

Does Inflation Targeting Anchor Long-Run Inflation Expectations?

**Evidence from Long-Term Bond Yields in the
United States, United Kingdom, and Sweden**

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Summary

- Long-term interest rates in the U.S. move a great deal
 - not just unconditionally, but conditionally (in response to economic news)
- This behavior is inconsistent with standard macroeconomic models in which the steady state is constant over time and known by all agents
- Long-term interest rates in the U.K. and Sweden (both inflation targeters) generally do *not* respond to economic news
 - but U.K. behaves similar to U.S. prior to Bank of England gaining independence from Treasury/Parliament in 1997-98
- All of our empirical evidence can be explained by changes in long-term inflation expectations in the U.S. (and greater anchoring in U.K., Sweden)

Outline of Talk

Review basic ideas from Gurkaynak, Sack, Swanson (2005):

1. Macro Model Implications
 - a. steady state
 - b. “excess sensitivity” of long-term interest rates
2. Empirical Methodology
 - a. forward rates
 - b. macroeconomic, monetary policy surprises

This paper:

1. Compare U.S., U.K., Sweden
 - a. compare inflation targeters (U.K. post-1998, Sweden) to non-inflation targeters (U.S., U.K. pre-1997)
2. Compare sensitivity of nominal rates, real rates, inflation compensation

A Benchmark Model (GSS 2005)

$$\pi_t = \mu E_t \pi_{t+1} + (1 - \mu) A_\pi(L) \pi_t + \gamma y_t + \varepsilon_t^\pi$$

$$y_t = \mu E_t y_{t+1} + (1 - \mu) A_y(L) y_t - \beta (i_t - E_t \pi_{t+1}) + \varepsilon_t^y$$

Clarida-Gali-Gertler “New Keynesian” specification: $\mu = 1$

Rudebusch “Hybrid New Keynesian” specification: $\mu = 0.3$

Close the model with a “Taylor-type Rule”:

$$i_t = (1 - c) [(1 + a) \bar{\pi}_t + b y_t] + c i_{t-1} + \varepsilon_t^i$$

Figure 1: Impulse Response Functions for Two New Keynesian Models

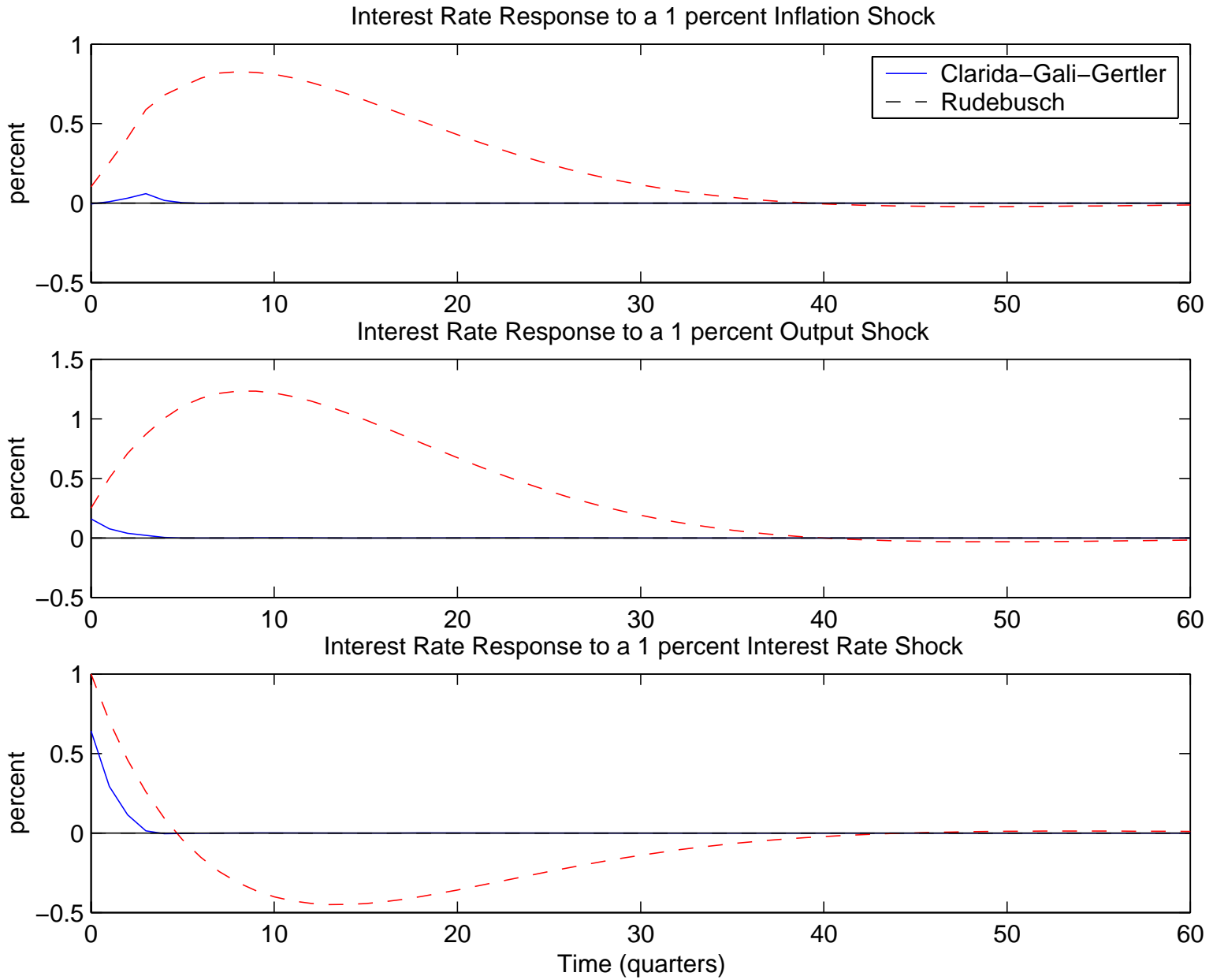
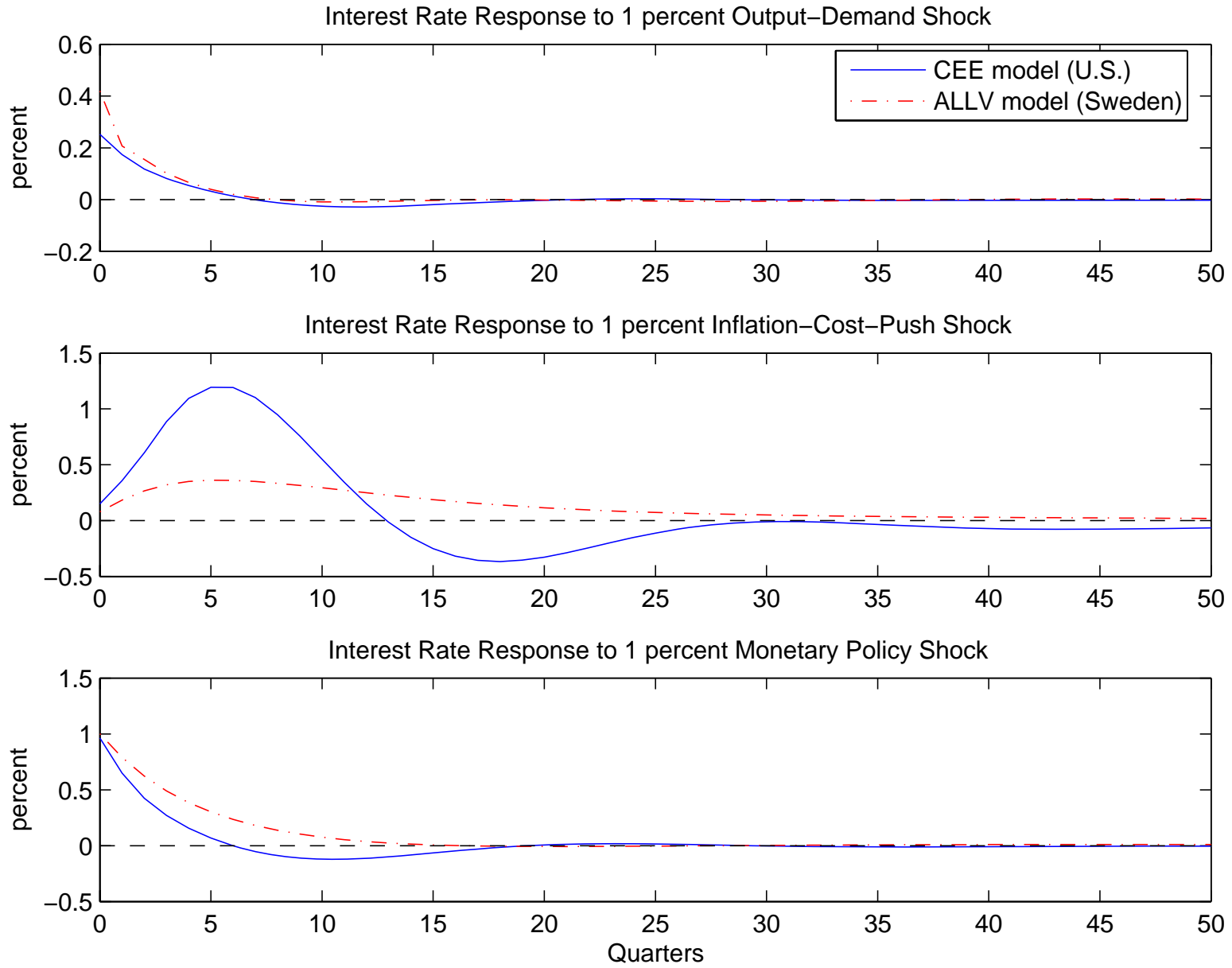


Figure 1: Interest Rate Impulse Responses in Two Benchmark DSGE Macroeconomic Models



Empirical Methodology

Regress interest rate responses in narrow (1-day) windows on macroeconomic data releases and monetary policy announcements on those same days

Note:

1) use *forward* interest rates (rather than term rates)

e.g.,

$$(1 + fwd_{9to10}) = \frac{(1 + r_{10})^{10}}{(1 + r_9)^9}$$

2) use *surprise* component of macroeconomic data release (or monetary policy announcement)

Macroeconomic data release
(or monetary policy announcement)

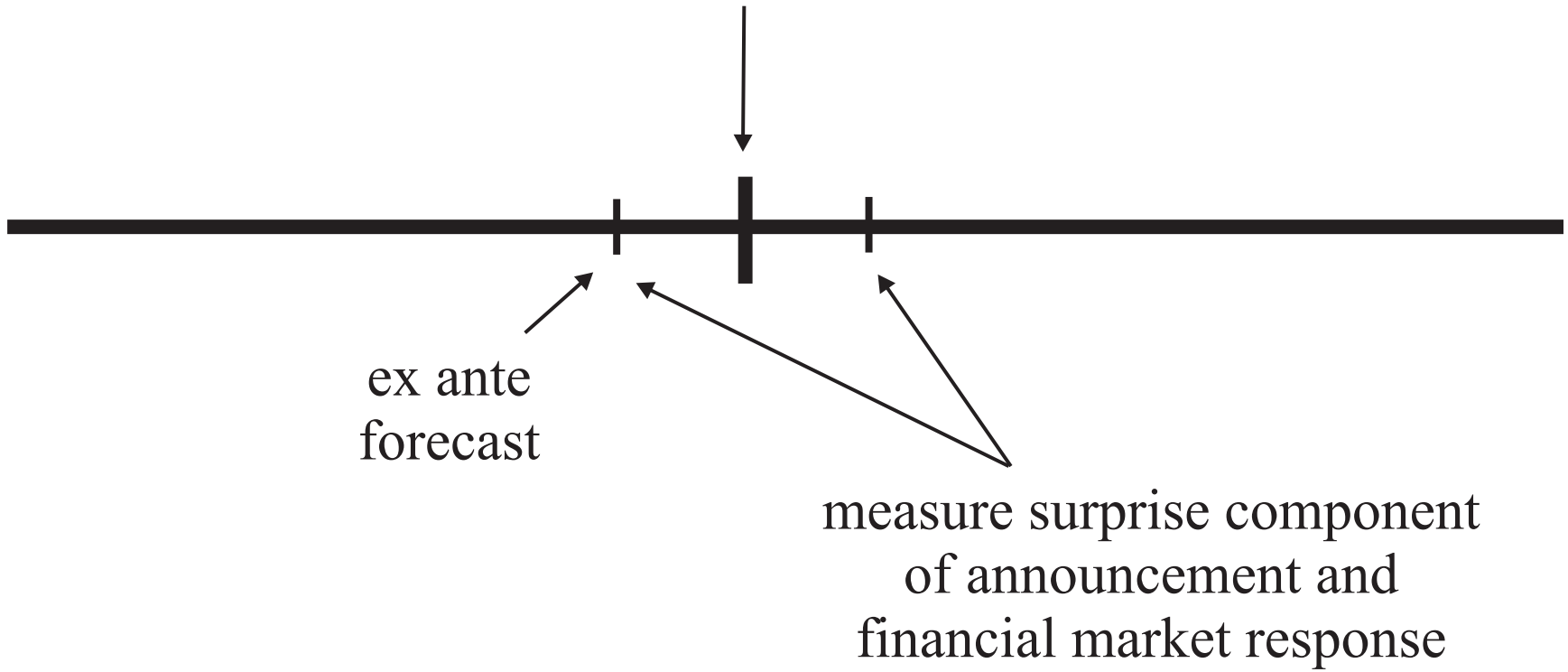


Table 1: Responses of Forward Rates to Economic News (1990-2002)

	---Ending 1 yr. ahead---		--- Ending 5 yrs. ahead---		---Ending 10 yrs. ahead---	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
<i>Macroeconomic Data Releases</i>						
Capacity Utilization	1.36	0.33***	1.26	0.57**	0.80	0.61
Consumer Confidence	2.11	0.40***	2.88	0.56***	1.97	0.54***
CPI (Core)	1.67	0.42***	1.81	0.60***	1.09	0.66*
Employment Cost Index	3.43	0.89***	4.42	1.13***	3.73	0.93***
GDP (Advance)	4.39	1.42***	4.12	2.19*	3.76	1.82**
Initial Claims	-0.83	0.24***	-0.79	0.29***	-0.59	0.27**
Leading Indicators	0.95	0.34***	0.61	0.57	0.55	0.58
NAPM	3.00	0.51***	3.29	0.54***	1.53	0.63**
New Home Sales	1.08	0.39***	1.65	0.54***	0.92	0.51*
Non-farm Payrolls	5.10	0.57***	3.48	0.91***	1.88	0.97*
PPI (Core)	0.39	0.45	1.22	0.56**	1.46	0.50***
Retail Sales	2.97	0.72***	2.62	1.03**	1.93	0.92**
Unemployment Rate	-1.76	0.51***	-0.77	0.73	0.14	0.66
<i>Monetary Policy Surprises</i>	0.47	0.10***	-0.04	0.14	-0.16	0.07**

Huber-White standard errors. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level. The estimated coefficient indicates the basis-point response of the one-year forward rate per standard deviation of the macroeconomic variable and per basis-point surprise in monetary policy announcement. Regressions include constant terms that are not shown in the table.

Figure 3: Response of Forward Rates to Macroeconomic Surprises

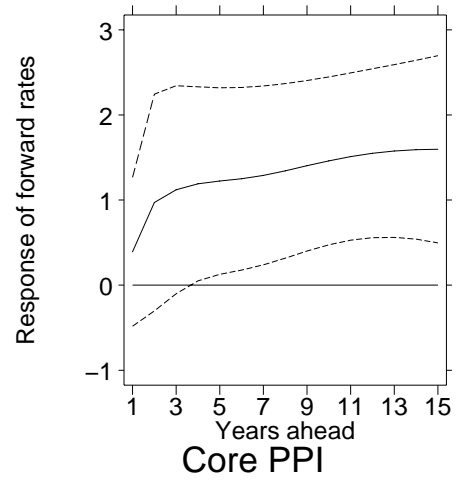
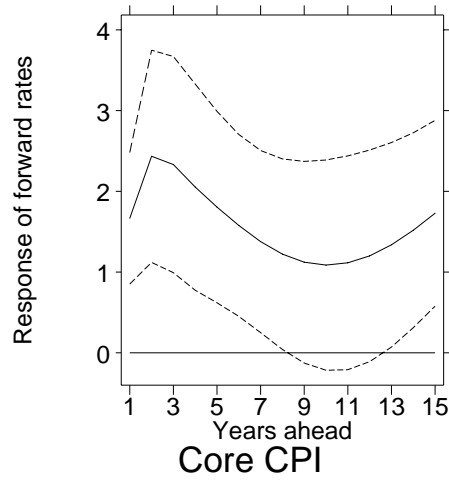
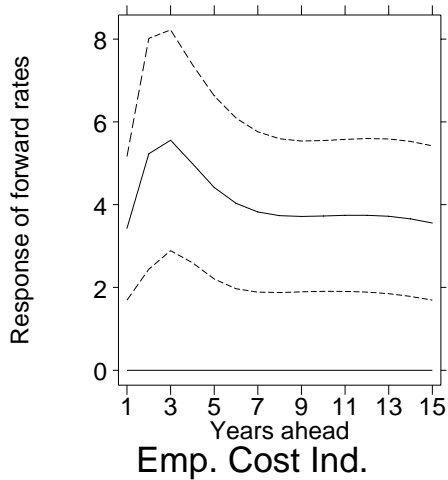
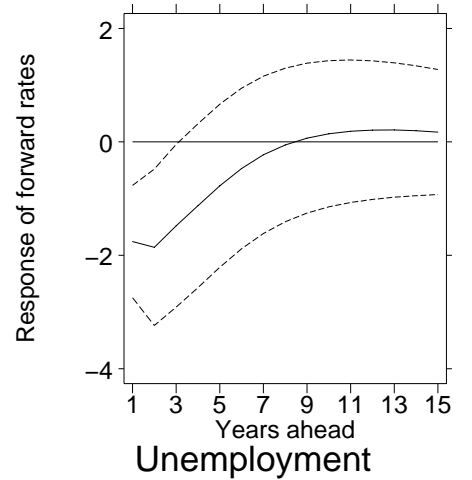
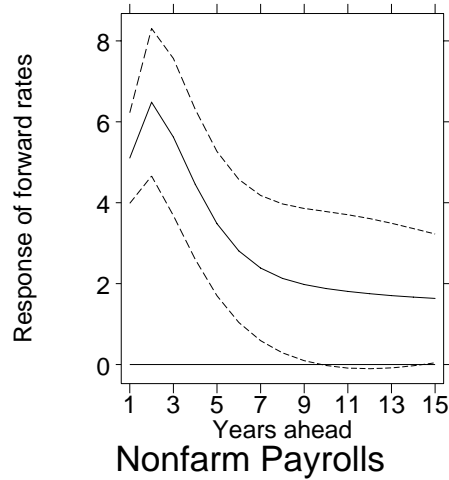
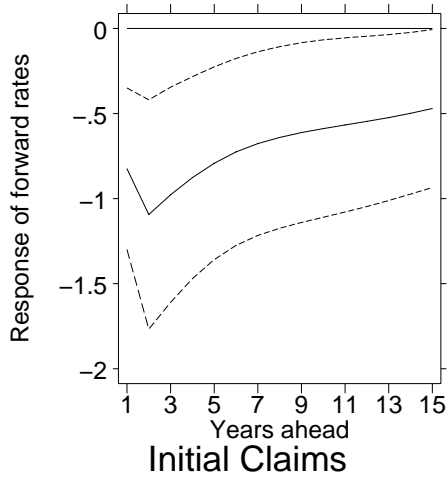
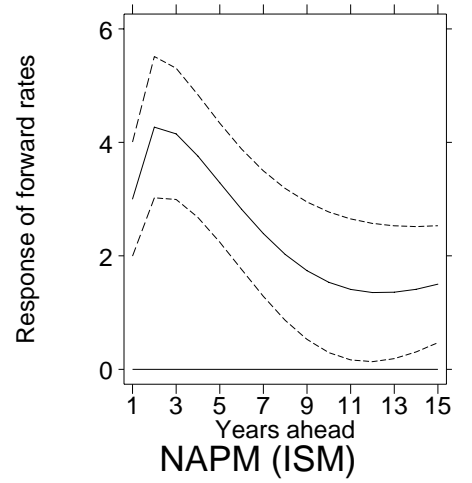
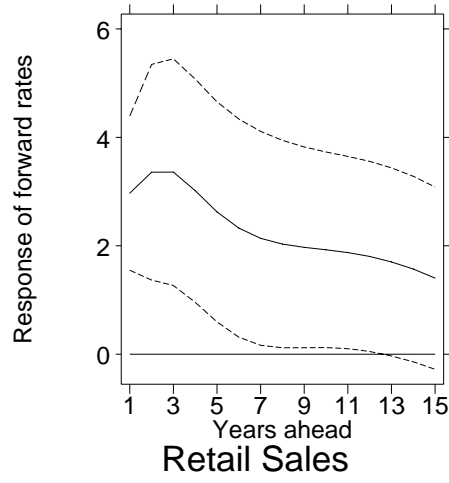
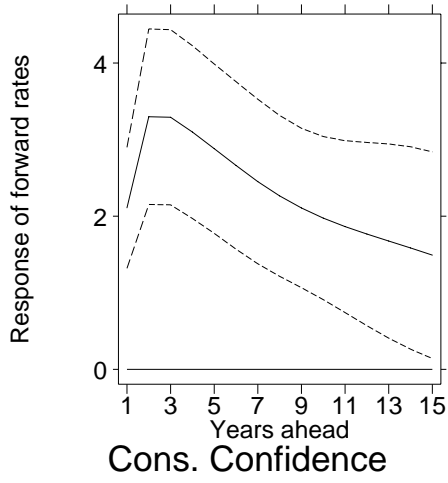


Table 1: Responses of Forward Rates to Economic News (1990-2002)

	---Ending 1 yr. ahead---		--- Ending 5 yrs. ahead---		---Ending 10 yrs. ahead---	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
<i>Macroeconomic Data Releases</i>						
Capacity Utilization	1.36	0.33 ^{***}	1.26	0.57 ^{**}	0.80	0.61
Consumer Confidence	2.11	0.40 ^{***}	2.88	0.56 ^{***}	1.97	0.54 ^{***}
CPI (Core)	1.67	0.42 ^{***}	1.81	0.60 ^{***}	1.09	0.66 [*]
Employment Cost Index	3.43	0.89 ^{***}	4.42	1.13 ^{***}	3.73	0.93 ^{***}
GDP (Advance)	4.39	1.42 ^{***}	4.12	2.19 [*]	3.76	1.82 ^{**}
Initial Claims	-0.83	0.24 ^{***}	-0.79	0.29 ^{***}	-0.59	0.27 ^{**}
Leading Indicators	0.95	0.34 ^{***}	0.61	0.57	0.55	0.58
NAPM	3.00	0.51 ^{***}	3.29	0.54 ^{***}	1.53	0.63 ^{**}
New Home Sales	1.08	0.39 ^{***}	1.65	0.54 ^{***}	0.92	0.51 [*]
Non-farm Payrolls	5.10	0.57 ^{***}	3.48	0.91 ^{***}	1.88	0.97 [*]
PPI (Core)	0.39	0.45	1.22	0.56 ^{**}	1.46	0.50 ^{***}
Retail Sales	2.97	0.72 ^{***}	2.62	1.03 ^{**}	1.93	0.92 ^{**}
Unemployment Rate	-1.76	0.51 ^{***}	-0.77	0.73	0.14	0.66
<i>Monetary Policy Surprises</i>	<i>0.47</i>	<i>0.10^{***}</i>	<i>-0.04</i>	<i>0.14</i>	<i>-0.16</i>	<i>0.07^{**}</i>

Huber-White standard errors. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level. The estimated coefficient indicates the basis-point response of the one-year forward rate per standard deviation of the macroeconomic variable and per basis-point surprise in monetary policy announcement. Regressions include constant terms that are not shown in the table.

Figure 4: Response of Forward Rates to Monetary Policy Surprises

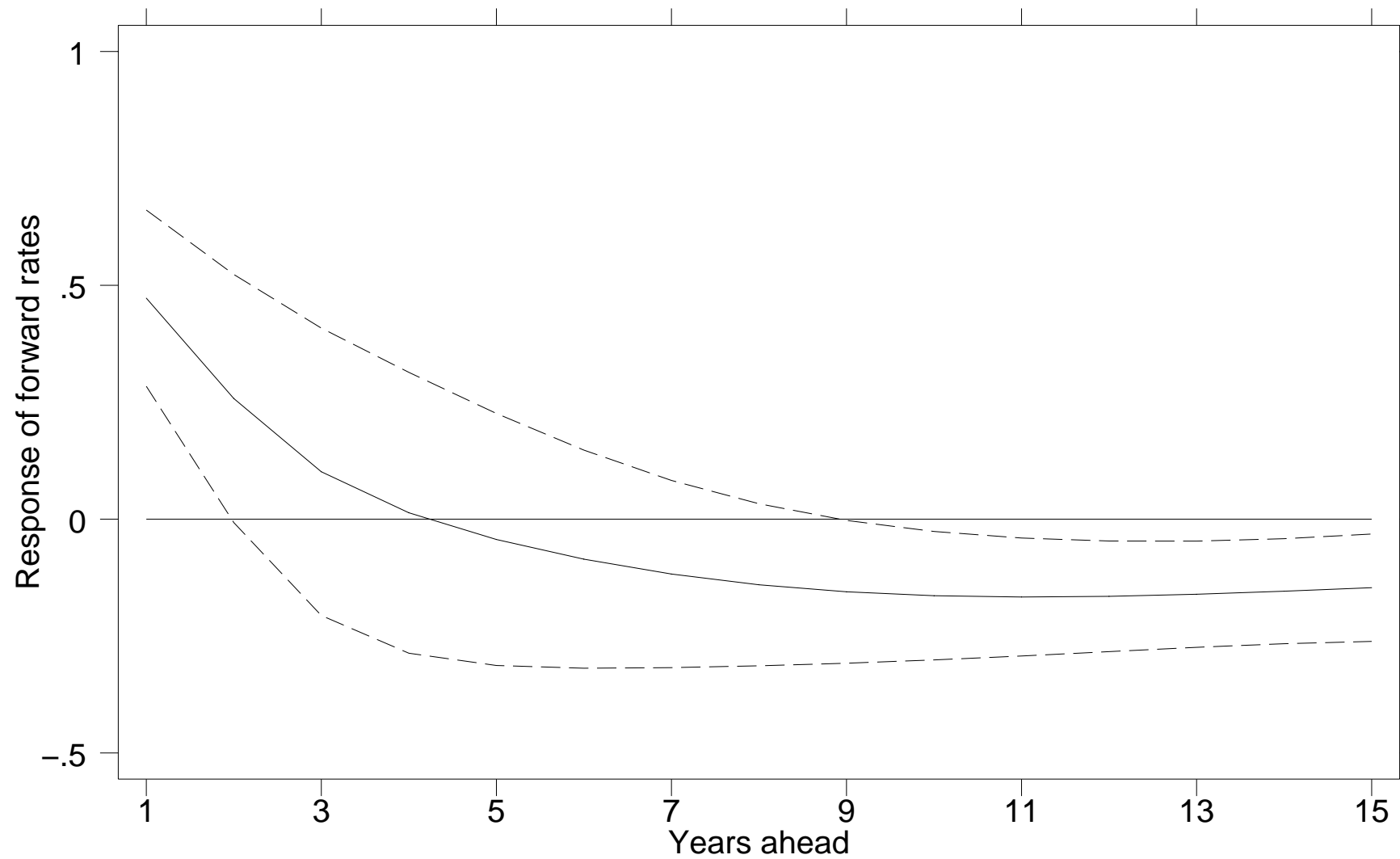


Figure 5: Ten-year-ahead Forward Rate and Monetary Policy Surprises

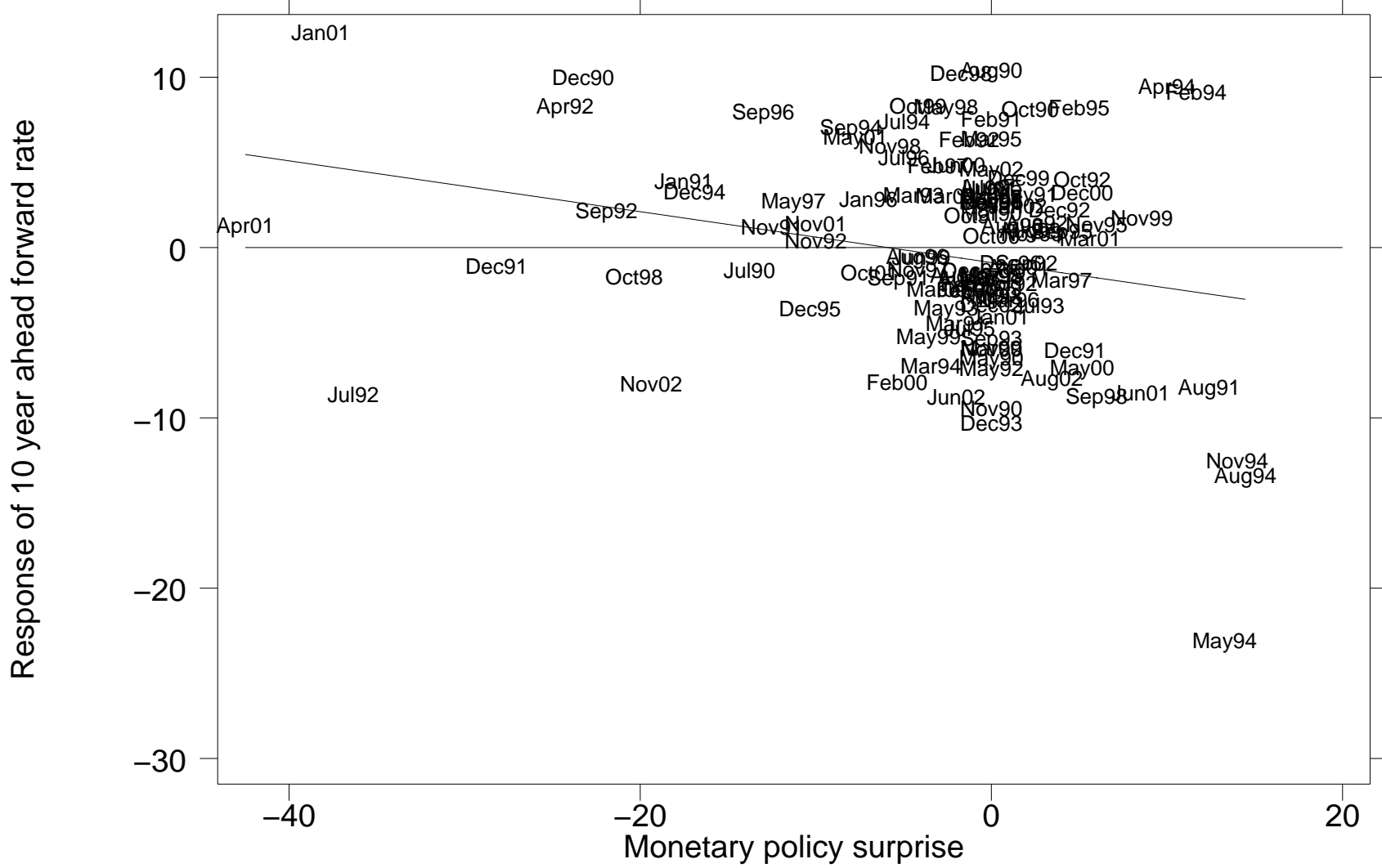


Table 2: Response of STRIPS-based Forward Rates to Economic News

	---Ending 5 yrs. Ahead---		---Ending 10 yrs. Ahead---	
	Coef.	Std. Err.	Coef.	Std. Err.
<i>Macroeconomic Data Releases</i>				
Capacity Utilization	2.05	0.91 **	1.37	0.79 *
Consumer Confidence	3.82	1.77 **	1.16	0.63 *
CPI (Core)	2.86	1.22 **	1.75	1.06 *
Employment Cost Index	3.76	1.70 **	3.92	1.22 ***
GDP (Advance)	5.66	2.48 **	5.14	2.69 *
Initial Claims	-1.29	0.46 ***	-0.23	0.50
Leading Indicators	2.02	1.30	0.06	0.80
NAPM	5.23	1.07 ***	2.73	0.80 ***
New Home Sales	0.86	0.90	1.31	0.71 *
Non-farm Payrolls	3.51	0.85 ***	1.93	1.18 *
PPI (Core)	-0.06	0.87	1.27	0.63 **
Retail Sales	5.24	1.49 ***	2.05	1.14 *
Unemployment Rate	-1.98	0.89 **	0.00	1.19
<i>Monetary Policy Surprises</i>	0.02	0.15	-0.30	0.08 ***

Summary of Empirical Observations

Far-ahead forward rates:

- 1) exhibit economically and statistically significant responses to economic news
- 2) move in *same* direction as output and inflation surprises
- 3) move in *opposite* direction to monetary policy surprises

Possible Explanations

According to Fisher's Equation:

$$i^* = r^* + \pi^*$$

The N -year-ahead forward rate satisfies (for large enough N):

$$fwd_{N \text{ to } N+1} = r^* + \pi^* + \rho$$

Possible Explanations

According to Fisher's Equation:

$$i^* = r^* + \pi^*$$

The N -year-ahead forward rate satisfies (for large enough N):

$$fwd_{N \text{ to } N+1} = r^* + \pi^* + \rho$$

Note:

- Changes in r^* alone are not sufficient to explain empirical findings

Possible Explanations

According to Fisher's Equation:

$$i^* = r^* + \pi^*$$

The N -year-ahead forward rate satisfies (for large enough N):

$$fwd_{N \text{ to } N+1} = r^* + \pi^* + \rho$$

Note:

- Changes in r^* alone are not sufficient to explain empirical findings
- Changes in ρ alone are not sufficient to explain empirical findings

Possible Explanations

According to Fisher's Equation:

$$i^* = r^* + \pi^*$$

The N -year-ahead forward rate satisfies (for large enough N):

$$fwd_{N \text{ to } N+1} = r^* + \pi^* + \rho$$

Note:

- Changes in r^* alone are not sufficient to explain empirical findings
- Changes in ρ alone are not sufficient to explain empirical findings
- But changes in π^* alone *are* sufficient to explain all empirical findings

Model with Time-varying π^*

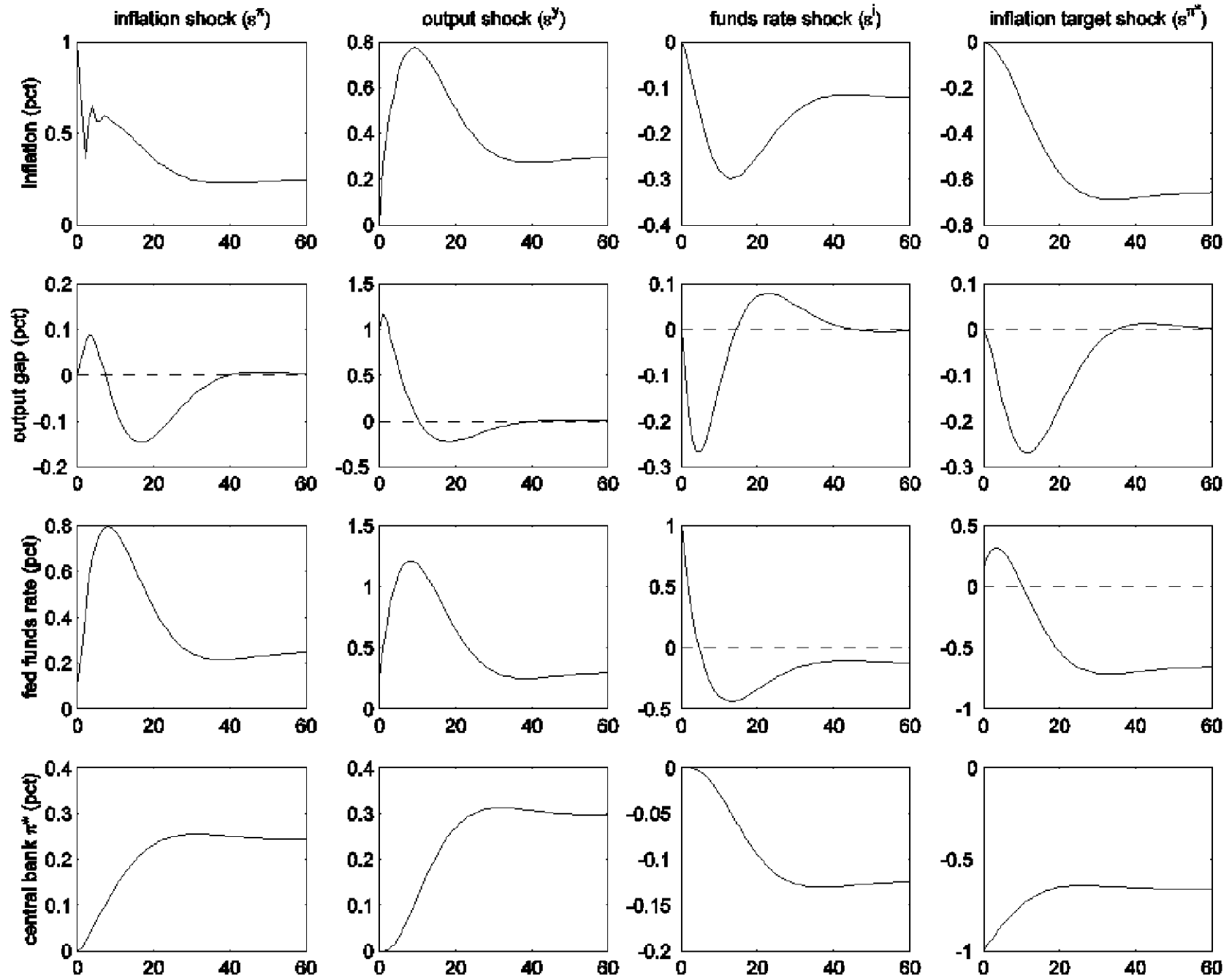
$$\pi_t = \mu E_t \pi_{t+1} + (1-\mu) A_\pi(L) \pi_t + \gamma y_t + \varepsilon_t^\pi$$

$$y_t = \mu E_t y_{t+1} + (1-\mu) A_y(L) y_t - \beta (i_t - E_t \pi_{t+1}) + \varepsilon_t^y$$

$$i_t = (1-c) \left[\bar{\pi}_t + a(\bar{\pi}_t - \pi_t^*) + b y_t \right] + c i_{t-1} + \varepsilon_t^i$$

$$\pi_t^* = \pi_{t-1}^* + \theta(\bar{\pi}_{t-1} - \pi_{t-1}^*) + \varepsilon_t^{\pi^*}$$

Impulse Responses for Rudebusch Model with Time-varying π^* (Perfect Information)



Model with Time-varying π^* and Imperfect Information

$$\pi_t = \mu E_t \pi_{t+1} + (1-\mu) A_\pi(L) \pi_t + \gamma y_t + \varepsilon_t^\pi$$

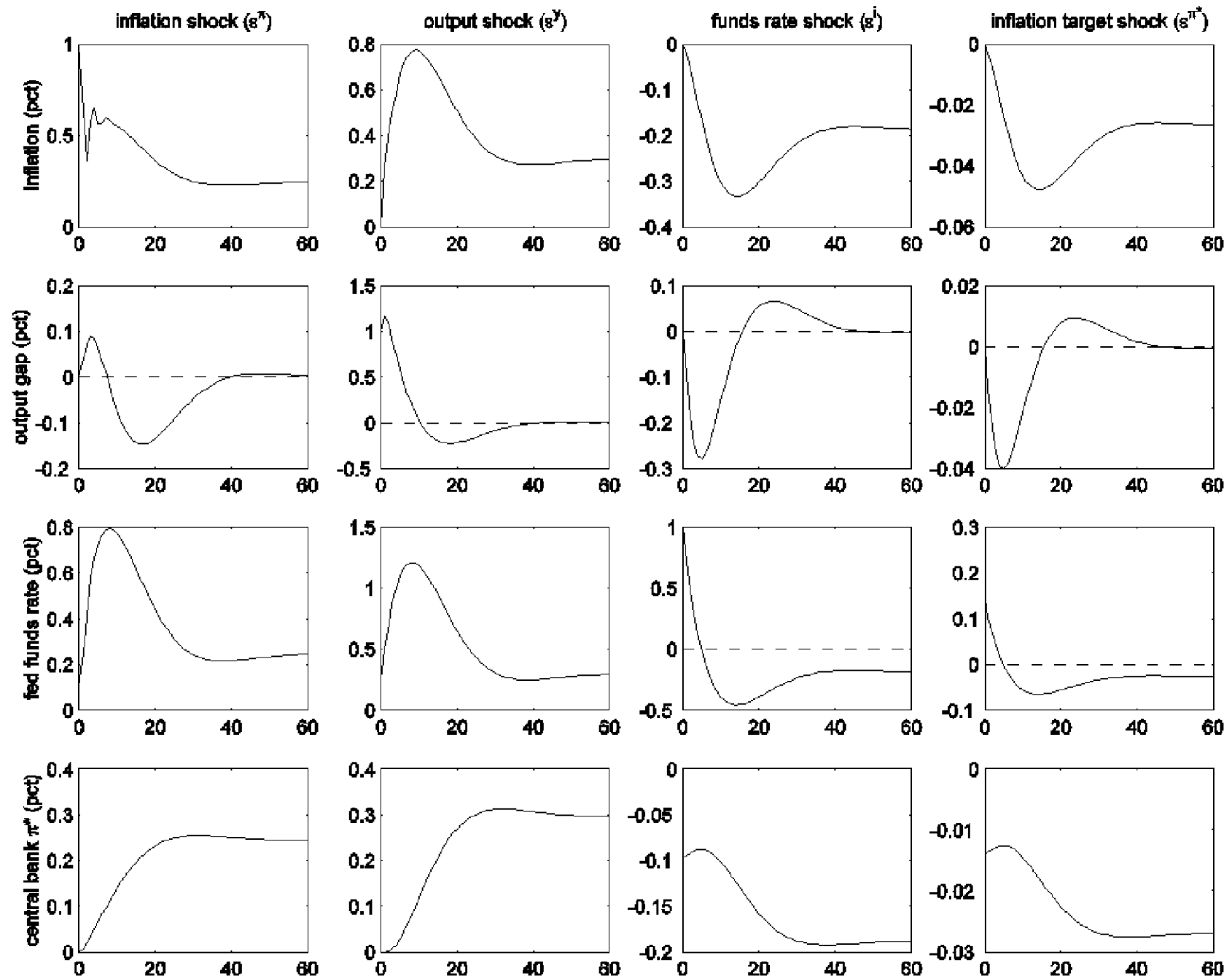
$$y_t = \mu E_t y_{t+1} + (1-\mu) A_y(L) y_t - \beta (i_t - E_t \pi_{t+1}) + \varepsilon_t^y$$

$$i_t = (1-c) \left[\bar{\pi}_t + a(\bar{\pi}_t - \pi_t^*) + b y_t \right] + c i_{t-1} + \varepsilon_t^i$$

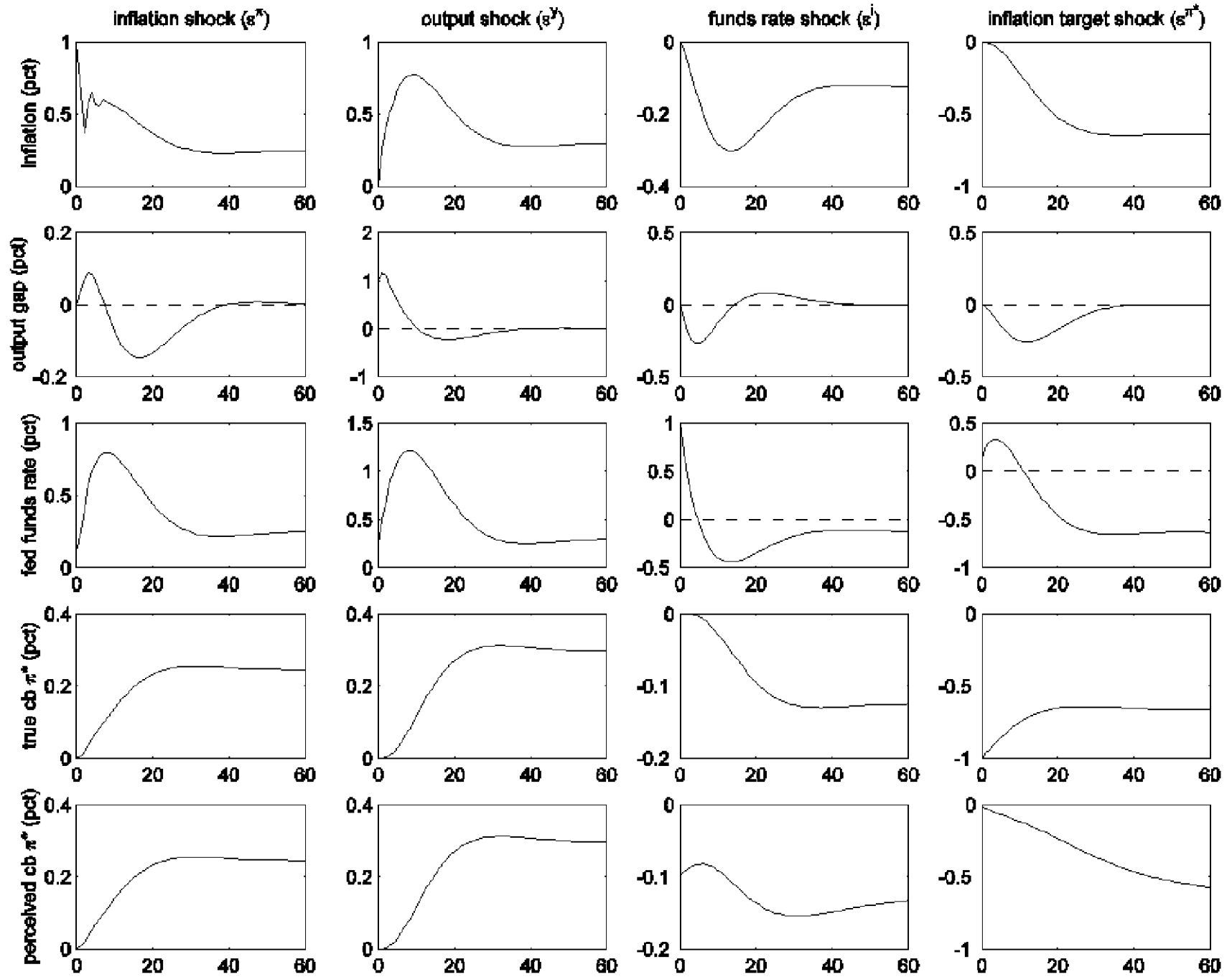
$$\pi_t^* = \pi_{t-1}^* + \theta(\bar{\pi}_{t-1} - \pi_{t-1}^*) + \varepsilon_t^{\pi^*}$$

$$\hat{\pi}_t^* = \hat{\pi}_{t-1}^* + \theta(\bar{\pi}_{t-1} - \hat{\pi}_{t-1}^*) - \kappa(i_t - \hat{i}_t)$$

Expected Impulse Responses for Rudebusch Model with Time-varying π^* (Imperfect Information)



Actual Impulse Responses for Rudebusch Model with Time-varying π^* (Imperfect Information)



Summary of Analysis for the U.S.

- Forward nominal interest rates respond significantly to economic news
- Changes in r^* alone not sufficient to explain empirical findings
- Changes in risk premium alone have a hard time explaining empirical findings (e.g., cyclicalities go wrong way)
- Changes in π^* alone are sufficient to explain *all* empirical findings
- Imperfect information in private sector not necessary, but increases magnitude, intuitiveness of effects of changes in π^*

Comparing the U.S., U.K., and Sweden (GLS 2006)

1. U.K.: inflation targeter since October 1992
(though Bank of England not independent pre-1997)
Sweden: inflation targeter since January 1993
U.S.: informal commitment to “price stability”
2. U.S., U.K., and Sweden have all issued inflation-indexed bonds
 - compare forward nominal rates, real rates, and “inflation compensation”
 - U.S.: TIPS since January 1997 (forward rates since 1998)
 - U.K.: inflation-indexed bonds since at least mid-1980s
 - Sweden: inflation-indexed bonds since 1994 (forward rates since 1996)

Relatively short sample, but daily bond yield data, frequent release of important macro statistics yield about 1000 observations per country

Table 1: U.S. Forward Rate Responses to Economic News (1998-2005)

	1-year Nominal Rate	1-year Forward Nominal Rate ending in 10 yrs	1-year Forward Real Rate ending in 10 yrs	1-year Forward Inflation Compensation ending in 10 yrs
Capacity	1.57**	0.98	0.46	0.52
Utilization	(2.76)	(1.68)	(1.74)	(0.94)
Consumer	1.46**	0.62	0.19	0.43
Confidence	(2.89)	(0.99)	(0.47)	(0.94)
Core Consumer	0.98	1.18	-0.24	1.42*
Price Index	(1.51)	(1.74)	(-0.57)	(2.30)
real GDP	2.17*	2.07*	0.30	1.77*
(advance)	(2.51)	(2.22)	(0.52)	(2.06)
Initial	-1.13**	-0.73*	-0.21	-0.51*
Jobless Claims	(-3.79)	(-2.53)	(-1.32)	(-2.10)
NAPM/ISM	2.28**	2.98**	1.50**	1.48*
Manufacturing	(2.65)	(4.27)	(3.52)	(2.55)
New Home	0.53	1.15*	-0.27	1.42**
Sales	(1.36)	(2.38)	(-0.98)	(3.47)
Nonfarm	4.44**	1.84*	1.32**	0.52
Payrolls	(7.03)	(2.26)	(3.46)	(0.83)
Retail Sales	1.69**	1.44	0.56	0.88
(ex autos)	(2.68)	(1.70)	(1.48)	(1.45)
Unemployment	-0.97	0.78	0.89	-0.11
Rate	(-1.47)	(0.79)	(1.36)	(-0.15)
Monetary	0.23*	-0.12	0.00	-0.12
Policy	(2.02)	(-1.43)	(0.03)	(-1.43)
# Observations	971	971	971	971
R^2	.14	.06	.04	.04
Joint test p-value	.0000**	.0000**	.0005**	.0002**

Table 3
U.K. Forward Rate Responses to Economic News,
pre-Bank of England Independence (1993-April 1997)

	1-year Nominal Rate	1-year Forward Nominal Rate ending in 10 yrs	1-year Forward Real Rate ending in 10 yrs	1-year Forward Inflation Compensation ending in 10 yrs
Average Earnings	3.23** (3.33)	0.69 (0.82)	0.55 (1.72)	0.15 (0.20)
real GDP (preliminary)	1.75 (1.68)	2.36* (2.14)	0.55 (1.71)	1.80* (2.02)
Manufacturing Production	0.76 (0.88)	-0.27 (-0.21)	-0.60 (-1.76)	0.33 (0.29)
Producer Price Index	2.13** (3.12)	2.98** (2.95)	0.76* (2.30)	2.22* (2.61)
core Retail Price Index	2.39** (3.19)	3.21** (3.07)	0.62 (1.88)	2.60** (3.08)
Retail Sales	2.17** (2.98)	0.32 (0.30)	0.51 (1.17)	-0.19 (-0.24)
Monetary Policy	0.67** (5.73)	-0.54** (-3.91)	0.06 (1.27)	-0.60** (-5.99)
# Observations	237	237	237	237
R^2	.35	.18	.07	.21
Joint test p-value	.0000**	.0000**	.003**	.0000**

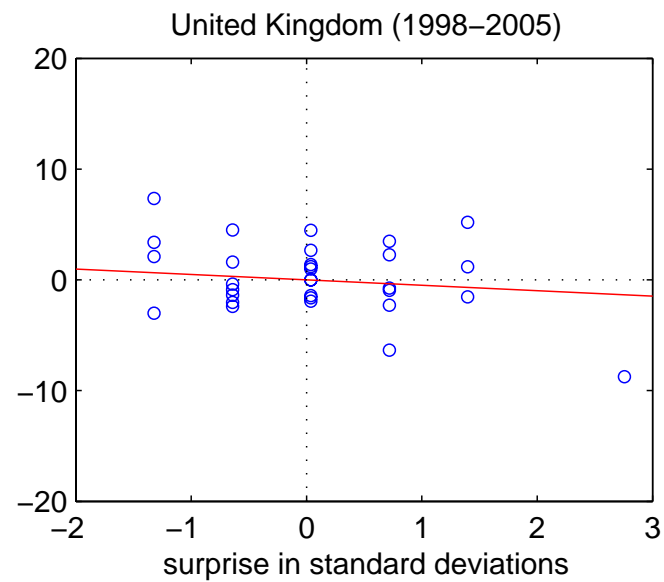
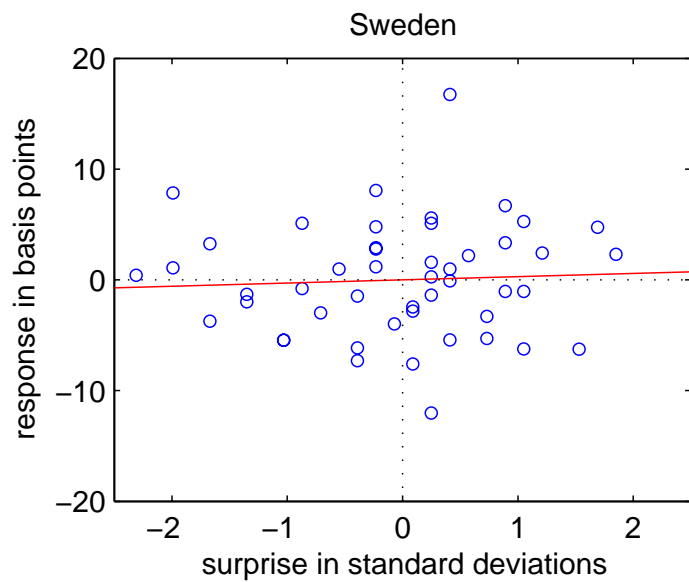
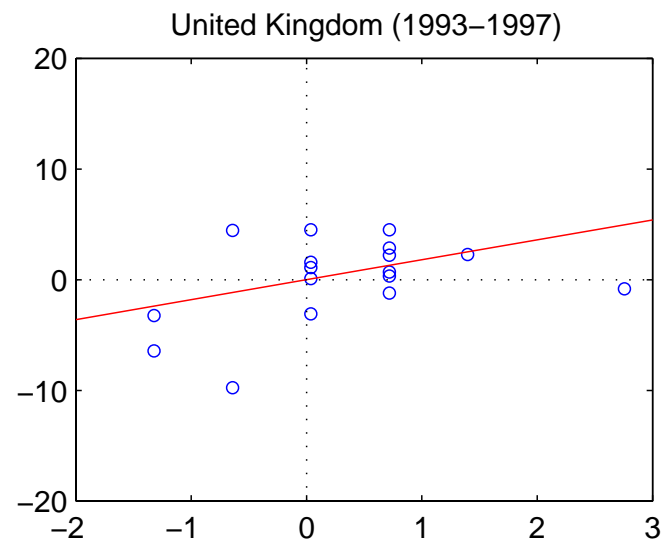
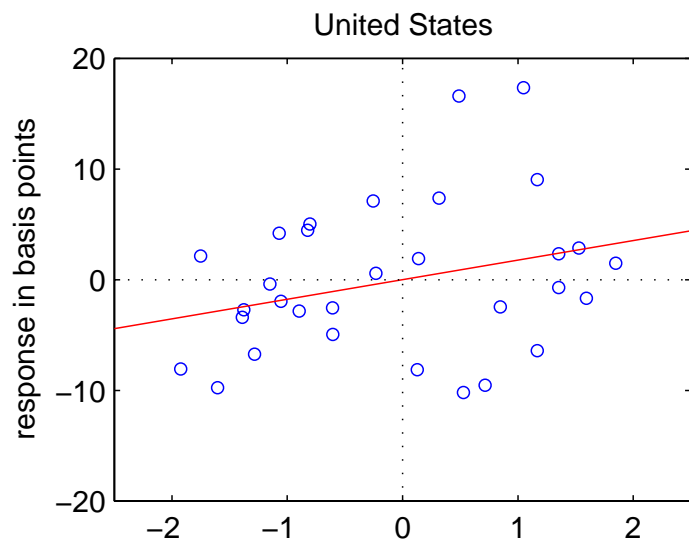
Table 4
U.K. Forward Rate Responses to Economic News,
post-Bank of England Independence (July 1998-2005)

	1-year Nominal Rate	1-year Forward Nominal Rate ending in 10 yrs	1-year Forward Real Rate ending in 10 yrs	1-year Forward Inflation Compensation ending in 10 yrs
Average Earnings	1.81** (4.12)	-0.38 (-1.15)	-0.12 (-0.53)	-0.26 (-0.94)
real GDP (preliminary)	2.04** (4.02)	-0.53 (-0.47)	-0.03 (-0.09)	-0.49 (-0.54)
Manufacturing Production	1.26** (3.09)	0.59 (1.08)	0.63** (2.69)	-0.04 (-0.09)
Producer Price Index	0.21 (0.55)	0.22 (0.58)	0.44 (1.88)	-0.22 (-0.63)
core Retail Price Index	2.60** (4.83)	-0.89 (-1.84)	-0.13 (-0.53)	-0.76 (-1.95)
Retail Sales	1.58** (3.92)	-1.08* (-2.05)	0.09 (0.34)	-1.18** (-2.75)
Monetary Policy	0.72** (5.96)	-0.12 (-0.92)	0.01 (0.20)	-0.13 (-1.01)
# Observations	480	480	480	480
R^2	.24	.02	.02	.03
Joint test p-value	.0000**	.119	.123	.051

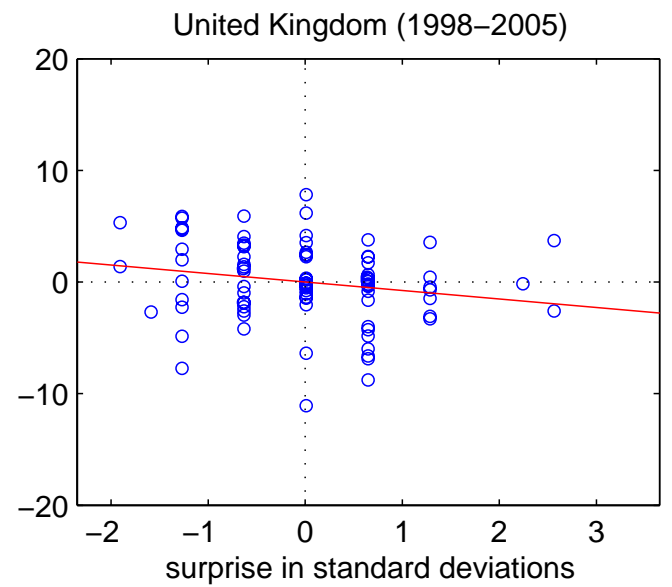
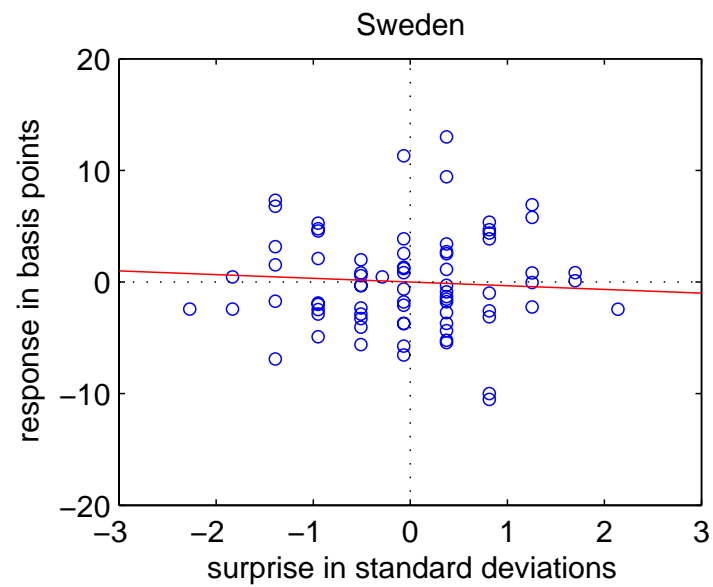
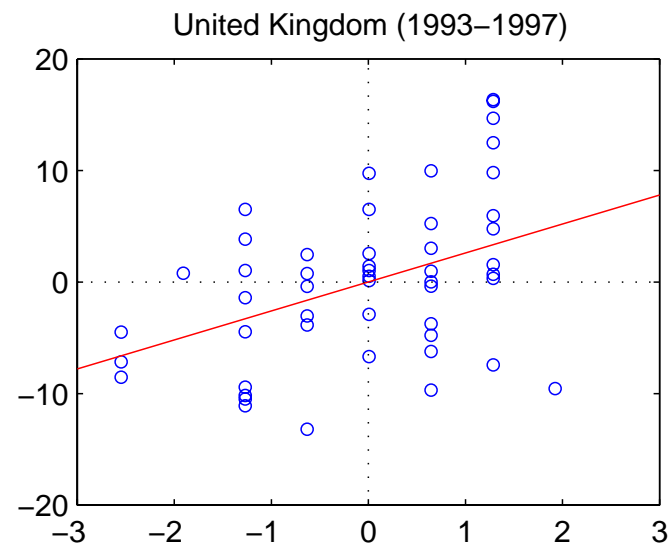
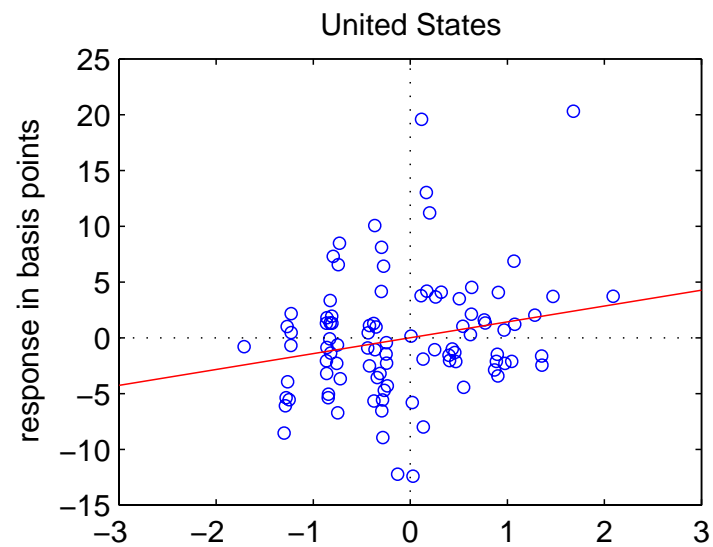
Table 5
Swedish Forward Rate Responses to Domestic Economic News (1996-2005)

	1-year Nominal Rate	1-year Forward Nominal Rate ending in 10 yrs	1-year Forward Real Rate ending in 10 yrs	1-year Forward Inflation Compensation ending in 10 yrs
Consumer Price Index	1.94* (2.55)	1.01 (1.25)	0.16 (0.64)	0.85 (1.13)
core Consumer Price Index	2.72** (4.26)	-0.68 (-0.71)	-0.36 (-0.96)	-0.33 (-0.37)
real GDP (preliminary)	0.79 (1.17)	0.72 (1.12)	0.43 (0.94)	0.29 (0.45)
Industrial Production	-0.14 (-0.24)	-0.71 (-1.31)	-0.04 (-0.14)	-0.67 (-1.55)
Producer Price Index	0.63 (0.83)	-0.47 (-1.41)	-0.23 (-1.01)	-0.24 (-0.76)
Retail Sales	-0.49 (-0.72)	0.26 (0.49)	-0.39 (-1.93)	0.65 (1.21)
Unemployment	-0.26 (-0.67)	-0.42 (-0.93)	-0.37 (-1.57)	-0.04 (-0.11)
Monetary Policy	0.72** (3.62)	0.25 (1.56)	0.03 (0.63)	0.23 (1.48)
# Observations	514	514	514	514
R^2	.12	.02	.02	.01
Joint test p-value	.0000**	.337	.341	.420

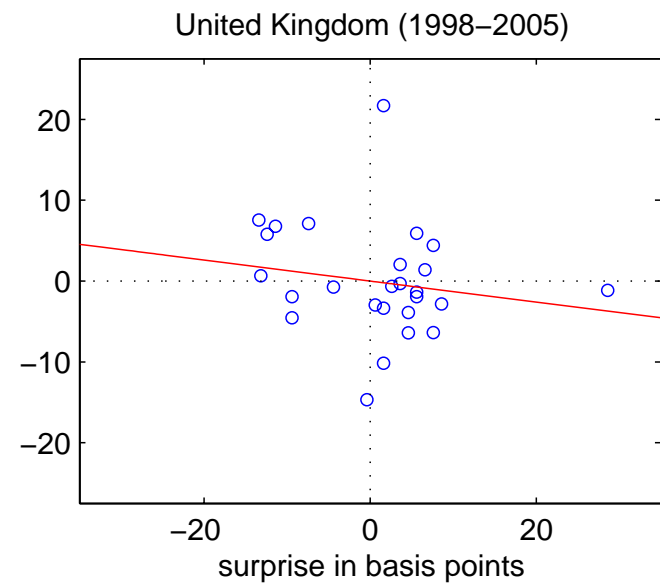
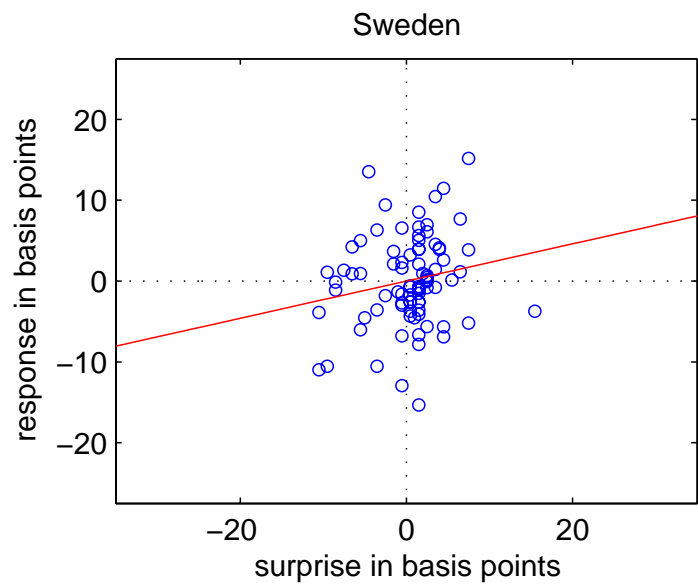
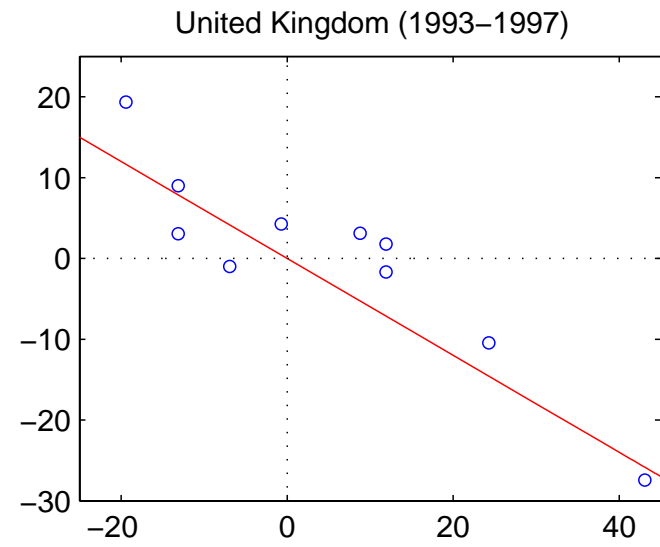
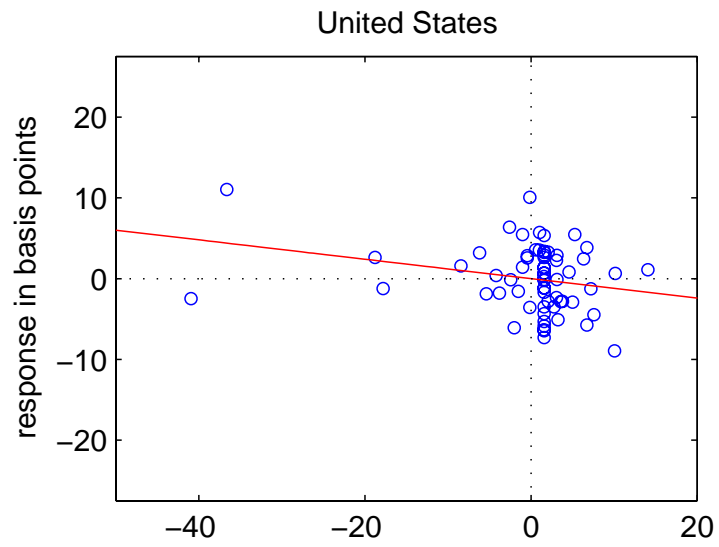
(a) GDP Surprises



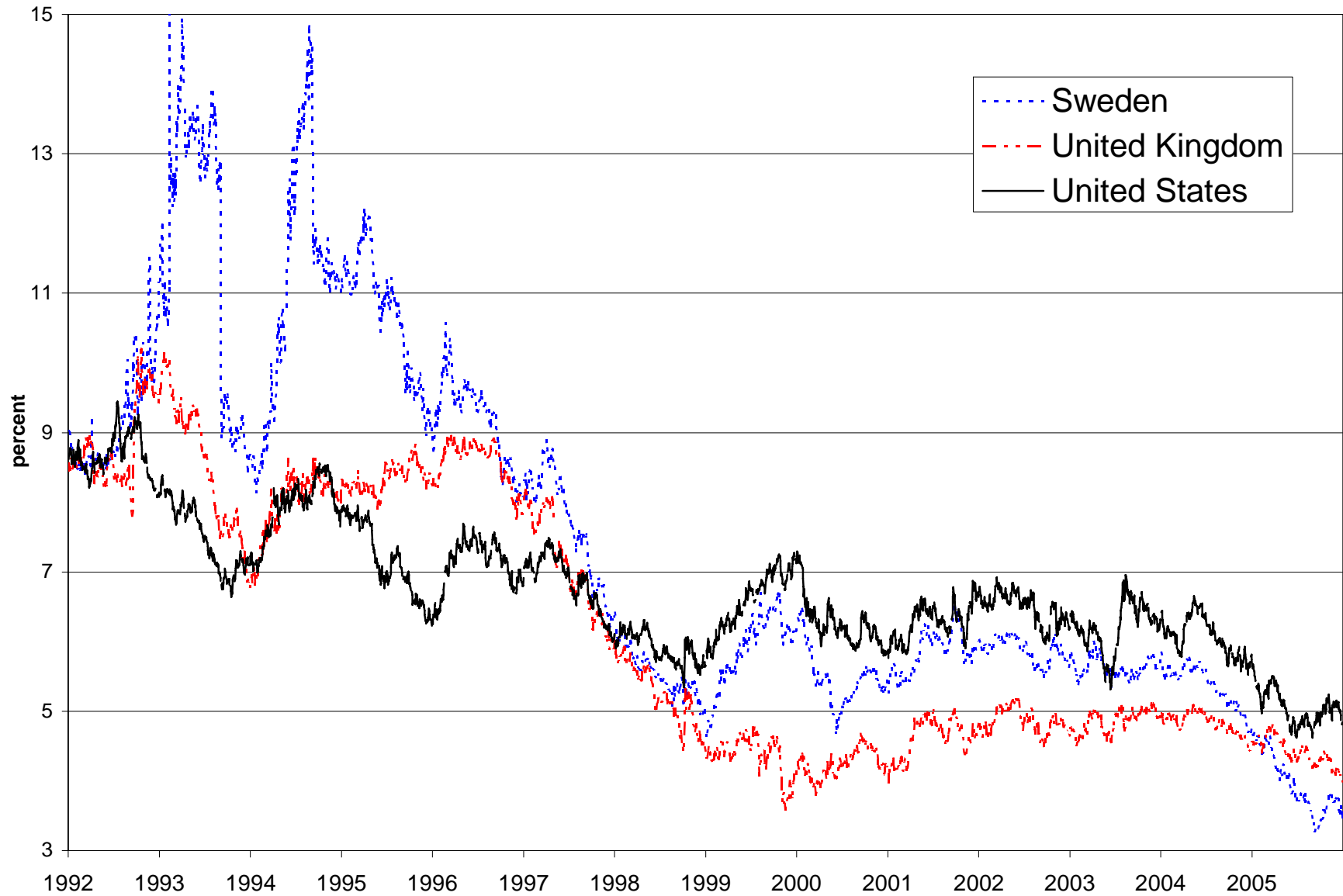
(b) Inflation Surprises



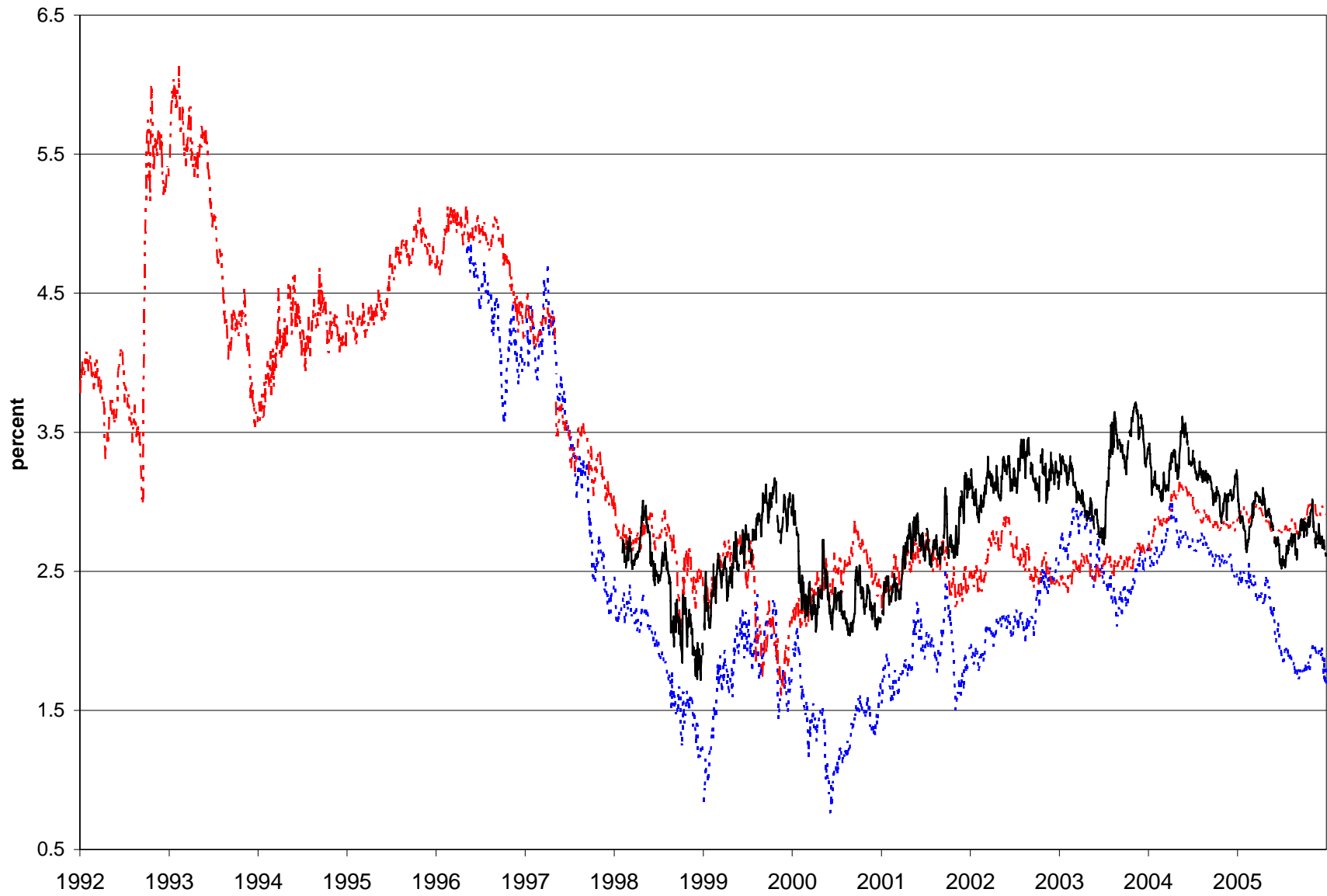
(c) Monetary Policy Surprises



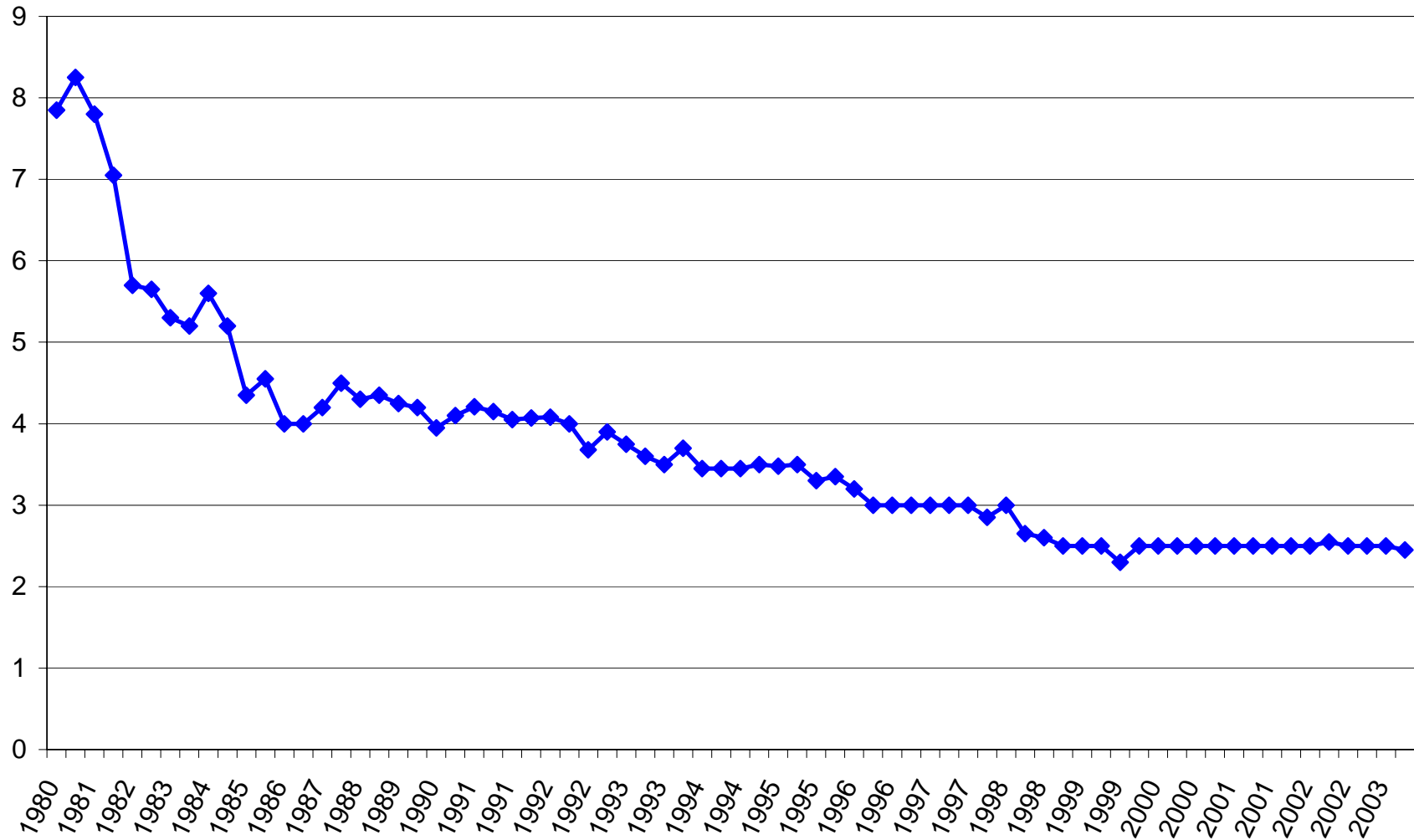
(a) Far-Ahead Forward Nominal Rates



(b) Far-Ahead Forward Inflation Compensation



Long-Term Inflation Expectations from SPF



Conclusions

- 1) In the U.S., far-ahead forward nominal rates and inflation compensation respond strongly to economic news
- 2) All of our empirical findings are consistent with changes in π^*
- 3) Standard macro models impose an incorrect restriction: constant π^*
- 4) A credible inflation target seems to reduce long-term interest rate sensitivity, as in the U.K., Sweden

Caveats:

Forward rates in the U.K., Sweden are still fairly volatile *unconditionally*

– but perhaps less so than in the U.S.

Inflation targeting is not a silver bullet—credibility, commitment required

– even then, some unconditional volatility remains