

# Shadow Banking in the Business Cycle

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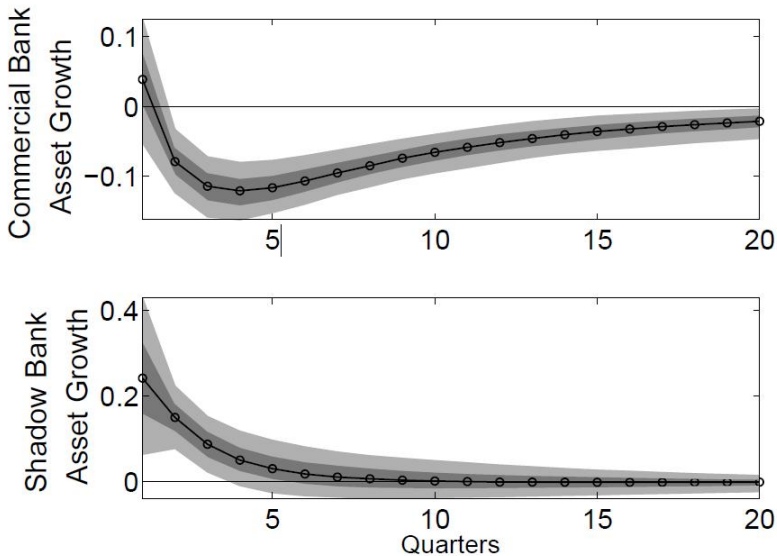
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*What is needed is a framework for macroeconomic analysis in which intermediation plays a crucial role and [...] which also takes account of the fact that **the U.S. financial sector is now largely market-based.***

-Woodford (2010)

# Effect of increase in FFR on asset growth



Source: Nelson, Pinter, Theodoridis

» levels » SB size

# Research Questions

- If shadow bank lending reacts in the opposite direction to bank lending, how does credit intermediation via shadow banks affect the reaction of *aggregate* loan supply to monetary policy?
- (How) does the decreasing volatility of aggregate credit translate into lower volatility of output and consumption?
- What implications does this have for the business cycle?

- Distinguish between deposit taking institutions (banks) and non-deposit taking institutions (shadow banks)
- This distinction gives rise to opposing effects of the balance sheet channel and the lending channel
- Analyze lending response and volatility of key variables depending on shadow bank size
- Bayesian estimation of shock processes (real, financial, monetary policy) in this framework + repo creation
- Implication for monetary policy

## Theoretical framework

- Shadow banking can reduce the peak impact of monetary tightening on aggregate lending by 50%, because additional lending channel (shadow banks) counteracts the balance sheet channel (banks)
- Shadow banking amplifies propagation of some shocks and reduces others

## Empirical observations'

- Monetary policy was not artificially low pre-2007
- Erosion of trust in shadow banks precipitated the crisis

- Gertler & Karadi (JME, 2011); turning off for the moment
  - habit formation
  - capital utilization
  - government consumption
- and extending by a shadow banking sector
  - credit intermediation relies on prior funding
  - search and matching between investors/deposit holders and shadow banks  
⇒ analogously to credit market matching (Wasmer & Weil, AER, 2004)
  - extension: repo funding

▶ GK Economy

# The Household's Program

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

Budget constraint:  $C_t + B_{t+1} = W_t L_t + R_t^w B_t + \Pi_t + T_t \quad \{\varrho_t\}$

Weighted interest rate:  $R_t^w = R_t \frac{D_t}{D_t + FS_t} + R_t^{SB} \frac{FS_t}{D_t + FS_t}$

First-Order Conditions:

$$\varrho_t = (C_t - hC_{t-1})^{-1} - \beta h E_t (C_{t+1} - hC_t)^{-1}$$

$$\varrho_t W_t = \chi^{HH} L_t^\varphi$$

with:  $E_t \beta \Lambda_{t,t+1} R_{t+1}^w = 1$

$$\Lambda_{t,t+1} = \frac{\varrho_{t+1}}{\varrho_t}$$

▶ HH with repo creation



# Goods Producer's Program

$$\max_{K_{t+1}, L_t} E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+1+i} [P_{mt} Y_t + (Q_t - \delta) \xi_t K_t - W_t L_t - R_{kt} \xi_t K_t Q_{t-1}]$$

Output:  $Y_t = A_t (\xi_t K_t)^\alpha L_t^{1-\alpha}$

Financing of fixed capital:  $K_{t+1} = S_t + S_t^{SB}$

First-Order Conditions:

$$R_{kt+1} Q_t \xi_{t+1} = P_{mt+1} \alpha \frac{Y_{t+1}}{\xi_{t+1} K_{t+1}} + (Q_{t+1} - \delta)$$

$$W_t = P_{mt} (1 - \alpha) \frac{Y_t}{L_t}$$

# The Banker's Program

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

with

Balance Sheet:  $Q_t S_t = N_t + D_{t+1}$

Evolution of net worth:  $N_{t+1+i} = R_{kt+1+i} Q_{t+i} S_{t+i} - R_{t+1+i} D_{t+1+i}$   
 $= (R_{kt+1+i} - R_{t+1+i}) Q_{t+i} S_{t+i} + R_{t+1+i} N_{t+i}$

Incentive constraint:  $V_t \geq \lambda Q_t S_t$

# The Banker's Balance Sheet

A banker's loan portfolio depends on the size of their net wealth and leverage

$$Q_t S_t = \underbrace{\frac{\eta_t}{\lambda - \nu_t}}_{\phi_t} N_t$$

with

$$\nu_t = E_t[(1 - \theta)\Lambda_{t,t+1}(R_{kt+1} - R_{t+1}) + \beta\Lambda_{t,t+1}\theta x_{t,t+1}\nu_{t+1}]$$

$$\eta_t = E_t[(1 - \theta) + \beta\Lambda_{t,t+1}z_{t,t+1}\theta\eta_{t+1}]$$

$$x_{t,t+1} = Q_{t+1}S_{t+1}/Q_tS_t$$

$$z_{t,t+1} = N_{t+1}/N_t.$$

► recursive

► net worth

# The Shadow Banker's Program

$$V_t^{SB} = \max_{v_t, S_t^{SB}} E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+i} \Pi_{t+i}^{SB}$$

with

Profits:  $\Pi_t^{SB} = (R_{kt} - R_t^{SB}) Q_{t-1} S_{t-1}^{SB} - v_t$

Balance Sheet:  $Q_t S_t^{SB} = F S_t$

LOM Fund Shares:  $F S_t = (1 - \chi^{SB}) F S_{t-1} + q_t v_t$

Euler condition for fund advertisements:

$$\frac{1}{q_t} = E_t \beta \Lambda_{t,t+1} \left\{ (R_{kt+1} - R_{t+1}^{SB}) + \frac{1 - \chi^{SB}}{q_{t+1}} \right\}$$

► SB with repo creation

# Funding Market Matching

CD matching function:

$$m(v_t, \underbrace{D_{t+1} - FS_t}_{\equiv D_{t+1}^u}) = s \quad v_t^{1-\xi} (D_{t+1}^u)^\xi$$

The probability that a shadow bank will find suitable funding is

$$q(\theta_t) = \frac{m(v_t, D_{t+1}^u)}{v_t} = s \quad \left( \frac{D_{t+1}^u}{v_t} \right)^\xi$$

Funding market tightness is given by

$$\theta_t \equiv \frac{v_t}{D_{t+1}^u}.$$

Shadow banks and households bargain over surplus, which leads to the interest rate on fund shares:

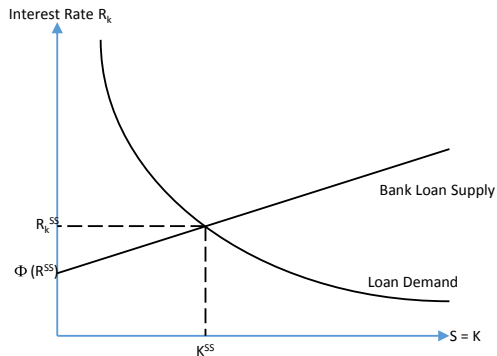
$$R_{t+1}^{SB} = (1 - \omega^{HH})R_{t+1} + \omega^{HH} \{R_{kt+1} + \theta_{t+1}\}$$

▶ remaining equations

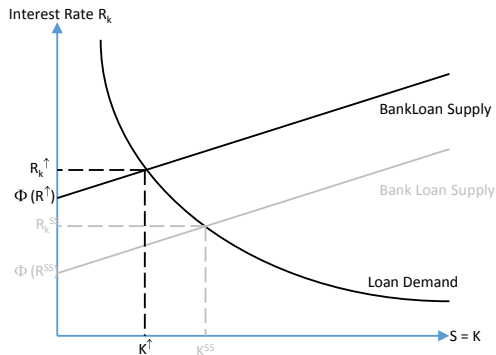
▶ Balance sheet adjustments

▶ Timeline

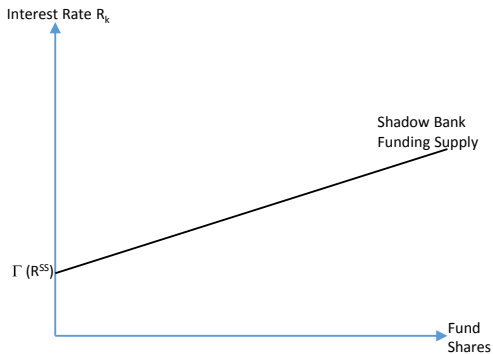
# Partial Equilibrium



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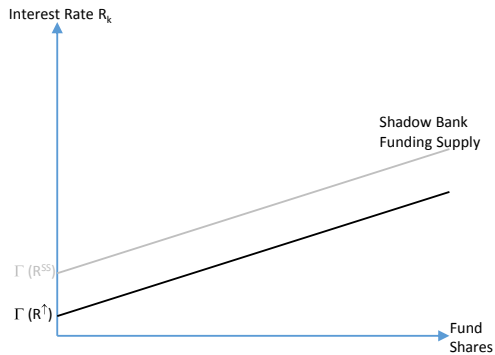


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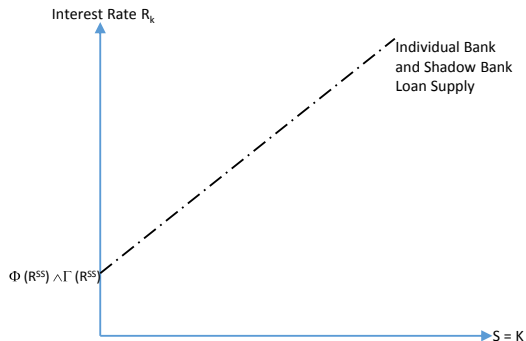




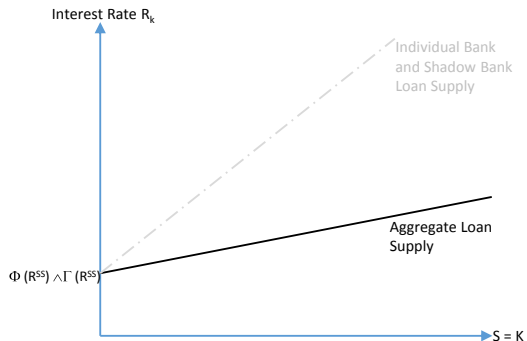
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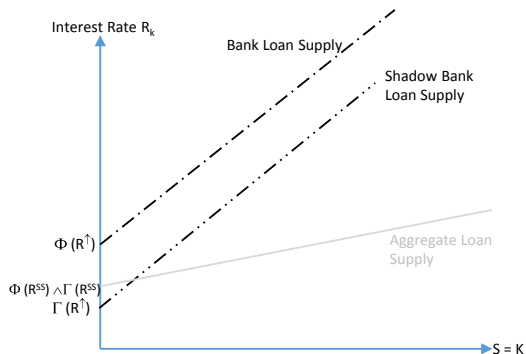
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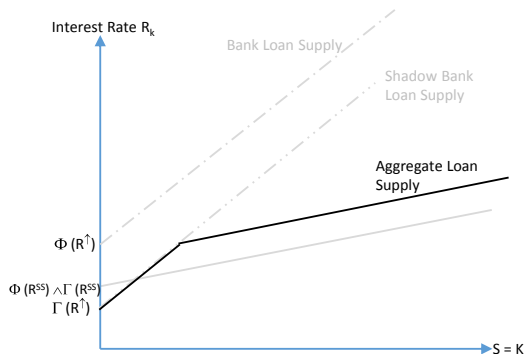
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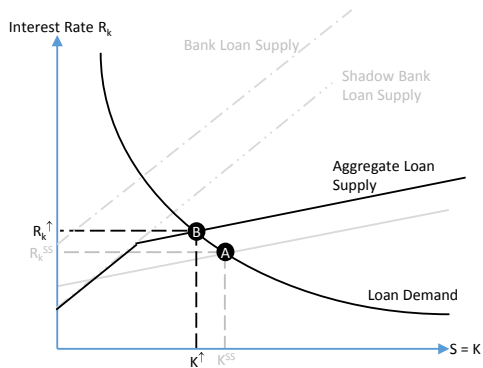
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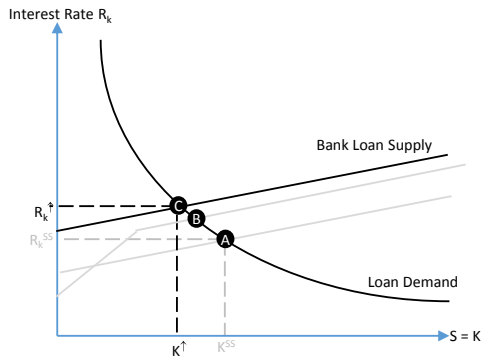
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# Parameterization

Parameter symbol	Value	Parameter name	Source
<b>Shadow Banks</b>			
$\chi^{SB}$	0.05	Separation rate	US fund redemption
$s$	3	Matching efficiency	rel size of SB system
$\omega^{HH}$	0.5	Household bargaining power	interest rate premium
$\xi$	0.5	Matching elasticity	Hosios condition
$\lambda^{SB}$	0.381	Fraction of shadow bank assets that can be diverted	equal to banks
<b>Households</b>			
$\beta$	0.99	Discount rate	GK (2011)
$h$	0 (0.815)	Habit	turned off
$\chi^{HH}$	3.409	Relative utility weight of labor	GK (2011)
$\varphi$	0.276	Inverse Frisch elasticity of labor supply	GK (2011)
<b>Banks</b>			
$\lambda$	0.381	Fraction of bank assets that can be diverted	GK (2011)
$\omega$	0.002	Proportional transfer to the incoming bankers	GK (2011)
$\theta$	0.972	Survival rate of the bankers	GK (2011)
<b>Goods Producers</b>			
$\alpha$	0.33	Effective capital share	GK (2011)
$\delta$	0.025	Depreciation rate	GK (2011)
<b>Retail Firms</b>			
$\epsilon$	4.167	Elasticity of substitution	GK (2011)
$\gamma$	0.779	Probability of keeping prices fixed	GK (2011)
$\gamma_p$	0.241	Price indexation	GK (2011)
<b>Government</b>			
$\kappa_\pi$	1.5	Inflation coefficient of Taylor rule	GK (2011)
$\kappa_y$	0.125	Output gap coefficient of Taylor rule	GK (2011)
$G/Y$	0.2	Steady state proportion of government expenditures	GK (2011)

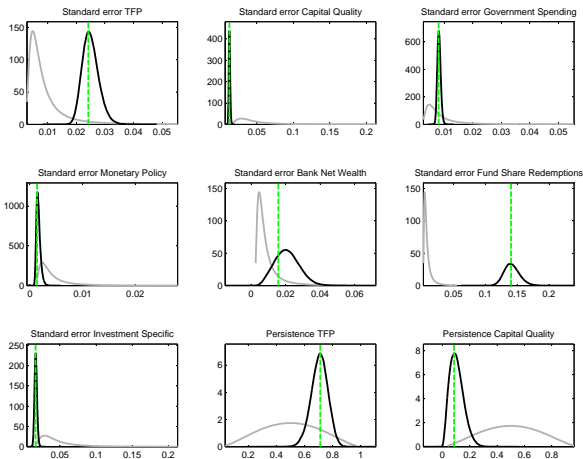


# Parameterization

Symbol	name	Type	Prior Mean	Std. Dev.	Mode	Posterior STd. Dev.
Persistence						
$\rho_A$	TFP	Beta	0.5	0.2	0.71	.06
$\rho_\xi$	Capital Quality	Beta	0.5	0.2	0.08	0.05
$\rho_g$	Government Spending	Beta	0.5	0.2	0.75	0.06
$\rho_i$	Monetary Policy	Beta	0.5	0.2	0.95	.01
$\rho_{Ne}$	Bank Net Wealth	Beta	0.5	0.2	0.68	0.18
$\rho_{FS}$	Fund Share Redemption	Beta	0.5	0.2	0.68	0.08
$\rho_{IE}$	Investment Efficiency	Beta	0.5	0.2	0.31	0.07
Std dev.						
$e_A$	TFP	Inverse Gamma	0.010	0.05	0.024	.003
$e_\xi$	Capital Quality	Inverse Gamma	0.010	0.05	0.012	0.001
$e_g$	Government Spending	Inverse Gamma	0.010	0.05	0.008	0.001
$e_i$	Monetary Policy	Inverse Gamma	0.010	0.05	0.001	0.001
$e_{Ne}$	Bank Net Wealth	Inverse Gamma	0.010	0.05	0.016	0.009
$e_{FS}$	Fund Share Redemption	Inverse Gamma	0.010	0.05	0.163	0.012
$e_{IE}$	Investment Efficiency	Inverse Gamma	0.010	0.05	0.020	0.002

Shock processes independent a priori.

# Posterior Distributions

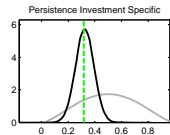
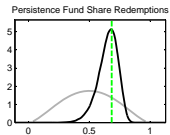
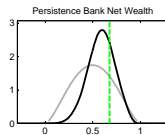
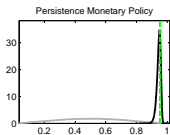
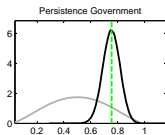


» Convergence

» Mode Check



# Posterior Distributions

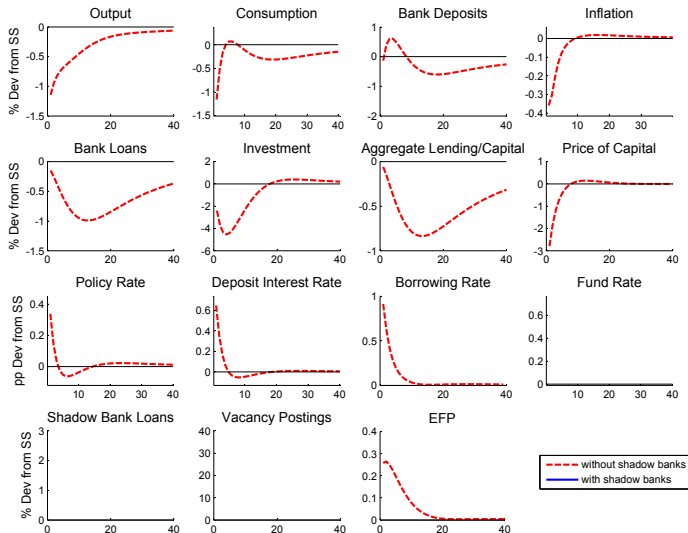


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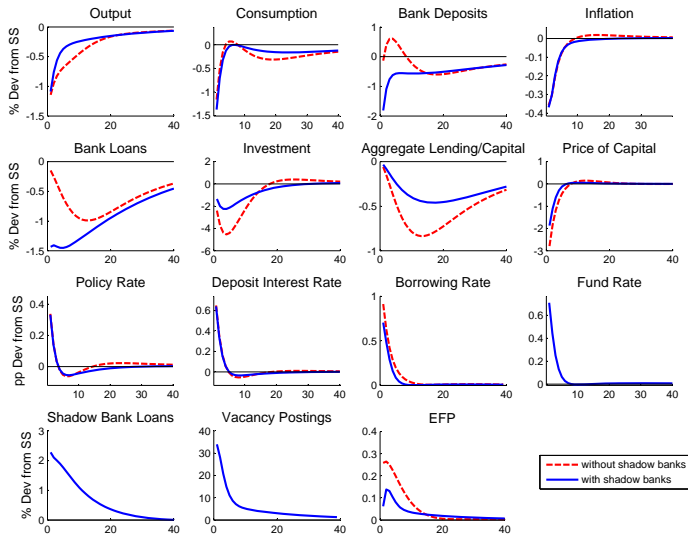


# Positive 1 s.d. shock to monetary policy rate



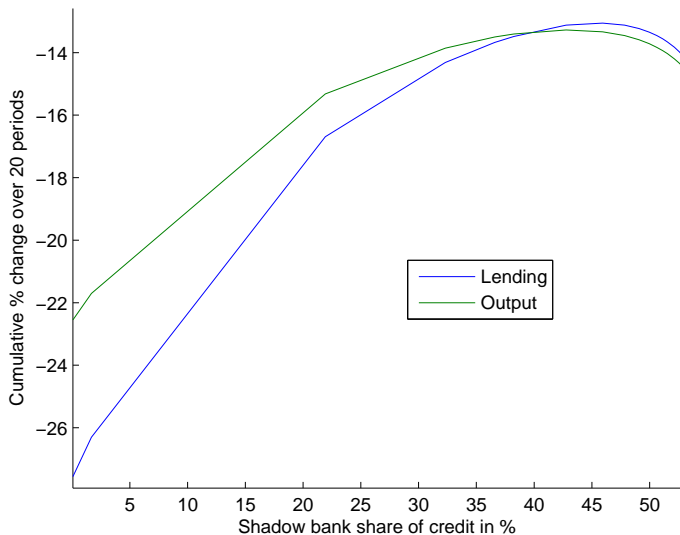
▶ IRFs other shocks

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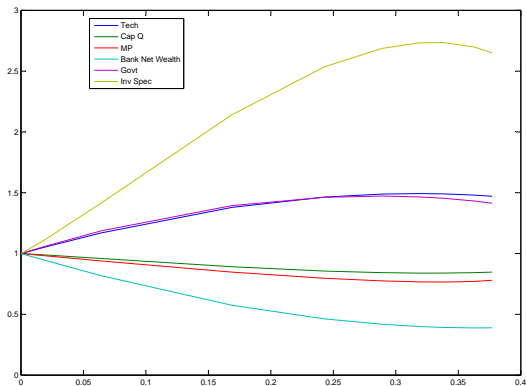


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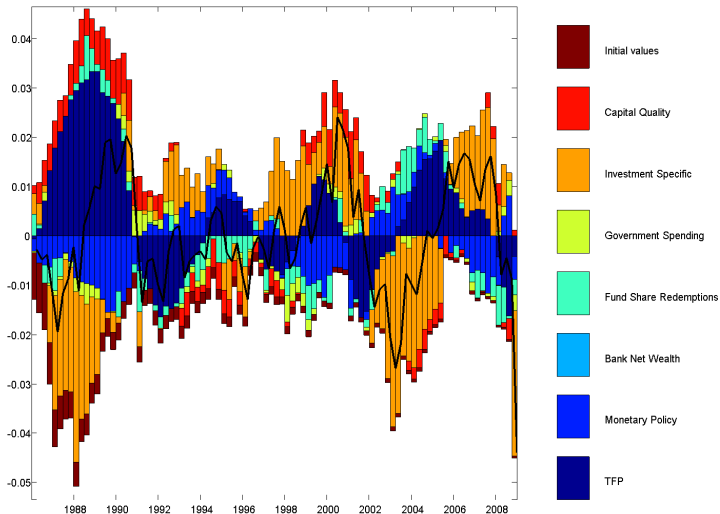
# Aggregate loan reduction depending on size



# Variance Decomposition



# Historical Shock Decomposition





## Monetary DSGE model with banking **and shadow banking**

- IRFs closer to empirical observations
- Balance sheet channel and lending channel separate
- Lending channel insulates balance sheet channel
- Monetary policy made fewer mistakes than otherwise implied
- tractable implementation of shadow banking / the lending channel  
⇒ applicable to variety of banking models

- Optimal policy
- Role of quantitative easing; macroprudential measures
- Optimal shadow banking size?
  
- Active savings choice by households
- Add realism, e.g. shadow bank funding from banking sector
- Bayesian estimation of structural parameters
- US / Europe Comparison

