International Great Inflation and Common Monetary Policy

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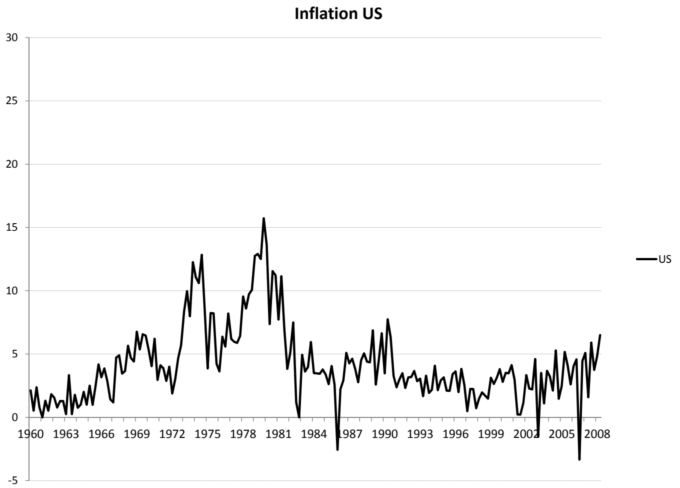
US Great Inflation

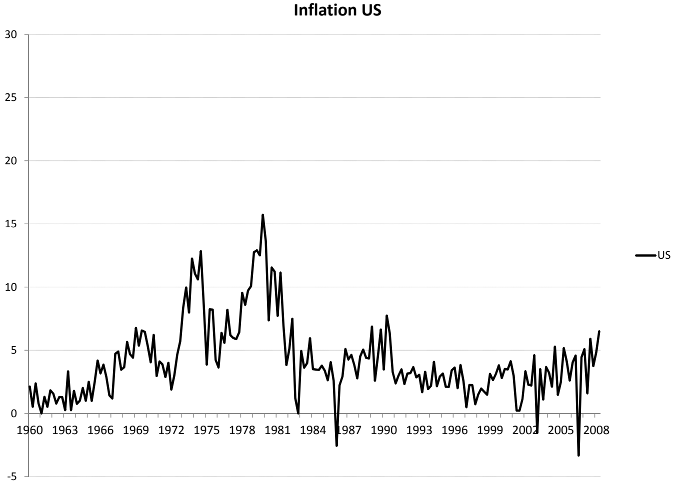


Explanations of the Great Inflation

- Non Monetary Policy Reasons
  - Bad luck. (Blinder (NBER, 1982), Sims & Zha (AER, 2006).)
  - Political pressure. (Meltzer (StL Fed Review 2005).)
  - Output gap mismeasurement. (Orphanides (AER 2002, JME 2004).)
- Monetary Policy Reasons: Bad Ideas
  - Memory of the Great Depression. (DeLong (NBER 1995).)
  - The natural rate hypothesis. (Cogley & Sargent (RED 2005), Sargent, Williams & Zha (AER 2006).)
  - High cost of disinflation, inflation as a cost-push phenomenon, etc. (Romer & Romer (AER 2002), Nelson (2005).)
- Combination
  - Inflation expectations and bad shocks. (Clarida, Gali & Gertler (QJE 2000).)
  - Time inconsistency-Expectations trap. (Christiano & Gust (2000).)

G7 Great Inflation

- Common trends in inflation patterns.



G7 Great Inflation

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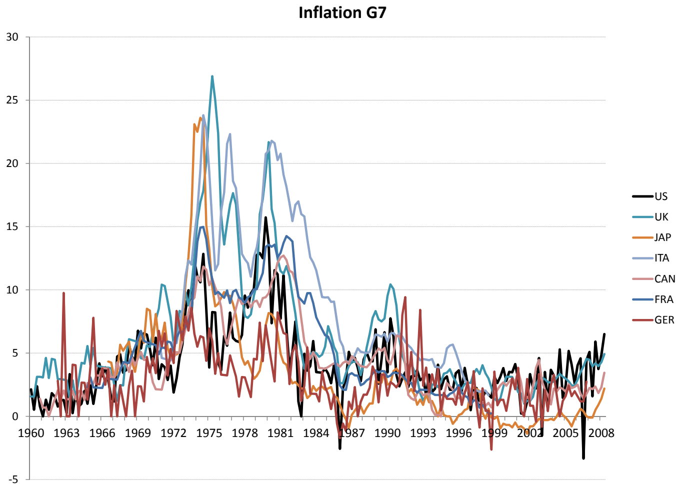

- Common trends in monetary policy?

What we do

- Consider monetary policy and Great Inflation in G7 countries.
- Study *evolution* of monetary policy in G7 countries over time.
- Check if changes in monetary policy correlate across countries.
- Look for commonality in the evolution of monetary policies.

How we do it

- Estimate time-varying Taylor policy rule for each of G7 countries.
- Check for the existence of a long-run relationship between changes in estimated response to inflation of interest rate.
- Check for the existence of common shocks to interest rate.

What we find

- Similar pattern of interest rate responses to inflation in G7 countries:
  - Low response to inflation during the 1970s and higher response to inflation during the 1980s
- Evidence of long-run commonality in those changes:
  - Cointegrating relationship and common stochastic trends.
- Lower importance of common shocks:
  - PCA: first component accounting for 24% of residuals' variability.

Framework: Taylor rule

- Kim and Nelson's (JBES 1989, JME 2006) time-varying parameters model.
- Target federal funds rate:

$$r^*_{i,t} = \beta^*_{0,i,t} + \beta_{1,i,t}(E_t(\pi_{i,t+1}) - \pi^*_{i,t}) + \beta_{2,i,t}E_t(y_{i,t+1})$$

- Actual federal funds rate:

$$r_{i,t} = (1 - \theta_{i,t})r^*_{i,t} + \theta_{i,t}r_{i,t-1} + m_{i,t}, \quad 0 < \theta_{i,t} < 1,$$

State-space

- Measurement equation

$$r_{i,t} = (1 - \theta_{i,t})(\beta_{0,i,t} + \beta_{1,i,t}\pi_{i,t} + \beta_{2,i,t}y_{i,t}) + \theta_{i,t}r_{i,t-1} + e_{i,t},$$

where

$$e_{i,t} = -(1 - \theta_{i,t})[\beta_{1,i,t}(\pi_{i,t} - E_t(\pi_{i,t+1})) + \beta_{2,i,t}(y_{i,t} - E_t(y_{i,t+1}))] + m_{i,t}$$

and

$$\theta_{i,t} = \frac{1}{1 + \exp(-\beta_{3,i,t})}$$

- Transition equation

$$\beta_{k,i,t} = \beta_{k,i,t-1} + \epsilon_{k,i,t},$$

with

$$\epsilon_{k,i,t} \sim i.i.d.N(0, \sigma^2_{\epsilon,k,i}), \quad k = 0, 1, 2, 3.$$

Issues

- Endogeneity.
- Non-linearity with respect to the coefficients.
- Heteroscedastic disturbances.

$$r_{i,t} = (1-\theta_{i,t})(\beta_{0,i,t} + \beta_{1,i,t}\pi_{i,t} + \beta_{2,i,t}y_{i,t}) + \theta_{i,t}r_{i,t-1} + e_{i,t},$$

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$$e_{i,t} \sim (0, \sigma^2_{e_i}).$$

Issues

- **Endogeneity**.
  - (Time-varying) Instrumental variables on inflation and output gap.
  - 4 lags of inflation, output gap, M2 and interest rate spreads.
  - Kim (2006) standardized prediction errors.
- Non-linearity
- Heteroscedasticity

Issues

- Endogeneity
- **Non-linearity**
  - Linearize around $\beta_{k,i,t} = \beta_{k,i,t|k,i,t-1}$.
- Heteroscedasticity

Issues

- Endogeneity

- Non-linearity

- **Heteroscedasticity**
  - GARCH(1,1) model of the variance

$$r_{i,t} = (1-\theta_{i,t})(\beta_{0,i,t} + \beta_{1,i,t}\pi_{i,t} + \beta_{2,i,t}y_{i,t}) + \theta_{i,t}r_{i,t-1} + e_{i,t},$$
$$e_{i,t} \mid I_{t-1} \sim i.i.d.N(0, \sigma^2_{e_{i,t}}),$$

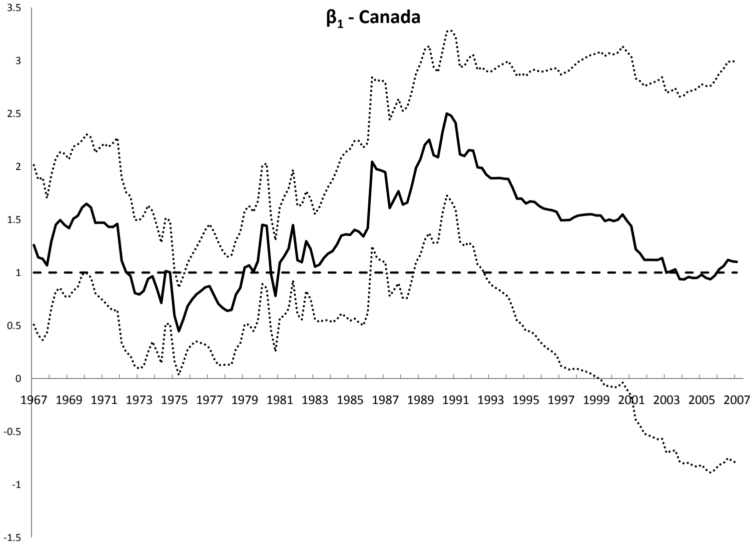
where

$$\sigma^2_{e_{i,t}} = a_0 + a_1 e^2_{i,t-1} + a_2\sigma^2_{e_{i,t-1}}.$$

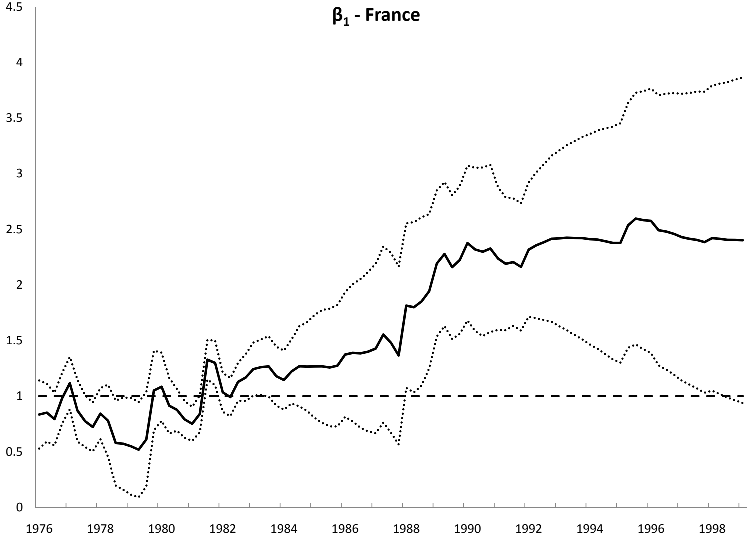
Estimation

- Recursive estimation, Kalman filter.
- Step 1: Instrumental variables:
  - Maximize likelihood to generate hyperparameters.
  - Use Kalman filter to generate forecast errors, and variance of forecast errors.
- Step 2:
  - Maximize likelihood to generate hyperparameters for the linearized version of measurement equation.
  - Use Kalman filter to generate response to inflation for each country considered.

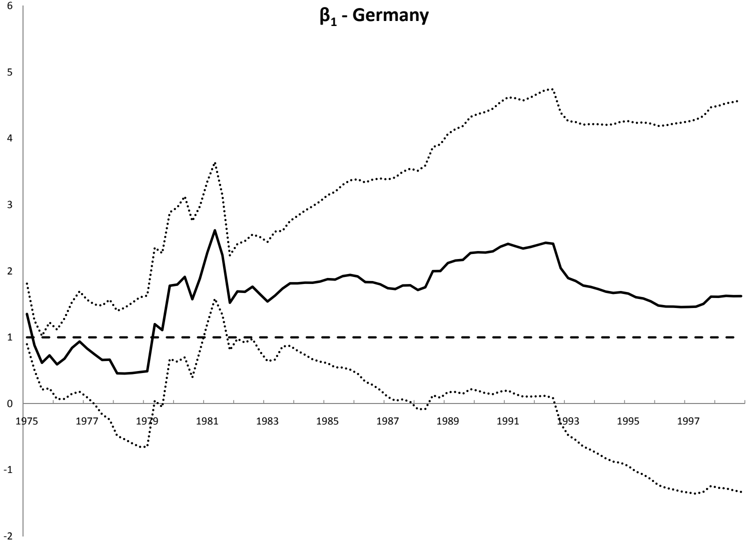
Response to Inflation: Canada



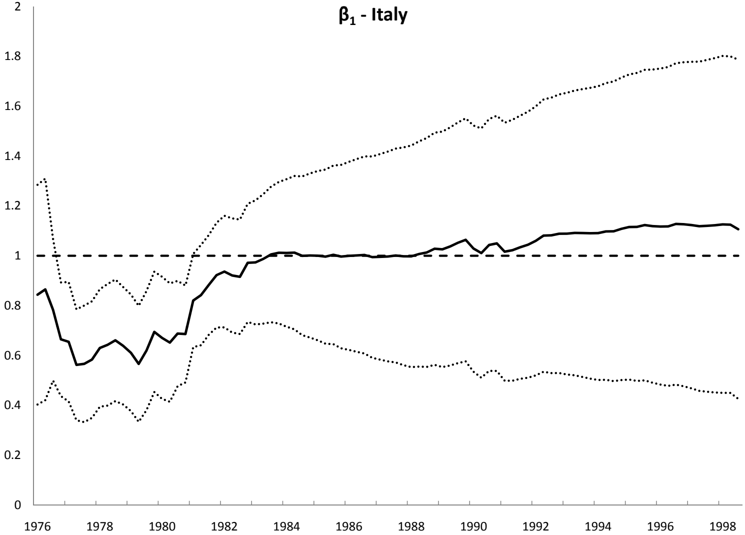
Response to Inflation: France



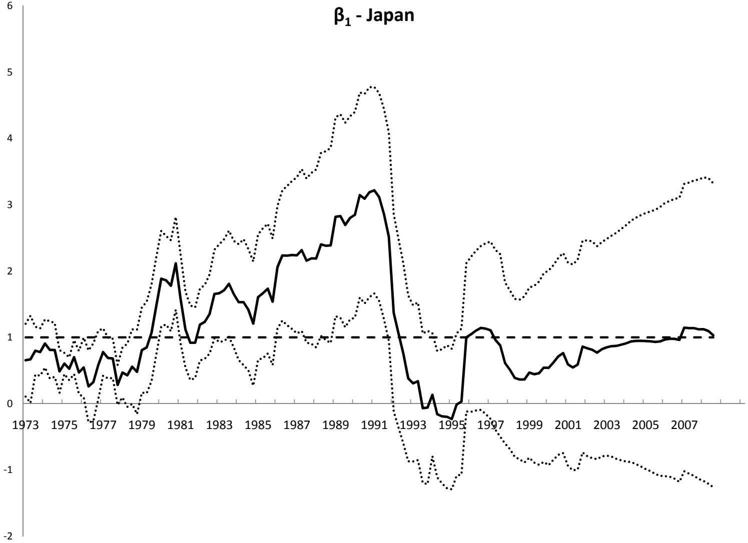
Response to Inflation: Germany



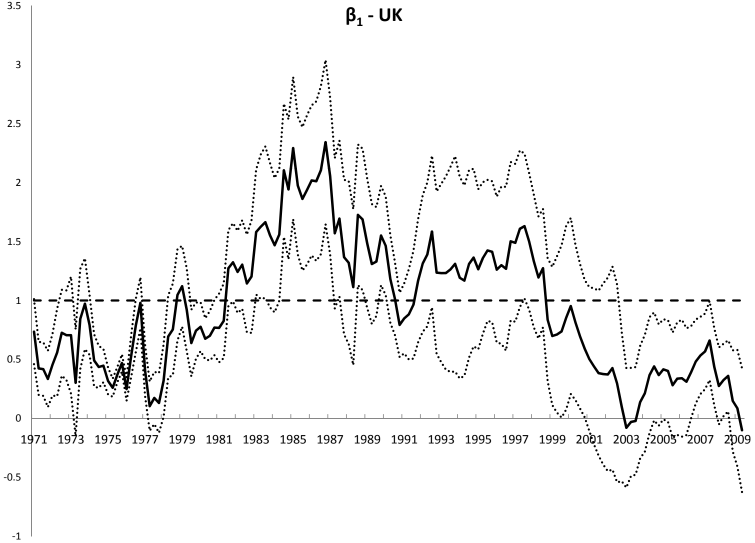
Response to Inflation: Italy



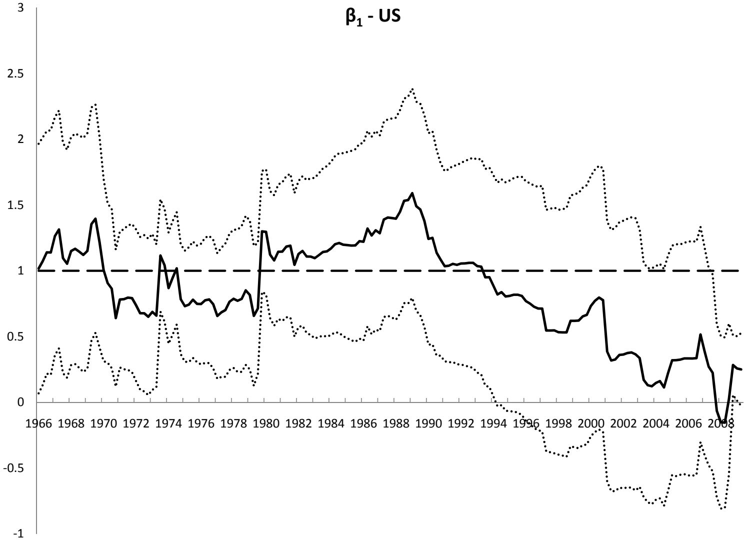
Response to Inflation: Japan



Response to Inflation: UK



Response to Inflation: US



Cointegration

- Engle and Granger's (1987) cointegration: a linear long-run relationship between I(1) variables.

  ⇒ "long-run" relationship in how monetary policy is conducted across countries.

- Evolution of monetary policy in the model is

$$\beta_{j,i,t} = \beta_{j,i,t-1} + \epsilon_{j,i,t}, \qquad \forall j, i,$$

- Apply Johansen test to check the existence of cointegration in estimated Taylor-rule coefficients.
- Bootstrap cointegration regression and generate the distribution of Johansen statistics as $\beta_{\mathbf{1,t}}$ are generated regressors.

Bootstrapping cointegrating relationship

- *Step 1*: Estimate the regression $\Delta\boldsymbol{\beta}_{\mathbf{1},t} = \boldsymbol{\Pi}\boldsymbol{\beta}_{\mathbf{1},t-\mathbf{1}} + u_{1,t}$ under the restriction of h cointegrated vectors and compute the $\hat{u}_{1,t}$.
- *Step 2*: For $\hat{u}_{1,t}$ estimate an AR(q) model and construct the VAR-sieve bootstrap of ν_t^*.
- *Step 3*: Repeat B times
  - *(a)*: Draw T observation from (ν_t^*) and construct $\mathbf{u}_{\mathbf{1},\mathbf{t}}^* = \hat{\Phi}_1\mathbf{u}_{\mathbf{1},\mathbf{t}-\mathbf{1}}^* + \ldots + \hat{\Phi}_q\mathbf{u}_{\mathbf{1},\mathbf{t}-\mathbf{q}}^* + \nu_t^*$
  - *(b)*: Construct $\beta_{\mathbf{1},\mathbf{t}}^* = \beta_{\mathbf{1},\mathbf{0}}^* + \sum_{k=1}^{t} \mathbf{u}_{\mathbf{1},\mathbf{k}}^*$.
  - *(c)*: Use the bootstrap sample $\left\{\boldsymbol{\beta}_{\mathbf{1},t}^*\right\}$ to estimate the VECM model and compute the Johansen statistics, λ_{max} and λ_{trace}.
- *Step 5*: Test if the null hypothesis of h cointegrating vectors can be rejected.
- Repeat this process for every null hypothesis of h cointegrating vectors.

Cointegration: results

- Find unit root in estimated coefficients for inflation.

Table: Augmented Dickey-Fuller (unit root) test of β_1

Country	*t-statistics*	*p-value*$_0$	*p-value*$_{AIC}$
$\beta_{1,CAN}$	-1.674	0.440	0.367
$\beta_{1,FRA}$	-1.104	0.711	0.724
$\beta_{1,GER}$	-2.118	0.238	0.108
$\beta_{1,ITA}$	-1.456	0.551	0.551
$\beta_{1,JAP}$	-1.222	0.662	0.662
$\beta_{1,UK}$	-1.467	0.546	0.546
$\beta_{1,US}$	-2.352	0.159	0.159

NOTE: *t-statistics* computed for 0 lags. *p-value*$_0$ computed for 0 lags and *p-value*$_{AIC}$ computed for optimal number lags according to AIC, both based on MacKinnon (1996).

Cointegration: results

- Find unit root in estimated coefficients for inflation.
- Drop Japan – monetary policy considerably altered from 1990.
- Can reject hypothesis of 4 cointegrating vectors at 10% and 3 cointergraing vectors at 5%

Table: Johansen's trace and maximum eigenvalue tests for cointegration for 6 countries, no Japan.

H_0	H_1^{trace}	λ_{trace}	p-$value_{trace}$	H_1^{max}	λ_{max}	p-$value_{max}$
$r = 0$	$r \geq 1$	197.21***	0.002	$r = 1$	83.42***	0.008
$r \leq 1$	$r \geq 2$	113.78	0.193	$r = 2$	40.95	0.645
$r \leq 2$	$r \geq 3$	72.83*	0.054	$r = 3$	32.90	0.25
$r \leq 3$	$r \geq 4$	39.93**	0.019	$r = 4$	24.56**	0.023
$r \leq 4$	$r \geq 5$	15.37*	0.052	$r = 5$	9.19	0.182
$r \leq 5$	$r \geq 6$	6.18		$r = 6$	6.18	

NOTE: $p - values$ based on bootstrapped regression. Specification: VAR(1) in levels, no drift, no trend trend. Constant in cointegrating relationship.

Cointegration: results

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  — *strong* evidence of a long-run relationship: only 1 or 2 stochastic trends describing behavior of responses to inflation.

Cointegration: results

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  — *strong* evidence of a long-run relationship: only 1 or 2 stochastic trends describing behavior of responses to inflation.
- Also
  - find two cointegrating vectors if taken non-European countries (CAN, JAP, US) for 1970-1990.

Principal component analysis

- Principal component analysis of error terms in the Taylor rule:
  $\Rightarrow$ importance of common shocks.
- First component explains 26% and four components needed to explain 73% of the residuals' variability:
  $\Rightarrow$ lower importance of common shocks in a model with a time-varying Taylor-rule.

Table: Principle Component Analysis in the series of residuals ($\omega_{i,t}$) of the Taylor rule for Canada, France, Germany, Italy, Japan, US and UK, for the sample 1976:2 to 1998:4.

	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6	Comp 7
Eigenvalue	1.803	1.447	1.040	0.854	0.741	0.622	0.494
Proportion	0.257	0.206	0.149	0.122	0.106	0.089	0.071
Cumulative Proportion	0.257	0.463	0.612	0.734	0.840	0.929	1

Conclusions

Goal:

- Attempt to investigate the international Great Inflation and gather information from the international experience.

Result:

- Monetary authorities changing policy over time.
  - Low response to inflation during the 1970s, higher during the 1980s.
  - Common response to inflation across countries.
  - Lower response to inflation in recent years.
- Low importance of shocks
- Bad policy vs bad luck explanation of the Great Inflation.
- Missing link between common inflation and ideas

Conclusions

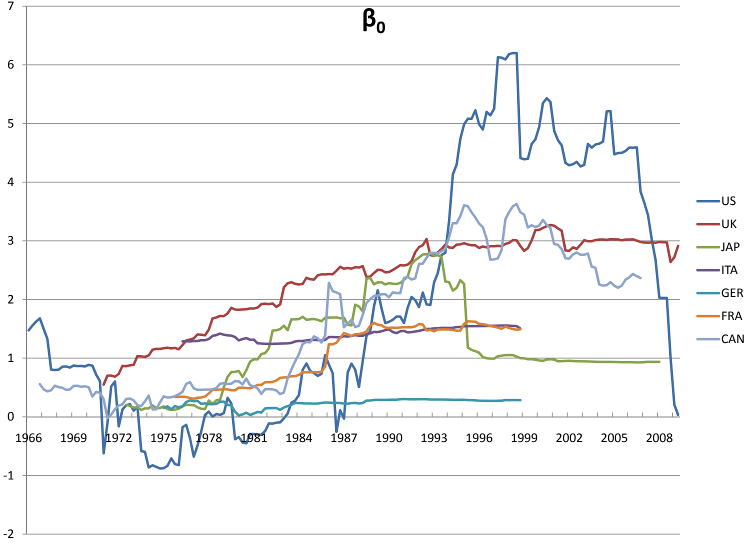
Table 1: Cross-country Correlations of Innovations to Federal Funds Rate Response to Inflation

	USA	Germany	UK	France	Japan	Italy
USA	1	0.803* (.43, .85)	0.090 (−1.47, .39)	.755* (.39, .87)	.245 (−.56, .44)	.385 (−.15, .55)
Germany	0.803* (.43, .85)	1	.047 (−3.52, .36)	.844* (.45, .82)	.227 (−1.58, .49)	.361 (−.35, .47)
UK	0.090 (−1.47, .39)	.047 (−3.52, .36)	1	.088 (−2.54, .41)	.356 (−.34, .52)	.090 (−.79, .30)
France	.755* (.39, .87)	.844* (.45, .82)	.088 (−2.54, .41)	1	.141 (−1.46, .48)	.287 (−.36, .39)
Japan	.245 (−.56, .44)	.227 (−1.58, .49)	.356 (−.34, .52)	.141 (−1.46, .48)	1	.052 (−1.06, .30)
Italy	.385 (−.15, .55)	.361 (−.35, .47)	.090 (−.79, .30)	.287 (−.36, .39)	.052 (−1.06, .30)	1

Each cell contains mean of the distribution and 10% and 90% quintile of the distribution in parentheses.

* denotes significance at 80% level

Constant


β0
7
6
5
4
3
2
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-1
-2
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1972
1975
1978
1981
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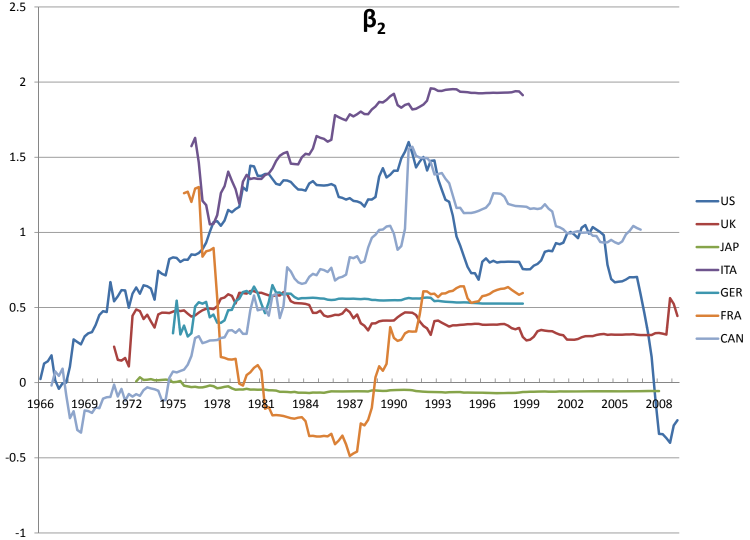
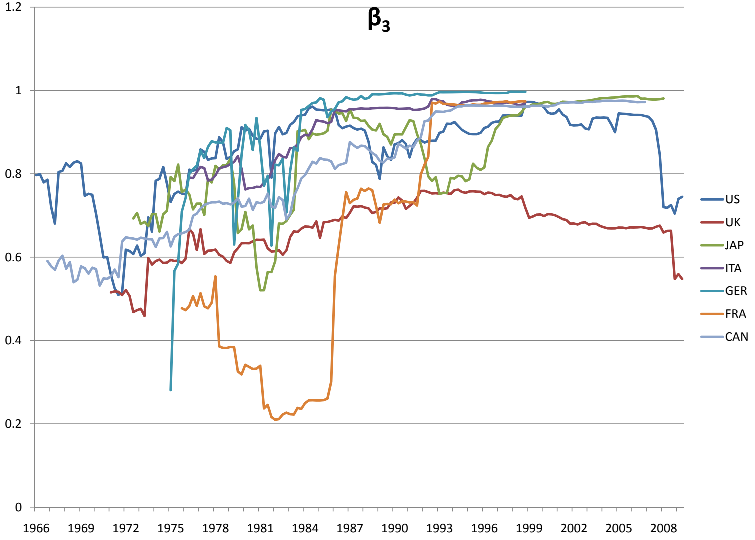
1987
1990
1993
1996
1999
2002
2005
2008
US
UK
JAP
ITA
GER
FRA
CAN

Response to Output



Smoothing


β3
1.2
1
0.8
0.6
0.4
0.2
0
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
US
UK
JAP
ITA
GER
FRA
CAN