Optimal policy responses to financial shocks

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Models of monetary policy with banking

- Recent financial crisis has emphasized how much a meaningful role for banks is missing from standard models of monetary policy.
- Benchmark New Keynesian (NK) model abstracts from money and banking.
- A number of recent contributions have added a banking sector to the NK model, e.g.
  - Andrés and Arce (2008),
  - Canzoneri, Cumby, Diba, and López-Salido (2008),
  - Christiano, Motto, and Rostagno (2008),
  - Gerali, Neri, Sessa, and Signoretti (2008),
  - Goodfriend and McCallum (2007).

Questions left unanswered

- These models, however, do not directly address some issues of interest for policymakers during a financial crisis:
  - how should fiscal and monetary policy react to an increase in the default rate on bank loans?
  - how are liquidity problems affecting the funding side of banks transmitted to the lending side?
  - how does a large fiscal transfer (a capital infusion like the US bank bailout) affect the banks' willingness to lend?
  - was it wise for the Federal Reserve to accommodate the massive increase in US banks' demand for excess reserves?
- The most relevant papers in this respect are those of Cúrdia and Woodford (2009a, b, c).

Main goal of the paper

- In this paper, we add a banking sector to a basic NK model and consider the positive and normative implications of three financial shocks:
  - a shock that increases the default rate on bank loans,
  - a shock that increases the demand for reserves,
  - a shock that hampers the ability of banks to securitize loans.
- Our main goal is to show how financial frictions matter for the transmission of financial shocks and for the optimal fiscal and monetary policy responses to these shocks.
- In particular, NK models have a strong policy implication identifying price stability as the overriding objective of good monetary policy: do financial shocks and frictions alter this policy prescription?

Nature of the financial frictions

- We consider two frictions in the market for bank equity.
- The first friction is a cost of adjustment of dividend payments:
  - this cost is motivated by the observation that managers smooth dividends (Lintner, 1956);
  - we follow the existing literature (e.g. Jermann and Quadrini, 2006) and introduce this cost in an ad hoc way.
- The second friction is a cost of issuing securities.

In the absence of dividend adjustment cost

- Banks can recapitalize themselves costlessly by lowering dividend payments and, if need be, paying negative dividends.
- This implies that:
  - the lending and borrowing sides of banks are essentially decoupled;
  - the spread between the lending rate and the risk-free (CCAPM) rate depends on default risk but not on the securitization shock nor on the shock to demand for reserves;
  - a fiscal transfer simply induces banks to pay more dividends, without altering their lending or other activities.

In the presence of dividend adjustment cost

- Banks may engage in costly securitization because the alternative may be a costly adjustment of dividend payments.
- This implies that:
    - the spread between the lending rate and the risk-free rate increases, and the volume of loans falls, when securitization costs or the demand for reserves increase;
    - a fiscal cash infusion reduces the spread and increases the volume of loans.
- So, in this setting, we can have a meaningful analysis of optimal fiscal and monetary responses to financial shocks.

Main results

- Optimal monetary policy tolerates little variability in one measure of inflation. This measure is inflation in the price index for intermediate goods (IGPI inflation).
- In response to liquidity shocks (increases in the demand for reserves or costs of securitization):
  - optimal monetary policy moves the interest rate very little and allows a sharp increase in money growth. This finding is reminiscent of Poole's (1970) results in the context of the IS-LM model;
  - optimal fiscal policy makes a transfer to banks in order to reverse the tightening of their balance sheet.

General features

- We consider an economy populated with:
  - infinitely-lived households;
  - monopolistically competitive banks;
  - monopolistically competitive firms producing differentiated intermediate goods;
  - perfectly competitive firms producing the final good;
  - and fiscal and monetary authorities.
- The timing of events in each period is the following:
  - realization of current shocks;
  - financial exchange;
  - goods exchange.

Representative household

- The representative household chooses a_t, c_t^M, c_t^D, m_t^H, d_t and h_t to maximize

$$U_t = E_t \left\{ \sum_{j=0}^{+\infty} \beta^j \left[\Phi \ln\left(c_{t+j}^M\right) + (1-\Phi)\ln\left(c_{t+j}^D\right) - \frac{1}{1+\chi} h_{t+j}^{1+\chi} \right] \right\}$$

subject to the cash- and deposits-in-advance constraints

$$m_t^H - c_t^M \geq 0, \qquad d_t - c_t^D \geq 0,$$

and the budget constraint

$$\left(\frac{1+R_{t-1}^A}{\Pi_t}\right) a_{t-1} + \left[\left(\frac{1+R_{t-1}^D}{\Pi_t}\right) d_{t-1} - \frac{c_{t-1}^D}{\Pi_t}\right] + \left(\frac{m_{t-1}^H}{\Pi_t} - \frac{c_{t-1}^M}{\Pi_t}\right) + w_t h_t + \pi_t^I + z_t - a_t - m_t^H - d_t - t_t \geq 0.$$

Intermediate goods producers

- Monopolistic competitors.
- Production function:

$$x_t(j) = h_t(j)\exp\left(z_t^p\right).$$

- Set their prices facing a Calvo-type price rigidity (with no indexation).

Final goods producers

- Perfectly competitive.
- Production function:

$$y_t = \left(\int_0^1 x_t(j)^{\frac{\varepsilon-1}{\varepsilon}} \, dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \equiv x_t .$$

- Those hit by a default shock use their inputs but do not produce any output.
- Must borrow from banks to buy intermediate goods: $L_t = P_t^X x_t$.
- The zero-profit condition is

$$\frac{P_t}{P_t^X} = \left(1 + R_t^L \right) .$$

Banks I

- The representative bank chooses a_t, z_t, m_t^B, R_t^D and R_t^L to maximize its stock-market value

$$E_t \left\{ \sum_{j=0}^{+\infty} \beta^j \lambda_{t+j} z_{t+j} \right\}$$

subject to the demand curve for loans

$$l_t = \left(\frac{1 + R_t^L}{1 + \overline{R}_t^L} \right)^{-\sigma_l} \bar{l}_t,$$

the demand curve for deposits

$$d_t = \left(\frac{1 + R_t^D}{1 + \overline{R}_t^D} \right)^{-\sigma_d} \bar{d}_t,$$

the reserves to manage the liquidity of deposits

$$m_t^B = d_t \exp(z_t^d),$$

Banks II

and the cash-flow constraint

$$\begin{aligned} z_t = & \; a_t + d_t + (1 - \delta_{t-1}) \left(\frac{1 + R^L_{t-1}}{\Pi_t} \right) l_{t-1} + \frac{1}{\Pi_t} m^B_{t-1} \\ & - \frac{\Phi_a}{2} (a_t - a^*_t)^2 - \left(\frac{1 + R^A_{t-1}}{\Pi_t} \right) a_{t-1} - \left(\frac{1 + R^D_{t-1}}{\Pi_t} \right) d_{t-1} \\ & - l_t - m^B_t - \tau_t - \frac{\Phi_z}{2} (z_t - z^*)^2 . \end{aligned}$$

- When $\Phi_a > 0$, banks face a cost of issuing an amount of securities a_t different from $a^*_t = a_{ss} \exp(-z^s_t)$.
- When $\Phi_z > 0$, banks face a cost of setting dividends different from $z^* = z_{ss} > 0$.

Banks III

- In a symmetric equilibrium, two first-order conditions are:

$$\lambda_t - \lambda_t^z \left[1 + \Phi_z \left(z_t - z^*\right)\right] = 0,$$
$$\lambda_t^z \left[1 - \Phi_a \left(a_t - a_t^*\right)\right] - \beta \left(1 + R_t^A\right) E_t \left\{\frac{\lambda_{t+1}^z}{\Pi_{t+1}}\right\} = 0.$$

- In the absence of dividend adjustment cost ($\Phi_z = 0$), the marginal cost of securitization is zero ($\Phi_a \left(a_t - a_t^*\right) = 0$).

Government

- The fiscal authority sets t_t to maintain a balanced budget: $t_t = g_t - \tau_t$.
- In normative analysis:
  - g_t is exogenous and stochastic;
  - τ_t and R^A_t are endogenous and set optimally.
- In positive analysis:
  - τ_t and g_t are exogenous and stochastic;
  - R^A_t is endogenous and evolves according to

$$\left(1+R^A_t\right) = \left(1+R^A_{t-1}\right)^{\rho}\left[\left(1+R^A_{ss}\right)\left(\frac{\Pi^{(X)}_t}{\Pi_{ss}}\right)^{\theta_m}\right]^{1-\rho}\exp\left(\varepsilon^m_t\right).$$

Market clearing conditions

- Goods market clearing condition:

$$(1-\delta_t)\, y_t = c_t + g_t + \frac{\Phi_a}{2}\left(a_t - a_t^*\right)^2 + \frac{\Phi_z}{2}\left(z_t - z^*\right)^2 .$$

- Money market clearing condition:

$$m_t = m_t^H + m_t^B .$$

Calibration of financial parameters

- We set $\Phi_z = 0.25$, following Jermann and Quadrini (2006). We also set $\Phi_a = 0.25$.
- The s.d. of the default shock innovation (resp. of the reserves-demand shock innovation) is set such that an increase in the charge-off rate (resp. in the reserves-to-deposits ratio) of the magnitude observed during the recent financial crisis would occur on average once in 80 years in our model.
- The s.d. of the securitization shock innovation is set such that a one-s.d. innovation reduces the zero-cost amount of securities by the same amount as a one-s.d. reserves-demand shock innovation increases reserves (for a constant amount of deposits). Therefore, the two liquidity shocks have the same impact effect in terms of tightening the banks' balance sheets.

Optimal steady-state inflation

- As in Khan, King, and Wolman (2003), the optimal steady-state inflation rate has to strike a balance between two forces:
  - the monetary distortion calls for deflation (the Friedman rule would be optimal if prices were fully flexible);
  - price rigidity calls for zero inflation (price stability would be optimal if there were no monetary distortion).
- We solve for the optimal (Ramsey) steady-state inflation rate using Dynare and the program Get Ramsey developed by Levin and López-Salido (2004) and used in Levin, Onatski, Williams and Williams (2005).
- We find that the optimal steady-state deflation rate is about 0.04 percent per quarter, both in the presence and in the absence of equity market frictions.

Figure 1: Responses to productivity shock
in the presence of equity market frictions

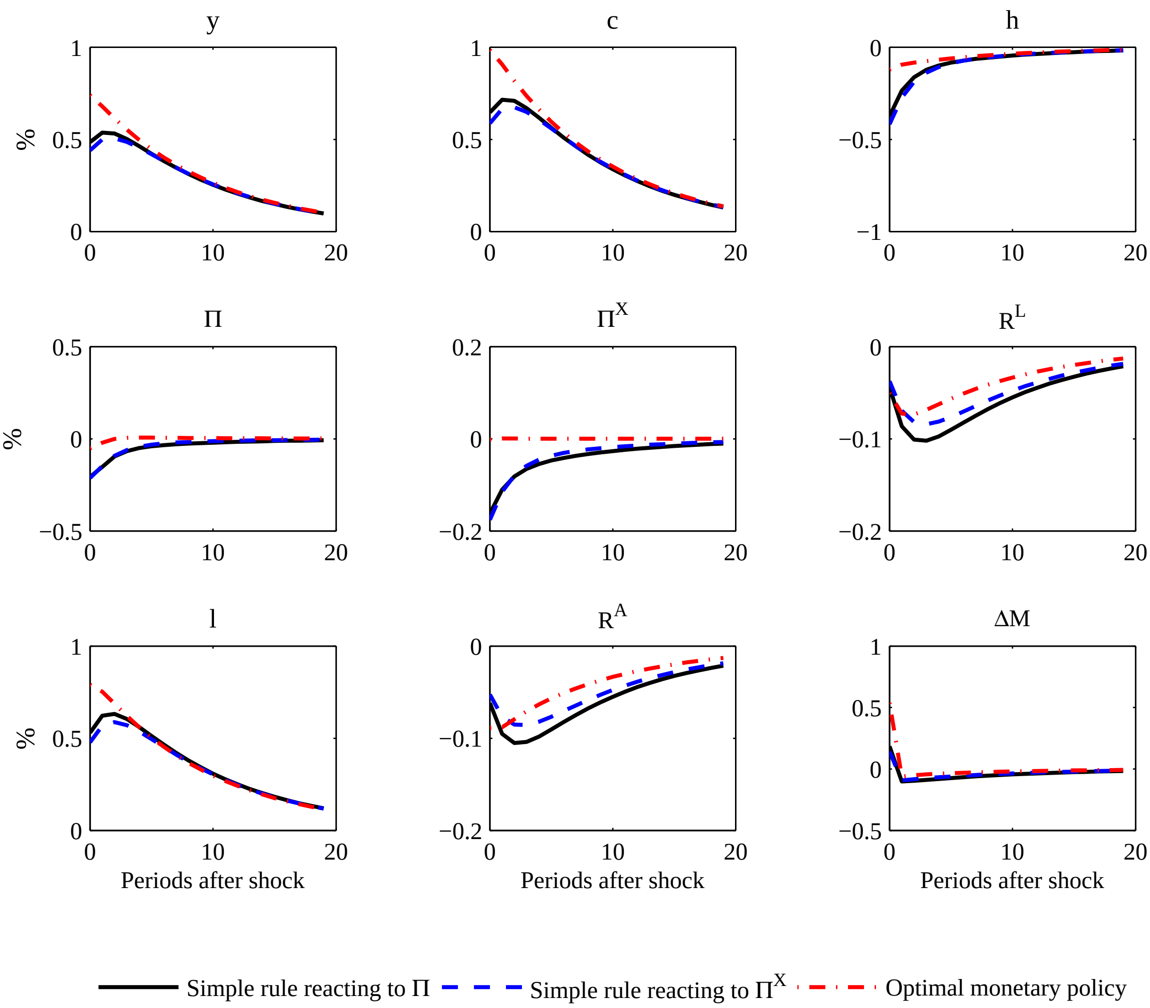


Figure 2: Responses to monetary policy shock
in the presence of equity market frictions

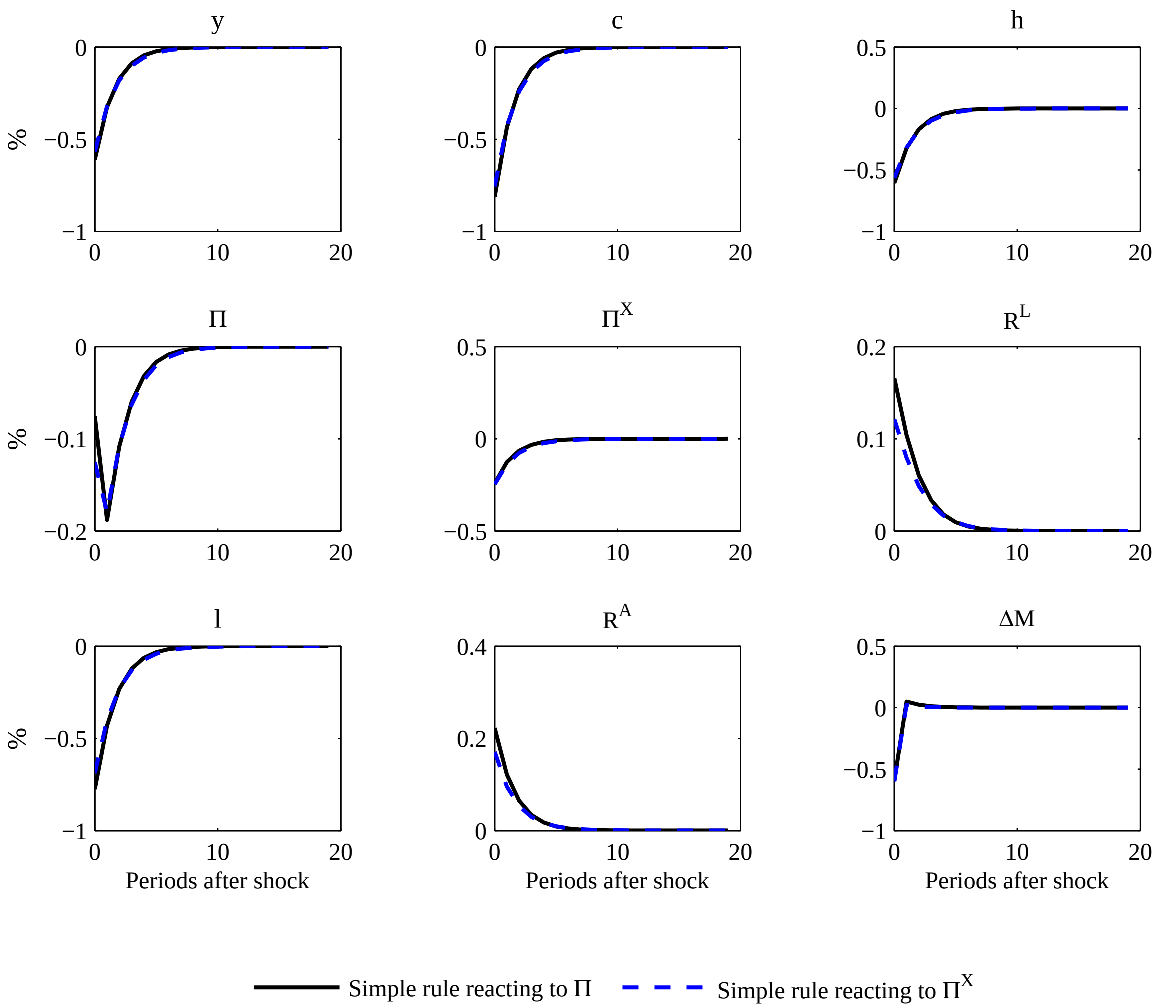


Figure 3: Responses to government−expenditures shock
in the presence of equity market frictions

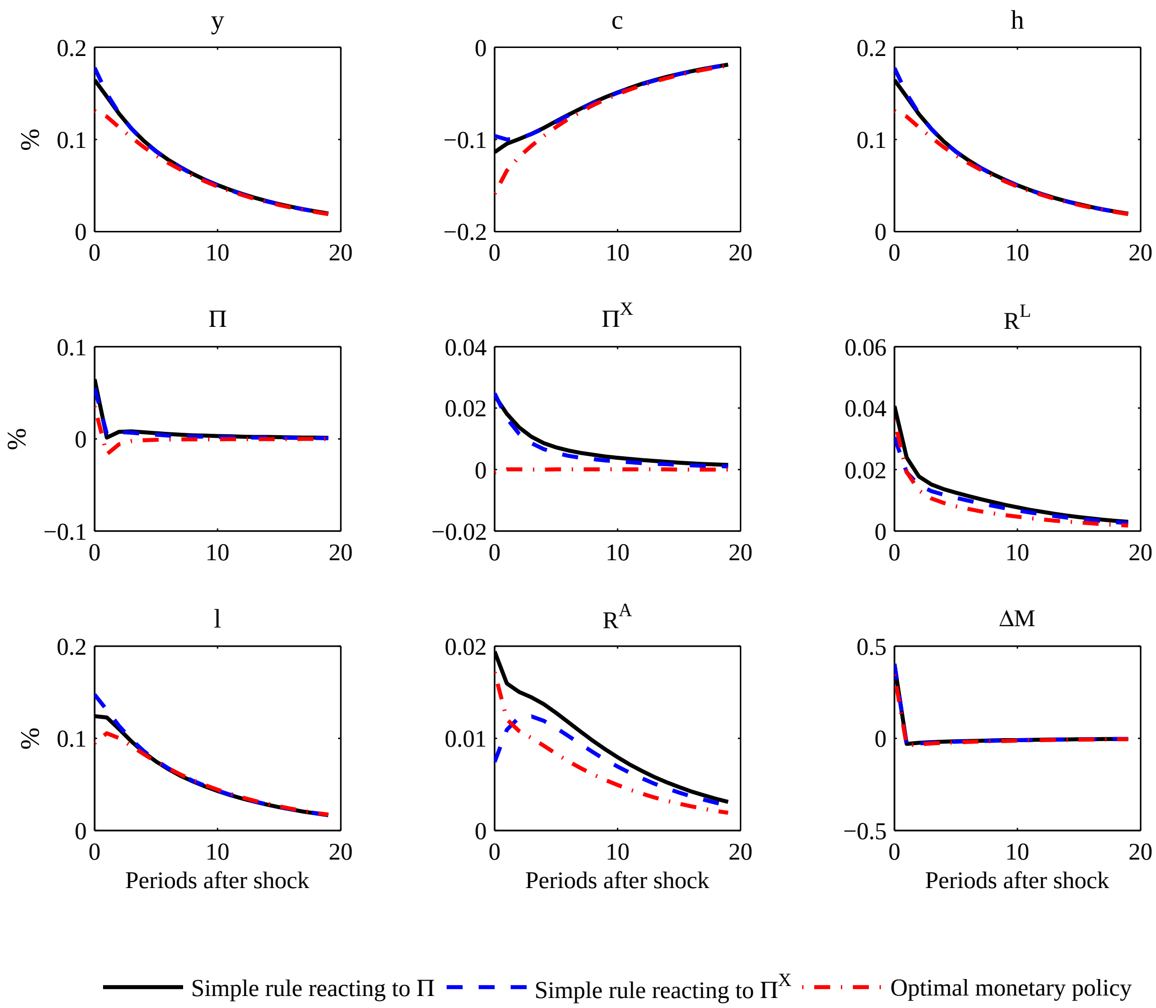


Figure 4: Responses to default shock
in the presence of equity market frictions

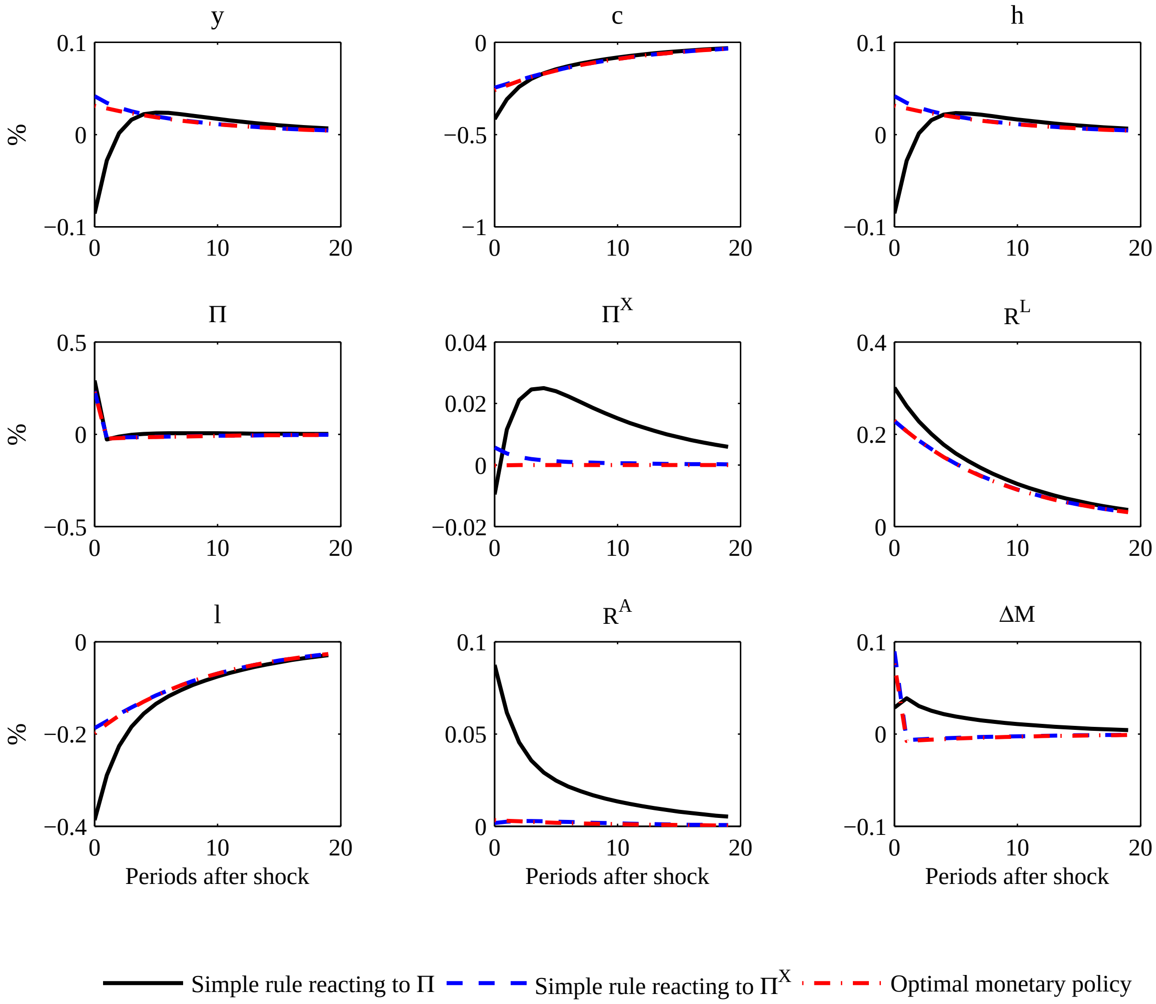


Figure 5: Responses to securitization shock
in the presence of equity market frictions

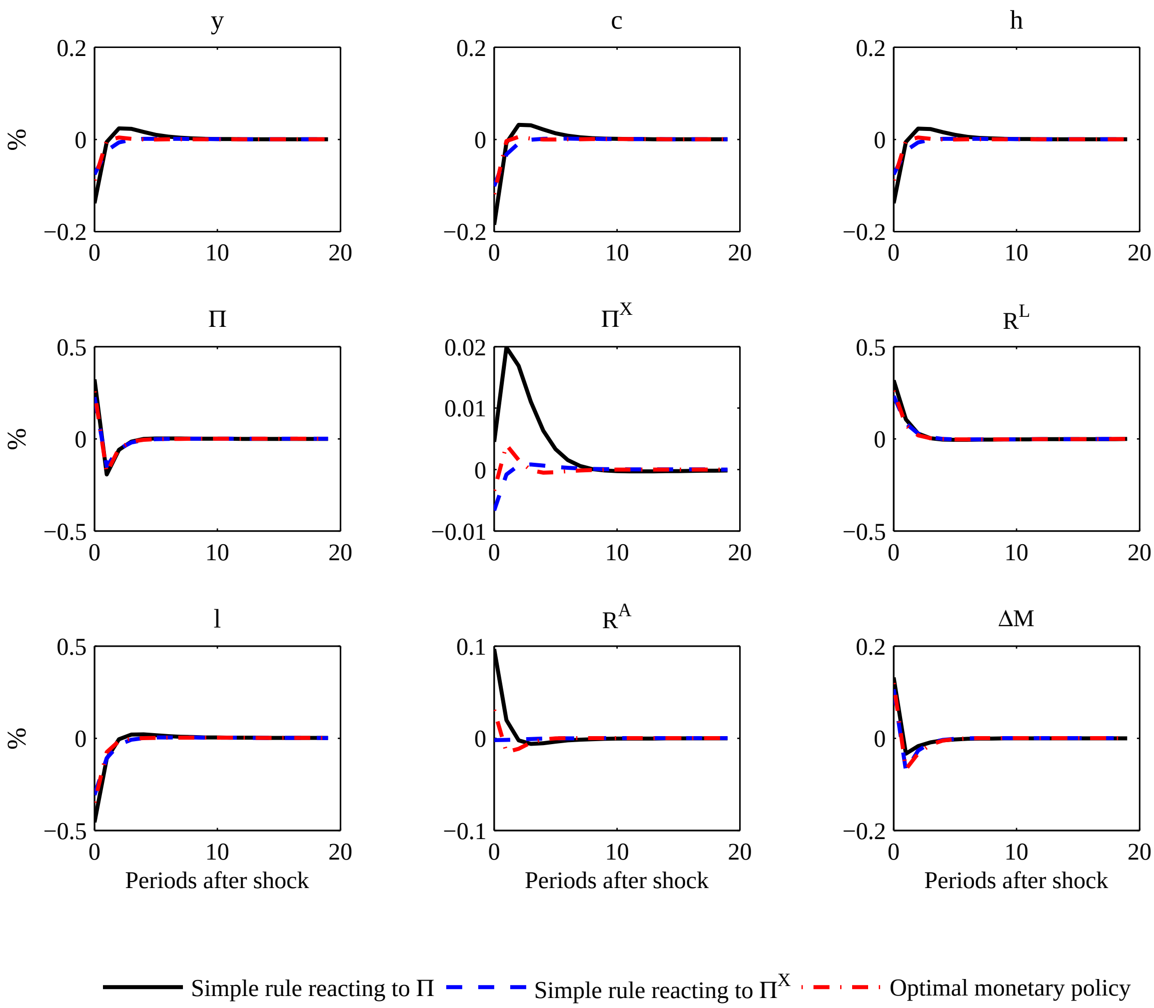


Figure 6: Responses to shock to demand for reserves
in the presence of equity market frictions

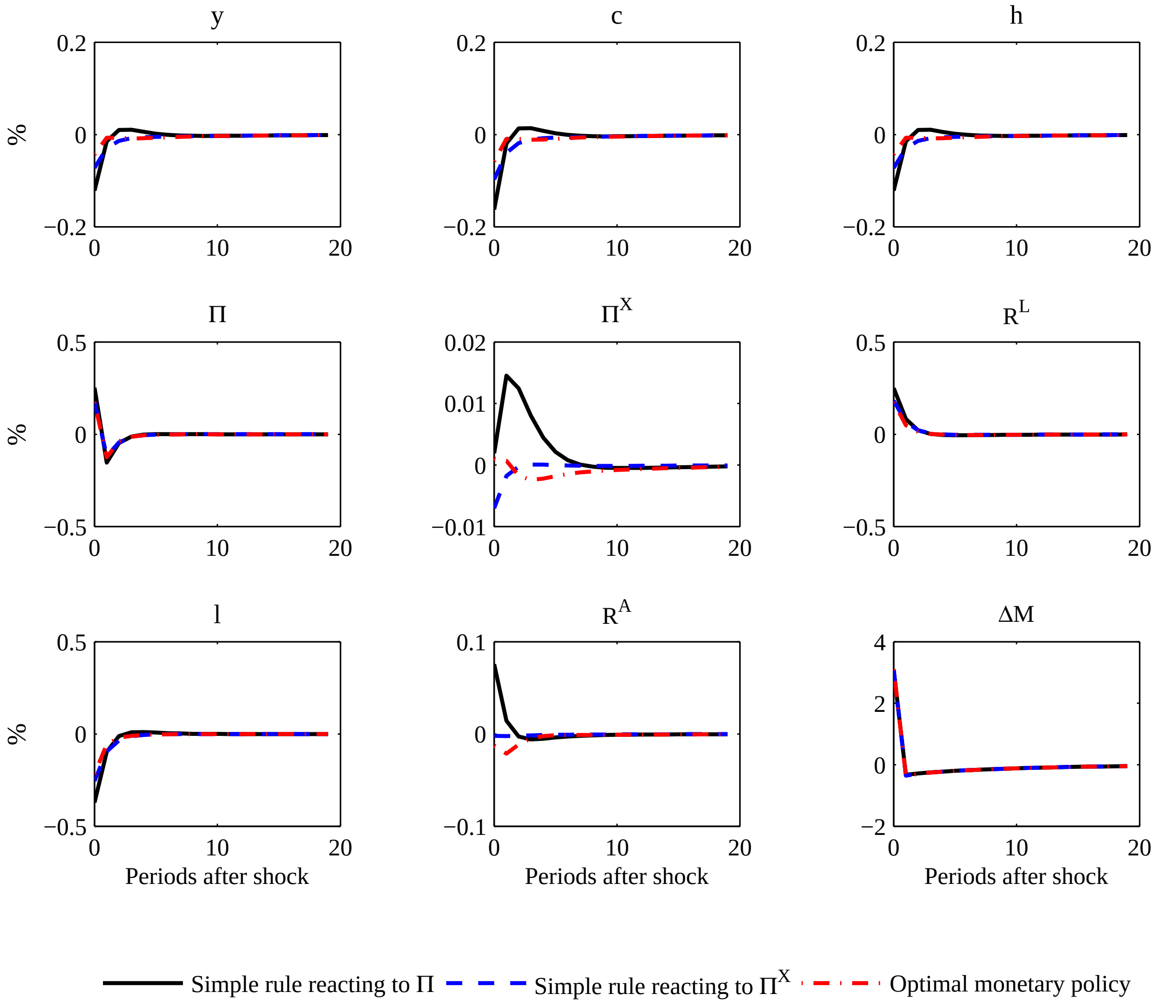
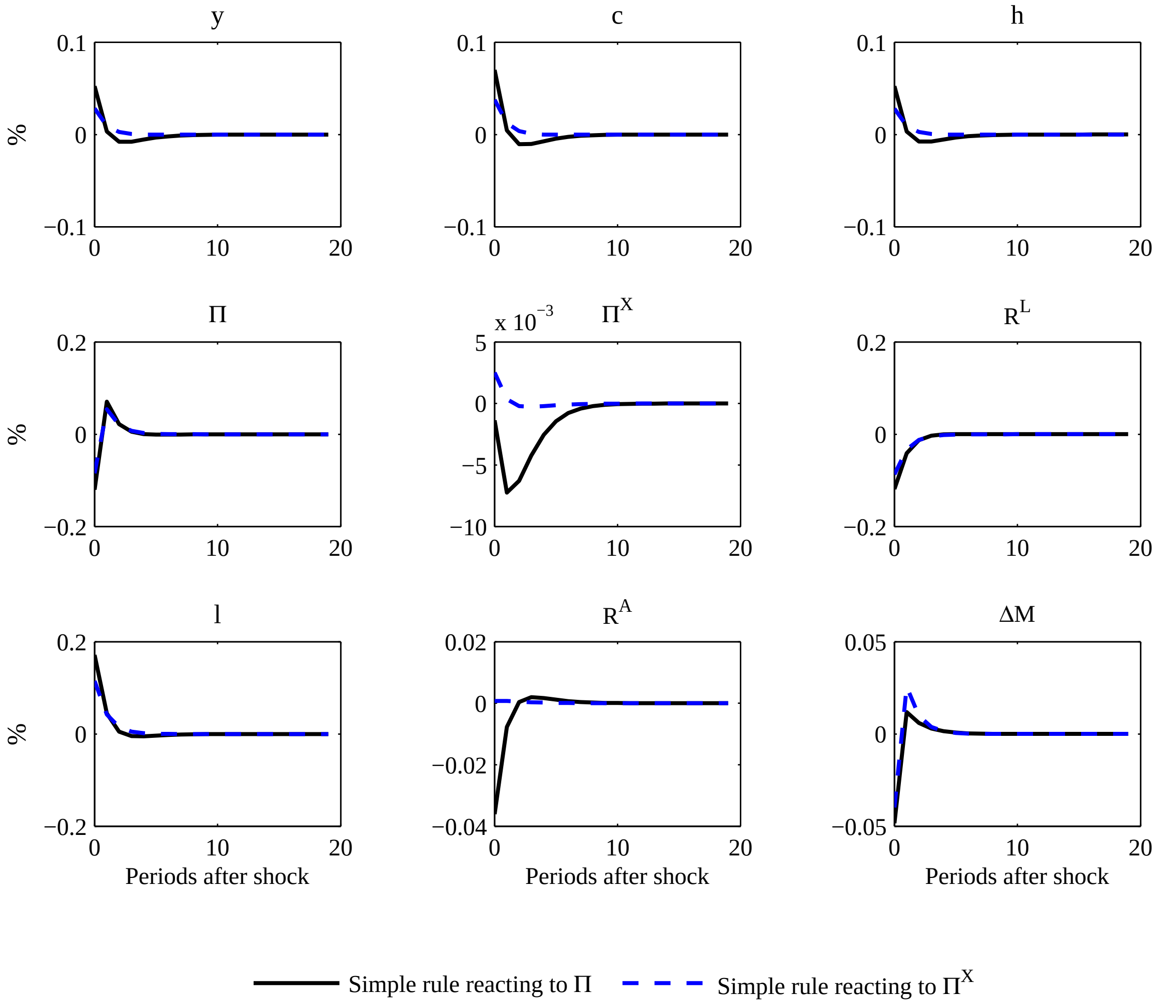


Figure 7: Responses to fiscal transfer to banks
in the presence of equity market frictions



Optimal monetary policy I

- Compared to the simple rule reacting to CPI inflation, optimal monetary policy
  - tolerates roughly as much variability in CPI inflation;
  - tolerates much less variability in IGPI inflation;
  - moves the interest rate very little in response to liquidity shocks (increases in the demand for reserves or costs of securitization). This finding is reminiscent of Poole's (1970) results in the context of the IS-LM model.

Optimal monetary policy II

- The first two results suggest that financial shocks and equity market frictions do not alter NK models' strong policy implication identifying price stability as the overriding objective of good monetary policy.
- What matters here is stabilization of IGPI inflation, because welfare losses in NK models arise from price dispersion across differentiated goods, which here are intermediate goods.
- CPI inflation is equal to IGPI inflation adjusted for the change in the lending rate; so when the central bank stabilizes CPI inflation, financial shocks cause fluctuations in the lending rate and, therefore, in IGPI inflation.

Welfare losses I

- We compute the conditional expectation of the household's value function starting in the deterministic steady state and express welfare differences as consumption equivalents following Lucas (2003).
- We obtain the following welfare losses from simple rules compared to optimal monetary policy:
  - 0.03 percent for the rule reacting to IGPI inflation (with $\theta_m = 1.5$);
  - 0.03 percent for the rule reacting to CPI inflation (with $\theta_m = 1.5$);
  - 0.08 percent for the rule reacting to CPI inflation (with $\theta_m = 5$);
  - 0.0001 percent for the rule reacting to IGPI inflation (with $\theta_m = +\infty$).

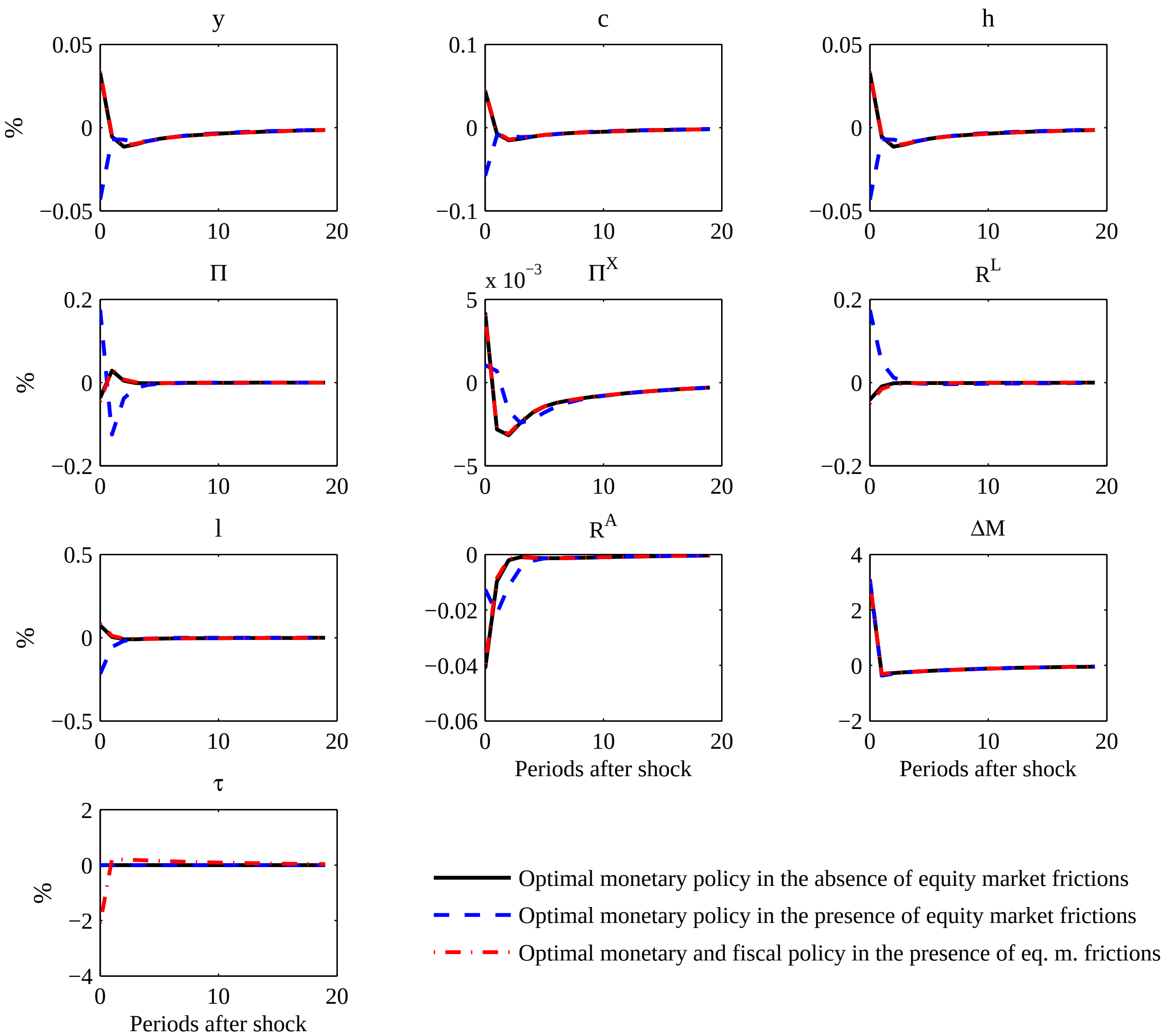
Welfare losses II

- These low values are consistent with Lucas' (2003) point that the welfare costs of macroeconomic volatility may be no more than 0.1 percent altogether.
- We find nonetheless that other monetary policies may lead to welfare losses that are one order of magnitude larger than Lucas' estimates:
  - 1.26 percent for a constant money growth rate policy;
  - 0.58 percent for a standard Taylor rule (where the output gap is output relative to its steady-state value).

Optimal fiscal and monetary policy

- Our model takes into account the benefits of fiscal intervention (in terms of loosening banks' balance-sheet constraint) but abstracts from its costs arising from tax distortions.
- The policy response to a securitization shock is purely fiscal, and this fiscal response exactly offsets the effects of the shock. This is because a fiscal transfer from households to banks can save households the resource cost of the securitization shock by reversing the tightening of banks' balance sheet.
- In response to shocks to the demand for reserves, the fiscal instrument is essentially used to offset the friction in the equity market, and optimal monetary policy opts for essentially the same solution that it would choose in the absence of this friction.

Figure 10: Responses to shock to demand for reserves



Summary

- The normative punch line of simple NK models driven by efficient shocks applies to our model: a simple rule that stabilizes the "right" measure of inflation is optimal, or very close to optimal.
- In our simple model, in response to liquidity shocks (increases in the demand for reserves or costs of securitization):
  - optimal monetary policy moves the interest rate very little and allows a sharp increase in money growth. Welfare losses from a hypothetical policy restricting money growth would be large;
  - optimal fiscal policy makes a transfer to banks that offsets the tightening of their balance sheet.

Directions for future research

- Better structural understanding of the dividend-smoothing motive.
- Incorporating a binding capital-adequacy constraint and taking note of how securitization affects it.
- Extending the model to a setting with asymmetric information and credit rationing.

Shortcomings of our financial shocks

- Default is simply an exogenous shock that hits some borrowers, making them unable to pay back their loans (as in Cúrdia and Woodford, 2009a, b, c).
- We abstract from default decisions and asymmetric information about default risk: there is no credit rationing and banks do not need to impose a collateral constraint on borrowers.
- The three financial "shocks" in our model are inspired by observations that presumably have a common cause in reality:
    - asymmetric information about default risk is presumably what has hampered securitization;
    - counterparty risk in the interbank market is presumably the reason banks are reluctant to lend their excess reserves to each other (Taylor and Williams, 2008), and this in turn leads to a precautionary demand for reserves by all banks.

Timing I

- Each period is divided into two subperiods: a financial exchange followed by a goods exchange.
- In the financial exchange, after the realization of current shocks,
  - retailers borrow from banks to buy the intermediate goods and assemble the final good to be sold to consumers, the government, and banks;
  - households pay taxes and choose their asset portfolios, acquiring the money and deposits that they plan to use in the subsequent goods exchange;
  - and firms producing intermediate goods pay wages and dividends with the proceeds of their sales to retailers.

Timing II

- In the goods exchange,
  - households use money and deposits to buy goods from the retailers that have not been hit by a default shock (those who have been hit by the shock end up not producing anything);
  - retailers must wait until the following financial exchange to use the cash and liquidate the deposits that they acquire; so, they are indifferent between these means of payment and set the same price for cash and deposit goods.

Banks III

- In a symmetric equilibrium, the first-order conditions are:

$$\lambda_t - \lambda_t^z \left[1 + \Phi_z \left(z_t - z^*\right)\right] = 0,$$

$$\lambda_t^z \left[1 - \Phi_a \left(a_t - a_t^*\right)\right] - \beta \left(1 + R_t^A\right) E_t \left\{ \frac{\lambda_{t+1}^z}{\Pi_{t+1}} \right\} = 0,$$

$$\left(\frac{1 + R_t^L}{1 + R_t^A}\right) \left[1 - \Phi_a \left(a_t - a_t^*\right)\right] \left(1 - \delta_t\right) = \frac{\sigma_l}{\sigma_l - 1},$$

$$\frac{1 - \Phi_a \left(a_t - a_t^*\right)}{1 + R_t^A} = 1 - \frac{\lambda_t^d}{\lambda_t^z},$$

$$\left(\frac{1 + R_t^D}{1 + R_t^A}\right) \left[1 - \Phi_a \left(a_t - a_t^*\right)\right] = \frac{\sigma_d}{\sigma_d + 1} \left(1 - z_t^d \frac{\lambda_t^d}{\lambda_t^z}\right).$$

- In the absence of dividend adjustment cost ($\Phi_z = 0$), the marginal cost of securitization is zero ($\Phi_a \left(a_t - a_t^*\right) = 0$).

Shock processes

Name	Not.	Equation	Proc.
productivity shock	z_t^p	$x_t(j) = h_t(j)\exp\left(z_t^p\right)$	AR(1)
gov.-expenditures shock	$\log\left(g_t\right)$	several equations	AR(1)
securitization shock	z_t^s	$a_t^* = a_{ss}\exp\left(-z_t^s\right)$	AR(1)
shock to demand for res.	z_t^d	$m_t^B = d_t \exp(z_t^d)$	AR(1)
default shock	$\log\left(\delta_t\right)$	several equations	AR(1)
fiscal policy shock	ε_t^τ	$\tau_t = \tau_{ss}\exp\left(-\varepsilon_t^\tau\right)$	i.i.d.
monetary policy shock	ε_t^m	$1 + R_t^A = \ldots \exp\left(\varepsilon_t^m\right)$	i.i.d.

where the last two shocks are considered only in positive analysis.

Parametrization I

$\pi_{ss} = 0.9996$	steady-state gross inflation rate per quarter
$\delta_{ss} = 0.0086$	s.-s. default rate per quarter (arbitrary)
$z^d_{ss} = 0.076$	s.-s. reserve ratio
$\beta = 0.99$	discount factor
$\Phi = 0.43$	share of cash goods in consumption
$\sigma = 7$	elasticity in the goods aggregator
$\sigma_d = 230$	elasticity in the deposits aggregator
$\sigma_l = 420$	elasticity in the loans aggregator
$\rho = 0.8$	degree of inertia in interest-rate rule
$\theta_m = 1.5$	coefficient on inflation in interest-rate rule
$\chi = 1$	inverse of Frisch elasticity of labor supply

Parametrization II

$\rho_p = 0.9$	inertia in productivity shocks
$\rho_g = 0.9$	inertia in government purchases
$\rho_s = 0.9$	inertia in shock to cost of issuing securities
$\rho_d = 0.9$	inertia in shock to deposit liquidity management
$\rho_\delta = 0.9$	inertia in shock to default rate
$\alpha = 0.75$	probability Calvo fairy does not visit price setter
$\frac{g_{ss}}{(1-\delta_{ss})y_{ss}} = 0.25$	s.-s. share of government purchases in output
$\frac{a_{ss}}{l_{ss}} = 0.19$	s.-s. ratio of bank securities to loans
$\tau_{ss} = 0$	s.-s. lump-sum tax on banks
$\Phi_a = 0$ or 0.25	adjustment-cost parameter for securities
$\Phi_z = 0$ or 0.25	adjustment-cost parameter for dividends

Better simple rules I

- These results suggest that simple rules stabilizing IGPI inflation should get close to optimal monetary policy.
- One such rule is the rule that adjusts the policy rate in response to IGPI inflation:

$$\left(1+R_t^A\right)=\left(1+R_{t-1}^A\right)^{\rho}\left[\left(1+R_{ss}^A\right)\left(\frac{\Pi_t^X}{\Pi_{ss}}\right)^{\theta_m}\right]^{1-\rho}.$$

- We check that, indeed, it stabilizes more IGPI inflation and gets closer to optimal monetary policy.

Better simple rules II

- But in reality central banks do not have an operational measure of inflation that (like our model's IGPI inflation) is purged of the effects of financial shocks.
- To address this issue, we assume that our central bank can only react to CPI inflation and observable interest-rate spreads and consider the following simple rule:

$$r_t^A = r_{t-1}^A + (\pi_t - \pi_{ss}) - (r_t^L - r_t^A) + (r_{t-1}^L - r_{t-1}^A).$$

- This is a first difference rule responding to CPI inflation, but each period the target for the policy rate is adjusted by the spread between the bank lending rate and the policy rate, and a correction is made to purge last period's spread-adjustment from r_{t-1}^A.

Better simple rules III

- This rule stabilizes π^X perfectly in our model.
- To see this, note that the terms in r_t^A and r_{t-1}^A cancel each other out in this rule, so that this rule can be alternatively interpreted as a "pure targeting rule" (Woodford, 2003, chap. 8):

$$(\pi_t - \pi_{ss}) - r_t^L + r_{t-1}^L = 0.$$

  Since the mark-up of the final good price over the intermediate good price is the lending rate, this implies $\pi_t^X = \pi_{ss}^X$.
- We obtain that this rule gets extremely close to optimal monetary policy.

Figure 8: Responses to default shock
in the absence of equity market frictions

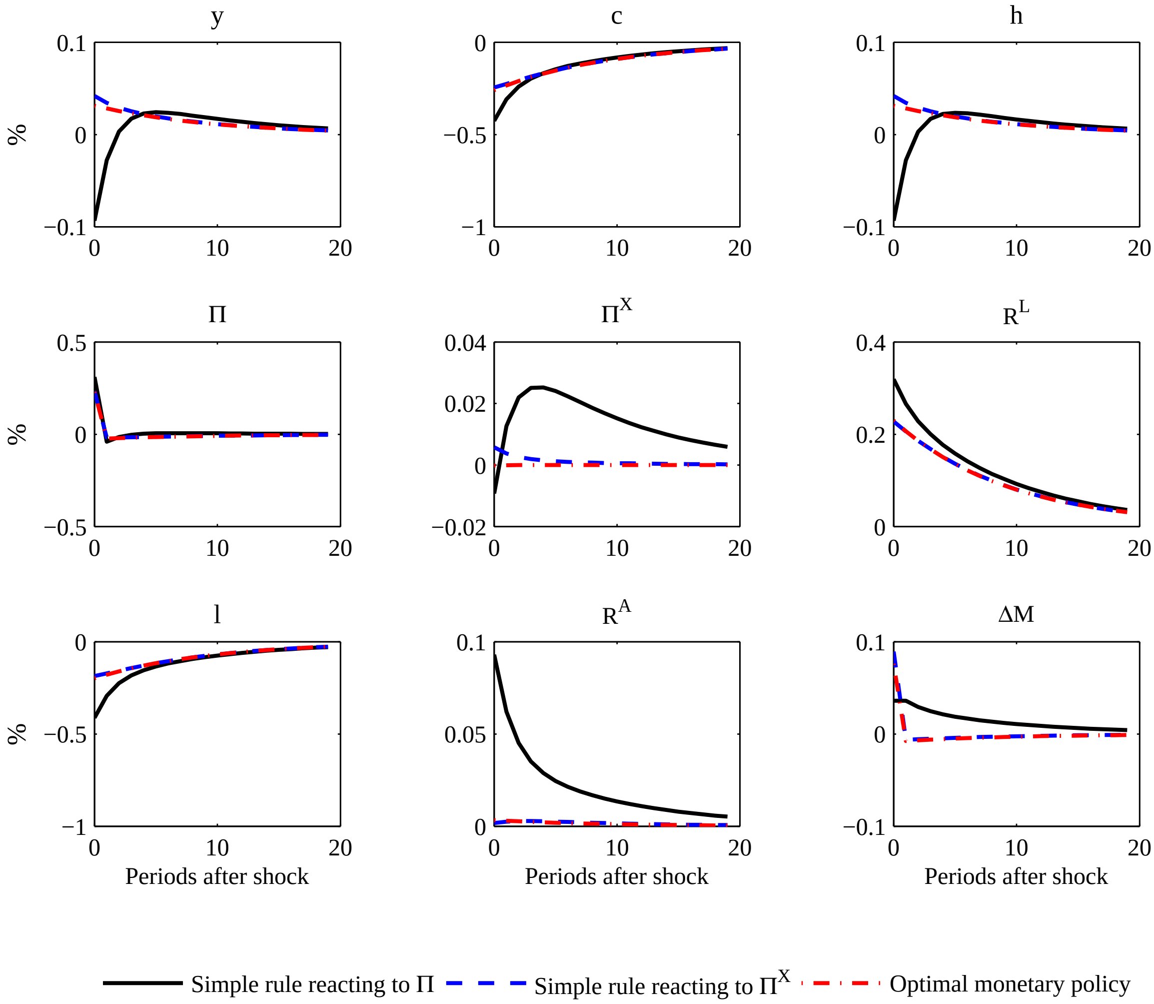


Figure 9: Responses to shock to demand for reserves
in the absence of equity market frictions