:

$$(1 - \psi_t) S_t = S_{pt} \Leftrightarrow S_t = \frac{1}{1 - \psi_t} S_{pt}$$

Back

Aggregate Resource Constraints

Overall, output Y_t must be equal to the sum of consumption C_t, investment I_t, government expenditures G_t, investment adjustments costs $f(\cdot)$ and the cost of intermediaring assets $\tau\psi_t Q_t S_t$:

$$Y_t = C_t + I_t + G_t + \frac{\eta_i}{2}\left(\frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}} - 1\right)^2 (I_{nt} + I_{ss}) + \tau\psi_t Q_t S_t$$

The capital accumulation equation is given by

$$K_t = \xi_t K_{t-1} + I_{nt}$$

By assumption, the capital stock K_t is equal to the claims S_t:

$$K_t = S_t$$