Lending Standards, Credit Booms, and Monetary Policy

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Motivation and Question

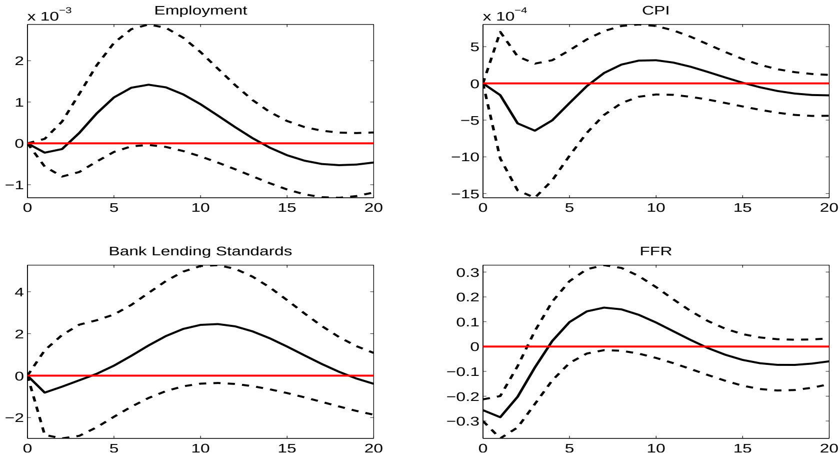
- monetary policy and credit booms (Taylor, 2007; Adrian and Shin, 2010): 'too low for too long'
  - risk on the liability side of financial intermediaries (Angeloni et al., 2013; Gertler and Karadi, 2011; Gertler et al., 2012)
  - risk on the asset side: fewer studies
- this paper's focus: *lending standard* decisions of banks
- step 1: Is there empirical (macro) evidence supporting asset-side risk channel in response to MP shocks?
- step 2: Formulate a microfoundation (contract) for bank's lending standard decision
- step 3: Study the implications of this contract in a monetary GE model

Empirical Strategy: Data

- previous literature:
  - strong evidence in favor of (ex ante) asset risk channel at the micro level (e.g., Jimenez et al., 2014; Bonfim and Soares, 2014)
  - mixed evidence at the macro level (e.g., Angeloni et al., 2013; Buch et al., 2014), limited data availability
- this paper: lending standards from SLOOS of the Fed
  - coverage: large domestic and foreign banks
  - 19 measures: type of measure (collateral requiements, loan covenants etc.), type of the bank, type of the loan and type of the borrower Figure

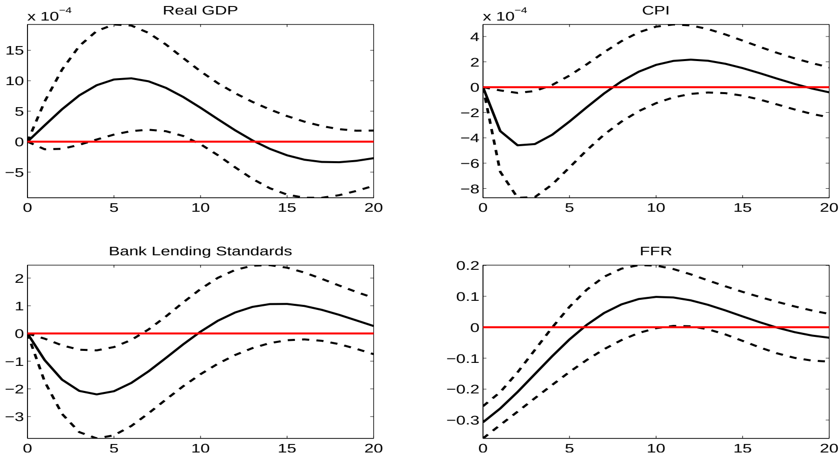
IRFs to a Monetary Easing in a small VAR: the Choice of Measures and the Omitted Variable Bias (I)

$Y_t = [EMPL_t, CPI_t, LS_t, FFR_t]$, lag $= 2$, 2 std bands, sample 1991Q2 - 2008Q4, Cholesky ID



IRFs to a Monetary Easing in a small VAR: the Choice of Measures and the Omitted Variable Bias (II)

$Y_t = [GDP_t, CPI_t, LS_t, FFR_t]$, lag = 2, 2 std bands, sample 1991Q2 - 2008Q4, Cholesky ID



Empirical Strategy: Econometric Methodology

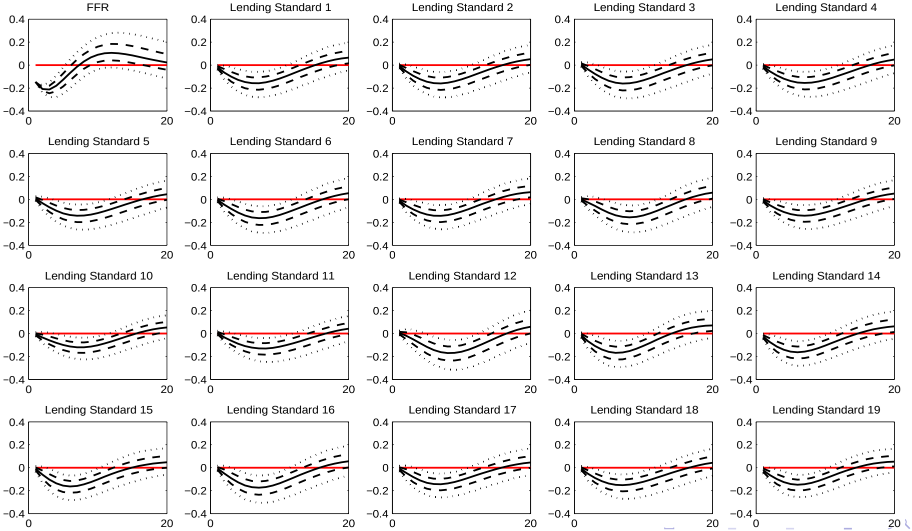
- econometric model: FAVAR

$$X_t = \Lambda^f F_t + \Lambda^y Y_t + e_t, \tag{1}$$

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + \nu_t, \tag{2}$$

- F_t are extracted factors, Y_t are observables, X_t is the informational data set
- data: 138 macro and financial time series, including 19 SLOOS lending standards
- Bayesian estimation
- recursive identification along the lines of Bernanke et al. (2005): FFR ordered last in the transition equation (2)
- baseline: sample 1991Q1-2008Q2, lag order = 2, FFR as observable, 3 latent factors

Baseline FAVAR: IRFs in Response to a Monetary Loosening (25bp), 68% and 90% bands



Robustness of Empirical Results

- number of factors:
  - statistical criteria point to 3-5 factors (Onatski, 2009; Alessi et al. 2010; Bai and Ng, 2007; Stock and Watson, 2005)
  - robust under more factors: 4, 5, 6 and 7
  - consistent with the scree plot figure
  - the variables of interest are well explained by the model
- lag order
- observable variables (FFR and CPI)
- estimation methodology: principal components
- subsamples 1997Q1 - 2008Q2, 1994Q1 - 2008Q2
- including Greenbook projections into the infromational data set
- alternative measures of banks' risk-bearing capacity: excess bond premium of Gilchrist and Zakrajšek (2012)

Microfoundation: A CSV Contract

- starting point: costly state verification (Townsend, 1979; Gale and Hellwig, 1985) contract between risk-neutral bank and risk-neutral entrepreneur
- two dimensions of credit expansion: loan volume relative to collateral and loan quality (default threshold $\bar{\omega}$)
- problem: banks are passive and do not take risks (BGG, 1999)
- contract modification: 'reversed roles', i.e. bank decides on the quantity and quality of credit
- bank has market power and makes 'take-it-or-leave-it' offer to the borrower

The Contract Setup

- At the end of period t, entrepreneur i finances capital purchases $Q_t K_t^i$ using its net worth, N_t^i, and borrowing the rest, B_t^i, from the bank.
- The entrepreneur's return on capital in period $t+1$ is $\omega_{t+1}^i R_{t+1}^k Q_t K_t^i$, where
  - R_{t+1}^k is the aggregate return on capital,
  - $\omega_{t+1}^i \in [0, \infty)$ is an *idiosyncratic* component that is i.i.d. across i and t, with *cdf* $F(\omega)$ and $E(\omega) = 1$.
- Ex post default threshold is defined as:

$$\bar{\omega}_{t+1}^i \equiv \frac{Z_t^i B_t^i}{R_{t+1}^k Q_t K_t^i}.$$

  - No default: $\omega_{t+1}^i \geq \bar{\omega}_{t+1}^i$, the entrepreneur pays the bank the fixed amount $Z_t^i B_t^i$ and keeps the residual $\left(\omega_{t+1}^i - \bar{\omega}_{t+1}^i\right) R_{t+1}^k Q_t K_t^i$,
  - Default: $\omega_{t+1}^i < \bar{\omega}_{t+1}^i$, the bank monitors the entrepreneur, incurs a CSV cost $\mu \omega_{t+1}^i R_{t+1}^k Q_t K_t^i$ and extracts the remainder.

The Contract: Bank's Decision Problem

- Bank's problem without aggregate risk:

$$\max_{K_t^i, \bar{\omega}_{t+1}^i} \quad \left[\Gamma(\bar{\omega}_{t+1}^i) - \mu G(\bar{\omega}_{t+1}^i)\right] R_{t+1}^k Q_t K_t^i - R_t^n (Q_t K_t^i - N_t^i)$$

$$\text{s.t.} \quad \left[1 - \Gamma(\bar{\omega}_{t+1}^i)\right] R_{t+1}^k Q_t K_t^i \geq R_{t+1}^k N_t^i \qquad [\lambda_t^i]$$

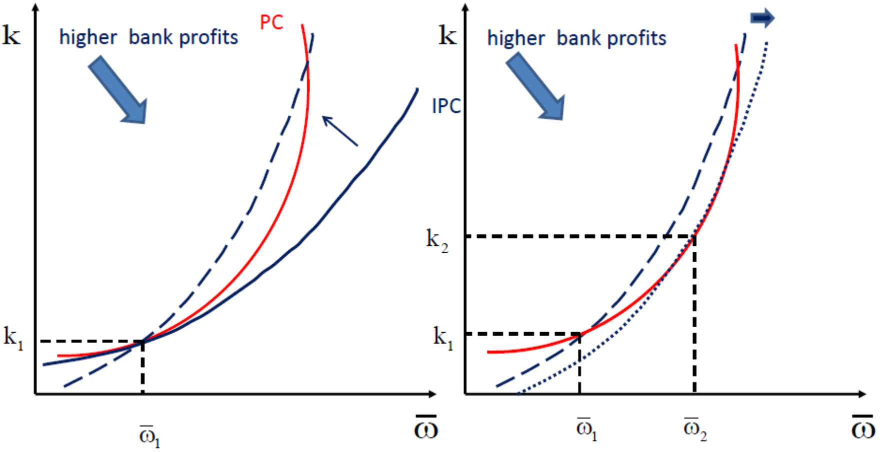
- Denote $k_t^i \equiv \frac{Q_t K_t^i}{N_t^i}$ and get FOCs:

$$\begin{aligned}
k_t^i: &\quad \left[\Gamma(\bar{\omega}_{t+1}^i) - \mu G(\bar{\omega}_{t+1}^i)\right] R_{t+1}^k + \lambda_t^i \left[1 - \Gamma(\bar{\omega}_{t+1}^i)\right] R_{t+1}^k = R_t^n, \\
\bar{\omega}_{t+1}^i: &\quad \left[\Gamma'(\bar{\omega}_{t+1}^i) - \mu G'(\bar{\omega}_{t+1}^i)\right] + \lambda_t^i \Gamma'(\bar{\omega}_{t+1}^i) = 0, \\
\lambda_t^i: &\quad \left[1 - \Gamma(\bar{\omega}_{t+1}^i)\right] k_t^i - 1 = 0.
\end{aligned}$$

- positive relation between borrower's leverage and EFP (cf. BGG, 1999)

Partial Equilibrium (No Aggregate Risk): the Effect of $R_n \downarrow$

Note : $k_{IPC} = \frac{\pi^b - 1 - n}{[\Gamma(\bar{\omega}) - \mu G(\bar{\omega})]s - 1}$ and $k_{PC} = \frac{1}{1 - \Gamma(\bar{\omega})}$, where $s \equiv R^k / R^n$, $k \equiv QK/N$



DSGE: Agents and Main Assumptions

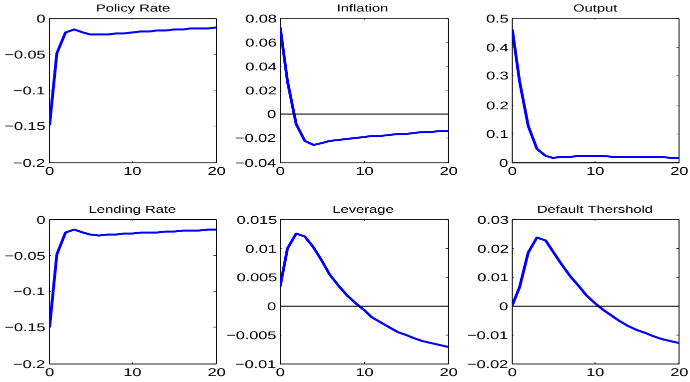
- Agents
  - a representative household
  - a representative capital goods producer,
  - a continuum of competitive entrepreneurs,
  - a continuum of monopolistically competitive retailers,
  - a monopolistic bank,
  - a monetary authority (Taylor rule).
- Assumptions
  - nominal price rigidity as in Calvo (1983),
  - investment adjustment costs.

$\rightarrow$ model structure very similar to BGG (1999), a different contract

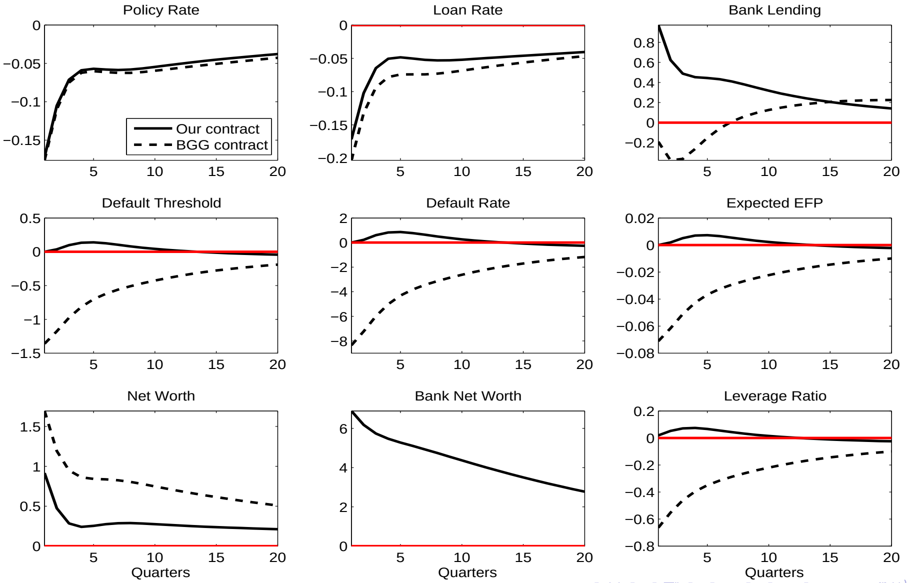
▸ model equations

DSGE: IRFs to a 25bp Monetary Policy Shock

Note: IRFs are plotted in terms of percentage deviations from steady state ‣ calibration

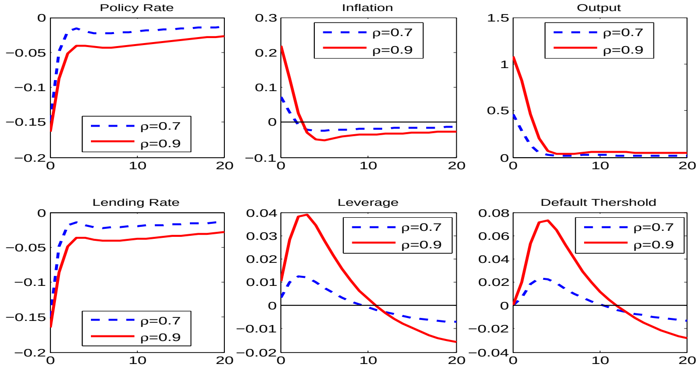


Our Contract vs BGG, Same Model Calibration



'Too Low for Too Long'

$$\hat{i}_t = \rho \hat{i}_{t-1} + \phi_y \hat{y}_t + \phi_\pi \hat{\pi}_t + \epsilon_t$$

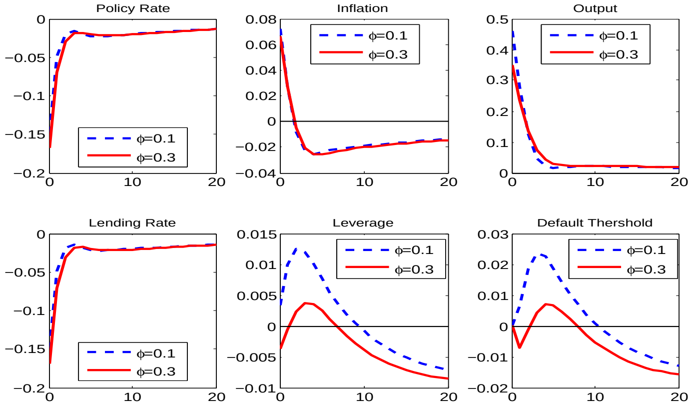


Robustness of the GE Result

'Switching off/on' the DSGE frictions:

- habit formation in consumption
- trend inflation
- presence of price indexation
- monetary policy rule specification (forward-looking vs. outcome-based rules)
- investment adjustment cost matters: higher ϕ dampens positive response of EFP to monetary easing

The Role of Investment Adjustment Costs (ϕ)



Concluding Remarks

- We find empirical evidence in favor of *ex ante* asset side risk channel (measured by lending standards) for large U.S. banks in response to MP shocks
- We reformulate the CSV contract from the bank's perspective
- It is optimal for the bank to loosen its lending standard in response to monetary easing (consistently with the data)
- More to explore: role of bank default and limited liability (externalities), equity decision of the bank

DSGE: Bank

- monopolistic bank

$$\max_{K_t^i, \bar{\omega}_{t+1}^i} \quad E_t \left\{ \left[\Gamma\left(\bar{\omega}_{t+1}^i\right) - \mu G\left(\bar{\omega}_{t+1}^i\right) \right] R_{t+1}^k Q_t K_t^i - \frac{R_t^n}{\pi_{t+1}} \left(Q_t K_t^i - N_t^i - N_t^{b,i} \right) \right\}$$

subject to

$$E_t \left\{ \left[1 - \Gamma\left(\bar{\omega}_{t+1}\right) \right] R_{t+1}^k \right\} Q_t K_t = E_t \left\{ R_{t+1}^k \right\} N_t.$$

Bank's aggregate expected profits:

$$E_t V_{t+1}^b = E_t \left\{ \left[\Gamma\left(\bar{\omega}_{t+1}\right) - \mu G\left(\bar{\omega}_{t+1}\right) \right] R_{t+1}^k Q_t K_t - \frac{R_t^n}{\pi_{t+1}} \left(Q_t K_t - N_t - N_t^b \right) \right\}$$

Bank's net worth:

$$N_t^b = \gamma^b V_t^b.$$

Balance sheet identity:

$$B_t = N_t^b + D_t$$

DSGE: Entrepreneur

- competitive entrepreneurs

  Participation constraint:

$$E_t\left\{\left[1-\Gamma\left(\bar{\omega}_{t+1}\right)\right]R^k_{t+1}\right\}Q_tK_t=E_t\left\{R^k_{t+1}\right\}N_t$$

  Net worth:

$$N_t=\gamma^e\left[1-\Gamma(\bar{\omega}_t)\right]R^k_tQ_{t-1}K_{t-1}$$

  The aggregate real rate of return per unit of capital:

$$R^k_t=\frac{r^k_t+(1-\delta)Q_t}{Q_{t-1}}$$

DSGE: Household and Retailer

- household

$$\max_{C_t, H_t, D_t} \quad E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{H_t^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} \right\},$$

$$\text{s. t.} \quad C_t + D_t \leq W_t H_t + \frac{R_{t-1}^n}{\pi_t} D_{t-1},$$

- monopolistically competitive retailers

$$\max_{P_t^*} \quad E_t \left\{ \sum_{s=0}^{\infty} \theta^s \Lambda_{t,t+s} \Pi_{t,s} \right\},$$

s.t. $Y_{t+s}(i) = \frac{P_{t,s}}{P_{t+s}}^{-\epsilon} Y_{t+s}$
where $\Lambda_{t,t+s} \equiv \beta^s E_t \left[\frac{U'(C_{t+s}) P_t}{U'(C_t) P_{t+s}} \right]$ and $\Pi_{t,s} \equiv (P_{t,s} - MC_{t,s}) \left[\frac{P_{t,s}}{P_{t+s}} \right]^{-\epsilon} Y_{t+s}$,
$P_{t,s} = P_t^* \left(\frac{P_{t+s-1}}{P_{t-1}} \right)^{\gamma}$.

DSGE: Capital Goods Producer, MP, Market Clearing

- capital goods producer

$$\max_{I_t} \quad \sum_{t=0}^{\infty} \beta^t \left\{ Q_t [K_t - (1-\delta) K_{t-1}] - I_t \right\},$$

s.t. $K_t = (1-\delta)K_{t-1} + \left[1 - S\left(\frac{I_t}{I_{t-1}}\right)\right] I_t,$
where $S\left(\frac{I_t}{I_{t-1}}\right) = \frac{\phi}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2.$

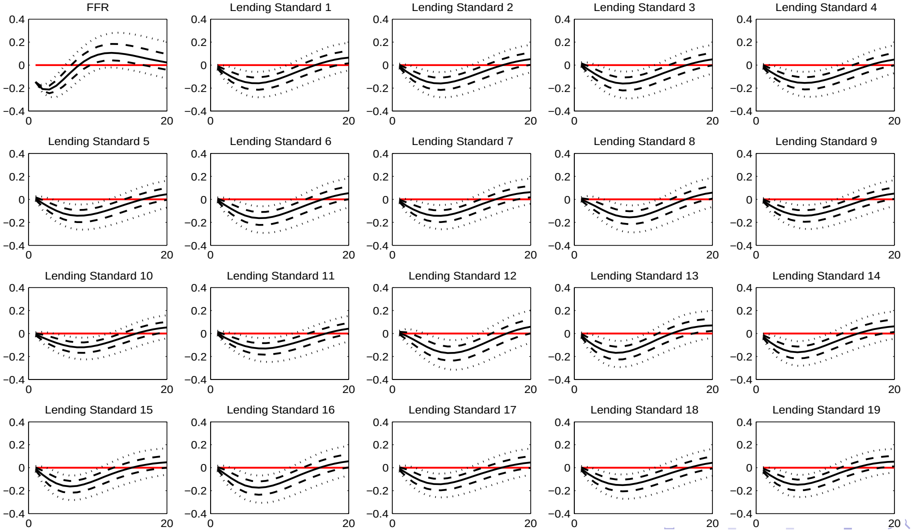
- monetary policy and market clearing

$$\frac{R_t^n}{R_{ss}^n} = \left(\frac{R_{t-1}^n}{R_{ss}^n}\right)^{\rho} \left[\left(\frac{\pi_t}{\pi_{ss}}\right)^{\phi_\pi} \left(\frac{Y_t}{Y_{ss}}\right)^{\phi_y}\right]^{1-\rho} e^{\nu_t}$$

$$Y_t = C_t + C_t^e + C_t^b + I_t + \mu G(\bar{\omega}_t) R_t^k Q_{t-1} K_{t-1}$$

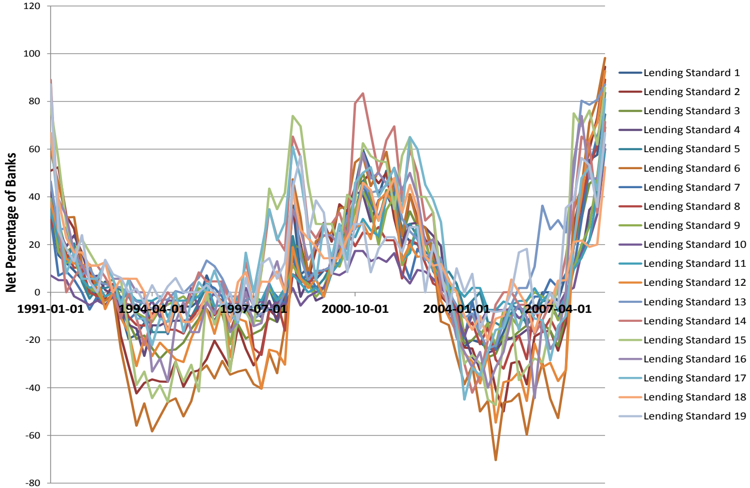
back

FAVAR with 5 Factors: IRFs in Response to a Monetary Loosening (25bp) back



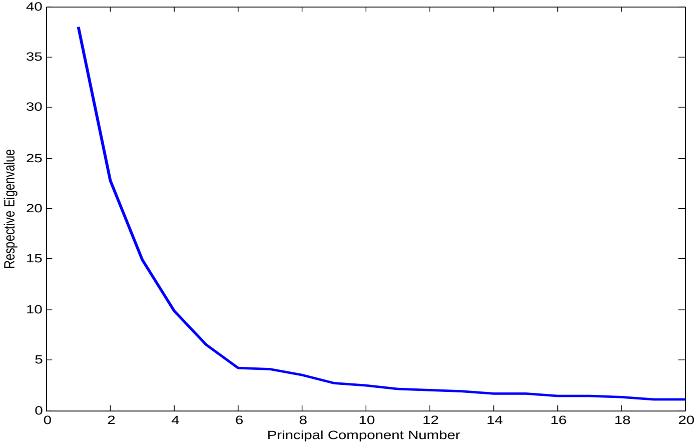
Lending Standards Measures: 1991Q1 - 2008Q4

back



FAVAR Scree Plot (Principal Components Analysis)

back



Baseline Parameter Calibration: Steady State

Steady-State Variable or Ratio	Computation	Value
capital-output ratio	$Y/(4 \cdot K)$	1.9451
household consumption relative to output	C/Y	0.6963
entrepreneur consumption relative to output	C^e/Y	0.0784
bank consumption relative to output	C^b/Y	0.0251
capital investment relative to output	I/Y	0.1945
employment as a share of time endowment*	H	1/3
gross price markup of retailers*	$\epsilon/(\epsilon - 1)$	1.1111
leverage ratio of entrepreneurs*	QK/N	1.5372
default monitoring costs relative to output	$\mu G(\bar{\omega}) R^k QK/Y$	0.0057
annualized default rate of entrepreneurs*	$4 \cdot F(\bar{\omega})$	4.735%
annualized risk-free policy interest rate*	$4 \cdot (R^n - 1)$	2.010%
annualized interest rate on bank loans*	$4 \cdot (Z - 1)$	6.816%
annualized rate of return to capital	$4 \cdot (R^k - 1)$	6.195%
annualized external finance premium	$4 \cdot (R^k/R^n - 1)$	4.164%

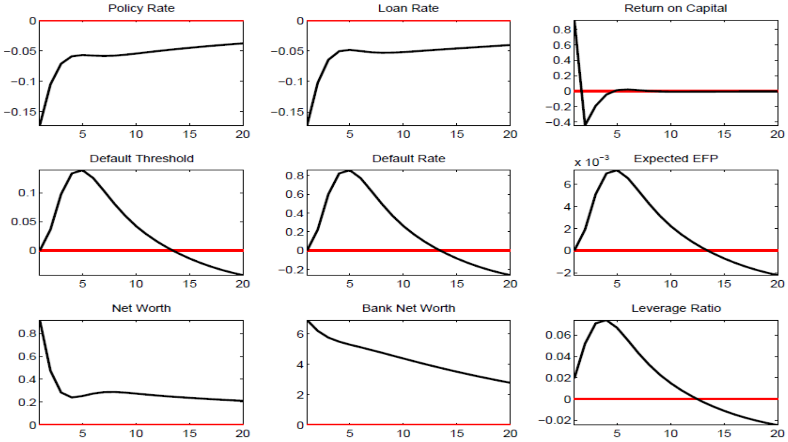
* Steady state values targeted in benchmark calibration

back

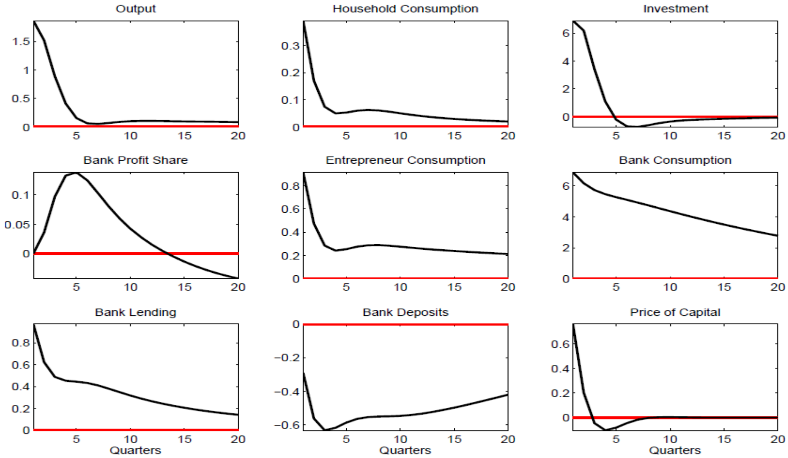
Baseline Parameter Calibration

Household and production sector	Parameter	Value
coefficient of relative risk aversion	σ	2
Frisch elasticity of labor supply	η	3
relative weight of labor in the utility function	χ	5.19
quarterly discount factor of households	β	0.995
elasticity of substitution between retailer varieties	ϵ	10
quarterly depreciation rate of physical capital	δ	0.025
coefficient of quadratic investment adjustment costs	ϕ	0.1
elasticity of output with respect to capital	α	0.35
Calvo probability of quarterly price adjustments	θ	0.75
automatic price indexation to past inflation	γ	0.2
Monetary policy	**Parameter**	**Value**
interest-rate persistence in the monetary policy rule	ρ	0.9
responsiveness of monetary policy to inflation deviations	ϕ_π	1.5
responsiveness of monetary policy to output deviations	ϕ_y	0.5
standard deviation of unsystematic monetary policy shocks	σ_ν	0.25
Optimal financial contract	**Parameter**	**Value**
exogenous consumption rate of entrepreneurial net worth	γ^e	0.985
exogenous consumption rate of bank net worth	γ^b	0.95
monitoring cost as a fraction of total return on capital	μ	0.20
variance of idiosyncratic productivity draws	σ^2_ω	0.18
steady-state default threshold of entrepreneurs	$\bar{\omega}$	0.35

Extended Set of IRFs to a Monetary Policy Shock (25bp), Baseline I



Extended Set of IRFs to a Monetary Policy Shock (25bp), Baseline II



IRFs to a Monetary Policy Shock (25bp) under BGG Rule

$$\hat{i}_t = \rho \hat{i}_{t-1} + \phi_\pi \hat{\pi}_{t-1} + \epsilon_t$$