Financial Stability and Optimal Interest-Rate Policy

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Federal Reserve Board

The New Normal of Monetary Policy, March 2015

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Motivation

- Should interest-rate policy be altered in response to changes in credit conditions?
  - Focus on optimal policy.
- Intertemporal trade-off between costs and benefits of leaning against financial imbalances.
  - Reduced economic activity today in exchange for lower likelihood of crises tomorrow.
  - How quantitatively relevant?

What We Do

- Build a New Keynesian model with endogenous financial crises.
- Characterize optimal interest-rate policy in presence of endogenous probability of a crisis.
  - Non-linear quadratic approach.
- Characterize optimal interest-rate policy accounting for parameter uncertainty.
  - Bayesian and Robust Control approaches.

What We Find

- Optimal interest-rate adjustment in response to credit conditions is very small under baseline calibration.

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- Optimal interest-rate adjustment in response to credit conditions is very small under baseline calibration.
- Optimal policy can call for larger interest-rate adjustments when crisis probability is more sensitive to credit imbalances or crisis is expected to be severe.
- Uncertainty over the crisis probability and its sensitivity to monetary policy calls for more aggressive interest-rate policy.
  - Deviation from attenuation principle (Brainard (1967)).

Outline

The Model

- New Keynesian sticky-price model with an endogenous financial crisis event.
- Crisis follows a Markov process. Transition probability depends on aggregate financial conditions.
- Two periods, denoted $t = 1$ and $t = 2$.
- Trade-off: Tighter interest-rate policy in normal times can lower output in $t = 1$ and reduce probability of crisis occurring in period t=2.

Private Sector

- Output gap y, inflation π, and credit conditions L in $t = 1$:

$$
\begin{aligned}
y_1 =& E_1^{ps} y_2 - \sigma \left[i_1 - E_1^{ps} \pi_2 \right] \\
\pi_1 =& \kappa y_1 + E_1^{ps} \pi_2 \\
L_1 =& \rho_L L_0 + \phi_i i_1 + \phi_y y_1 + \phi_\pi \pi_1 + \phi_0 .
\end{aligned}
$$

- In period $t = 2$ output gap and inflation can take values:

$$
(y_2, \pi_2) = \begin{cases} (y_{2,nc}, \pi_{2,nc}), & \text{with probability } 1 - \gamma_1 \\ (y_{2,c}, \pi_{2,c}), & \text{with probability } \gamma_1 \end{cases}
$$

with $y_{2,c} < y_{2,nc} = 0$ and $\pi_{2,c} < \pi_{2,nc} = 0$ and

$$
\gamma_1 = \frac{\exp(h_0 + h_1 L_1)}{1 + \exp(h_0 + h_1 L_1)}
$$

- E_1^{ps} non-rational private sector expectations in $t = 1$.

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- Assumption eliminates precautionary saving motive. Focus on intertemporal policy trade-off.

Central Bank's Problem

- The policy problem: choose policy rate in t=1 given initial credit conditions, L_0:

$$WL_1 = \min_{i_1} \;\; u(y_1, \pi_1) + \beta E_1[WL_2]$$

subject to the private sector equilibrium conditions.

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$$u(y_1, \pi_1) = \frac{1}{2}(\lambda y_1^2 + \pi_1^2).$$

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- Expected welfare loss in period $t = 2$:

$$E_1[WL_2] = (1 - \gamma_1)WL_{2,nc} + \gamma_1 WL_{2,c}$$

where:

$$WL_{2,nc} = u(y_{2,nc}, \pi_{2,nc}), \quad WL_{2,c} = \frac{u(y_{2,c}, \pi_{2,c})}{1 - \beta\mu}$$

Calibration - NK block

Parameter	Description	Parameter Value
Standard parameters		
β	Discount Factor	0.995
σ	Interest-rate sensitivity of output	1.0
κ	Slope of the Phillips Curve	0.024
λ	Weight on output stabilization	$1/16$
i^*	Long-Run Natural Rate of Interest	0.01
Parameters related to the second period		
$y_{2,nc}$	Output gap in the non-crisis state	0
$\pi_{2,nc}$	Inflation gap in the non-crisis state	0
$WL_{2,nc}$	Loss in the non-crisis state	0
$y_{2,c}$	Output gap in the crisis state	-0.1
$\pi_{2,c}$	Inflation gap in the crisis state	$-0.02/4$
μ	Persistence of the crisis state	$7/8$
$WL_{2,c}$	Loss in the crisis state	$\frac{u(y_{2,c},\pi_{2,c})}{1-\beta\mu}$
ϵ	Perceived crisis probability	$0.05/100$

Calibration - Crisis Probability

- Calibrate transition probability parameters:

$$\gamma_1 = \frac{\exp(h_0 + h_1 L_1)}{1 + \exp(h_0 + h_1 L_1)}$$

- Credit conditions:

$$L_1 = \phi_0 + \rho_L L_0 + \phi_y y_1 + \phi_i i_1 + \phi_\pi \pi_1 + \varepsilon_1$$

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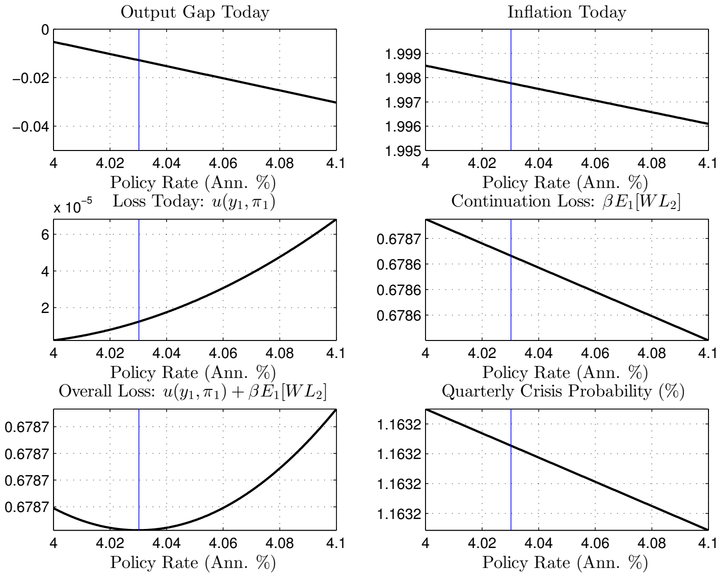
- Adapt Schularick and Taylor (2012) findings: L cumulative 5-year growth rate of real bank loans.
- Growth of real bank loans can depend on $(y, \pi, \imath)$

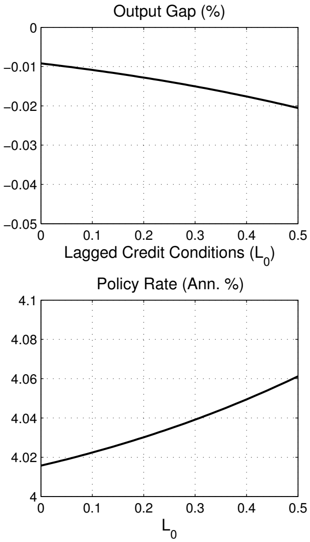
Parameter	Description	Parameter Value	SE
h_0	Constant term	-3.396	0.54
h_1	Coefficient on L	1.88	0.57
ρ_L	Coefficient on the lagged L	.95	
ϕ_0	Intercept	$(1 - \rho_L) * 0.2$	
ϕ_i	Coefficient on the policy rate	0	–
ϕ_y	Coefficient on output gap	0.18	0.04
ϕ_π	Coefficient on inflation gap	-1	–

Basic Trade-off



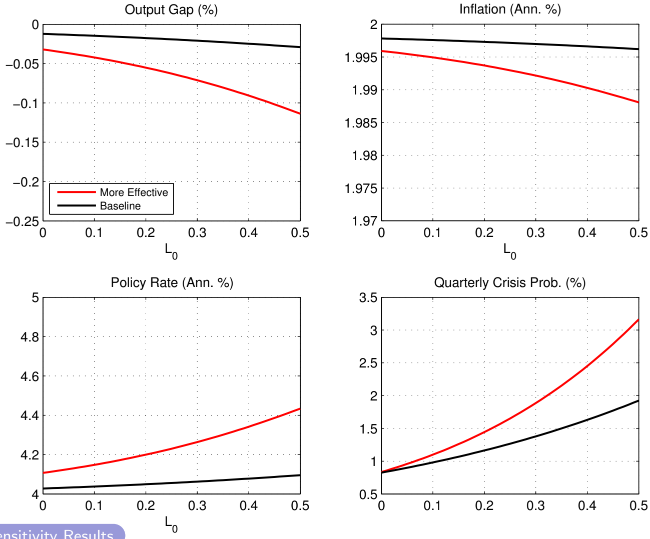
*With $L_0 = 0.2$ (L_0 is the lagged 5-yr growth rate of real bank loans)

Optimal Policy



Sensitivity Analysis

Crisis probability more sensitive to policy rate (higher h_1 and ϕ_y).



More Sensitivity Results

Optimal Policy with Parameter Uncertainty

Motivation:

- Parameters related to crises are particularly uncertain because crises are infrequent.

Optimal Policy with Parameter Uncertainty

4 Sources of Uncertainty:

- h_1: Elasticity of crisis probability to credit conditions.
- ϕ_y: Elasticity of credit conditions to output.
- $(\pi_{2,c}, y_{2,c})$: "Severity" of the crisis.
- (σ, κ): Elasticity of today's output/inflation to policy rate.

2 Types of Policymaker:

- Bayesian
- Robust

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Bayesian policymaker:

$$\min_{i_1} \; E_{1,\theta}\left[u(y_1, \pi_1) + \beta WL_2\right]$$

Robust policymaker:

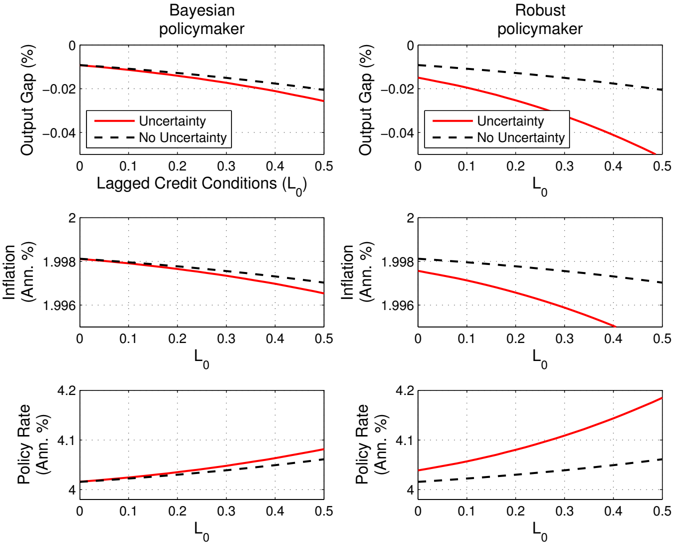
$$\min_{i_1}\left[\max_{\theta \in [\theta_{min}, \theta_{max}]} \; u(y_1, \pi_1) + \beta E_1[WL_2]\right]$$

where θ is the set of parameters subject to uncertainty.

Calibration

Parameter	Value	Probability
Uncertain Elasticity of Crisis Prob. to Credit Conditions		
$h_{1,min}$	0.74	1/3
$h_{1,base}$	1.88	1/3
$h_{1,max}$	3.02	1/3
Uncertain Severity of Srisis		
$\pi_{2,c,min}$	$-0.03/4$	1/3
$\pi_{2,c,base}$	$-0.02/4$	1/3
$\pi_{2,c,max}$	$-0.01/4$	1/3
$y_{2,c,min}$	-0.15	1/3
$y_{2,c,base}$	-0.1	1/3
$y_{2,c,max}$	-0.05	1/3

Uncertain crisis prob. (h_1)



*h_1: Elasticity of crisis prob. to credit conditions

Trade-off faced by the Bayesian Policymaker

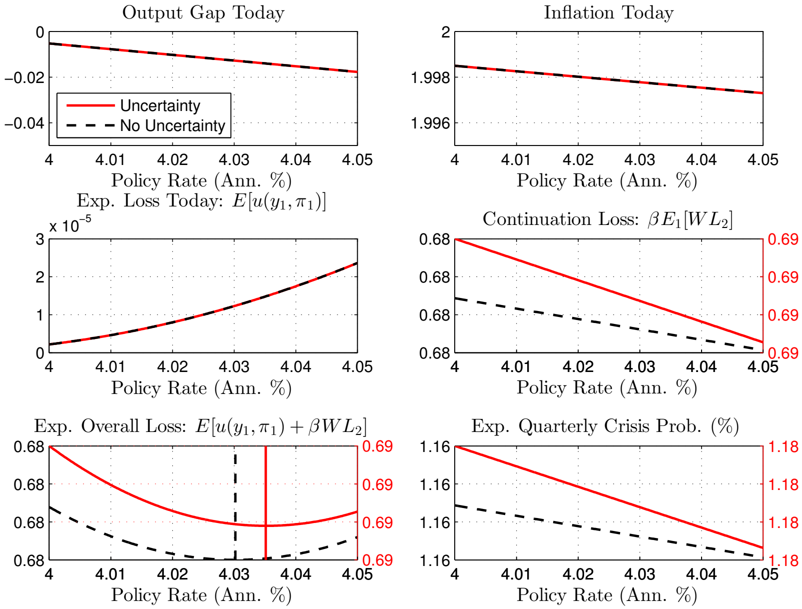
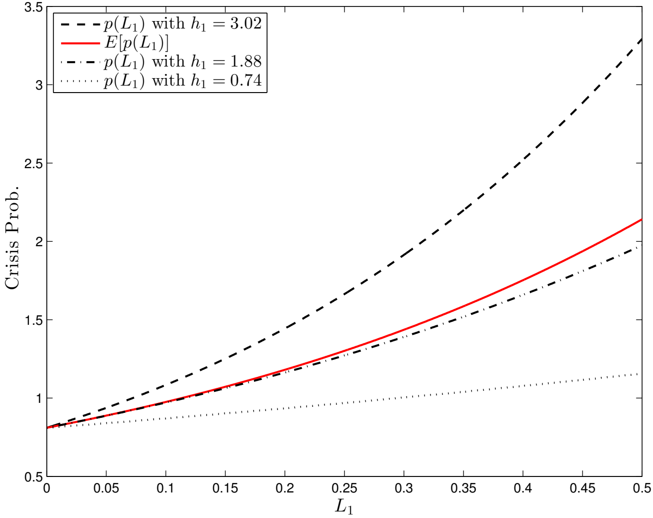
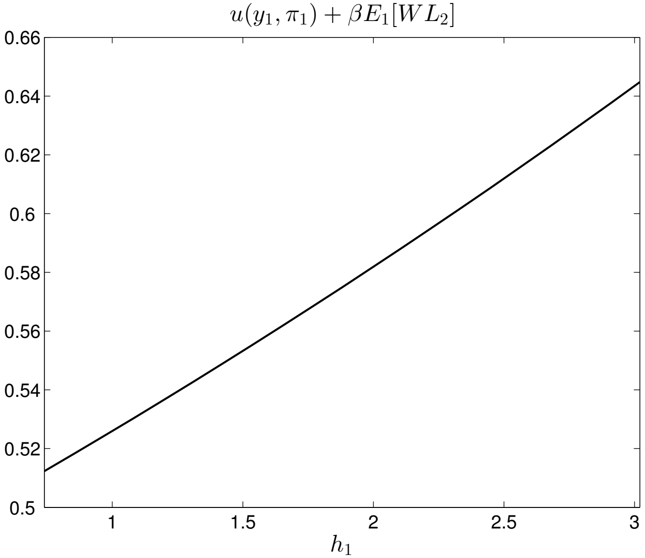


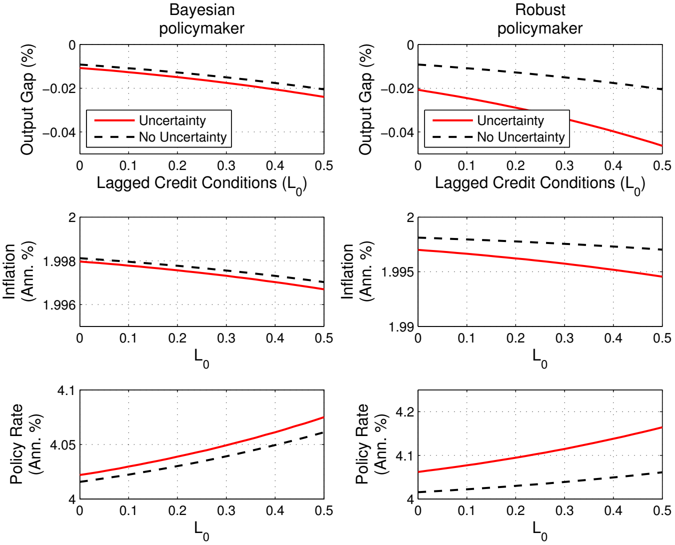
Fig: The Effects of a Mean-Preserving Spread on h_1 for the Crisis Probability Function: $\gamma_1 = \frac{\exp(h_0+h_1 L_1)}{1+\exp(h_0+h_1 L_1)}$



Objective function of the hypothetical evil agent



Uncertain severity of the crisis ($y_{2,c}$ and $\pi_{2,c}$)



*$(y_{2,c}, \pi_{2,c})$: Output gap and inflation in the crisis

Table: Effects of Uncertainty on Optimal Policy Rate

	Bayesian	Robust
h_1	Higher	Higher
$(\pi_{2,c}, y_{2,c})$	Higher	Higher
(σ, κ)	Lower	Lower

Conclusions

- Solve for optimal interest-rate policy in a New Keynesian model with endogenous financial crises.
  - Optimal adjustment to interest rates in response to credit conditions is very small under baseline calibration.
  - Optimal policy can call for larger interest-rate adjustments under alternative/plausible calibrations.
- Compute optimal policy under parameter uncertainty.
  - Bayesian and robust-control central banks should respond more aggressively when probability and severity of financial crises are uncertain.

THANK YOU

Output Growth and Inflation Expectations in the Great Recession: Evidence from the SPF

- Every quarter, participants in the Survey of Professional Forecasters (SPF) report the probability distribution of the growth rate of real average GDP and CPI expected over the current and next calendar years.

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  - Realized average real GDP fell by -0.29% in 2008, and -2.81% in 2009.

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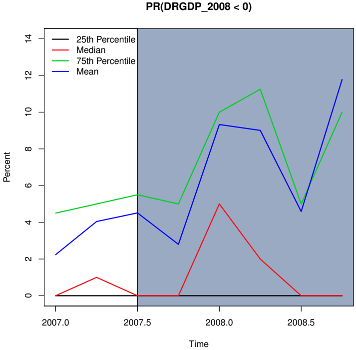
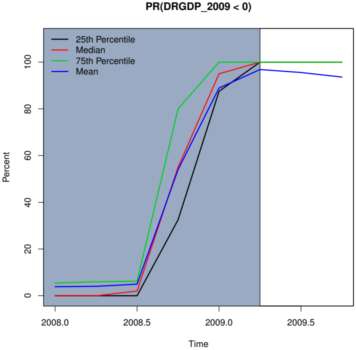
- Great Recession episode:
  - Realized average real GDP fell by -0.29% in 2008, and -2.81% in 2009.
  - CPI inflation recorded a negative entry in 2008:Q4 and quickly reverted into positive territory.

Output Growth and Inflation Expectations in the Great Recession: Evidence from the SPF

Figure: Probability of Negative Growth of Average Real GDP in 2008 and 2009



(a) 2008



(b) 2009

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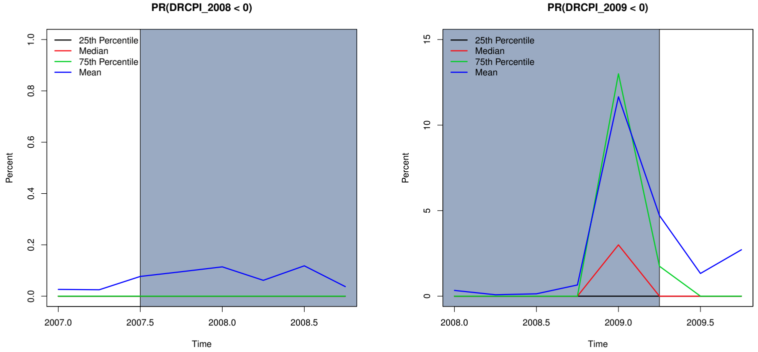
Figure: Probability of Negative Growth of Average CPI in 2008 and 2009



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- Supporting evidence of forecasters did not anticipate effects of the financial crisis of 2007-2009.

Back

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- Expectations that recession will be lengthy and costly is updated with a lag to unfolding of events.

Back

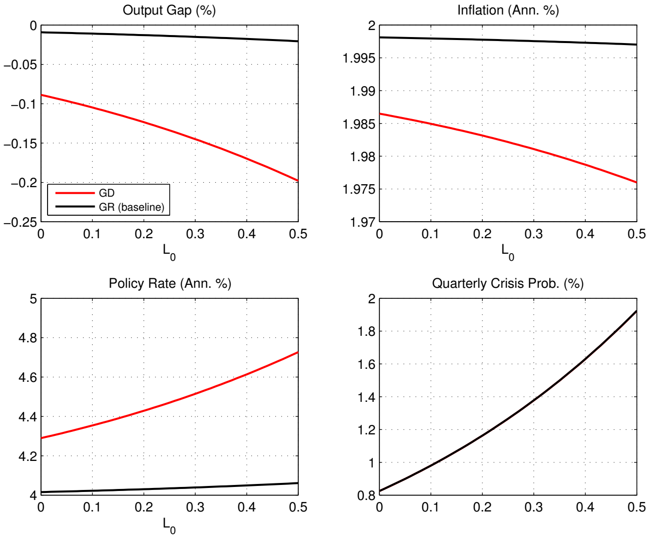
Output Growth and Inflation Expectations in the Great Recession: Evidence from the SPF

- Supporting evidence of forecasters did not anticipate effects of the financial crisis of 2007-2009.
- Expectations that recession will be lengthy and costly is updated with a lag to unfolding of events.
- Forecasters' expectations for GDP growth and CPI inflation do not seem to respond preemptively to the accumulation of financial imbalances in the 2000s.

Back

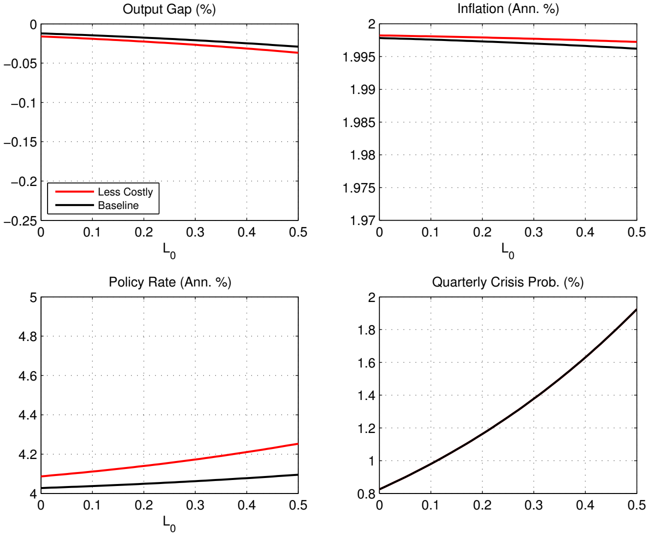
Sensitivity Analysis (II)

Larger declines in output and inflation during a crisis (lower $y_{2,c}$ and $\pi_{2,c}$).



Sensitivity Analysis (III)

Today's output and inflation less sensitive to policy rate (lower σ and κ).



Calibration Crisis Probability

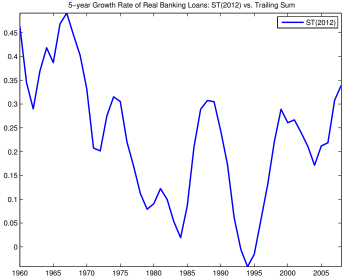
- Predictor in annual terms:

$$L_t^a = \Sigma_{s=0}^4 \Delta \log \frac{B_{i,t-s}}{P_{i,t-s}}$$

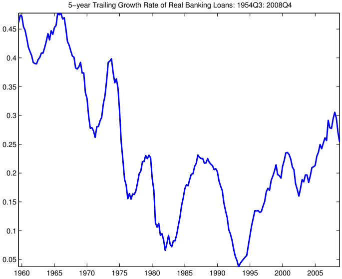
- Predictor in quarterly terms:

$$L_t^q := \sum_{s=0}^{19} \Delta \log \frac{B_{t-s}}{P_{t-s}} \approx \Delta \log \frac{B_t}{P_t} + \frac{19}{20} L_{t-1}^q$$

applied to post-war U.S. data:



(c) Annual Predictor



(d) Quarterly trailing sum

Calibration Bank Lending Growth

- Quarterly real credit growth: $\Delta \log \frac{B_t}{P_t} = \Delta \log B_t - \pi_t$

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- We estimate a process for nominal bank lending growth:

$$\Delta \log B_t = c + \phi_i i_t + \phi_y y_t + \varepsilon_t^B$$

instrumenting i_t and y_t with their lagged values.

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instrumenting i_t and y_t with their lagged values.

- So that:

$$L_1 \approx \rho_L L_0 + \phi_0 + \phi_y y_1 + \pi_1 + \epsilon_1$$

Parameter	Description	Parameter Value	SE
ρ_L	Coefficient on the lagged L	19/20	
ϕ_0	Intercept	$(1-\rho_L) * 0.2$	
ϕ_i	Coefficient on the policy rate	0	–
ϕ_y	Coefficient on output gap	0.18	0.04
ϕ_π	Coefficient on inflation gap	-1	–