Switches in the US Macroeconomic Data using the Rudebusch-Svensson VAR model

first_name last_name
Your institution
first_name@last_name.com

12-Oct-2014 16:55:49

Abstract

This report investigates switches in the parameters of a simple VAR model by Rudebusch and Svensson (1999) estimated on US data. 4 variants of the modelare estimated: (i) the first model has constant parameters; (ii) the second model allows for switches in the policy parameters only; (iii) the third specification allows for switches in volatility only ;(iv) the fourth variant allows for independent switches in both parameters and the volatility of shocks.

We find ample evidence in favor of switching parameters...

1 Model code

```
8: % new file with name ::  svar_core.rs
8: endogenous  Y, "Output gap", PAI, "Inflation", I, "Fed Funds rate"
11: exogenous EPAI,  "Phil. curve shock", EY, "IS curve shock", EI, "Taylor rule shock"
14: parameters alpha_pai1, "$\alpha_{\pi,1}$", alpha_pai2, "$\alpha_{\pi,2}$", alpha_y, "$\alpha_{y}$", c_pai,
15: c_y, "$c_{y}$", beta_y1, "$\beta_{y,1}$", beta_y2, "$\beta_{y,2}$", beta_r, "$\beta_{r}$",
18: observables I, Y, PAI
21: model(linear)
25:     # alpha_pai = 1/sig_pai;
26:     # beta_y    = 1/sig_y;
27:     # gam_i     = 1/sig_i;
29:    alpha_pai*PAI   = c_pai + alpha_pai1*PAI{-1} + alpha_pai2*PAI{-2} +alpha_y*Y{-1} + EPAI;
32:    beta_y*Y = c_y + beta_y1*Y{-1} + beta_y2*Y{-2} -beta_r*(I{-1}-PAI{-1}) + EY;
36:    gam_i*I = c_i + gam_i*rho_i*I{-1} +gam_i*(1-rho_i)*(gam_y*Y+gam_pai*PAI) + EI;
38: steady_state_model(imposed)
39:  xx_ssmdef_1=alpha_pai-alpha_pai1-alpha_pai2;
40:  xx_ssmdef_2=gam_i*(1-rho_i);
41:  xx_ssmdef_3=beta_r*(gam_pai-1);
42:  xx_ssmdef_4=c_y-beta_r*c_i/xx_ssmdef_2-xx_ssmdef_3*c_pai/xx_ssmdef_1;
43:  xx_ssmdef_5=beta_y-beta_y1-beta_y2+beta_r*gam_y+xx_ssmdef_3*alpha_y/xx_ssmdef_1;
45:  Y=xx_ssmdef_4/xx_ssmdef_5;
46:  PAI=c_pai/xx_ssmdef_1+alpha_y*Y/xx_ssmdef_1;
47:  I=c_i/xx_ssmdef_2+gam_y*Y+gam_pai*PAI;
50: parameterization
51:     alpha_pai1,  0.9,  0.05,  1.5,  gamma_pdf(0.9);
52:     alpha_pai2,  0.05  ,  -1  ,  1  ,  normal_pdf(0.9);
53:     alpha_y,     0.1,  0.05,  1.5,  gamma_pdf(0.9);
54:     c_pai,       0  ,  -1  ,  1  ,  normal_pdf(0.9);
55:     c_y,         0  ,  -1  ,  1  ,  normal_pdf(0.9);
```

```
56:     beta_y1,     0.9,  0.1 ,  1.5,  gamma_pdf(0.9);
57:     beta_y2,     0.05  ,  -2  ,  2  ,  normal_pdf(0.9);
58:     beta_r,      0.1,  0.05,  1  ,  gamma_pdf(0.9);
1: % new file with name ::  switching_volatility.rs
1: parameters vol_tp_1_2, vol_tp_2_1
3: parameters(vol,2) sig_pai, "$\sigma_{\pi}$" sig_y, "$\sigma_{y}$", sig_i, "$\sigma_{i}$"
5: parameterization
6:  sig_pai(vol,1),    0.1,  0.05,    3,  weibull_pdf(0.9);
7:  sig_pai(vol,2),    0.1,  0.05,    3,  weibull_pdf(0.9);
8:  sig_y(vol,1),       0.1,  0.05,    3,  weibull_pdf(0.9);
9:  sig_y(vol,2),       0.1,  0.05,    3,  weibull_pdf(0.9);
10:  sig_i(vol,1),  0.1,  0.05,     3,  weibull_pdf(0.9);
11:  sig_i(vol,2),  0.1,  0.05,     3,  weibull_pdf(0.9);
13:  vol_tp_1_2,    0.15,0.1,  0.5,  beta_pdf(0.9);
14:  vol_tp_2_1,    0.15,0.1,  0.5,  beta_pdf(0.9);
16: parameter_restrictions
18:  sig_pai(vol,2)>=sig_pai(vol,1);
1: % new file with name ::  switching_policy.rs
1: parameters pol_tp_1_2 pol_tp_2_1
3: parameters(pol,2) rho_i, "$\rho_{i}$" gam_y, "$\gamma_{y}$" gam_pai, "$\gamma_{\pi}$" c_i, "$c_{i}$"
5: parameterization
6:  rho_i(pol,1),  0.6,  0.1,  0.7,  beta_pdf(0.9);
7:  rho_i(pol,2),  0.6,  0.1,  0.7,  beta_pdf(0.9);
8:  gam_y(pol,1),  0.5,  0.1,  1.5,  gamma_pdf(0.9);
9:  gam_y(pol,2),  0.5,  0.1,  1.5,  gamma_pdf(0.9);
10:  gam_pai(pol,1),  1.5,  0.5,  3,  gamma_pdf(0.9);
11:  gam_pai(pol,2),  1.0,  0.5,  3,  gamma_pdf(0.9);
12:  c_i(pol,1),  0  ,  -1,  1,  normal_pdf(0.9);
13:  c_i(pol,2),  0  ,  -1,  1,  normal_pdf(0.9);
```

```
15:  pol_tp_1_2,    0.15,0.1,  0.5,  beta_pdf(0.9);
16:  pol_tp_2_1,    0.15,0.1,  0.5,  beta_pdf(0.9);
18: parameter_restrictions
20:  gam_pai(pol,1)>=gam_pai(pol,2);
```

2 Description of variables

Table # 1: Endogenous Variables

Model code	Description
I	Fed Funds rate
PAI	Inflation
Y	Output gap

Table # 2: Exogenous Variables

Model code	Description
EI	Taylor rule shock
EPAI	Phil. curve shock
EY	IS curve shock

Table # 3: Observed Variables

Model code	Description
I	Fed Funds rate
PAI	Inflation
Y	Output gap

3 Model equations

```
EQ1: alpha_pai*PAI-(c_pai+alpha_pai1*PAI{-1}+alpha_pai2*PAI_AUX_L_1{-1}+alpha_y*Y{-1}+EPAI)=0;

EQ2: beta_y*Y-(c_y+beta_y1*Y{-1}+beta_y2*Y_AUX_L_1{-1}-beta_r*(I{-1}-PAI{-1})+EY)=0;

EQ3: gam_i*I-(c_i+gam_i*rho_i*I{-1}+gam_i*(1-rho_i)*(gam_y*Y+gam_pai*PAI)+EI)=0;

EQ4: PAI_AUX_L_1-PAI{-1}=0;

EQ5: Y_AUX_L_1-Y{-1}=0;
```

4 Estimation results

Table # 4: Estimation Results

parameter	Prior distr	Prior prob	low	high	svar_constant	svar_policy	svar_volatility	svar_policy_volatility
$\alpha_{\pi,1}$	gamma	0.9	0.05	1.5	0.1429	0.1435	0.1427	0.1426
$\alpha_{\pi,2}$	normal	0.9	-1	1	0.09042	0.09074	0.08927	0.08841
α_y	gamma	0.9	0.05	1.5	0.1726	0.1694	0.1681	0.1655
c_π	normal	0.9	-1	1	2.122	2.1	2.119	2.092
c_y	normal	0.9	-1	1	-0.4236	-0.4645	-0.4015	-0.4427
$\beta_{y,1}$	gamma	0.9	0.1	1.5	2.283	2.191	0.9232	1.032
$\beta_{y,2}$	normal	0.9	-2	2	3.61	3.593	2.77	2.914
β_r	gamma	0.9	0.05	1	0.1314	0.132	0.1345	0.1343
σ_π	weibull	0.9	0.05	3	0.002802	0.002799	–	–
σ_y	weibull	0.9	0.05	3	0.02455	0.02436	–	–
σ_i	weibull	0.9	0.05	3	0.001116	0.001065	–	–
ρ_i	beta	0.9	0.1	0.7	0.8897	–	0.947	–
γ_y	gamma	0.9	0.1	1.5	0.2067	–	0.1126	–
γ_π	gamma	0.9	0.5	3	1.489	–	1.629	–
c_i	normal	0.9	-1	1	0.3927	–	0.1285	–
ρ_i(pol,1)	beta	0.9	0.1	0.7	–	0.2285	–	0.9856
ρ_i(pol,2)	beta	0.9	0.1	0.7	–	0.877	–	0.8447
γ_y(pol,1)	gamma	0.9	0.1	1.5	–	0.1376	–	0.1561
γ_y(pol,2)	gamma	0.9	0.1	1.5	–	0.1886	–	0.08697
γ_π(pol,1)	gamma	0.9	0.5	3	–	2.929	–	1.768
γ_π(pol,2)	gamma	0.9	0.5	3	–	1.384	–	1.768
c_i(pol,1)	normal	0.9	-1	1	–	0.04525	–	0.4883
c_i(pol,2)	normal	0.9	-1	1	–	0.42	–	-1.186
pol_tp_1_2	beta	0.9	0.1	0.5	–	0.09504	–	0.09743

Continued on next page

– *Continued from previous page*

parameter	Prior distr	Prior prob	low	high	svar_constant	svar_policy	svar_volatility	svar_policy_volatility
pol_tp_2_1	beta	0.9	0.1	0.5	–	0.04386	–	0.1618
σ_π(vol,1)	weibull	0.9	0.05	3	–	–	0.002791	0.002785
σ_π(vol,2)	weibull	0.9	0.05	3	–	–	0.002791	0.002785
σ_y(vol,1)	weibull	0.9	0.05	3	–	–	0.01491	0.01513
σ_y(vol,2)	weibull	0.9	0.05	3	–	–	0.04546	0.04045
σ_i(vol,1)	weibull	0.9	0.05	3	–	–	0.001268	0.0009077
σ_i(vol,2)	weibull	0.9	0.05	3	–	–	0.0001857	8.989e-05
vol_tp_1_2	beta	0.9	0.1	0.5	–	–	0.02907	0.06847
vol_tp_2_1	beta	0.9	0.1	0.5	–	–	0.1599	0.1505

Table # 5: Estimation Statistics

	svar_constant	svar_policy	svar_volatility	svar_policy_volatility
log-post:	1363	1361	1408	1432
log-lik:	1383	1384	1426	1457
log-prior:	-20.32	-22.81	-18.54	-25.34
log-endog_prior	0	0	0	0
number of active inequalities	0	0	0	0
log-MDD(Laplace)	1317+1.571i	1298+1.571i	1328	1310+1.571i
estimation sample	1985Q1:2013Q1	1985Q1:2013Q1	1985Q1:2013Q1	1985Q1:2013Q1
number of observations	113	113	113	113
number of parameters	15	21	20	26
number of func. evals	3728	2969	2779	4510
estimation algorithm	fmincon	fmincon	fmincon	fmincon
solution algorithm	rise_1	mfi	rise_1	mfi
start time:	12-Oct-2014 15:29:05	12-Oct-2014 15:29:05	12-Oct-2014 15:29:05	12-Oct-2014 15:29:05
end time :	12-Oct-2014 15:31:50	12-Oct-2014 15:32:01	12-Oct-2014 15:31:52	12-Oct-2014 15:36:17
total time:	0:2:45	0:2:55	0:2:46	0:7:11

Table # 6: Steady state values

	svar_constant	svar_policy		svar_volatility		svar_policy_volatility			
	regime_1	regime_1	regime_2	regime_1	regime_2	regime_1	regime_2	regime_3	r
Fed Funds rate	0.01031	0.01546	0.009285	0.012	0.007607	0.04	0.01001	0.002752	
Inflation	0.005942	0.005877	0.005877	0.005916	0.005909	0.005827	0.00582	0.005827	
PAI_AUX_L_1	0.005942	0.005877	0.005877	0.005916	0.005909	0.005827	0.00582	0.005827	
Output gap	-0.01217	-0.01321	-0.01318	-0.006346	-0.02195	-0.007198	-0.02134	-0.007117	-
Y_AUX_L_1	-0.01217	-0.01321	-0.01318	-0.006346	-0.02195	-0.007198	-0.02134	-0.007117	-

Figure # 1: Observed data from the US

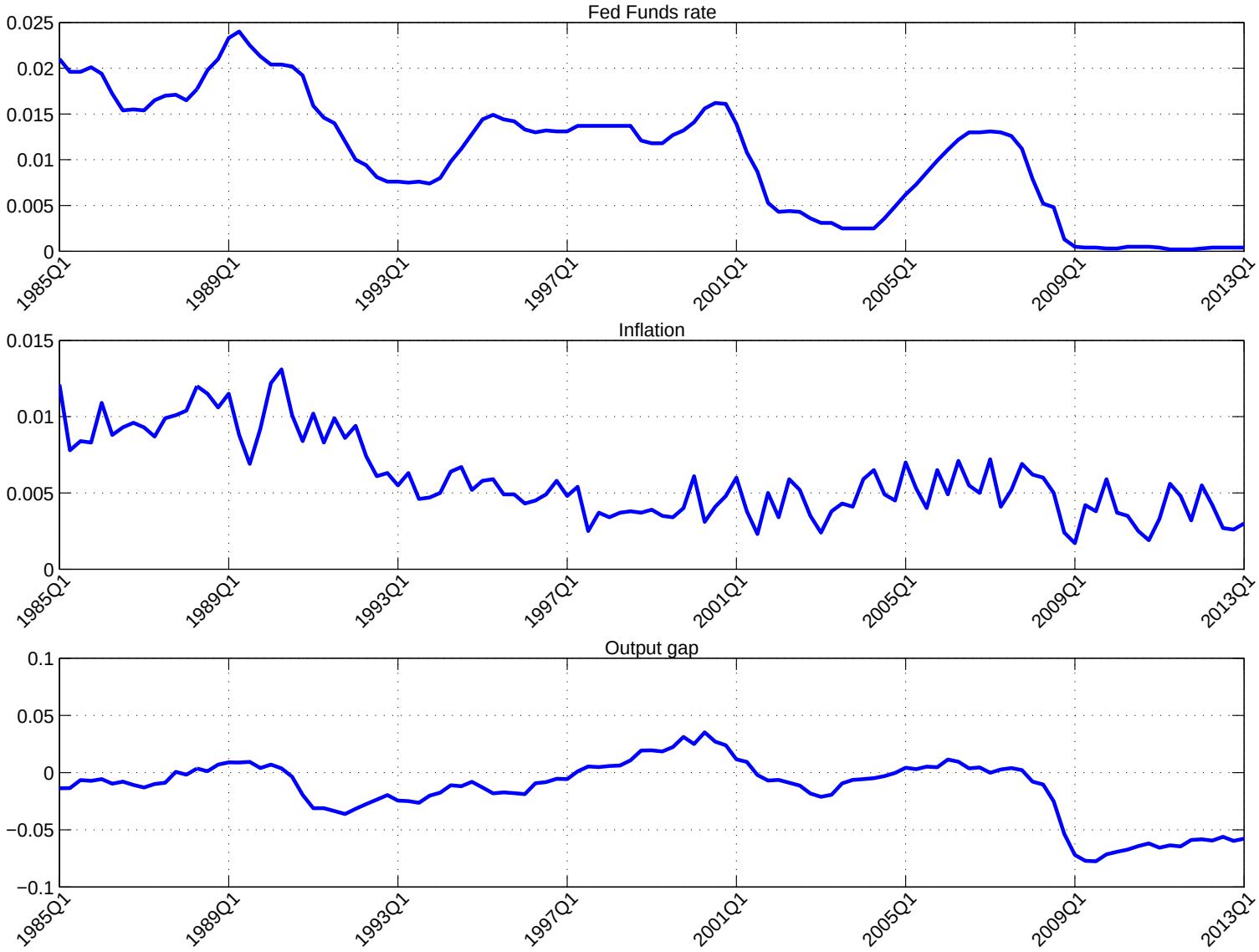


Figure # 2: Smoothed probabilities for svar_constant model

Figure # 3: Smoothed probabilities for svar_policy model

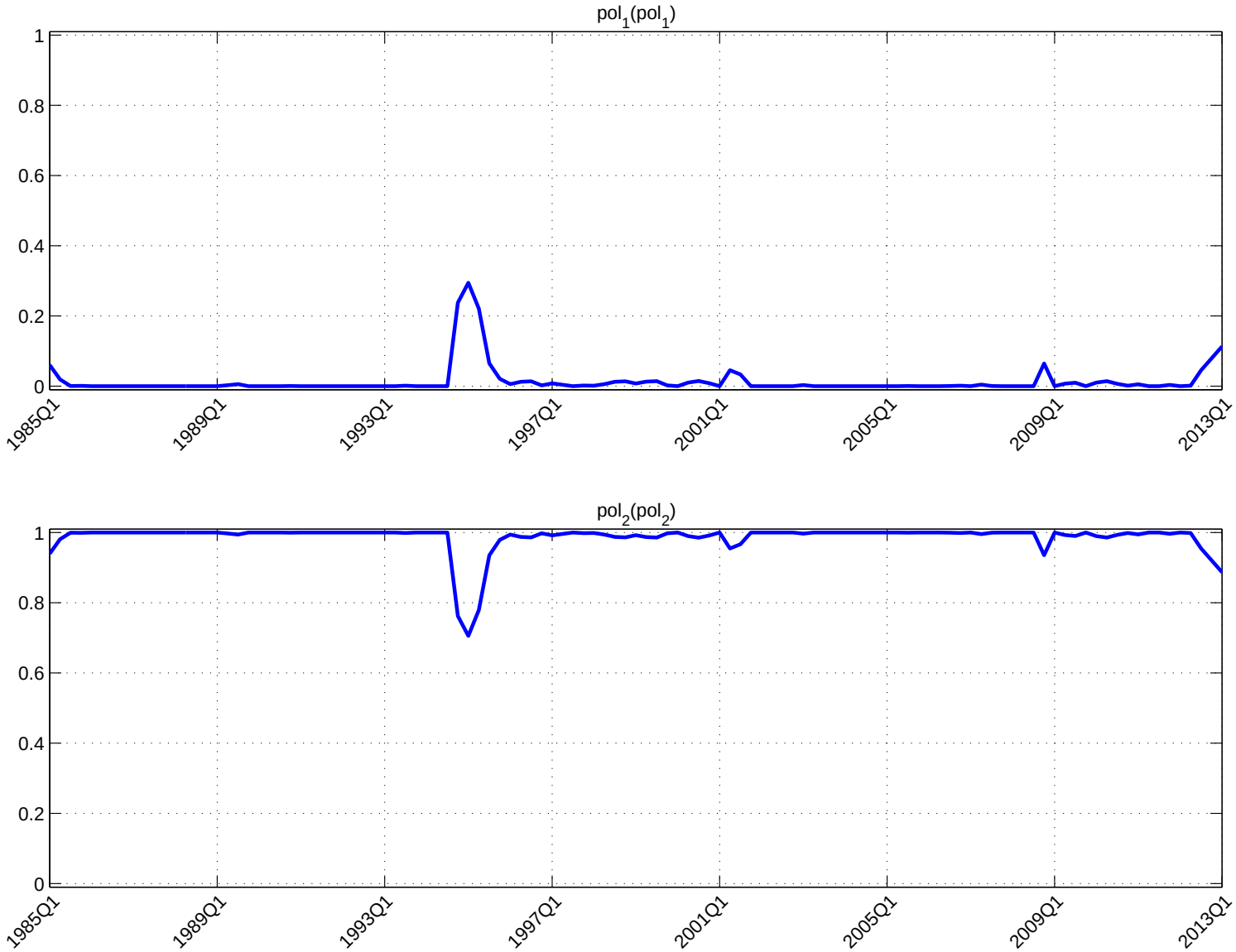


Figure # 4: Smoothed probabilities for svar_volatility model

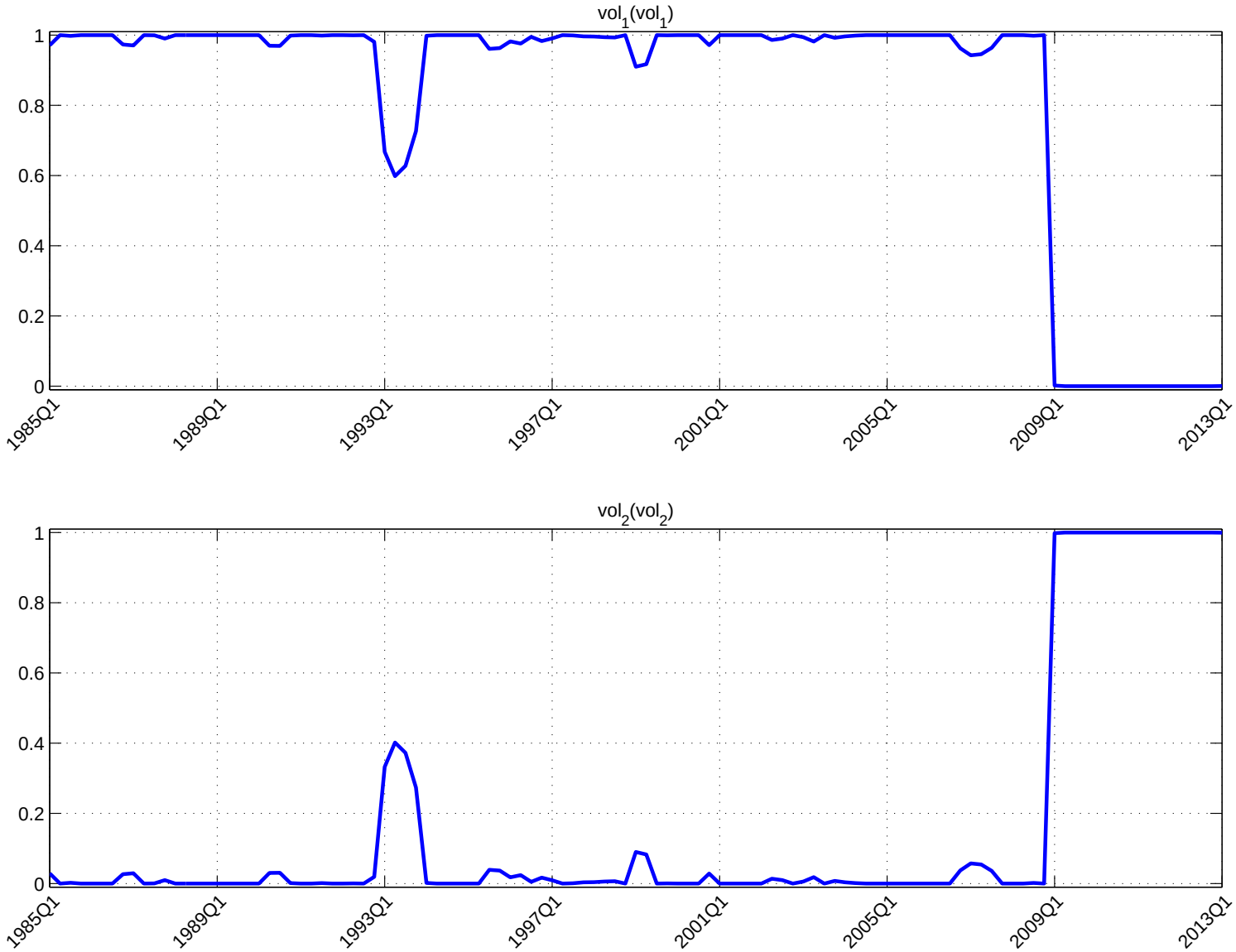


Figure # 5: Smoothed probabilities for svar_policy_volatility model

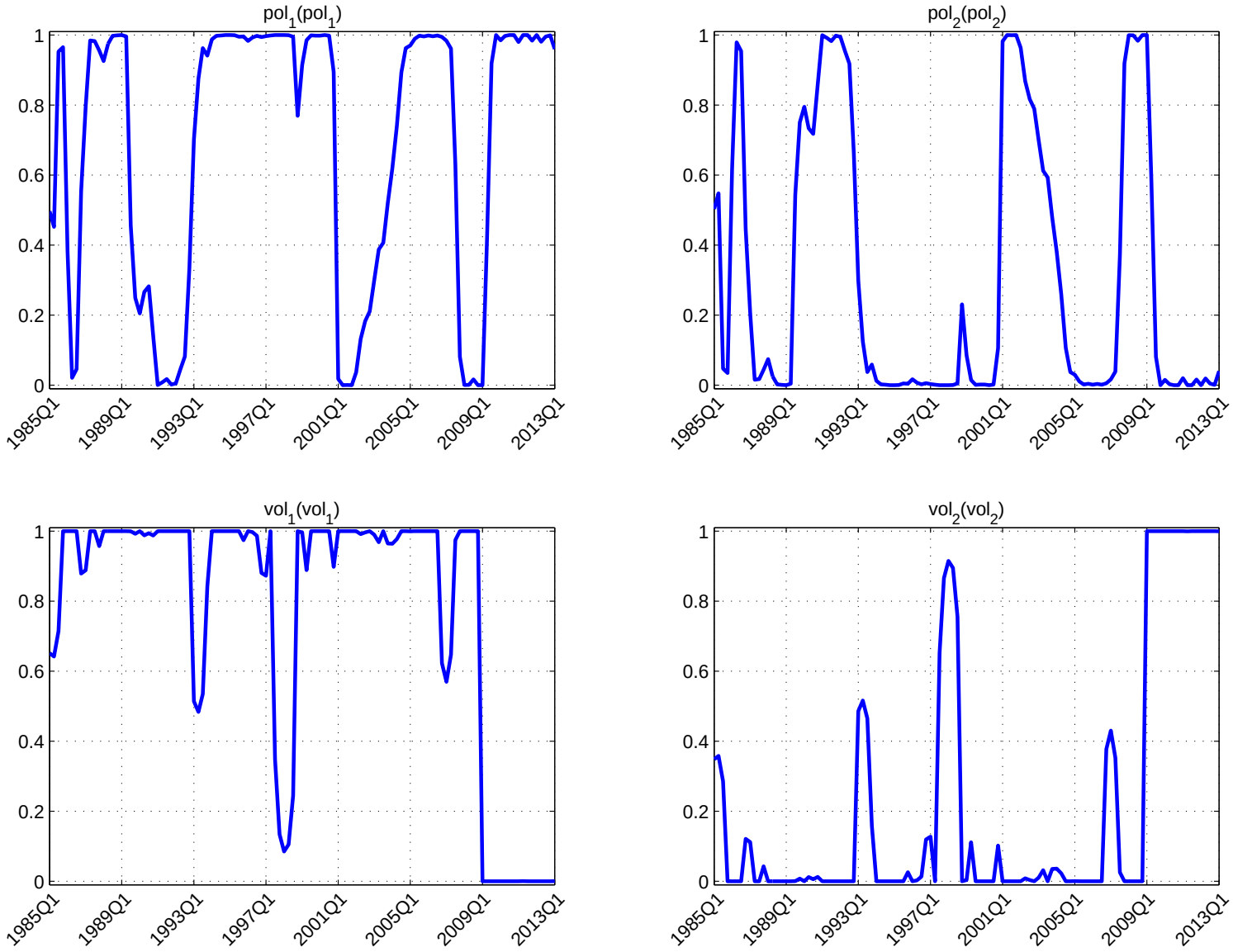


Figure # 6: svar_policy:: Observed vs pol_1(pol_1)

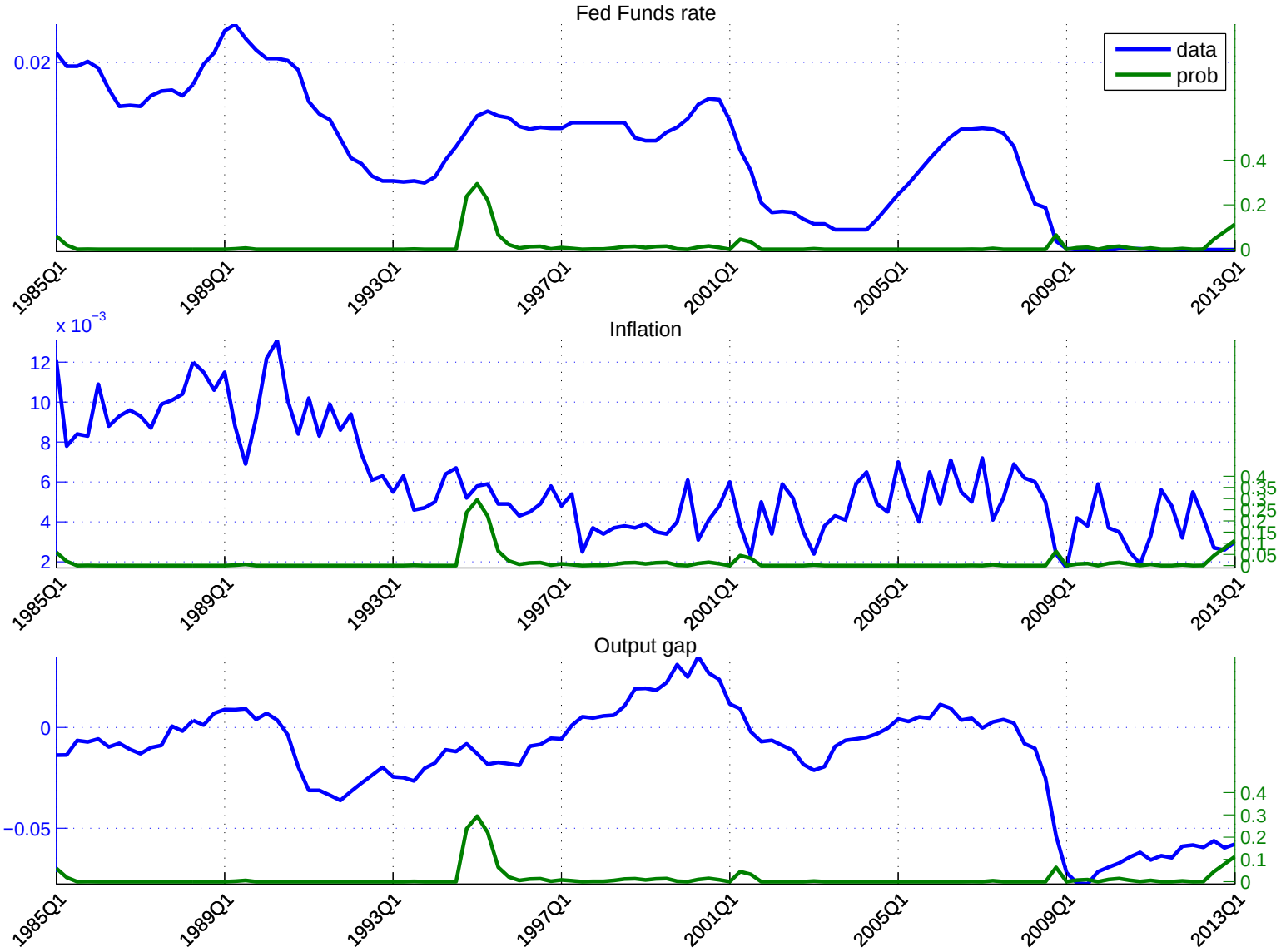


Figure # 7: svar_policy:: Observed vs pol_2(pol_2)

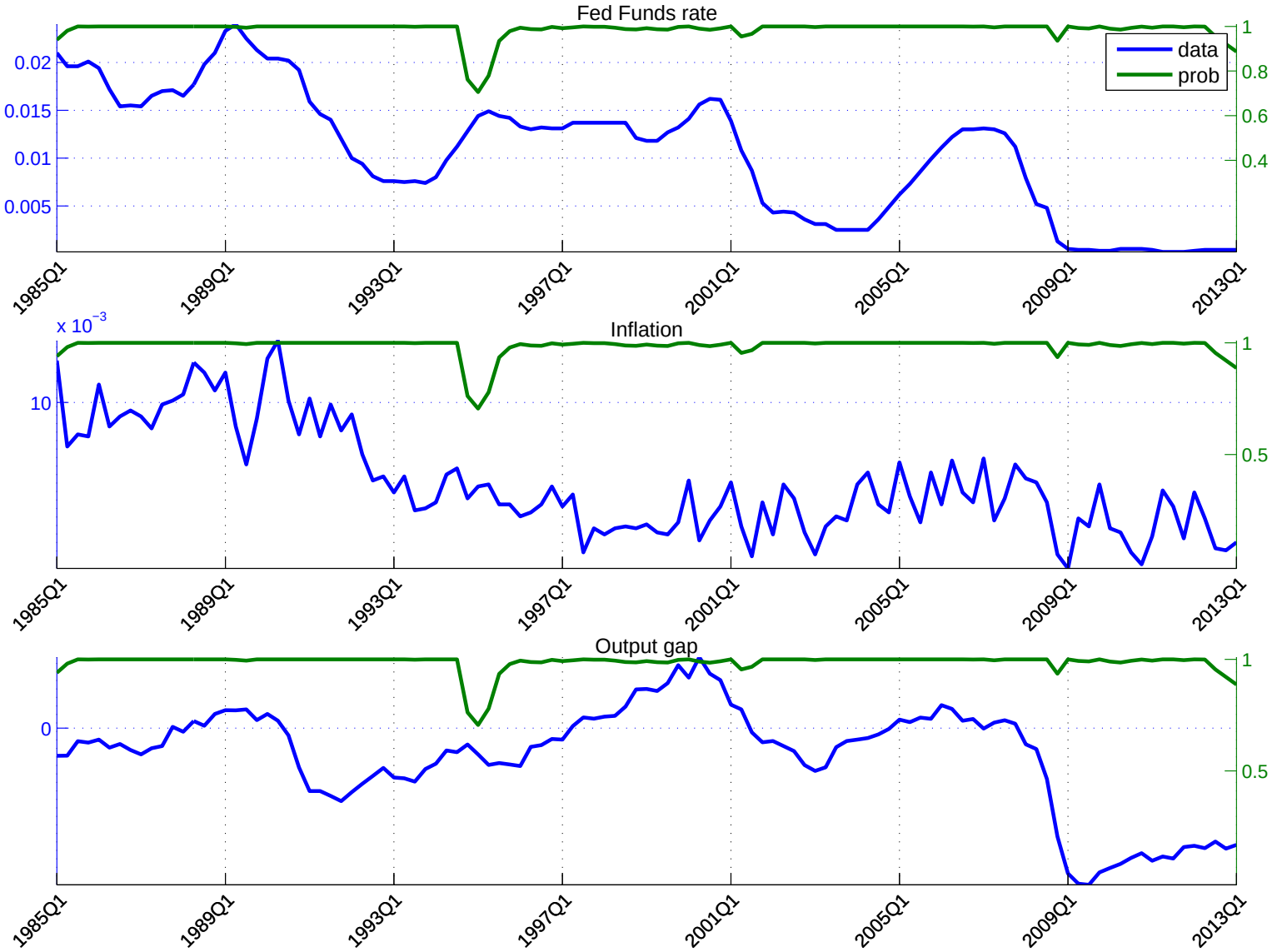


Figure # 8: svar_volatility:: Observed vs vol_1(vol_1)

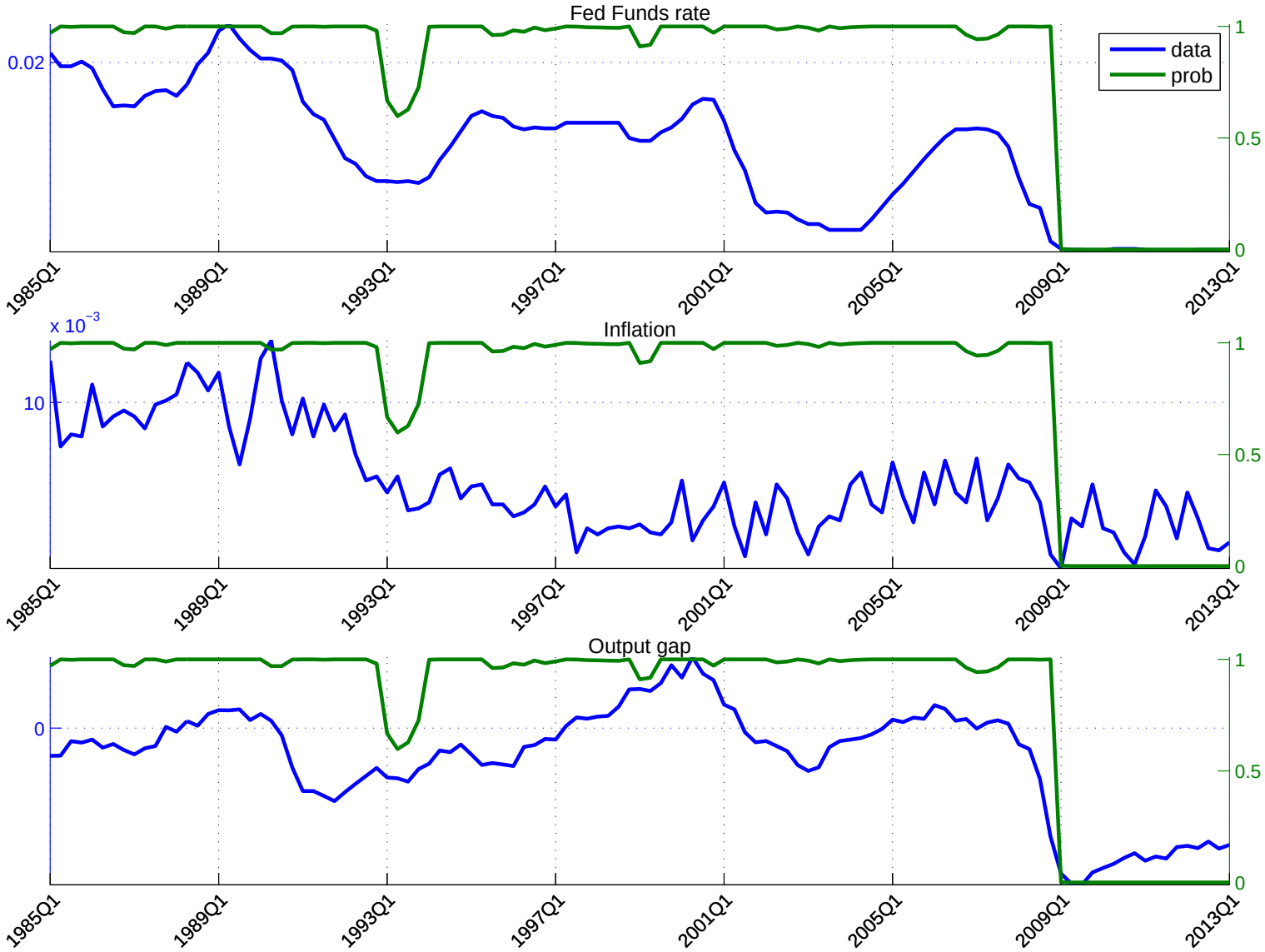


Figure # 9: svar_volatility:: Observed vs vol_2(vol_2)

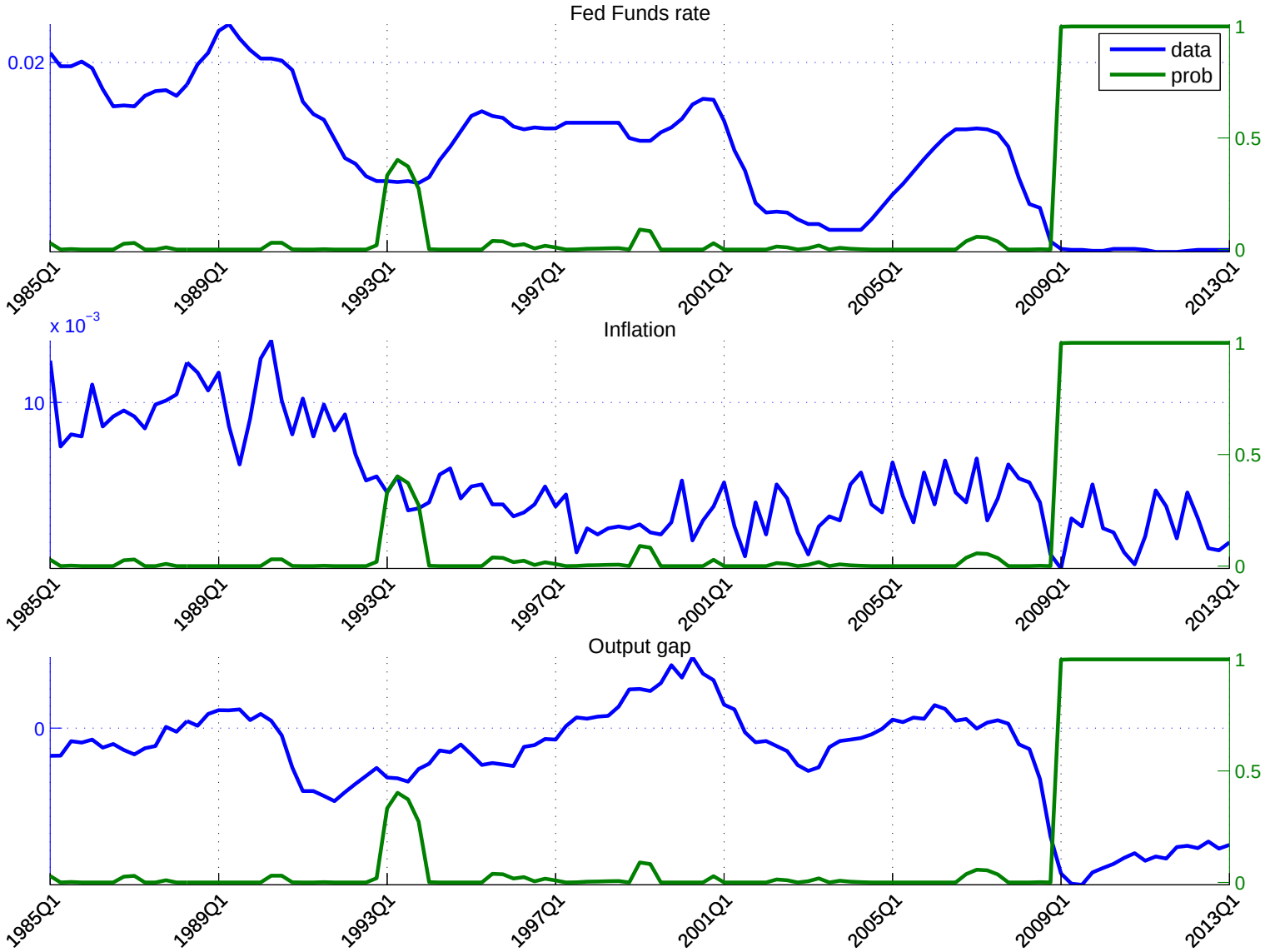


Figure # 10: svar_policy_volatility:: Observed vs pol_1(pol_1)

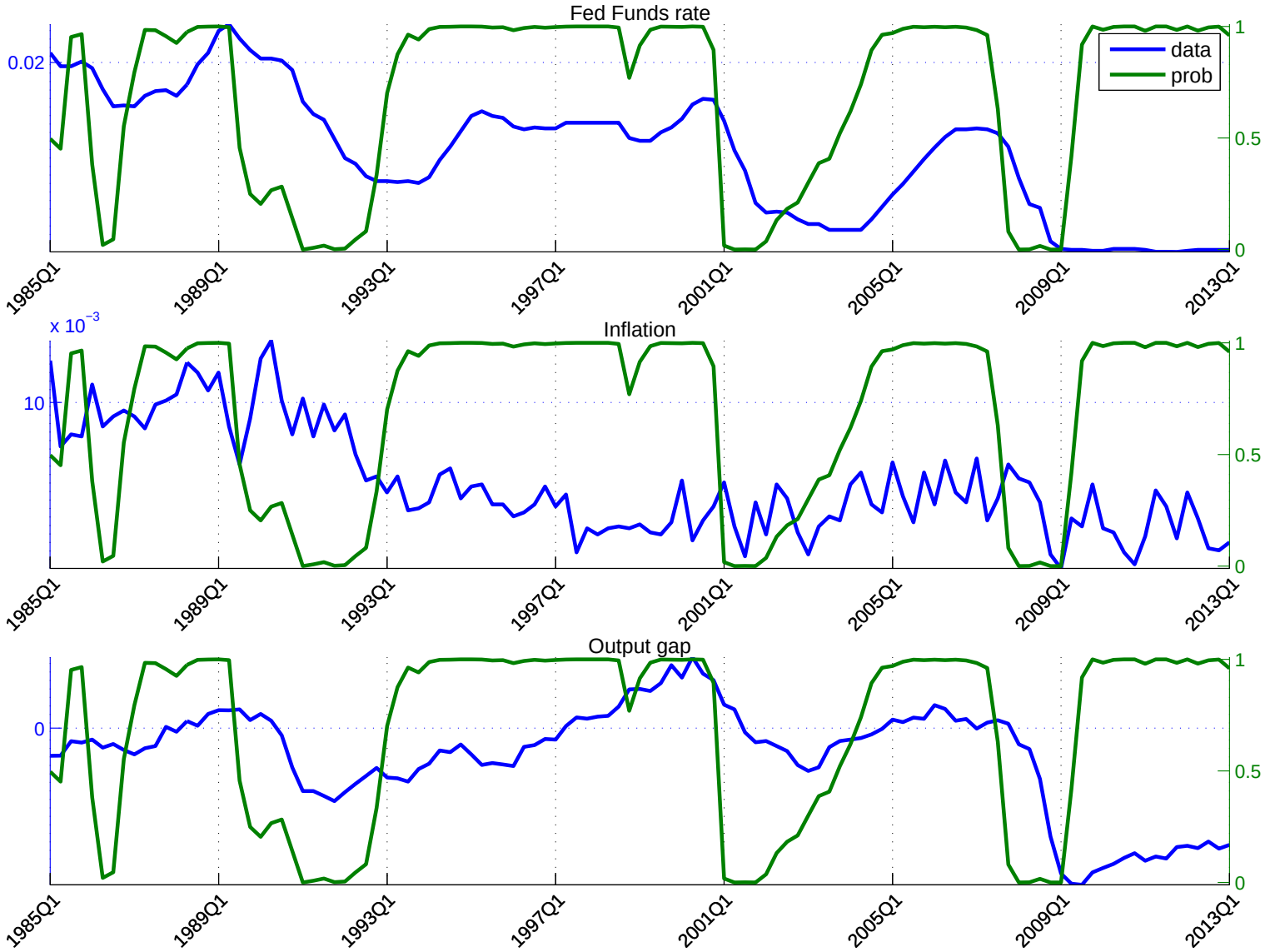


Figure # 11: svar_policy_volatility:: Observed vs pol_2(pol_2)

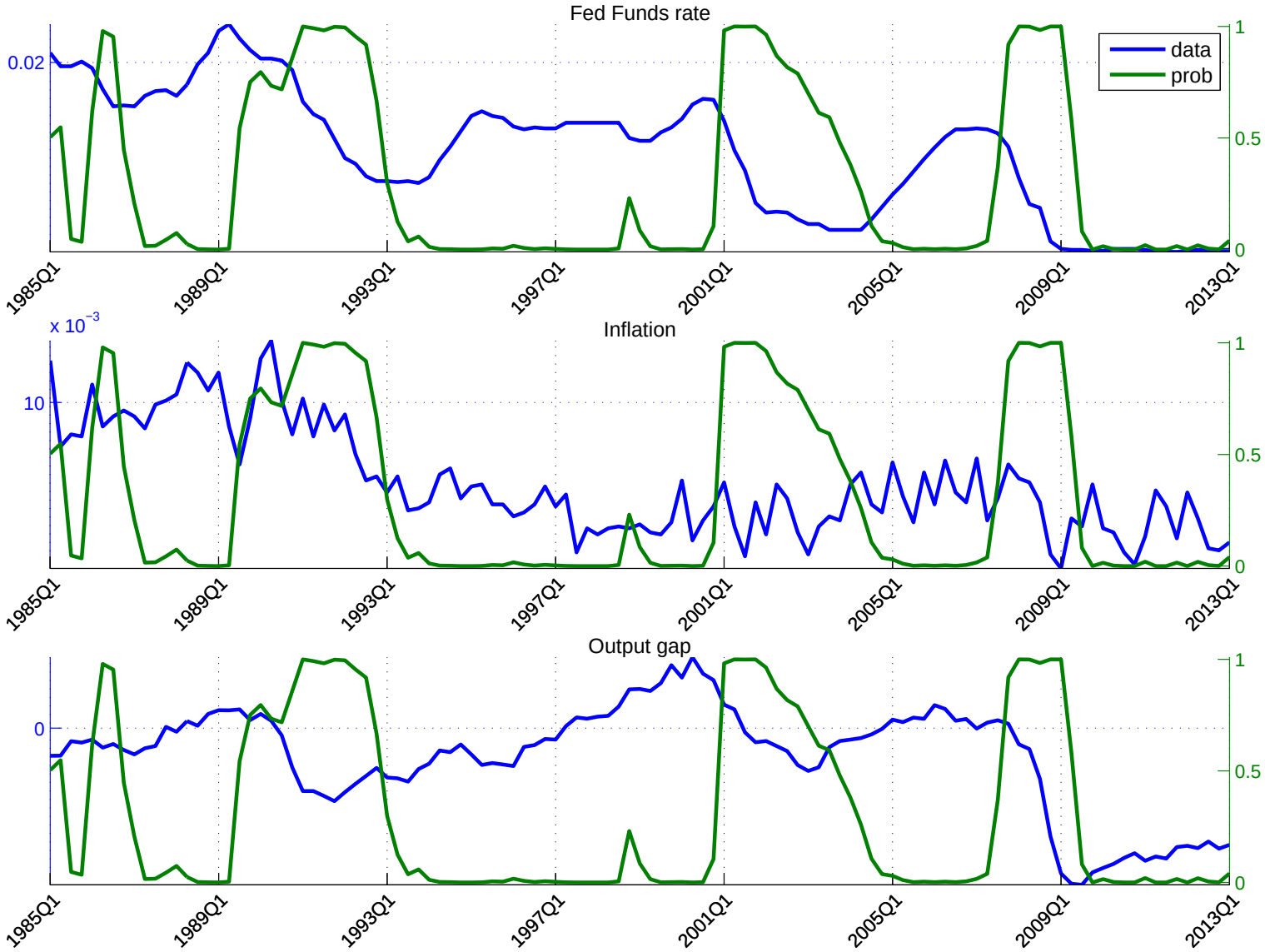


Figure # 12: svar_policy_volatility:: Observed vs vol_1(vol_1)

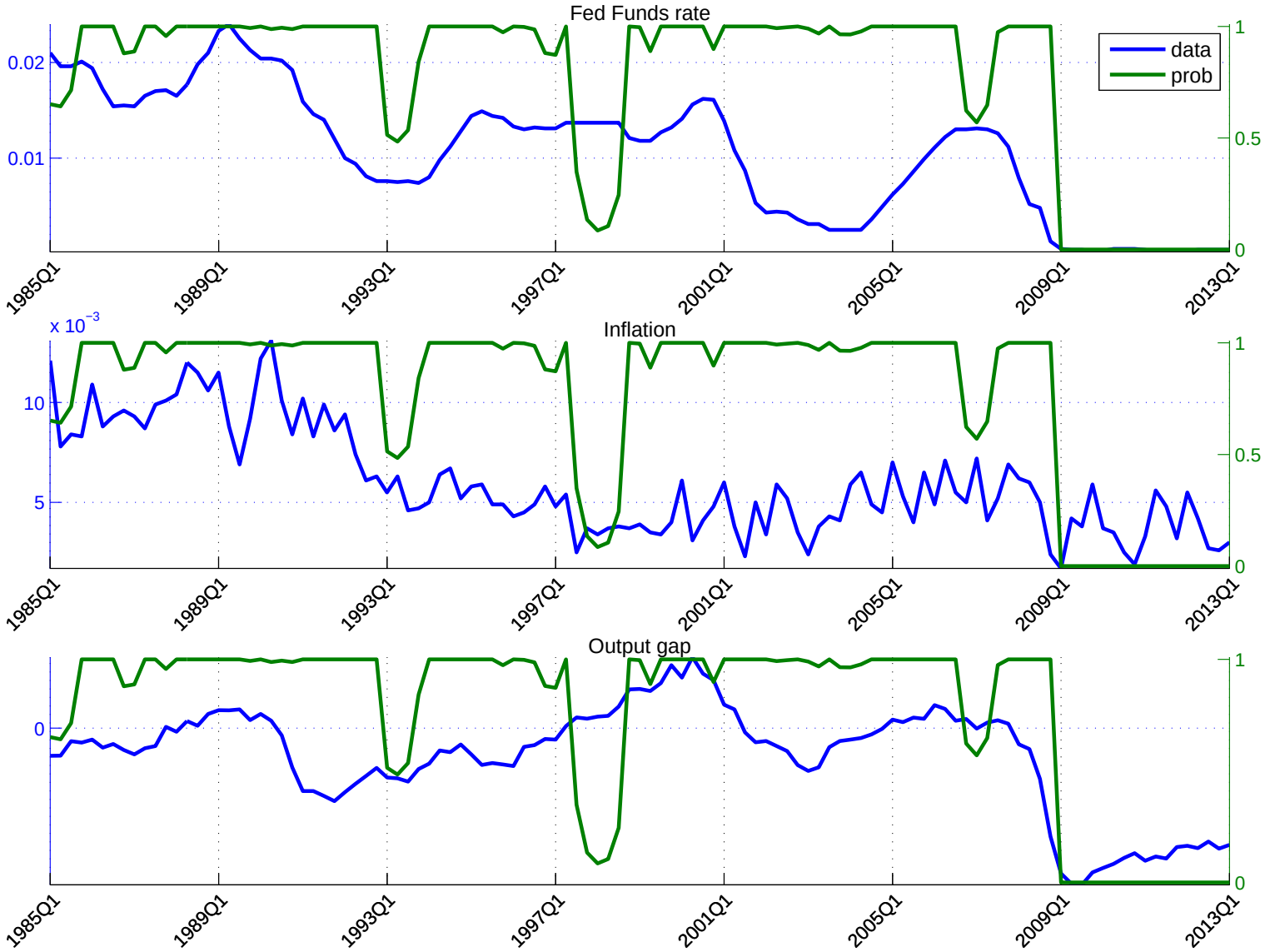


Figure # 13: svar_policy_volatility:: Observed vs vol_2(vol_2)

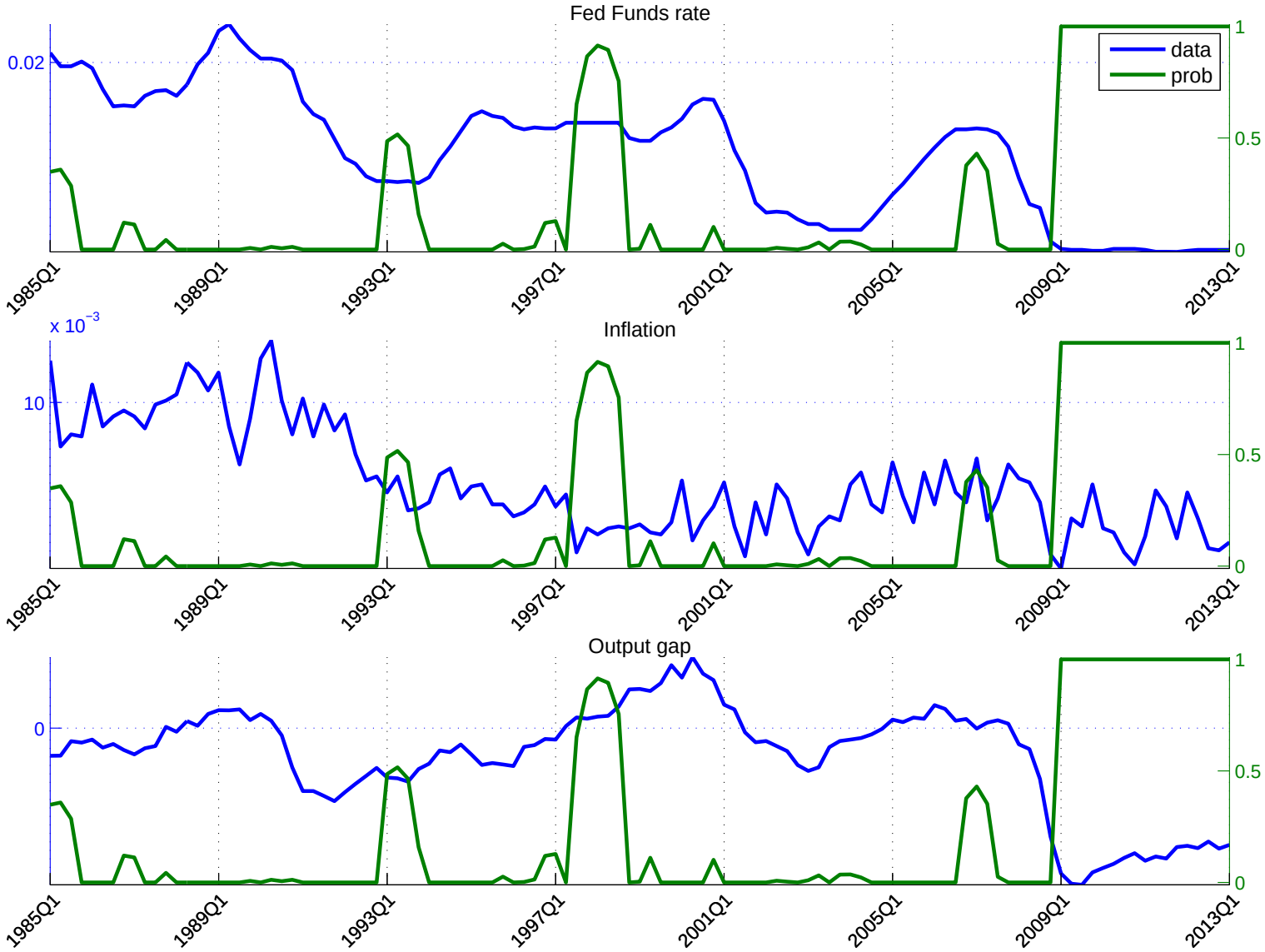


Figure # 14: Unobserved variables

Figure # 15: (Generalized) IRFs to a Taylor rule shock shock

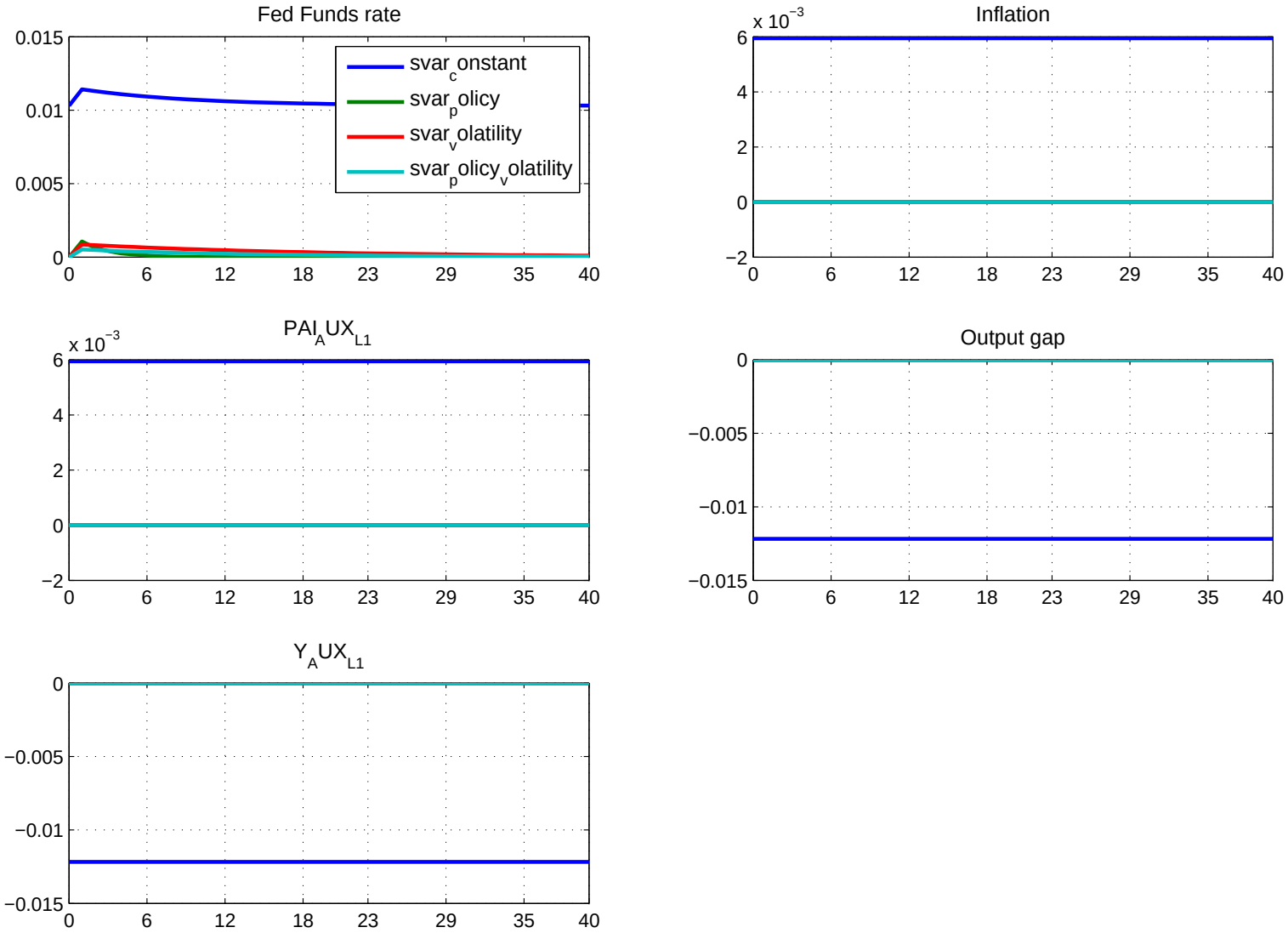


Figure # 16: (Generalized) IRFs to a Phil. curve shock shock

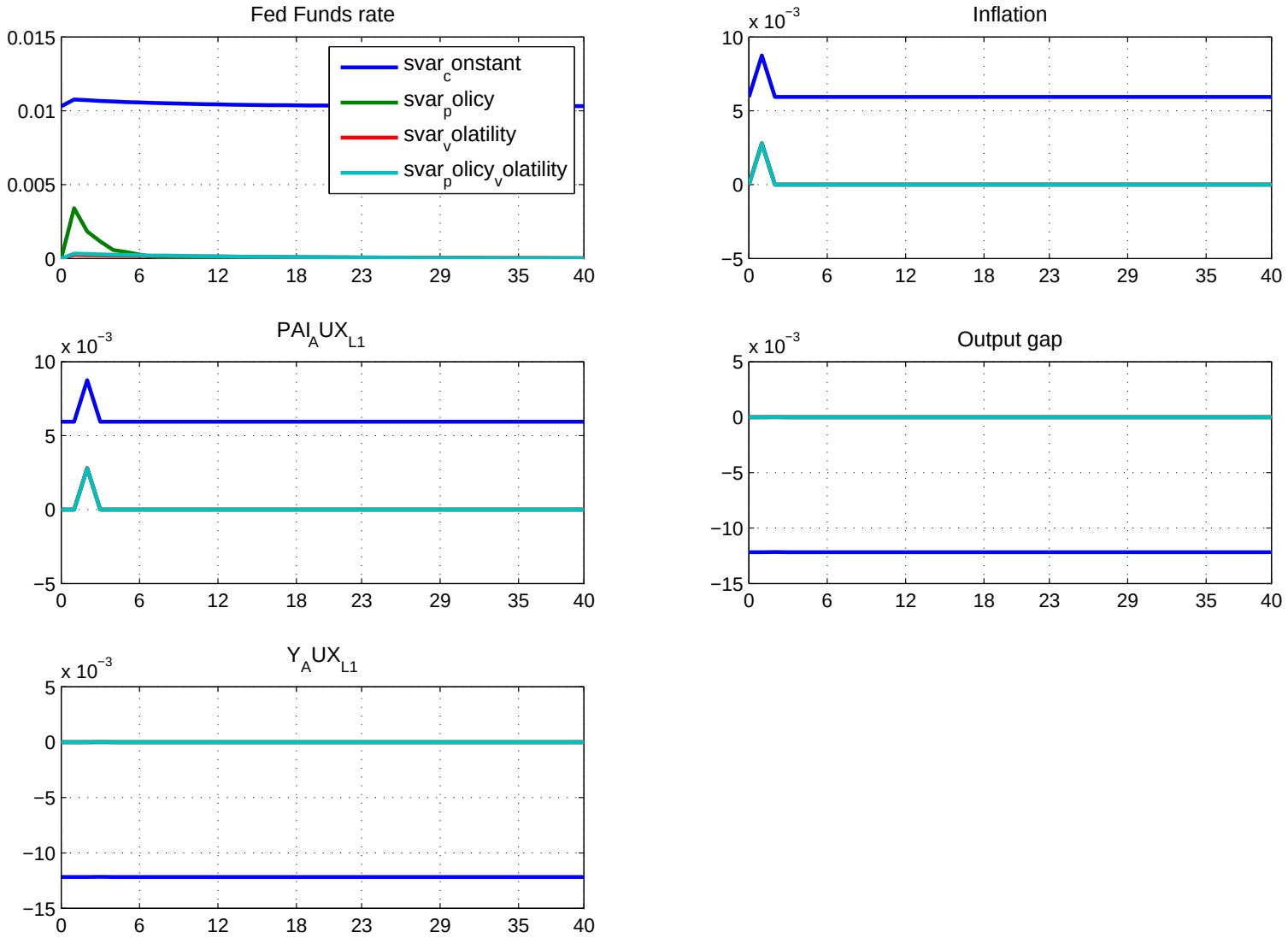


Figure # 17: (Generalized) IRFs to a IS curve shock shock

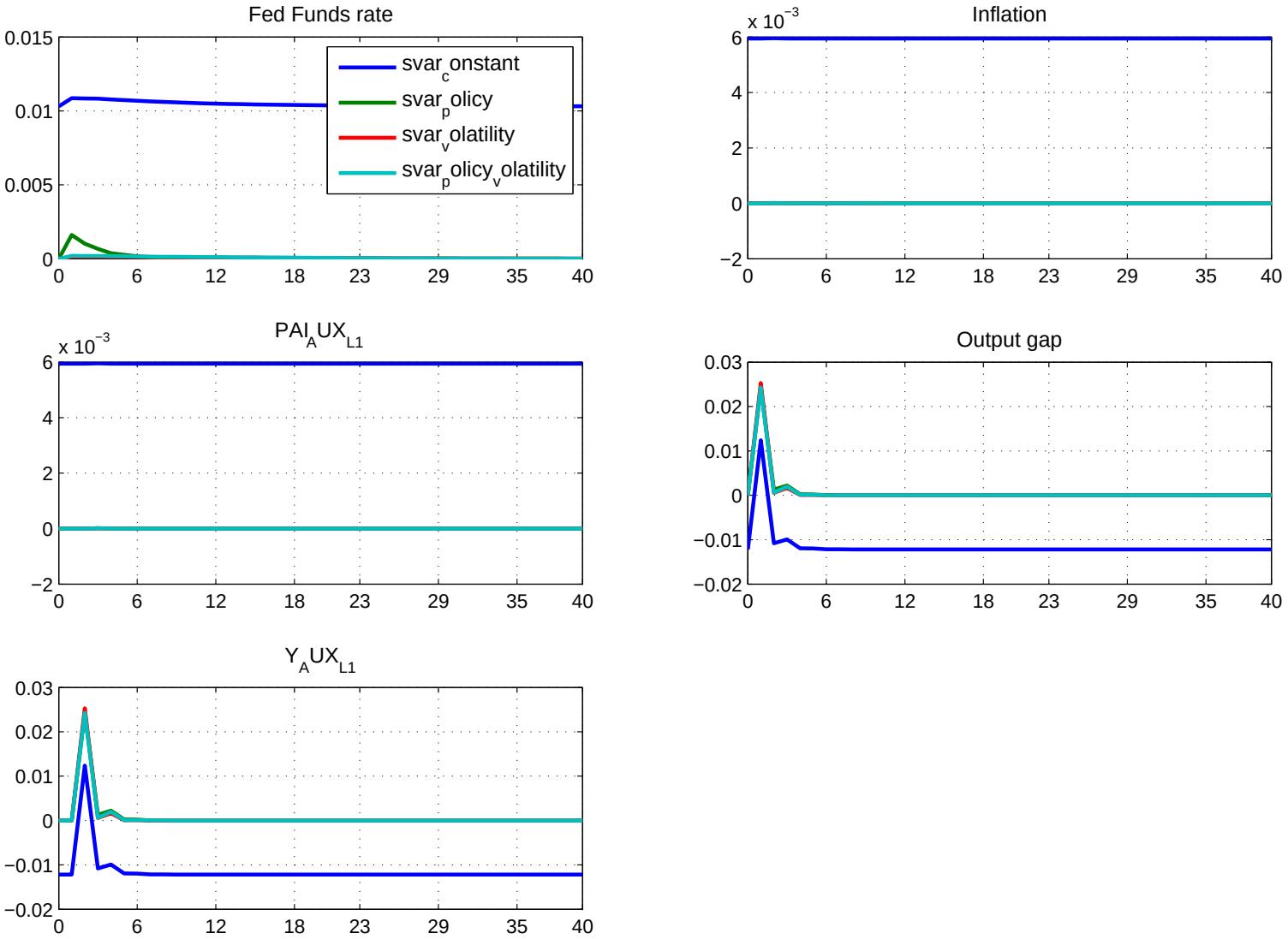


Figure # 18: historical decomposition of Fed Funds rate

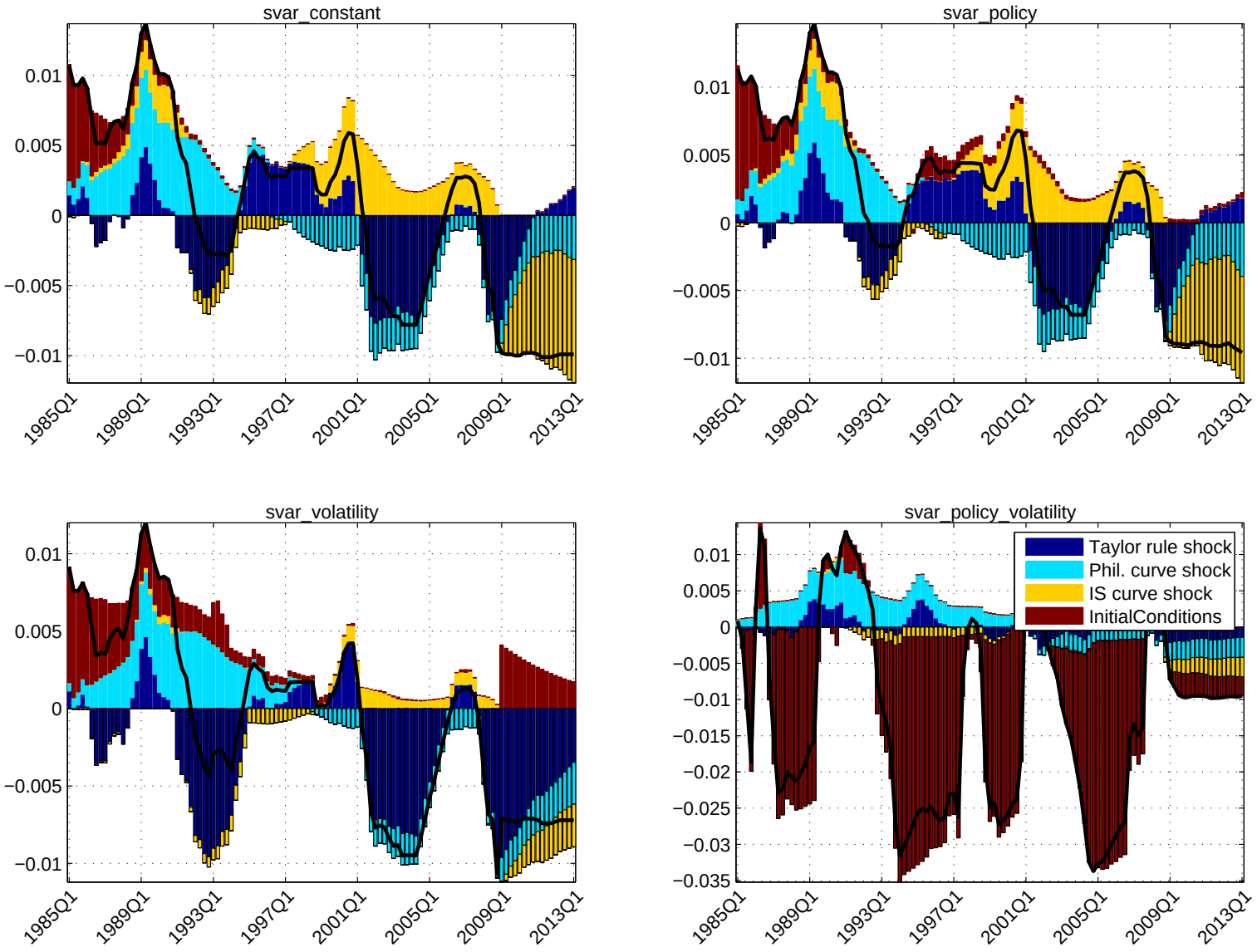


Figure # 19: historical decomposition of Inflation

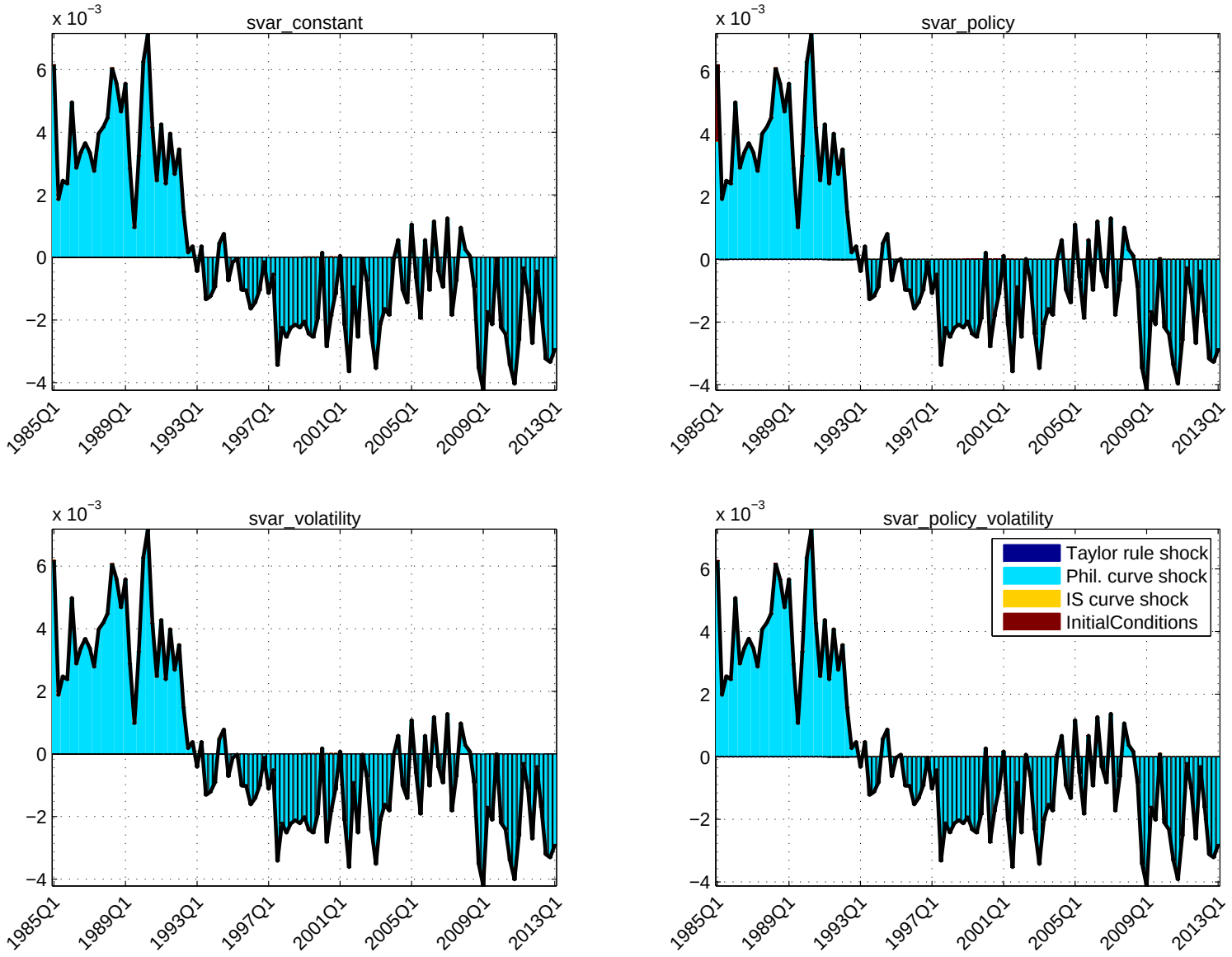


Figure # 20: historical decomposition of PAI_AUX_L_1

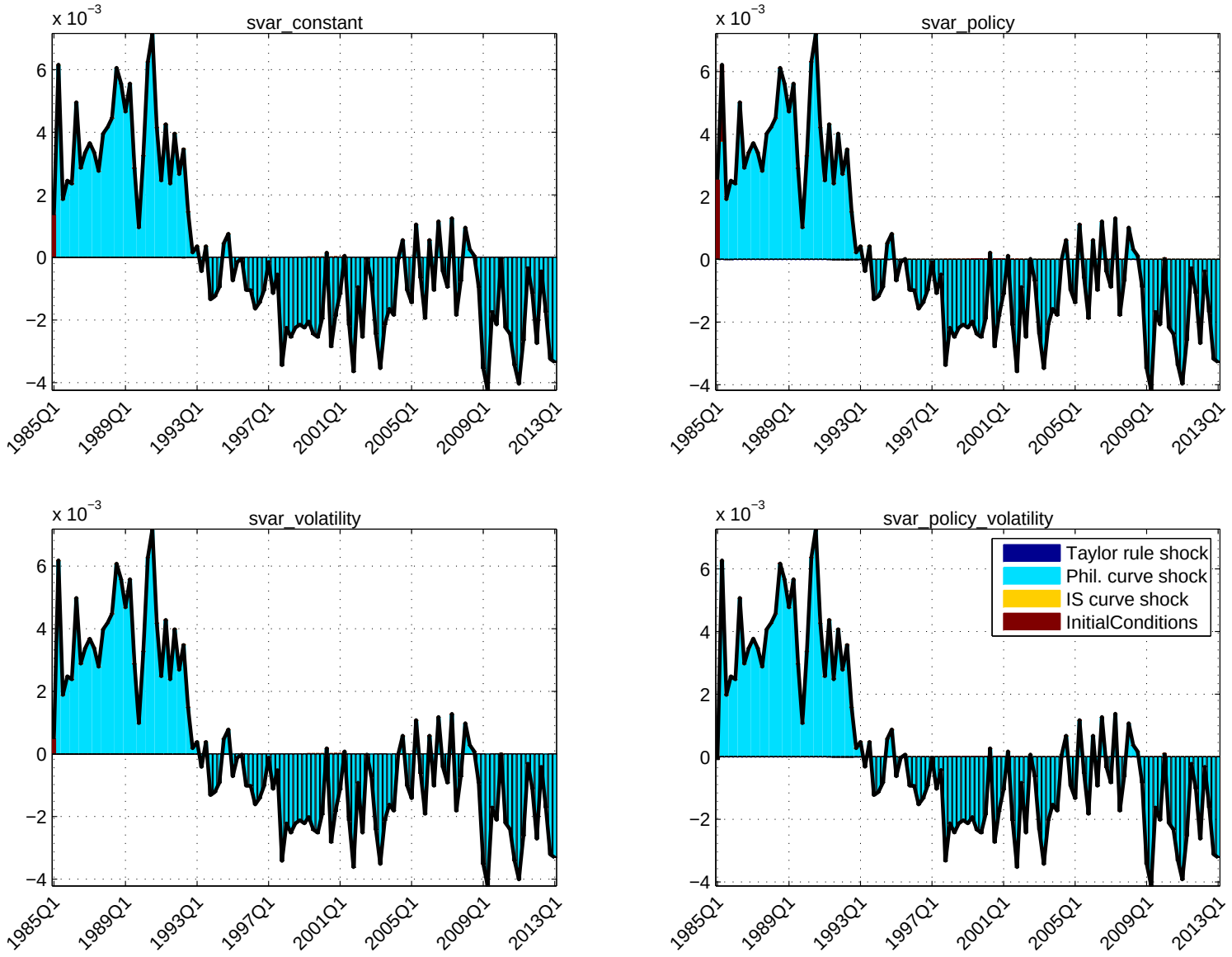


Figure # 21: historical decomposition of Output gap

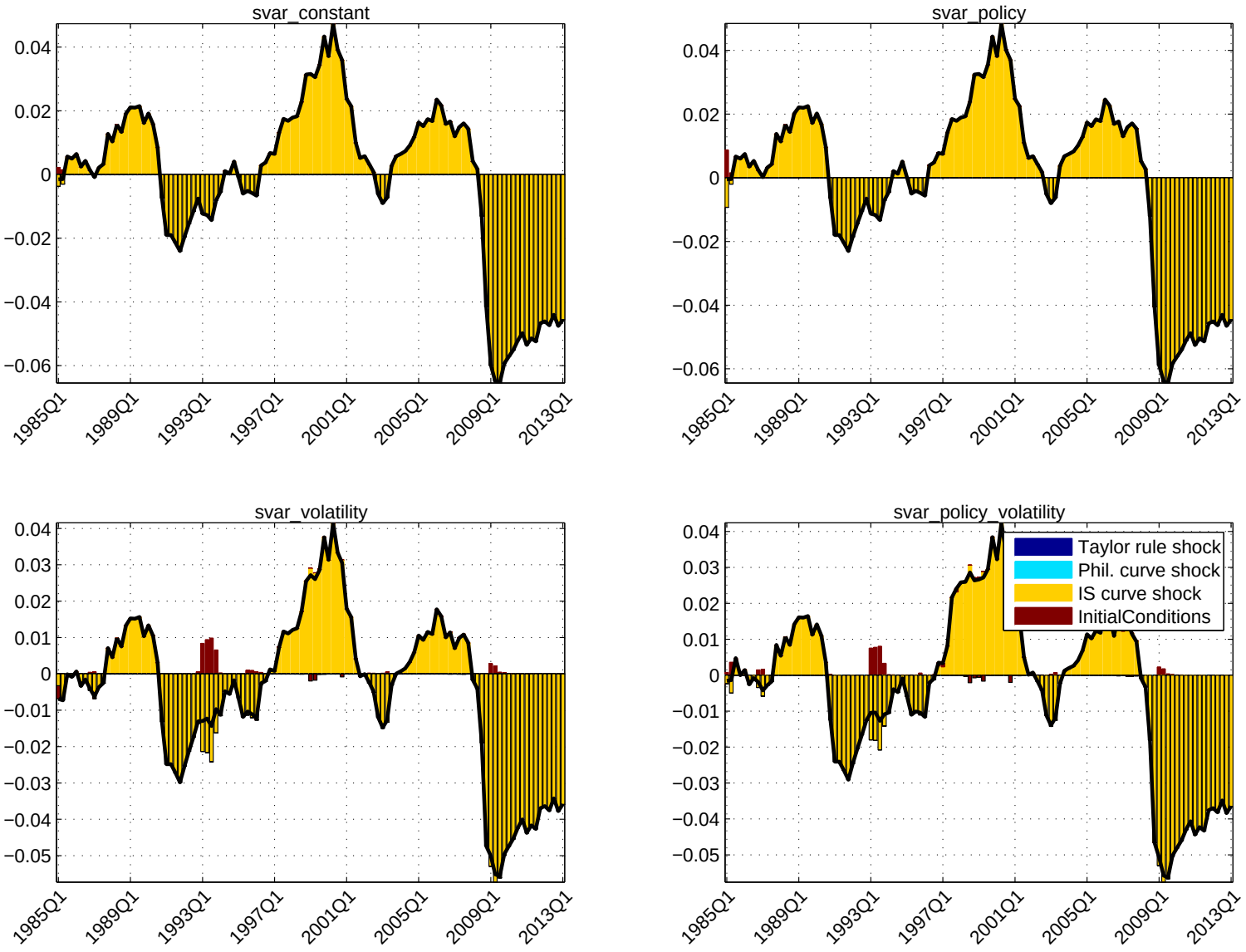


Figure # 22: historical decomposition of Y_AUX_L_1

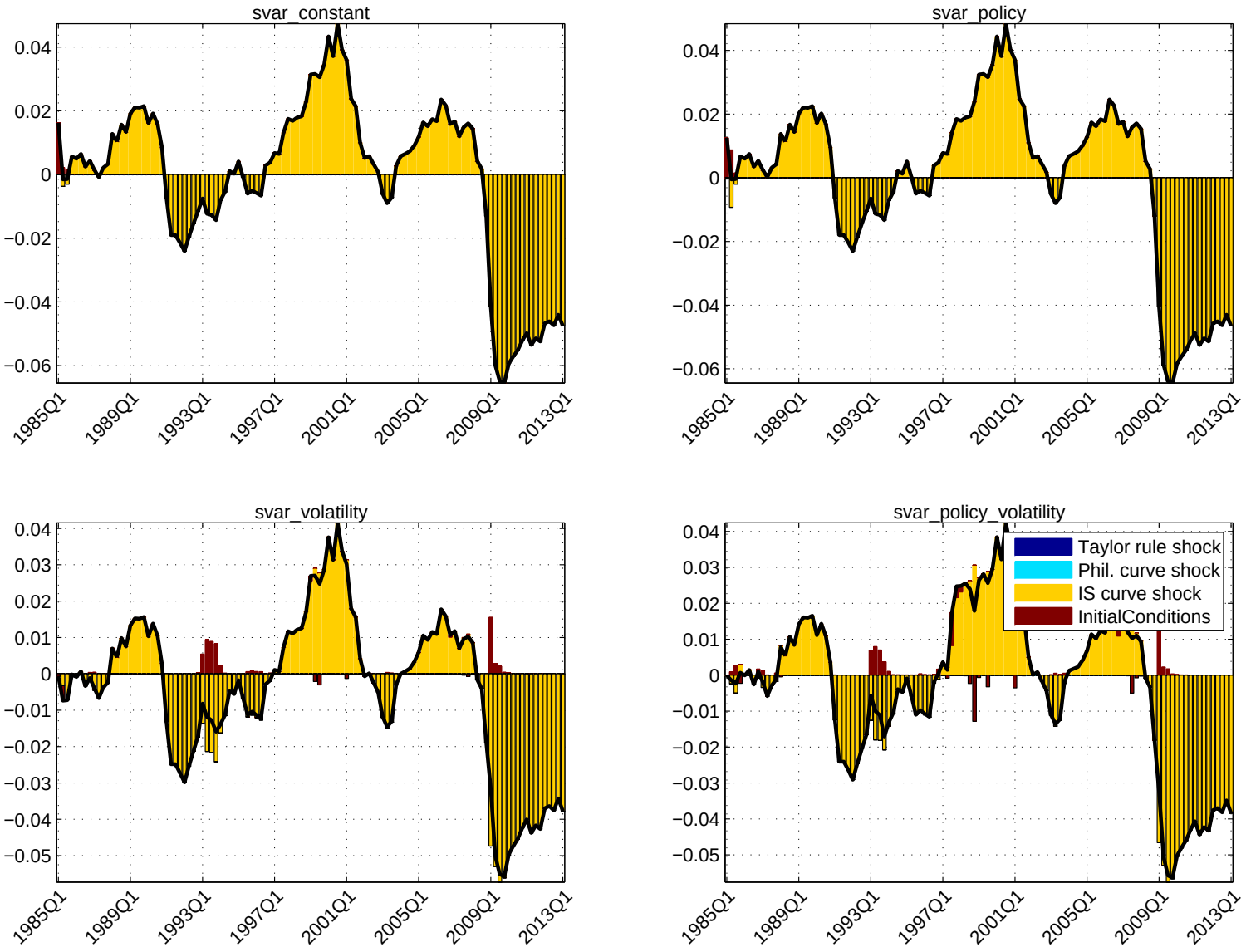


Figure # 23: Variance decomposition of Fed Funds rate

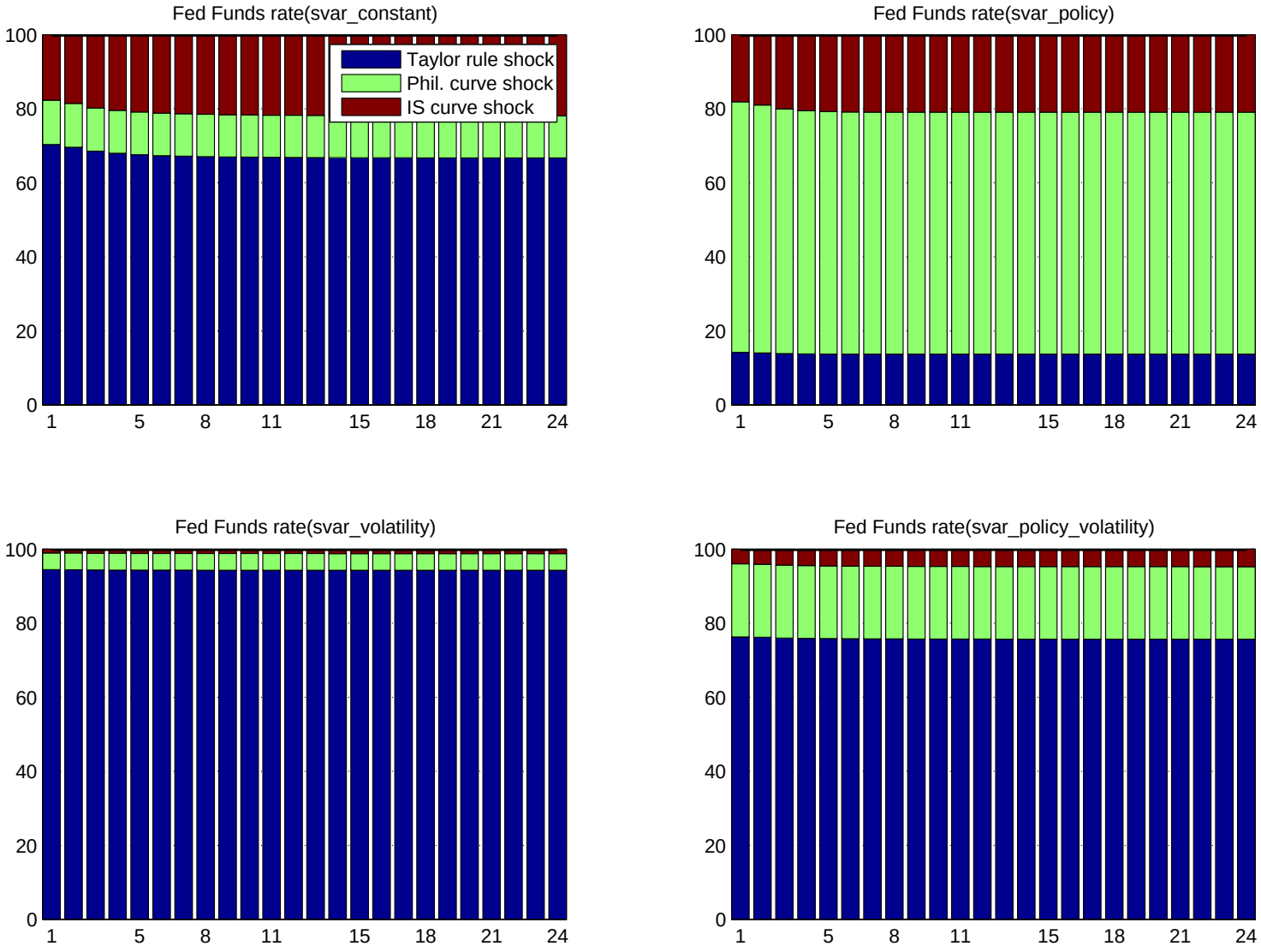


Figure # 24: Variance decomposition of Inflation

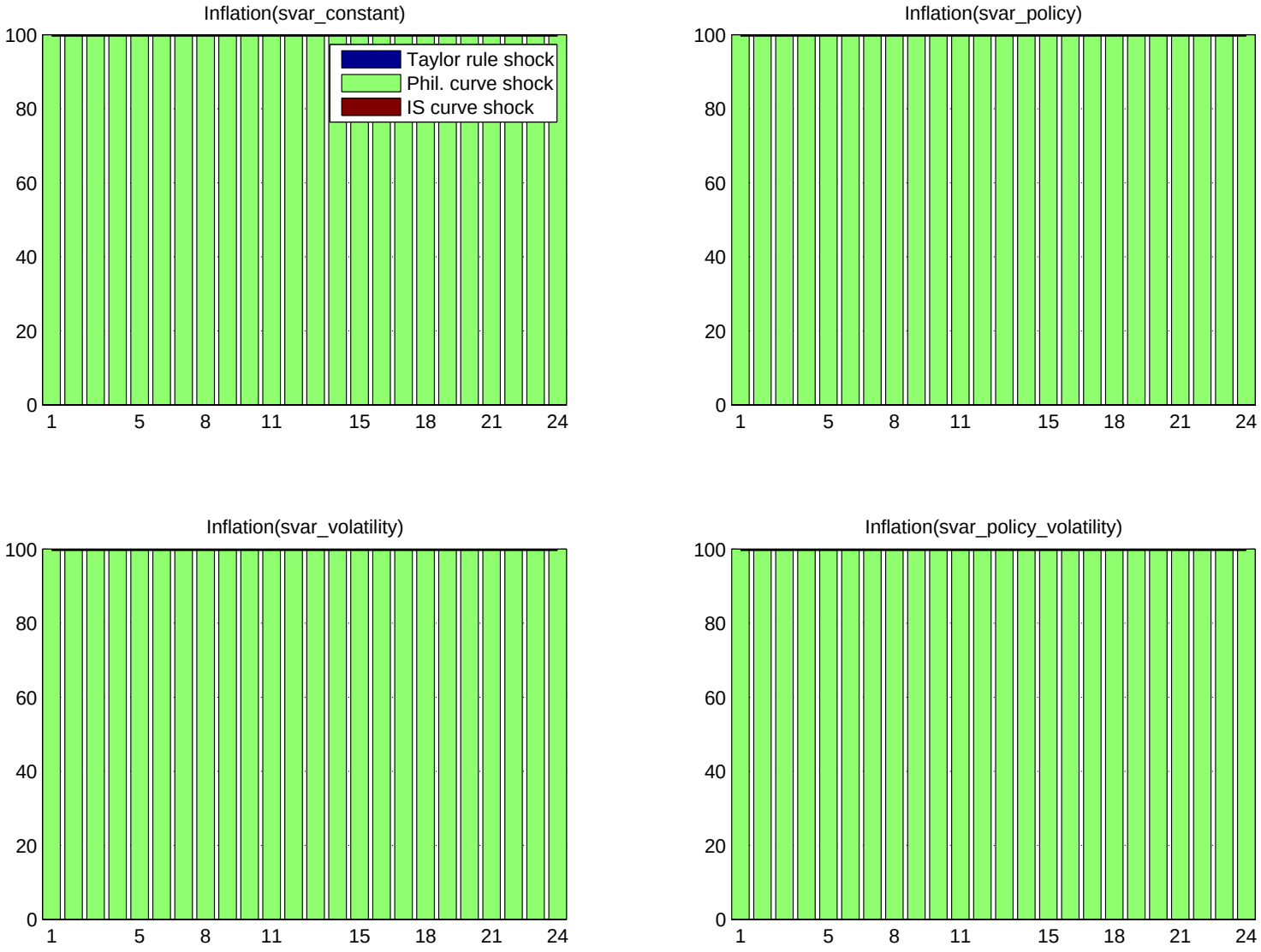


Figure # 25: Variance decomposition of Output gap

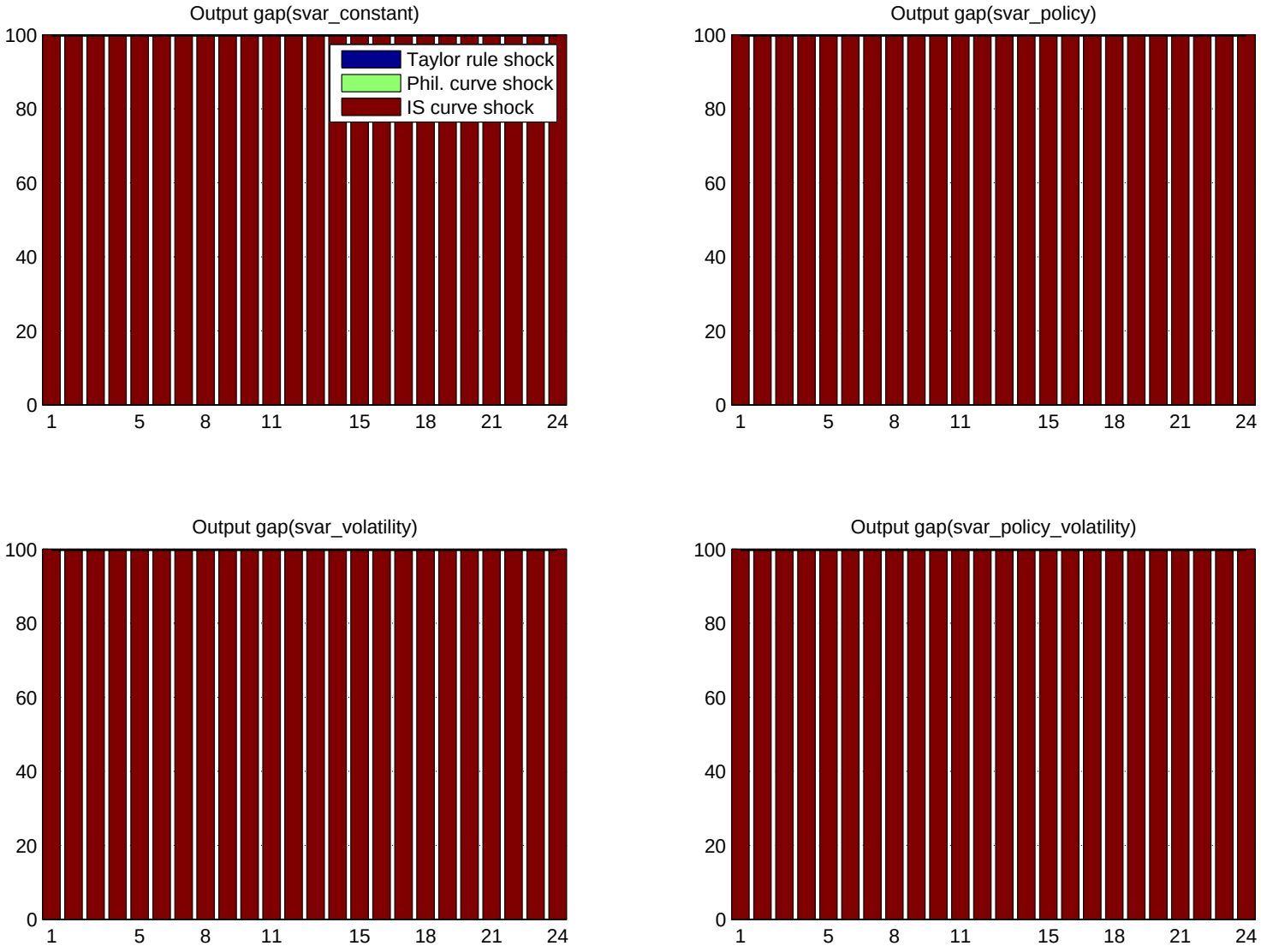
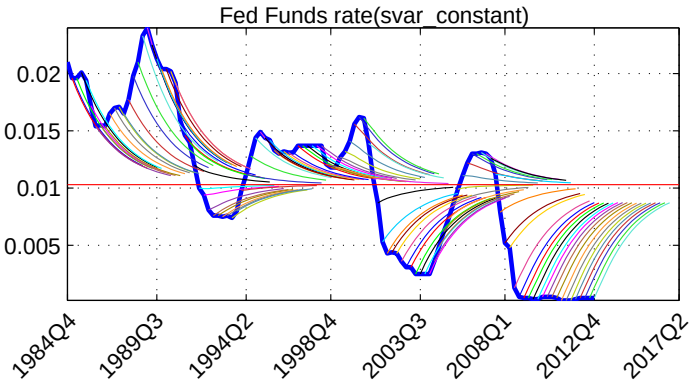
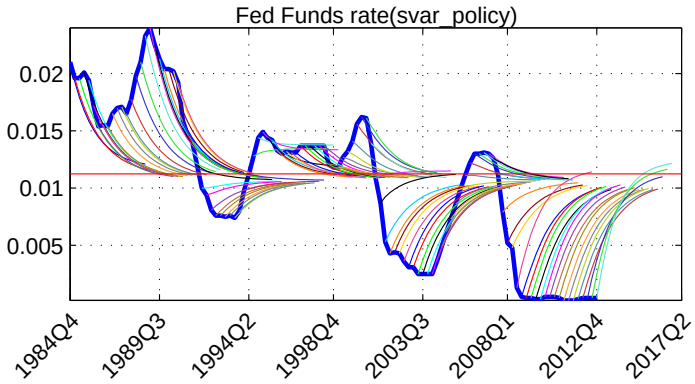
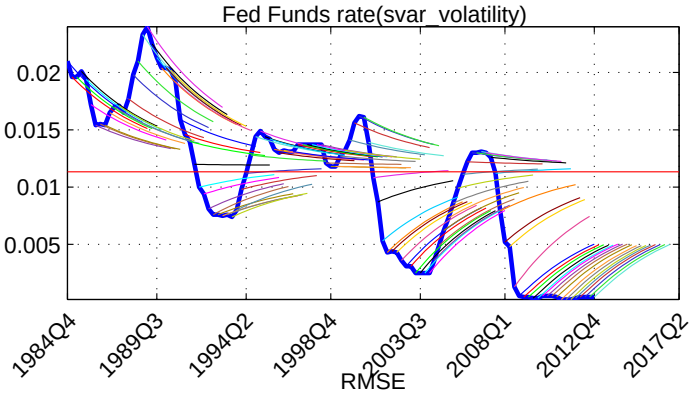
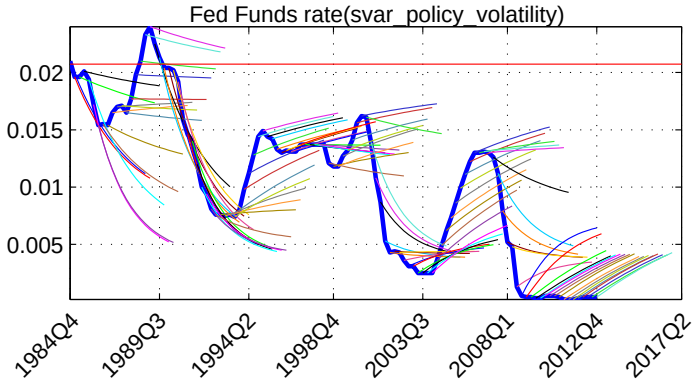


Figure # 26: real-time forecasts for Fed Funds rate









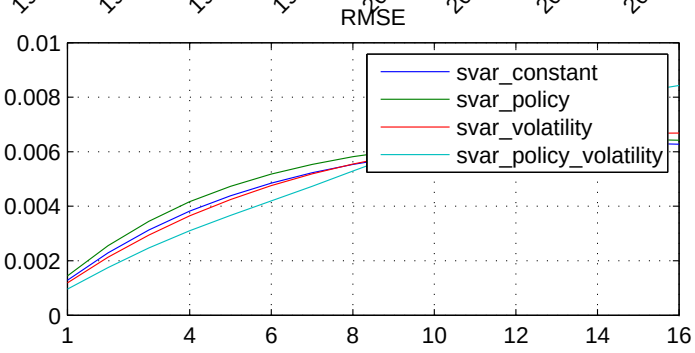


Figure # 27: real-time forecasts for Inflation

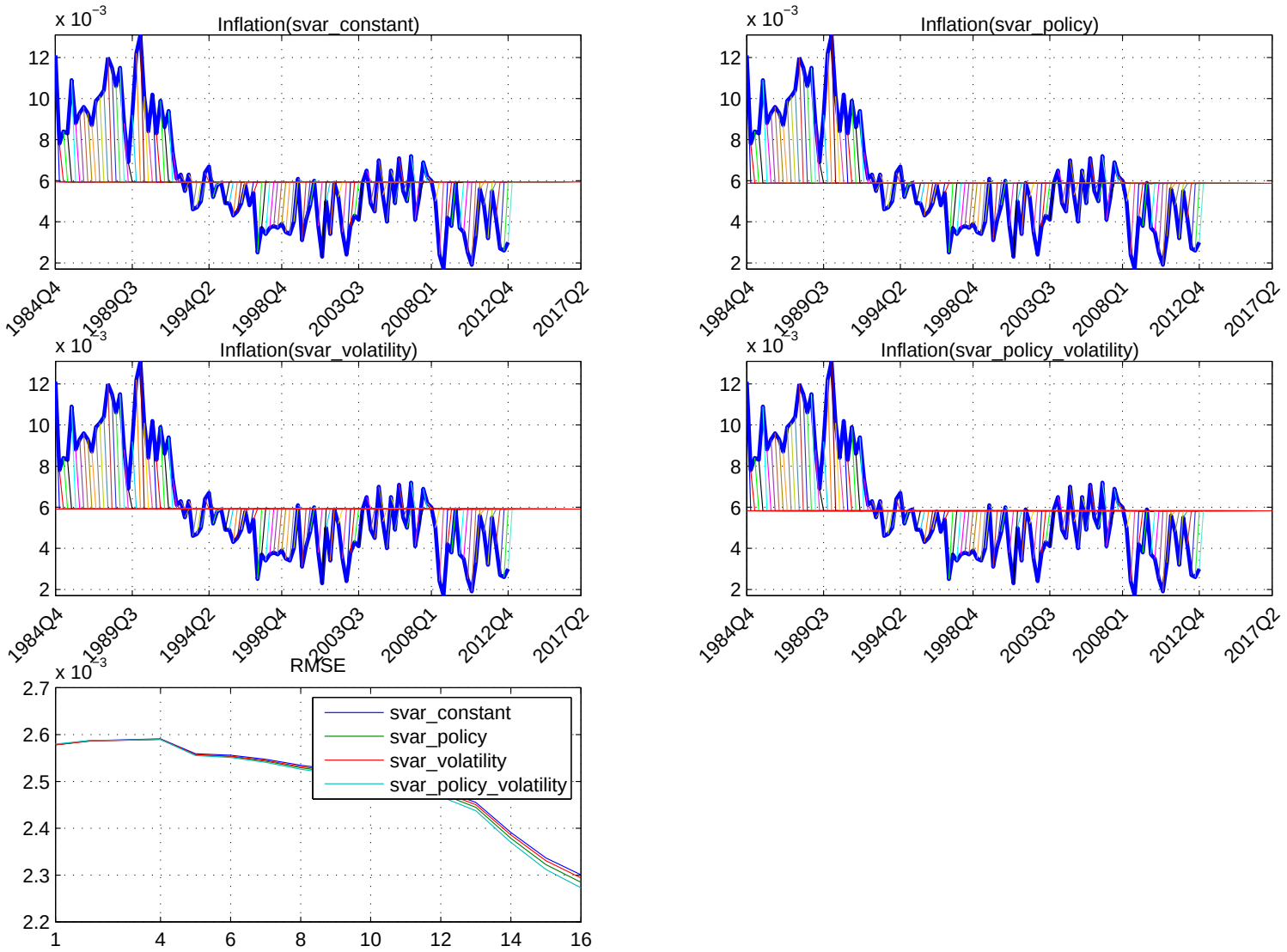
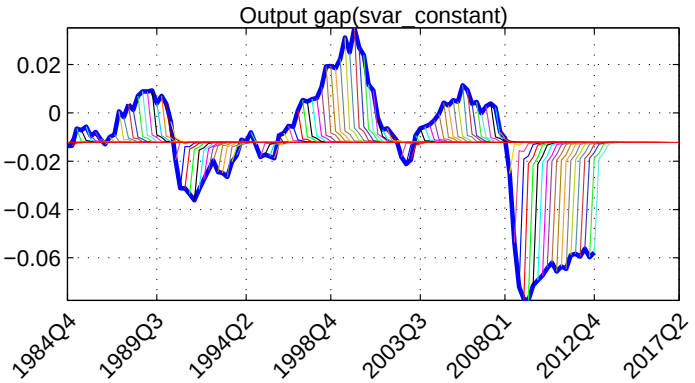
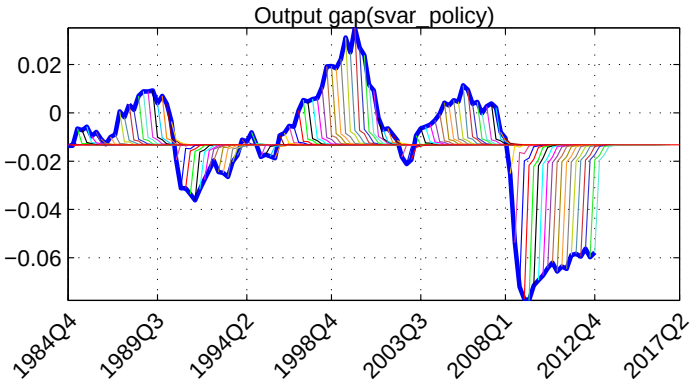
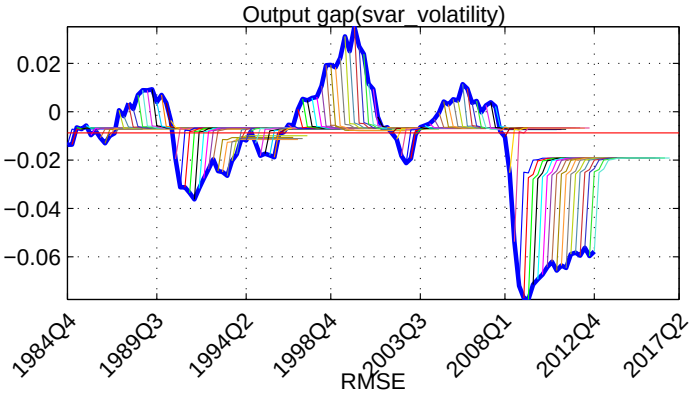
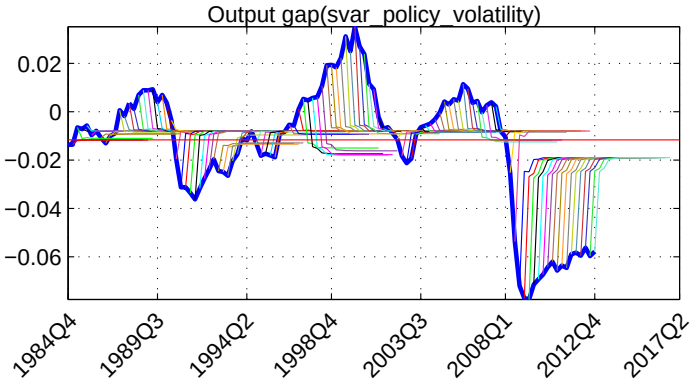


Figure # 28: real-time forecasts for Output gap









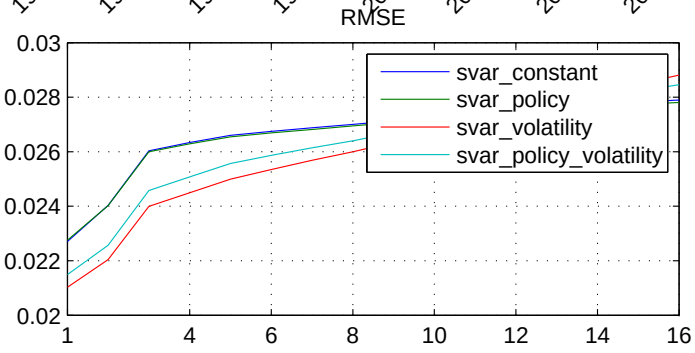


Figure # 29: Vector autocorrelations(1)

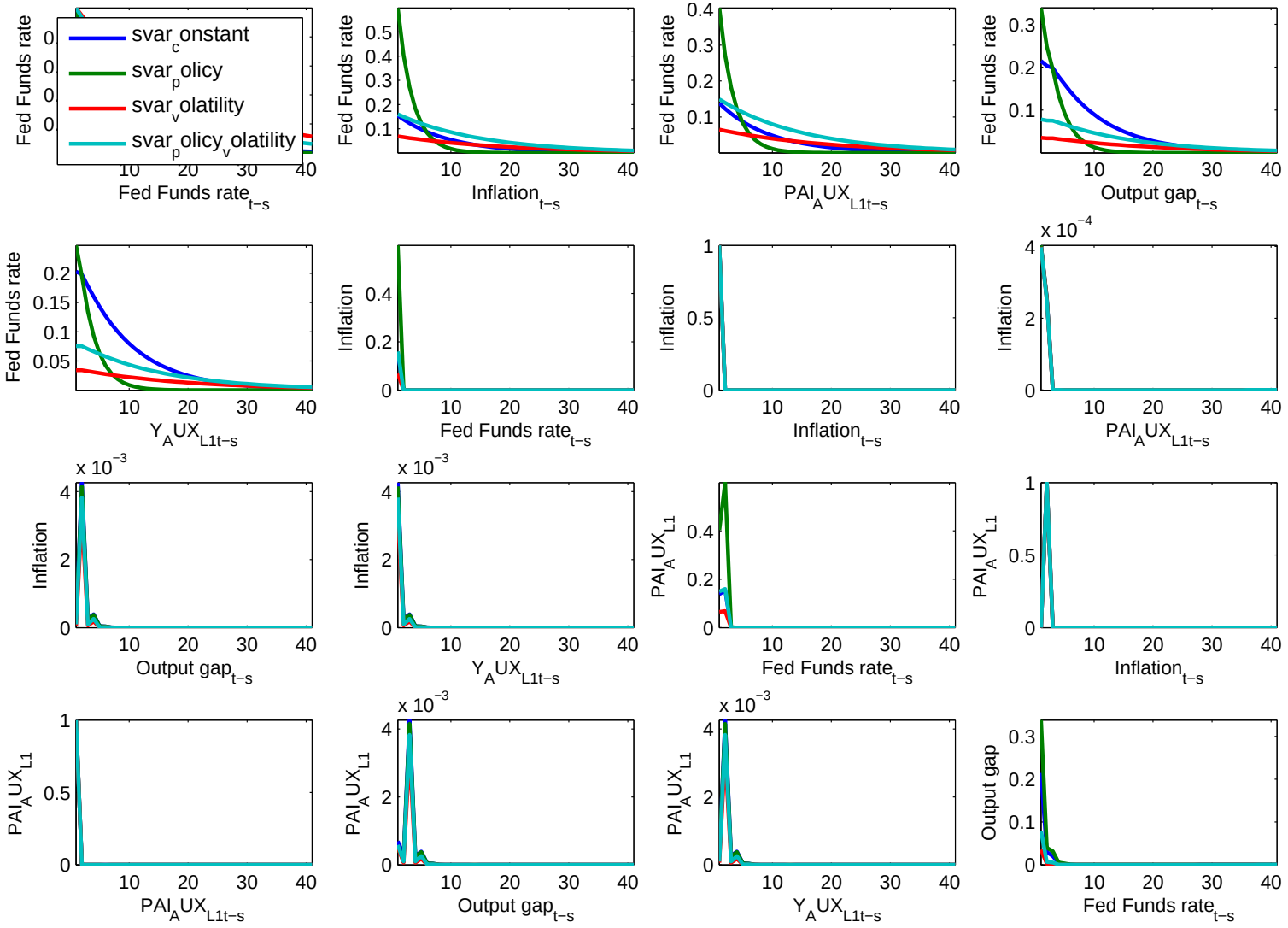


Figure # 30: Vector autocorrelations(2)

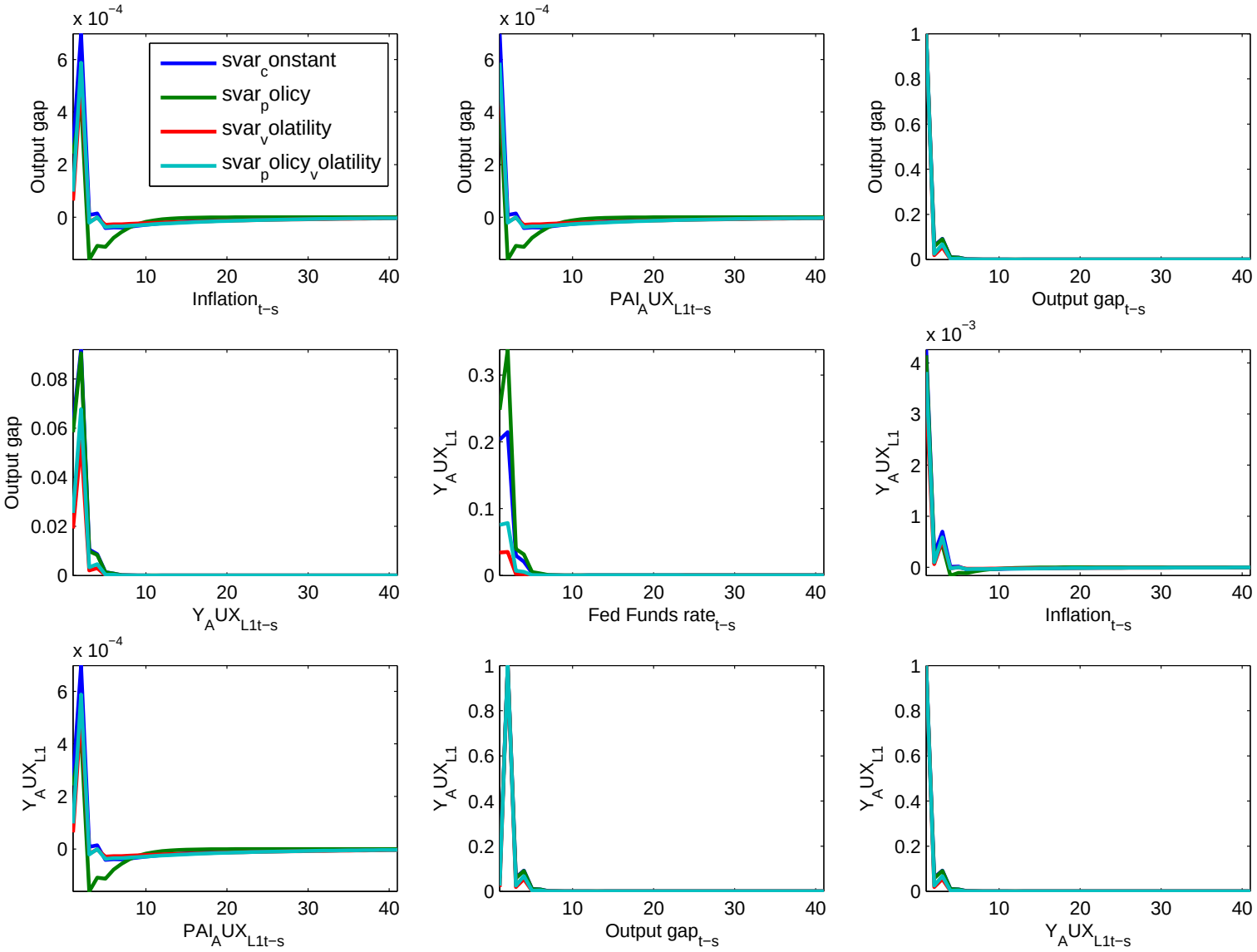


Figure # 31: Smoothed shocks

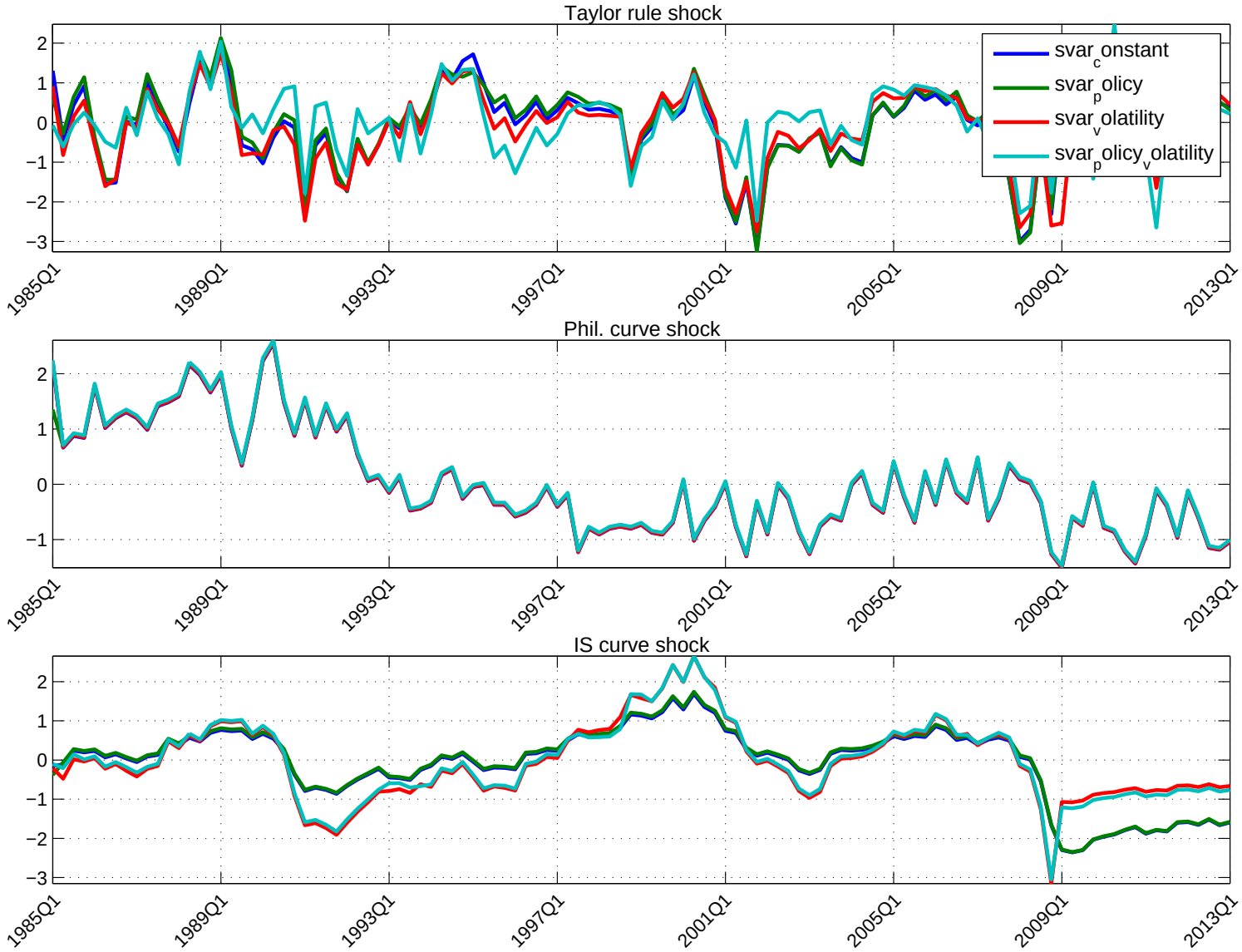


Table # 7: Exogenous Variables

Model code	Description
EI	Taylor rule shock
EPAI	Phil. curve shock
EY	IS curve shock

Table # 8: Shock correlation structure in svar_constant

	EI	EPAI	EY
EI	1	-0.02267	-0.01879
EPAI	-0.02267	1	0.23
EY	-0.01879	0.23	1

Table # 9: Shock correlation structure in svar_policy

	EI	EPAI	EY
EI	1	-0.01291	0.01442
EPAI	-0.01291	1	0.231
EY	0.01442	0.231	1

Table # 10: Shock correlation structure in svar_volatility

	EI	EPAI	EY
EI	1	-0.02304	0.3151
EPAI	-0.02304	1	0.00692
EY	0.3151	0.00692	1

Table # 11: Shock correlation structure in svar_policy_volatility

	EI	EPAI	EY
EI	1	0.05	0.1989
EPAI	0.05	1	0.04611
EY	0.1989	0.04611	1

Figure # 32: Empirical distribution of smoothed shocks

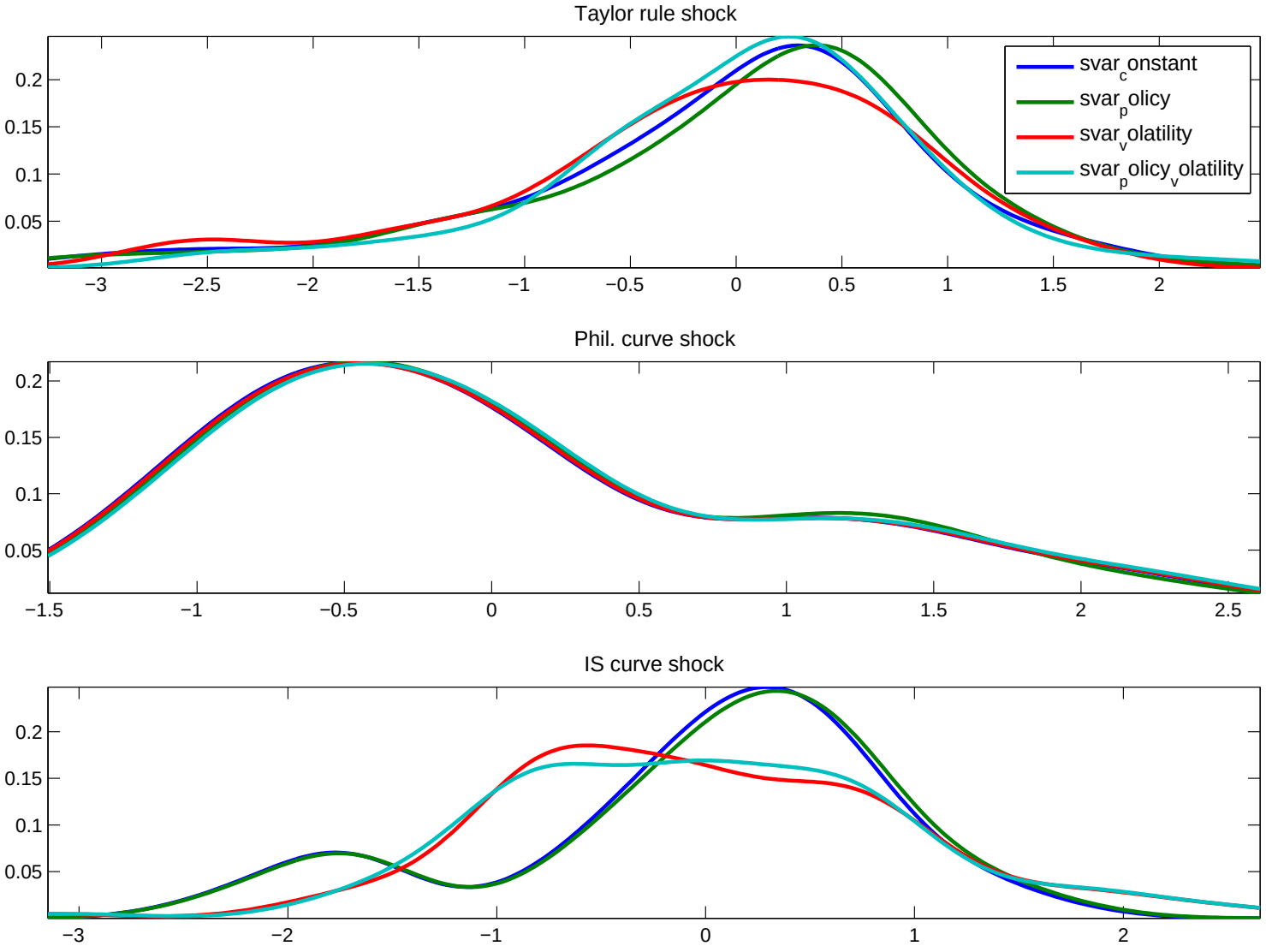


Figure # 33: svar_constant:: Posterior Impulse responses to a EI shock in irf

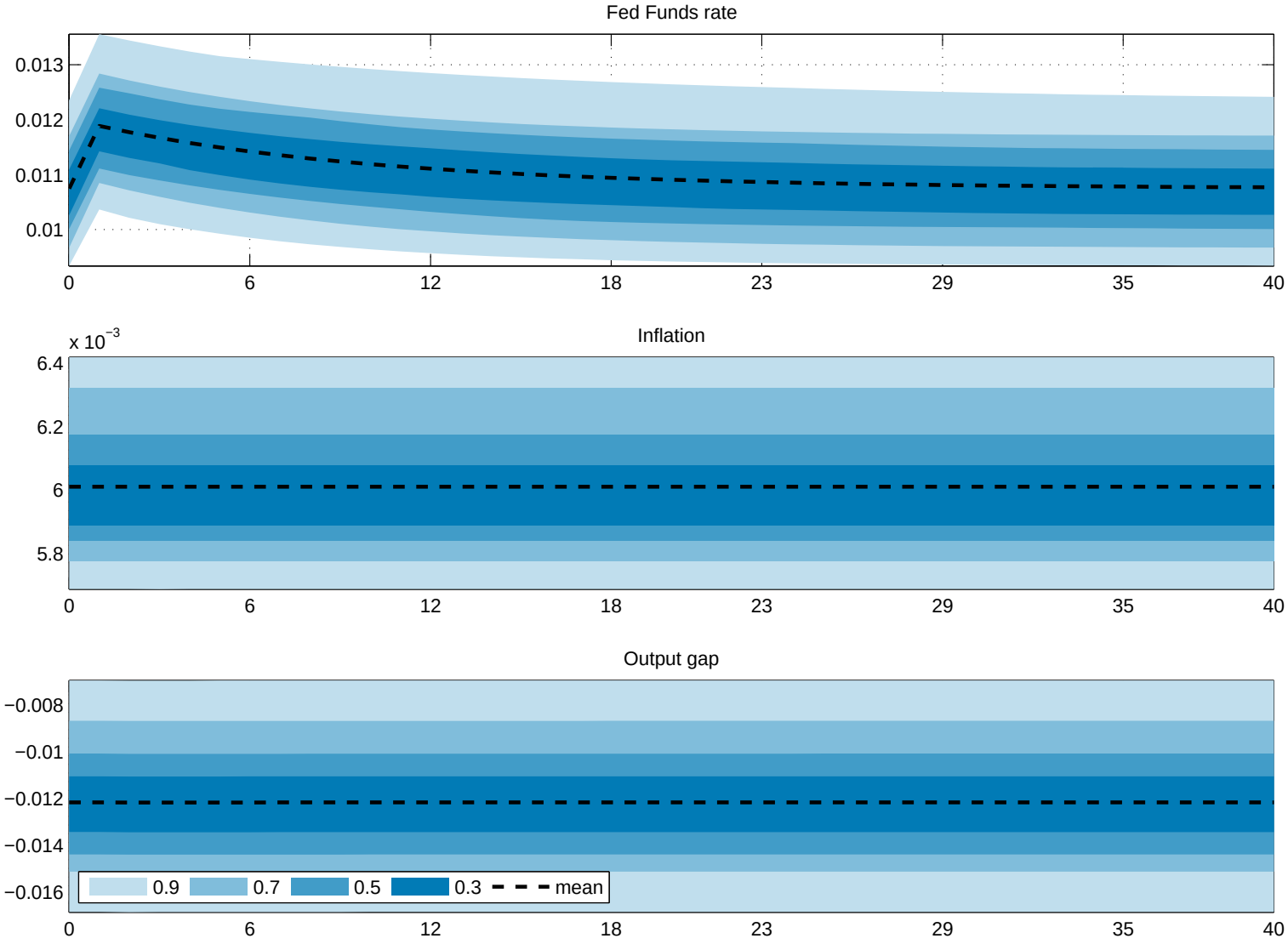


Figure # 34: svar_constant:: Posterior Impulse responses to a EPAI shock in irf

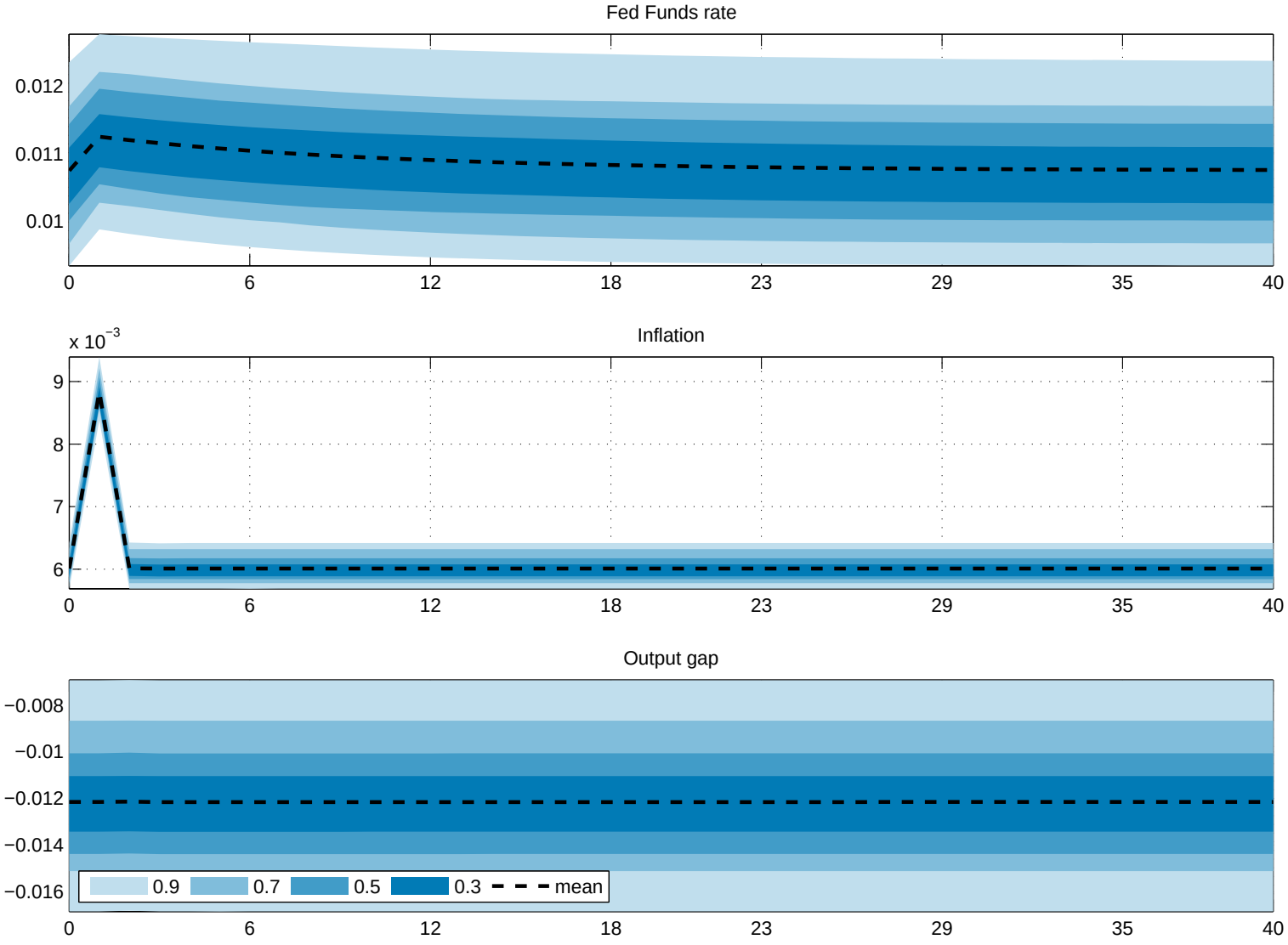


Figure # 35: svar_constant:: Posterior Impulse responses to a EY shock in irf

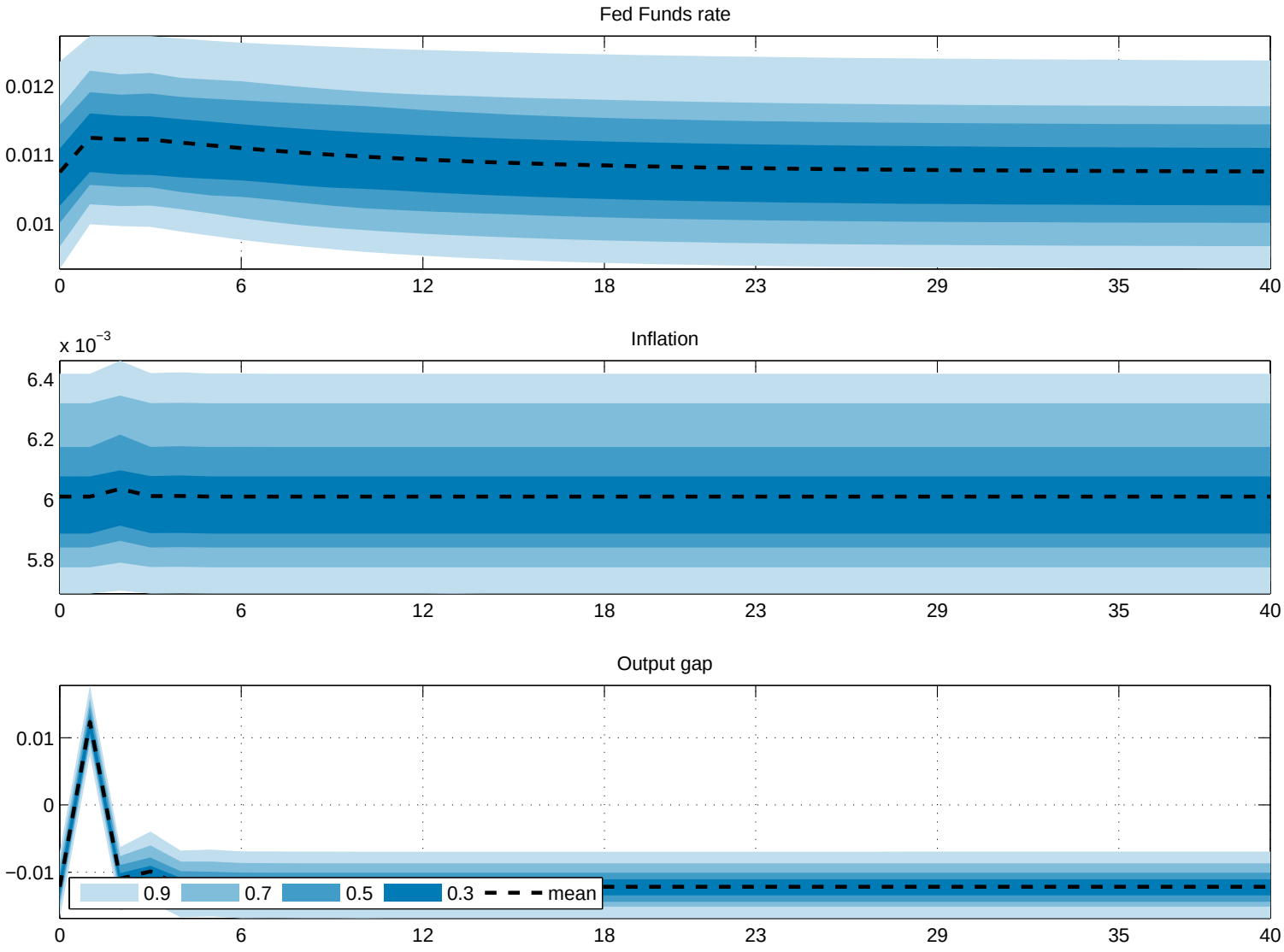


Figure # 36: svar_policy:: Posterior Impulse responses to a EI shock in regime_1

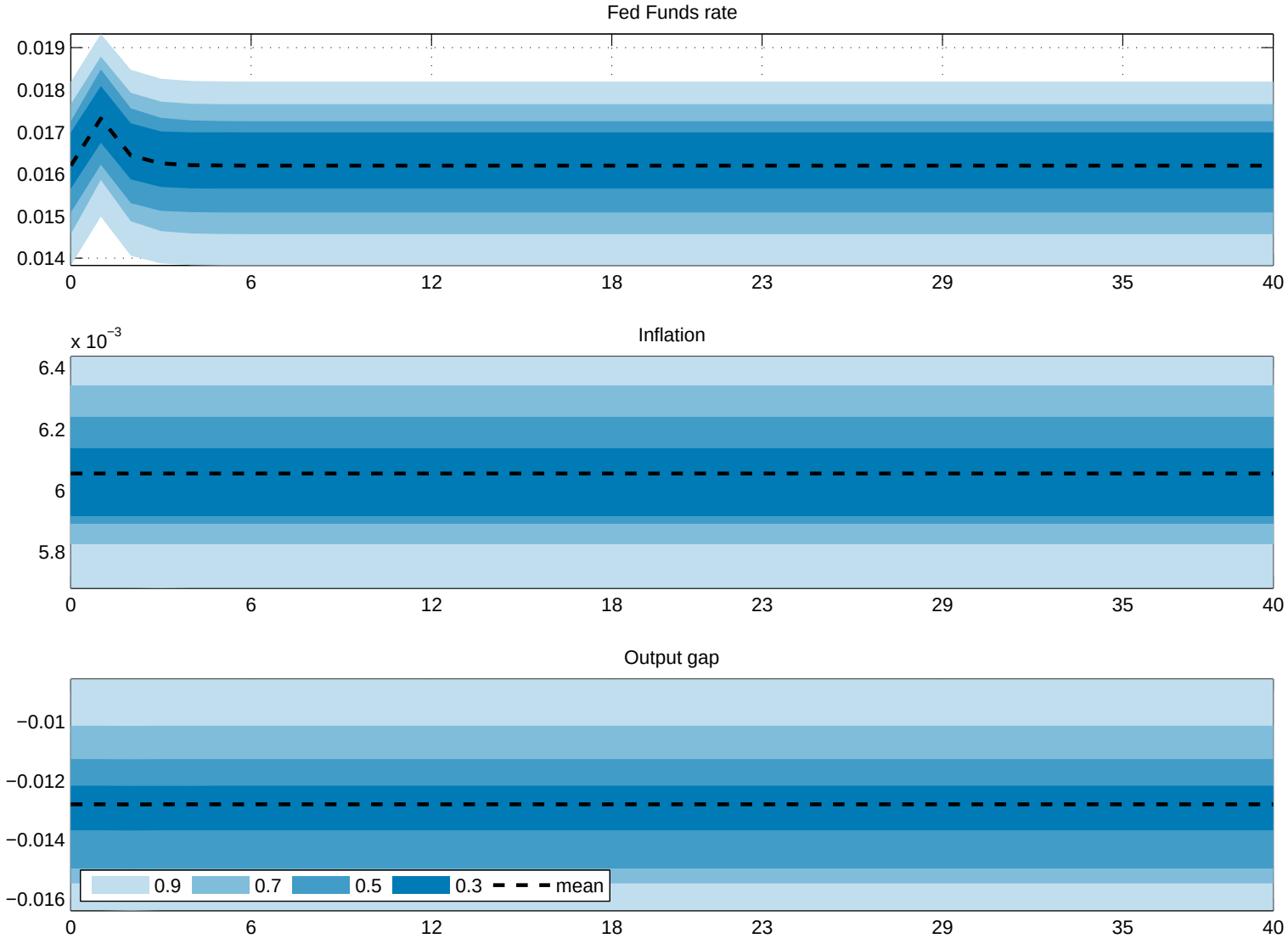


Figure # 37: svar_policy:: Posterior Impulse responses to a EI shock in regime_2

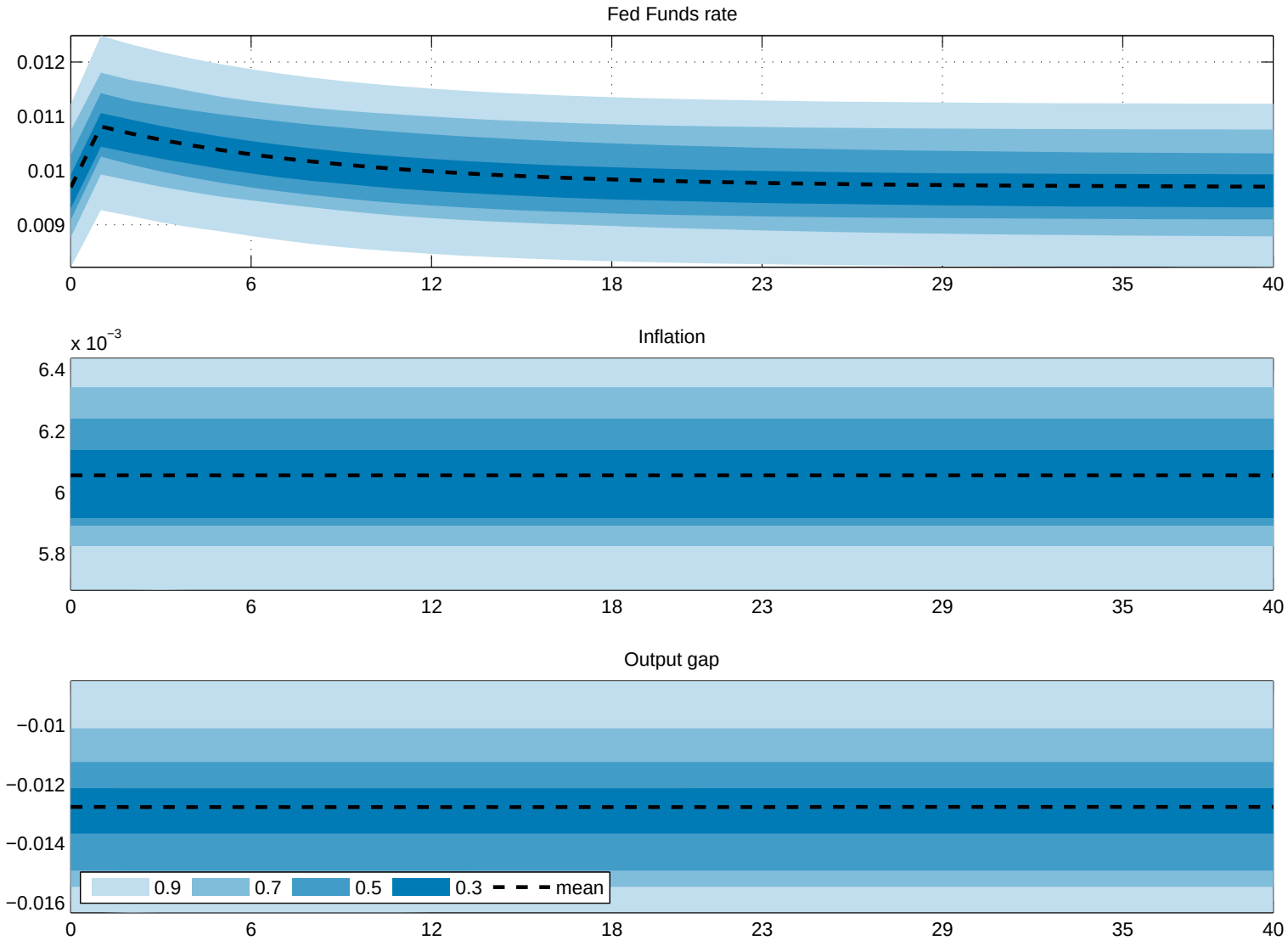


Figure # 38: svar_policy:: Posterior Impulse responses to a EPAI shock in regime_1

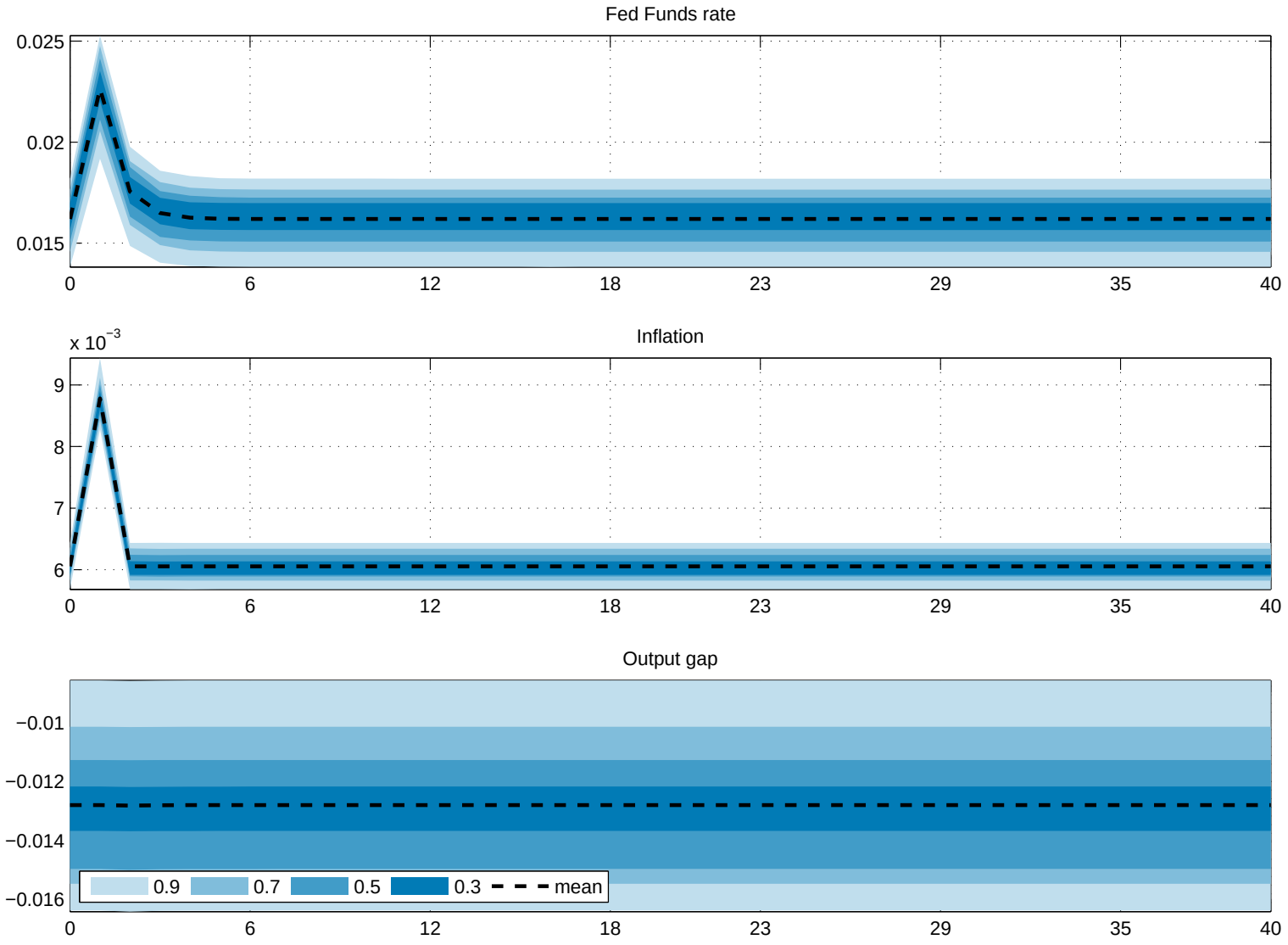


Figure # 39: svar_policy:: Posterior Impulse responses to a EPAI shock in regime_2

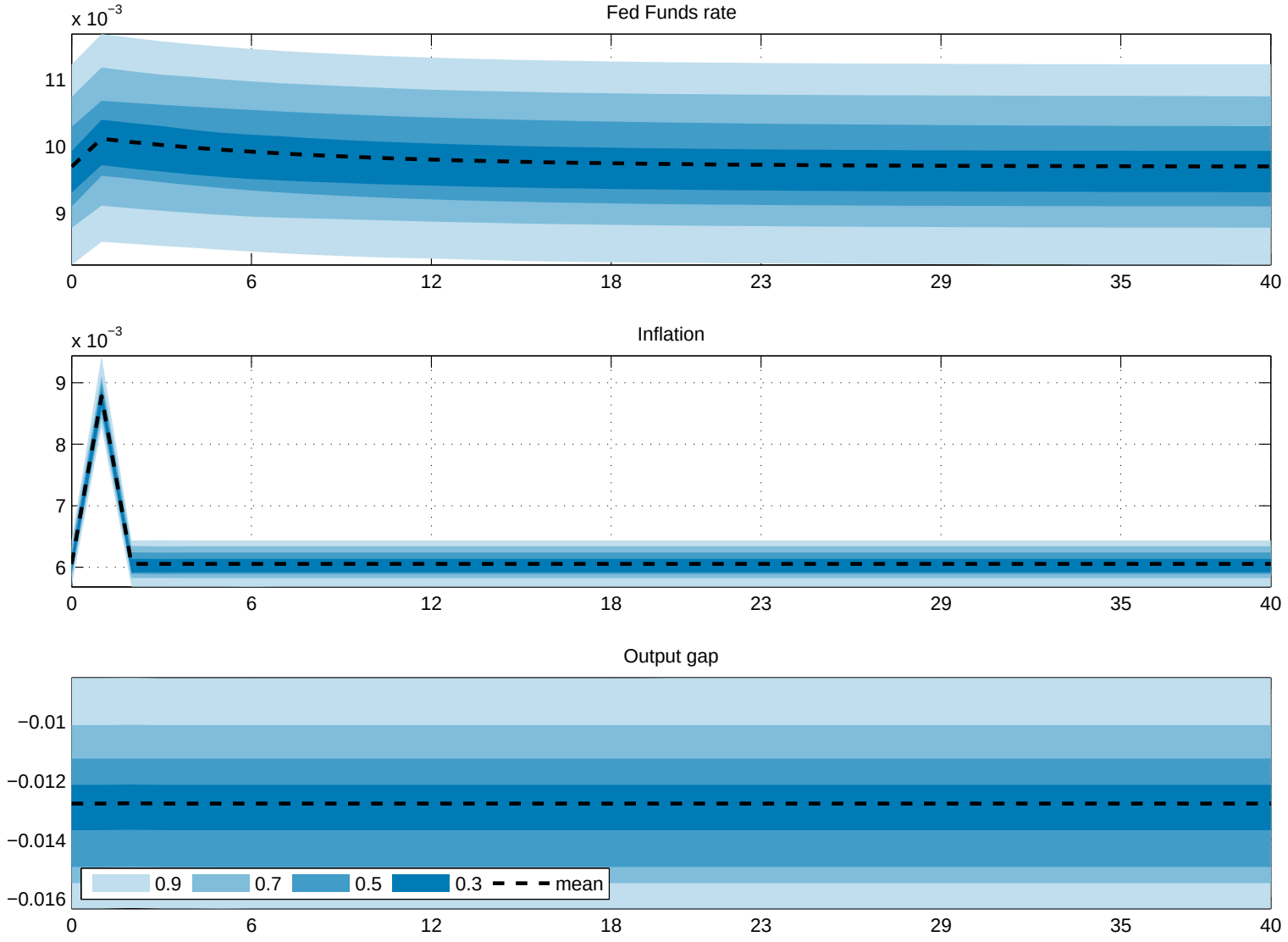


Figure # 40: svar_policy:: Posterior Impulse responses to a EY shock in regime_1

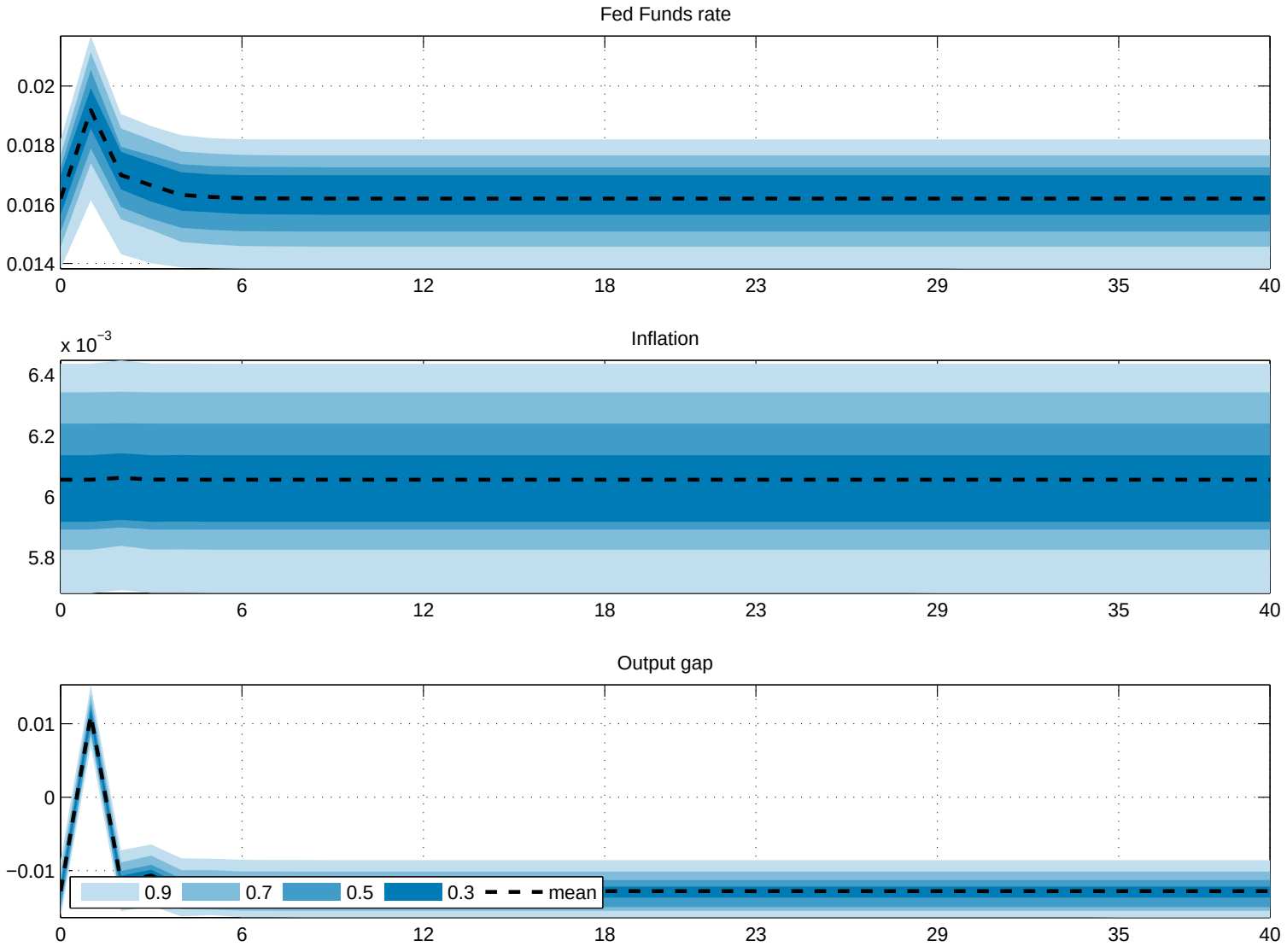


Figure # 41: svar_policy:: Posterior Impulse responses to a EY shock in regime_2

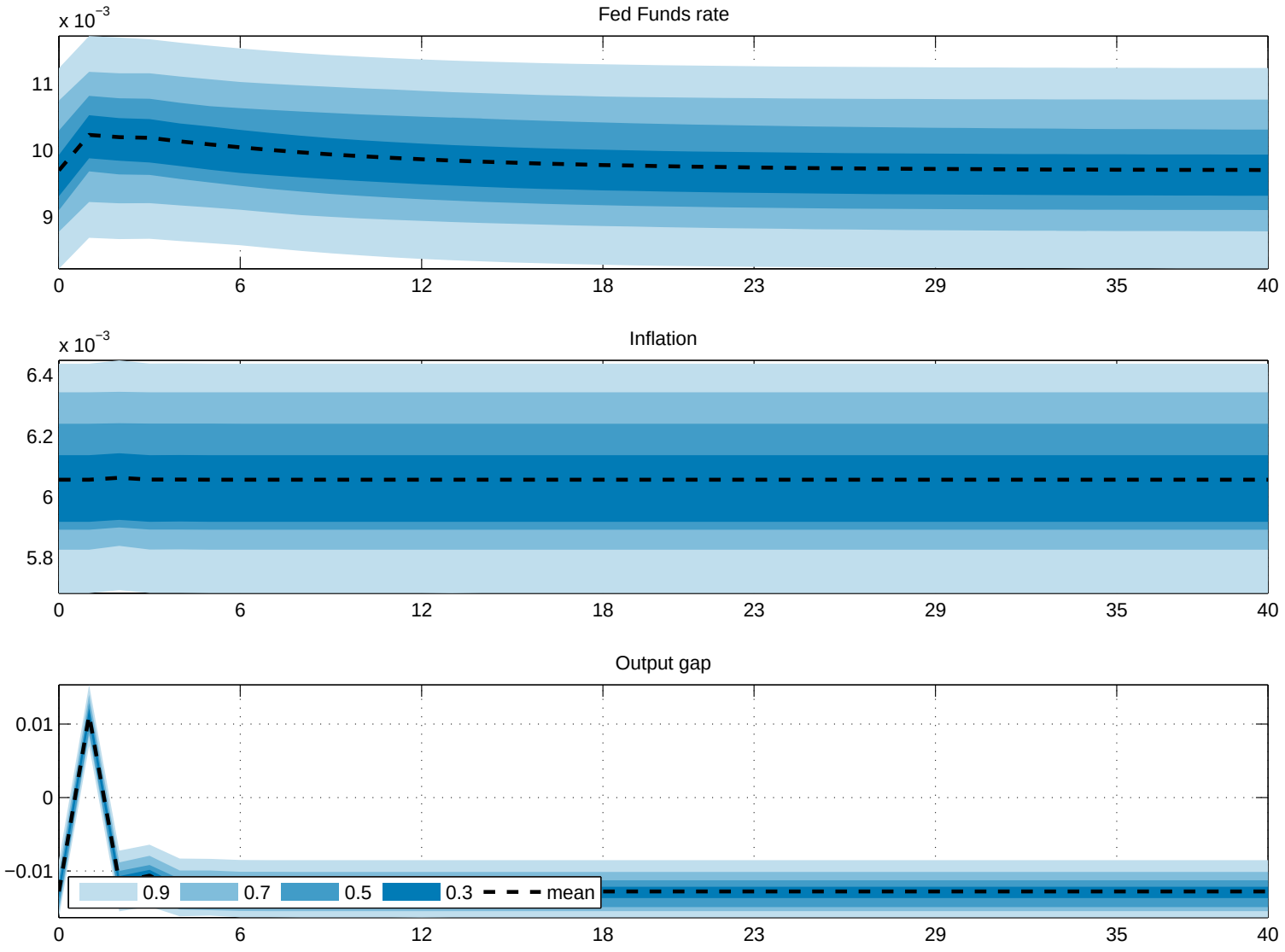


Figure # 42: svar_volatility:: Posterior Impulse responses to a EI shock in regime_1

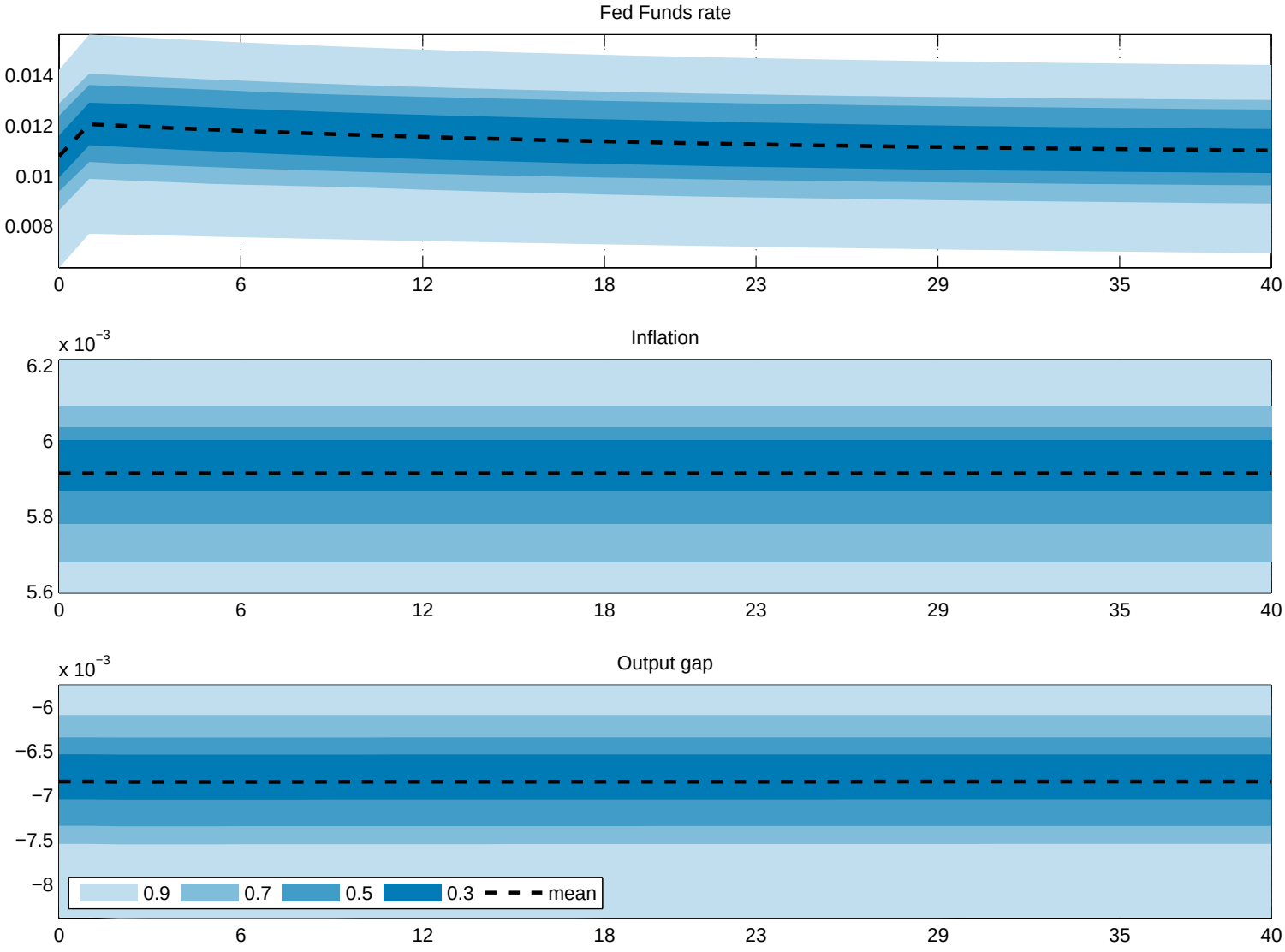


Figure # 43: svar_volatility:: Posterior Impulse responses to a EI shock in regime_2

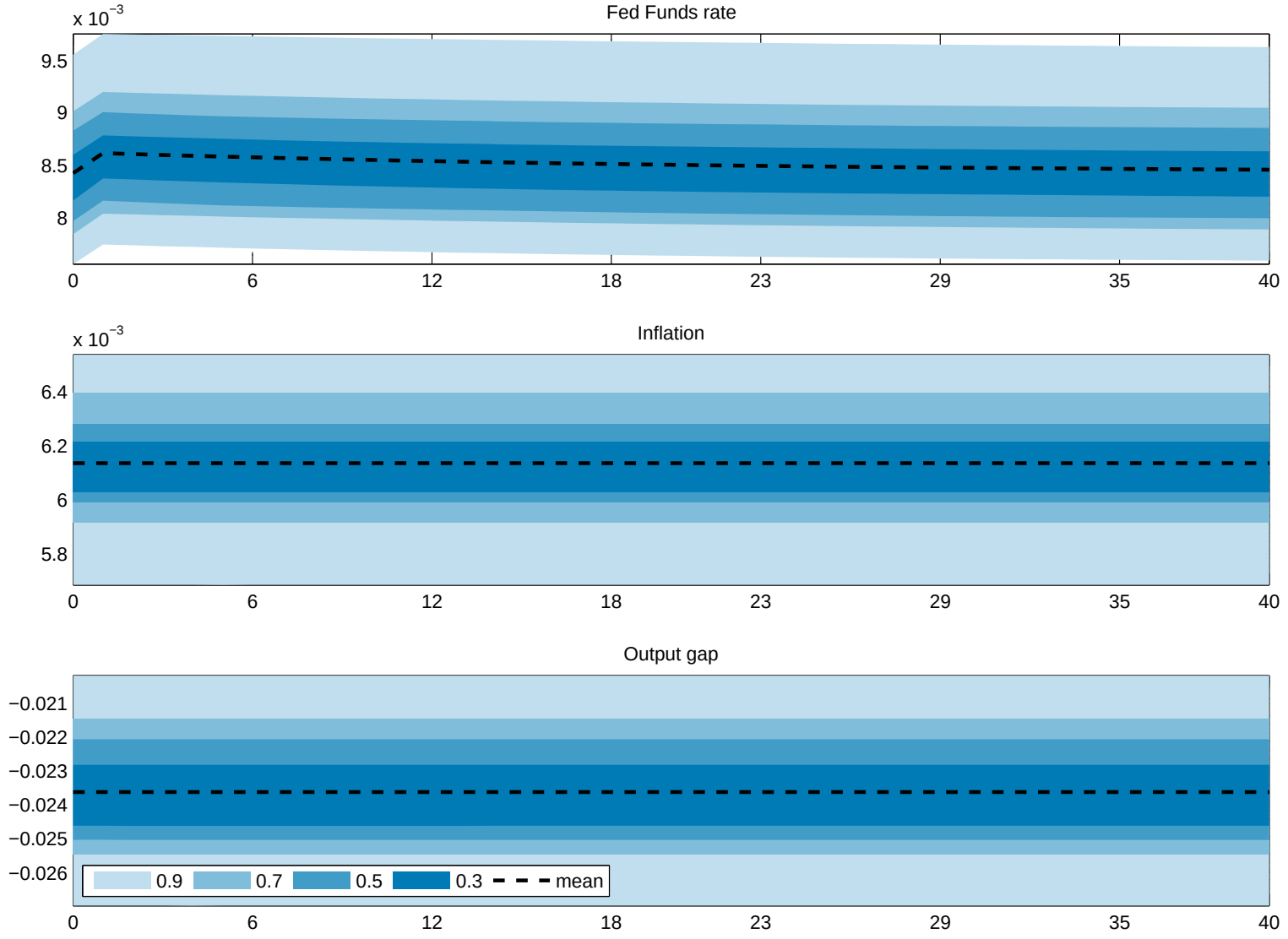


Figure # 44: svar_volatility:: Posterior Impulse responses to a EPAI shock in regime_1

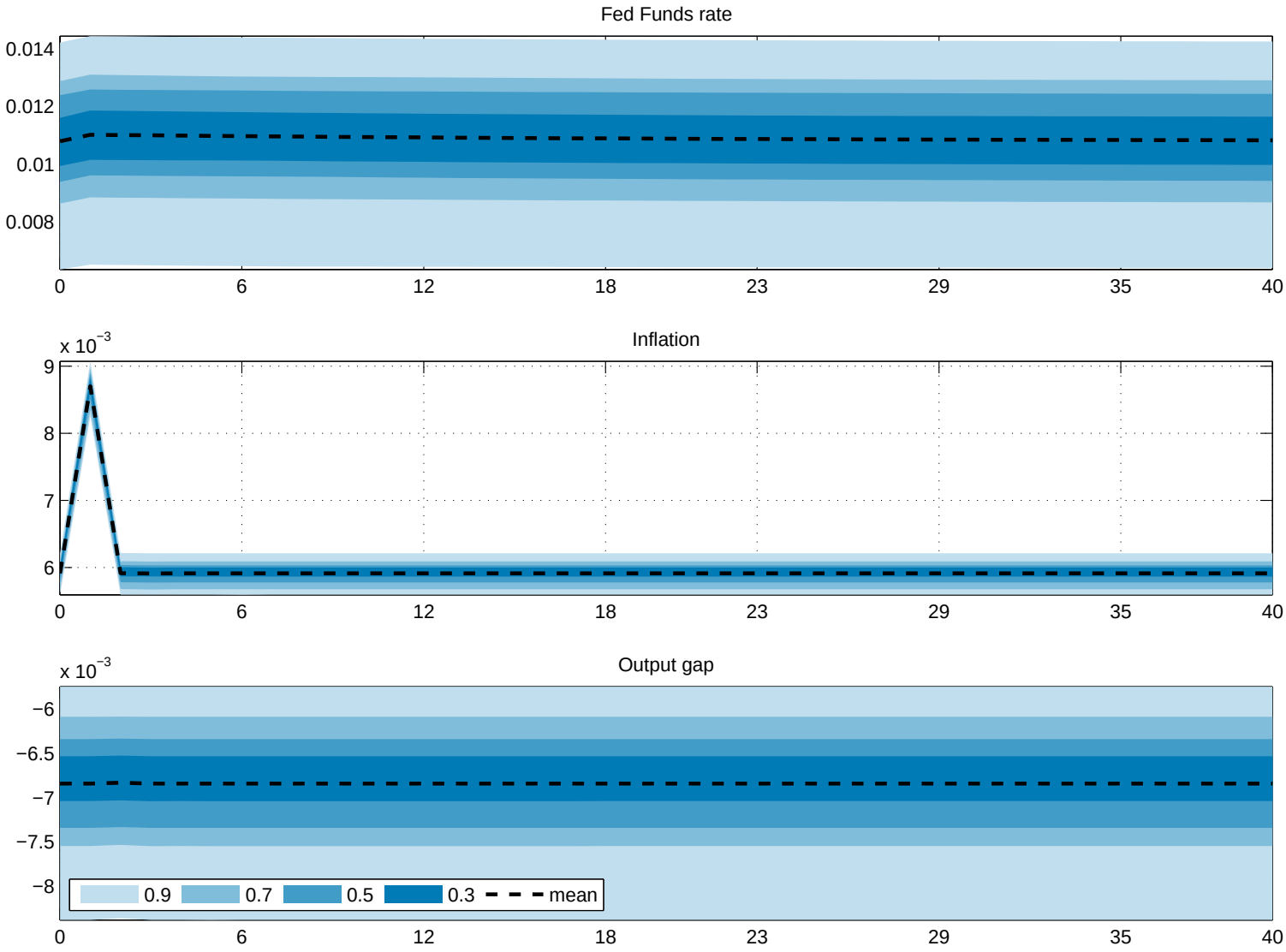


Figure # 45: svar_volatility:: Posterior Impulse responses to a EPAI shock in regime_2

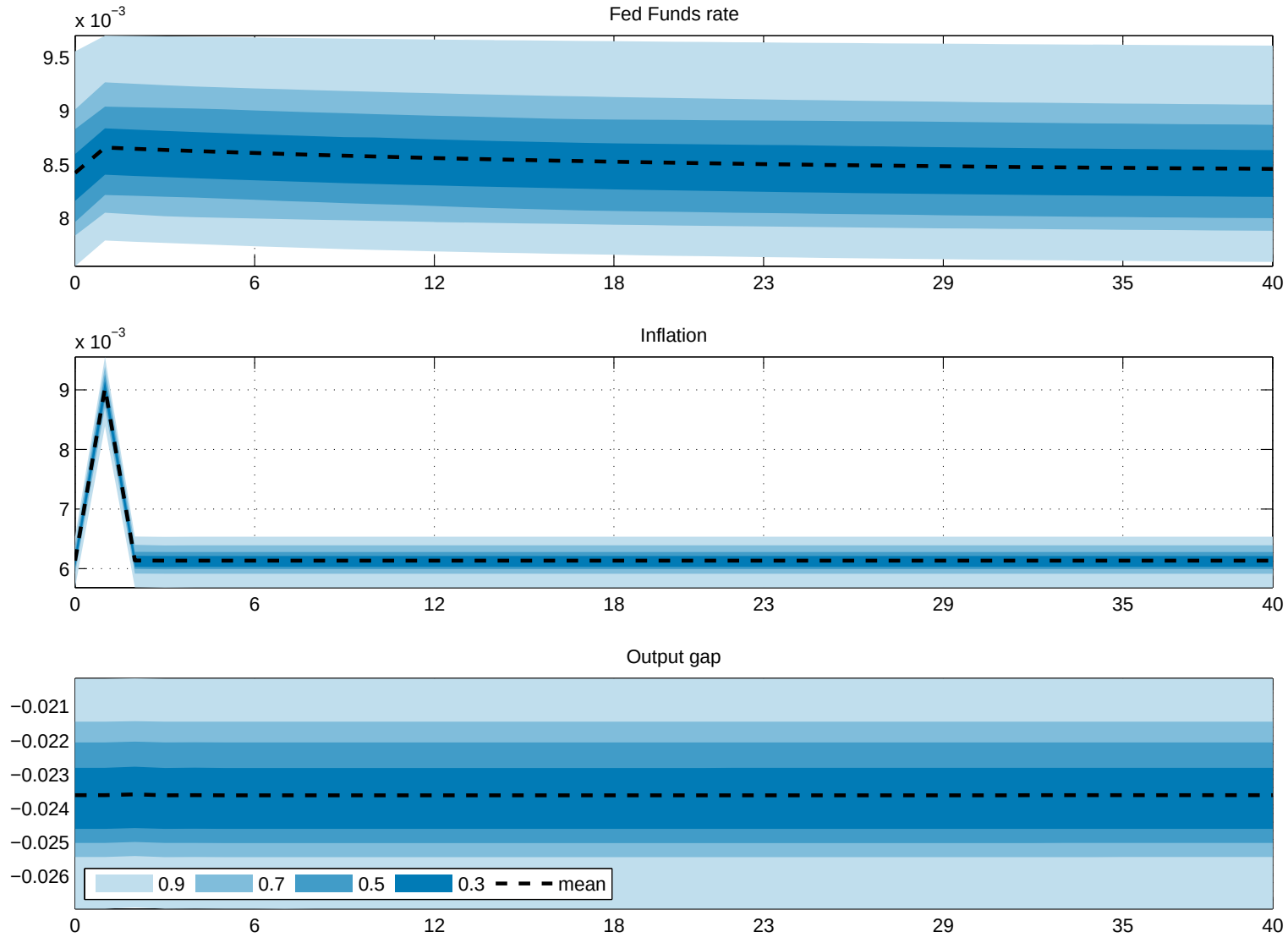


Figure # 46: svar_volatility:: Posterior Impulse responses to a EY shock in regime_1

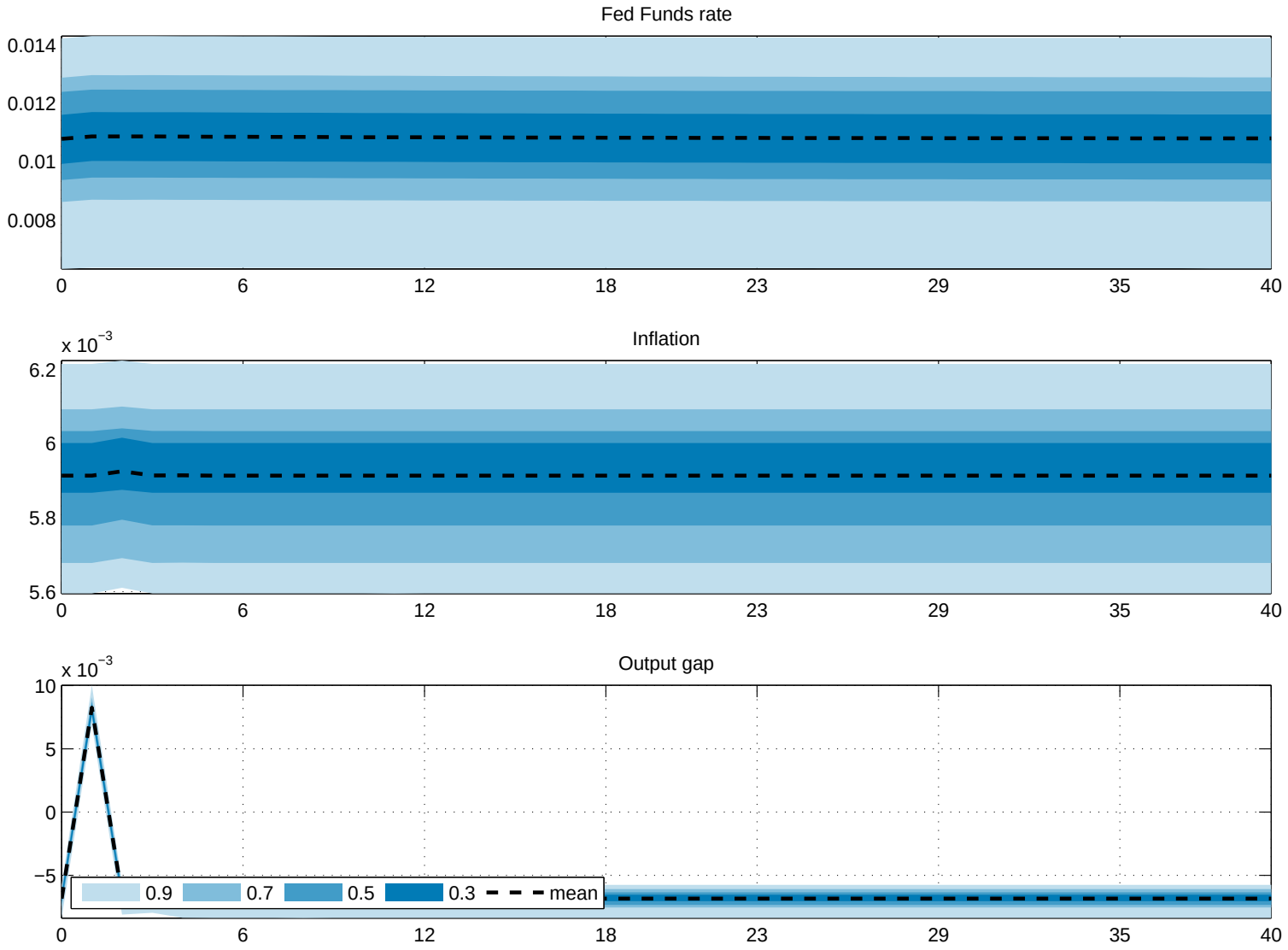


Figure # 47: svar_volatility:: Posterior Impulse responses to a EY shock in regime_2

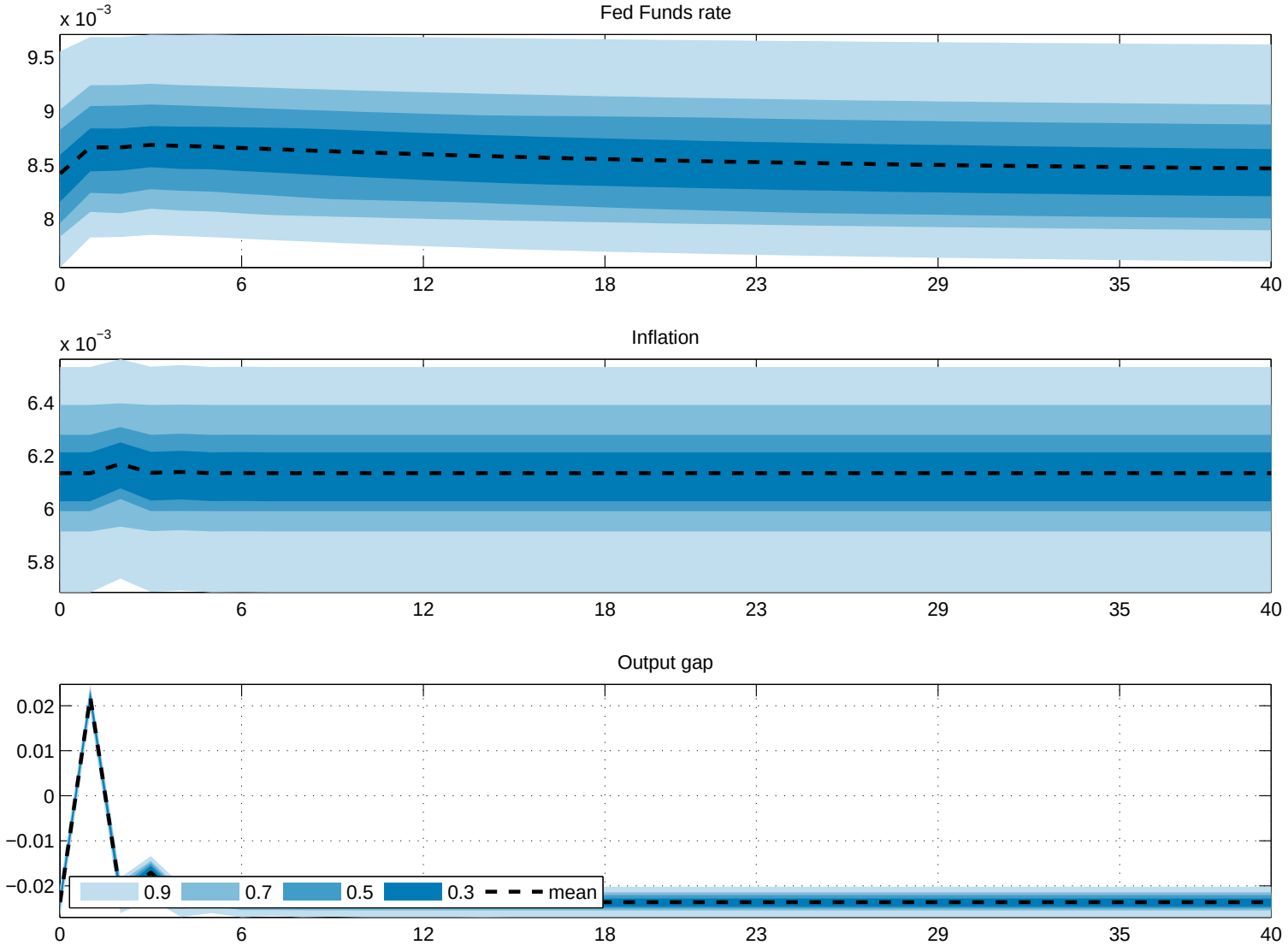


Figure # 48: svar_policy_volatility:: Posterior Impulse responses to a EI shock in regime_1

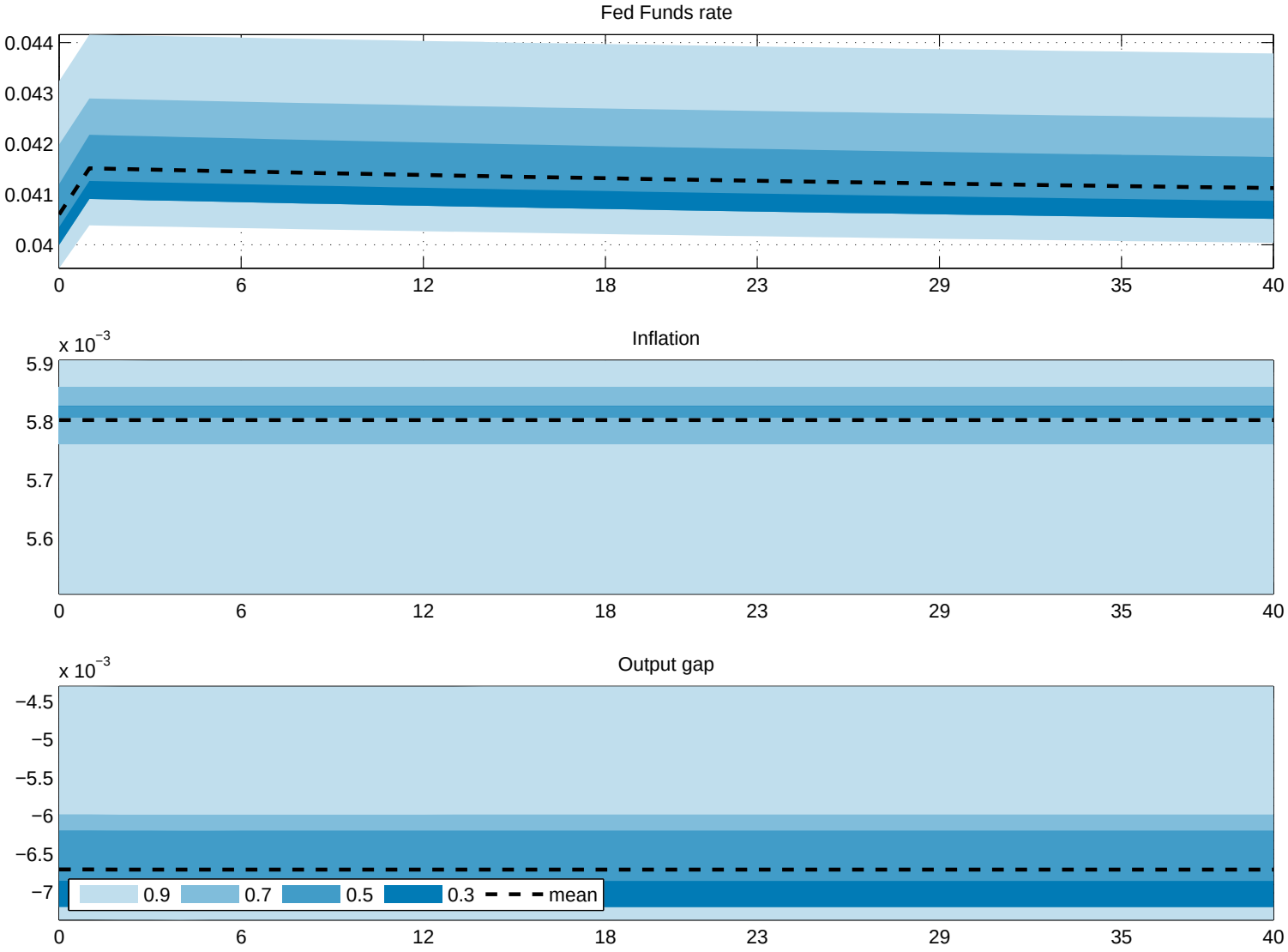


Figure # 49: svar_policy_volatility:: Posterior Impulse responses to a EI shock in regime_2

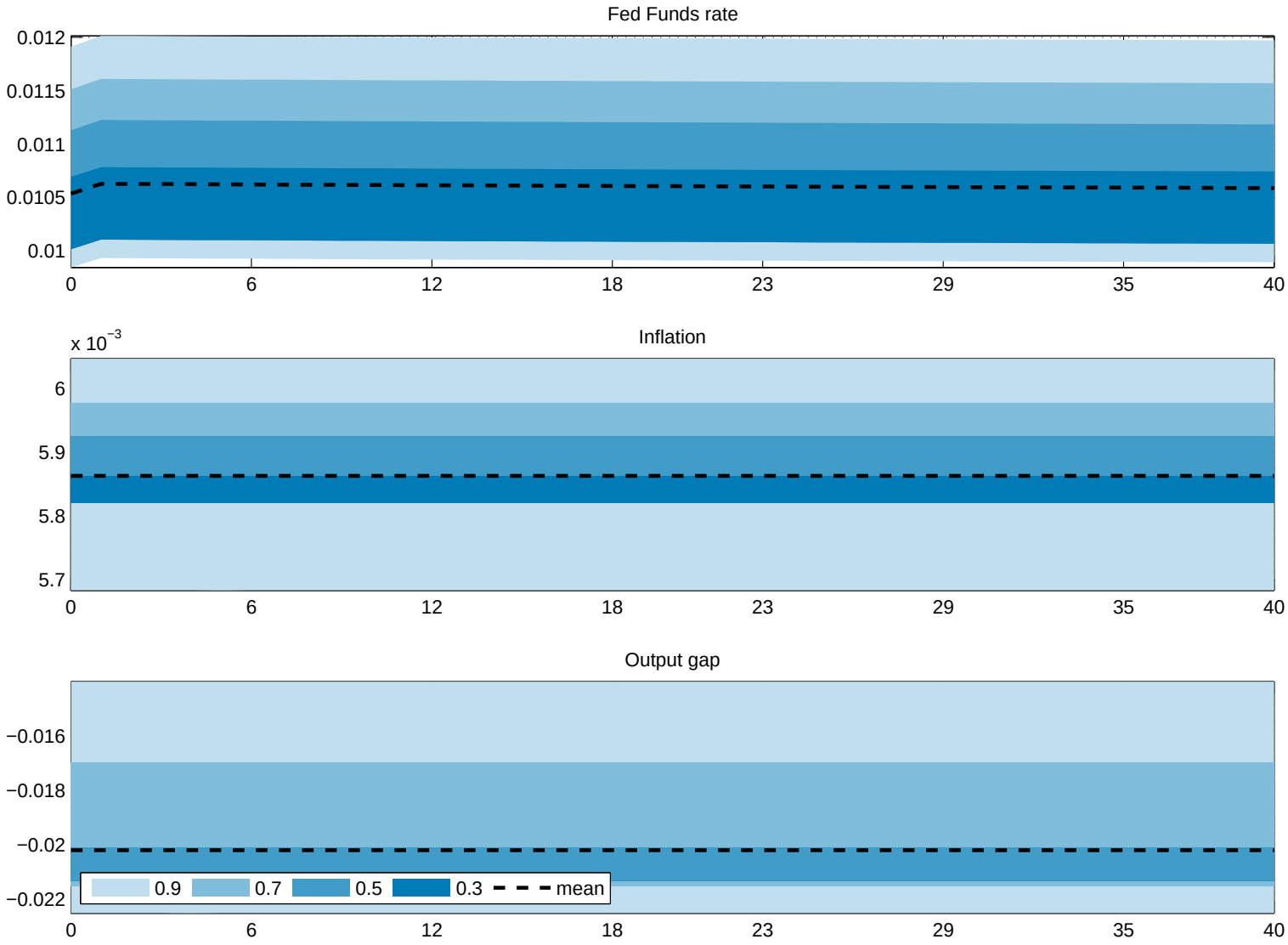


Figure # 50: svar_policy_volatility:: Posterior Impulse responses to a EI shock in regime_3

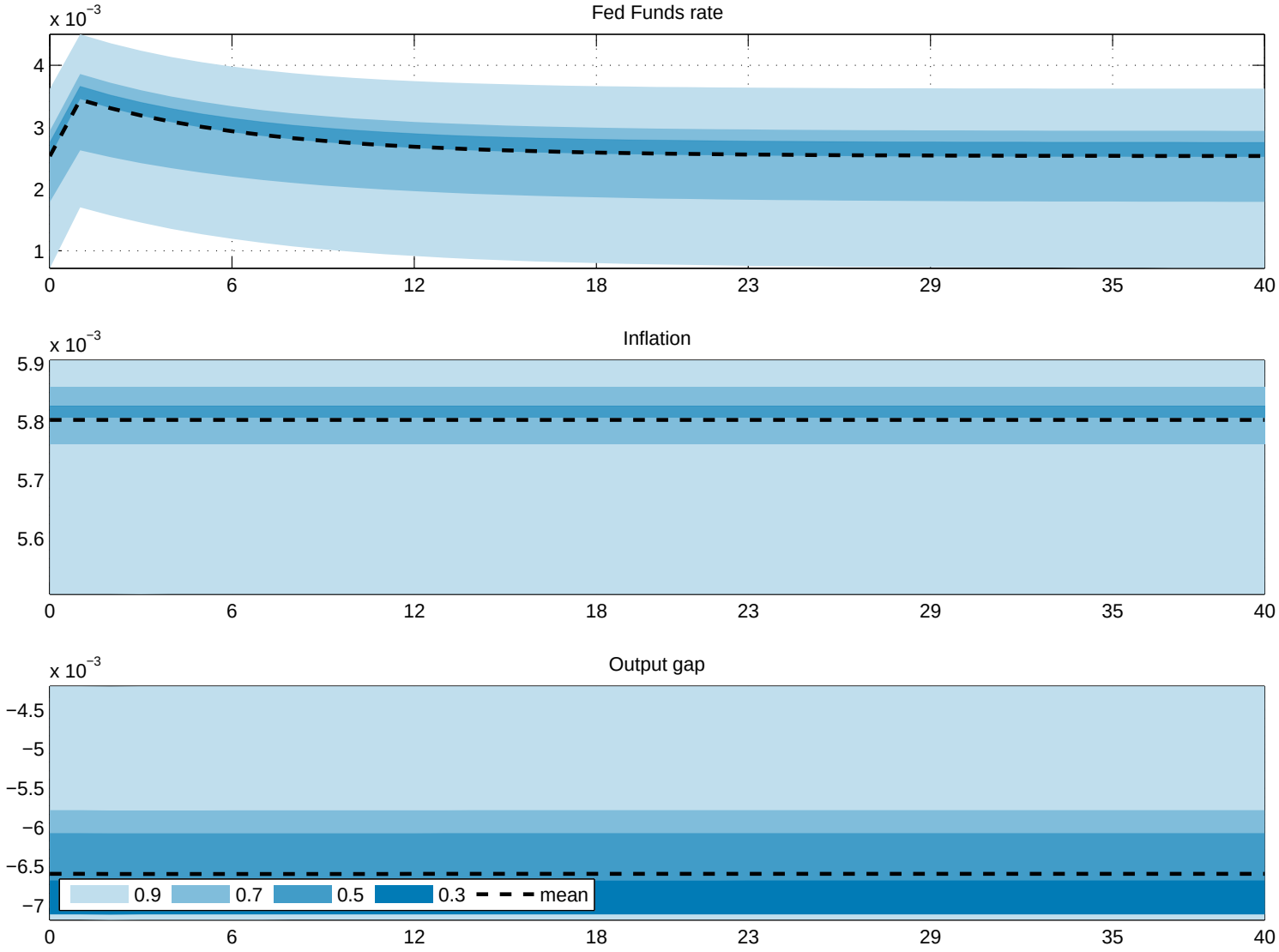


Figure # 51: svar_policy_volatility:: Posterior Impulse responses to a EI shock in regime_4

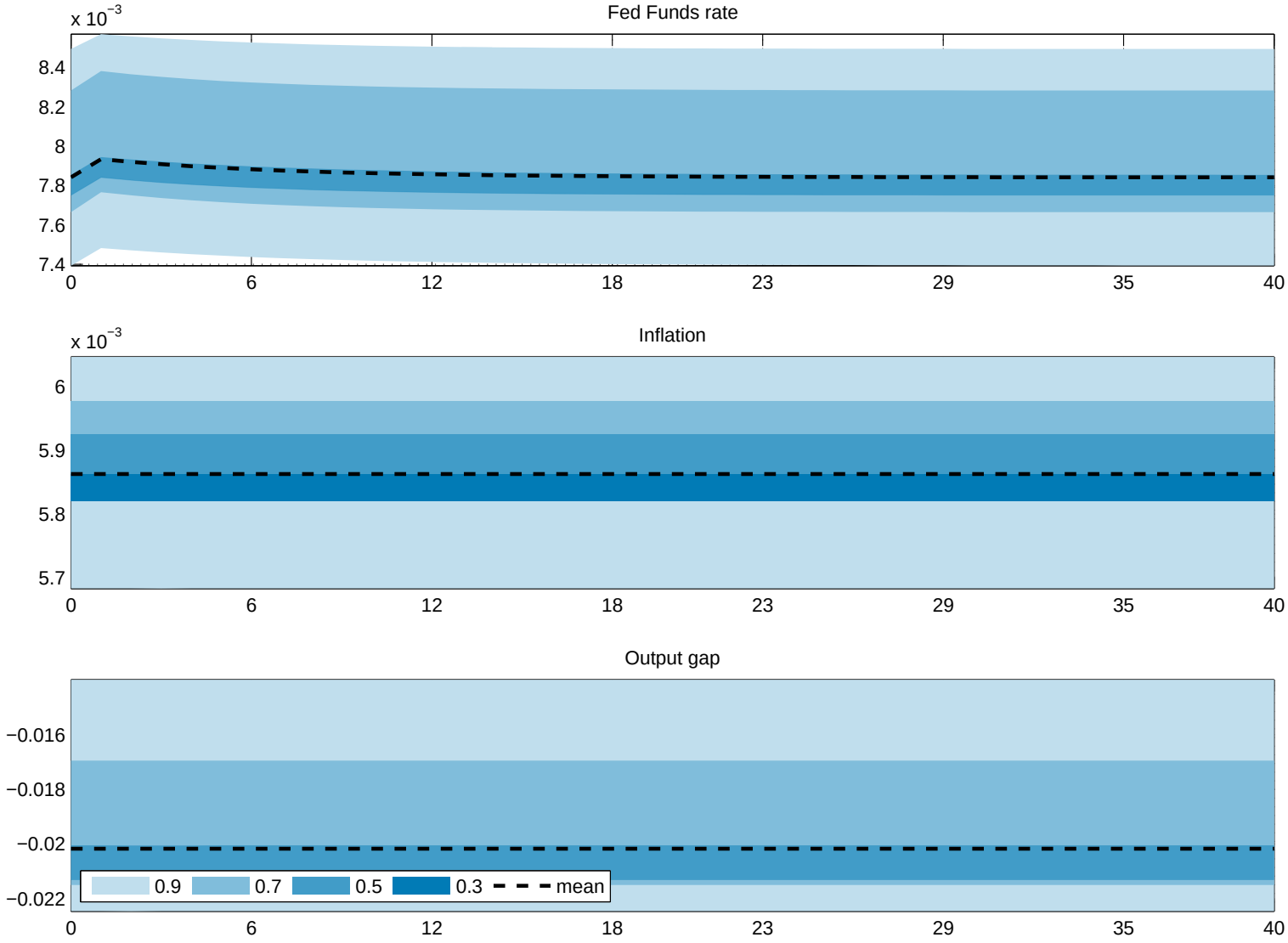


Figure # 52: svar_policy_volatility:: Posterior Impulse responses to a EPAI shock in regime

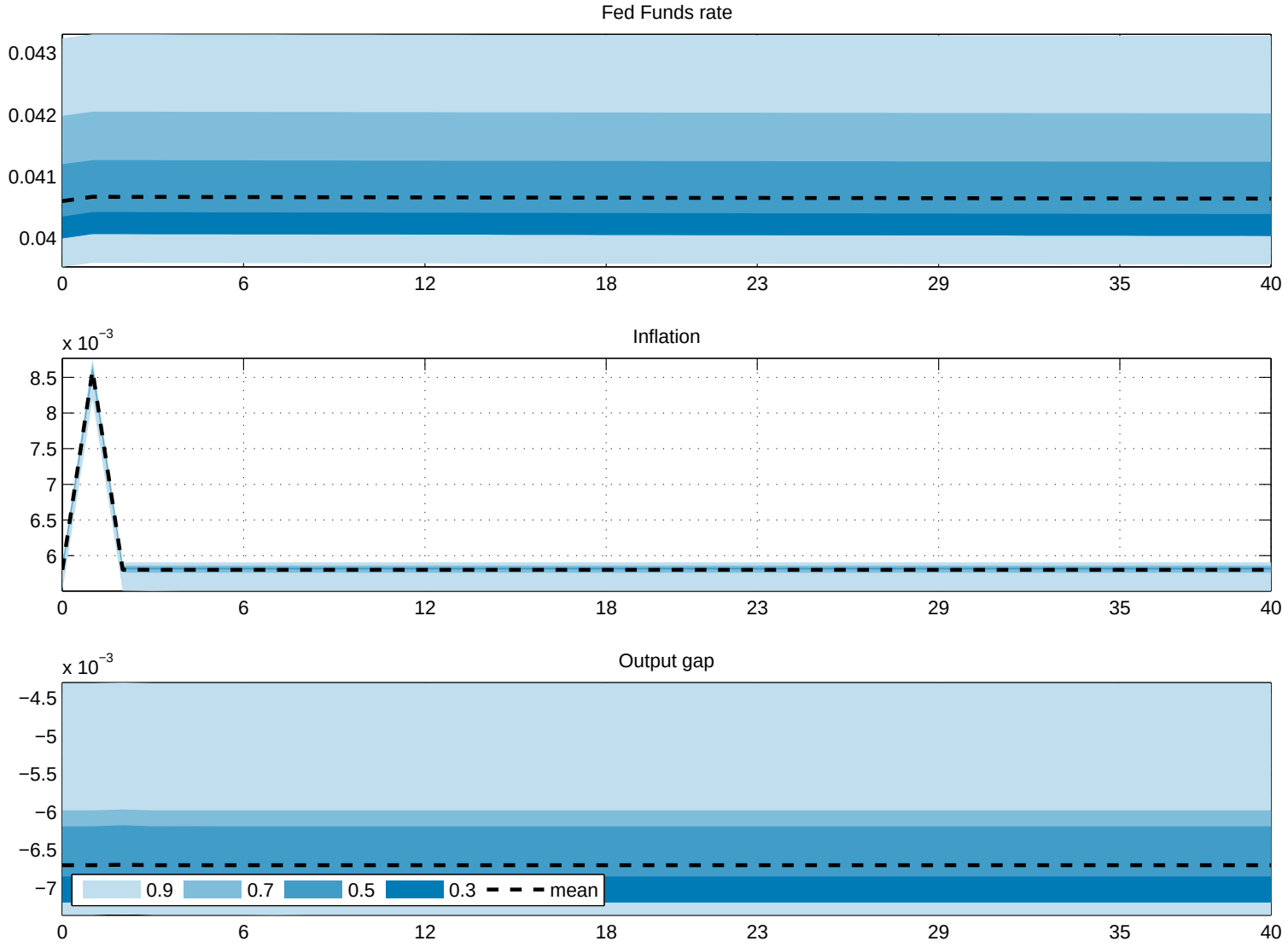


Figure # 53: svar_policy_volatility:: Posterior Impulse responses to a EPAI shock in regime

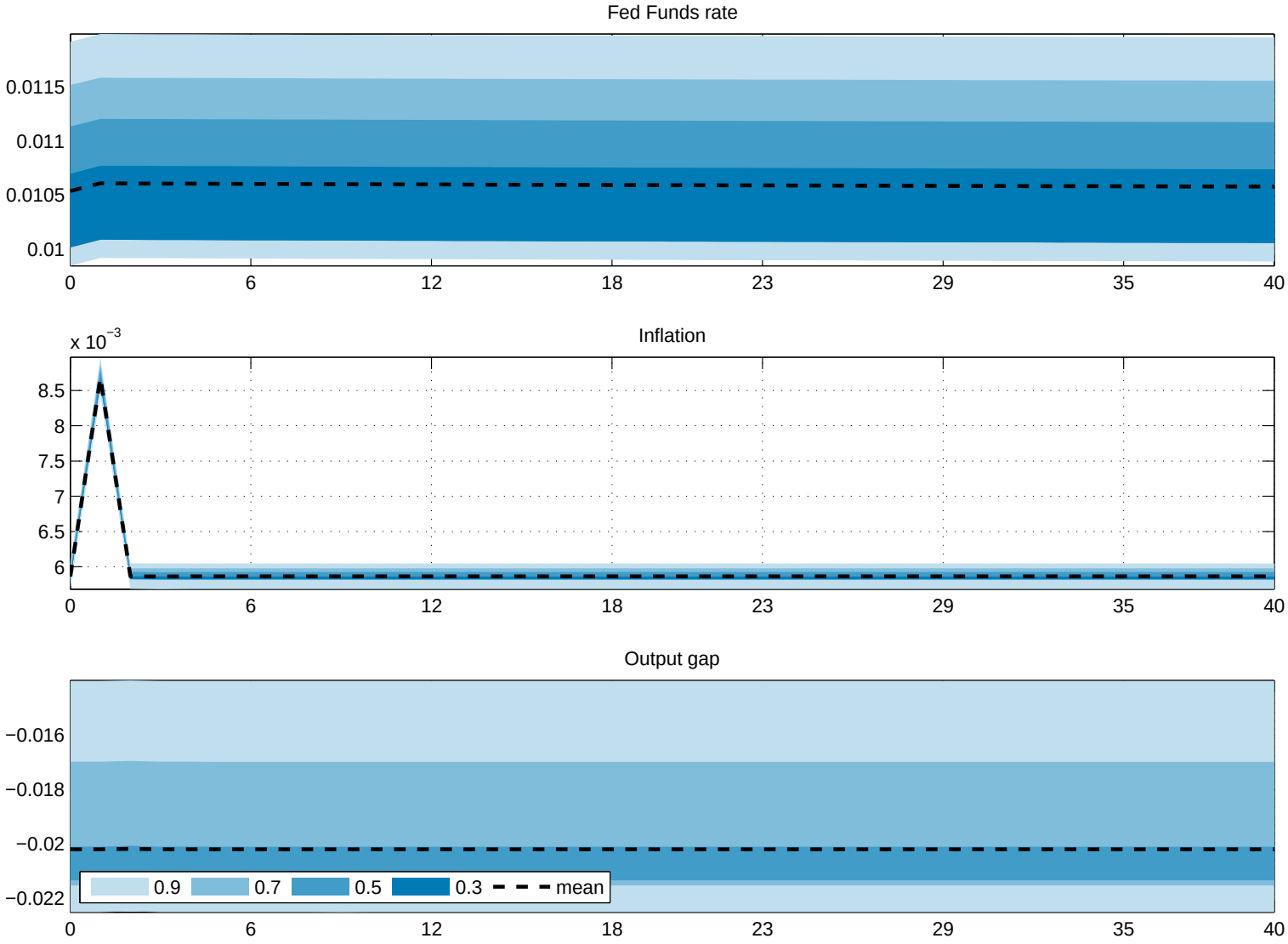


Figure # 54: svar_policy_volatility:: Posterior Impulse responses to a EPAI shock in regime

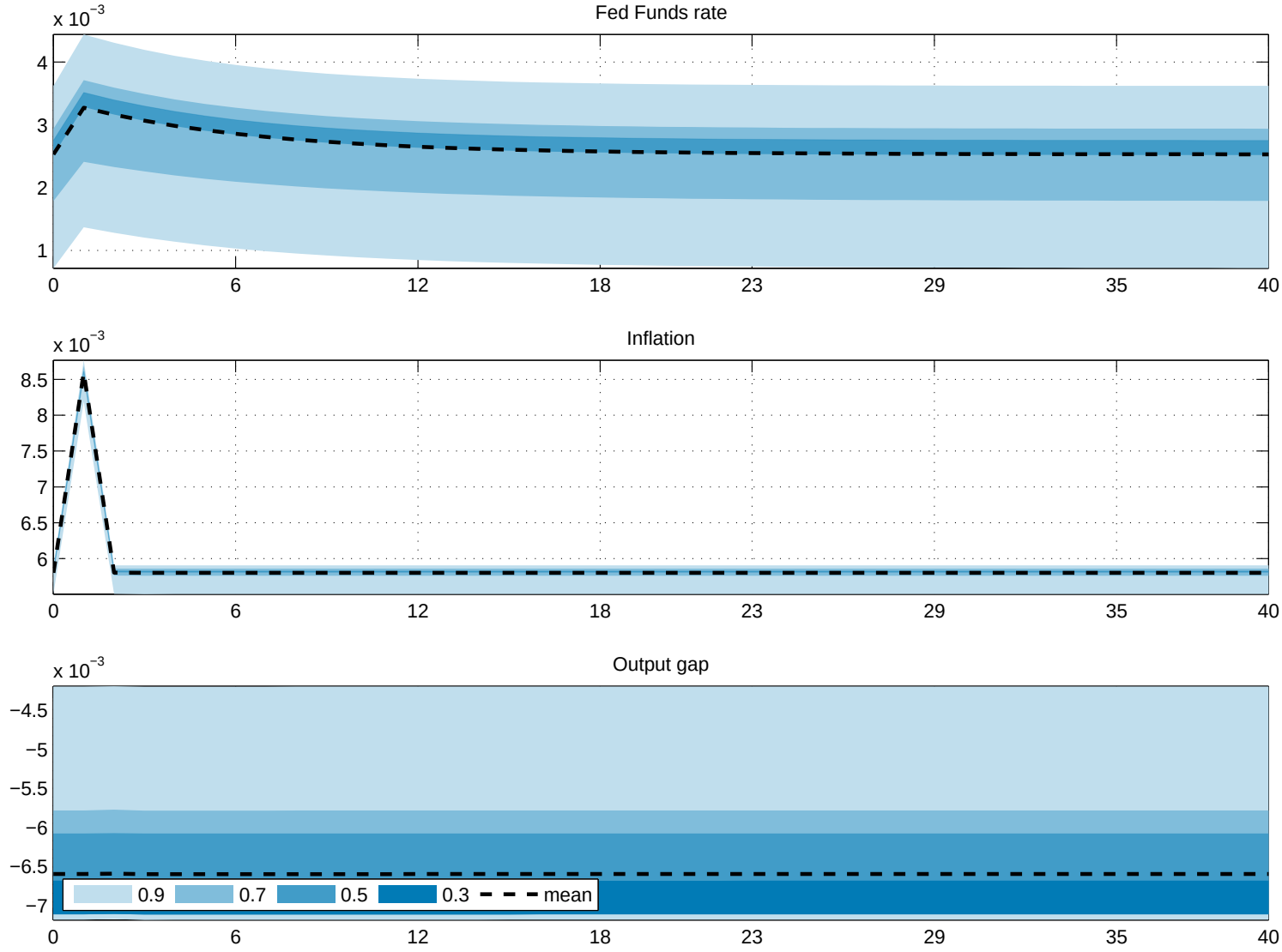


Figure # 55: svar_policy_volatility:: Posterior Impulse responses to a EPAI shock in regime

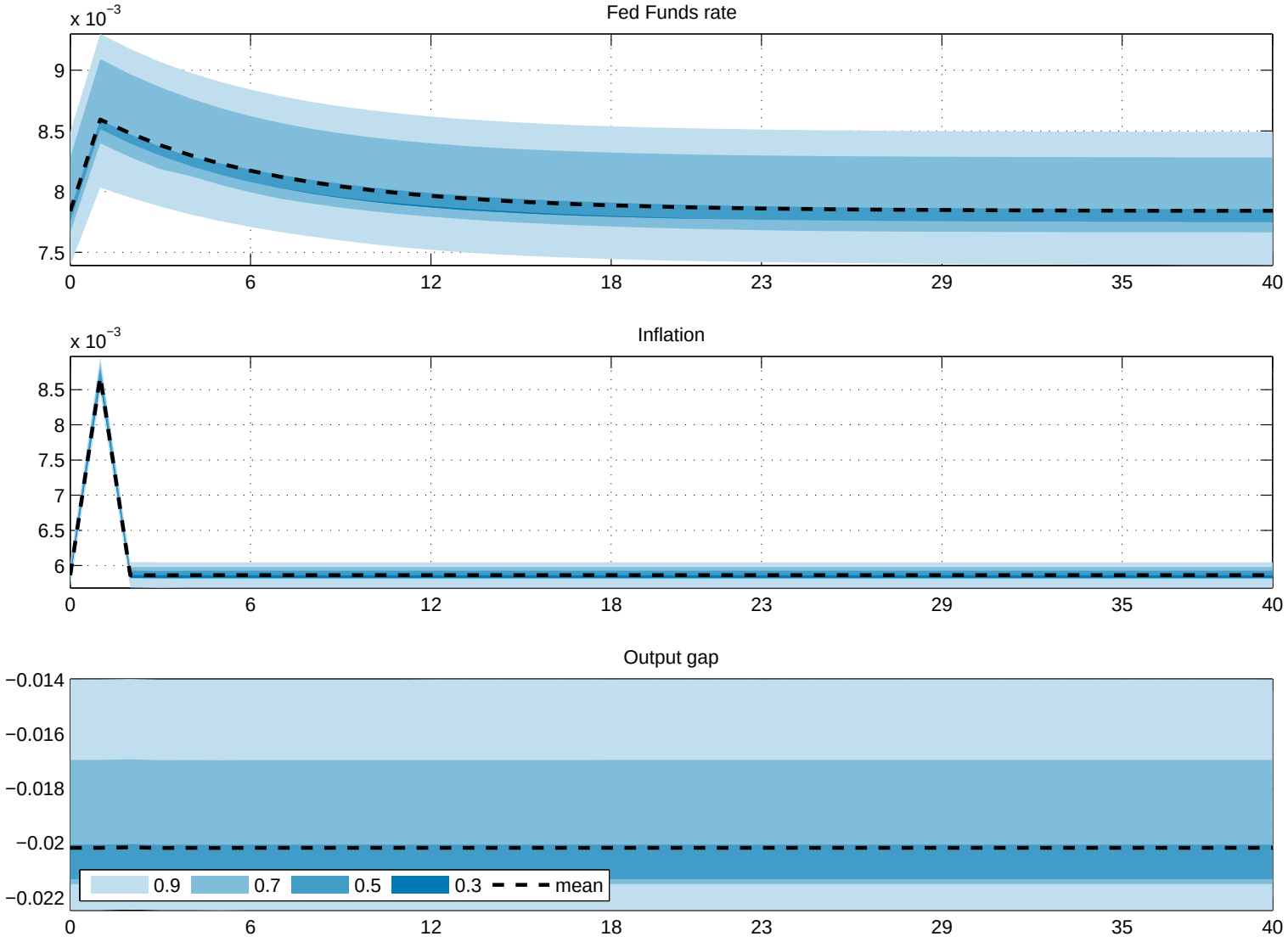


Figure # 56: svar_policy_volatility:: Posterior Impulse responses to a EY shock in regime_1

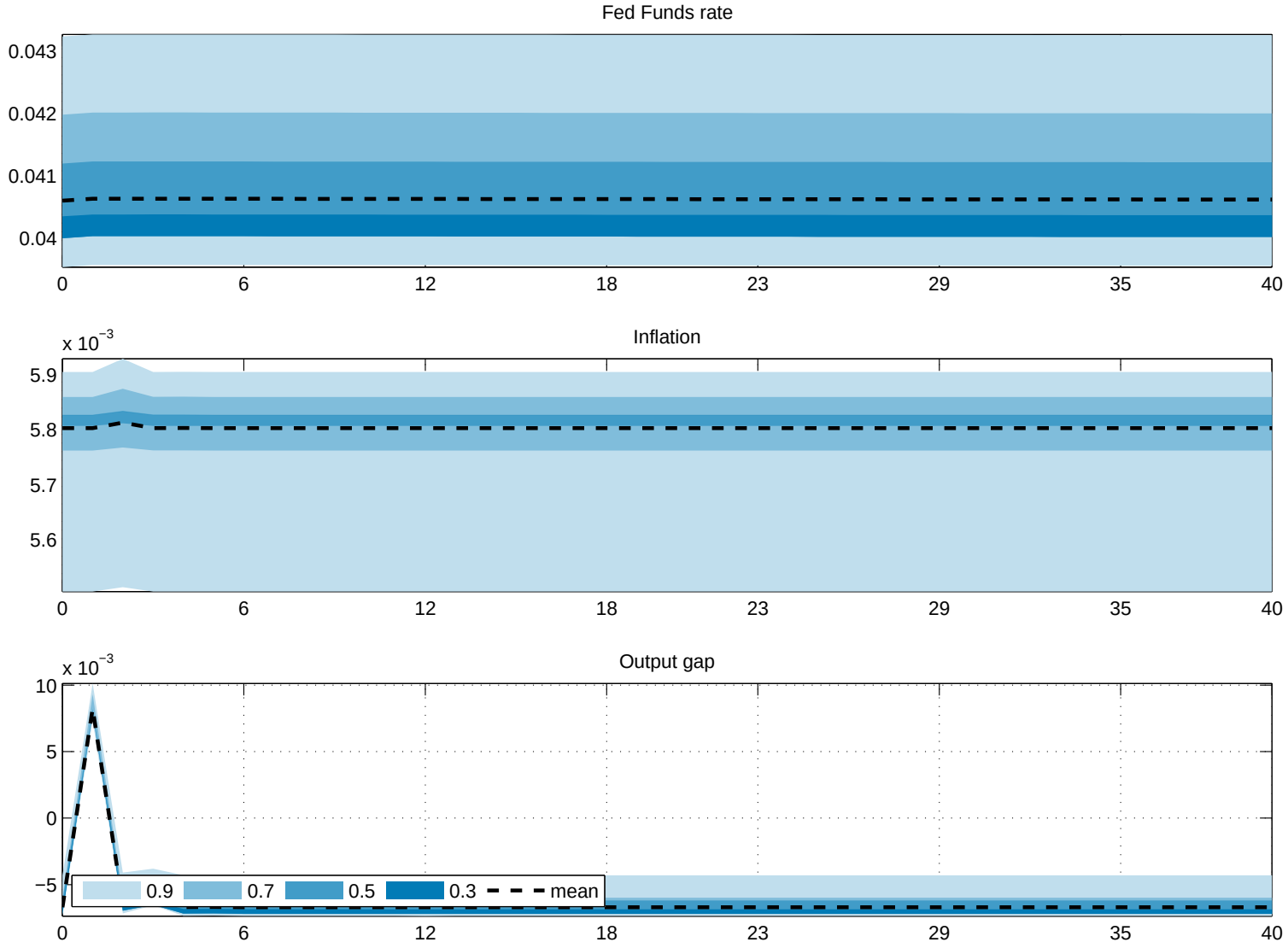


Figure # 57: svar_policy_volatility:: Posterior Impulse responses to a EY shock in regime_2

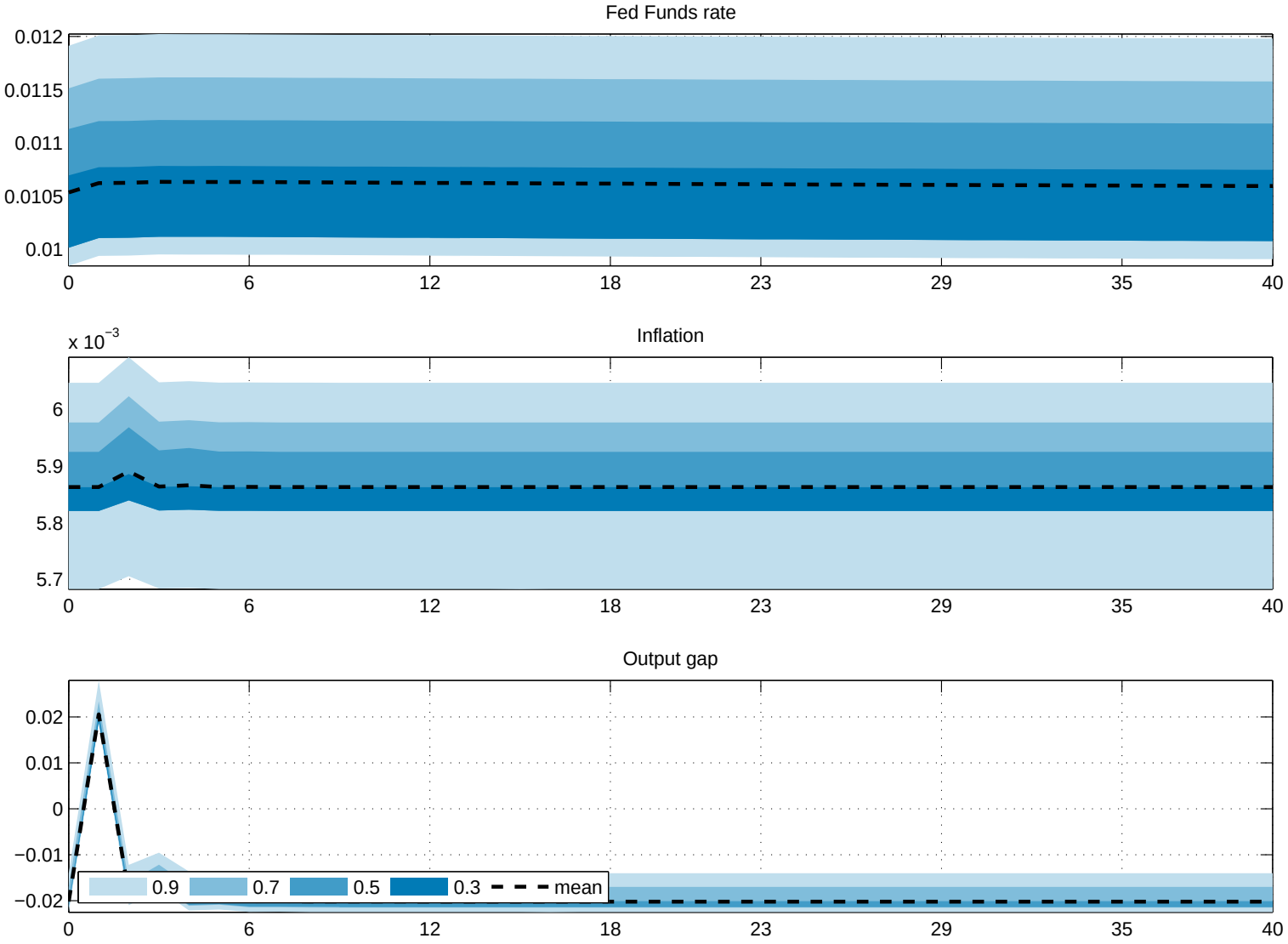


Figure # 58: svar_policy_volatility:: Posterior Impulse responses to a EY shock in regime_3

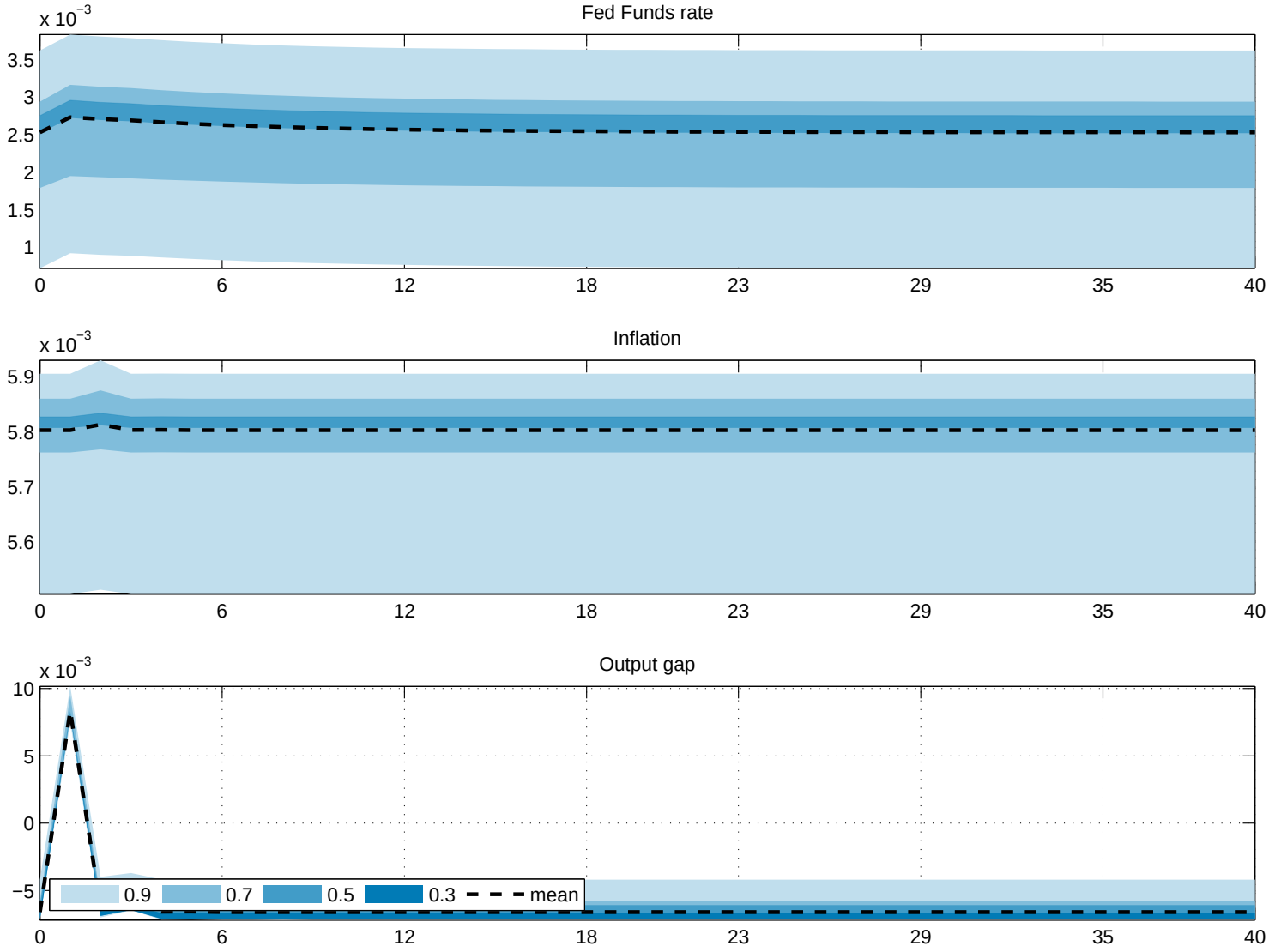


Figure # 59: svar_policy_volatility:: Posterior Impulse responses to a EY shock in regime_4