Switches in the US Macroeconomic Data: Policy or Volatility?

first_name last_name
Your institution
first_name@last_name.com

12-Oct-2014 15:21:49

Abstract

This report investigates switches in the parameters of a simple new Keynesian model estimated on US data. 4 variants of the modelare estimated: (i) the first variant allows for switches in volalitily only; (ii) the second model allows for switches in the policy parameters only; (iii) the third specification allows for switches in both policy parameters and the volatility of shocks, but in a synchronized fashion; (iv) the third 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 ::  fwz_est.rs
8: endogenous  X, "Output gap", PAI, "Inflation", R, "Fed Funds rate",
9: ZS, "Supply shock process", ZD "Demand shock process"
12: exogenous ES,  "Supply shock", ED, "Demand shock", ER, "Monetary policy shock"
15: parameters tau, "$\tau $", beta_trans, "$100\left( \frac{1}{\beta }-1\right) $",
16: kappa, "$\kappa $", rhor, "$\rho _{r}$",
17: rhod, "$\rho _{d}$" rhos, "$\rho _{s}$"
24: varobs R, X, PAI
27: model(linear)
29:  # beta=1/(1+beta_trans/100);
33:    X   = X{+1}-tau*(R-PAI{+1})+ZD;
35:    PAI = beta*PAI{+1}+kappa*X+ZS;
37:    R   = rhor*R{-1}+(1-rhor)*(gamma_1*PAI+gamma_2*X)+sigr*ER;
40:    ZD = rhod*ZD{-1}+sigd*ED;
42:    ZS = rhos*ZS{-1}+sigs*ES;
46: parameterization
47:  tau          ,    0.5376,     0.1000,    0.5000,  gamma_pdf(.90);
48:  kappa        ,    0.5800,     0.0500,    1.0000,  gamma_pdf(.90);
49:  beta_trans   ,    0.1000,     0.2000,    0.4000,  beta_pdf(.90);
52:  rhod         ,    0.83  ,     0.5000,    0.9000,  beta_pdf(.90);
53:  rhos         ,    0.85  ,     0.5000,    0.9000,  beta_pdf(.90);
54:  rhor         ,    0.60  ,     0.5000,    0.9000,  beta_pdf(.90);
4: % new file with name ::  switching_volatility.rs
4: parameters vol_tp_1_2, vol_tp_2_1
6: parameters(vol,2) sigd, "$\sigma _{d}$" sigs, "$\sigma _{s}$" sigr, "$\sigma _{r}$"
8: parameterization
9:  sigd(vol,1)          ,    0.18   ,    0.0005,    1.0000,  weibull_pdf(.90);
10:  sigd(vol,2)          ,    0.27   ,    0.0005,    1.0000,  weibull_pdf(.90);
```

```
11:  sigs(vol,1)          ,    0.3712 ,    0.0005,    1.0000,  weibull_pdf(.90);
12:  sigs(vol,2)          ,    0.8701 ,    0.0005,    1.0000,  weibull_pdf(.90);
13:  sigr(vol,1)          ,    0.18   ,    0.0005,    1.0000,  weibull_pdf(.90);
14:  sigr(vol,2)          ,    0.23   ,    0.0005,    1.0000,  weibull_pdf(.90);
16:  vol_tp_1_2           ,   0.0128  ,    0.0500,    0.1500,  beta_pdf(.90);
17:  vol_tp_2_1           ,   0.0128  ,    0.0500,    0.1500,  beta_pdf(.90);
23: parameter_restrictions
24:  sigd(vol,2)>=sigd(vol,1);
4: % new file with name ::  switching_policy_parameters_coefChain.rs
4: parameters coef_tp_1_2 coef_tp_2_1
6: parameters(coef,2) gamma_1, "$\gamma _{1}$", gamma_2, "$\gamma _{2}$"
8: parameterization
9:  gamma_1(coef,1) ,    2.19   ,     0.5000,    5.0000,  gamma_pdf(.90);
10:  gamma_1(coef,2) ,    0.77   ,     0.5000,    5.0000,  gamma_pdf(.90);
11:  gamma_2(coef,1) ,    0.30   ,     0.0500,    3.0000,  gamma_pdf(.90);
12:  gamma_2(coef,2) ,    0.17   ,     0.0500,    3.0000,  gamma_pdf(.90);
14:  coef_tp_1_2     ,   0.0128  ,    0.0500,    0.1500,   beta_pdf(.90);
15:  coef_tp_2_1     ,   0.0128  ,    0.0500,    0.1500,   beta_pdf(.90);
21: parameter_restrictions
22:  gamma_1(coef,1)>=gamma_1(coef,2)
```

2 Description of variables

Table # 1: Endogenous Variables

Model code	Description
PAI	Inflation
R	Fed Funds rate
X	Output gap
ZD	Demand shock process
ZS	Supply shock process

Table # 2: Exogenous Variables

Model code	Description
ED	Demand shock
ER	Monetary policy shock
ES	Supply shock

Table # 3: Observed Variables

Model code	Description
PAI	Inflation
R	Fed Funds rate
X	Output gap

3 Model equations

```
EQ1: X-(X{1}-tau*(R-PAI{1})+ZD)=0;

EQ2: PAI-(beta*PAI{1}+kappa*X+ZS)=0;

EQ3: R-(rhor*R{-1}+(1-rhor)*(gamma_1*PAI+gamma_2*X)+sigr*ER)=0;

EQ4: ZD-(rhod*ZD{-1}+sigd*ED)=0;

EQ5: ZS-(rhos*ZS{-1}+sigs*ES)=0;
```

4 Estimation results

Table # 4: Estimation Results

parameter	Prior distr	Prior prob	low	high	volOnly	polOnly	volPolSame	volPolInd
τ	gamma	0.9	0.1	0.5	0.0637	0.06268	0.0411	0.0441
κ	gamma	0.9	0.05	1	0.0196	0.006308	0.003086	0.003779
$100\left(\frac{1}{\beta}-1\right)$	beta	0.9	0.2	0.4	0.2891	0.2893	0.2893	0.2894
ρ_d	beta	0.9	0.5	0.9	0.9489	0.9506	0.9647	0.9614
ρ_s	beta	0.9	0.5	0.9	0.9904	0.975	0.9586	0.9551
ρ_r	beta	0.9	0.5	0.9	0.912	0.8653	0.9008	0.8976
γ_1	gamma	0.9	0.5	5	2.321	–	–	–
γ_2	gamma	0.9	0.05	3	0.1559	–	–	–
σ_d(vol,1)	weibull	0.9	0.0005	1	0.0003421	–	0.0001693	0.0001981
σ_d(vol,2)	weibull	0.9	0.0005	1	0.0003421	–	0.0003686	0.0006061
σ_s(vol,1)	weibull	0.9	0.0005	1	0.0001283	–	6.637e-05	7.451e-05
σ_s(vol,2)	weibull	0.9	0.0005	1	8.328e-05	–	7.759e-05	0.0001012
σ_r(vol,1)	weibull	0.9	0.0005	1	0.001627	–	0.0004655	0.0005297
σ_r(vol,2)	weibull	0.9	0.0005	1	0.0005569	–	0.001072	0.00161
vol_tp_1_2	beta	0.9	0.05	0.15	0.09972	–	0.08592	0.06334
vol_tp_2_1	beta	0.9	0.05	0.15	0.08568	–	0.09031	0.1114
γ_1(coef,1)	gamma	0.9	0.5	5	–	2.62	–	1.243
γ_1(coef,2)	gamma	0.9	0.5	5	–	0.9182	–	2.986
γ_2(coef,1)	gamma	0.9	0.05	3	–	0.1646	–	0.3423
γ_2(coef,2)	gamma	0.9	0.05	3	–	0.09916	–	0.1762
coef_tp_1_2	beta	0.9	0.05	0.15	–	0.07425	–	0.09911
coef_tp_2_1	beta	0.9	0.05	0.15	–	0.1036	–	0.08681
σ_d	weibull	0.9	0.0005	1	–	0.0003592	–	–
σ_s	weibull	0.9	0.0005	1	–	5.73e-05	–	–

Continued on next page

– *Continued from previous page*

parameter	Prior distr	Prior prob	low	high	volOnly	polOnly	volPolSame	volPolInd
σ_r	weibull	0.9	0.0005	1	–	0.0008339	–	–
γ_1(vol,1)	gamma	0.9	0.5	5	–	–	3.158	–
γ_1(vol,2)	gamma	0.9	0.5	5	–	–	1.248	–
γ_2(vol,1)	gamma	0.9	0.05	3	–	–	0.1831	–
γ_2(vol,2)	gamma	0.9	0.05	3	–	–	0.3685	–

Table # 5: Estimation Statistics

	volOnly	polOnly	volPolSame	volPolInd
log-post:	1599	1605	1627	1641
log-lik:	1608	1610	1638	1646
log-prior:	-8.96	-4.443	-11.12	-5.096
log-endog_prior	0	0	0	0
number of active inequalities	0	0	0	0
log-MDD(Laplace)	1478+1.571i	1509	1494+1.571i	1506
estimation sample	1985Q1:2013Q1	1985Q1:2013Q1	1985Q1:2013Q1	1985Q1:2013Q1
number of observations	113	113	113	113
number of parameters	16	15	18	20
number of func. evals	1914	1752	2893	2923
estimation algorithm	fmincon	fmincon	fmincon	fmincon
solution algorithm	rise_1	mfi	mfi	mfi
start time:	11-Oct-2014 10:21:01	11-Oct-2014 10:21:01	11-Oct-2014 10:21:01	11-Oct-2014 10:21:01
end time :	11-Oct-2014 10:22:47	11-Oct-2014 10:24:11	11-Oct-2014 10:25:42	11-Oct-2014 10:28:10
total time:	0:1:46	0:3:10	0:4:41	0:7:9

Table # 6: Steady state values

	volOnly		polOnly		volPolSame		volPolInd			
	regime_1	regime_2	regime_1	regime_2	regime_1	regime_2	regime_1	regime_2	regime_3	reg
Inflation	0	0	0	0	0	0	0	0	0	
Fed Funds rate	0	0	0	0	0	0	0	0	0	
Output gap	0	0	0	0	0	0	0	0	0	
Demand shock process	0	0	0	0	0	0	0	0	0	
Supply shock process	0	0	0	0	0	0	0	0	0	

Figure # 1: Observed data from the US

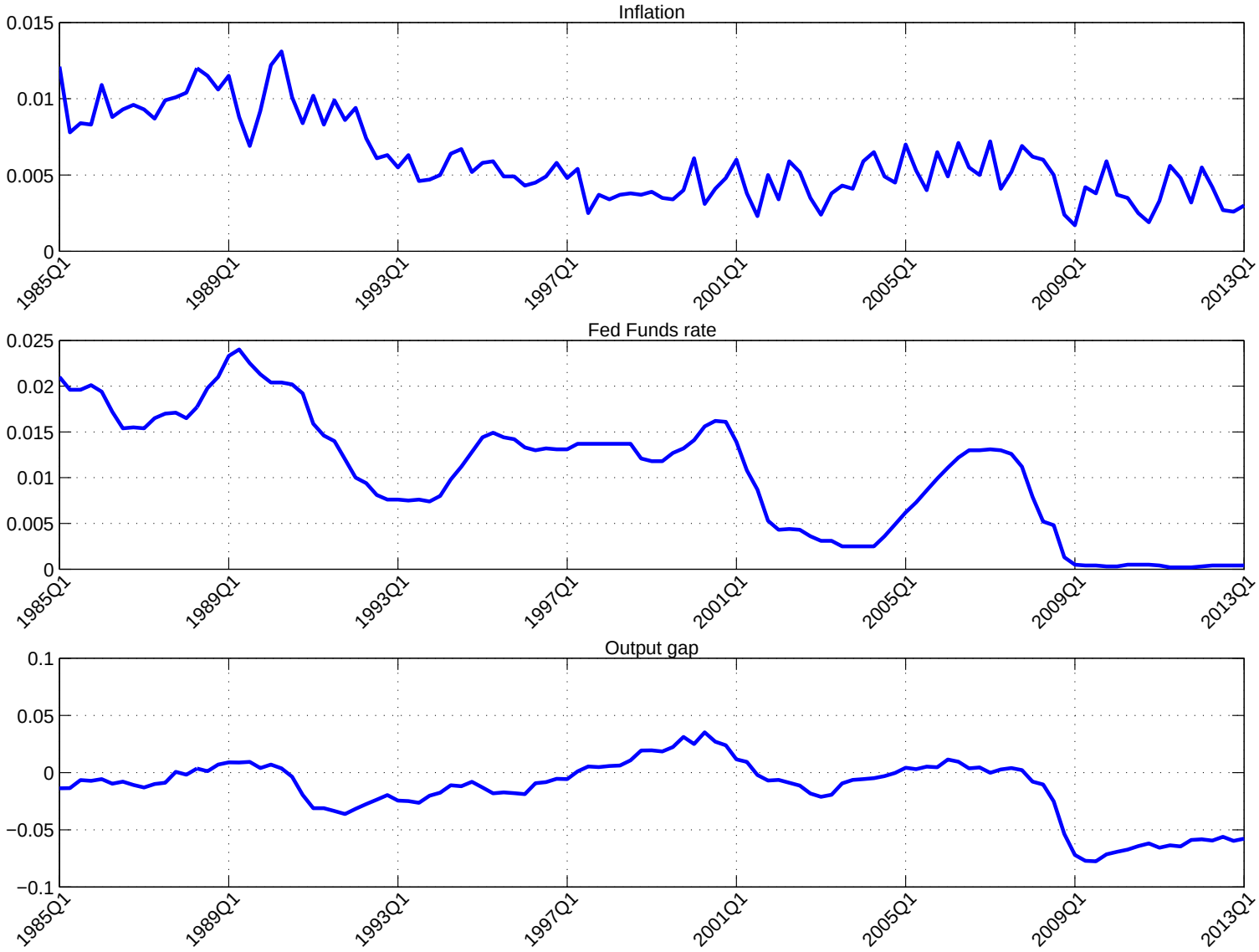

Figure # 2: Smoothed probabilities for volOnly model

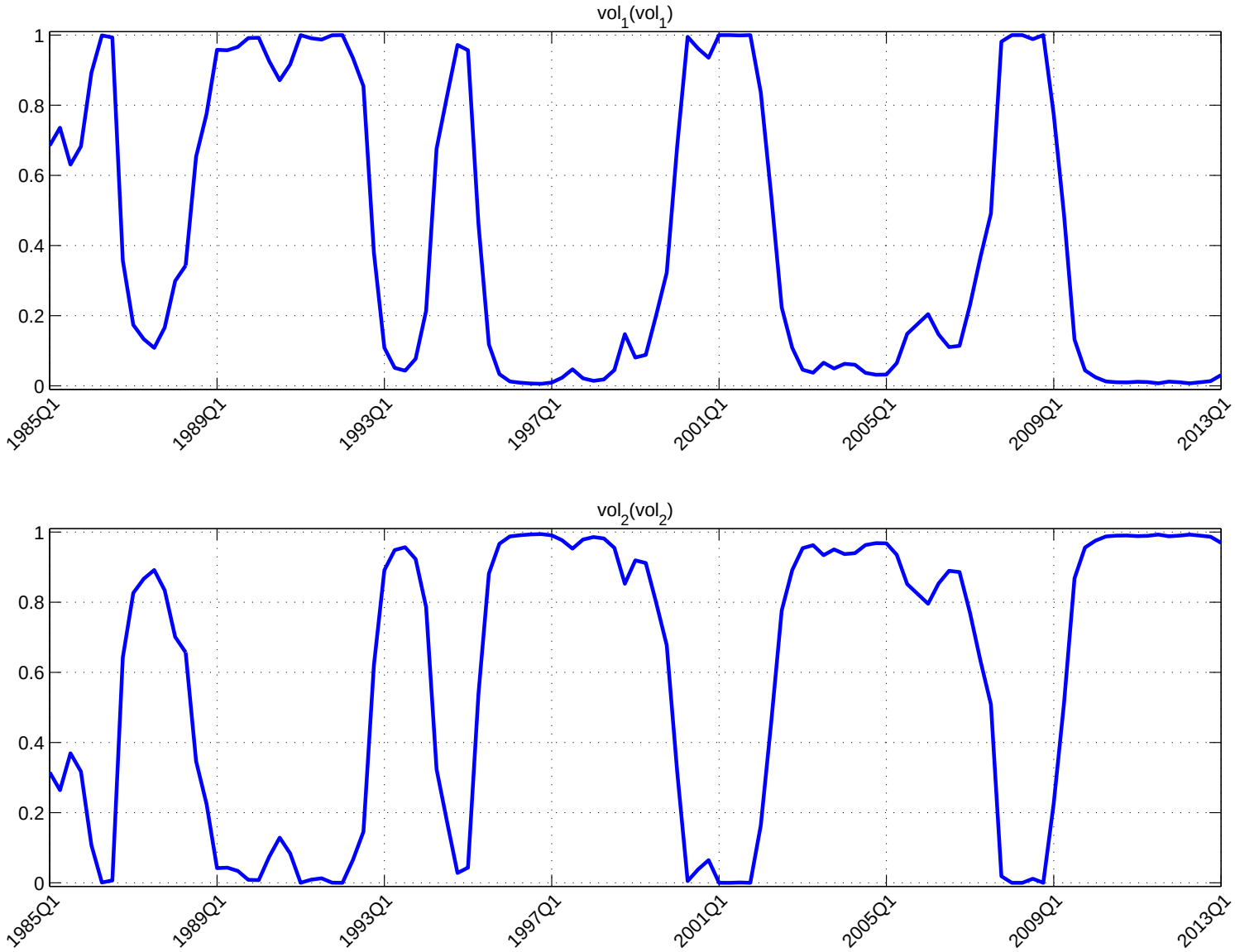

Figure # 3: Smoothed probabilities for polOnly model

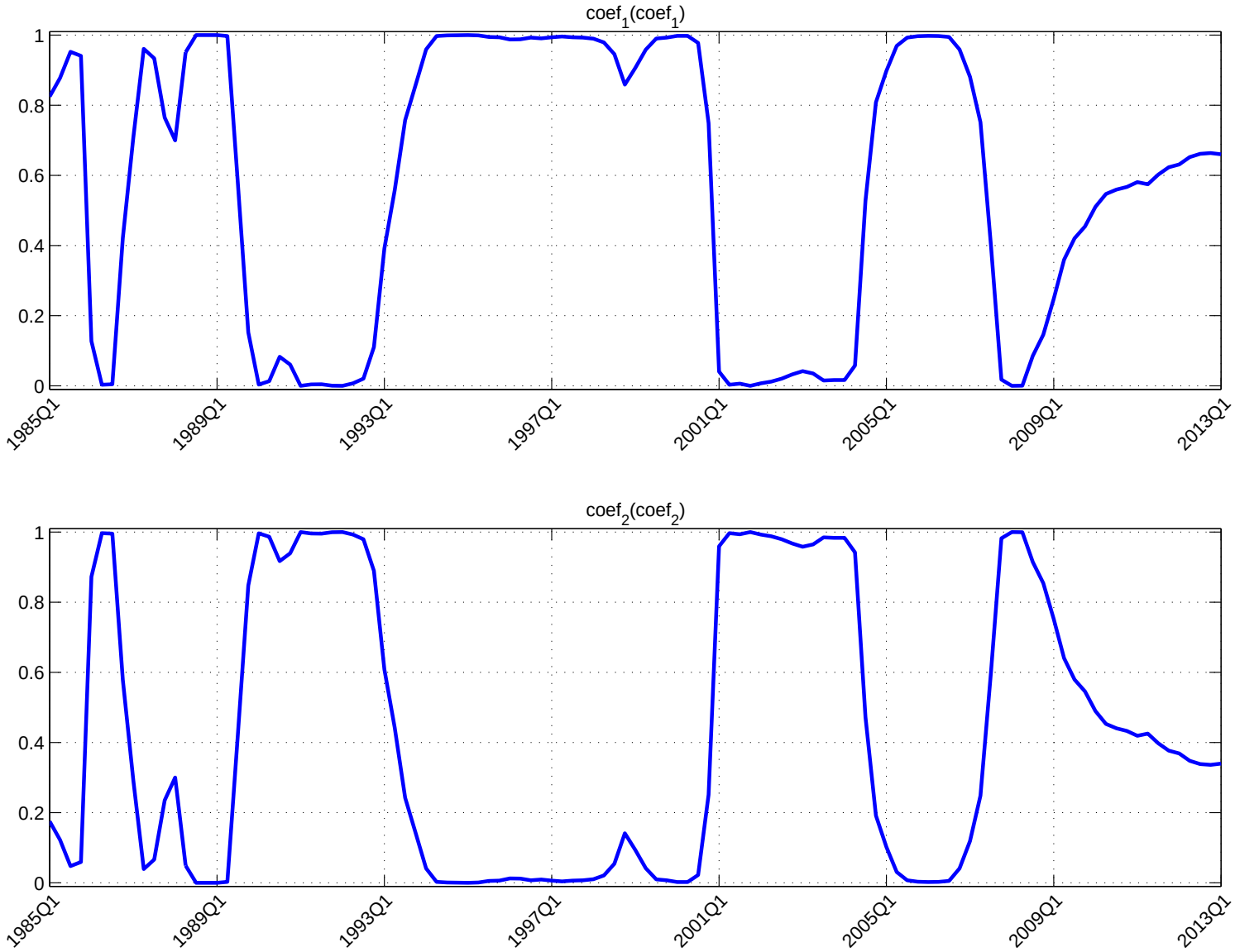

Figure # 4: Smoothed probabilities for volPolSame model

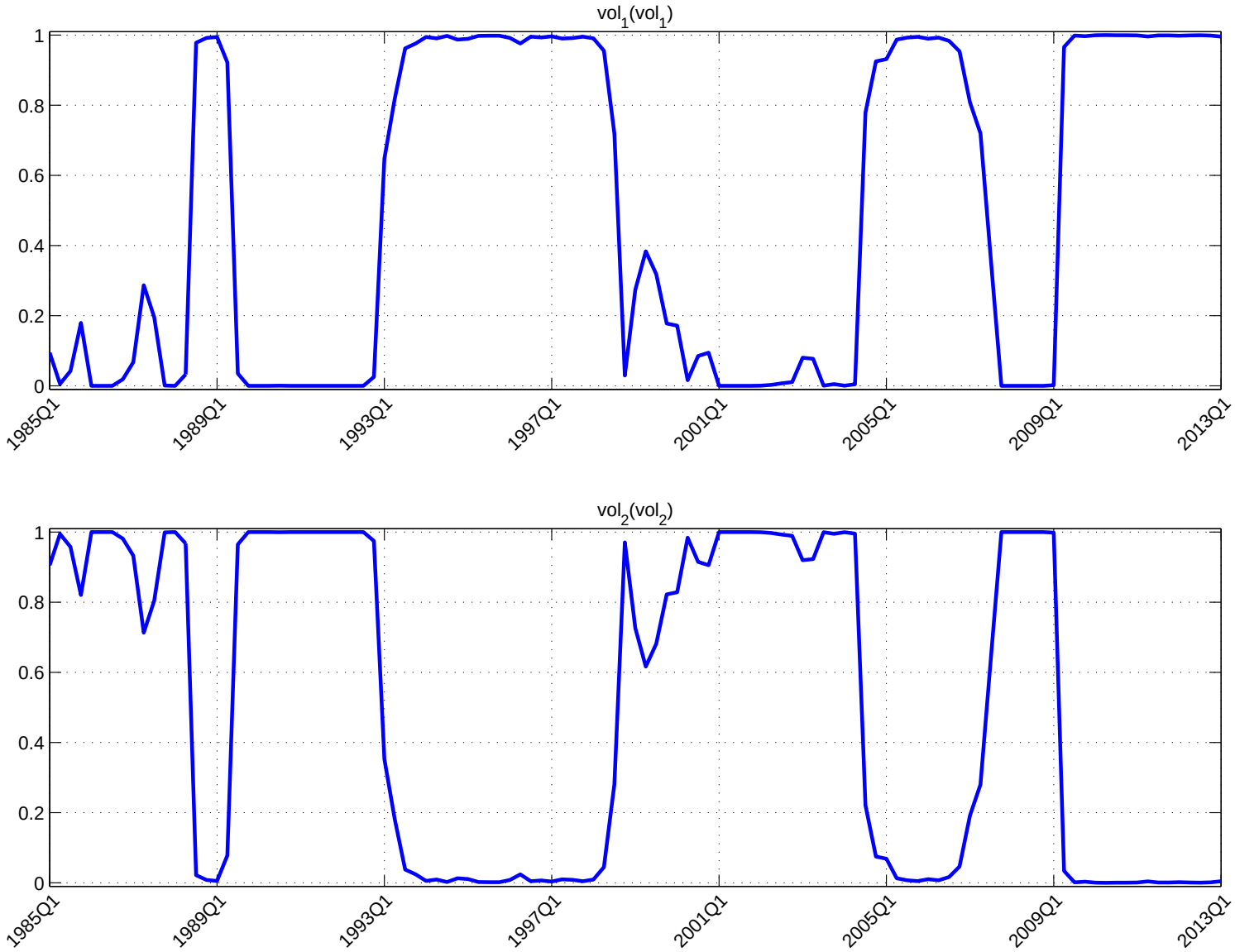

Figure # 5: Smoothed probabilities for volPolInd model

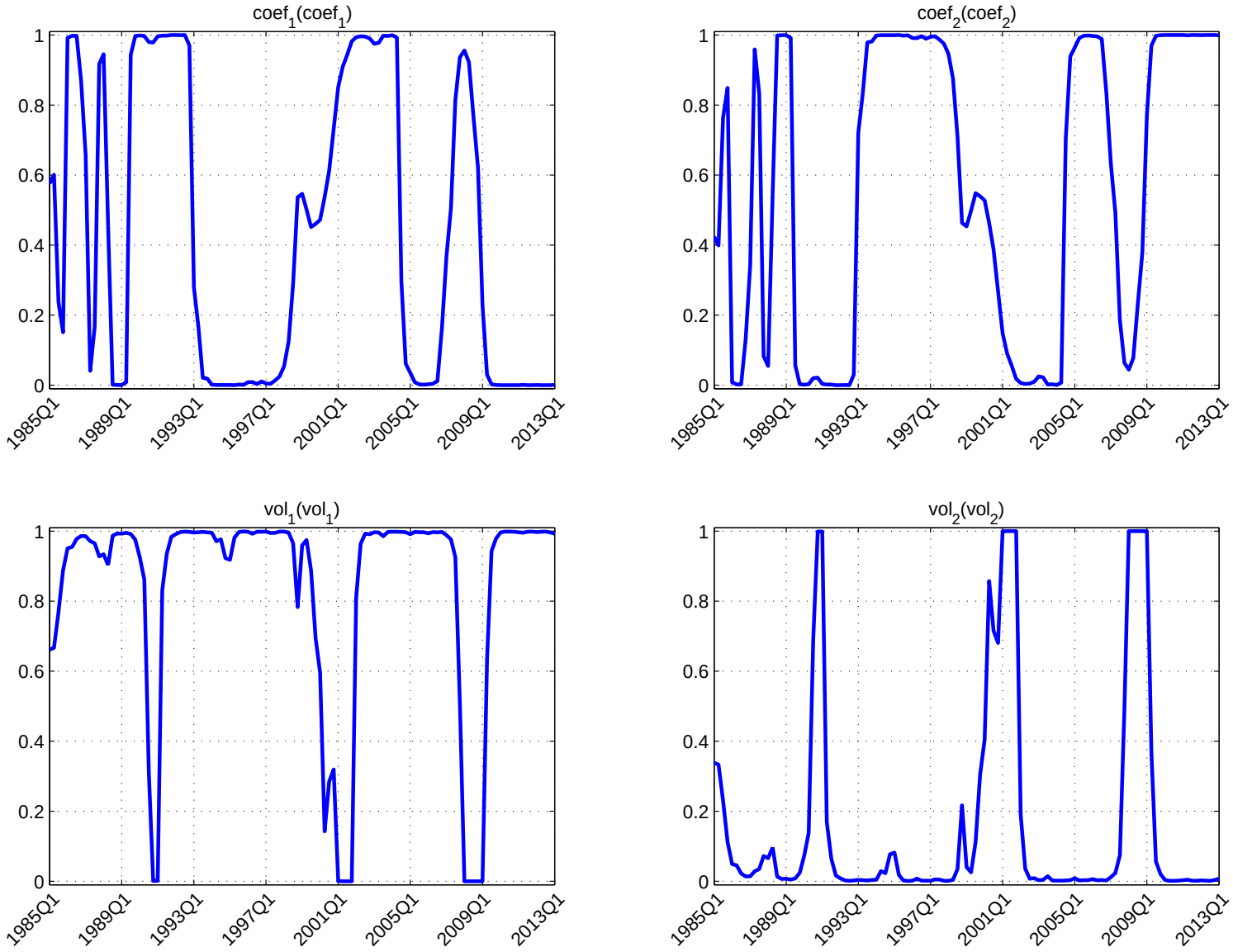

Figure # 6: volOnly:: Observed vs vol_1(vol_1)

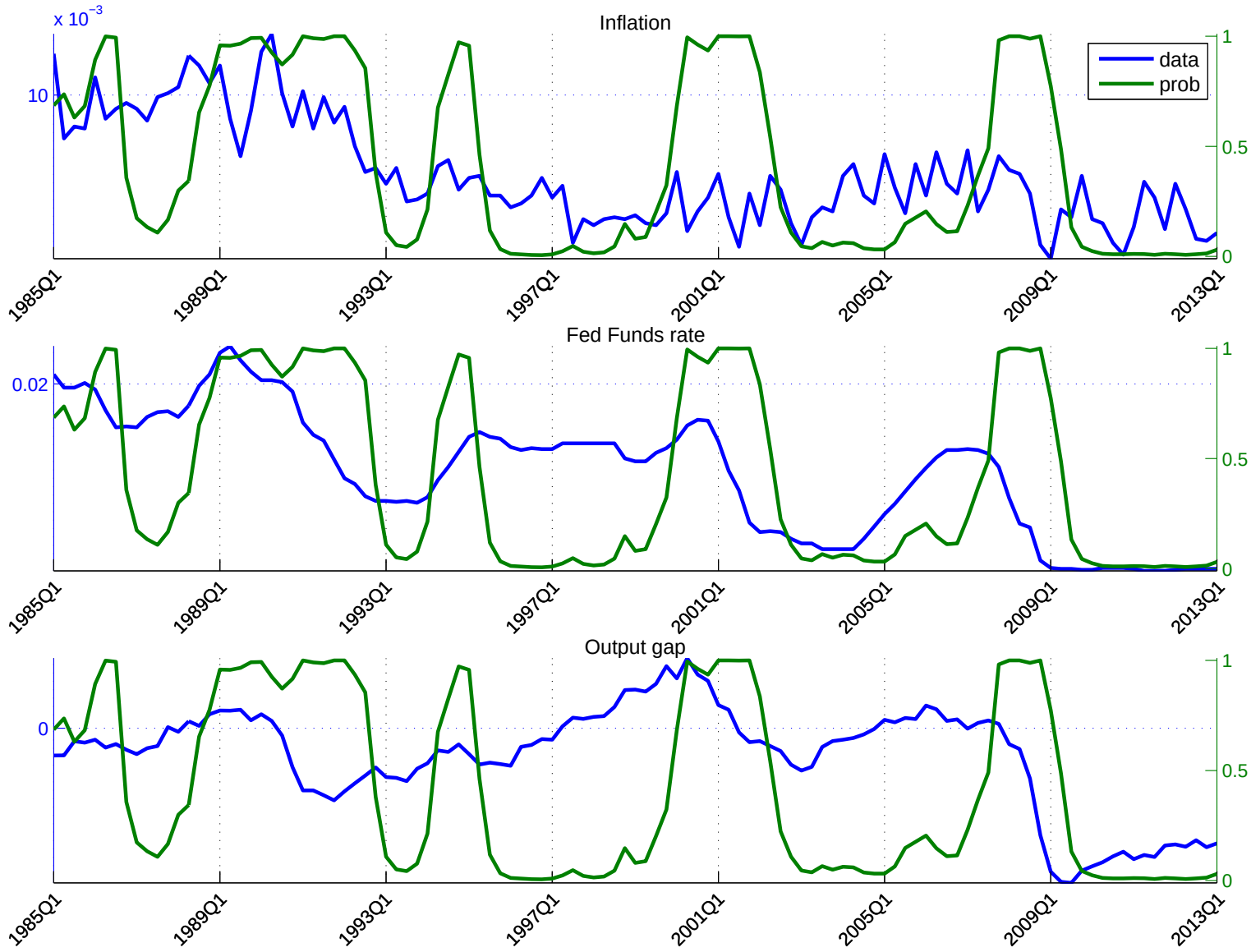

Figure # 7: volOnly:: Observed vs vol_2(vol_2)

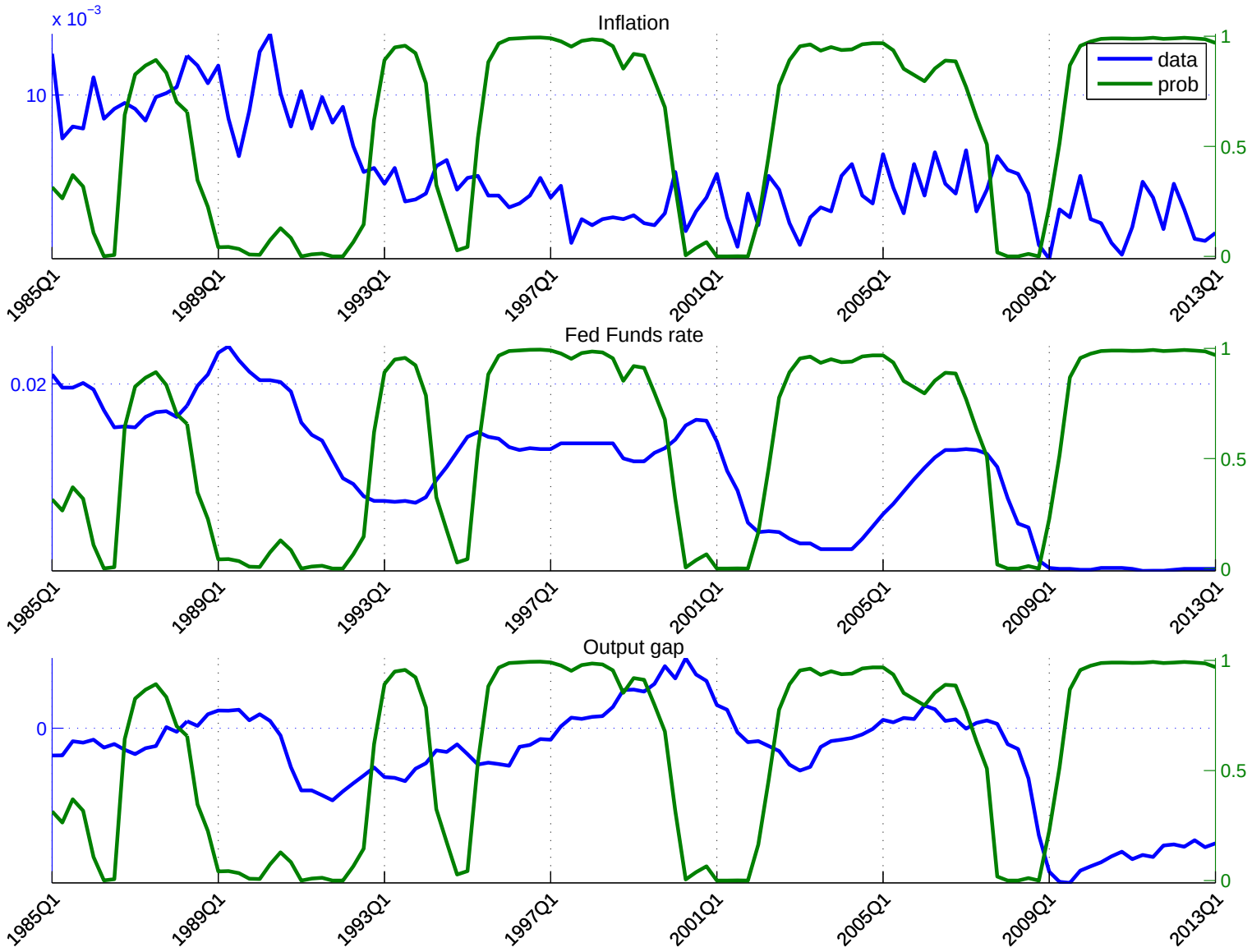

Figure # 8: polOnly:: Observed vs coef_1(coef_1)

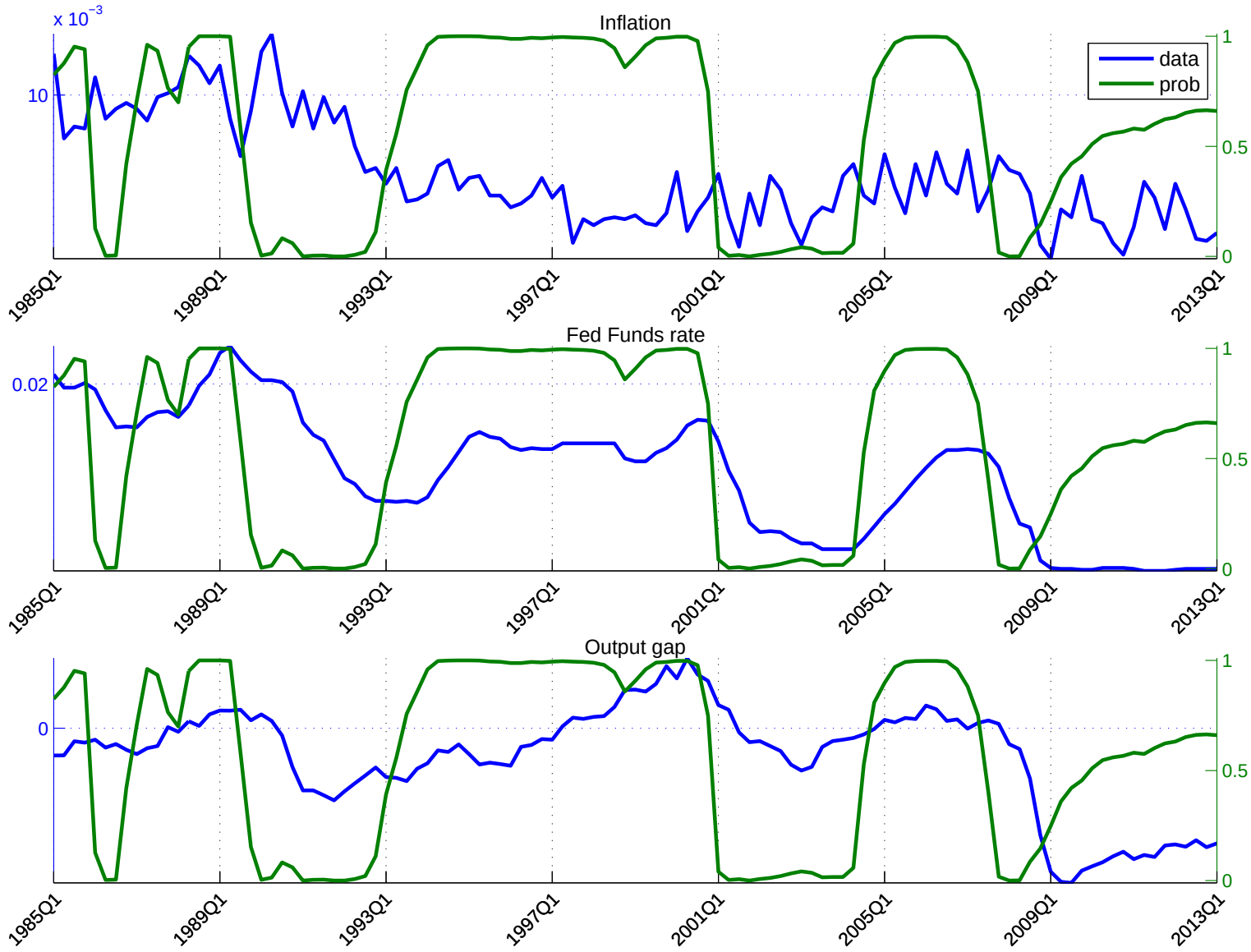

Figure # 9: polOnly:: Observed vs coef_2(coef_2)

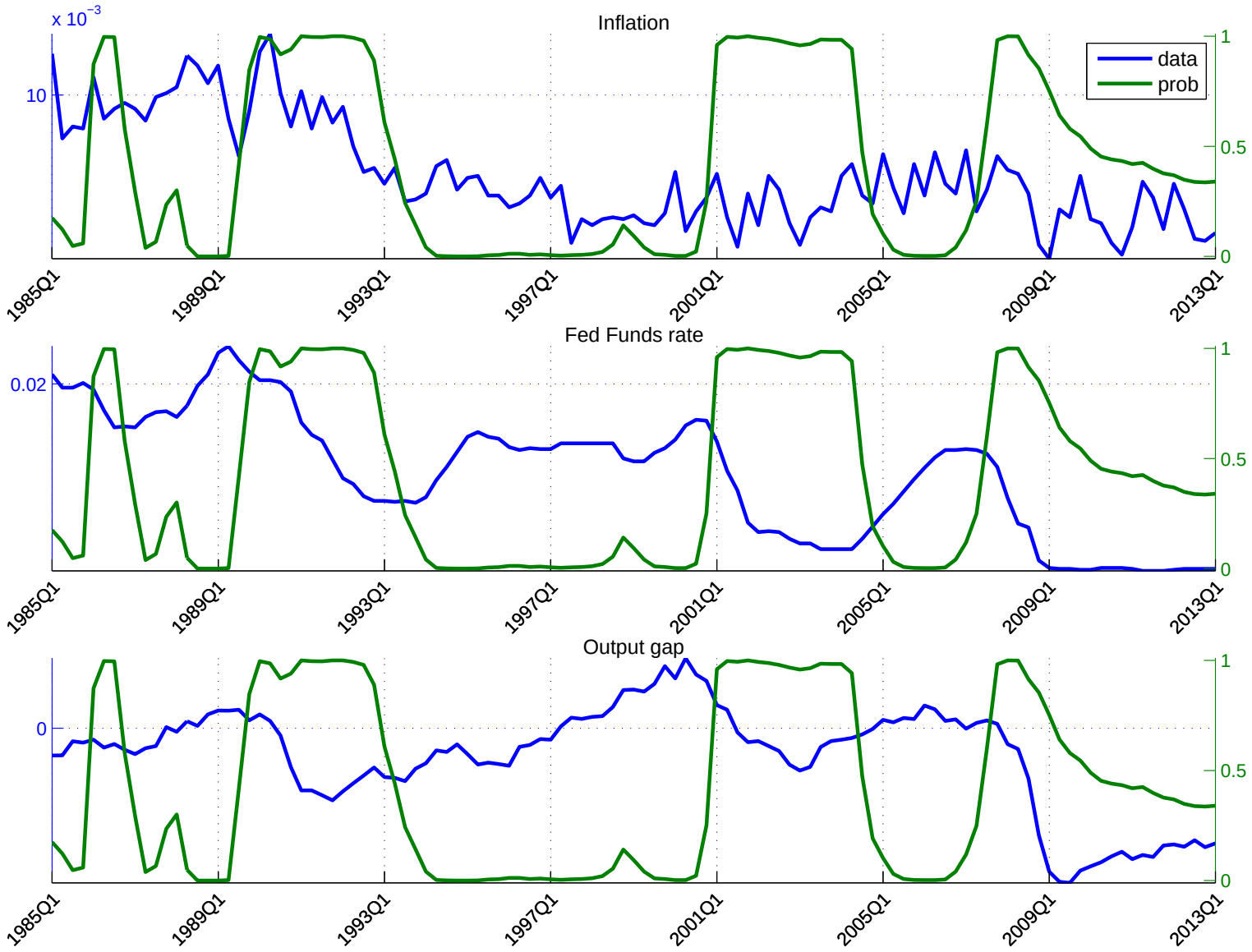

Figure # 10: volPolSame:: Observed vs vol_1(vol_1)

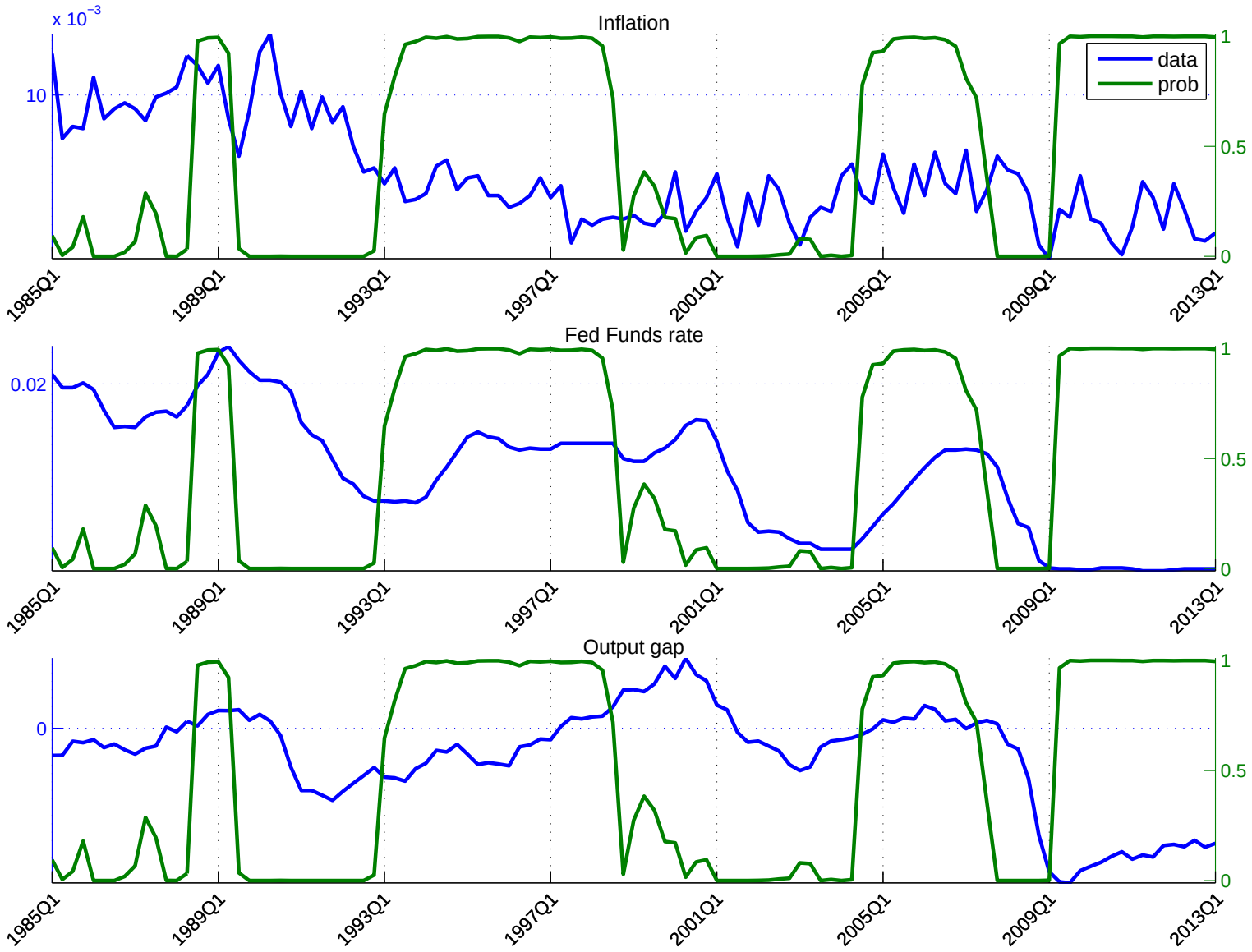

Figure # 11: volPolSame:: Observed vs vol_2(vol_2)

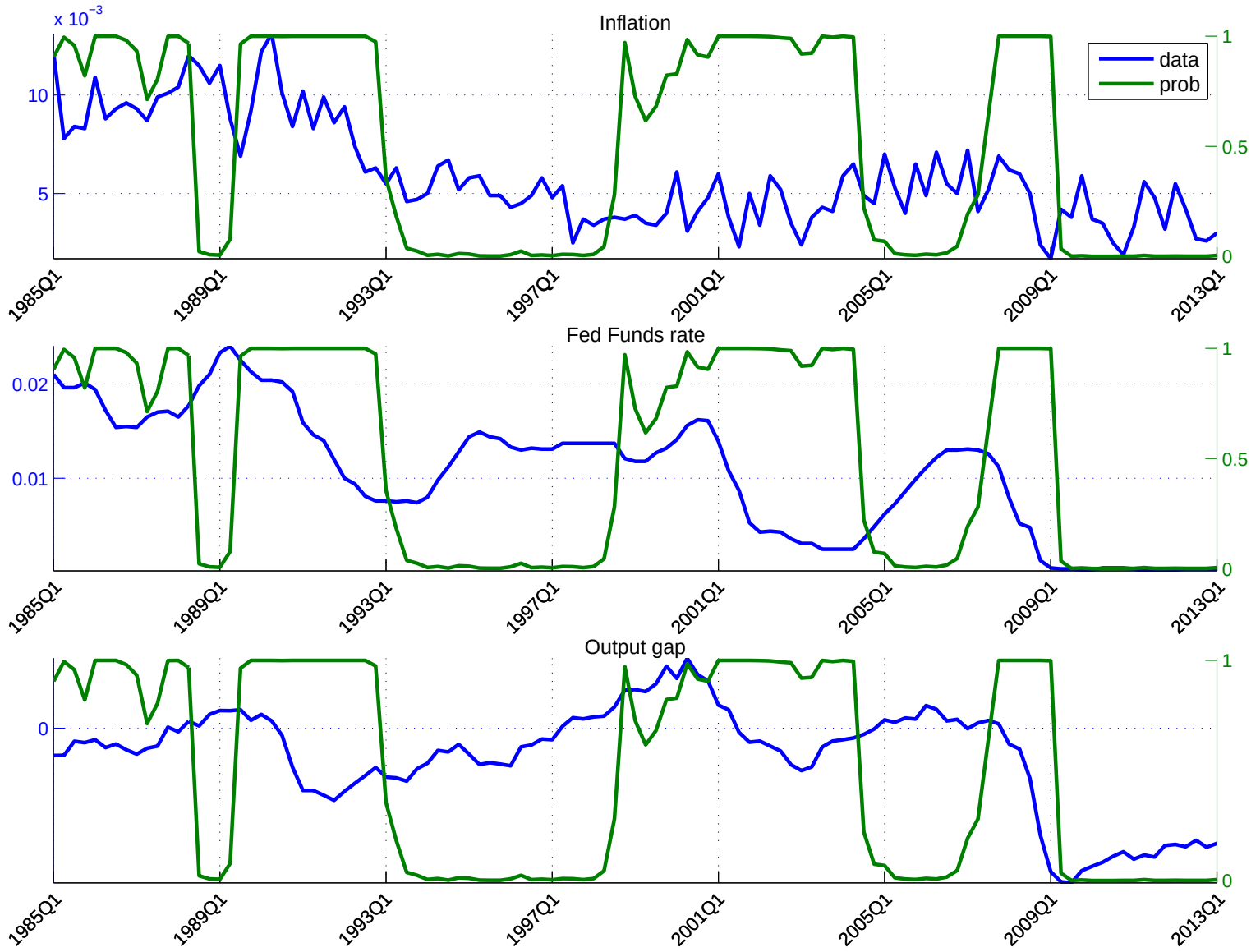

Figure # 12: volPolInd:: Observed vs coef_1(coef_1)

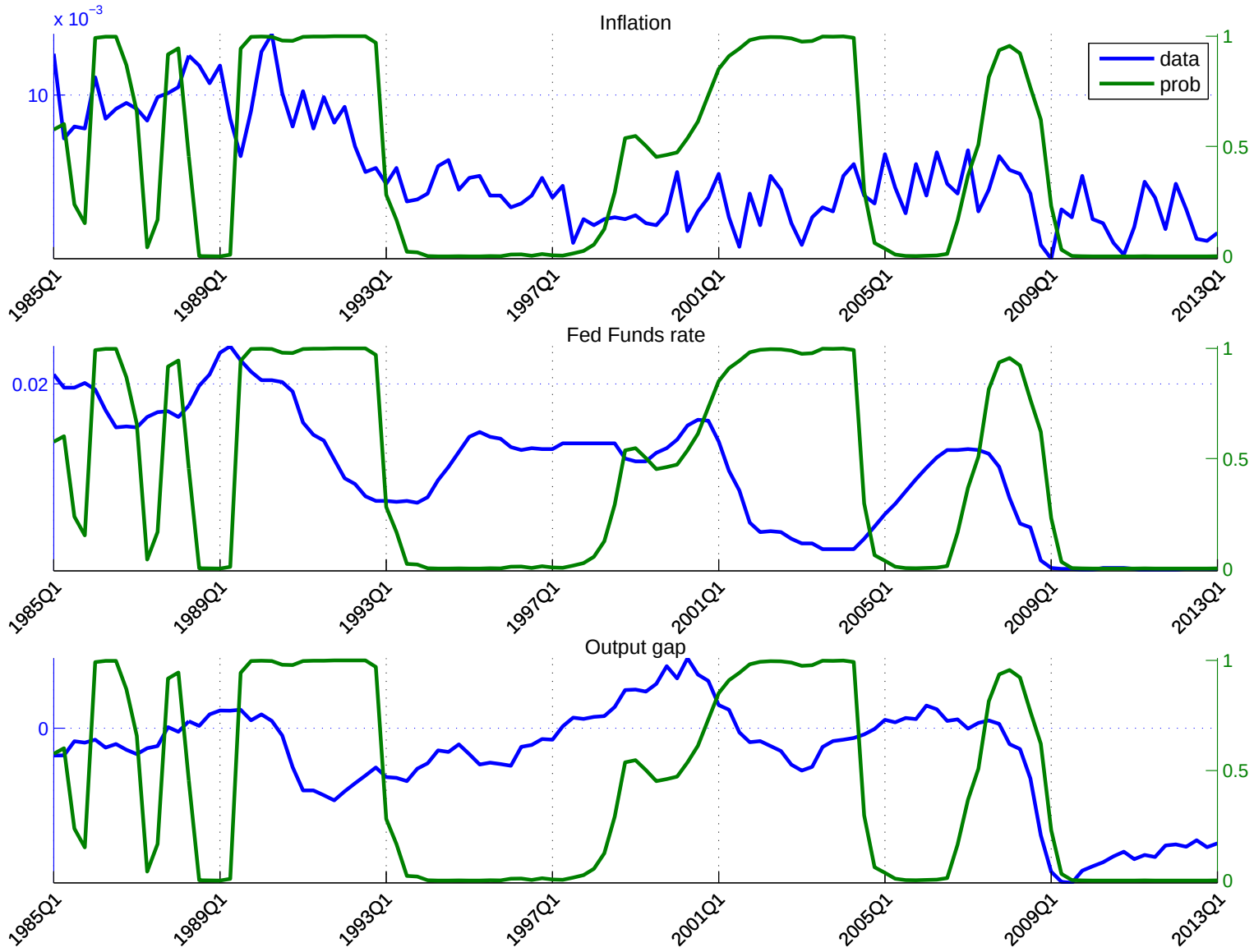

Figure # 13: volPolInd:: Observed vs coef_2(coef_2)

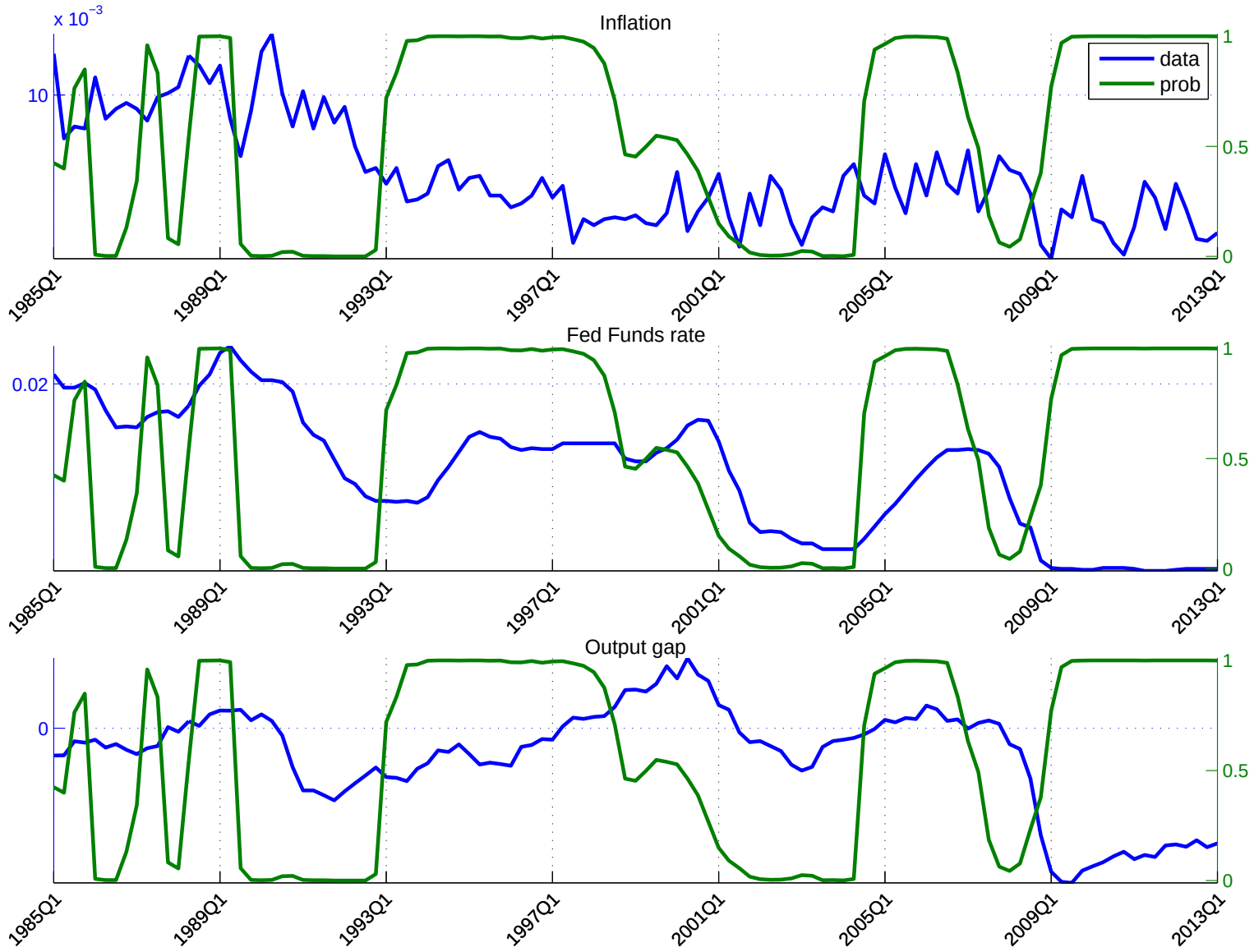

Figure # 14: volPolInd:: Observed vs vol_1(vol_1)

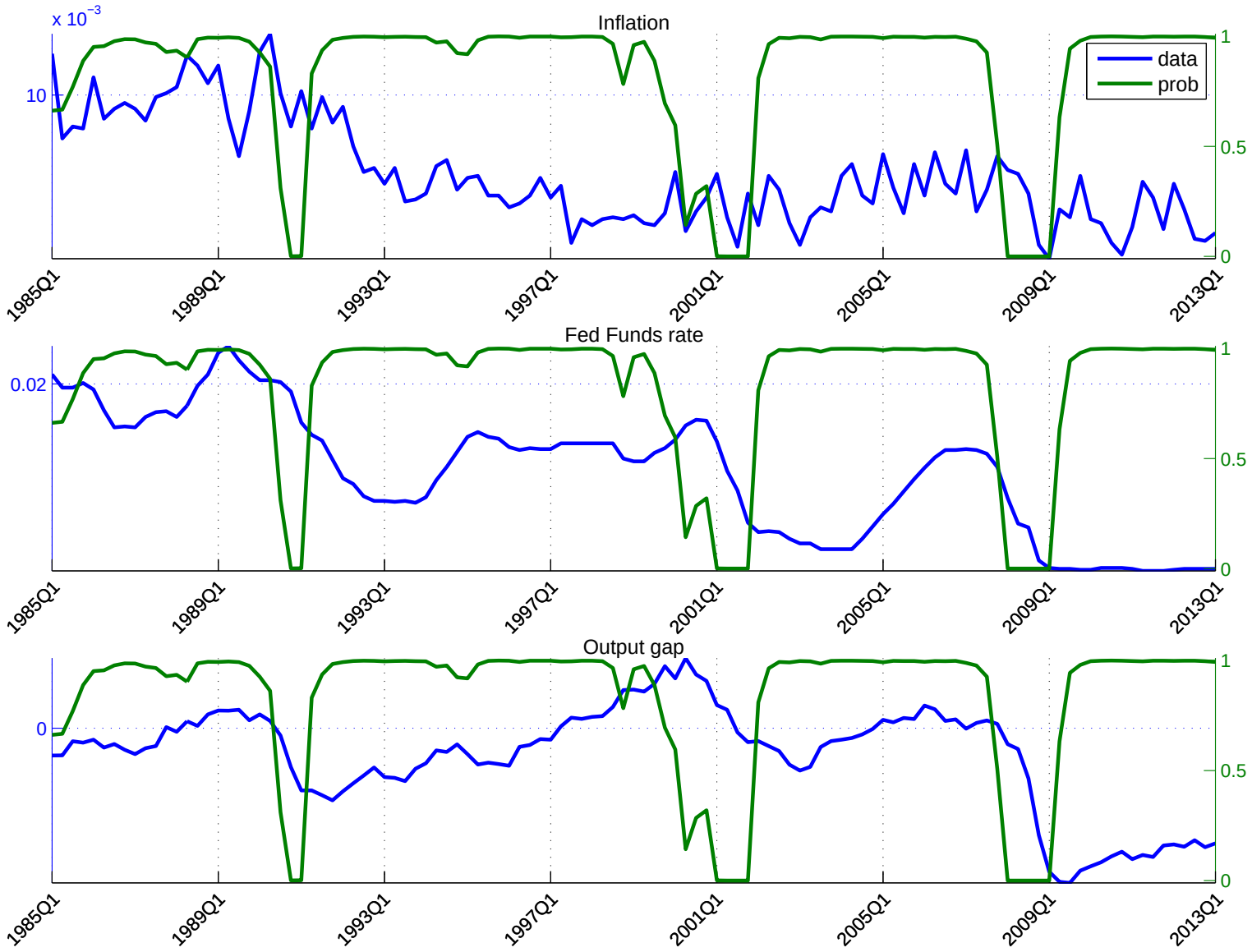

Figure # 15: volPolInd:: Observed vs vol_2(vol_2)

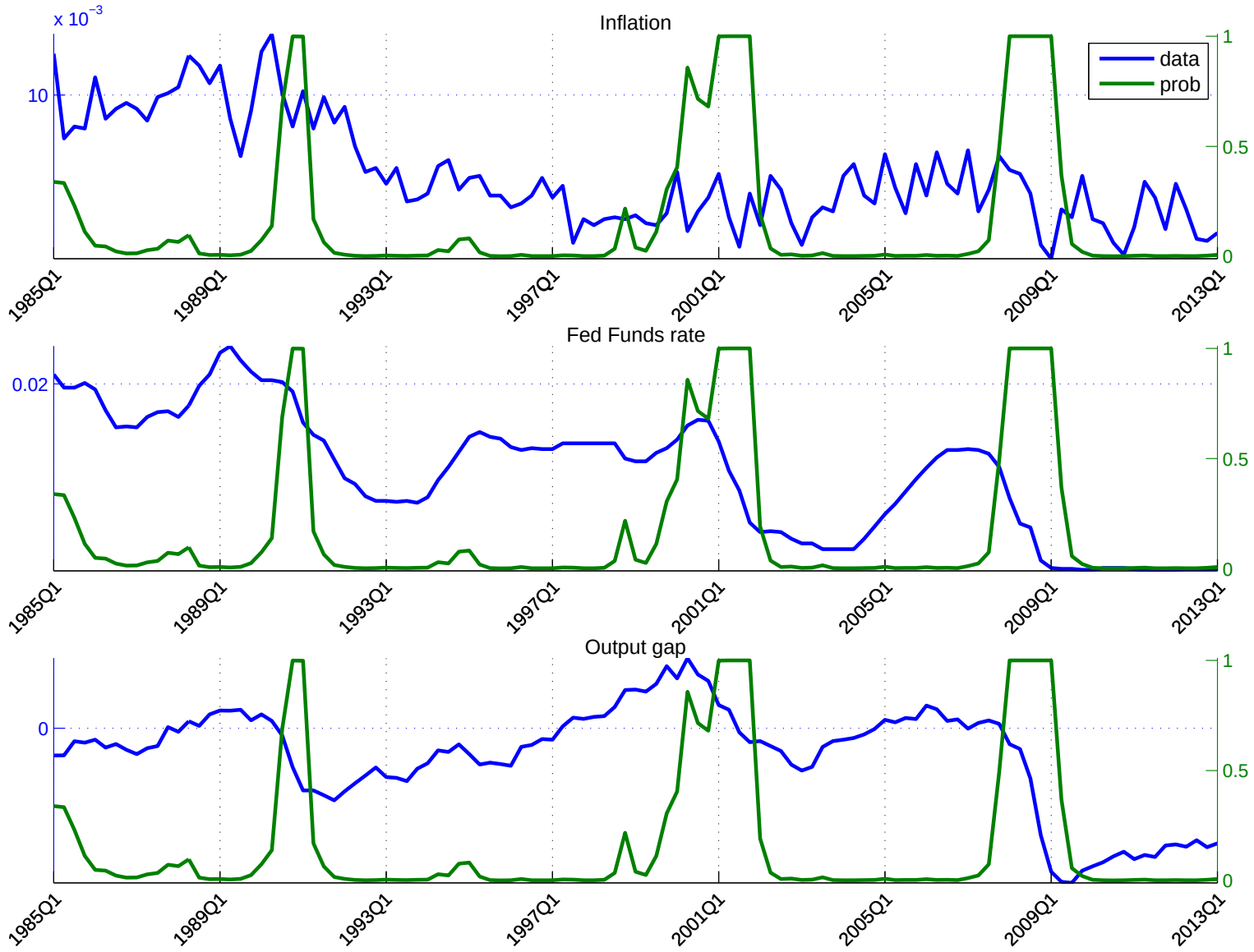

Figure # 16: Unobserved variables

Figure # 17: (Generalized) IRFs to a Demand shock shock

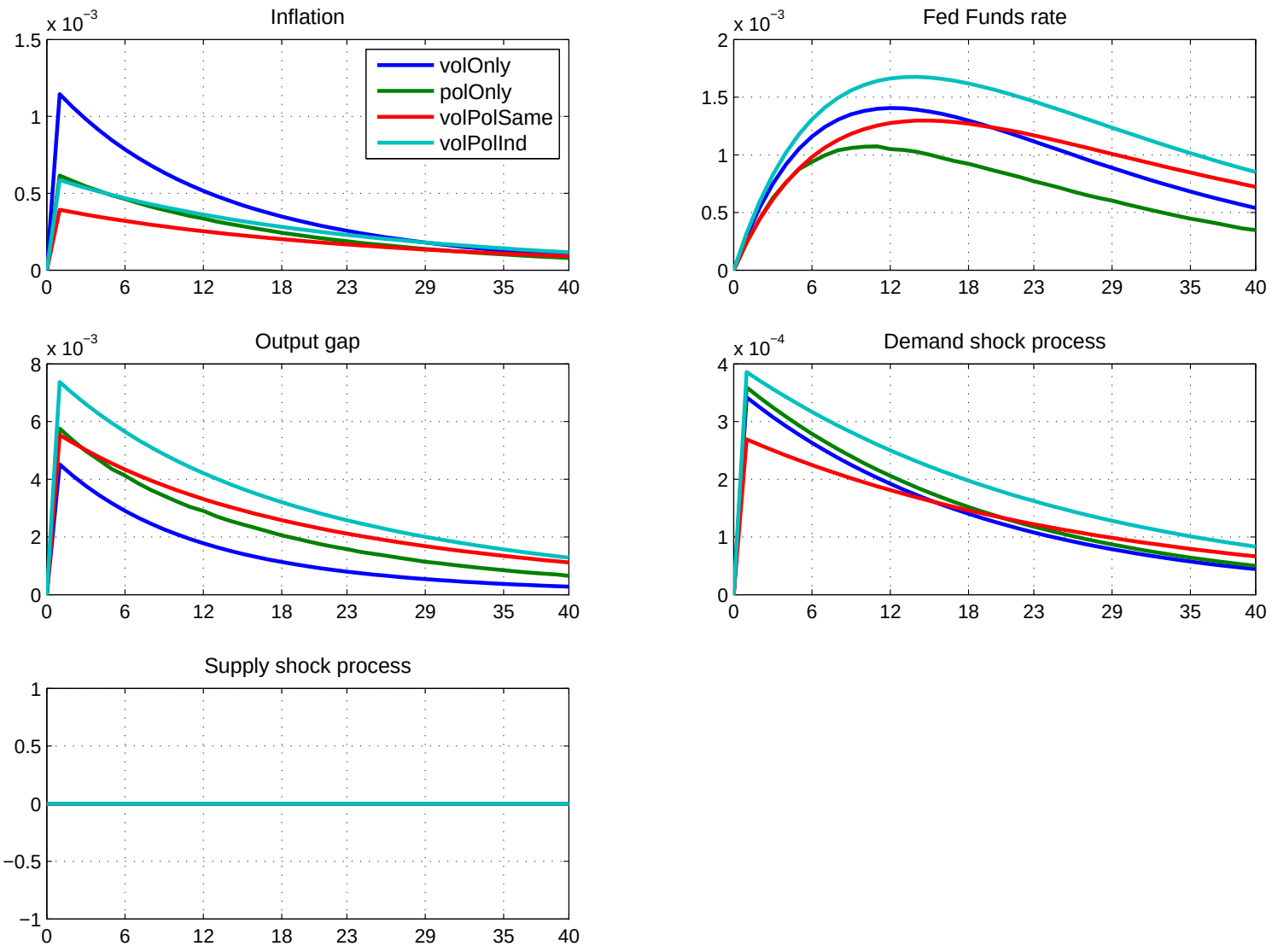

Figure # 18: (Generalized) IRFs to a Monetary policy shock shock

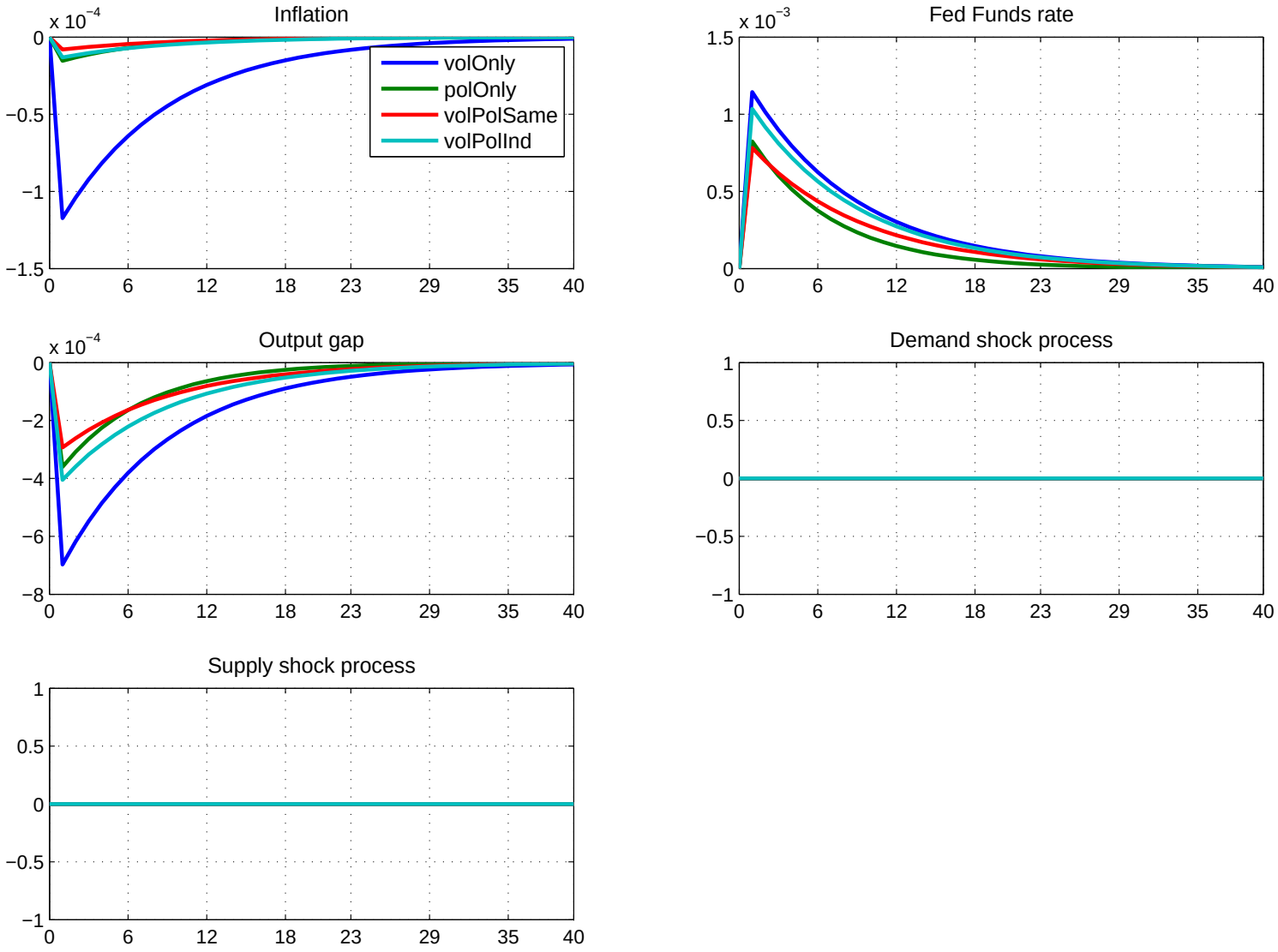

Figure # 19: (Generalized) IRFs to a Supply shock shock

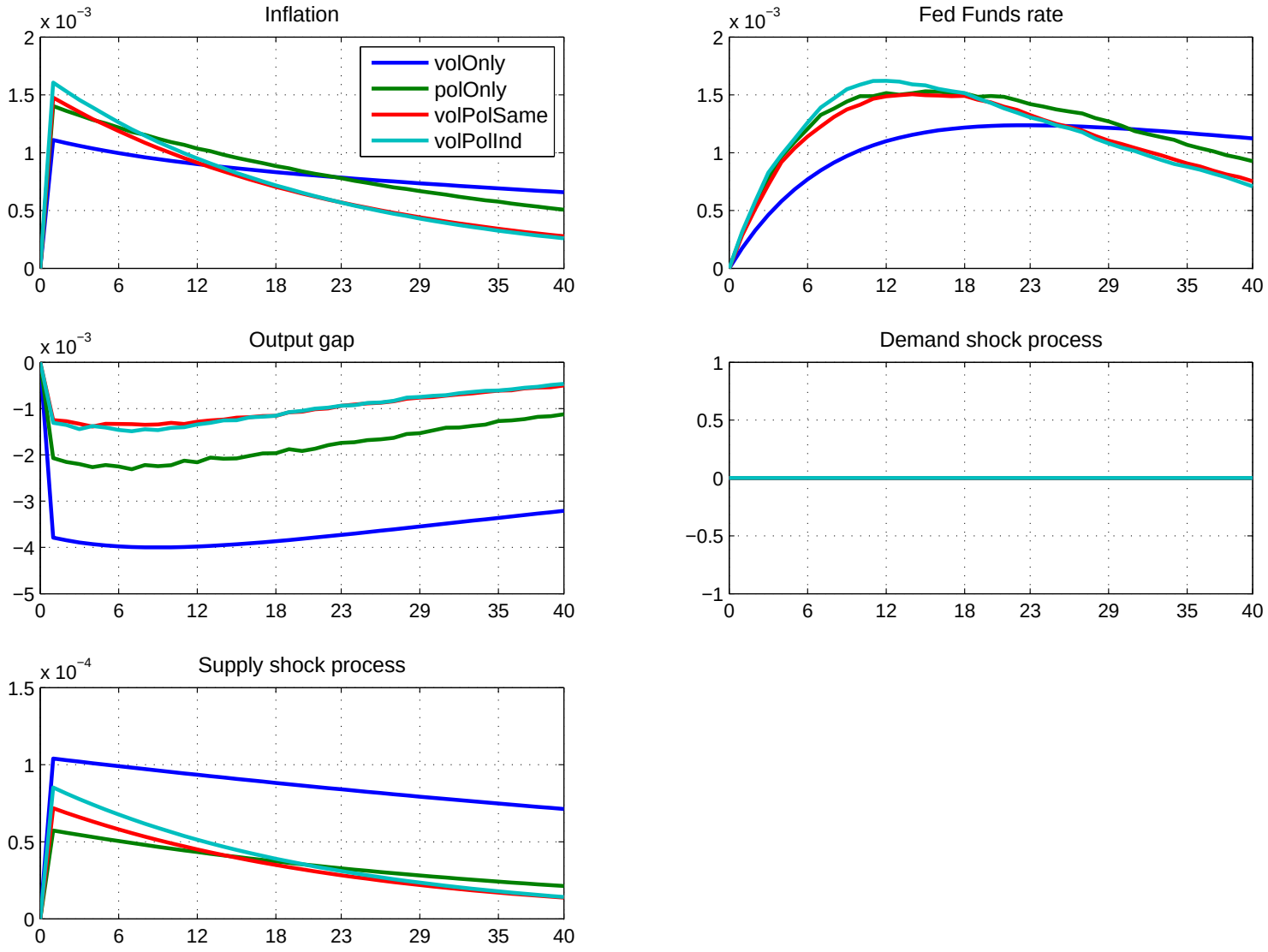

Figure # 20: historical decomposition of Inflation

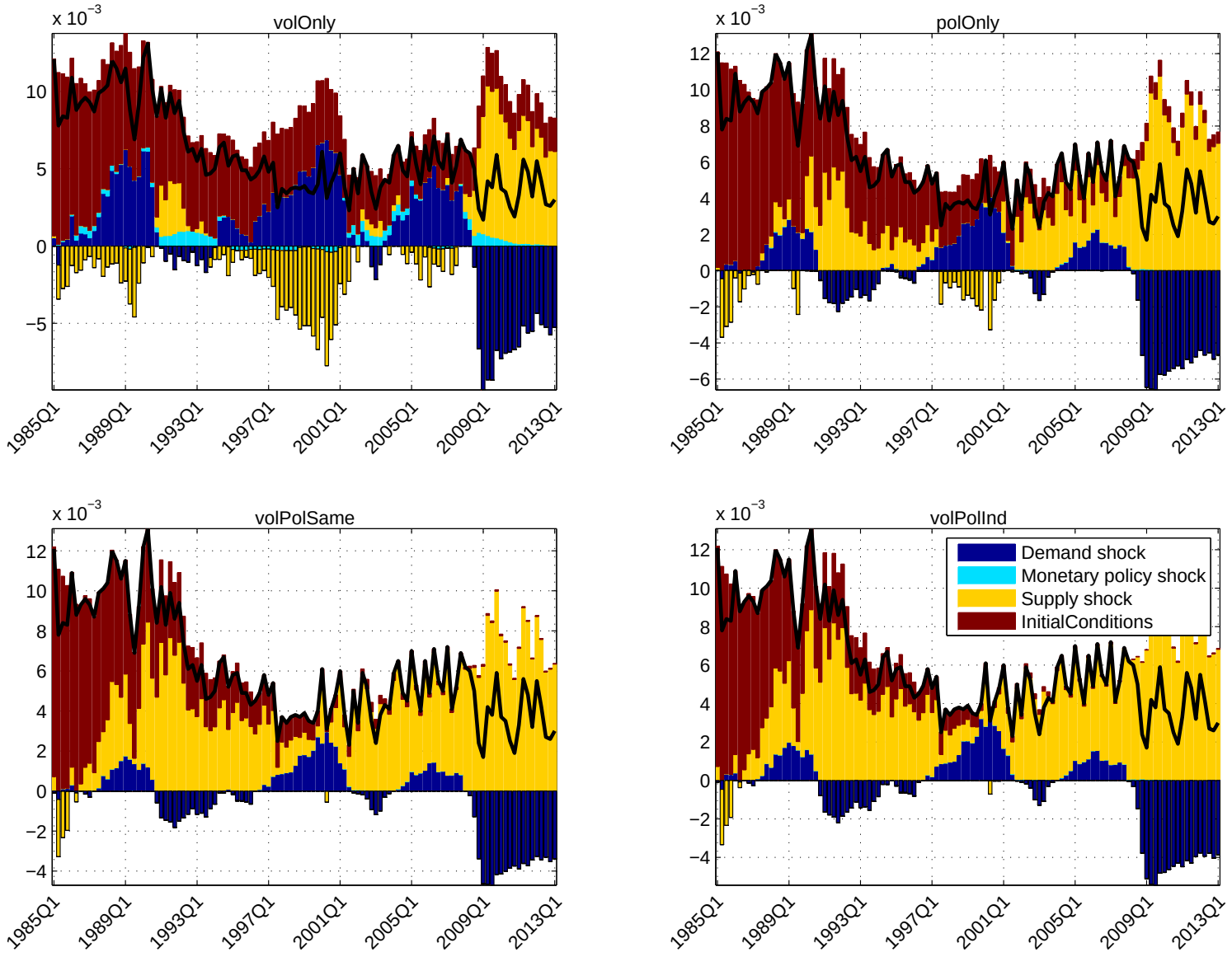

Figure # 21: historical decomposition of Fed Funds rate

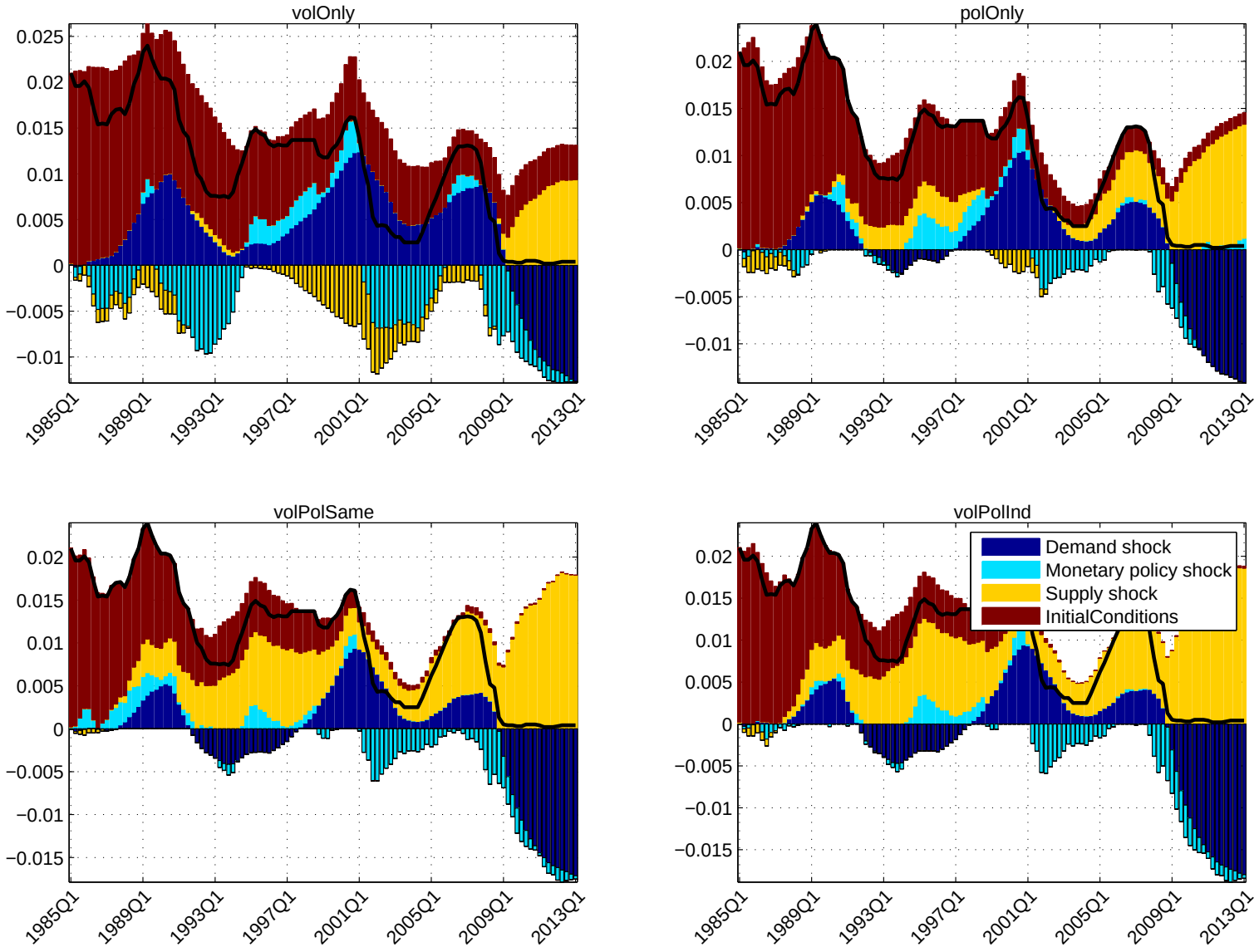

Figure # 22: historical decomposition of Output gap

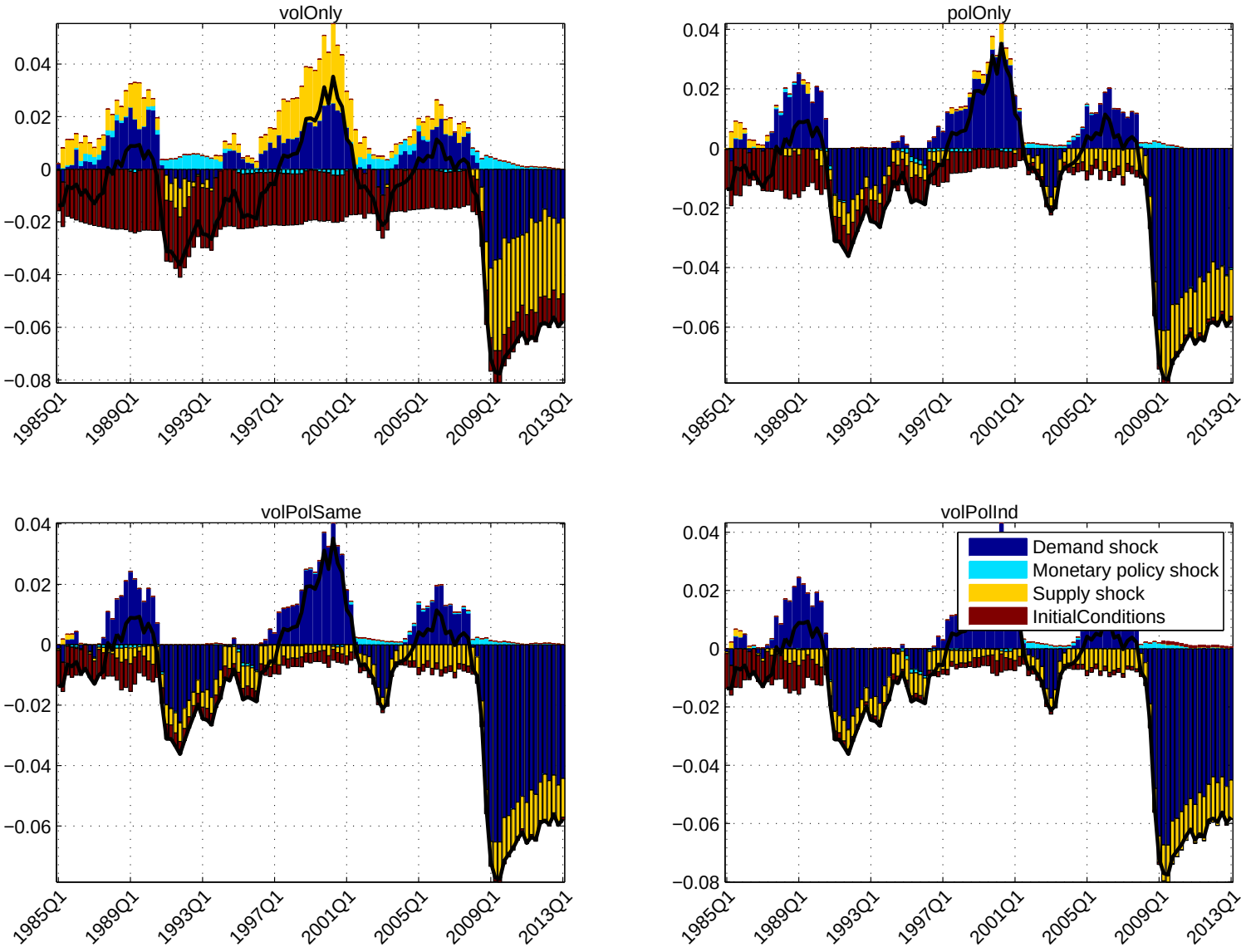

Figure # 23: historical decomposition of Demand shock process

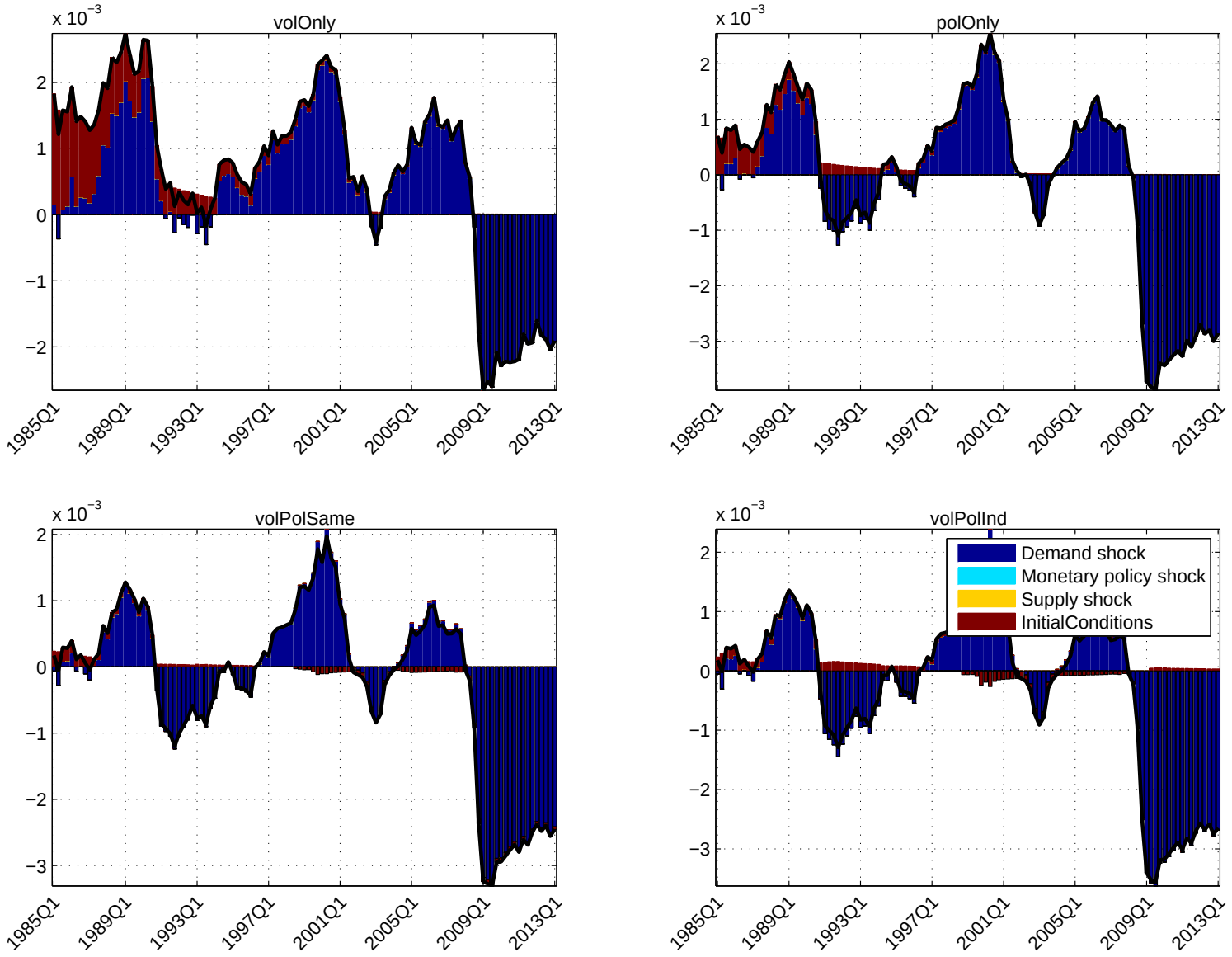

Figure # 24: historical decomposition of Supply shock process

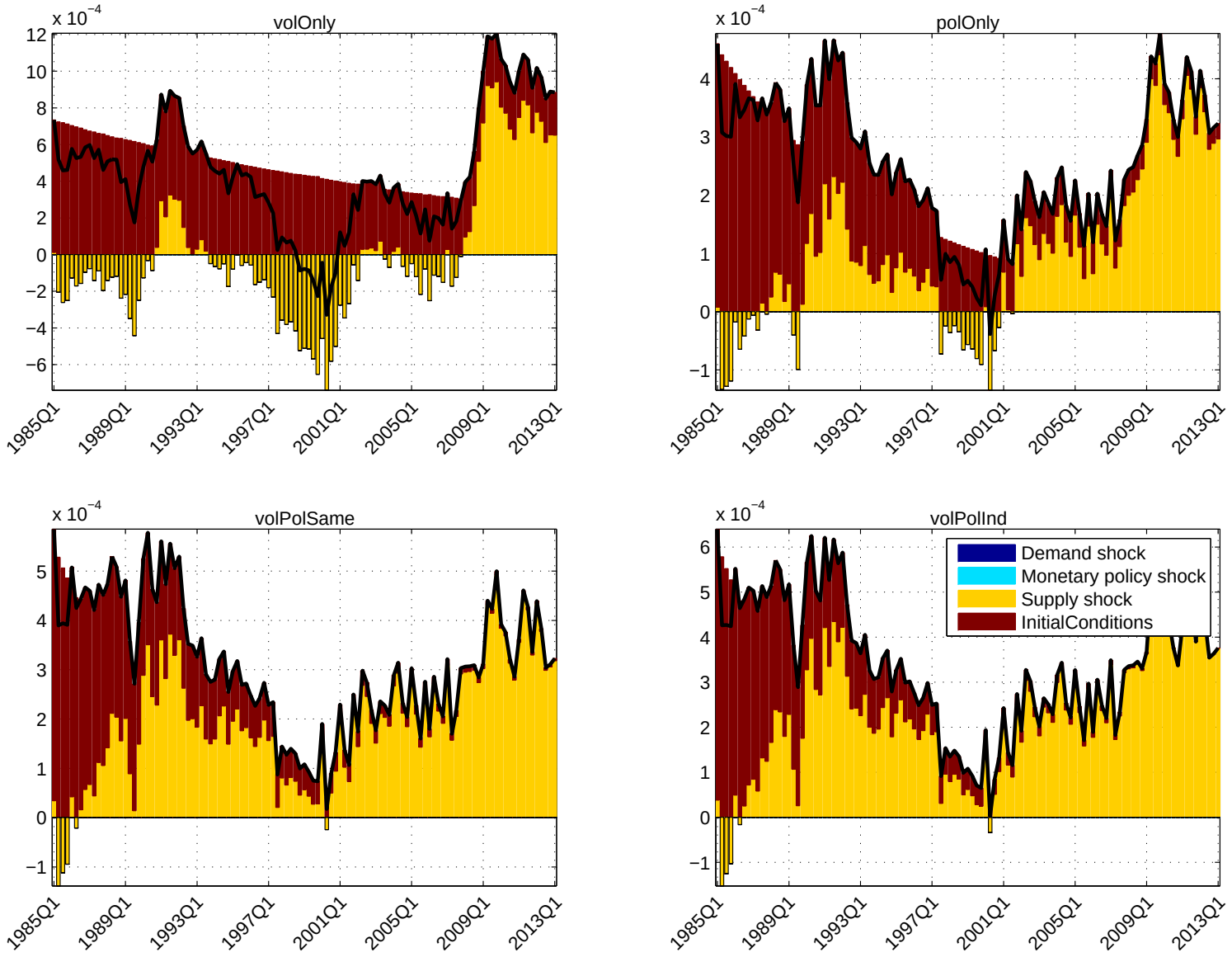

Figure # 25: Variance decomposition of Inflation

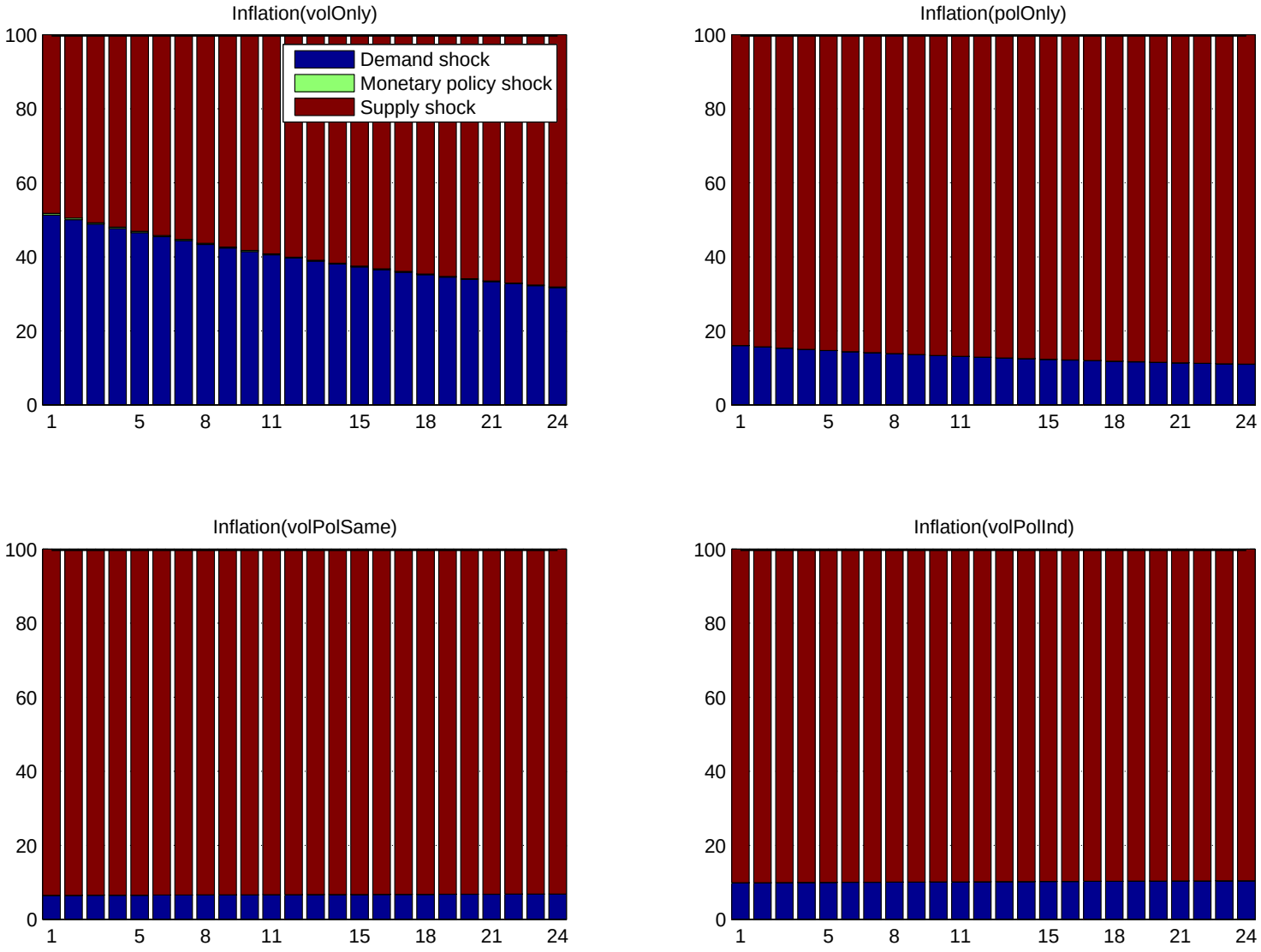

Figure # 26: Variance decomposition of Fed Funds rate

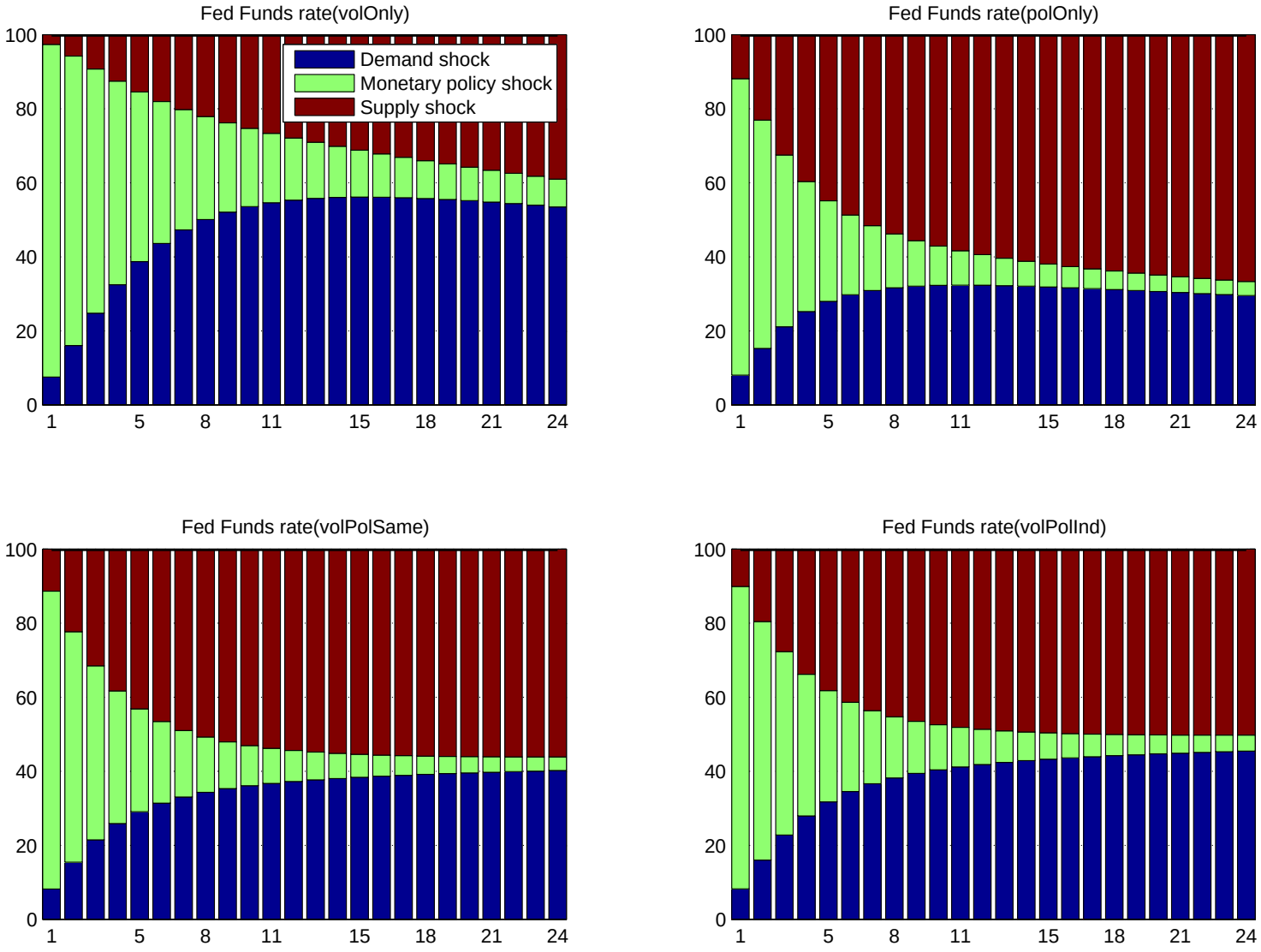

Figure # 27: Variance decomposition of Output gap

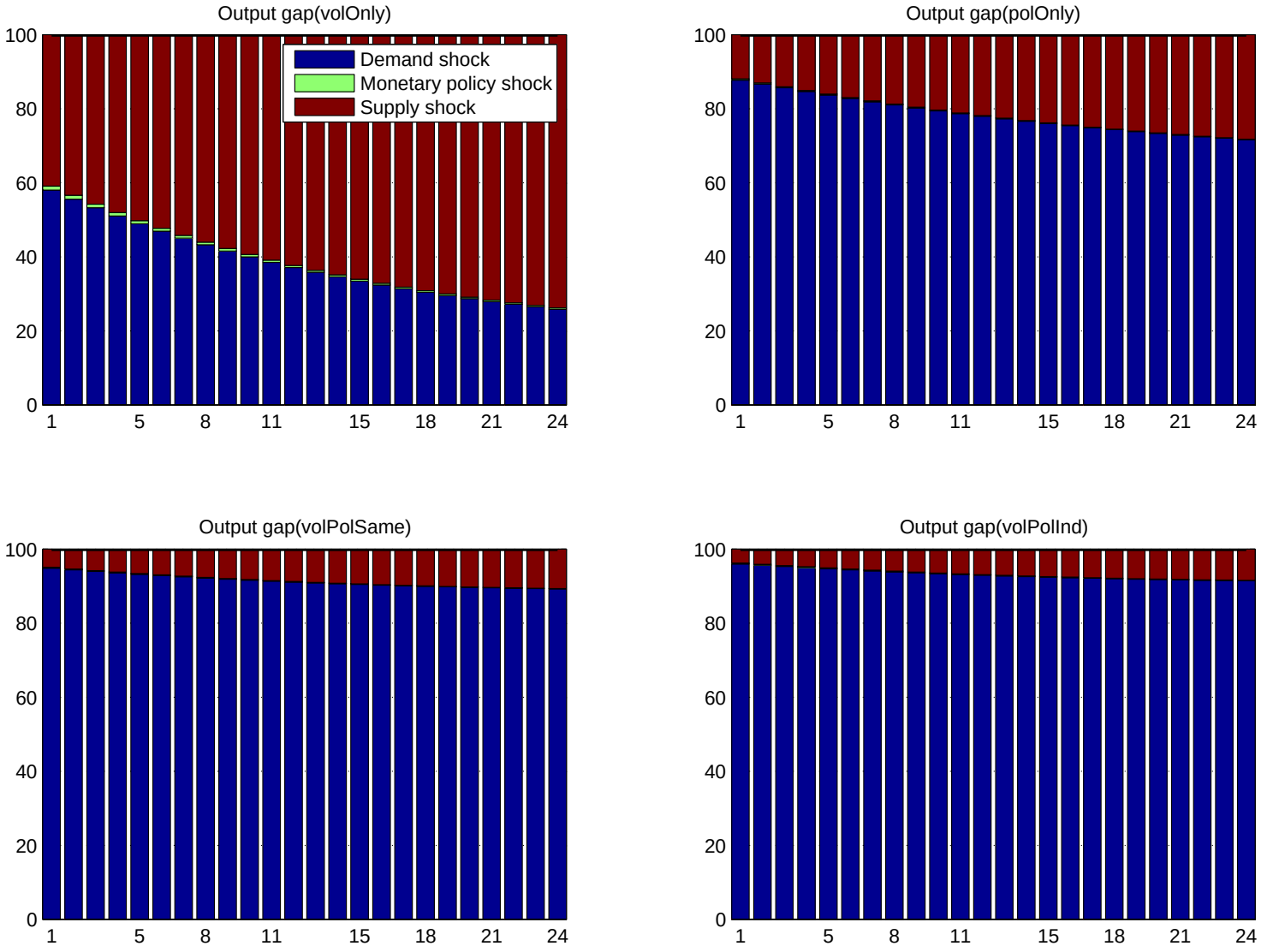

Figure # 28: real-time forecasts for Inflation

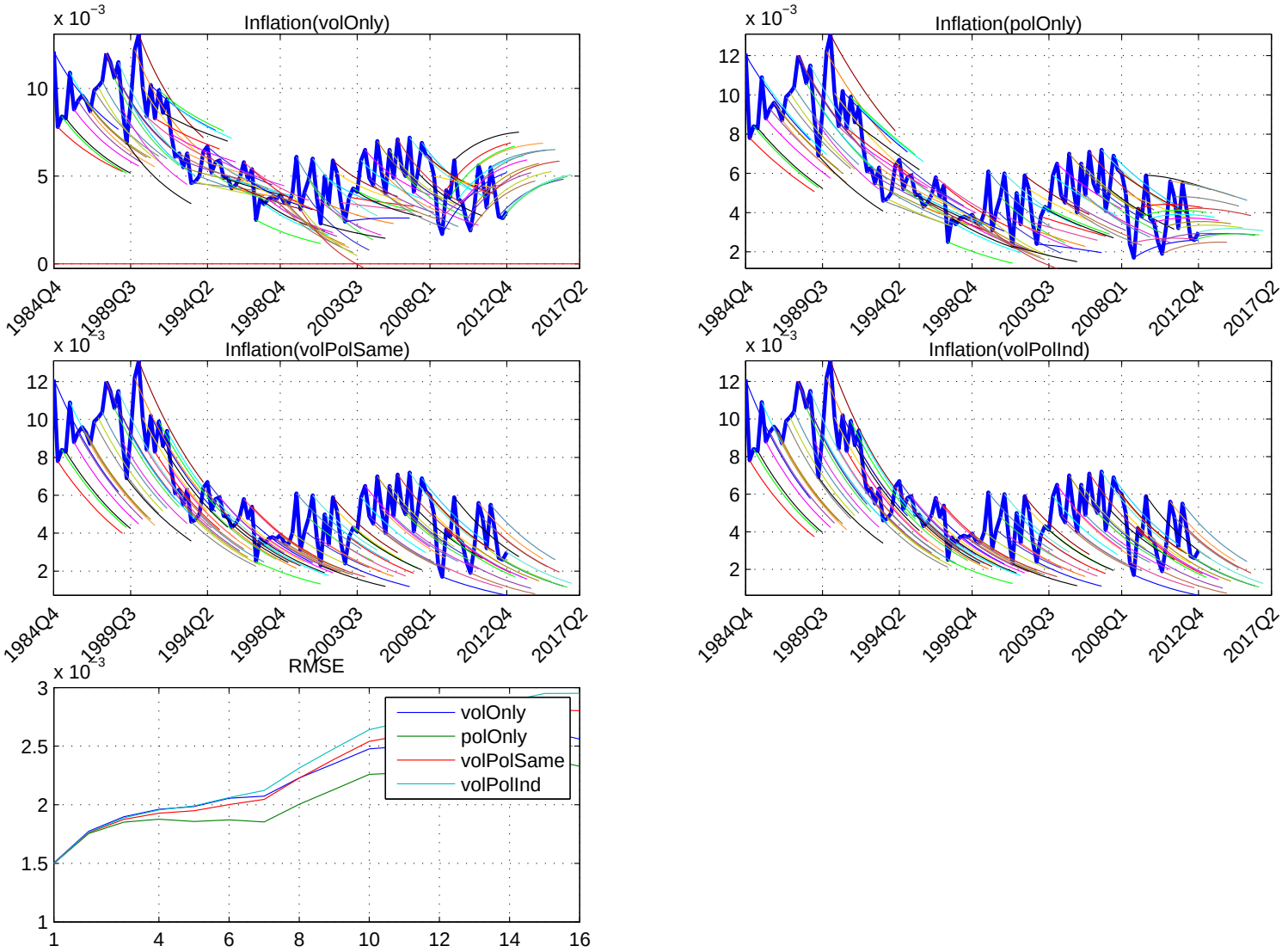

Figure # 29: real-time forecasts for Fed Funds rate

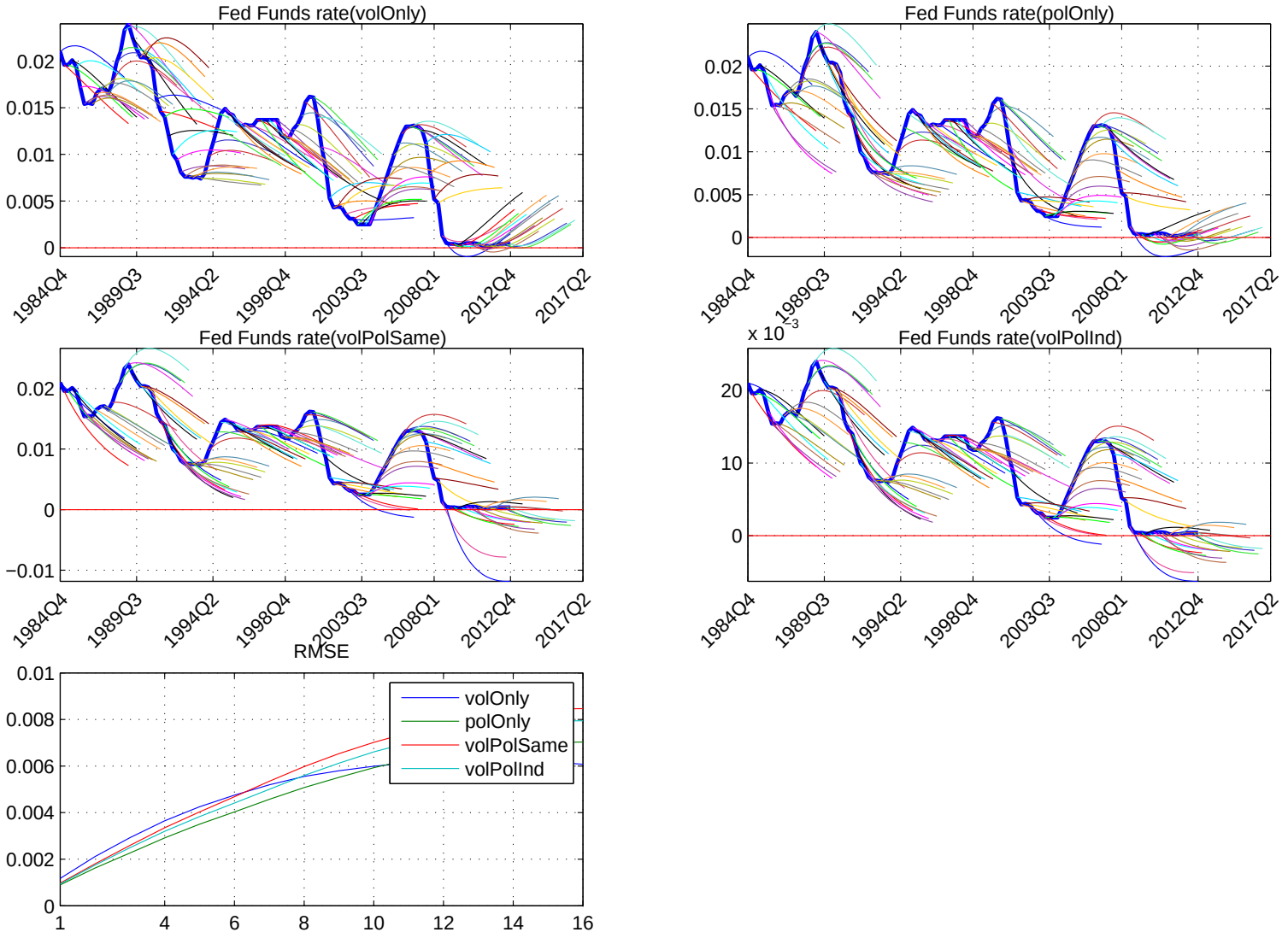

Figure # 30: real-time forecasts for Output gap

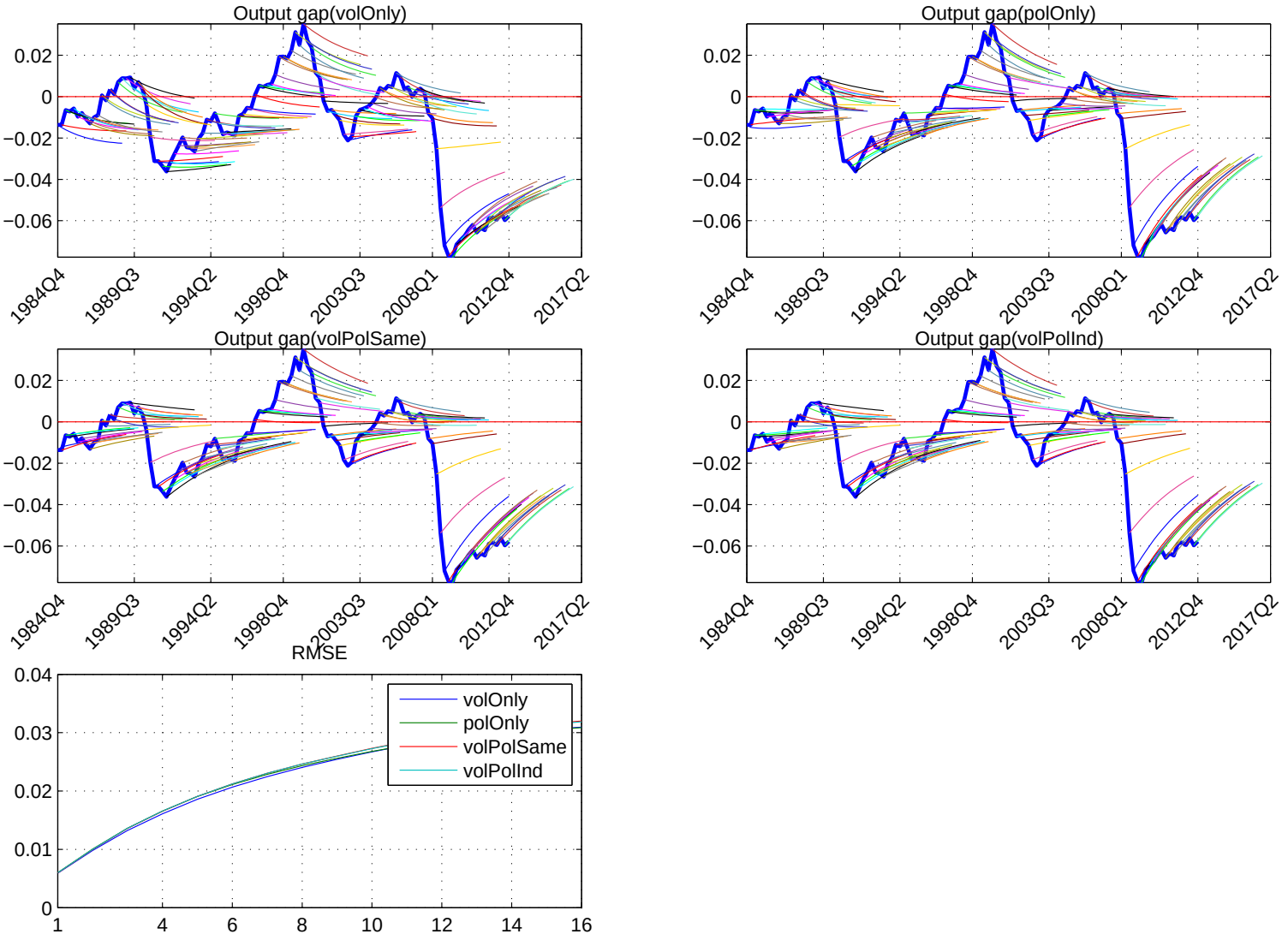

Figure # 31: Vector autocorrelations(1)

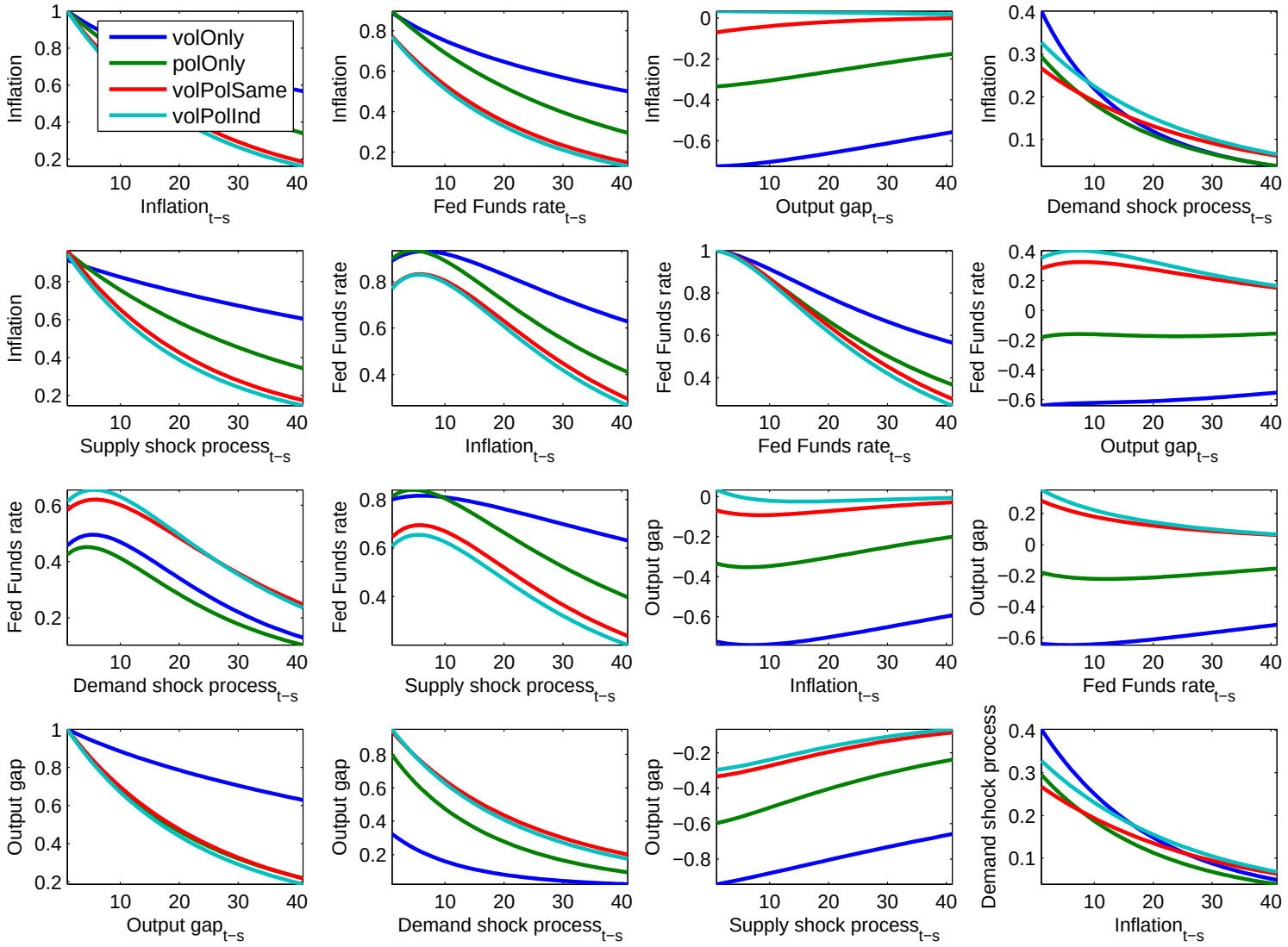

Figure # 32: Vector autocorrelations(2)

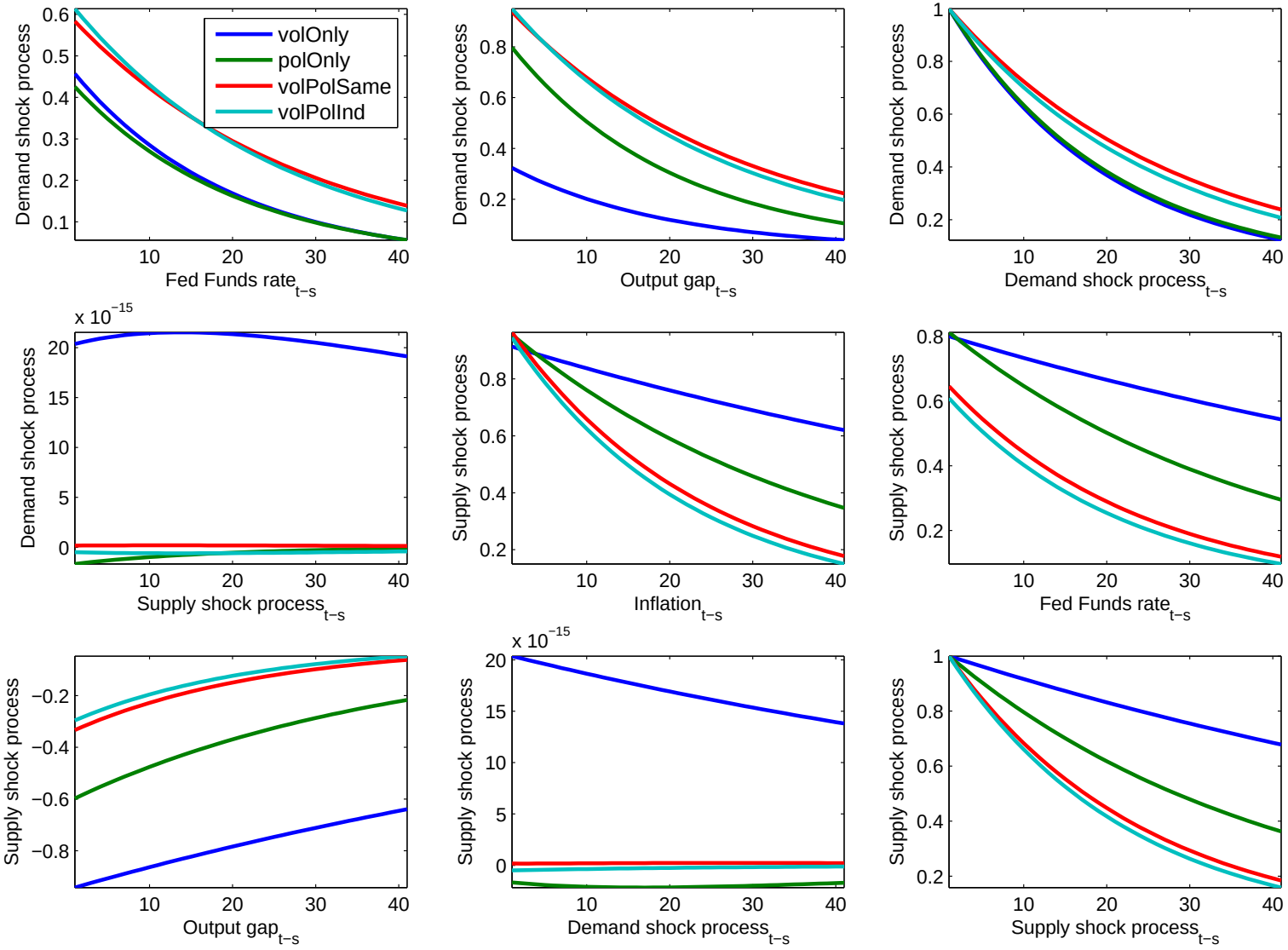

Figure # 33: Smoothed shocks

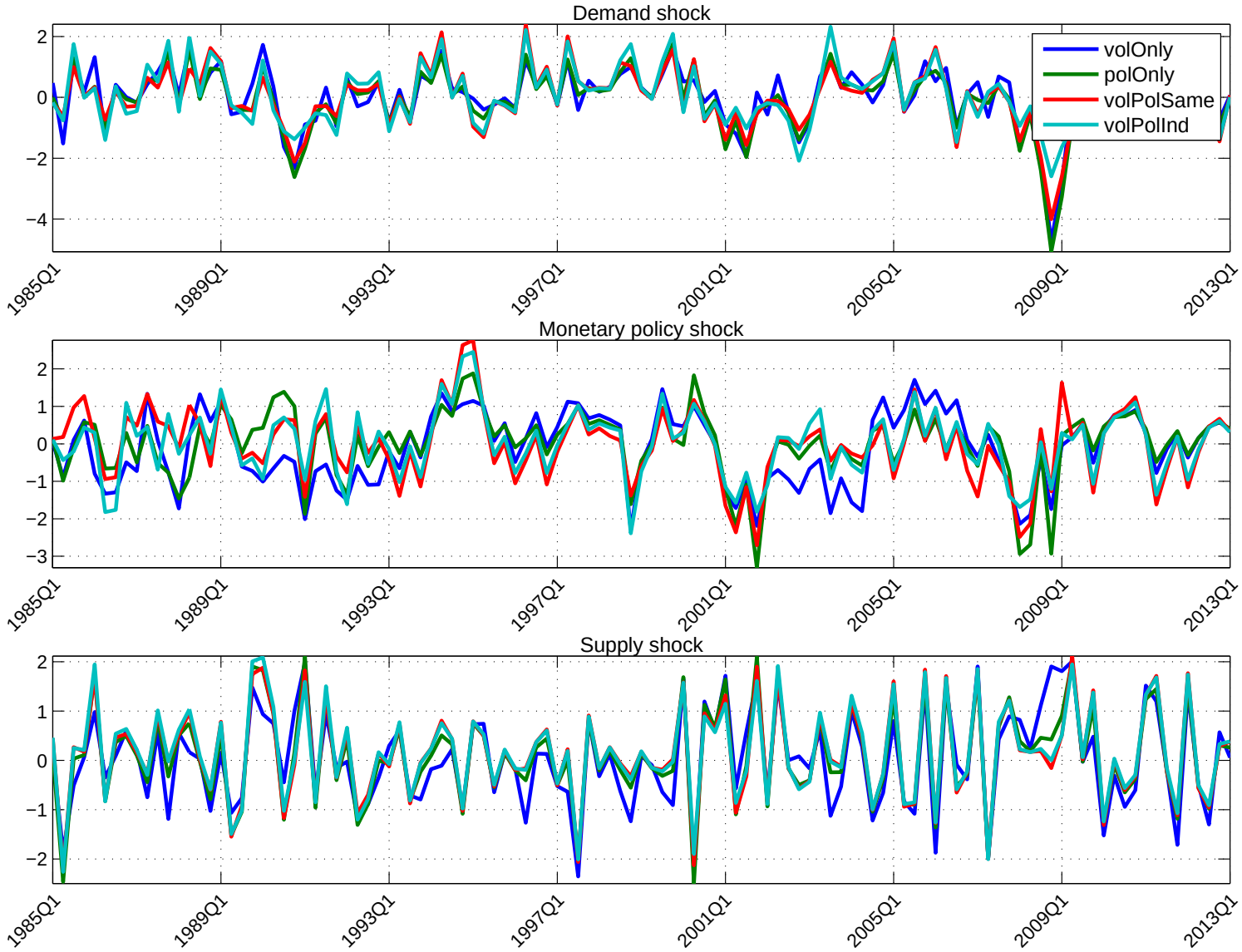

Table # 7: Exogenous Variables

Model code	Description
ED	Demand shock
ER	Monetary policy shock
ES	Supply shock

Table # 8: Shock correlation structure in volOnly

	ED	ER	ES
ED	1	0.2253	-0.07312
ER	0.2253	1	-0.2777
ES	-0.07312	-0.2777	1

Table # 9: Shock correlation structure in polOnly

	ED	ER	ES
ED	1	0.2486	-0.03932
ER	0.2486	1	-0.2123
ES	-0.03932	-0.2123	1

Table # 10: Shock correlation structure in volPolSame

	ED	ER	ES
ED	1	0.1207	0.0009862
ER	0.1207	1	-0.2212
ES	0.0009862	-0.2212	1

Table # 11: Shock correlation structure in volPolInd

	ED	ER	ES
ED	1	0.06076	0.01435
ER	0.06076	1	-0.1915
ES	0.01435	-0.1915	1

Figure # 34: Empirical distribution of smoothed shocks