Policy Rules and Economic Performance

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(Policy) Rules *versus* (Constrained) Discretion

- Rules *versus* Discretion
  - Friedman (1959), Council of Economic Advisors (1962)
  - Sargent and Wallace (1975), Kydland and Prescott (1977)
- Policy Rules *versus* Constrained Discretion
  - Taylor (1993)
  - Bernanke (2003)
- Policy Rules *and* Constrained Discretion
  - Constraining Constrained Discretion

Outline of the Paper

- Taylor Rules
- Real-Time Data
- Taylor Rules and Constrained Discretion
- Policy Rule Evaluation by Economic Performance
- Perspectives
- Conclusions and Implementation

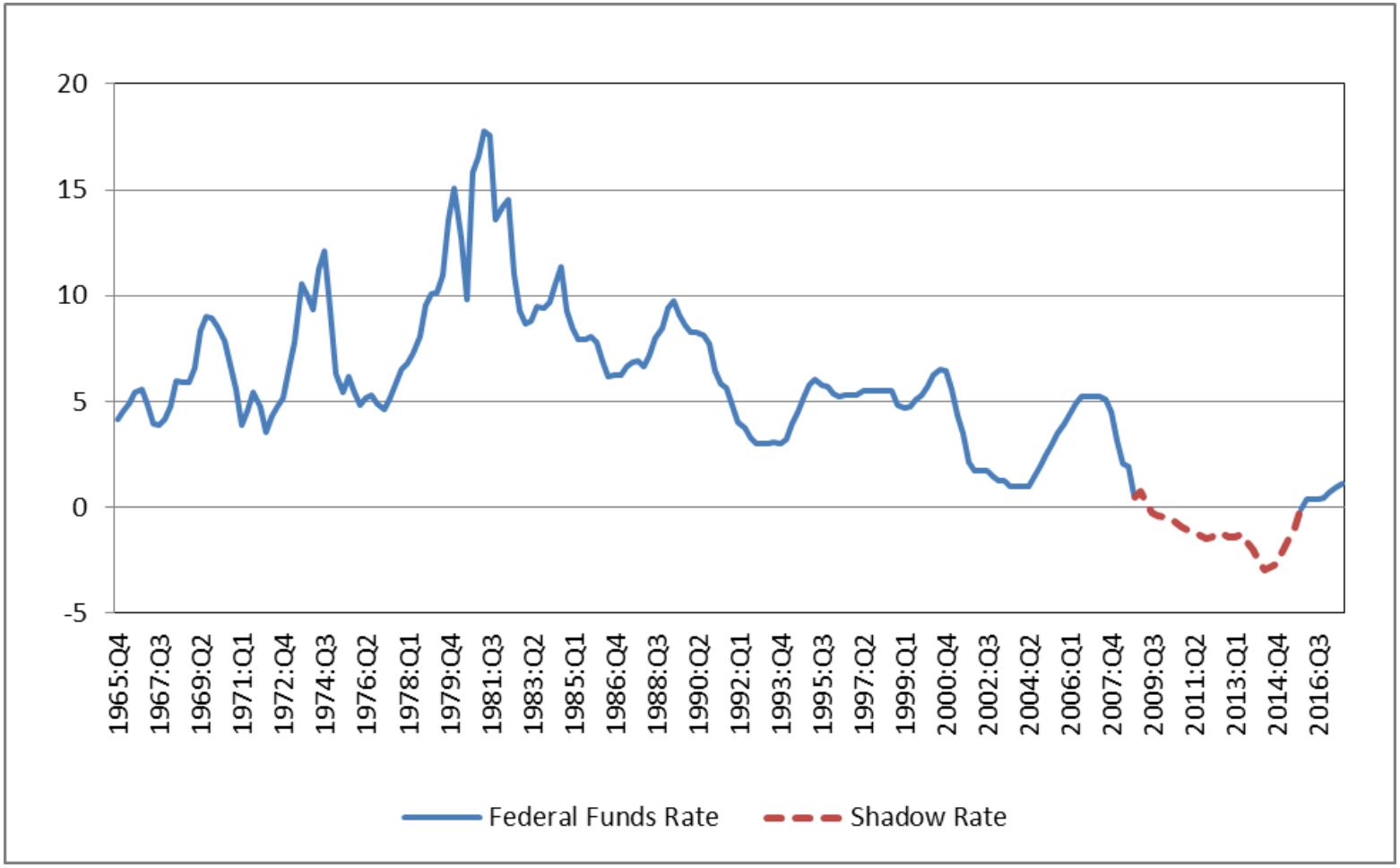
Taylor Rules

- Equal Coefficients - Taylor (1993)
  - $i_t = \pi_t + 0.5\,(\pi_t - \pi_t^*) + 0.5\,y_t + R_t^*$
  - "Balanced"
- Larger Coefficient on the Output Gap - Yellen (2012)
  - $i_t = \pi_t + 0.5\,(\pi_t - \pi_t^*) + 1.0\,y_t + R_t^*$
  - "Output Gap Tilting"
- Larger Coefficient on the Inflation Gap
  - $i_t = \pi_t + 1.0\,(\pi_t - \pi_t^*) + 0.5\,y_t + R_t^*$
  - "Inflation Gap Tilting"

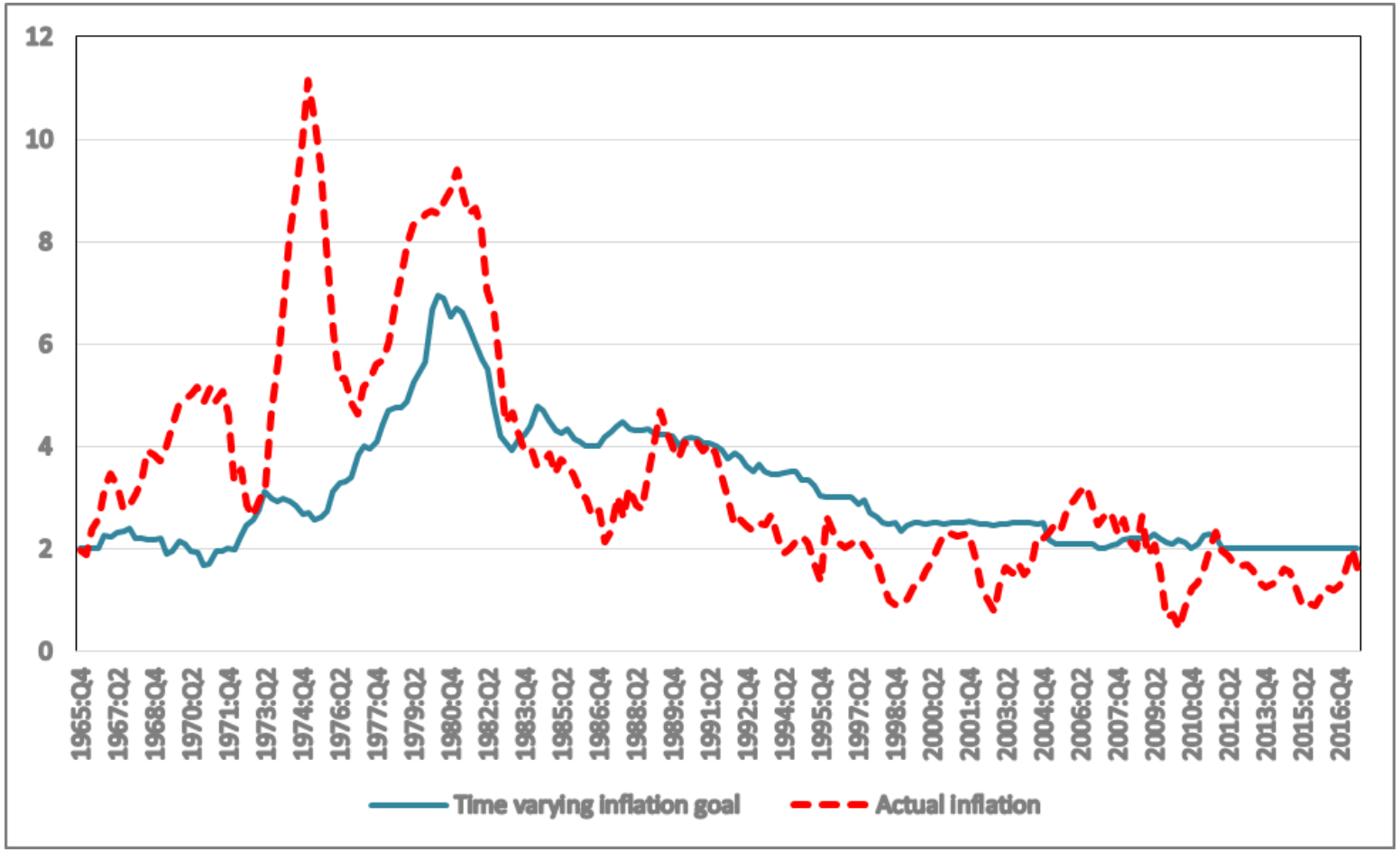
Real-Time Data

- Philadelphia Fed Nominal and Real GDP/GDP from 1965
- Policy Rate
  - Federal Funds Rate
  - Shadow FFR from Wu and Xia (2016) for 2009 - 2015
- Inflation
  - GDP Deflator
  - Less Affected by Energy Prices than PCE
  - Core PCE Not Available Before 1996
- Inflation Target
  - Two Percent as in Taylor (1993)
  - Time-Varying Inflation Goal from Fuhrer and Olivei (2017)

The Federal Funds Rate and the Shadow Rate



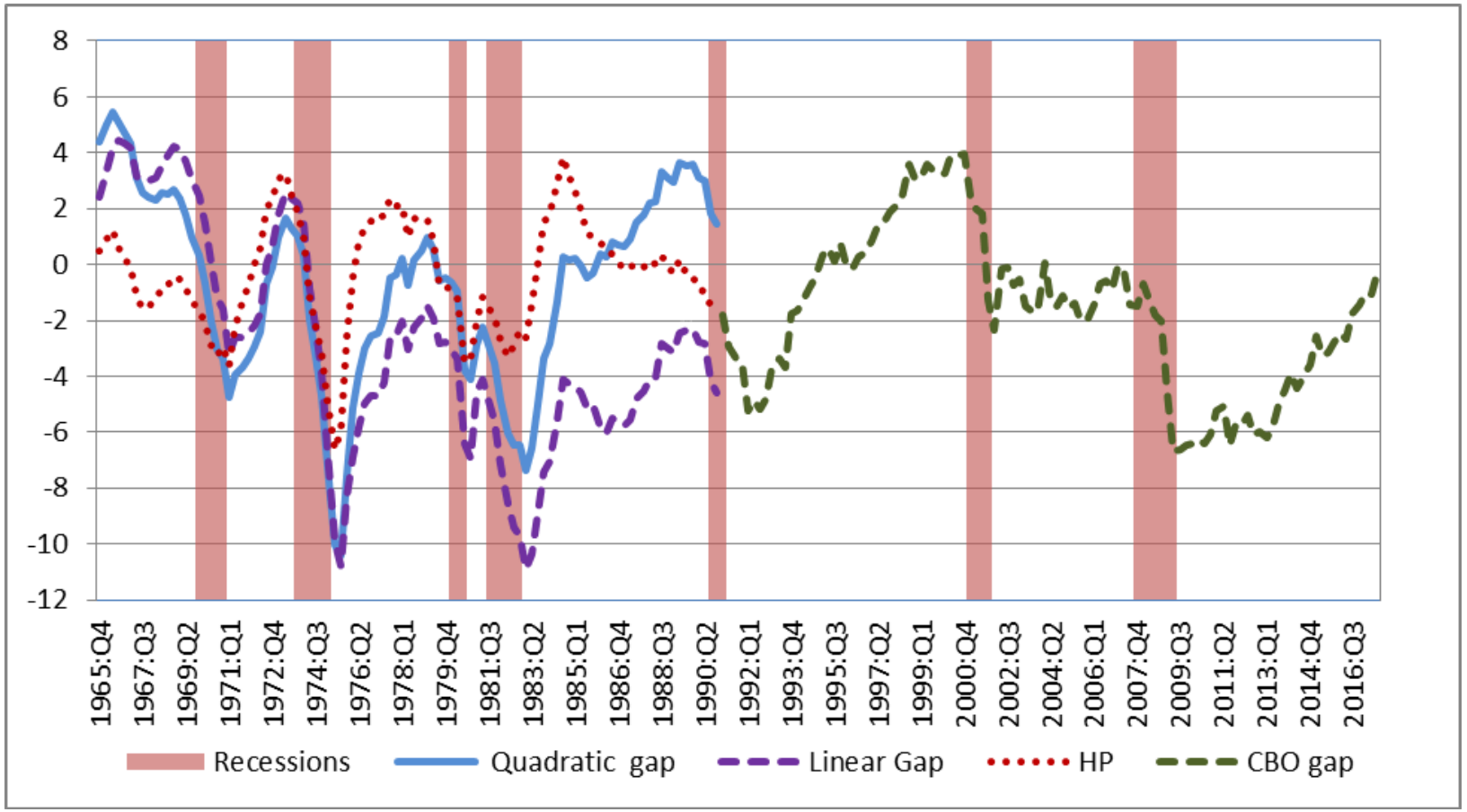
Time-varying Inflation Goal and Actual Inflation



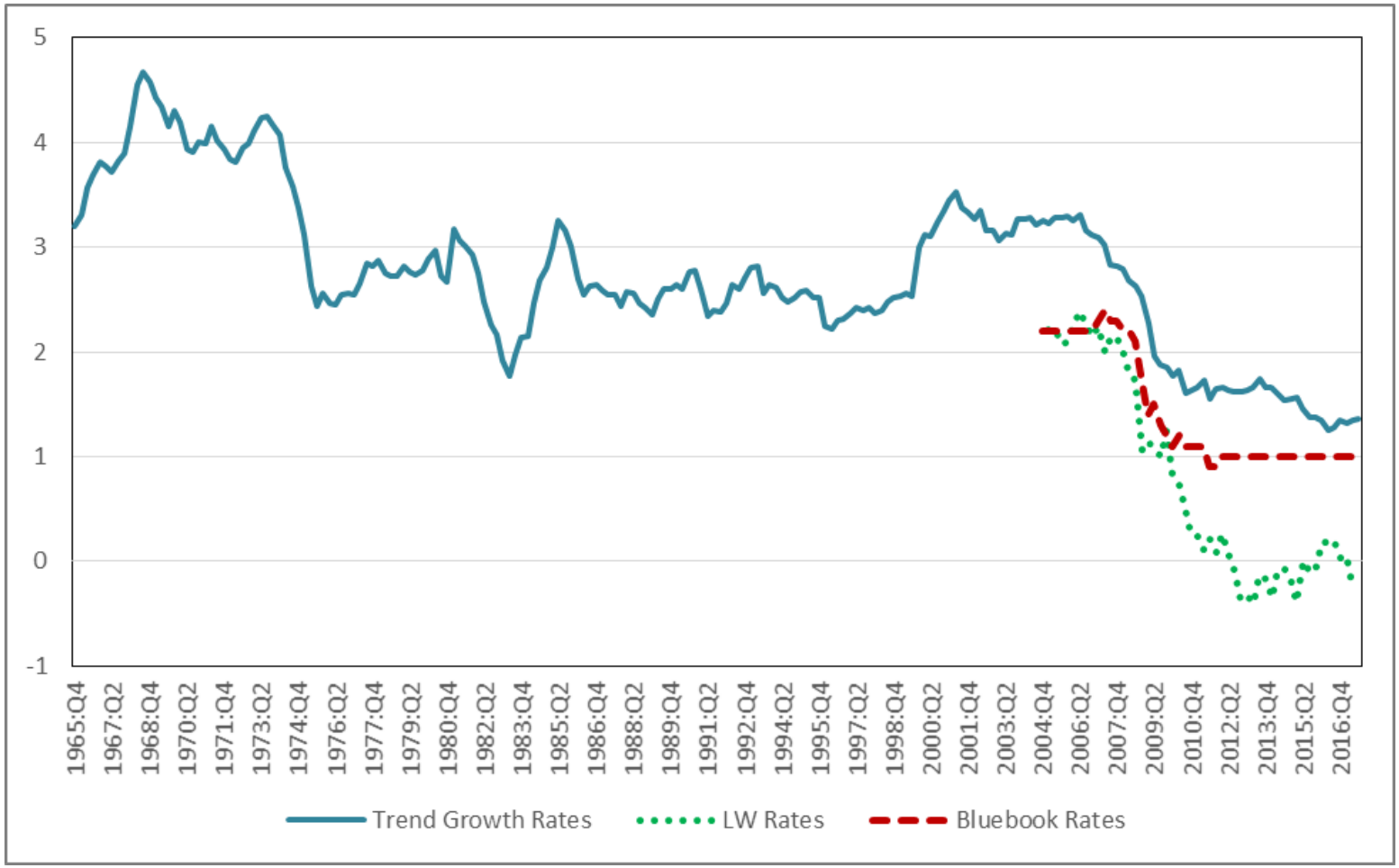
Real-Time Data

- Output Gap
  - GDP/GNP - Philadelphia Fed Real -Time Data from 1965 - 2017
  - Quadratic Detrended from 1965 - 1990
  - Potential GDP from CBO from 1991 – 2017
- Equilibrium Real Interest Rate
  - Two Percent in Taylor (1993)
  - Trend Growth over 10 Year Period (Also in Taylor (1993))
  - Trend Growth + Laubach-Williams (from 2005)
  - Trend Growth + Bluebook (from 2005 – 2012)

Linear, Quadratic, Hodrick-Prescott Detrended and CBO Real-Time Output Gaps



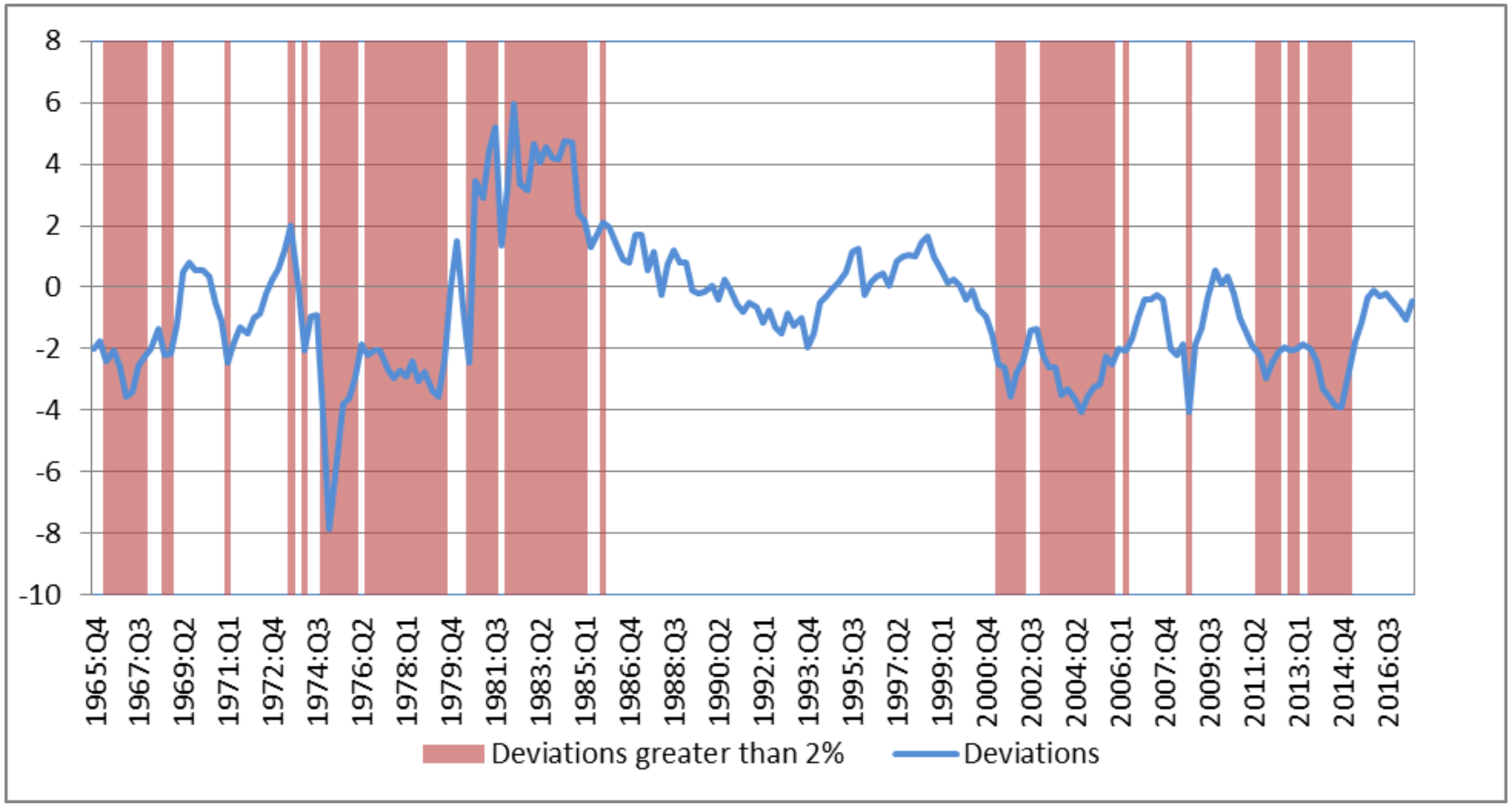
Trend Growth, LW and Bluebook Equilibrium Real Interest Rates



Taylor Rule Deviations with Real-Time Data

- Taylor Rule Deviations = Actual FFR – Prescribed FFR
  - Absolute Value
- Nikolsko-Rzhevskyy, Papell, and Prodan (2014)
  - Structural Change Tests for Low and High Deviations
- Approximation
  - Low Deviations < 2.0
  - High Deviations > 2.0
- Illustrate for Taylor (1993) Rule
  - Correlation Between “Two” and Structural Change = 0.79

Deviations from the Original Taylor Rule



Taylor Rules and Constrained Discretion

- Constrained Discretion as a Subset of Taylor Rules
  - $i_t = \pi_t + \alpha(\pi_t - \pi^*) + \gamma y_t + R^*$
  - $i_t = \mu + \delta\pi_t + \gamma y_t$
- Constrained Discretion
  - Inflation Target
    - Taylor Principle
    - $\alpha > 0$ so that $\delta > 1$
  - Dual Mandate
    - $\gamma > 0$

Taylor Rules and Constrained Discretion

- Minimum Coefficients
  - $\alpha > 0$ (Taylor Principle) and $\gamma > 0$ (Dual Mandate)
- Maximum Coefficients
  - Theory: α and γ Infinite if No Uncertainty About π and y
    - Ball (1994) and Boehm and House (2014)
  - Simulations - Need to Include Variance of Interest Rate Changes to Avoid Extreme Values of α and γ

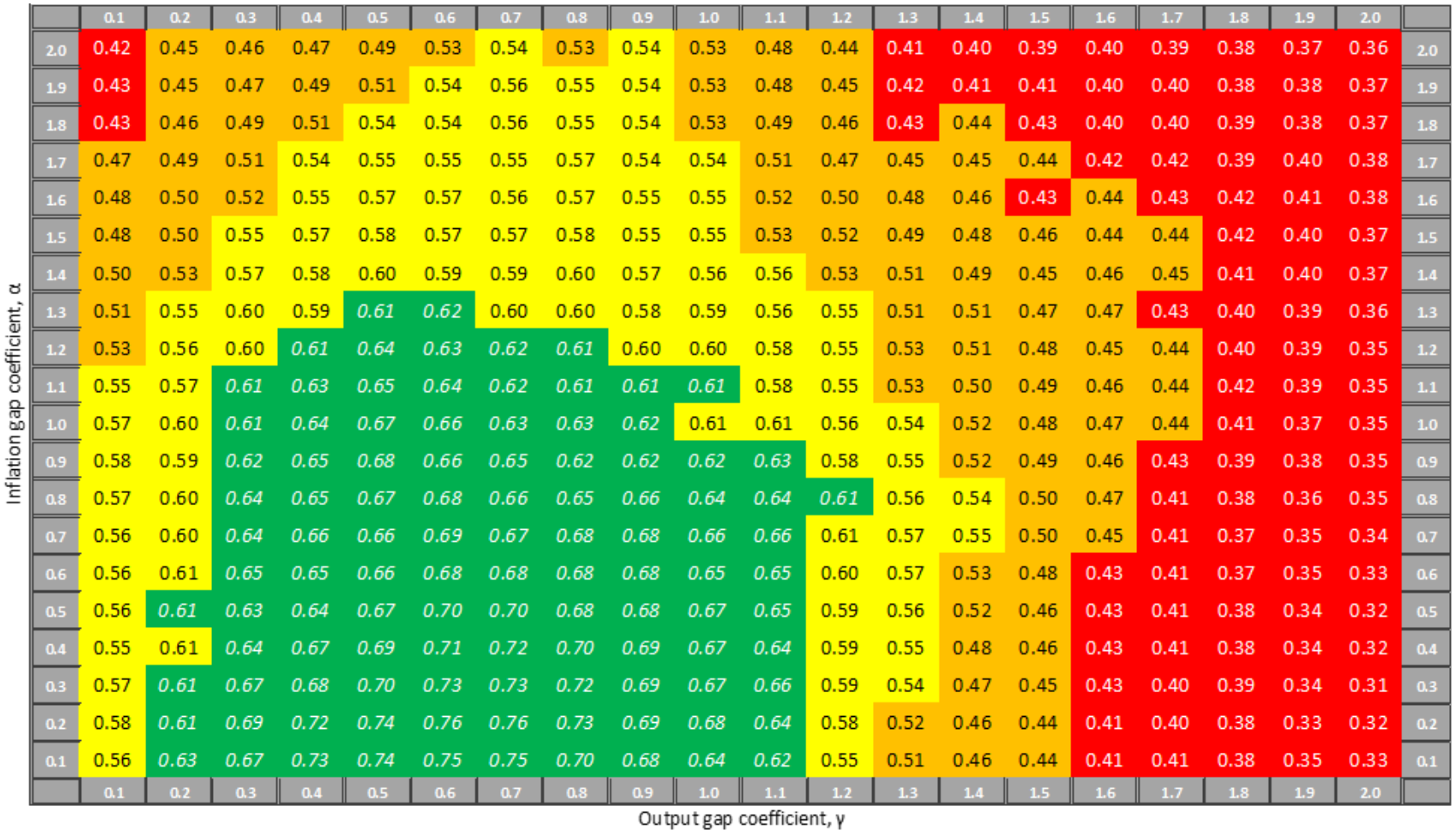
Taylor Rules and Constrained Discretion

- Tension Between Theory, Simulation, and Estimation
- Optimal α and γ in Taylor and Wieland (2012)
  - 2.00 and 0.52 in Taylor (1993),
  - 1.04 and 0.26 in Smets and Wouters (2007)
  - 1.58 and 0.45 in Christiano, Eichenbaum, and Evans (2005)
- Optimal α = 1.00 and γ = 0.61 in Boehm and House (2014)
- Estimated α and γ
  - 0.53 and 0.77 in Taylor (1989)
  - 0.39 and 0.92 in Rudebusch (2006)
  - 0.49 and 0.47 in NR, P, and P (2014)

Taylor Rules and Constrained Discretion

- Relation between Rules and Fed Policy
- Consider all Rules with α and γ between 0 and 2
  - Step Size Equals 0.1
  - $\pi^* = R^* = 2$
  - Coefficients Include all Four Optimal Rules
- Calculate “Share of Time” with Low Deviations
  - Low Deviations Periods / Total Periods
  - Equals 0.67 for Taylor (1993) Rule

Share of Time with Low Deviations
400 Policy Rules, R*= 2, π*=2, Output Gap



Inflation gap coefficient, α	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
2.0	0.42	0.45	0.46	0.47	0.49	0.53	0.54	0.53	0.54	0.53	0.48	0.44	0.41	0.40	0.39	0.40	0.39	0.38	0.37	0.36
1.9	0.43	0.45	0.47	0.49	0.51	0.54	0.56	0.55	0.54	0.53	0.48	0.45	0.42	0.41	0.41	0.40	0.40	0.38	0.38	0.37
1.8	0.43	0.46	0.49	0.51	0.54	0.54	0.56	0.55	0.54	0.53	0.49	0.46	0.43	0.44	0.43	0.40	0.40	0.39	0.38	0.37
1.7	0.47	0.49	0.51	0.54	0.55	0.55	0.55	0.57	0.54	0.54	0.51	0.47	0.45	0.45	0.44	0.42	0.42	0.39	0.40	0.38
1.6	0.48	0.50	0.52	0.55	0.57	0.57	0.56	0.57	0.55	0.55	0.52	0.50	0.48	0.46	0.43	0.44	0.43	0.42	0.41	0.38
1.5	0.48	0.50	0.55	0.57	0.58	0.57	0.57	0.58	0.55	0.55	0.53	0.52	0.49	0.48	0.46	0.44	0.44	0.42	0.40	0.37
1.4	0.50	0.53	0.57	0.58	0.60	0.59	0.59	0.60	0.57	0.56	0.56	0.53	0.51	0.49	0.45	0.46	0.45	0.41	0.40	0.37
1.3	0.51	0.55	0.60	0.59	0.61	0.62	0.60	0.60	0.58	0.59	0.56	0.55	0.51	0.51	0.47	0.47	0.43	0.40	0.39	0.36
1.2	0.53	0.56	0.60	0.61	0.64	0.63	0.62	0.61	0.60	0.60	0.58	0.55	0.53	0.51	0.48	0.45	0.44	0.40	0.39	0.35
1.1	0.55	0.57	0.61	0.63	0.65	0.64	0.62	0.61	0.61	0.61	0.58	0.55	0.53	0.50	0.49	0.46	0.44	0.42	0.39	0.35
1.0	0.57	0.60	0.61	0.64	0.67	0.66	0.63	0.63	0.62	0.61	0.61	0.56	0.54	0.52	0.48	0.47	0.44	0.41	0.37	0.35
0.9	0.58	0.59	0.62	0.65	0.68	0.66	0.65	0.62	0.62	0.62	0.63	0.58	0.55	0.52	0.49	0.46	0.43	0.39	0.38	0.35
0.8	0.57	0.60	0.64	0.65	0.67	0.68	0.66	0.65	0.66	0.64	0.64	0.61	0.56	0.54	0.50	0.47	0.41	0.38	0.36	0.35
0.7	0.56	0.60	0.64	0.66	0.66	0.69	0.67	0.68	0.68	0.66	0.66	0.61	0.57	0.55	0.50	0.45	0.41	0.37	0.35	0.34
0.6	0.56	0.61	0.65	0.65	0.66	0.68	0.68	0.68	0.68	0.65	0.65	0.60	0.57	0.53	0.48	0.43	0.41	0.37	0.35	0.33
0.5	0.56	0.61	0.63	0.64	0.67	0.70	0.70	0.68	0.68	0.67	0.65	0.59	0.56	0.52	0.46	0.43	0.41	0.38	0.34	0.32
0.4	0.55	0.61	0.64	0.67	0.69	0.71	0.72	0.70	0.69	0.67	0.64	0.59	0.55	0.48	0.46	0.43	0.41	0.38	0.34	0.32
0.3	0.57	0.61	0.67	0.68	0.70	0.73	0.73	0.72	0.69	0.67	0.66	0.59	0.54	0.47	0.45	0.43	0.40	0.39	0.34	0.31
0.2	0.58	0.61	0.69	0.72	0.74	0.76	0.76	0.73	0.69	0.68	0.64	0.58	0.52	0.46	0.44	0.41	0.40	0.38	0.33	0.32
0.1	0.56	0.63	0.67	0.73	0.74	0.75	0.75	0.70	0.68	0.64	0.62	0.55	0.51	0.46	0.44	0.41	0.41	0.38	0.35	0.33

Output gap coefficient, γ

Taylor Rules and Constrained Discretion

- "Plausible" Policy Rules for Constrained Discretion
  - $0 < \alpha \leq 1, 0 < \gamma \leq 1$
- Accords with
  - Estimates
  - "Share of Time"
  - Smets and Wouters (2007) and Boehm and House (2014)

Policy Rule Evaluation

- Optimal Policy Rule
  - Estimate Model
  - Simulate using Estimated Coefficients and Disturbances
  - Pick Optimal Policy Rule to Minimize Loss Function
- Smets and Wouters (2007) Model in Taylor and Wieland (2012)
  - α =1.04 and γ = 0.26
  - Inflation Gap Tilting
- FRB/US Model for October 2007 in Tetlow (2015)
  - α =0.53 and γ = 1.17
  - Output Gap Tilting

Policy Rules and Economic Performance

- Quadratic Loss Functions
  - Loss = $\Sigma ((\pi - \pi^*)^2 + (U - U^*)^2)$
  - Can't Compare Policy Rules - Loss Independent of Rule
- Loss Ratios
  - For a Given Policy Rule
  - Average Loss in High Deviations Periods Divided by Average Loss in Low Deviations Periods
- Metric to Evaluate Policy Rules
  - Loss Ratio > 1 is the Minimal Criterion
  - Higher Loss Ratio is Better

Policy Rules and Economic Performance

- Consider “Plausible” Rules with α and γ between 0 and 1
  - Step Size Equals 0.1
- Calculate Loss Ratios for High and Low Deviations Periods
- Benchmark and Other Specifications
  - Equal Weights on Inflation and Unemployment Loss
    - (1.25 - 0.75 and 1.5 – 0.5 for π and U)
  - Output Gap (Unemployment Gap)
  - $\pi^* = R^* = 2$ (Time-Varying π^* and R^*)
  - Threshold for Deviations = 2.0 (1.5 and 2.5)
  - Policy Lag of 6 Quarters (4 and 8)

Loss Ratios: R*=2%, π*=2%, Output Gap

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	
1.0	1.83	1.83	2.01	2.11	2.35	2.45	2.56	2.49	2.47	2.66	1.0
0.9	1.67	1.83	2.04	2.15	2.43	2.43	2.51	2.30	2.44	2.15	0.9
0.8	1.71	1.87	1.98	2.25	2.25	2.34	2.42	2.25	1.94	1.80	0.8
0.7	1.55	1.65	1.80	2.02	2.16	2.11	2.15	1.96	1.92	1.68	0.7
0.6	1.55	1.80	1.55	1.77	2.03	2.10	1.96	1.82	1.85	1.62	0.6
0.5	1.31	1.64	1.73	2.00	2.25	1.99	1.83	1.75	1.76	1.59	0.5
0.4	1.23	1.45	1.69	1.79	1.82	1.84	1.72	1.42	1.40	1.33	0.4
0.3	1.23	1.23	1.31	1.38	1.42	1.46	1.46	1.43	1.37	1.20	0.3
0.2	0.84	0.91	0.84	0.83	0.83	0.92	1.13	1.08	1.04	1.12	0.2
0.1	0.80	0.84	0.92	0.87	0.92	1.13	1.17	1.18	1.15	1.19	0.1
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	

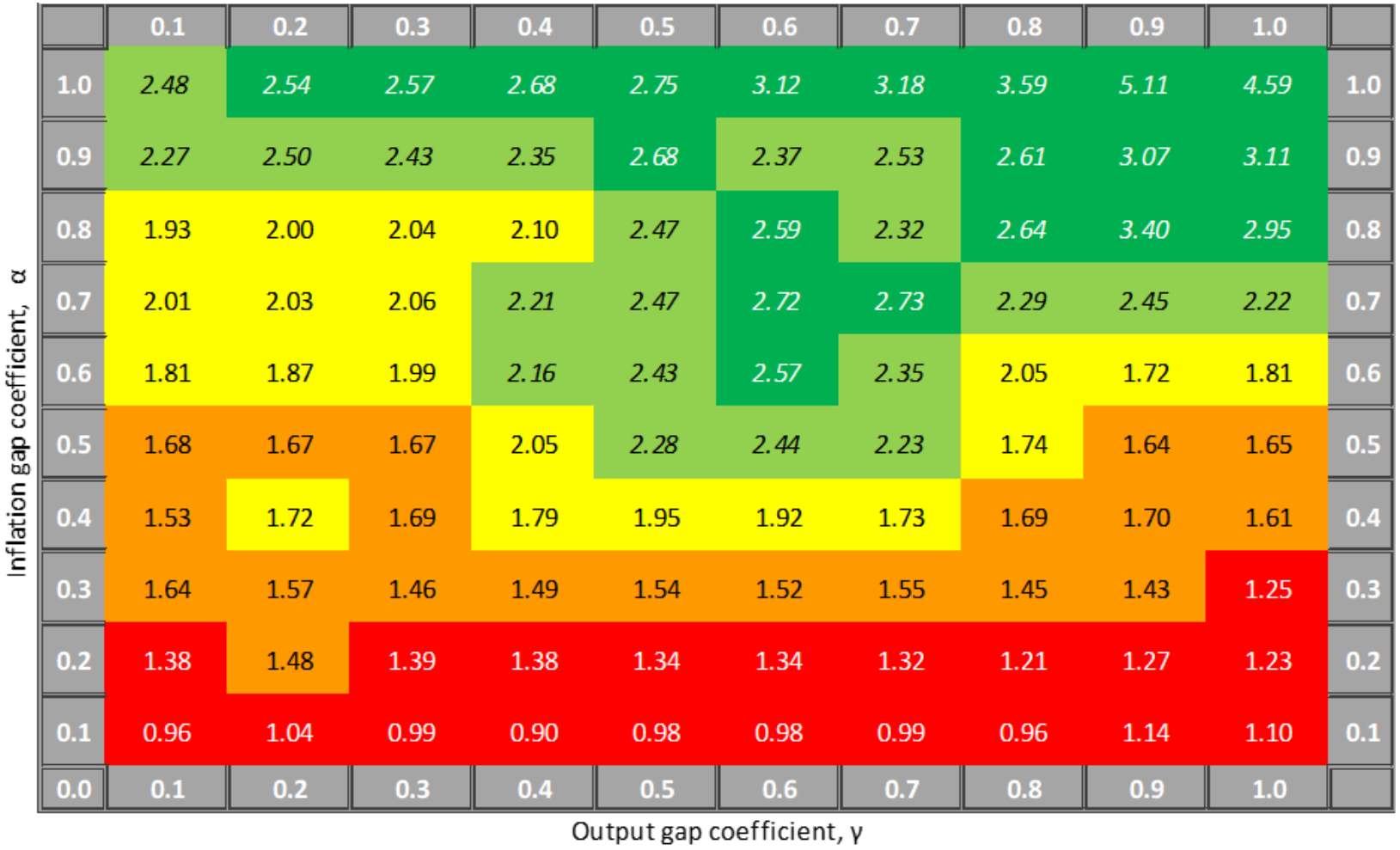
Benchmark Specification

- Economic Performance is Better in Low Deviations Periods
  - Loss Ratio >1 for 91 of 100 Rules
    - Taylor Principle is Necessary but Not Sufficient
  - Average Loss Ratio = 1.69
- Performance Better with Inflation Gap Tilting Rules
  - Relative Loss Ratio = 1.35
- Performance Better with Large Coefficient Rules
  - Relative Loss Ratio = 1.47
- Performance Better with Both
  - Relative Loss Ratio = 1.97

Loss Ratios: R*=2%, π*=2, Output Gap

	Inflation gap/Output gap Rules	High response/Low response Rules	Higher quadrant/Lower quadrant Rules
Equal Weights on Inflation and Unemployment Loss. Threshold = 2%			
Policy Lag = 6 quarters (Average Loss=1.69)	1.35***	1.47***	1.97***
Policy Lag = 4 quarters	1.34***	1.60***	2.03***
Policy Lag = 8 quarters	1.55***	1.51***	2.40***
Equal weights on Inflation and Unemployment Loss. Policy Lag = 6 quarters			
Threshold = 2.5%	1.49***	1.57***	2.22***
Threshold = 1.5%	1.19**	1.39***	1.66***
Threshold = 2%. Policy Lag = 6 quarters			
1.25:0.75 Inflation and Unemployment Loss Weights	1.49***	1.51***	2.22***
1.5:0.5 Inflation and Unemployment Loss Weights	1.61***	1.54***	2.44***
0.75:1.25 Inflation and Unemployment Loss Weights	1.19**	1.43***	1.68***
0.5:1.5 Inflation and Unemployment Loss Weights	1.00	1.37***	1.36***

Loss Ratios: R*=Trend Growth, π*=2, Output Gap

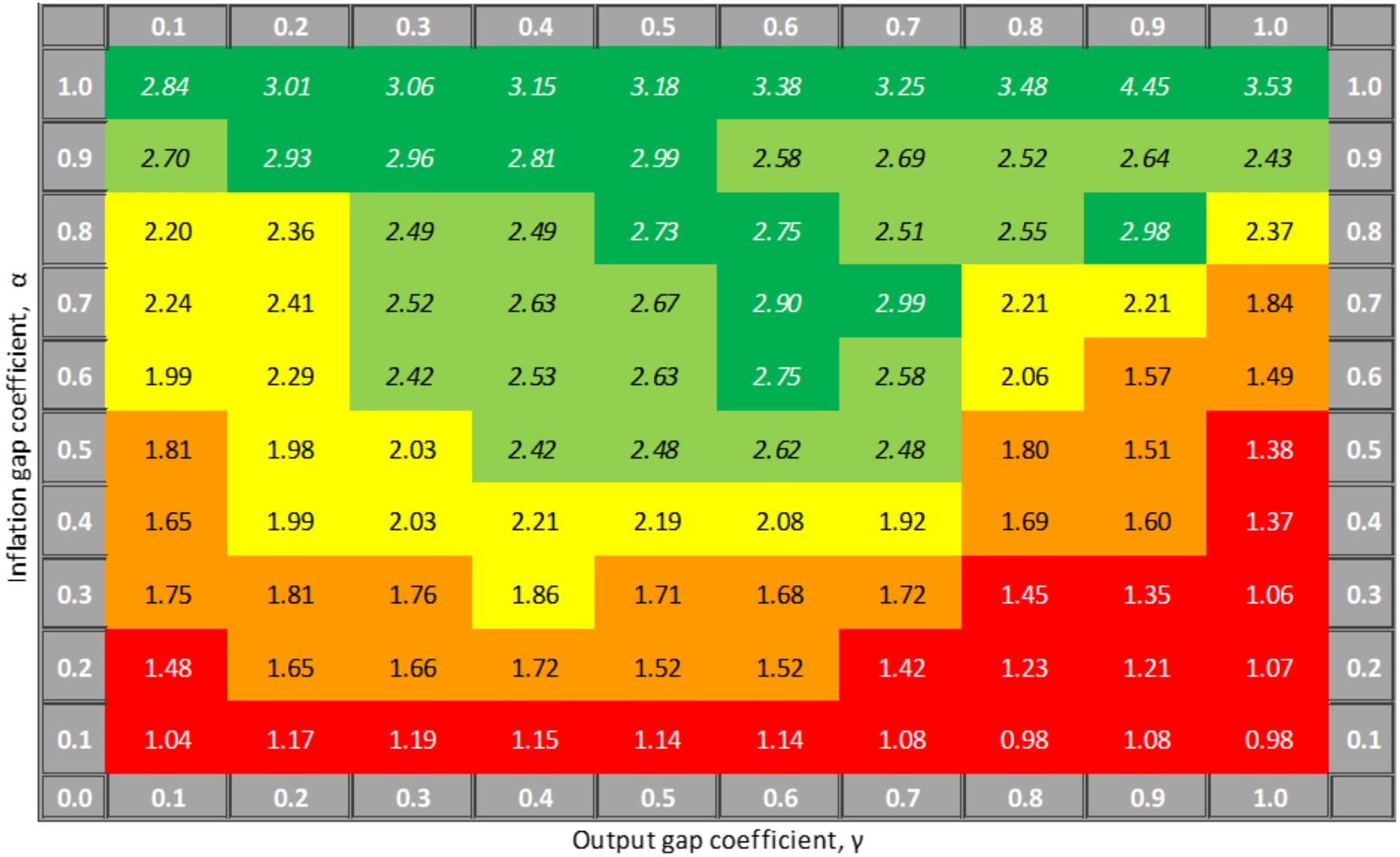


α \ γ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1.0	2.48	2.54	2.57	2.68	2.75	3.12	3.18	3.59	5.11	4.59
0.9	2.27	2.50	2.43	2.35	2.68	2.37	2.53	2.61	3.07	3.11
0.8	1.93	2.00	2.04	2.10	2.47	2.59	2.32	2.64	3.40	2.95
0.7	2.01	2.03	2.06	2.21	2.47	2.72	2.73	2.29	2.45	2.22
0.6	1.81	1.87	1.99	2.16	2.43	2.57	2.35	2.05	1.72	1.81
0.5	1.68	1.67	1.67	2.05	2.28	2.44	2.23	1.74	1.64	1.65
0.4	1.53	1.72	1.69	1.79	1.95	1.92	1.73	1.69	1.70	1.61
0.3	1.64	1.57	1.46	1.49	1.54	1.52	1.55	1.45	1.43	1.25
0.2	1.38	1.48	1.39	1.38	1.34	1.34	1.32	1.21	1.27	1.23
0.1	0.96	1.04	0.99	0.90	0.98	0.98	0.99	0.96	1.14	1.10
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Loss Ratios: R*=Trend Growth, π*=2, Output Gap

	Inflation gap/Output gap Rules	High response/Low response Rules	Higher quadrant/Lower quadrant Rules
Equal Weights on Inflation and Unemployment Loss. Threshold = 2%			
Policy Lag = 6 quarters (Average Loss=2.02)	1.39***	1.58***	2.13***
Policy Lag = 4 quarters	1.32***	1.60***	2.07***
Policy Lag = 8 quarters	1.47***	1.54***	2.19***
Equal weights on Inflation and Unemployment Loss. Policy Lag = 6 quarters			
Threshold = 2.5%	1.50***	1.62***	2.49***
Threshold = 1.5%	1.22**	1.83***	2.12***
Threshold = 2%. Policy Lag = 6 quarters			
1.25:0.75 Inflation and Unemployment Loss Weights	1.52***	1.71***	2.49***
1.5:0.5 Inflation and Unemployment Loss Weights	1.64***	1.85***	2.86***
0.75:1.25 Inflation and Unemployment Loss Weights	1.25***	1.43***	1.76***
0.5:1.5 Inflation and Unemployment Loss Weights	1.08*	1.27***	1.37***

Loss Ratios: R*=Trend Growth + LW, π*=2, Output Gap



	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	
1.0	2.84	3.01	3.06	3.15	3.18	3.38	3.25	3.48	4.45	3.53	1.0
0.9	2.70	2.93	2.96	2.81	2.99	2.58	2.69	2.52	2.64	2.43	0.9
0.8	2.20	2.36	2.49	2.49	2.73	2.75	2.51	2.55	2.98	2.37	0.8
0.7	2.24	2.41	2.52	2.63	2.67	2.90	2.99	2.21	2.21	1.84	0.7
0.6	1.99	2.29	2.42	2.53	2.63	2.75	2.58	2.06	1.57	1.49	0.6
0.5	1.81	1.98	2.03	2.42	2.48	2.62	2.48	1.80	1.51	1.38	0.5
0.4	1.65	1.99	2.03	2.21	2.19	2.08	1.92	1.69	1.60	1.37	0.4
0.3	1.75	1.81	1.76	1.86	1.71	1.68	1.72	1.45	1.35	1.06	0.3
0.2	1.48	1.65	1.66	1.72	1.52	1.52	1.42	1.23	1.21	1.07	0.2
0.1	1.04	1.17	1.19	1.15	1.14	1.14	1.08	0.98	1.08	0.98	0.1
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	

Loss Ratios: R*=Trend Growth + LW, π*=2, Output Gap

	Inflation gap/Output gap Rules	High response/Low response Rules	Higher quadrant/Lower quadrant Rules
Equal Weights on Inflation and Unemployment Loss. Threshold = 2%			
Policy Lag = 6 quarters (Average Loss=2.14)	1.55***	1.37***	2.04***
Policy Lag = 4 quarters	1.48***	1.43***	2.04***
Policy Lag = 8 quarters	1.67***	1.32***	2.10***
Equal weights on Inflation and Unemployment Loss. Policy Lag = 6 quarters			
Threshold = 2.5%	1.75***	1.37***	2.42***
Threshold = 1.5%	1.38***	1.59***	2.05***
Threshold = 2%. Policy Lag = 6 quarters			
1.25:0.75 Inflation and Unemployment Loss Weights	1.75***	1.43***	2.37***
1.5:0.5 Inflation and Unemployment Loss Weights	1.94***	1.49***	2.70***
0.75:1.25 Inflation and Unemployment Loss Weights	1.33***	1.31***	1.69***
0.5:1.5 Inflation and Unemployment Loss Weights	1.09*	1.24***	1.33***

Loss Ratios: R*=Trend Growth + Bluebook, π*=2, Output Gap

Inflation gap coefficient, α	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1.0	2.66	2.80	3.00	2.99	2.89	3.32	3.37	3.82	5.17	4.23
0.9	2.46	2.69	2.84	2.65	2.72	2.53	2.79	2.80	3.13	2.85
0.8	2.05	2.14	2.28	2.36	2.55	2.65	2.51	2.78	3.51	2.79
0.7	2.13	2.22	2.21	2.48	2.51	2.79	2.96	2.42	2.58	2.07
0.6	1.95	2.05	2.12	2.39	2.52	2.60	2.56	2.22	1.85	1.68
0.5	1.73	1.74	1.75	2.27	2.38	2.47	2.42	1.98	1.77	1.53
0.4	1.57	1.79	1.73	2.05	2.10	1.95	1.87	1.83	1.84	1.52
0.3	1.71	1.63	1.49	1.73	1.67	1.58	1.64	1.57	1.53	1.18
0.2	1.44	1.48	1.40	1.59	1.48	1.44	1.36	1.28	1.36	1.21
0.1	1.01	1.04	0.99	1.07	1.11	1.08	1.02	1.02	1.22	1.11
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Output gap coefficient, γ

Loss Ratios: R*=Trend Growth + Bluebook, π*=2, Output Gap

	Inflation gap/Output gap Rules	High response/Low response Rules	Higher quadrant/Lower quadrant Rules
Equal Weights on Inflation and Unemployment Loss. Threshold = 2%			
Policy Lag = 6 quarters (Average Loss=2.12)	1.43***	1.58***	2.13***
Policy Lag = 4 quarters	1.35***	1.60***	2.10***
Policy Lag = 8 quarters	1.53***	1.54***	2.19***
Equal weights on Inflation and Unemployment Loss. Policy Lag = 6 quarters			
Threshold = 2.5%	1.56***	1.62***	2.47***
Threshold = 1.5%	1.33***	1.83***	2.21***
Threshold = 2%. Policy Lag = 6 quarters			
1.25:0.75 Inflation and Unemployment Loss Weights	1.60***	1.71***	2.49***
1.5:0.5 Inflation and Unemployment Loss Weights	1.75***	1.85***	2.85***
0.75:1.25 Inflation and Unemployment Loss Weights	1.25***	1.43***	1.75***
0.5:1.5 Inflation and Unemployment Loss Weights	1.04	1.27***	1.36***

Loss Ratios: R*=Trend Growth + Bluebook, π^*=2, Unemployment Gap

α \ γ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1.0	2.64	2.54	2.50	2.70	2.77	2.67	2.59	2.69	2.49	2.23
0.9	2.20	2.34	2.36	2.36	2.52	2.45	2.32	2.55	2.22	1.94
0.8	1.88	2.12	2.10	2.52	2.49	2.48	2.41	2.43	2.10	1.95
0.7	1.99	2.07	2.15	2.23	2.19	2.16	2.14	1.80	1.82	1.56
0.6	1.79	1.88	2.06	2.12	2.28	2.02	1.74	1.66	1.50	1.46
0.5	1.54	1.58	1.80	1.93	2.10	1.76	1.51	1.43	1.50	1.29
0.4	1.58	1.71	1.72	1.78	1.53	1.33	1.30	1.21	1.28	1.28
0.3	1.71	1.40	1.35	1.19	1.09	1.03	1.00	0.92	1.03	1.06
0.2	1.32	1.22	0.79	0.79	0.83	0.87	0.85	0.81	0.81	0.83
0.1	0.85	0.80	0.72	0.73	0.82	0.87	0.84	0.84	0.85	0.92
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Loss Ratios: R*=Trend Growth + Bluebook, π*=2, Unemployment Gap

	Inflation gap/Output gap Rules	High response/Low response Rules	Higher quadrant/Lower quadrant Rules
Equal Weights on Inflation and Unemployment Loss. Threshold = 2%			
Policy Lag = 6 quarters (Average Loss=1.70)	1.81***	1.45***	2.68***
Policy Lag = 4 quarters	1.58***	1.49***	2.37***
Policy Lag = 8 quarters	2.05***	1.37***	2.92***
Equal weights on Inflation and Unemployment Loss. Policy Lag = 6 quarters			
Threshold = 2.5%	1.99***	1.45***	2.83***
Threshold = 1.5%	1.54***	1.54***	2.32***
Threshold = 2%. Policy Lag = 6 quarters			
1.25:0.75 Inflation and Unemployment Loss Weights	2.03***	1.48***	3.07***
1.5:0.5 Inflation and Unemployment Loss Weights	2.22***	1.49***	3.43***
0.75:1.25 Inflation and Unemployment Loss Weights	1.56***	1.43***	2.25***
0.5:1.5 Inflation and Unemployment Loss Weights	1.28***	1.39***	1.79***

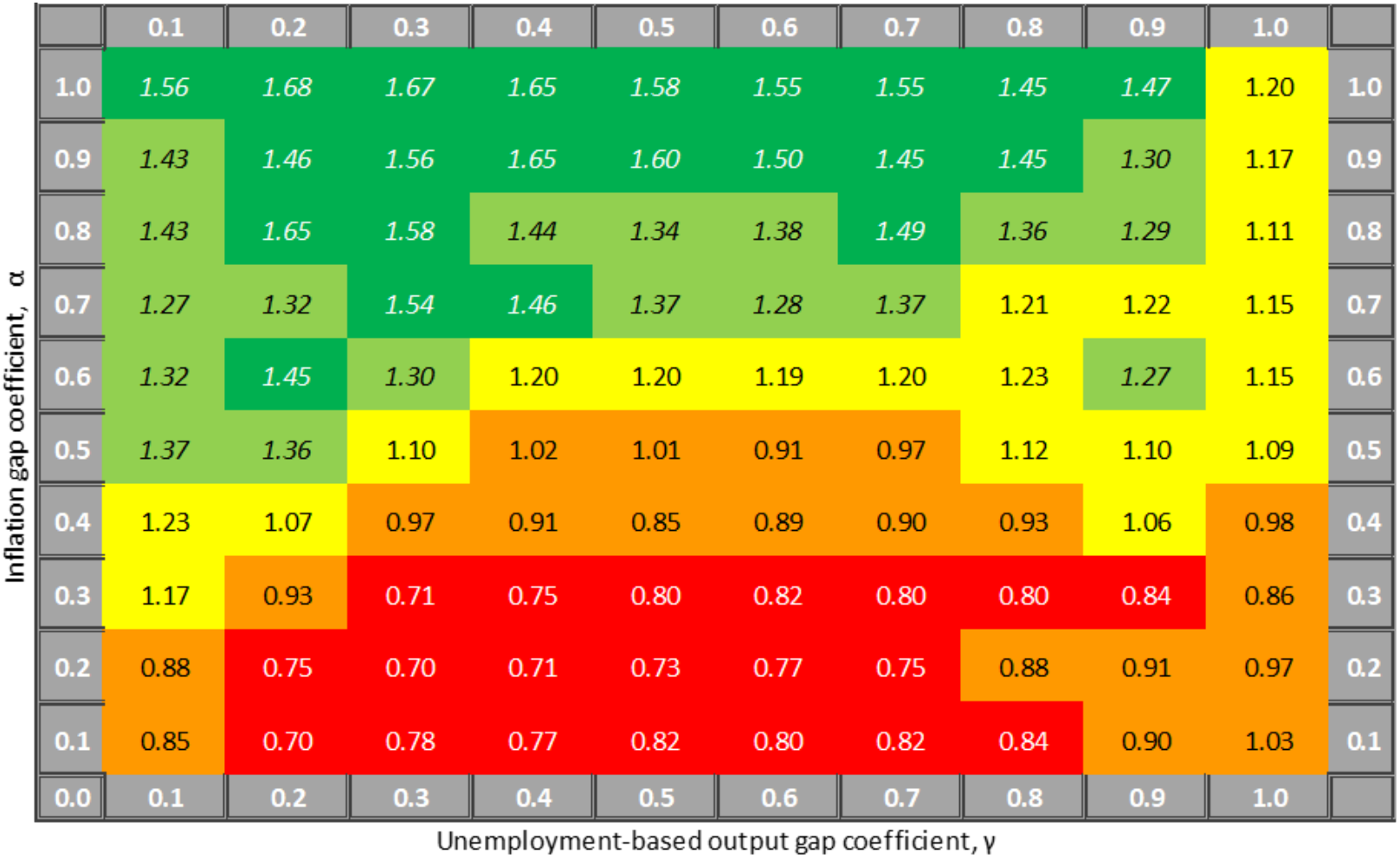
Loss Ratios: R*=Trend Growth + Bluebook, π*=Time-Varying, Output Gap

α \ γ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1.0	1.57	1.74	1.97	2.07	2.19	2.19	1.99	1.88	1.73	1.52
0.9	1.45	1.56	1.81	2.06	2.13	2.18	1.95	1.92	1.75	1.41
0.8	1.52	1.66	1.79	2.06	1.94	1.91	1.89	1.92	1.69	1.36
0.7	1.33	1.37	1.64	2.02	1.94	1.84	1.98	1.79	1.52	1.42
0.6	1.36	1.48	1.58	1.79	1.76	1.81	1.90	1.63	1.57	1.40
0.5	1.46	1.47	1.65	1.68	1.74	1.53	1.34	1.29	1.30	1.17
0.4	1.32	1.31	1.52	1.46	1.45	1.35	1.32	1.29	1.28	1.15
0.3	1.36	1.28	1.22	1.32	1.45	1.36	1.26	1.23	1.29	1.20
0.2	1.01	0.96	0.91	1.06	1.16	1.40	1.26	1.19	1.21	1.06
0.1	0.90	0.92	0.85	1.02	1.14	1.14	1.06	1.04	1.02	1.04

Loss Ratios: R*=Trend Growth + Bluebook, π*=Time-Varying, Output Gap

	Inflation gap/Output gap Rules	High response/Low response Rules	Higher quadrant/Lower quadrant Rules
Equal Weights on Inflation and Unemployment Loss. Threshold = 2%			
Policy Lag = 6 quarters (Average Loss=1.50)	1.34***	1.30***	1.69***
Policy Lag = 4 quarters	1.29***	1.40***	1.72***
Policy Lag = 8 quarters	1.53***	1.19**	1.79***
Equal weights on Inflation and Unemployment Loss. Policy Lag = 6 quarters			
Threshold = 2.5%	1.42***	1.52***	2.15***
Threshold = 1.5%	1.14**	1.14**	1.30***
Threshold = 2%. Policy Lag = 6 quarters			
1.25:0.75 Inflation and Unemployment Loss Weights	1.49***	1.32***	1.89***
1.5:0.5 Inflation and Unemployment Loss Weights	1.63***	1.33***	2.07***
0.75:1.25 Inflation and Unemployment Loss Weights	1.17**	1.28***	1.46***
0.5:1.5 Inflation and Unemployment Loss Weights	0.97	1.26***	1.21***

Loss Ratios: R*=Trend Growth + Bluebook, π*=Time-Varying, Unemployment Gap



α \ γ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1.0	1.56	1.68	1.67	1.65	1.58	1.55	1.55	1.45	1.47	1.20
0.9	1.43	1.46	1.56	1.65	1.60	1.50	1.45	1.45	1.30	1.17
0.8	1.43	1.65	1.58	1.44	1.34	1.38	1.49	1.36	1.29	1.11
0.7	1.27	1.32	1.54	1.46	1.37	1.28	1.37	1.21	1.22	1.15
0.6	1.32	1.45	1.30	1.20	1.20	1.19	1.20	1.23	1.27	1.15
0.5	1.37	1.36	1.10	1.02	1.01	0.91	0.97	1.12	1.10	1.09
0.4	1.23	1.07	0.97	0.91	0.85	0.89	0.90	0.93	1.06	0.98
0.3	1.17	0.93	0.71	0.75	0.80	0.82	0.80	0.80	0.84	0.86
0.2	0.88	0.75	0.70	0.71	0.73	0.77	0.75	0.88	0.91	0.97
0.1	0.85	0.70	0.78	0.77	0.82	0.80	0.82	0.84	0.90	1.03
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Loss Ratios: R*=Trend Growth + Bluebook, π*=Time-Varying, Unemployment Gap

	Inflation gap/Output gap Rules	High response/Low response Rules	Higher quadrant/Lower quadrant Rules
Equal Weights on Inflation and Unemployment Loss. Threshold = 2%			
Policy Lag = 6 quarters (Average Loss=1.15)	1.47***	1.30***	1.90***
Policy Lag = 4 quarters	1.34***	1.36***	1.80***
Policy Lag = 8 quarters	1.70***	1.19**	2.05***
Equal weights on Inflation and Unemployment Loss. Policy Lag = 6 quarters			
Threshold = 2.5%	1.41***	1.28***	1.72***
Threshold = 1.5%	1.30***	1.19**	1.62***
Threshold = 2%. Policy Lag = 6 quarters			
1.25:0.75 Inflation and Unemployment Loss Weights	1.63***	1.29***	2.10***
1.5:0.5 Inflation and Unemployment Loss Weights	1.76***	1.29***	2.27***
0.75:1.25 Inflation and Unemployment Loss Weights	1.30***	1.30***	1.67***
0.5:1.5 Inflation and Unemployment Loss Weights	1.10*	1.29***	1.42***

Perspectives

- Better Performance with Inflation Gap Tilting Rules
- Theory
  - Woodford (2003)
    - Optimal Taylor Rule Depends on All Parameters
    - Particular Specification (Page 531)
    - Coefficient on π > Coefficient on y in Taylor Rule *iff*
      - Coefficient on Expected π > Coefficient on y in NKPC
  - Accords with Mavroeidis, Plagborg-Moller and Stock (2014)
    - Survey of NKPC Estimates

Perspectives

- Laubach and Williams (2015)
  - Uncertainty in Measuring R*
  - Intercept Changes One-for-One with Changes in R*
  - Strong Response to Inflation to Reduce Influence of Intercept

Perspectives

- Simulation
  - Smets and Wouters (2007)
    - Optimal α in “Plausible” Range
    - Optimal α in Taylor (1999) and CEE (2005) too Large
- Calculate Loss Functions for Policy Rules

$$Loss = Var(\pi) + Var\,(\mathrm{y}) + Var(\Delta i)$$

  - α and γ between 0.1 and 1.0
  - Equal Weight on Variance of π, y, and Δi in Loss Function
- Lower Loss with $\alpha > \gamma$ in Policy Rule

Smets and Wouters (2007) Model

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	
1	*29.97*	*29.45*	*29.40*	*29.76*	*30.46*	*31.45*	*32.69*	*34.15*	35.80	37.61	1
0.9	*29.94*	*29.48*	*29.58*	*30.14*	*31.08*	*32.36*	*33.91*	35.70	37.68	39.84	0.9
0.8	*29.95*	*29.60*	*29.89*	*30.72*	*32.00*	*33.64*	35.59	37.79	40.20	42.78	0.8
0.7	*30.03*	*29.83*	*30.41*	*31.62*	*33.34*	*35.47*	37.94	40.67	43.62	46.73	0.7
0.6	*30.23*	*30.27*	*31.28*	*33.02*	*35.36*	38.16	41.31	44.74	48.38	52.18	0.6
0.5	*30.62*	*31.07*	*32.72*	*35.27*	38.49	42.22	46.32	50.68	55.23	59.90	0.5
0.4	*31.38*	*32.56*	*35.26*	39.05	43.59	48.66	54.07	59.69	65.44	71.23	0.4
0.3	*32.95*	35.51	40.06	45.87	52.45	59.49	66.76	74.10	81.41	88.62	0.3
0.2	36.69	42.21	50.23	59.51	69.35	79.32	89.17	98.76	107.99	116.84	0.2
0.1	48.82	61.39	76.24	91.45	106.16	120.02	132.92	144.85	155.85	165.99	0.1
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	

Inflation gap coefficient, α

Output gap coefficient, γ

FRB-US Model

- Tetlow (2015)
  - Optimal (Loss Minimizing) Taylor Rule
  - $Loss = \sum_{t=0}^{T} 0.99^t((\pi_t - \pi^*)^2 + (u_t - u^*)^2 + (\Delta i_t)^2)$
  - Studied 46 Vintages of Model Between 1996 and 2007
  - $\gamma > \alpha$ between 2000 and 2007
  - Opposite Result from Other Models

FRB-US Model

- Current Vintage of FRB-US Model
  - Calculate Loss Functions with α and γ between 0 and 1
  - Zero and No Zero Lower Bound
  - Fixed and Time-Varying Equilibrium Real Interest Rate

FRB-US Model: Zero bound on the nominal interest rate and R*=2%

Inflation gap coefficient, α	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
1	70.54	68.39	66.60	65.14	63.97	63.05	62.36	61.88	61.57	61.44
0.9	70.04	67.86	66.05	64.58	63.40	62.49	61.80	61.33	61.04	60.92
0.8	69.57	67.36	65.52	64.04	62.85	61.95	61.27	*60.81*	*60.53*	*60.42*
0.7	69.13	66.88	65.02	63.52	62.33	61.43	*60.76*	*60.31*	*60.04*	*59.95*
0.6	68.72	66.42	64.53	63.02	61.83	60.93	*60.28*	*59.83*	*59.58*	*59.50*
0.5	68.34	65.99	64.08	62.55	61.36	*60.46*	*59.82*	*59.39*	*59.15*	*59.09*
0.4	67.99	65.59	63.65	62.10	*60.91*	*60.02*	*59.39*	*58.97*	*58.75*	*58.70*
0.3	67.67	65.22	63.25	61.69	*60.50*	*59.61*	*58.98*	*58.58*	*58.37*	*58.33*
0.2	67.39	64.88	62.88	61.31	*60.11*	*59.23*	*58.61*	*58.22*	*58.02*	*58.00*
0.1	67.14	64.58	62.54	60.96	*59.76*	*58.88*	*58.27*	*57.89*	*57.71*	*57.69*
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1

Output gap coefficient, γ

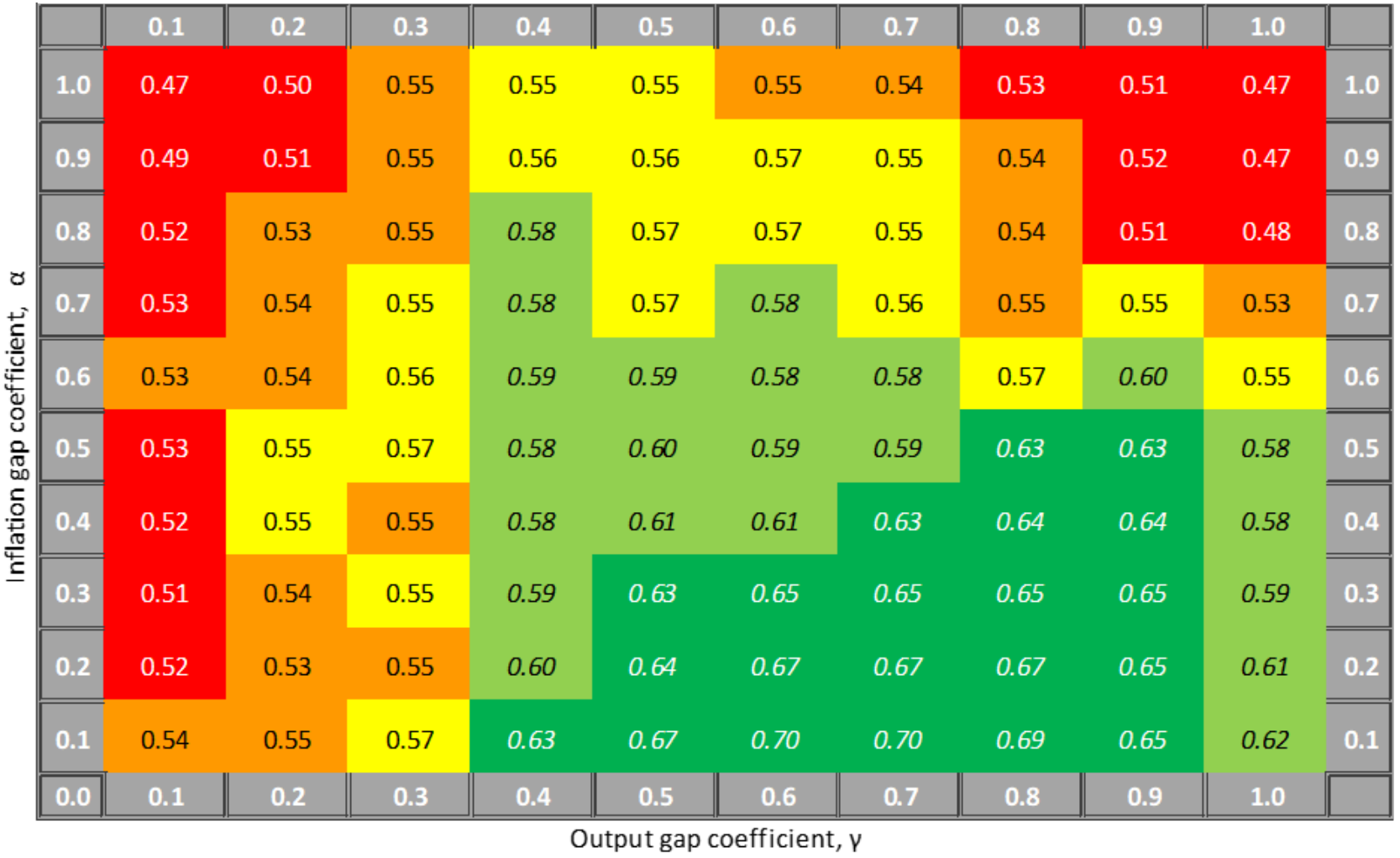
Optimal Policy Rules

- Rules that Maximize the Loss Ratios
  - Six Quarter Policy Lag
  - Two Percent Threshold for Deviations
  - Equal Weights on Inflation and Unemployment Gaps
- Coefficient on Inflation Gap α = 1.0 for All Specifications
- Coefficient on Output Gap γ Ranges from 0.2 to 1.0
  - Consistent with Smets and Wouters (2007) and Boehm and House (2014) Models
  - Not Consistent with FRB/US Model

Fed Policy

- Consider “Plausible” Rules with α and γ between 0 and 1
  - $\pi^* = R^* = 2$
- Low Deviations < 2.0
- High Deviations > 2.0
- Calculate Share of Time with Low Deviations
- Fed Policy Tilted Towards Output Gap Stabilization

Share of Time with Low Deviations - 100 policy rules, R*=Trend+Bluebook, π*=2, Output Gap



α \ γ	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1.0		0.47	0.50	0.55	0.55	0.55	0.55	0.54	0.53	0.51	0.47
0.9		0.49	0.51	0.55	0.56	0.56	0.57	0.55	0.54	0.52	0.47
0.8		0.52	0.53	0.55	*0.58*	0.57	0.57	0.55	0.54	0.51	0.48
0.7		0.53	0.54	0.55	*0.58*	0.57	*0.58*	0.56	0.55	0.55	0.53
0.6		0.53	0.54	0.56	*0.59*	*0.59*	*0.58*	*0.58*	0.57	*0.60*	0.55
0.5		0.53	0.55	0.57	*0.58*	*0.60*	*0.59*	*0.59*	*0.63*	*0.63*	*0.58*
0.4		0.52	0.55	0.55	*0.58*	*0.61*	*0.61*	*0.63*	*0.64*	*0.64*	*0.58*
0.3		0.51	0.54	0.55	*0.59*	*0.63*	*0.65*	*0.65*	*0.65*	*0.65*	*0.59*
0.2		0.52	0.53	0.55	*0.60*	*0.64*	*0.67*	*0.67*	*0.67*	*0.65*	*0.61*
0.1		0.54	0.55	0.57	*0.63*	*0.67*	*0.70*	*0.70*	*0.69*	*0.65*	*0.62*
0.0											

Conclusions

- Monetary Policy Evaluation with Taylor Rules
  - We Propose Outcomes-Based Measure of Rules
  - Rules Consistent with Constrained Discretion
- Rules that Produce Better Results
  - Higher Coefficient on Inflation than Output Gap
  - Large Coefficients on Both Gaps
  - Best Rules have Inflation Gap Tilting and Large Coefficients
- Accords with Theory and Model Simulations
- The Fed Should “Constrain” Constrained Discretion

Implementation

- Policy Rule Legislation
  - Fed Should Choose Inflation Gap Tilting Rule
  - Coefficient of 1.0 on Inflation Gap and 0.5 on Output Gap
- Monetary Policy Reports for 2017 and 2018
  - Taylor Rules with R* = 2 and Unemployment Gap
  - Taylor (1993) Balanced and Yellen (2012) Output Gap Tilting
- Add Inflation Gap Tilting Rule to Monetary Policy Report
  - Use Output Gap and $\pi^* = 2$
  - Choice of R*