Optimal Monetary Policy with Large Shocks

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Optimal monetary policy with large shocks

- Recent inflation surge reminded us large shocks matter
  - Prices rise swiftly in response to higher marginal costs but do not drop as fast when marginal costs fall
- Harding, Lindé and Trabandt (2022, 2023) propose a model consistent with firms' asymmetric price setting behavior
  - Nonlinear Phillips curve and state-dependent shock propagation when far from the steady state
- Poses important policy question
  - How do optimal monetary policy prescriptions change over the business cycle in the face of large adverse supply shocks with price setting asymmetries and a nonlinear Phillips curve?

What we do

- Study optimal monetary policy in a simple New Keynesian model with strategic complementarities in price setting
- Use nonlinear model to study large adverse supply shocks
  - Characterize Ramsey optimal policy in nonlinear model/LQ setup
  - Role of strategic complementarities
  - Small vs large shocks
  - Commitment vs discretion
  - Simple loss function vs Ramsey optimal policy

Preview of results

- Optimal monetary responds gradually and persistently with strategic complementarities
- Optimal policy in nonlinear model is markedly more aggressive to curb inflatinary pressures induced by large shocks
- Tylor rule is severely suboptimal
- Workhorse Linear-quadratic (LQ) setup misses important nonlinear effects with state-dependent price setting
- Commitment plays a crucial role to aggressively curb inflation surges
- Similar results apply when central bank minimizes a simple loss function

Final goods producers

- Final good produced by a representative, perfectly competitive firm using intermediate goods i with general technology (Kimball, 1995)

$$\int_0^1 G\left(\frac{Y_t(i)}{Y_t}\right)\ di = 1 \tag{1}$$

- Following Dotsey and King (2005); Levin, López-Salido, Yun (2007)

$$G(y) = \frac{\epsilon}{\epsilon - 1}\frac{1}{1+\eta}\left[(1+\eta)y - \eta\right]^{\frac{\epsilon-1}{\epsilon}} - \left[\frac{\epsilon}{\epsilon - 1}\frac{1}{1+\eta} - 1\right] \tag{2}$$

- When $\eta = 0$, CES aggregator (no strategic complementarities)

Intermediate goods producers

- Differentiated goods produced by a continuum of monopolistically competitive firms i using technology

$$Y_t(i) = A_t N_t(i) \tag{3}$$

- Profit maximization of firm i:

$$\max_{P_{t,i}{}^*} E_t \sum_{j=0}^{\infty} (\beta\theta)^j \varsigma_{t+j} \Omega_{t+j} \left[\left(1+\tau_{p,t+j}\right) P^*_{t,i} - MC_{t+j} \right] Y_{t+j,i}$$

subject to demand constraint.

- Marginal cost given by

$$MC_t = \phi_t \frac{W_t}{A_t}$$

where ϕ_t is a cost-push shock

Monetary policy: optimal policy vs. Taylor rule

- Optimal policy: the central bank maximizes social welfare,

$$E_0 \sum_{t=0}^{\infty} \beta^t \varsigma_t U(C_t, N_t)$$

  subject to the set of nonlinear equilibrium equations and the ZLB constraint for the nominal interest rate.
- We consider optimal monetary policy under commitment from a timeless perspective
- Taylor rule (subject to the ZLB):

$$i_t/i = \max \left[1/i, \left\{ \frac{\widetilde{rr}_t}{\widetilde{rr}} \right\}^{r_{\widetilde{rr}}} \left\{ \frac{\Pi_t}{\bar{\Pi}} \right\}^{r_\pi} \left\{ \frac{Y_t}{Y} / \frac{\tilde{Y}_t}{\tilde{Y}} \right\}^{r_x} \right]$$

  where $\widetilde{rr}_t$ and $\tilde{Y}_t$ denote flexible price real interest rate and output

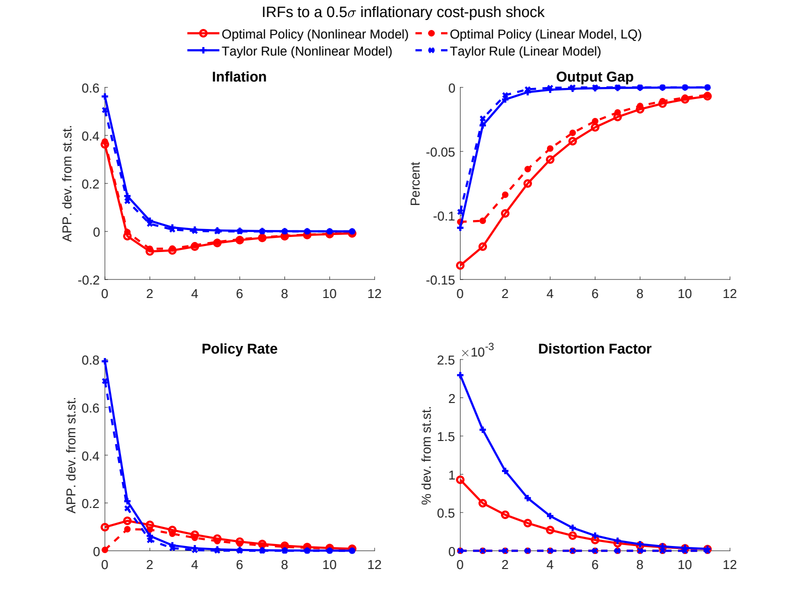
Model solution and simulation

- Characterize planner's problem following Levin and López-Salido (2004) and Levin, Onatski, Williams and Williams (2005)
- Solve model with extended path method in Dynare (Fair–Taylor)
- Stochastic simulation under certainty equivalence (sequence of MIT shocks)
- Parameterization follows HLT plus standard values in literature

Table 1: Model parameter values

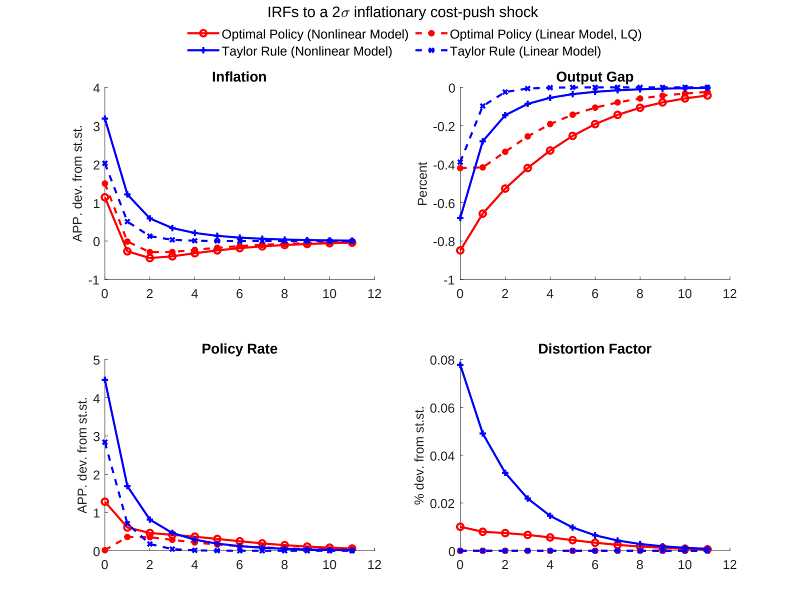
Parameters		
β	0.995	Discount factor
σ	2	Inverse EIS
χ	2.5	Inverse Frisch elasticity
θ	0.66	Calvo price rigidity
$\tilde{\epsilon}$	11	Substitution elasticity
η	-8	Kimball
r_π	1.5	Taylor rule: inflation
r_x	0.125	Taylor rule: output gap
$r_{\widetilde{rr}}$	1	Taylor rule: real potential rate
ι	0	Cost-push does not affect $\widehat{\tilde{Y}}_t$

IRFs to a small (0.5σ) adverse cost-push shock

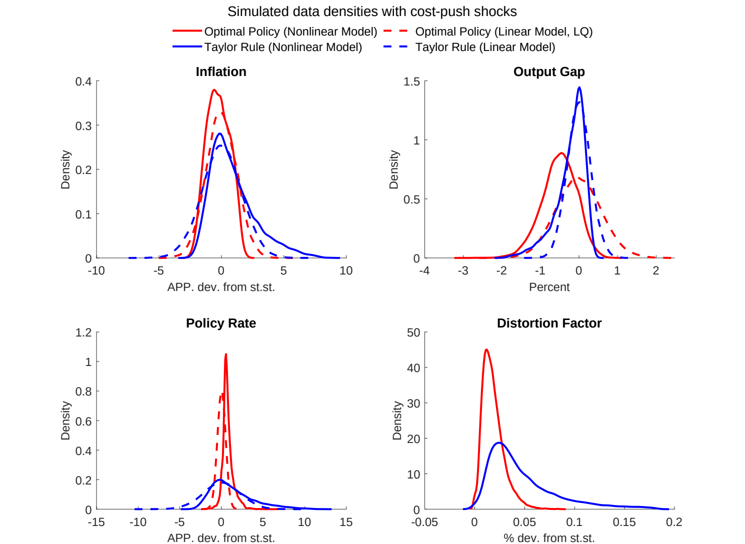


▸ CES demand

IRFs to a large (2σ) adverse cost-push shock



Implications of optimal policy in nonlinear model and LQ setup



Model simulations of 15,000 observations for cost-push shocks

ZLB imposed
CES demand

Table 2: Simulated data moments

	Optimal policy					
	Nonlinear model			Linear (LQ) model		
	mean	std	skewness	mean	std	skewness
Inflation	-0.2	0.9	0	0	1.2	0
Output	-0.5	0.5	-0.3	0	0.6	0
Policy rate	0.8	0.6	1.1	0	0.5	0
Distortion	0	0	1.2	0	0	–
	Taylor rule					
	Nonlinear model			Linear model		
	mean	std	skewness	mean	std	skewness
Inflation	0.9	1.8	1.1	0	1.6	0
Output	-0.2	0.4	-1.3	0	0.3	0
Policy rate	1.3	2.6	1.0	0	2.2	0
Distortion	0	0	1.5	0	0	–

Model simulations of 15,000 observations for cost-push shocks

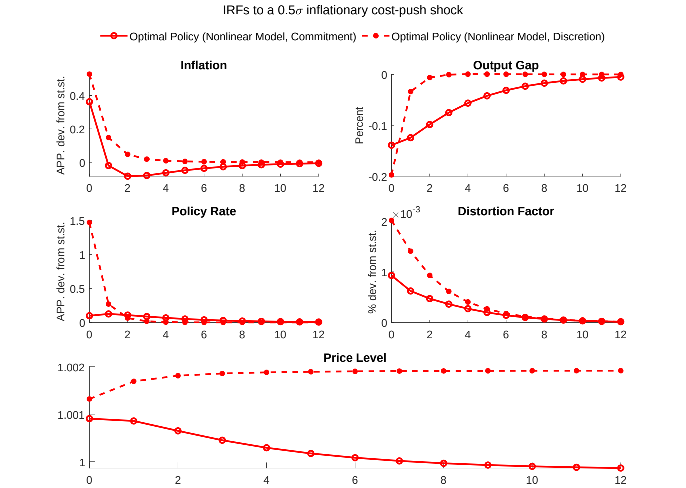
▸ ZLB imposed ▸ CES demand

Implications of optimal commitment policy with large shocks

- Optimal policy eliminates inflation skewness and brings it tightly centered around the target
- Average inflation becomes slightly negative as the central bank leans against big inflation surges
- Policy stance is tighter with a large cost in terms of output
- Discretion: what if policymaker cannot commit to optimal plan?
  $\rightarrow$ Under discretion we assume the policy maker does not take the future behavior of agents into account
- What if central bank follows a simple loss function?

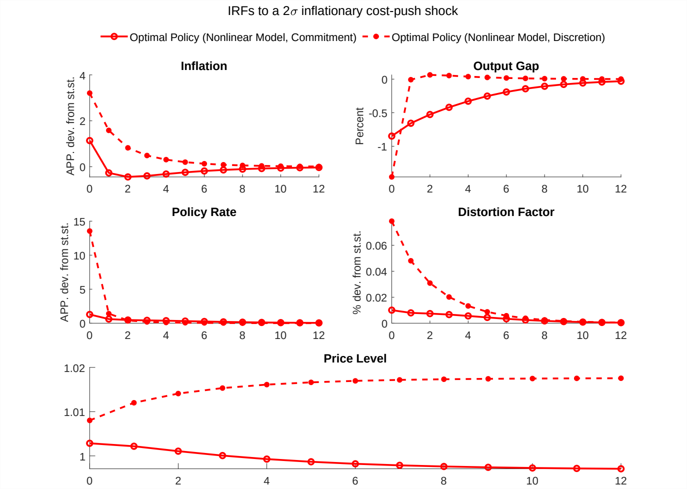
IRFs to small cost-push shock: commitment vs discretion

- Under discretion: persistent tight optimal policy prescription replaced with transitory (stronger) tightening $\rightarrow$ inflationary bias



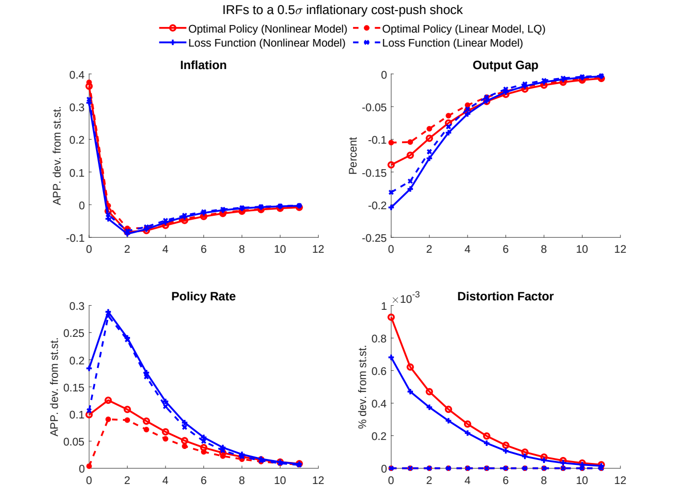
IRFs to large cost-push shock: commitment vs discretion

- Under discretion: persistent tight optimal policy prescription replaced with transitory (stronger) tightening → inflationary bias



IRFs to small cost-push shock: simple loss function

- Alternative to Ramsey optimal policy: minimize $L = \frac{1}{2}\left(\hat{\pi}_t^2 + \lambda_y \hat{x}_t^2\right)$



IRFs to large cost-push shock: simple loss function

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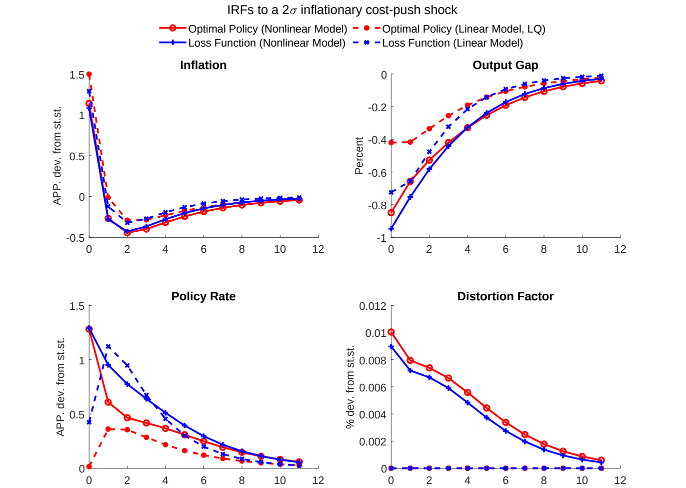
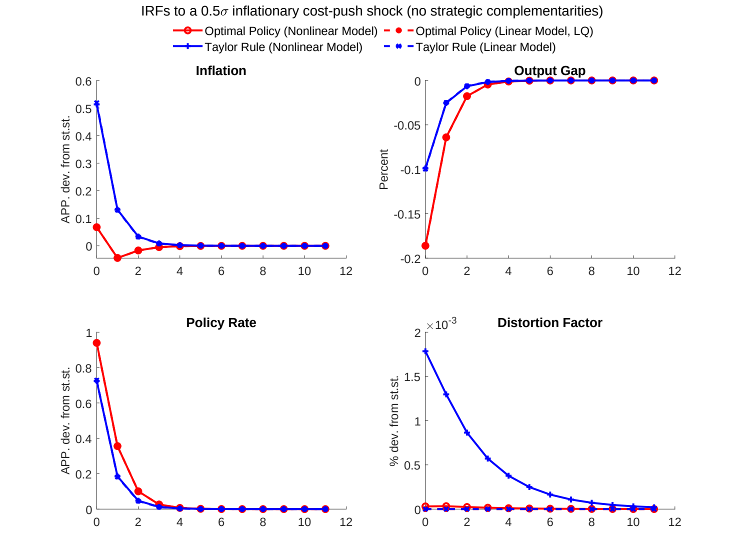


Concluding remarks

- Strategic complementarities in price setting crucially affect optimal monetary policy response to adverse cost-push shocks
- Optimal policy in nonlinear model responds much more aggressively to larger inflationary shocks to contain stronger inflation response
  - LQ approach misses important role of state-dependent inflation dynamics
  - Commitment plays key role for optimal policy. Under discretion most of the persistent optimal policy response disappears
- Ongoing work
  - Role of uncertainty for optimal monetary policy design
  - Design of simple rules that come closer to the optimal policy

APPENDIX

IRFs to a 0.5σ cost-push shock, no strategic complementarities



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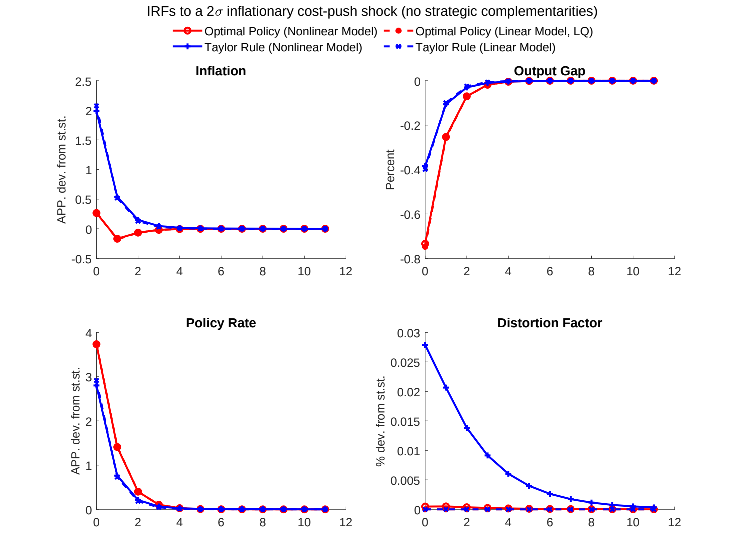
IRFs to a 2σ cost-push shock, no strategic complementarities



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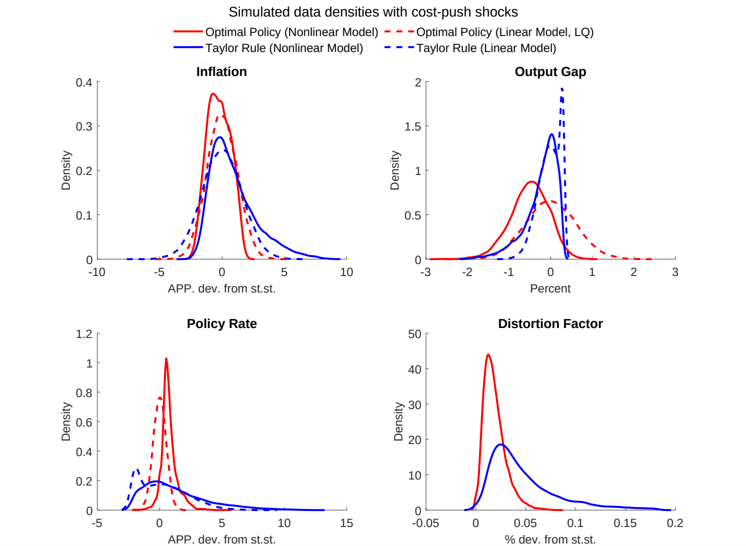
Optimal policy – ZLB imposed



Model simulations of 15,000 observations for cost-push shocks

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Table A1: Simulated data moments

Optimal policy						
	Nonlinear model			Linear (LQ) model		
	mean	std	skewness	mean	std	skewness
Inflation	-0.3	0.9	0.1	0	1.2	0
Output	-0.5	0.5	-0.3	0	0.6	0
Policy rate	0.8	0.6	1.1	0	0.5	0
Distortion	0	0	1.2	0	0	–
Taylor rule						
	Nonlinear model			Linear model		
	mean	std	skewness	mean	std	skewness
Inflation	0.9	1.8	1.1	0	1.6	0
Output	-0.2	0.4	-1.3	0	0.3	-0.6
Policy rate	1.3	2.6	1.1	0.2	1.9	0.7
Distortion	0	0	1.4	0	0	–

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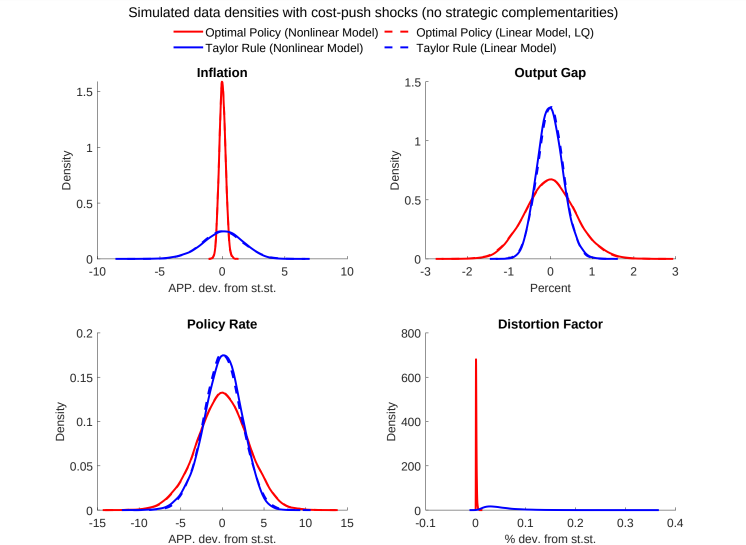
Optimal policy with CES demand



Model simulations of 15,000 observations for cost-push shocks

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Table A2: Simulated data moments (CES)

	Optimal policy					
	Nonlinear model			Linear (LQ) model		
	mean	std	skewness	mean	std	skewness
Inflation	0	0.4	1.2	0	0.4	1.2
Output	0	0.5	-0.3	0	0.6	-0.4
Policy rate	0.3	2.4	0.9	0.3	2.4	0.9
Distortion	0	0	4.6	0	0	–
	Taylor rule					
	Nonlinear model			Linear model		
	mean	std	skewness	mean	std	skewness
Inflation	-0.1	1.9	-0.8	-0.1	1.8	-0.5
Output	0	0.3	-0.5	0	0.3	-0.6
Policy rate	0.3	1.9	0.5	0.3	1.9	0.7
Distortion	0.1	0.1	2.6	0	0	–

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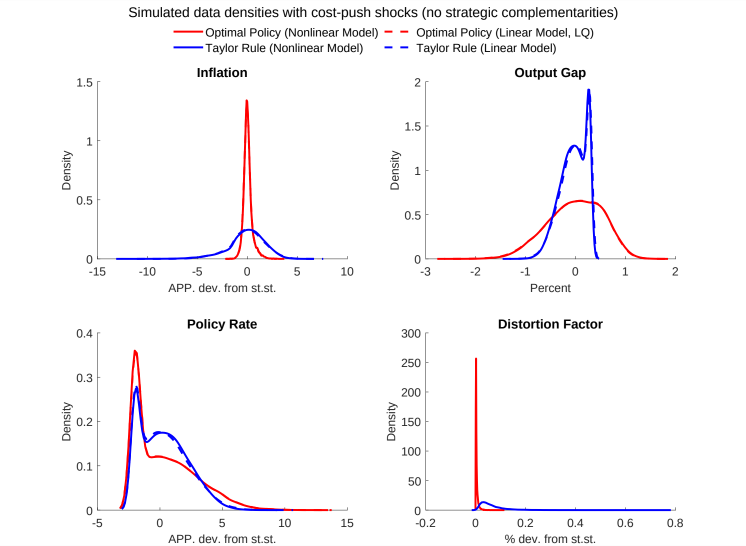
Optimal policy with CES demand – ZLB imposed



Model simulations of 15,000 observations for cost-push shocks

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Small shocks

- Simulations under same (small) shocks for $T = 15000$ periods

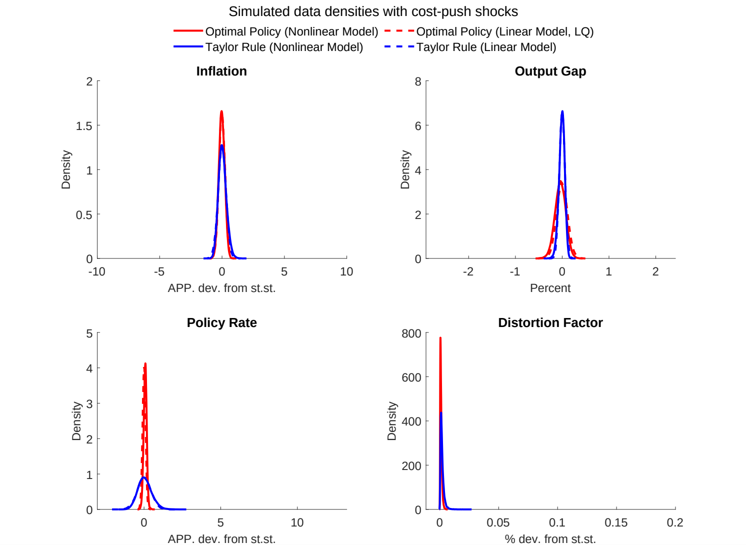

Table A3: Simulated data moments (small shocks)

Optimal policy						
	Nonlinear model			Linear (LQ) model		
	mean	std	skewness	mean	std	skewness
Inflation	0	0.2	0	0	0.2	0
Output	0	0.1	-0.1	0	0.1	0
Policy rate	0.1	0.1	0	0	0.1	0
Distortion	0	0	1.7	0	0	–
Taylor rule						
	Nonlinear model			Linear model		
	mean	std	skewness	mean	std	skewness
Inflation	0	0.3	0.4	0	0.3	0
Output	0	0.1	-0.4	0	0.1	0
Policy rate	0.1	0.5	0.4	0	0.4	0
Distortion	0	0	2.9	0	0	–

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Small shocks – no strategic complementarities

- Simulations under same (small) shocks for $T = 15000$ periods

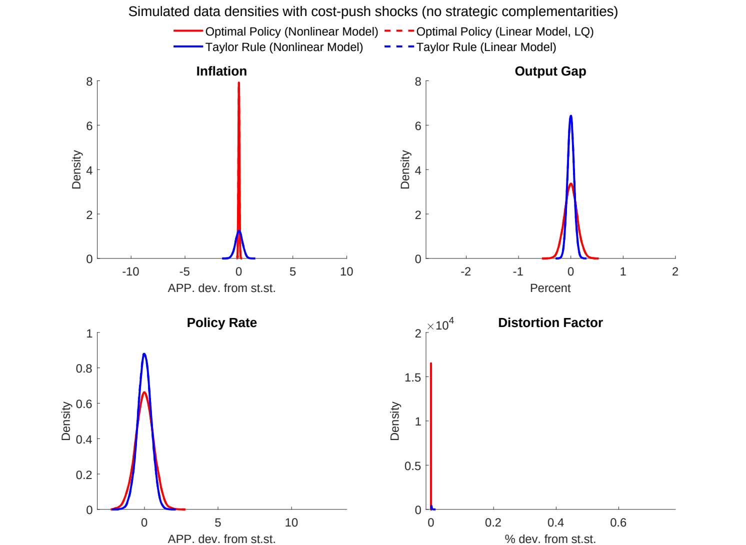

Table A4: Simulated data moments (CES, small shocks)

Optimal policy						
	Nonlinear model			Linear (LQ) model		
	mean	std	skewness	mean	std	skewness
Inflation	0	0.1	0.1	0	0.1	0.1
Output	0	0.1	0.1	0	0.1	0
Policy rate	0	0.6	0	0	0.6	0
Distortion	0	0	2.2	0	0	–
Taylor rule						
	Nonlinear model			Linear model		
	mean	std	skewness	mean	std	skewness
Inflation	0	0.3	-0.1	0	0.3	0
Output	0	0.1	0.1	0	0.1	0
Policy rate	0	0.5	-0.1	0	0.5	0
Distortion	0	0	1.9	0	0	–

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Table A5: Simulated data moments (No ZLB, CES)

	Optimal policy					
	Nonlinear model			Linear (LQ) model		
	mean	std	skewness	mean	std	skewness
Inflation	0	0.3	0.1	0	0.3	0
Output	0	0.6	0.1	0	0.6	0
Policy rate	0	3.1	-0.1	0	3.0	0
Distortion	0	0	2.1	0	0	–
	Taylor rule					
	Nonlinear model			Linear model		
	mean	std	skewness	mean	std	skewness
Inflation	0	1.6	-0.2	0	1.6	0
Output	0	0.3	0.2	0	0.3	0
Policy rate	0	2.3	-0.2	0	2.3	0
Distortion	0.1	0	1.9	0	0	–

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