Monetary Policy Inertia or Persistent Shocks ?

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Introduction (I)

- Over the recent years, a renewed interest in modelling monetary policymaking in terms of simple rules.
- Taylor rule is now considered as a useful description of central bank behavior.
- As recognized by Taylor (1993), this single equation cannot encompass all specificities of monetary policy.
- However, this rule describes quite well the interest rate (Fed Fund) sequence.

Introduction (II)

- Many factors can influence monetary policy (financial crises, real time data, omitted variables,...).
- Taylor rule must be considered as a simple equation in order to simply understand the central bank behavior, not as an automatic formula that the central bank must follow.
- Empirical regularities : persistent deviation from the target.
- Explanation : Interest rate inertia or persistent shocks to the rule ?

Introduction (III)

AIM OF THIS PAPER : to quantitatively investigate the relative importance of the partial adjustment *versus* other mechanisms that can make the illusion of policy inertia.

- **Monetary Policy**

$$\widehat{\imath}_t^* = a_\pi \widehat{\pi}_t + a_y \widehat{y}_t,$$

$$\widehat{\imath}_t = \rho_1 \widehat{\imath}_{t-1} + (1 - \rho_1)\, \widehat{\imath}_t^* + e_t,$$

$$e_t = \rho_2 e_{t-1} + \nu_t, \quad \nu_t \sim \text{iid}(0, \sigma_\nu^2).$$

Introduction (IV)

- $\widehat{i}_t^*$ similar to Taylor (1993)
- Two very different views.
- $\rho_1 > 0$ and $\rho_2 = 0$: monetary policy inertia (Clarida, Gali and Gertler, 2000) $\Longrightarrow$ Structural Persistence.
- $\rho_1 = 0$ and $\rho_2 > 0$: persistent shocks (Rudebush (2002, 2005) $\Longrightarrow$ Exogenous Persistence.

Introduction (V)

- **Empirical Issue.**
- Data are silent about the correct specification of the monetary policy.
- No clear cut evidence in favor of these two representation of the monetary policy : Rudebusch (2002), English et al. (2002), Castelnuovo (2003), Gerlach–Kristen (2004) and Apel and Jansson (2005)

Introduction (VI)

- **Econometric Issue**
- Well known econometric problem of identification when partial adjustment is combined with serially correlated shocks : Griliches, 1967, Blinder, 1986, McManus et al.1994, Maccini and Rossana, 1984, Goldfeld and Sichel, 1990, Sargent (1978), Kennan (1988).
- Taylor rule context with partial adjustment and serially correlated shocks.
- The target is not volatile enough $\Longrightarrow$ identification problem.
- This questions the use of single equation for discriminating between the two representations.

Introduction (VII)

- **Empirical Strategy.**
- We exploit cross–equation restrictions imposed by a DSGE model on aggregate data.
- If the Lucas critique quantitatively matters, any change in the parameters (inertia or persistent shock) will affect aggregate dynamics.
- This sensitivity of aggregate fluctuations to changes in monetary policy is then used in order to discriminate between the two monetary policies.

Introduction (VIII)

- **Econometric Methodology.**
- Minimum Distance Estimator (MDE), see Rotemberg and Woodford (1997) and Christiano, Eichembaum and Evans (2005).
- First, we estimate a SVAR with short-run restrictions to identify monetary policy shocks.
- Second, the monetary policy rule parameters in the DSGE model are estimated in order to reproduce IRFs from SVAR.
- **An important point :** to control for the effects of alternative policy rules, all the remaining parameters are calibrated prior to estimation (DSGE as an instrument).

Introduction (IX)

- **Empirical Findings (1).**
- When we consider the IRFs for the output gap, inflation, wage inflation, the Fed funds rate, and money growth, our results favor the persistent shock representation of monetary policy.
- When we consider only the responses of the Fed funds rate, there is not enough evidence to discriminate between the two competing views.
- In order to disentangle these two views, we must consider informative features of the data (hump-shaped responses of inflation and wage inflation).

Introduction (X)

- **Plan of the Talk.**
- Monetary DSGE model.
- Econometric approach.
- Empirical findings.
- Concluding Remarks.

The DSGE Model (I)

- New Keynesian model with real (habits in consumption) and nominal frictions (price and wage stickiness), in the lines of Giannoni and Woodford (2005) and Galí and Rabanal (2005).
- A benchmark DSGE model typically in use in the literature (good empirical performances).
- The model hit by monetary policy shocks only.
- Quantitative evaluation using SVAR $\Longrightarrow$ same timing restrictions.

The DSGE Model (II)

- **Production Side**
- Competitive firms produce an homogenous good that can be consumed or used as material goods.
- Monopolistic firms produce intermediary goods.
- Inputs of monopolistic firms : labor and material goods.
- Varying elasticity of demand.
- Calvo pricing.
- Price indexation.

The DSGE Model (III)

- **Aggregate Labor Index and Households**
- Differentiated labor (labor intermediaries) with monopoly power.
- Calvo wage setting + Wage indexation
- Households decision : consumption, real money balances and labor supply.

The DSGE Model (IV)

- **Monetary Policy**
- The model is closed by postulating a monetary policy rule of the form

$$\widehat{\imath}_t^* = a_\pi \widehat{\pi}_t + a_y \widehat{y}_t,$$

$$\widehat{\imath}_t = \rho_1 \widehat{\imath}_{t-1} + (1 - \rho_1)\, \widehat{\imath}_t^* + e_t,$$

$$e_t = \rho_2 e_{t-1} + \nu_t, \quad \nu_t \sim \mathrm{iid}(0, \sigma_\nu^2).$$

Econometric Approach (I)

- **Using the DSGE model as an instrument (1).**
- We use the cross–equation restrictions created by the DSGE model in order to properly identify the monetary policy rule parameters (inertia *versus* persistent shocks).
- Basic Idea : If the Lucas critique quantitatively matters, any change in monetary policy will affect aggregate dynamics.
- Let ψ denote the whole set of model parameters. Let $\psi_2 = (\rho_1, \rho_2, \sigma_\nu)'$ and let ψ_1 denote the vector collecting all the remaining parameters, so that $\psi = (\psi_1', \psi_2')'$. ψ_1 **is fixed during all our experiments.**

Econometric Approach (II)

- **The Monetary SVAR (1).**
- Identification of shock to Monetary Policy.
- We estimate an unconstrained VAR

$$Z_t = B_1 Z_{t-1} + \cdots + B_\ell Z_{t-\ell} + u_t, \;\; \mathsf{E}\{u_t u_t'\} = \Sigma$$

- Let the data vector

$$Z_t = \left(Z_{1,t}', \hat{\imath}_t, Z_{2,t}' \right)' \qquad \dim Z_{1,t} = n_1.$$

- To recover the structural shock ϵ_t, we express $u_t = S\eta_t$.
- Orthogonality of structural shocks + scale normalization

Econometric Approach (III)

- **The Monetary SVAR (2).**
- Identification of the monetary policy shock : Let S to be the Cholesky factorization of Σ.
- σ_i is the (n_1+1, n_1+1) element of S, and ϵ_t is the shock appearing in the (n_1+1)th equation of the system

$$A_0 Z_t = A_1 Z_{t-1} + \cdots + A_\ell Z_{t-\ell} + \eta_t,$$

where $A_0 = S^{-1}$ and $A_i = S^{-1} B_i$, $i = 1, \ldots, \ell$.

- From the previous structural representation, we can compute IRFs to the monetary policy shock.

Econometric Approach (IV)

- **Minimum Distance Estimation (1).**
- We seek to estimate the policy rule parameters ψ_2.
- Let X_t a set of variables of interest (a subset of Z_t).
- Let Γ_{XZ} a selection matrix ($X_t = \Gamma_{XZ} Z_t$), we define θ_k the vector of IRFs to a monetary shock at horizon $k \geq 0$, as implied by the above SVAR estimated on actual data

$$\theta_j \equiv \frac{\partial X_{t+j}}{\partial \epsilon_t} = \Gamma_{XZ} \frac{\partial Z_{t+j}}{\partial \epsilon_t}, \quad j \geq 0,$$

where ϵ_t is the monetary policy shock previously identified.

Econometric Approach (V)

- **Minimum Distance Estimation (2).**
- The object to be matched is $\theta = \text{vec}([\theta_0, \theta_1, \ldots, \theta_k])'$ where k is the selected horizon.
- Let $h(\cdot)$ denote the mapping from $\psi_2 = (\rho_1, \rho_2\, \sigma_\nu)'$ to the DSGE counterpart of θ.
- An estimate $\widehat{\psi}_2$ of ψ_2 is solution to

$$\widehat{\psi}_2 = \arg\min_{\psi_2 \in \Psi} (h(\psi_2) - \widehat{\theta}_T) V_T (h(\psi_2) - \widehat{\theta}_T)',$$

where V_T is a weighting matrix obtained from the estimated SVAR.

Econometric Approach (VI)

- **Minimum Distance Estimation (3).**
- Test of the model

$$\mathcal{J} = (h(\psi_2) - \widehat{\theta}_T)V_T(h(\psi_2) - \widehat{\theta}_T)'$$

Under the null hypothesis, $\mathcal{J} \sim \chi^2(\dim(\theta) - \dim(\psi_2))$.

- Decomposition of $\mathcal{J}$

$$\mathcal{J} = \sum_{i=1}^{\dim(X)} \mathcal{J}_i$$

A simple diagnostic tool in order to locate success and failure of the model.

Econometric Approach (VII)

- **The problem of multiple optima (1).**
- Estimation of the Taylor rule parameters from a single equation.
- No clear–cut conclusion about inertia and serial correlation (Rudebusch (2002), English et al. (2002), Castelnuovo (2003), Gerlach–Kristen (2004) and Apel and Jansson (2005))
- Well known problem in theoretical and applied econometrics (Griliches, 1967, Blinder, 1986, McManus et al. 1994, Sargent 1978, and Kennan 1988).

Econometric Approach (VIII)

- **The problem of multiple optima (2).**
- In the case of the augmented Taylor rule

$$\widehat{\imath}_t = (\rho_1 + \rho_2)\widehat{\imath}_{t-1} - \rho_1\rho_2\widehat{\imath}_{t-2} + (1 - \rho_1)\left(\widehat{\imath}_t^\star - \rho_2\widehat{\imath}_{t-1}^\star\right) + \nu_t$$

- According to the timing of decision in our model,

$$\widehat{\imath}_t^\star = \sum_{k=1}^{\infty} \eta_k(\psi_2)\nu_{t-k}$$

- Suppose that $\eta_k(\psi_2)$ for $(k = 1, ..., \infty)$ are small and not sensitive to any change in ρ_1 and ρ_2.

Econometric Approach (IX)

- **The problem of multiple optima (3).**
- In our framework (IRFs to a monetary policy shock), this means

$$\widehat{\imath}_t^\star \approx 0, \forall t$$

- The policy function rewrites

$$\widehat{\imath}_t \approx (\rho_1 + \rho_2)\widehat{\imath}_{t-1} - \rho_1\rho_2\widehat{\imath}_{t-2} + \nu_t.$$

- **The parameters ρ_1 and ρ_2 are not identified.**

Econometric Approach (X)

- **The problem of multiple optima (4).**
- Consider the reduced form

$$\widehat{\imath}_t = \beta_1 \widehat{\imath}_{t-1} + \beta_2 \widehat{\imath}_{t-2} + \nu_t$$

- ρ_1 and ρ_2 are only identified when $\rho_1 = \rho_2$. Inconclusive case.
- Provided that $\beta_2 \neq 0$, the solutions for (ρ_1, ρ_2) are given by

$$\rho_2 = \frac{\beta_1 \pm \sqrt{\beta_1^2 + 4\beta_2}}{2} \qquad \rho_1 = \beta_1 - \rho_2$$

  where $\beta_1^2 + 4\beta_2 = (\rho_1 - \rho_2)^2 \geq 0$.
- Two sets of values for ρ_1 and ρ_2 are observationally equivalent.

Econometric Approach (XI)

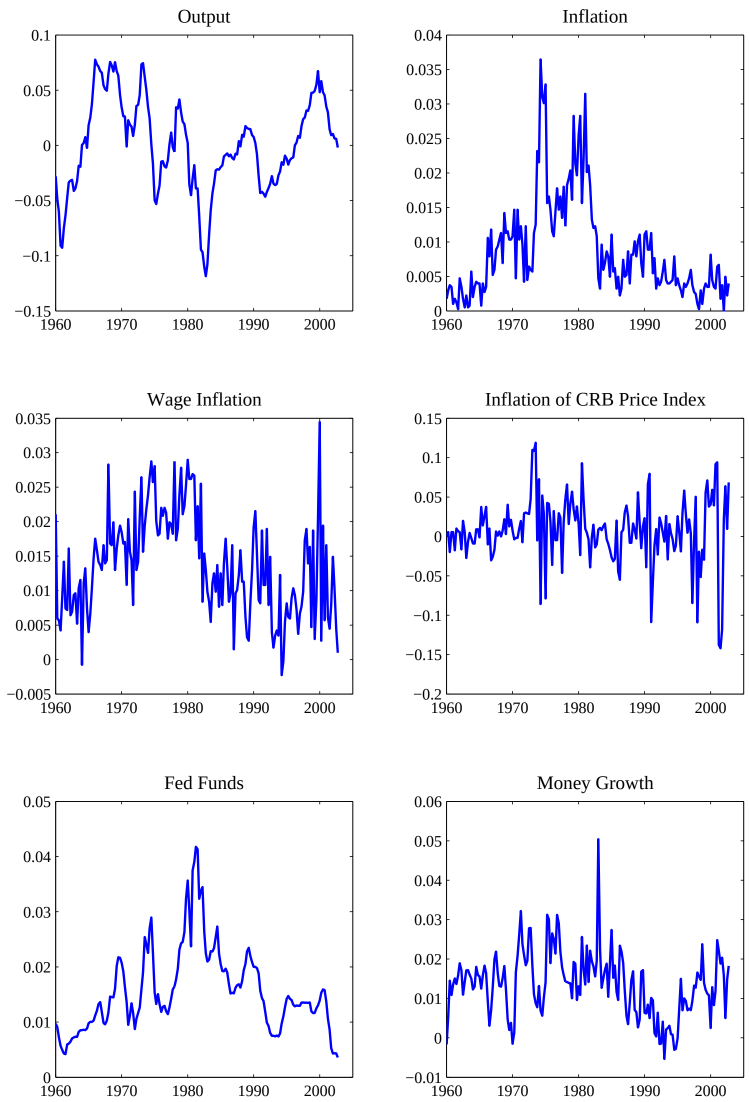
- **The problem of multiple optima (5).**
- We cannot distinguish between an inertial monetary policy with transitory shocks and a monetary policy with small partial adjustment and highly serially correlated shocks.
- When $\widehat{\imath}_t^\star$ is more volatile, this problem of multiple optima can potentially disappear.
- Another way to escape this problem is to consider additional variables in our MDE estimation.

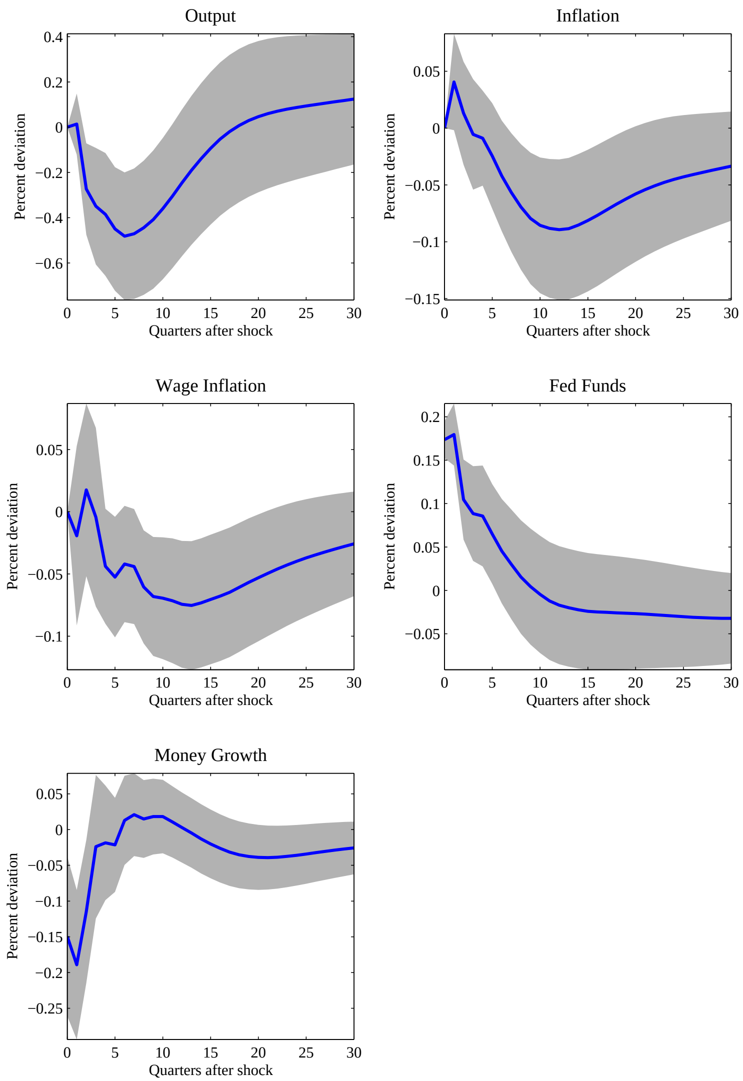
Empirical Results (I)

- Data and SVAR
- Parameter Calibration
- Estimation results
- Robustness (timing and sensitivity to calibration)

Empirical Results (II)

- **Data and SVAR**
- Data from the Non Farm Business (NFB) sector over the sample period 1960(1)-2002(4).
- Linearly detrended logarithm of per capita GDP, the growth rate of GDP's implicit price deflator, the growth rate of nominal hourly compensation, the growth rate of the logarithm of the CRB price index of sensitive commodities, the Fed fund rate and the growth rate of M2 : $Z_{1,t} = (\widehat{y}_t, \widehat{\pi}_t, \widehat{\pi}_t^w, \widehat{\pi}_t^c)', \widehat{i}_t, Z_{2,t} = (\widehat{\xi}_t)$.
- The variables of interest, X_t are $X_t = (\widehat{y}_t, \widehat{\pi}_t, \widehat{\pi}_t^w, \widehat{\imath}_t, \widehat{\xi}_t)'$


Output
Inflation
Wage Inflation
Inflation of CRB Price Index
Fed Funds
Money Growth
1960
1970
1980
1990
2000



Output
Inflation
Wage Inflation
Fed Funds
Money Growth
Percent deviation
Quarters after shock

Variance Decomposition

Forecast Horizon	0	4	8	20	30
$\widehat{y}_t$	0.00	0.07	0.16	0.13	0.13
$\widehat{\pi}_t$	0.00	0.01	0.04	0.20	0.22
$\widehat{\pi}_t^w$	0.00	0.01	0.04	0.15	0.17
$\widehat{\imath}_t$	0.86	0.40	0.27	0.21	0.22
$\widehat{\xi}_t$	0.08	0.14	0.13	0.13	0.14

Empirical Results (III)

- **Parameter Calibrations (1)**
- Potential source of arbitrariness.
- Consensual and conservative choices.
- Empirically plausible.

- **Parameter Calibrations (2)**
- Preferences.
- Technology.
- Price/Wage Setting.
- Nominal Interest Rate Target Level.

β	Subjective discount factor	0.99
b	Habit persistence	0.75
σ	Intertemporal elasticity of substitution ($= 1 - b$)	0.25
ω_w	Elasticity of marginal labor disutility	1.00
$\bar{v}$	Steady state money velocity	1.36
η_y	Money demand elasticity wrt $\widehat{y}_t$	1.00
η_i	Money demand elasticity wrt $\widehat{\imath}_t$	1.18
ϕ	Inverse of the elasticity of $\widehat{y}_t$ wrt $\widehat{n}_t$	1.33
ω_p	$\phi - 1$	0.33
s_m	Share of material goods	0.50
θ_p	Elasticity of demand for goods	6.00
μ_p	Markup ($= \theta_p/(\theta_p - 1)$)	1.20
ϵ_μ	Markup elasticity	1.00
θ_w	Elasticity of demand for labor	21.00
μ_w	Markup ($= \theta_w/(\theta_w - 1)$)	1.05
γ_p	Price indexation	1.00
γ_w	Wage indexation	1.00
α_p	Prob. of no price adj.	0.66
α_w	Prob. of no wage adj.	0.66
a_π	Monetary policy reaction to $\widehat{\pi}_t$	1.500
a_y	Monetary policy reaction to $\widehat{y}_t$	0.125

Empirical Results (IV)

- **Estimation Results**
- Selected data :

$$X_t = (\widehat{y}_t, \widehat{\pi}_t, \widehat{\pi}^w_t, \widehat{\imath}_t, \widehat{\xi}_t)'$$

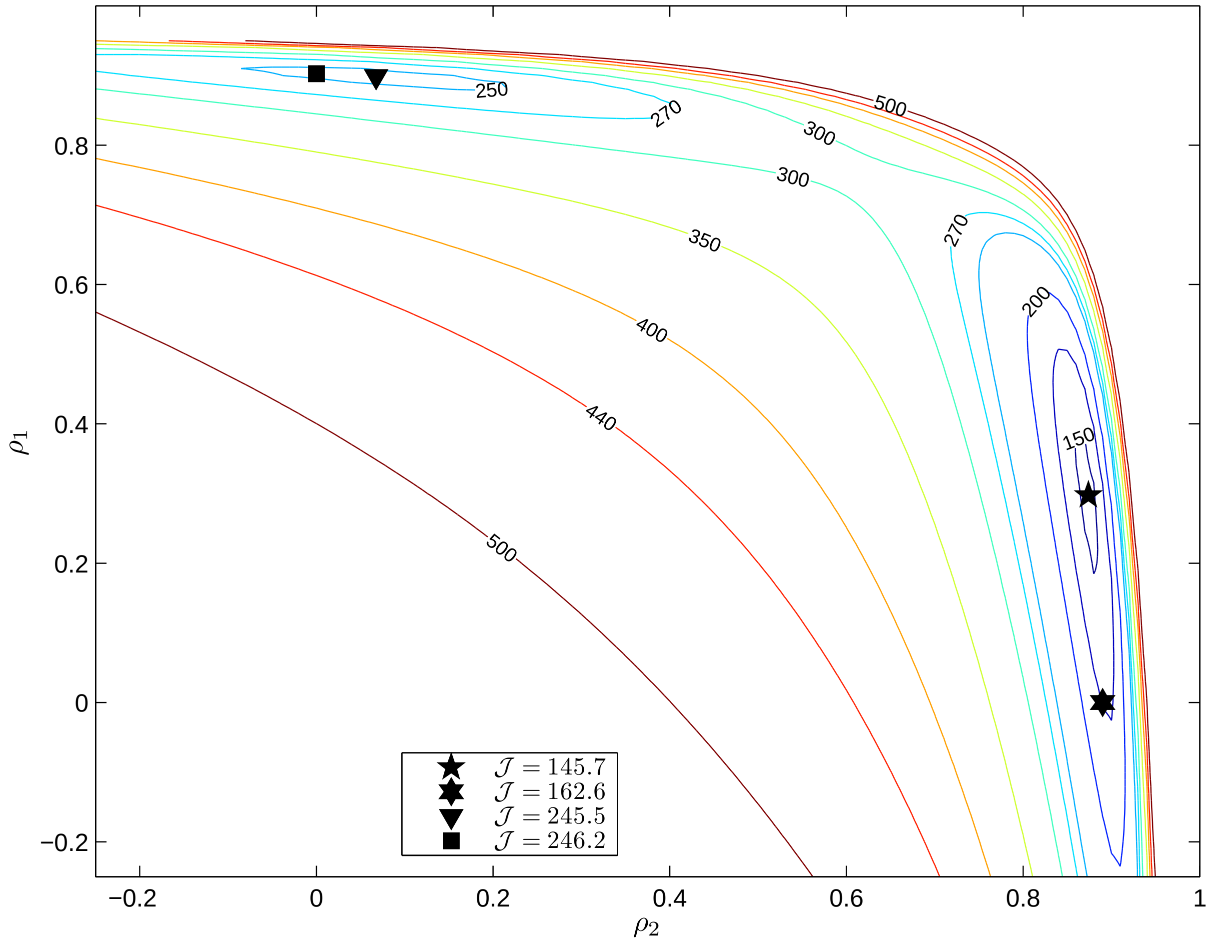
and

$$X_t = (\widehat{\imath}_t)'$$

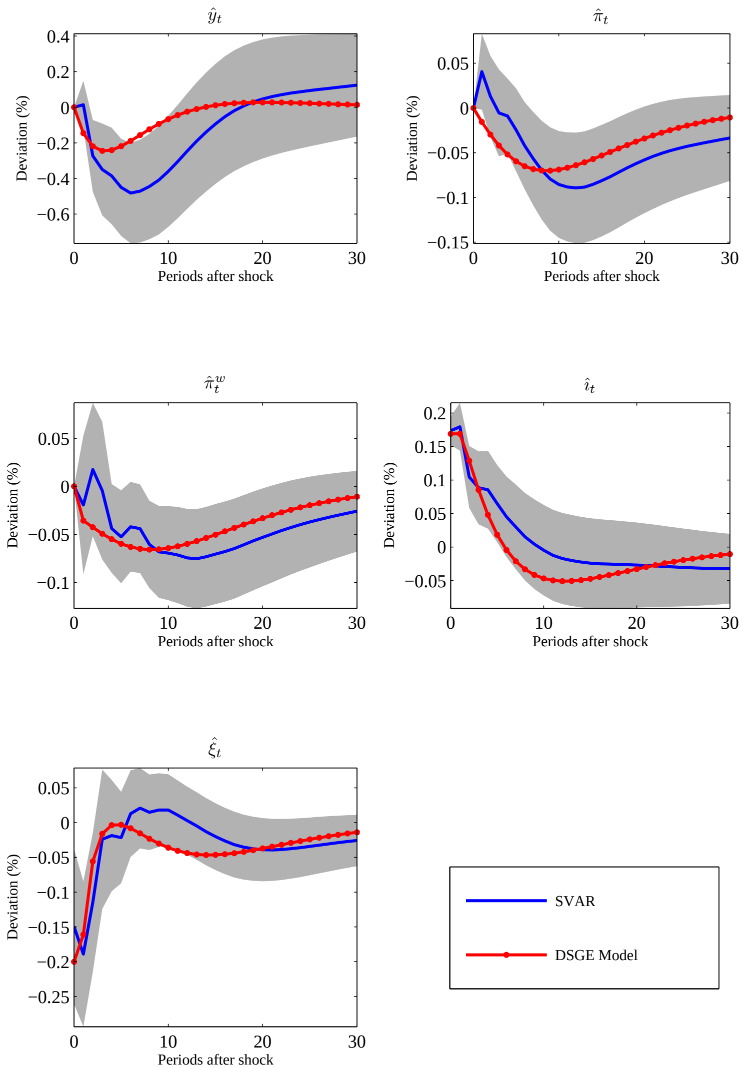
- Initial conditions.

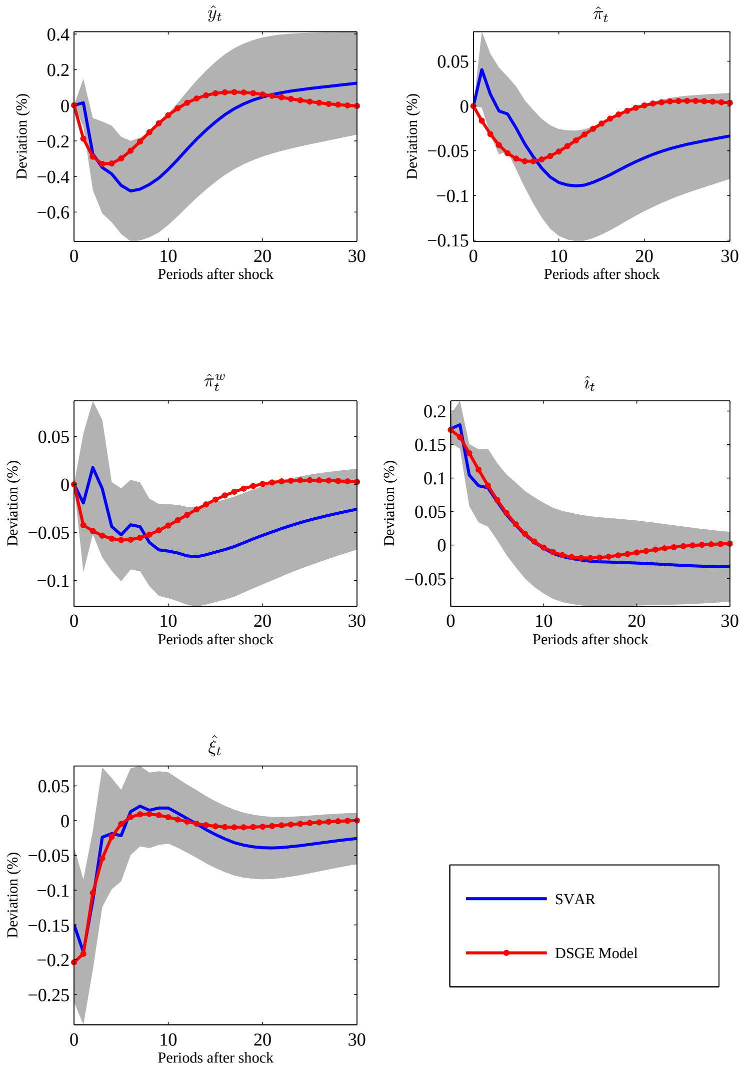
Estimation Results

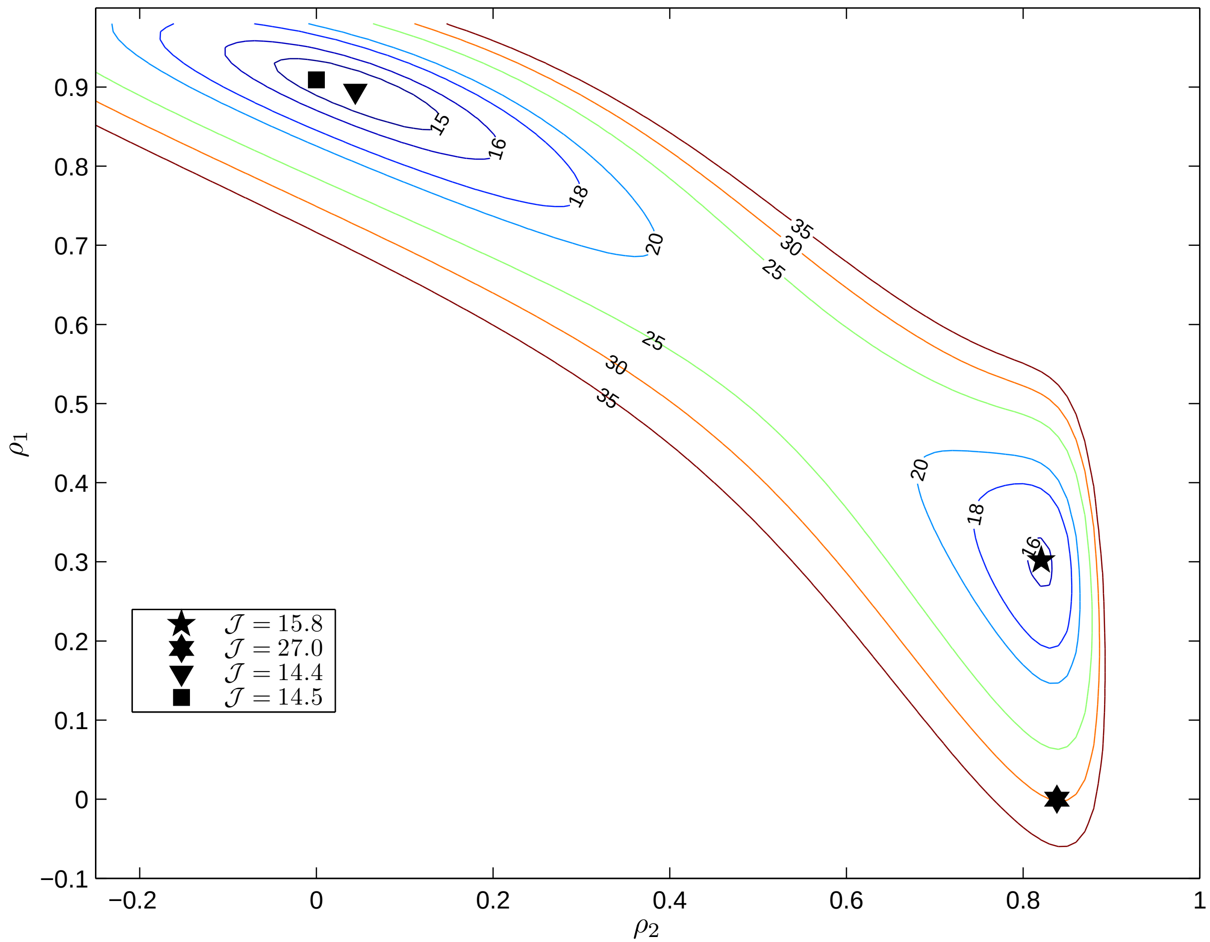
	$X_t = (\widehat{y}_t, \widehat{\pi}_t, \widehat{\pi}^w_t, \widehat{\imath}_t, \widehat{\xi}_t)'$					$X_t = (\widehat{\imath}_t)$				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
ρ_1	0.297	0.898	0.000	0.902	0.753	0.301	0.895	0.000	0.909	0.560
ρ_2	0.874	0.067	0.890	0.000	—	0.820	0.044	0.838	0.000	—
σ_ν	0.169	0.172	0.188	0.176	0.123	0.173	0.174	0.189	0.175	0.168
$\mathcal{J}$	145.6	245.5	162.6	246.1	246.5	15.7	14.3	26.9	14.4	21.6
$\mathcal{J}_y$	40.2	40.7	43.8	40.2	43.3	—	—	—	—	—
$\mathcal{J}_\pi$	34.2	86.2	28.3	86.4	72.0	—	—	—	—	—
$\mathcal{J}_{\pi^w}$	17.0	75.5	12.7	75.7	56.6	—	—	—	—	—
$\mathcal{J}_i$	23.5	14.4	37.6	14.5	50.6	15.7	14.3	26.9	14.4	21.6
$\mathcal{J}_\xi$	30.7	28.4	40.1	29.2	23.7	—	—	—	—	—



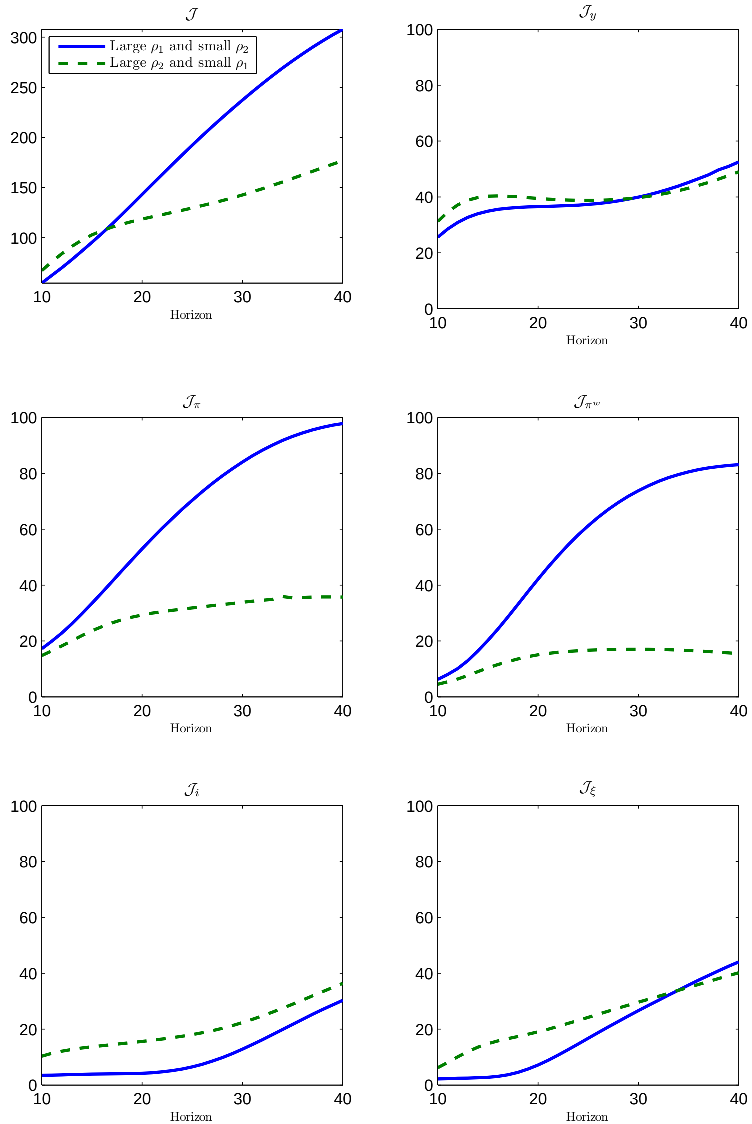
500
300
250
270
300
270
350
200
400
150
440
500
$\mathcal{J} = 145.7$
$\mathcal{J} = 162.6$
$\mathcal{J} = 245.5$
$\mathcal{J} = 246.2$
0.8
0.6
0.4
0.2
0
−0.2
ρ_1
−0.2
0
0.2
0.4
0.6
0.8
1
ρ_2


$\hat{y}_t$
$\hat{\pi}_t$
$\hat{\pi}_t^w$
$\hat{\imath}_t$
$\hat{\xi}_t$
Deviation (%)
Periods after shock
SVAR
DSGE Model


$\hat{y}_t$
$\hat{\pi}_t$
$\hat{\pi}_t^w$
$\hat{\imath}_t$
$\hat{\xi}_t$
Deviation (%)
Periods after shock
SVAR
DSGE Model



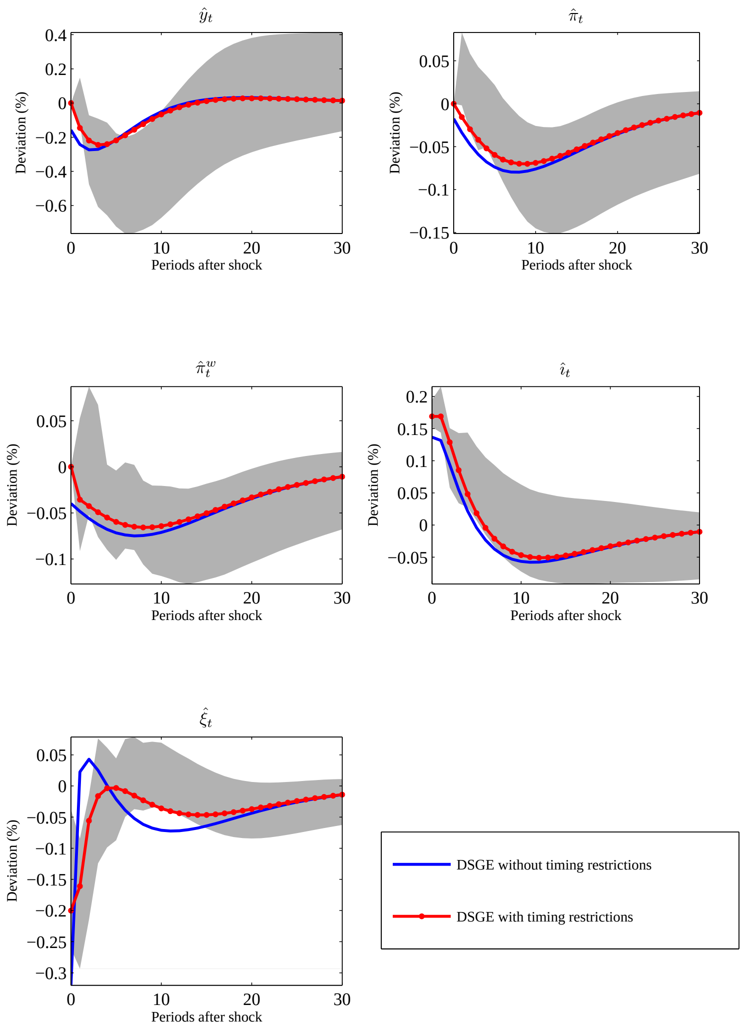
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
0
0.2
0.4
0.6
0.8
1
ρ_1
ρ_2
15
16
18
20
25
30
35
$\mathcal{J} = 15.8$
$\mathcal{J} = 27.0$
$\mathcal{J} = 14.4$
$\mathcal{J} = 14.5$

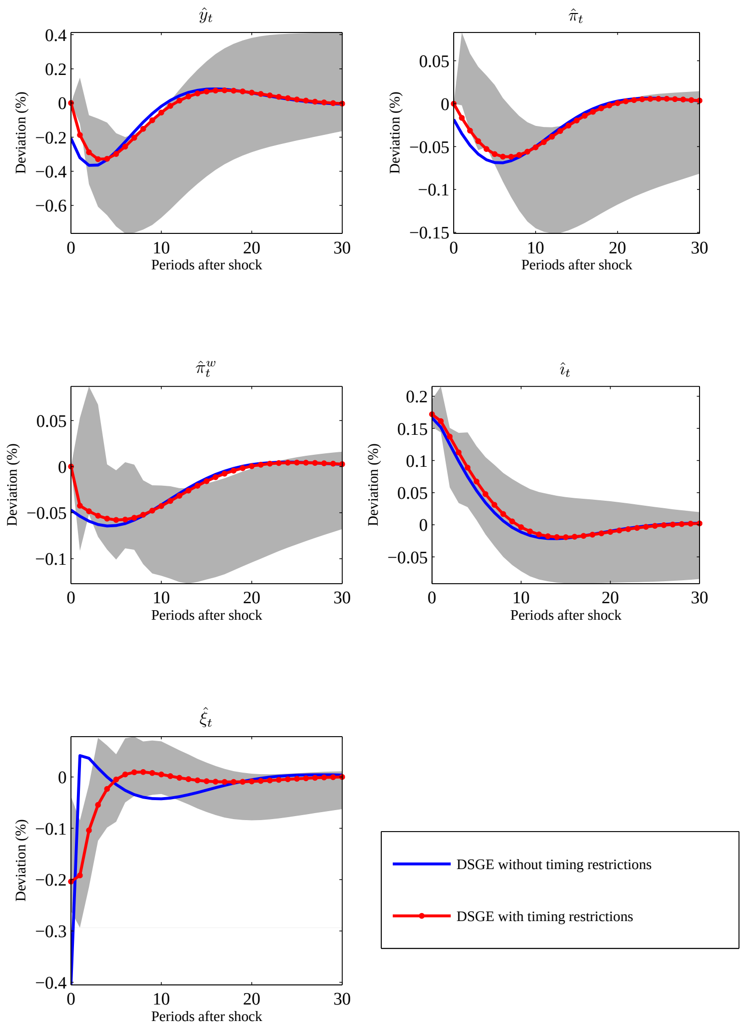


$\mathcal{J}$
Large ρ_1 and small ρ_2
Large ρ_2 and small ρ_1
Horizon
$\mathcal{J}_y$
Horizon
$\mathcal{J}_\pi$
Horizon
$\mathcal{J}_{\pi^w}$
Horizon
$\mathcal{J}_i$
Horizon
$\mathcal{J}_\xi$
Horizon

Empirical Results (V)

- **Robustness**
- Timing restrictions : innocuous.
- Calibration : large effects when $X_t = (\widehat{y}_t, \widehat{\pi}_t, \widehat{\pi}^w_t, \widehat{\imath}_t, \widehat{\xi}_t)'$, *i.e.* when the estimation criterion is informative, small effects when $X_t = (\widehat{\imath}_t)'$, *i.e.* when the estimation criterion is uninformative.


$\hat{y}_t$
$\hat{\pi}_t$
$\hat{\pi}_t^w$
$\hat{\imath}_t$
$\hat{\xi}_t$
Deviation (%)
Periods after shock
DSGE without timing restrictions
DSGE with timing restrictions



$\hat{y}_t$
$\hat{\pi}_t$
$\hat{\pi}_t^w$
$\hat{\imath}_t$
$\hat{\xi}_t$
Deviation (%)
Periods after shock
DSGE without timing restrictions
DSGE with timing restrictions

Sensitivity to Calibration Based on $X_t = (\widehat{y}_t, \widehat{\pi}_t, \widehat{\pi}_t^w, \widehat{\imath}_t, \widehat{\xi}_t)'$

		Large ρ_2, Small ρ_1						Large ρ_1, Small ρ_2					
	Value	$\mathcal{J}$	$\mathcal{J}_y$	$\mathcal{J}_\pi$	$\mathcal{J}_{\pi^w}$	$\mathcal{J}_i$	$\mathcal{J}_\xi$	$\mathcal{J}$	$\mathcal{J}_y$	$\mathcal{J}_\pi$	$\mathcal{J}_{\pi^w}$	$\mathcal{J}_i$	$\mathcal{J}_\xi$
b	0.00	396	73	36	19	238	31	528	97	117	123	121	71
ω_w	10.00	120	35	29	12	19	25	218	35	78	65	14	26
η_i	3.00	181	40	34	17	35	55	275	39	87	76	22	51
ϕ	1.00	103	32	22	10	17	21	199	31	68	62	13	24
θ_p	11.00	110	33	25	13	18	22	211	32	72	68	13	25
θ_w	11.00	183	48	41	25	30	39	281	49	94	89	16	32
γ_p	0.00	235	26	93	73	16	26	300	28	108	108	18	38
γ_w	0.00	266	30	79	62	36	59	308	29	107	101	23	49
α_p	0.00	356	67	109	71	57	52	—	—	—	—	—	—
α_w	0.00	481	76	49	70	212	73	499	85	118	154	69	74
a_π	3.00	133	46	27	11	23	27	264	42	93	83	17	30
a_y	0.50	147	44	29	13	28	33	216	40	75	61	15	25

Sensitivity to Calibration Based on $X_t = (\hat{\imath}_t)$

		Large ρ_2, Small ρ_1	Large ρ_1, Small ρ_2
Parameters	Value	$\mathcal{J}$	$\mathcal{J}$
b	0.00	—	25
ω_w	10.00	13	14
η_i	3.00	16	14
ϕ	1.00	11	13
θ_p	11.00	11	13
θ_w	11.00	19	16
γ_p	0.00	10	16
γ_w	0.00	22	19
α_p	0.00	—	20
α_w	0.00	—	24
a_π	3.00	15	16
a_y	0.50	18	14

Concluding Remarks

- A simple econometric framework to discriminate between two alternative representations of monetary policy.
- This approach takes advantage from the cross-equation restrictions contained in our monetary DSGE model.
- Two main results :
  1. When the framework contains enough information, we unambiguously favor a rule with serially correlated shocks.
  2. If not, we cannot discriminate between the two alternative rules.

  These results highlight the low discriminating power of single equation approaches.