Econometric Design, Evaluation and Implementation of Monetary Policy

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2019 Africa Meeting of the Econometric Society
Bank Al-Maghrib
Rabat, Morocco
July 11, 2019
4:00 pm - 5:30 pm

Outline

- Models started in “path-space”
- Evolved to “rules-space” with a major paradigm shift
- Central bank models followed
  - policy and performance improved
- Then retrogression, at least in large parts of world
  - Performance deteriorated: global financial crisis, slow recovery
- Lesson: need to get back to rules-based policy
- Now a revival of rules-based policy research
  - Explanations
  - Key Features
  - International
- Implications for econometric research

When it all began

- First macro-econometric model built by Jan Tinbergen in 1936. Developed to answer a key monetary policy question:
  - Should the Dutch guilder be devalued, and would that stimulate the economy?
- The paper was prepared for the October 24, 1936 meeting of the Dutch Economics and Statistics Association. The paper itself was already available in September.
- On 27 September, the Netherlands abandoned the gold parity of the guilder and the currency was devalued by about 20%.

Policy Analysis with Models in "Path Space"

- Instruments and Targets
- Different scenarios or paths for policy instruments
  - Exchange rate, government purchases,…
- Observe impact on target variables
- Cowles Commission and Foundation–Chicago, Yale
  - Need estimates of structural models, not reduced forms
  - Simultaneous equation estimation (FIML LIML, TSLS)
  - Model simulations: monetarist v Keynesian debate
  - Policy question addressed in this mode: Lawrence Klein
- Models introduced in central banks for policy in 1960s
  - MPS model at Fed

4 Decades Ago: Major Paradigm Shift

- Policy analysis moved from “Path-Space” to “Rules Space”
- Many antecedents:
  - Time series models, dynamic stochastic, control theory, A.W. Phillips
  - Realization that Friedman’s arguments about rules v discretion applied to feedback rules
  - Joint estimation and control led to rules
  - Rational expectations: Lucas critique, time inconsistency
  - Introduction of sticky prices and RE made approach amenable for monetary policy
- Some Papers:
  - Anderson & Taylor (1976), Lucas (1976), Kydland & Prescott (1977), Taylor (1979)

Paradigm Shift at Central Banks

- Change evident in Brookings Model Comparison project.
  - Bryant, Hooper and Mann (1993)
  - previous model-comparison exercises looked at *one-time changes* in instruments; this one emphasized *policy rules*.
  - Computational and conceptual barriers were overcome
- In early 1990s, MPS model was replaced by FRB/US at Fed.
  - Brayton and Tinsley (1996) "Expectations of private sectors are explicit; these expectations…constitute a major transmission channel of policy." Also Brayton, Levin, Tryon, and Williams (1997).
  - Similar story at many other central banks

From Complex Models to Simple Rules

- Models were complex so, at first, rules were complex.
  - Serious doubts about the framework.
- Could simple rules consistent with the research be found?
- Yes! Interest rate should react to real GDP & inflation
  - Set inflation target to 2% based on measurement bias and ZLB
- The research showed that the
  - interest rate reaction to inflation should be greater than 1; chose 1.5.
  - interest rate reaction to GDP gap should be greater than 0; chose 0.5
  - interest rate reaction to other variables should be small; chose 0.
- Equilibrium interest rate: 2% real and 4% nominal.
- The bottom line: set the interest rate equal to 1.5 times the inflation rate, plus .5 times the GDP gap, plus 1.
- Not a curve fitting exercise with instruments of policy were regressed on variables. Derived from econometric models.
- Same approach worked internationally

Surprising Similarities Across Econometric Models in this Paradigm

Consider the Pre-Crisis Models in Macro Model Data Base

1. Small Calibrated Models

Rotemberg, Woodford (1997)
Levin, Wieland, Williams (2003)
Clarida, Gali, Gertler (1999)
Clarida, Gali, Gertler 2-Country (2002)
McCallum, Nelson (1999)
Ireland (2004)
Bernanke, Gertler, Gilchrist (1999)
Gali, Monacelli (2005)

2. Estimated US Models

Fuhrer, Moore (1995)
Orphanides, Wieland (1998)
FRB-US model linearized as in Levin, Wieland, Williams (2003)
FRB-US model 08 linearized by Brayton and Laubach (2008)
FRB-US model 08 mixed expectations, linearized by Laubach (2008)
Smets, Wouters (2007)
CEE/ACEL Altig, Christiano, Eichenbaum, Linde (2004)
New Fed US Model by Edge, Kiley, Laforte (2007)
Rudebusch, Svensson (1999)
Orphanides (2003b)
IMF projection model by Carabenciov et al. (2008)
De Graeve (2008)
Christensen, Dib (2008)
Iacoviello (2005)

3. Estimated Euro Area Models

Coenen, Wieland (2005) (ta: Taylor-staggered contracts)
Coenen, Wieland (2005) (fm: Fuhrer-Moore staggered contracts)
ECB Area Wide model linearized as in Dieppe et al. (2005)
Smets, Wouters (2003)
Euro Area Model of Sveriges Riksbank (Adolfson et al. 2007)
Euro Area Model of the DG-ECFIN EU (Ratto et al. 2009)
ECB New-Area Wide Model of Coenen, McAdam, Straub (2008)

4. Estimated Small Open-Economy Models

RAMSES Model of Sveriges Riskbank, Adolfson et al.(2008b)
Model of the Chilean economy by Medina, Soto (2007)
CA_ToTEM10--ToTEM model of Canada based on Murchison and Rennison (2006)

5. Estimated/Calibrated Multi-Country Models

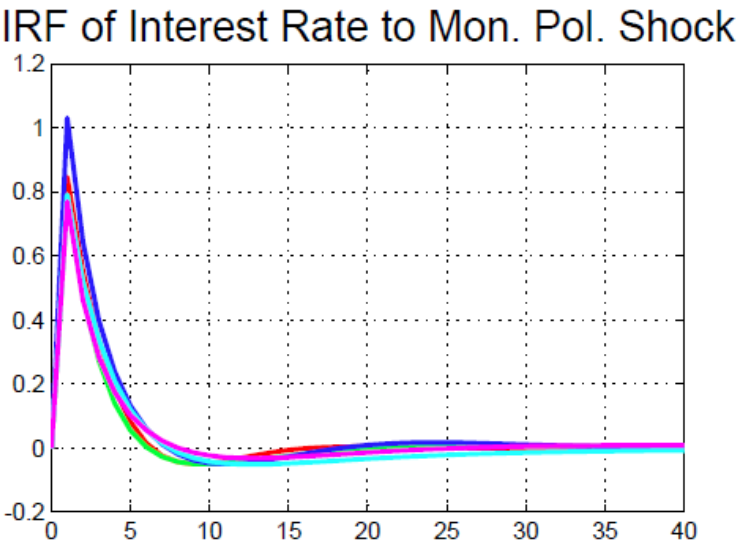
Taylor (1993a) model of G7 economies
Coenen,Wieland (2002, 2003) G3 economies
IMF model of euro area by Laxton, Pesenti (2003)
FRB-SIGMA model by Erceg, Gust, Guerrieri (2008)

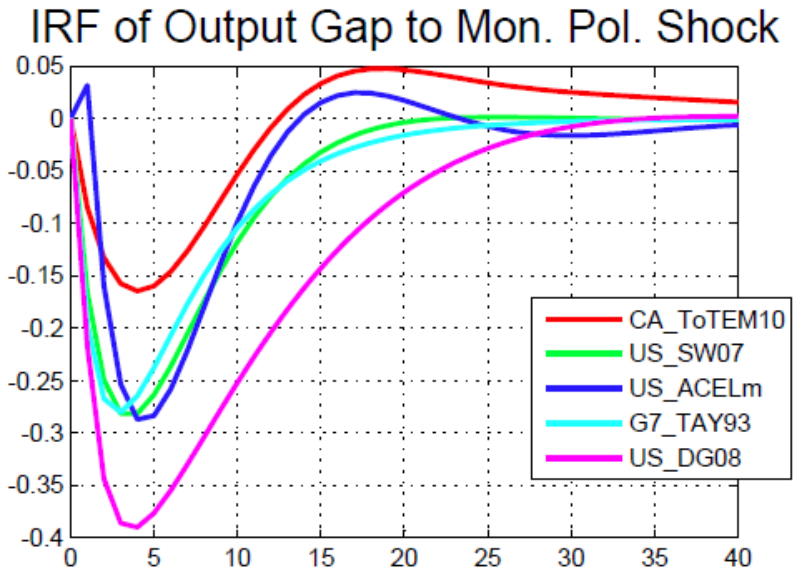
Compare Impact of Monetary Shocks in this Modelling Framework

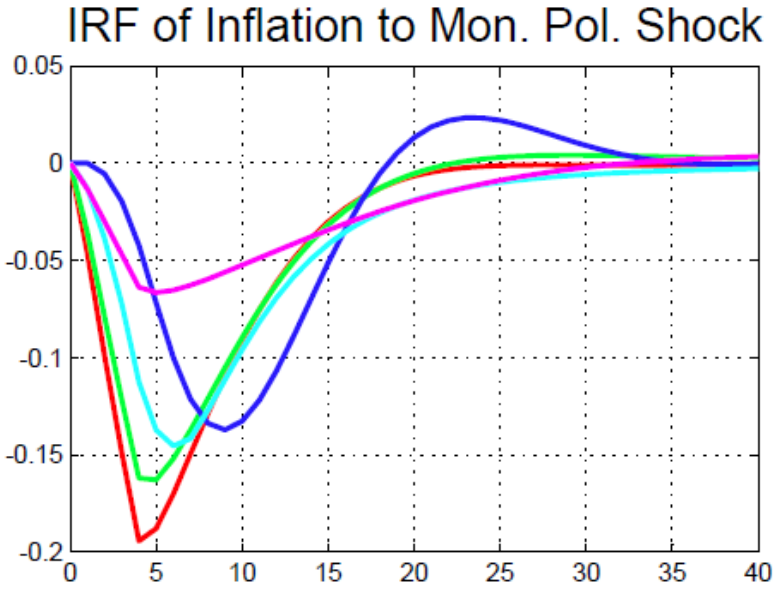
SW Rule

$$i_t = 0.81 i_{t-1} + 0.39 \pi_t + 0.97 y_t - 0.90 y_{t-1} + \varepsilon_t^i$$

Model Comparisons of Monetary Policy Impact in SW, CEE-ACEL, Taylor, DG, CA-ToTEM







Alleged Problems with the Framework

- Short term interest rate affects consumption and investment directly?
  - Textbook versus practical versions
- Assumed away financial frictions?
  - Econometric models focused on prices (rates of return) rather than quantities
  - But financial accelerator was there (De Graeve)
- Did not deal with zero lower bound?
  - 1% was the lower bound in early work in 1980s
  - Reifschneider-Williams (2000) method

The Framework Worked

- Central banks moved toward more transparent rules-based policies in 1980s, 1990s
  - including through a focus on price stability
- Detected by Clarida, Gali & Gertler, and confirmed by others
- Dramatic improvement compared with 1970s
- Mervyn King called it the NICE period
- Many emerging market countries joined
  - Including through Inflation Targeting
  - Performance improved & contributed to global stability

Inflation Targeting as Rules-Based Policy

"The inflation target is an efficient framework to conduct monetary policy. The issue then is how to operationalize this framework. When should monetary policy be tightened or loosened? The most traditional answer is the Taylor rule…."

-- Jose De Gregorio, Governor of the Central Bank of Chile (2007-2011) Quoted from "*How Latin America Weathered the Global Financial Crisis,*"

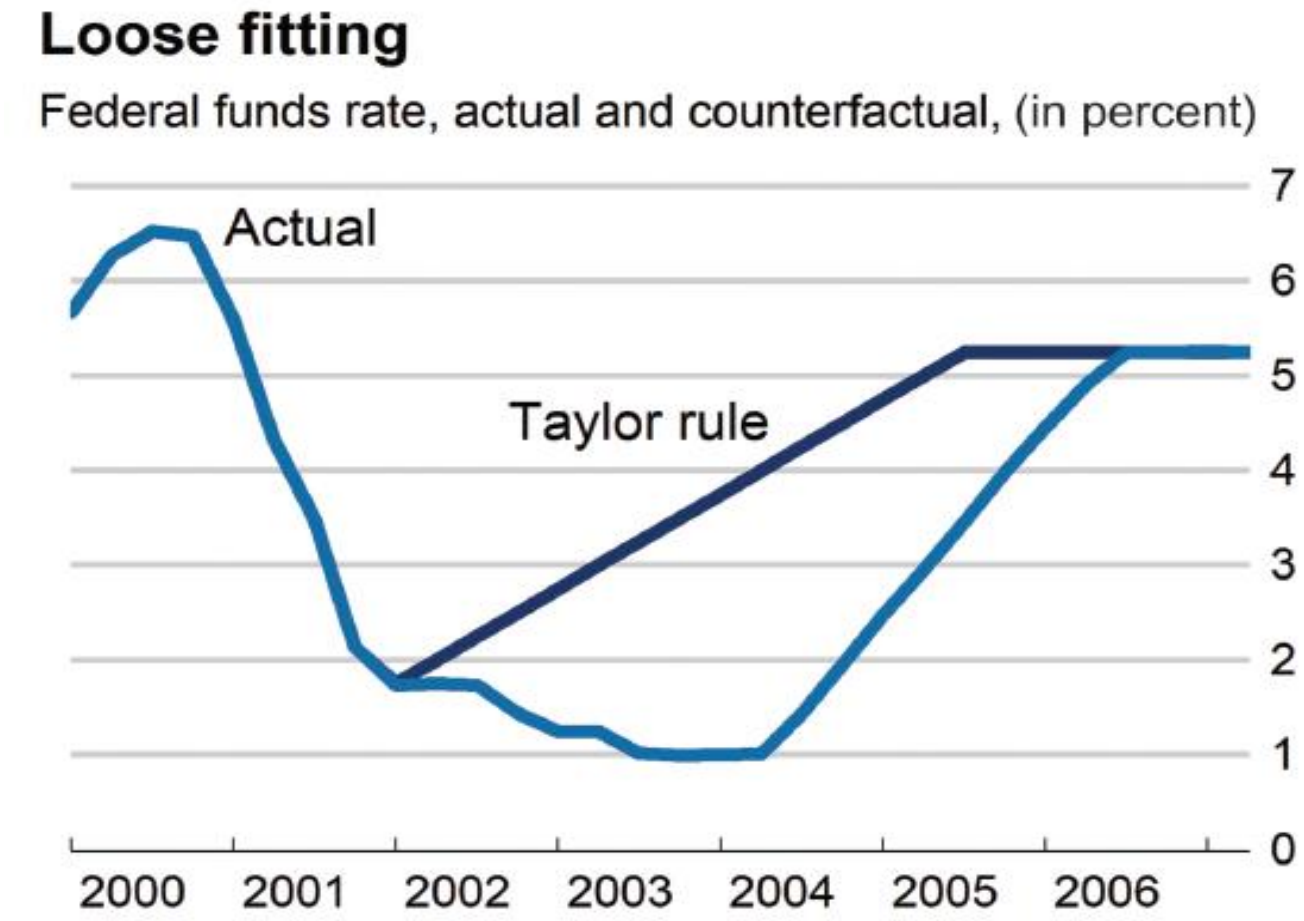
"The usual working assumption is a policy rule that associates the policy rate with the gap between projected and target inflation, and the output gap. "

-- Central Bank of Chile, *Monetary Policy in an Inflation Targeting Framework* (2007)

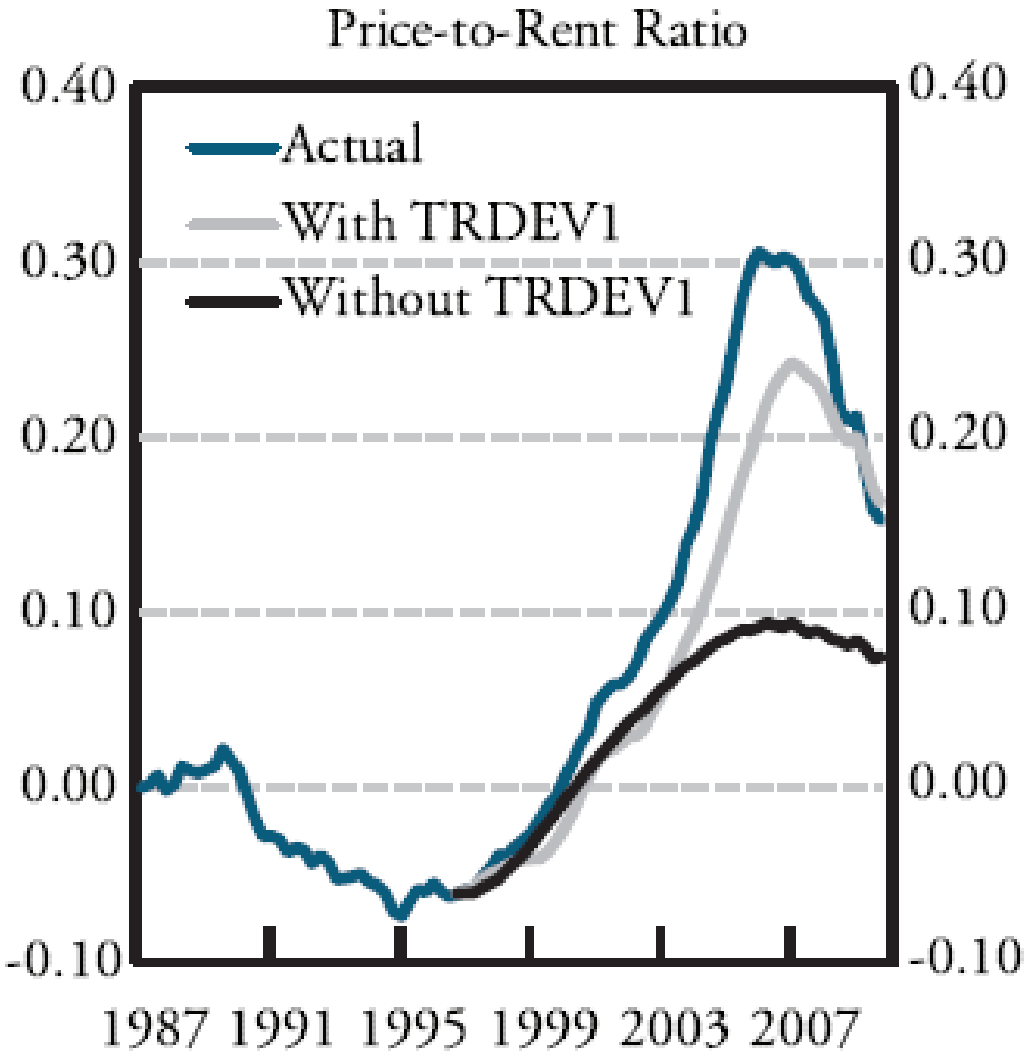
But then a Deviation

- Evidence of monetary policy swinging away from rule-like policies
- Detected by many (Taylor, Kahn, Ahrend, Lane)
  - More than a decade ago—*before* the financial crisis—too low for too long
  - Supported by recent work: Jordà, Schularick, A. Taylor (2015)
- Econometric and historical evidence of effects
  - Econometrics: Nikolsko-Rzhevskyy, Papell, Prodan
  - History: Meltzer
- "Global Great Deviation" Hofmann & Bogdanova
  - Policy spillovers: Siklos-Neuenkirch (2014), Gray (2013)

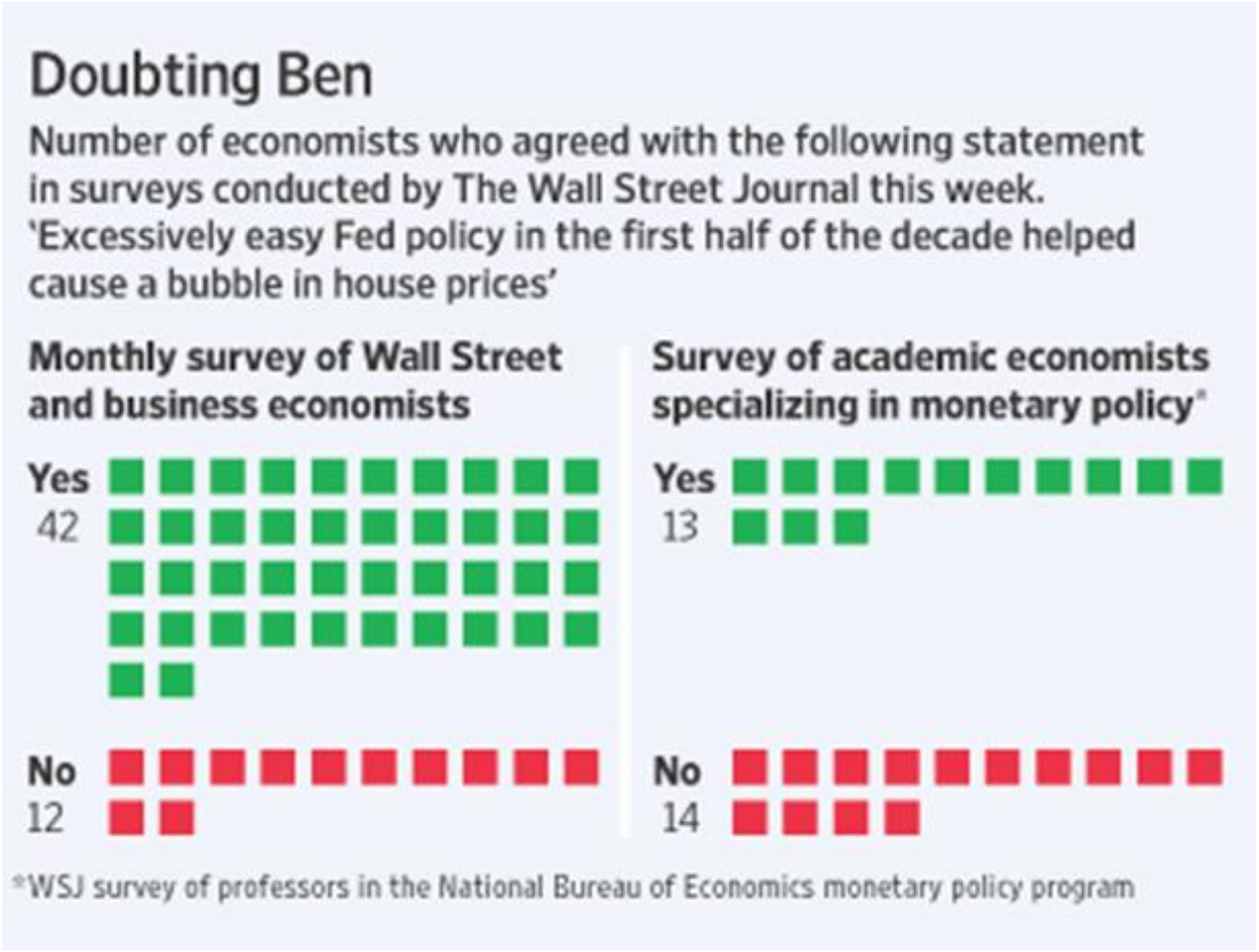
Chart from *The Economist*, October 18, 2007



Taylor (2007)

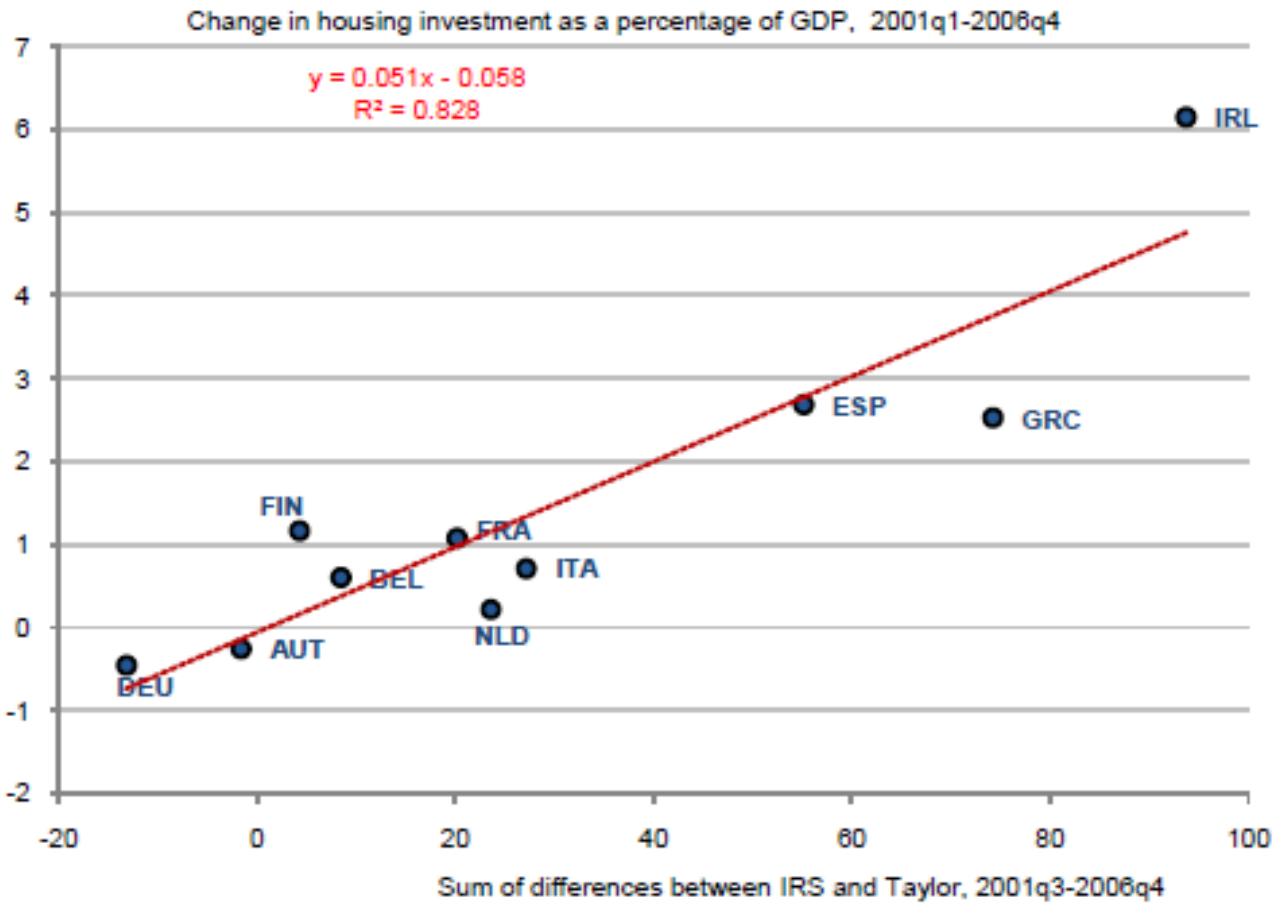


Source: George Kahn



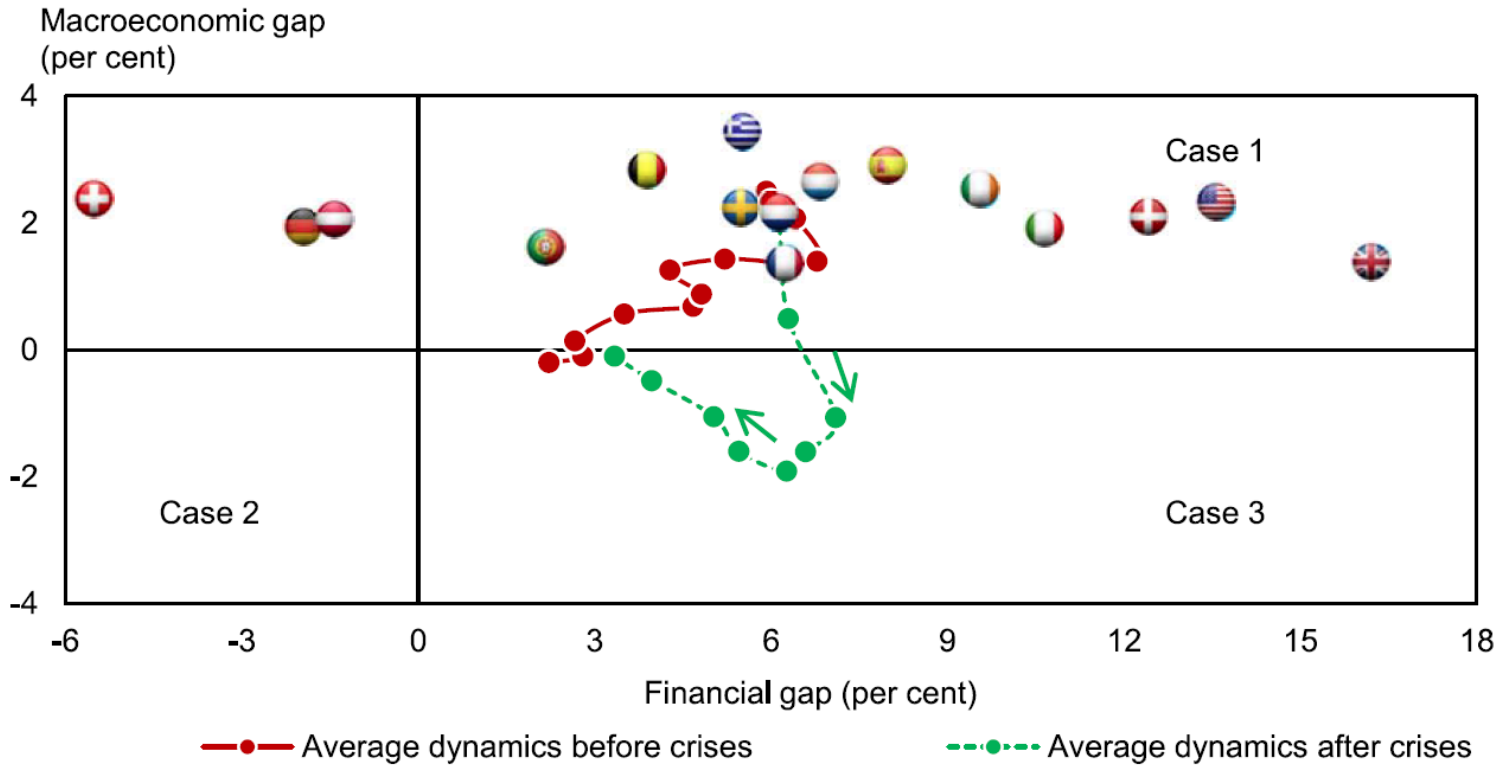
Hilsenrath (2010)

Housing investment versus differences between IRS and Taylor

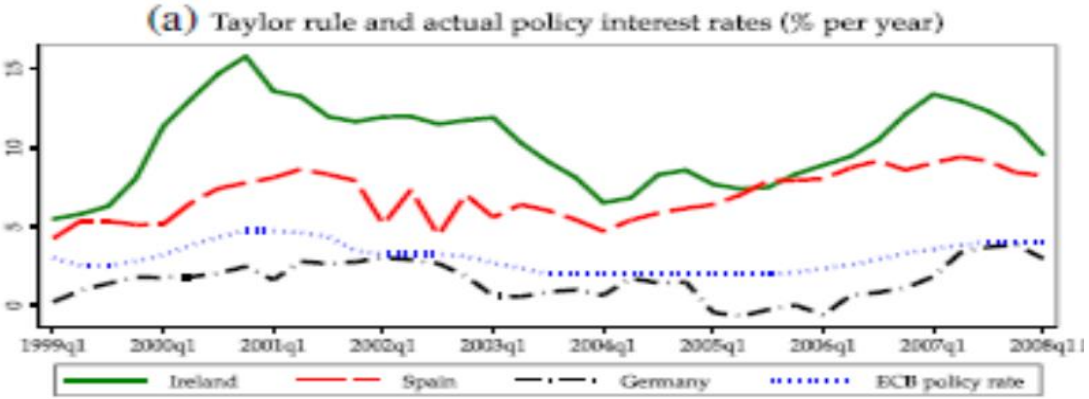


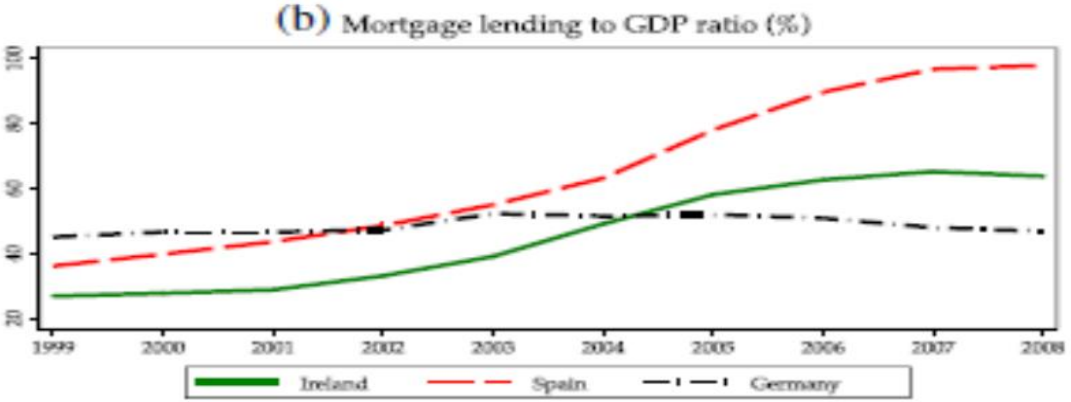
Source: Ahrend, Cournede, and Price (OECD)

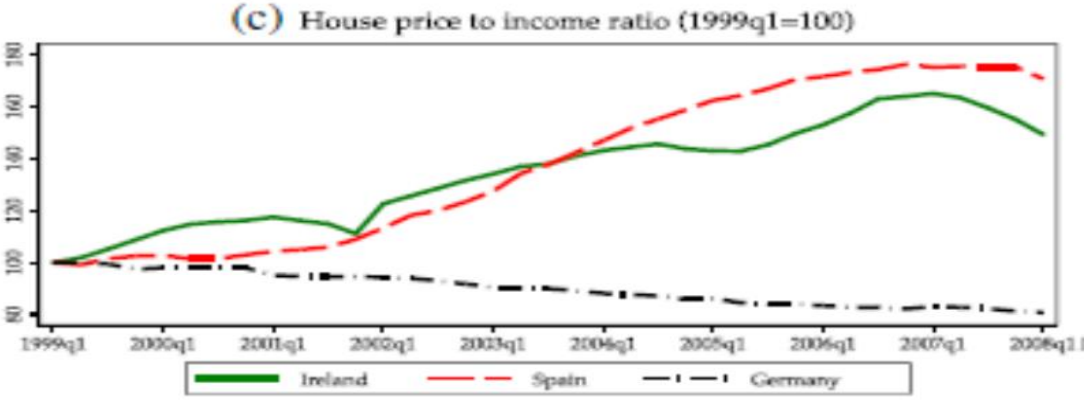
From Timothy Lane (2016)



Note: Data for selected advanced economies that faced a banking crisis in 2007–08. Vertical axis shows economic gap, measued as average of estimated output gap and inflation deviation from target. Horizontal axis shows financial gap, measured as average of deviations in the credit-to-GDP ratio and real house prices from historical trends.
Sources: International Monetary Fund staff estimates. Based on presentation by Giovanni Dell'Ariccia at Bank of Korea-IMF conference on *Leverage in Asia*, December 2015.







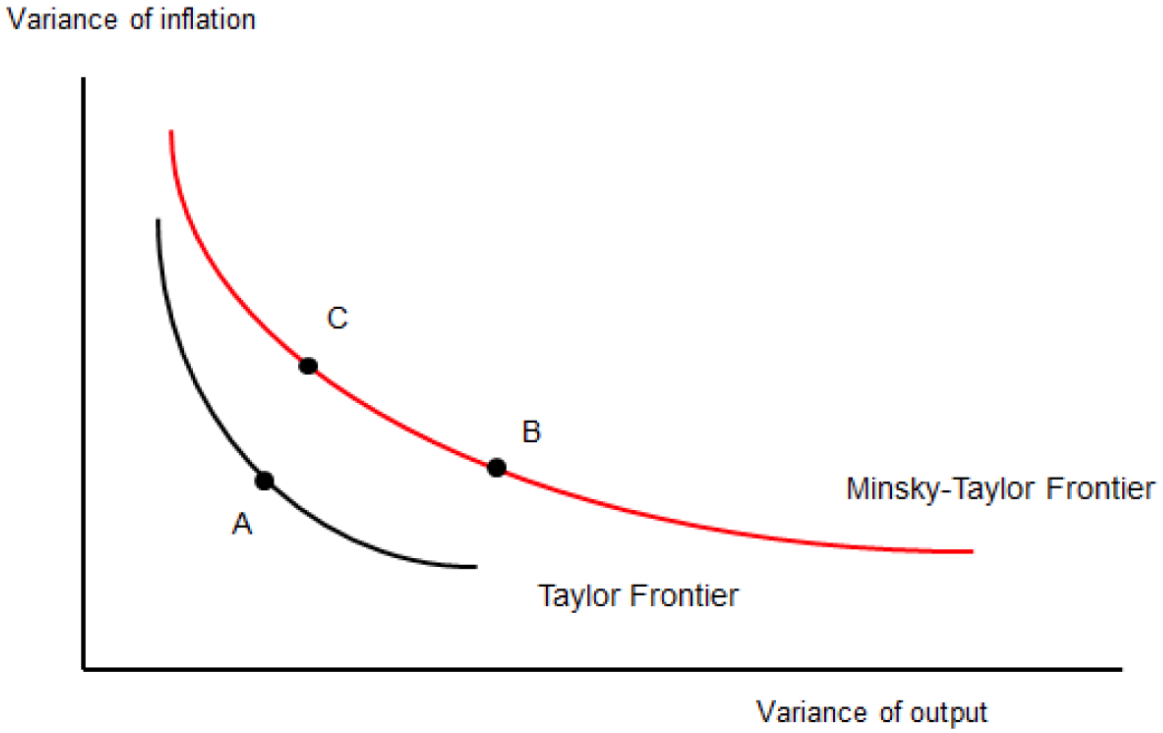
Source: Jordà, Òscar, Moritz Schularick, Alan M. Taylor (2015) r

And the Deviation Didn't Work

- The end of NICE
  - Great Recession
  - Not-So-Great Recovery
  - Concerns about international spillover effects
  - Small open economies impacted
- So there was a lesson:
- Return to monetary policy rules or strategies

Of course, there were other views

Chart from Carney (2013), also King (2012)



Now a Revival of Research on Monetary Policy Rules

- Ben Bernanke, Michael Kiley and John Roberts (2019) examine ten different monetary policy rules using the FRB/US model
- Thomas Mertens and John Williams (2019) evaluate different monetary rules with new Keynesian model; presented results in May.
- Eric Sims and Cynthia Wu (2019) evaluate different monetary policy rules with new structural model; presented results in June.

Example: 10 policy rules studied by Bernanke, Kiley, Roberts (2019)

$$i_t^{Tay} = r^* + \pi_t + 0.5(\pi_t - \pi^*) + \hat{y}_t$$

Taylor rule

$$i_t^{iTay} = \rho i_{t-1} + (1 - \rho)[r^* + \pi_t + 0.5(\pi_t - \pi^*) + \hat{y}_t]$$

$$i_t^{FPLT} = r^* + \pi_t + 0.5(\pi_t - \pi^*) + \hat{y}_t + P_t$$

$$i_t^{iFPLT} = \rho i_{t-1} + (1 - \rho)[r^* + \pi_t + 0.5(\pi_t - \pi^*) + \hat{y}_t + P_t]$$

$$i_t^{FTPLT} = \rho i_{t-1} + (1 - \rho)[r^* + \pi_t + 0.5(\pi_t - \pi^*) + \hat{y}_t + \alpha TP_t]$$

$$TP_t = \sum_{j=t1}^{m}(\pi_j - \pi^*)$$

$$i_t = \max\{0, i_t^{Tay} - \sum_{j=t1}^{t-1}(i_j - i_j^{Tay})\}$$

Reifschneider-Williams

$$i_t^{KR} = i_{t-1}^{KR} + \alpha[(\pi_t - \pi^*) + \hat{y}_t]$$

Plus 3 TPLT rules, which are like iTay except for an ELB threshold

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- Whole new section on monetary policy rules in last 4 of Fed's *Monetary Policy Reports* (2017-19) with five different policy rules presented & compared with actual policy.
  - Cochrane, Taylor and Wieland (2019) and Eberly, Stock and Wright (2019) evaluate monetary policy rules in the *Report*

Publications: Rules Are In

Monetary Policy Reports, Fed (2019)

A. Monetary policy rules

Taylor (1993) rule	$R_t^{T93} = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) + (u_t^{LR} - u_t)$
Balanced-approach rule	$R_t^{BA} = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) + 2(u_t^{LR} - u_t)$
Taylor (1993) rule, adjusted	$R_t^{T93adj} = maximum\{R_t^{T93} - Z_t, 0\}$
Price-level rule	$R_t^{PL} = maximum\{r_t^{LR} + \pi_t + (u_t^{LR} - u_t) + 0.5(PLgap_t), 0\}$
First-difference rule	$R_t^{FD} = R_{t-1} + 0.5(\pi_t - \pi^{LR}) + (u_t^{LR} - u_t) - (u_{t-4}^{LR} - u_{t-4})$

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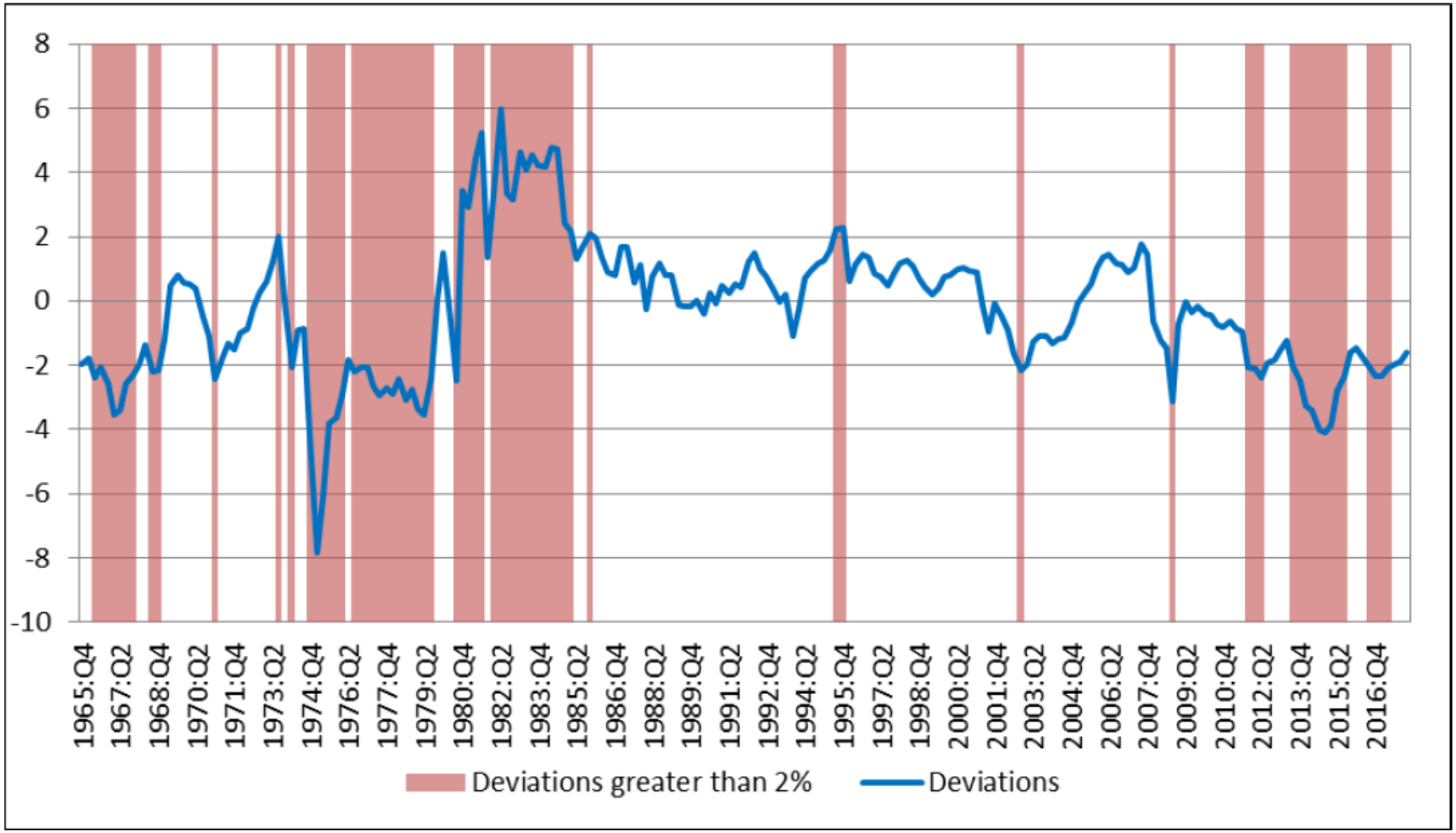
  - Cochrane, Taylor and Wieland (2019) and Eberly, Stock and Wright (2019) evaluate monetary policy rules in the *Report*
- New measures of discretion versus rules
  - Nikolsko-Rzhevskyy, Papell and Prodan (2018) compare policy rules with discretion historically using new econometric techniques

New Measures of Discretion

- Nikolsko-Rzhevskyy, Papell and Prodan define
  - Rule: specific policy rule for the interest rate
  - Discretion: deviation of actual interest rate from that rule.
- US economic performance was worse in periods of discretion (see time series chart)
- Calculations repeated for 400 rules of same form with φ_y and φ_π taking 20 different values between 0.1 & 2.0.
  - Discretion to Rules Loss Ratio: the average loss in high deviation periods divided by the average loss in low deviations periods.
  - Loss ratio is greater than one for all rules (see color chart)
  - "Inflation-tilting" rules result in better performance.
    - Fed's *Monetary Policy Report* should include such rules.

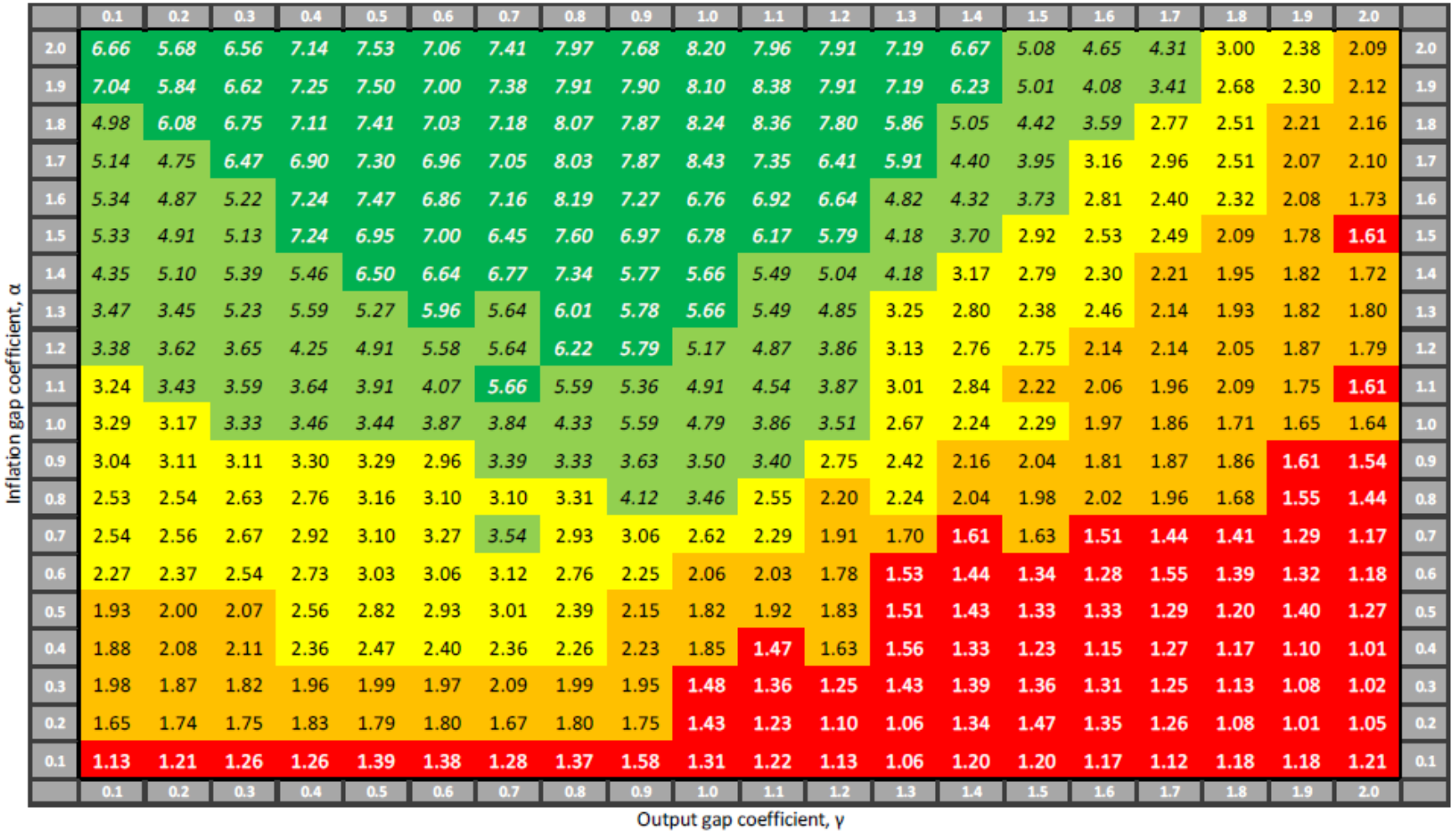
Figure 6. Deviations from the Original Taylor Rule



Source: Nikolsko-Rzhevskyy, Papell, and Prodan (2018)

Discretion to Rule Loss Ratios with Different Rules

Panel B: Inflation Gap α and Output Gap γ Coefficients Range [0,2]



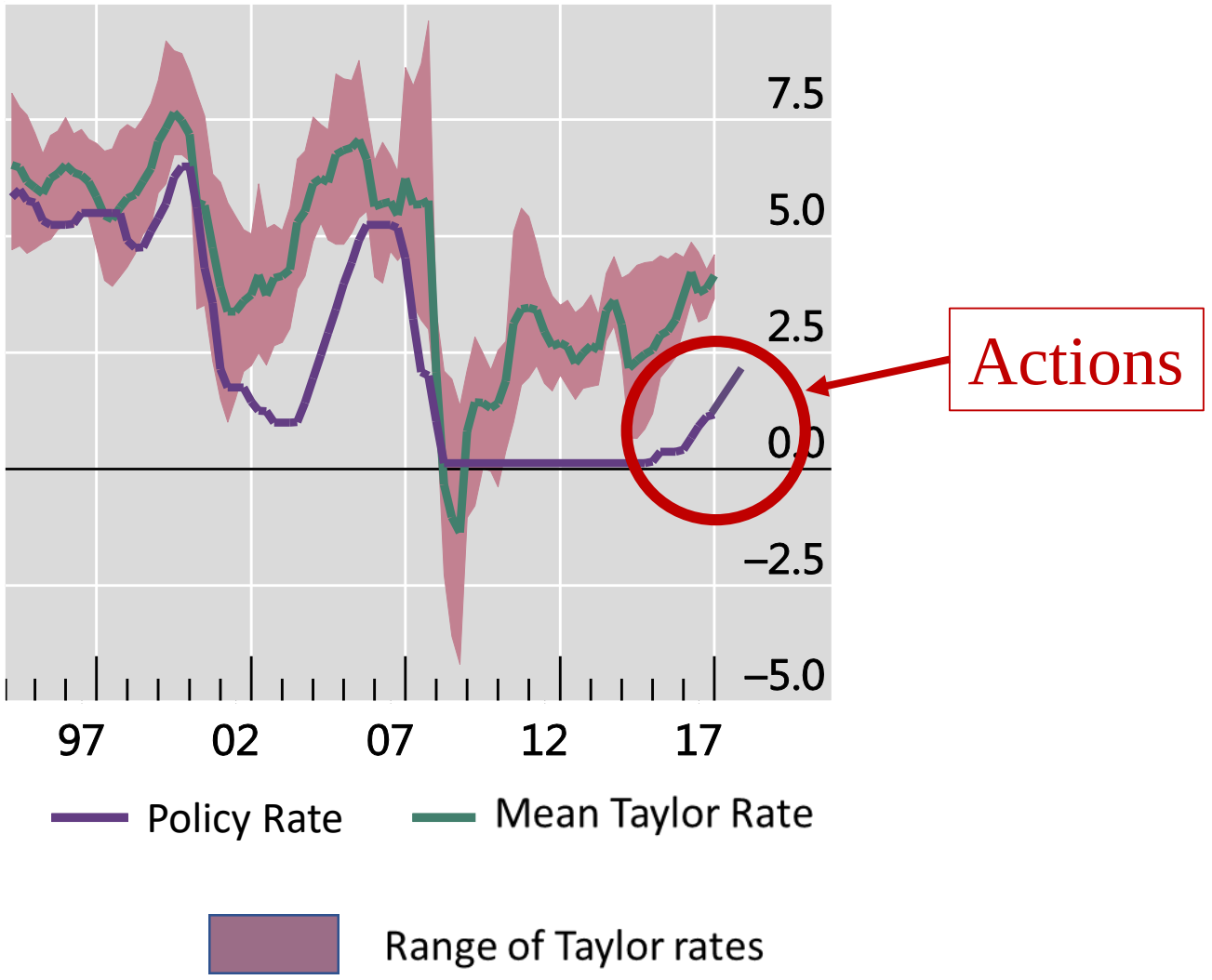
Inflation gap coefficient, α \ Output gap coefficient, γ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
2.0	6.66	5.68	6.56	7.14	7.53	7.06	7.41	7.97	7.68	8.20	7.96	7.91	7.19	6.67	5.08	4.65	4.31	3.00	2.38	2.09
1.9	7.04	5.84	6.62	7.25	7.50	7.00	7.38	7.91	7.90	8.10	8.38	7.91	7.19	6.23	5.01	4.08	3.41	2.68	2.30	2.12
1.8	4.98	6.08	6.75	7.11	7.41	7.03	7.18	8.07	7.87	8.24	8.36	7.80	5.86	5.05	4.42	3.59	2.77	2.51	2.21	2.16
1.7	5.14	4.75	6.47	6.90	7.30	6.96	7.05	8.03	7.87	8.43	7.35	6.41	5.91	4.40	3.95	3.16	2.96	2.51	2.07	2.10
1.6	5.34	4.87	5.22	7.24	7.47	6.86	7.16	8.19	7.27	6.76	6.92	6.64	4.82	4.32	3.73	2.81	2.40	2.32	2.08	1.73
1.5	5.33	4.91	5.13	7.24	6.95	7.00	6.45	7.60	6.97	6.78	6.17	5.79	4.18	3.70	2.92	2.53	2.49	2.09	1.78	1.61
1.4	4.35	5.10	5.39	5.46	6.50	6.64	6.77	7.34	5.77	5.66	5.49	5.04	4.18	3.17	2.79	2.30	2.21	1.95	1.82	1.72
1.3	3.47	3.45	5.23	5.59	5.27	5.96	5.64	6.01	5.78	5.66	5.49	4.85	3.25	2.80	2.38	2.46	2.14	1.93	1.82	1.80
1.2	3.38	3.62	3.65	4.25	4.91	5.58	5.64	6.22	5.79	5.17	4.87	3.86	3.13	2.76	2.75	2.14	2.14	2.05	1.87	1.79
1.1	3.24	3.43	3.59	3.64	3.91	4.07	5.66	5.59	5.36	4.91	4.54	3.87	3.01	2.84	2.22	2.06	1.96	2.09	1.75	1.61
1.0	3.29	3.17	3.33	3.46	3.44	3.87	3.84	4.33	5.59	4.79	3.86	3.51	2.67	2.24	2.29	1.97	1.86	1.71	1.65	1.64
0.9	3.04	3.11	3.11	3.30	3.29	2.96	3.39	3.33	3.63	3.50	3.40	2.75	2.42	2.16	2.04	1.81	1.87	1.86	1.61	1.54
0.8	2.53	2.54	2.63	2.76	3.16	3.10	3.10	3.31	4.12	3.46	2.55	2.20	2.24	2.04	1.98	2.02	1.96	1.68	1.55	1.44
0.7	2.54	2.56	2.67	2.92	3.10	3.27	3.54	2.93	3.06	2.62	2.29	1.91	1.70	1.61	1.63	1.51	1.44	1.41	1.29	1.17
0.6	2.27	2.37	2.54	2.73	3.03	3.06	3.12	2.76	2.25	2.06	2.03	1.78	1.53	1.44	1.34	1.28	1.55	1.39	1.32	1.18
0.5	1.93	2.00	2.07	2.56	2.82	2.93	3.01	2.39	2.15	1.82	1.92	1.83	1.51	1.43	1.33	1.33	1.29	1.20	1.40	1.27
0.4	1.88	2.08	2.11	2.36	2.47	2.40	2.36	2.26	2.23	1.85	1.47	1.63	1.56	1.33	1.23	1.15	1.27	1.17	1.10	1.01
0.3	1.98	1.87	1.82	1.96	1.99	1.97	2.09	1.99	1.95	1.48	1.36	1.25	1.43	1.39	1.36	1.31	1.25	1.13	1.08	1.02
0.2	1.65	1.74	1.75	1.83	1.79	1.80	1.67	1.80	1.75	1.43	1.23	1.10	1.06	1.34	1.47	1.35	1.26	1.08	1.01	1.05
0.1	1.13	1.21	1.26	1.26	1.39	1.38	1.28	1.37	1.58	1.31	1.22	1.13	1.06	1.20	1.20	1.17	1.12	1.18	1.18	1.21

Source: Nikolsko-Rzhevskyy, Papell, and Prodan (2018), Figure 8

Revival Also Seen in Actions and Statements

- Actions
  - Normalizing back towards rule-like policy
  - Most noticeable in 2017 and 2018
- Statements…

United States



Source: Bank for International Settlements, 2018

Statements

- Jan 18, 2017: Janet Yellen describes the Fed's strategy
  - When economy is weak…we lower short-term interest rates
  - When inflation too high… we increase interest rates
- Jan 19, 2017: Yellen compares strategy with the Taylor rule and other rules, and she explains the differences.
- Feb 11, 2017 : Stanley Fischer gives same message
- Feb 27 & Mar 1, 2018: In first testimony as Fed Chair, Jay Powell says that
  - "I find these rule prescriptions helpful."
- Emphasis on rules does not go unnoticed:
  - Larry Kudlow: "I think that's progress."
- Mar 8, 2018: Fed creates web site "Monetary Rules"
- Nov 27, 2018: Vice Chair Clarida "Economic research suggests that monetary policy should be 'data dependent.' …The seminal reference is Taylor (1993), "Discretion versus Policy Rules in Practice,"

What Explains the Current Revival?

- Especially considering the rise in 70s,80s,90s and fall in past 15 years
- Revealed preference:
  - Cecchetti & Schoenholtz (2019) found "The most frequently mentioned topic is the desirability of having a clear understanding of policymakers' reaction function."
  - Raghu Rajan: "what we need are monetary rules,"
  - Mario Draghi: "we would all clearly benefit from…improving communication over our reaction functions…"
- Need to improve monetary policy with concern about ELB
  - Calls for rules to deal with ELB and for their evaluation. Huge motivation, including Lilley & Rogoff (2019) & Bordo & Levin (2019)
- Disappointments with monetary policy leading to great recession with deviation from rules in the 2003-2005 "too low for too long" period
- Recognition that we need rules to evaluate QE
  - Brian Sack (2019), "'Talking more about the policy rules…is appropriate' to guide future bond purchase programs and improve their impact."
- Concern about Policy Rules Legislation in U.S. in 2017-2018
- Concerns about threats to independence

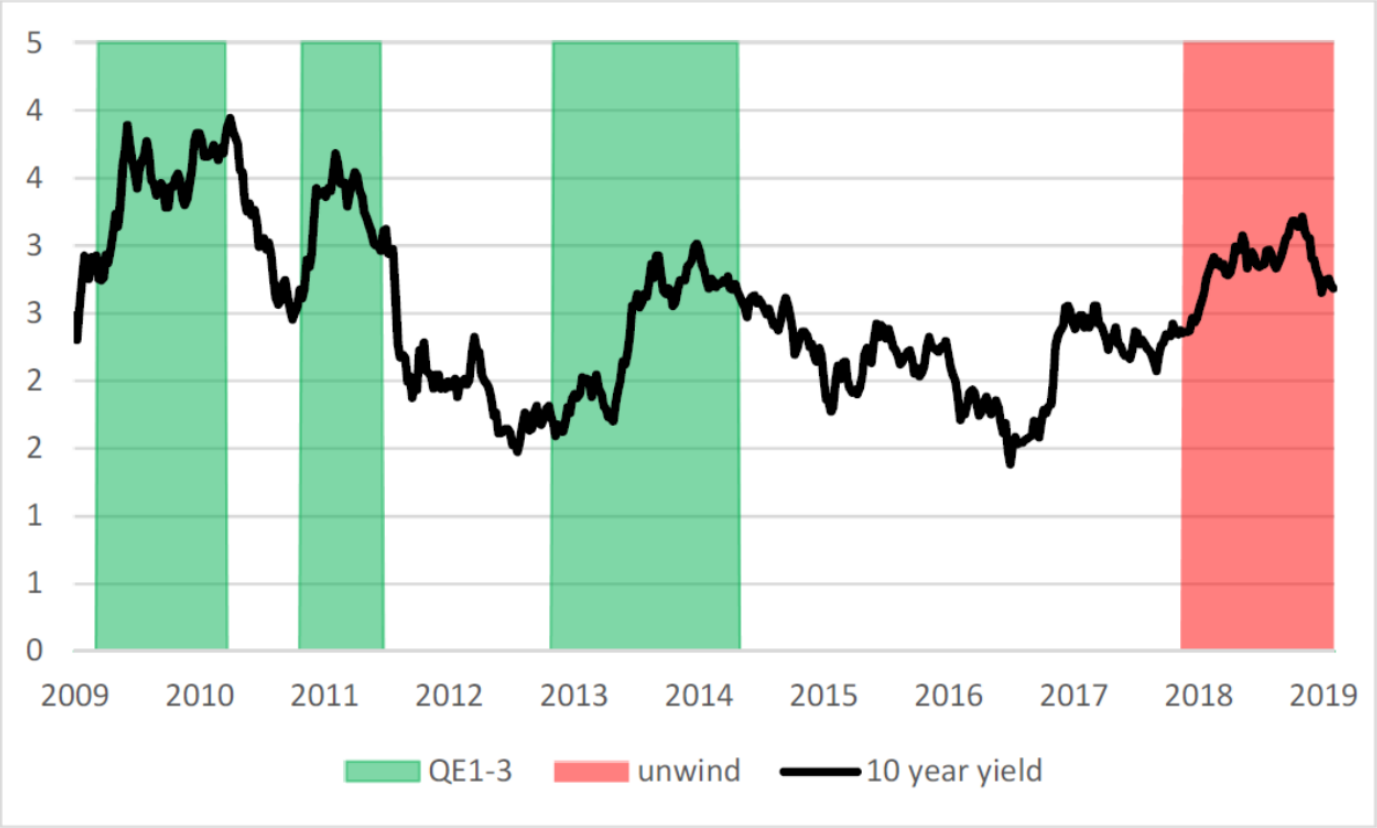
Key Features of the Revival

1. Monetary policy rules in revival are in terms of policy instruments
    - Not usually "forecast targeting" which is specific about the goals, such as 2% inflation, but not about the policy instruments.
    - Other examples: money supply, Belognia & Ireland (2019), or bond purchases, Sims & Wu (2019), as policy instrument
2. Very few rules assume instrument is QE or LSAPs.
    - Exception is Sims and Wu (2019), who propose a Taylor rule for LSAPs
        - Also Gagnon & Sack (2018)
        - Eberly, Stock & Wright (2019) assume that instrument is the slope, but without quantitative model of how instruments affect the slope.
    - Perhaps due to doubts about impact of quantitative easing

Jim Hamilton (2019)

- "On net this rate rose during each of the episodes QE1-3 in which Fed actions were attempting to bring it down, and fell when the Fed was not making new purchases."

Figure 2. Interest rate on 10-year Treasury bond.

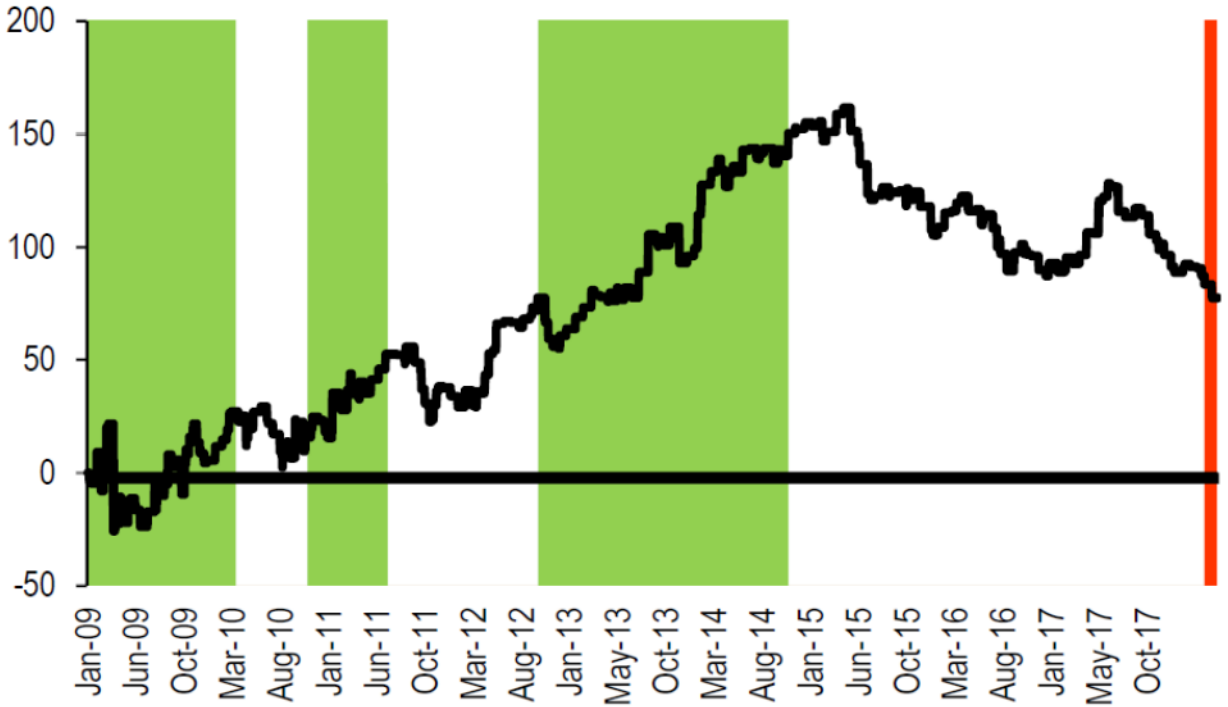


Hamilton (2019) Hoover Monetary Conference *Strategies for Monetary Policy*, May 3

Jim Hamilton (2019)

- "yields on average rose, not fell, during QE1-3, even if we focus on just days in which the Fed made an announcement."

Figure 3. Cumulative change in 10-year yield on Fed Days.



Notes to Figure 3. Cumulative change in interest rate on 10-year Treasury bond on FOMC meeting days days when FOMC minutes were released, or days with speech by Fed chair on economy or monetary policy, Jan 1, 2009 to Dec 29, 2017. Data source: Greenlaw et al. (2018).

Key Features of Revival

1. Monetary policy rules in revival are in terms of policy instruments
   - Not "forecast targeting" which is specific about the goals, such as 2% inflation, but not about the policy instruments.
   - Forecast targeting used by Svensson (2019), critiqued by Taylor (2010).
   - Other examples: papers with money supply, Belognia & Ireland (2019), or bond purchases, Sims & Wu (2019), as policy instrument
2. Very few rules assume instrument is QE or LSAPs.
   - Exception is Sims and Wu (2019), who propose a Taylor rule for LSAPs
     - Also Gagnon & Sack (2018)
     - Eberly, Stock & Wright (2019) assume that instrument is the slope, but without quantitative model of how instruments affect the slope.
   - Perhaps due to doubts about impact of quantitative easing
     - Bordo and Levin (2019): "Our empirical analysis indicates that QE3 was not an effective form of monetary stimulus"
     - Hamilton (2019): See charts…
3. Recent policy rules in Fed's *Monetary Policy Reports* and elsewhere have Taylor principle with coefficient on inflation greater than 1.
   - "One key principle is … the policy rate should be adjusted by more than one-for-one in response to persistent increases or decreases in inflation." – *Monetary Policy Report*
   - Implications for *Forward Guidance Puzzle*…

Forward Guidance Puzzle

- Forward guidance puzzle: *an announcement of a future interest rate increase has a large immediate effect which increases in size with the length of period between announcement and action*
  - Del Negro, Giannoni, and Patterson (2015) & McKay, Nakamura and Steinsson (2016).
- Maliar and Taylor (2019) show that forward guidance puzzle does not arise with sensible assumptions about policy rule
  - These assumptions include the Taylor principle.
  - As in Fed *Monetary Policy Reports* and recent research
- In simple NK model these assumptions yield two unstable roots and thus a unique stable solution…

Simple model

$$y_t = E_t[y_{t+1}] - \sigma(i_t - E_t[\pi_{t+1}]) \quad (1)$$

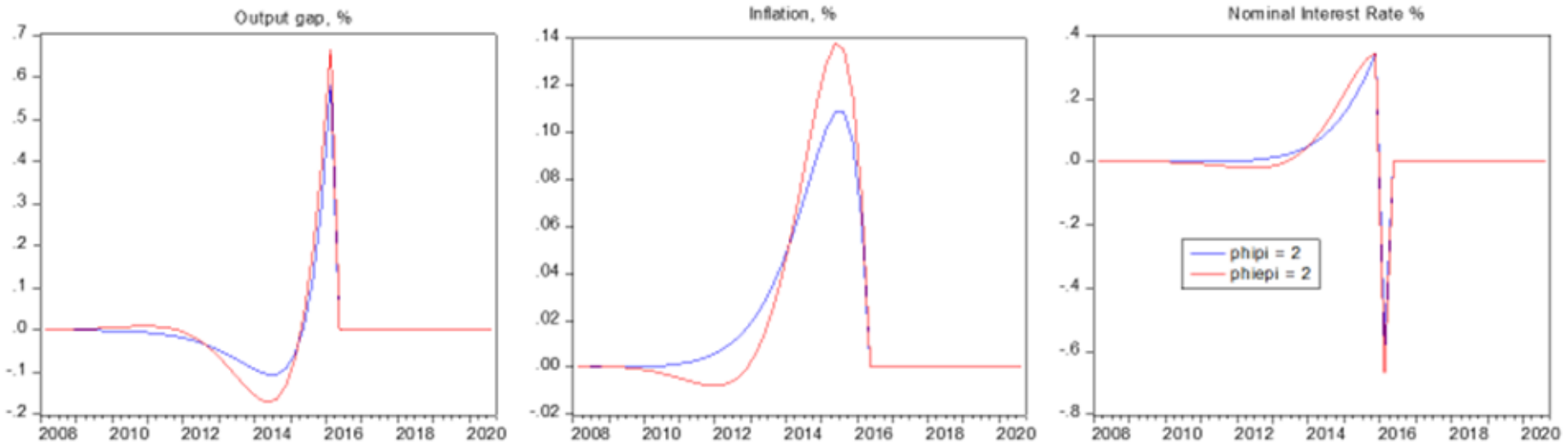
$$\pi_t = \beta E_t[\pi_{t+1}] + \kappa y_t \quad (2)$$

$$i_t = \varphi_\pi \pi_t + \varphi_{E\pi} E[\pi_{t+1}] + \varphi_y y_t + \varepsilon_t \quad (3)$$

real output y_t, the inflation rate π_t, and the interest rate i_t

The structural parameters are $\beta = .99$, $\kappa = .11$, and $\sigma = 1$, and the policy rule parameters are $\varphi_y = .5$ and either $\varphi_\pi = 2$ or $\varphi_{E\pi} = 2$. With $\varphi_\pi > 1$ and $\varphi_{E\pi} > 1$ the model satisfies the Taylor principle

Impact on Output and Inflation of an Announced Deviation from the Interest Rate Rule

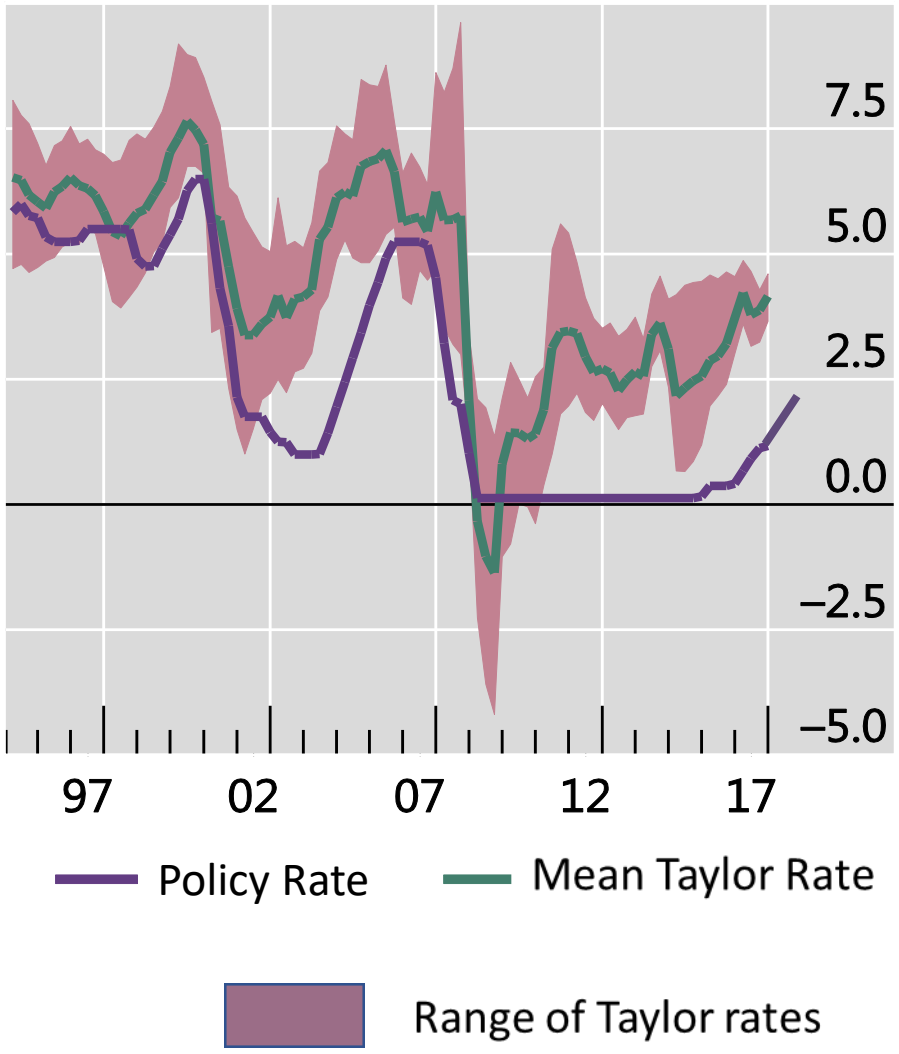


Simulation of model with equations (1), (2) and (3) with phiy = .5, phipi = 2 or phiepi=2,
kappa = .11, sigma = 1, beta=.99, g= 0, $i^*=0$, $i^n = 0$.
Charts show effects of a one-time shock $\varepsilon = -1$ to the policy rule (3) in 2016.1 anticipated in 2008.1, (T=28).

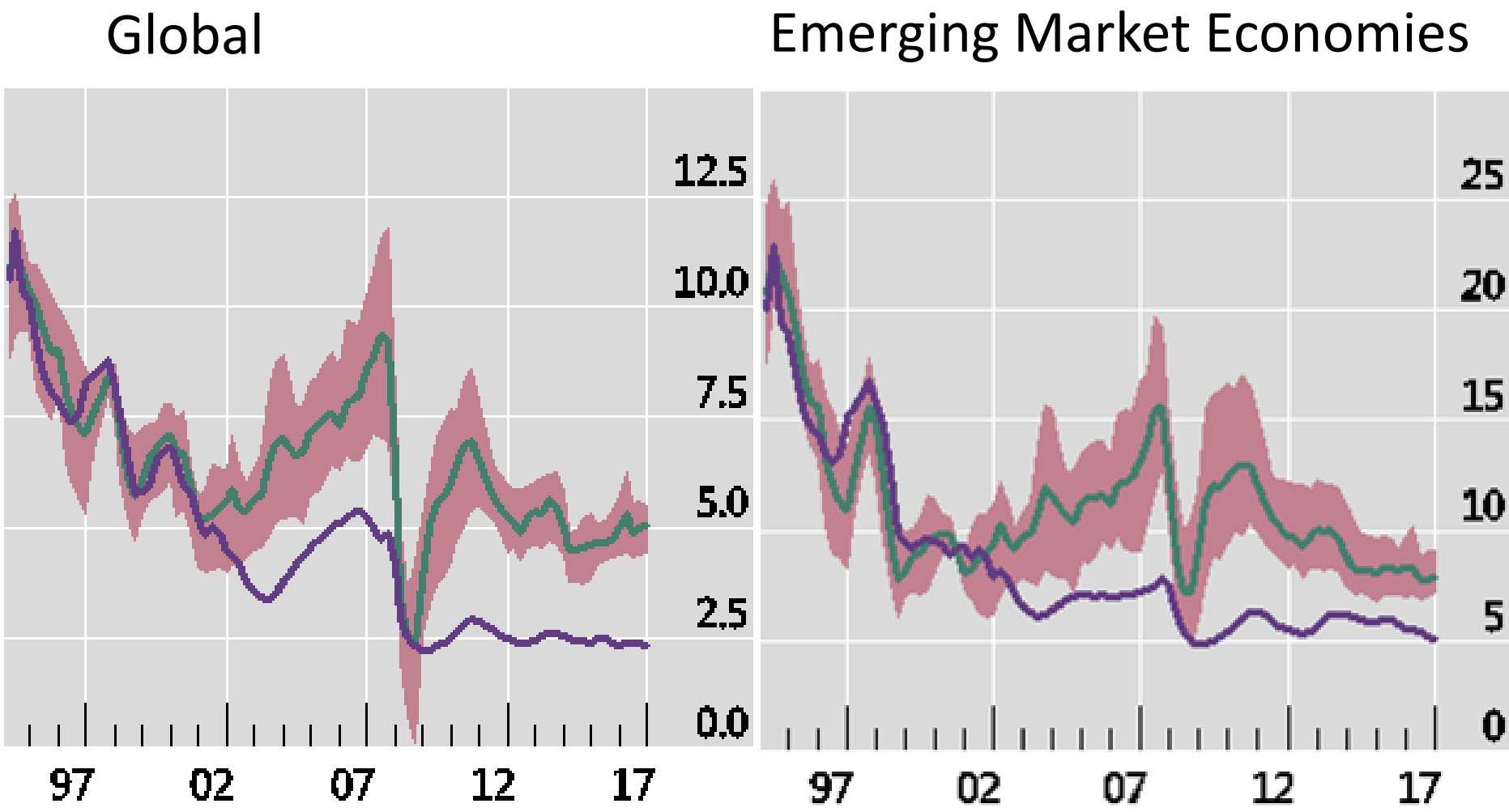
International Monetary Considerations

- Policy rules for international monetary system are a natural extension of the idea of policy rules in each country
  - Though rules will not be the same in each country
- International econometric models can be enormously helpful.
  - For example, can assess if Nash equilibrium is optimal globally
- Yet, less of a revival of policy rule research in global context
  - Research cited at the start of talk is largely single country

United States



Source: Bank for International Settlements, 2018


Global
Emerging Market Economies
12.5
10.0
7.5
5.0
2.5
0.0
25
20
15
10
5
0
97
02
07
12
17
97
02
07
12
17
Mean Taylor Rate
Policy Interest Rate
Range of Taylor rates
i = r*+π* + 1.5(π–π*) + 0.5y

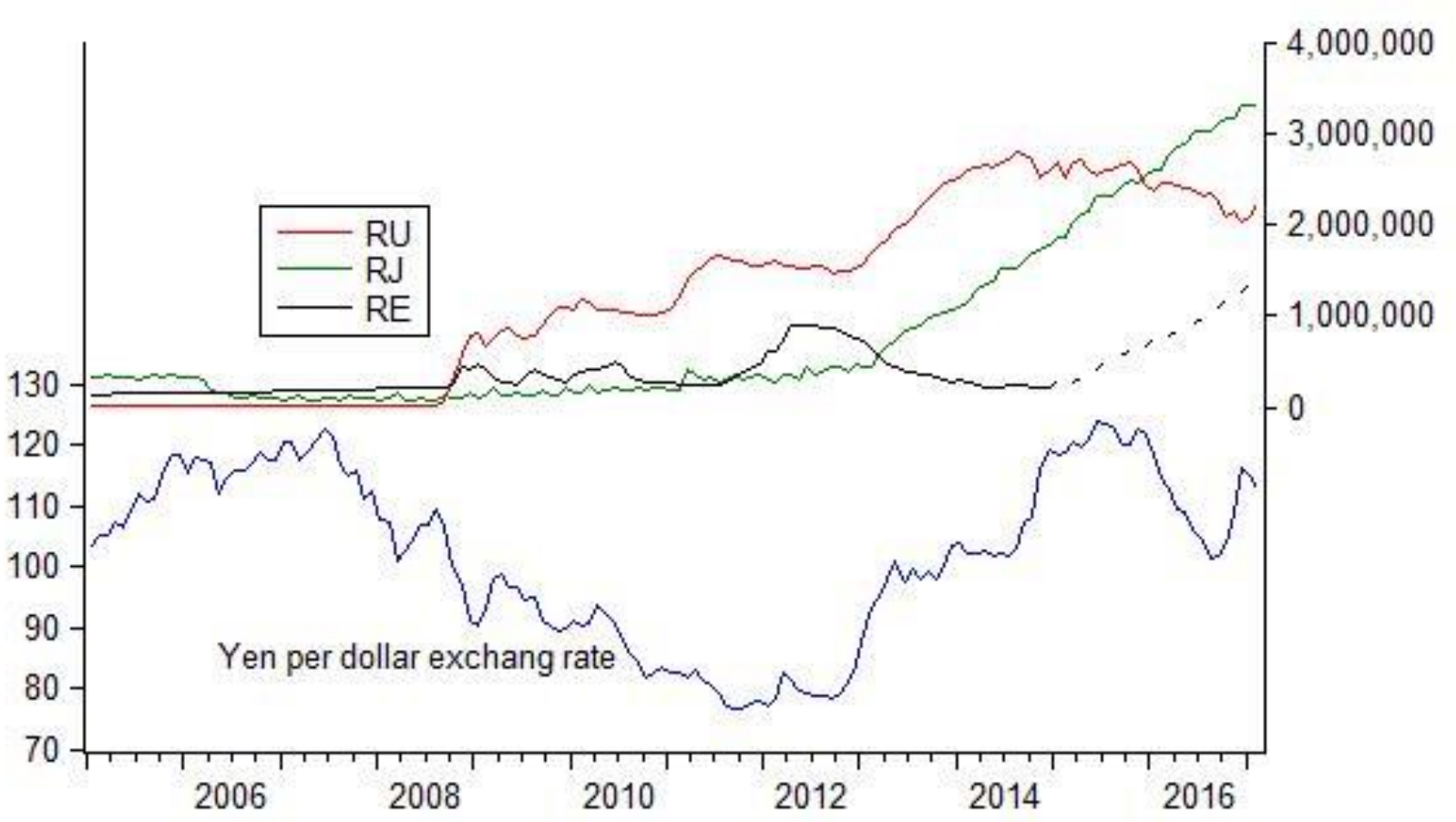
Source: BIS

Correlations Between Reserve Balances and Interest Rates

	R_U	R_J	R_E	R_S	I_U	I_J	I_E	I_S
R_U	1.00							
R_J	**0.72**	1.00						
R_E	**0.49**	**0.64**	1.00					
R_S	**0.89**	**0.85**	**0.69**	1.00				
I_U	**-0.77**	**-0.36**	**-0.44**	**-0.58**	1.00			
I_J	**-0.53**	**-0.45**	**-0.37**	**-0.48**	**0.49**	1.00		
I_E	**-0.81**	**-0.57**	**-0.51**	**-0.71**	**0.76**	**0.87**	1.00	
I_S	**-0.84**	**-0.61**	**-0.59**	**-0.76**	**0.78**	**0.85**	**0.97**	1.00

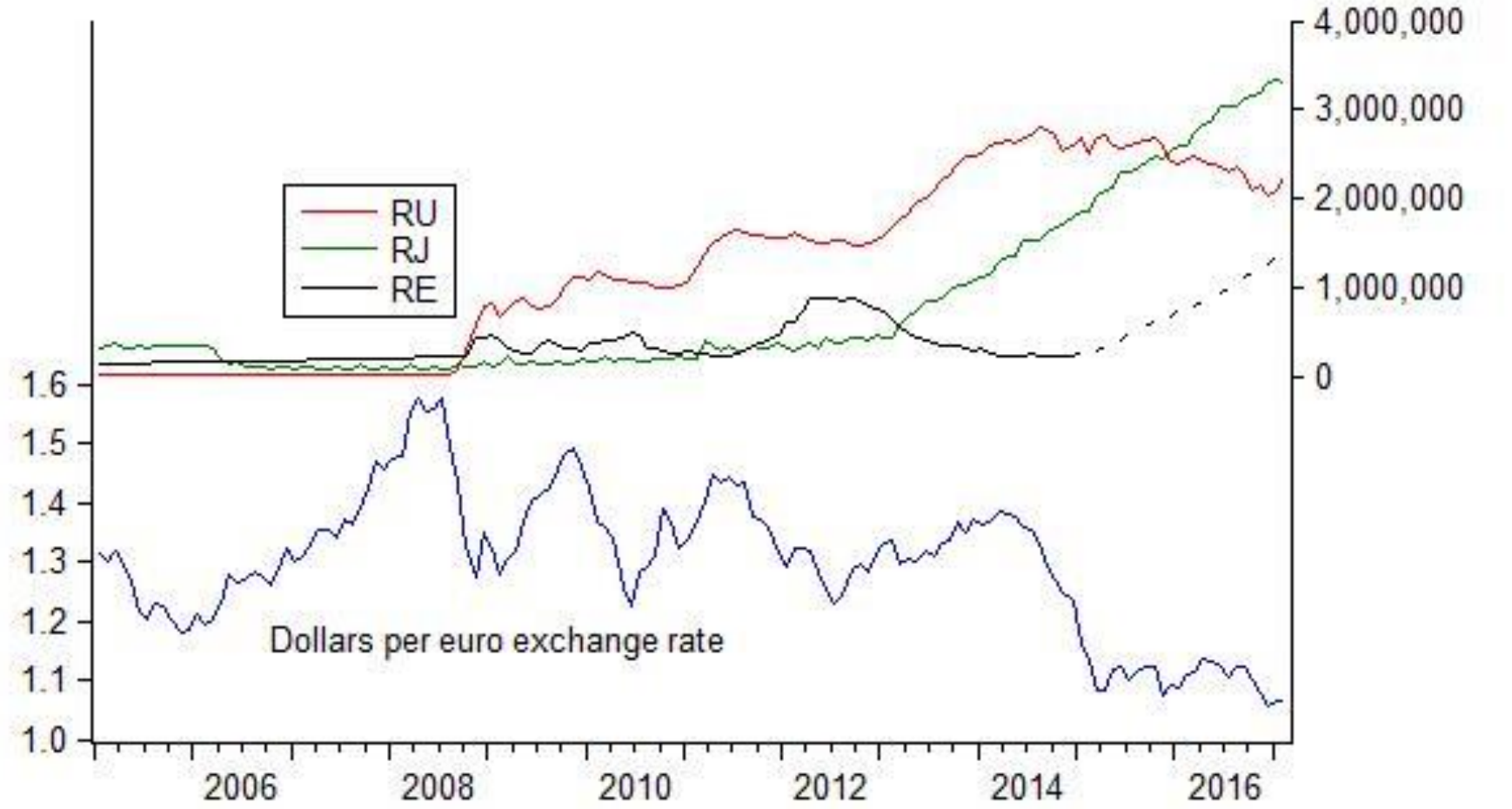
Sample: 2005.1 2017.5

Source: Taylor (2019)



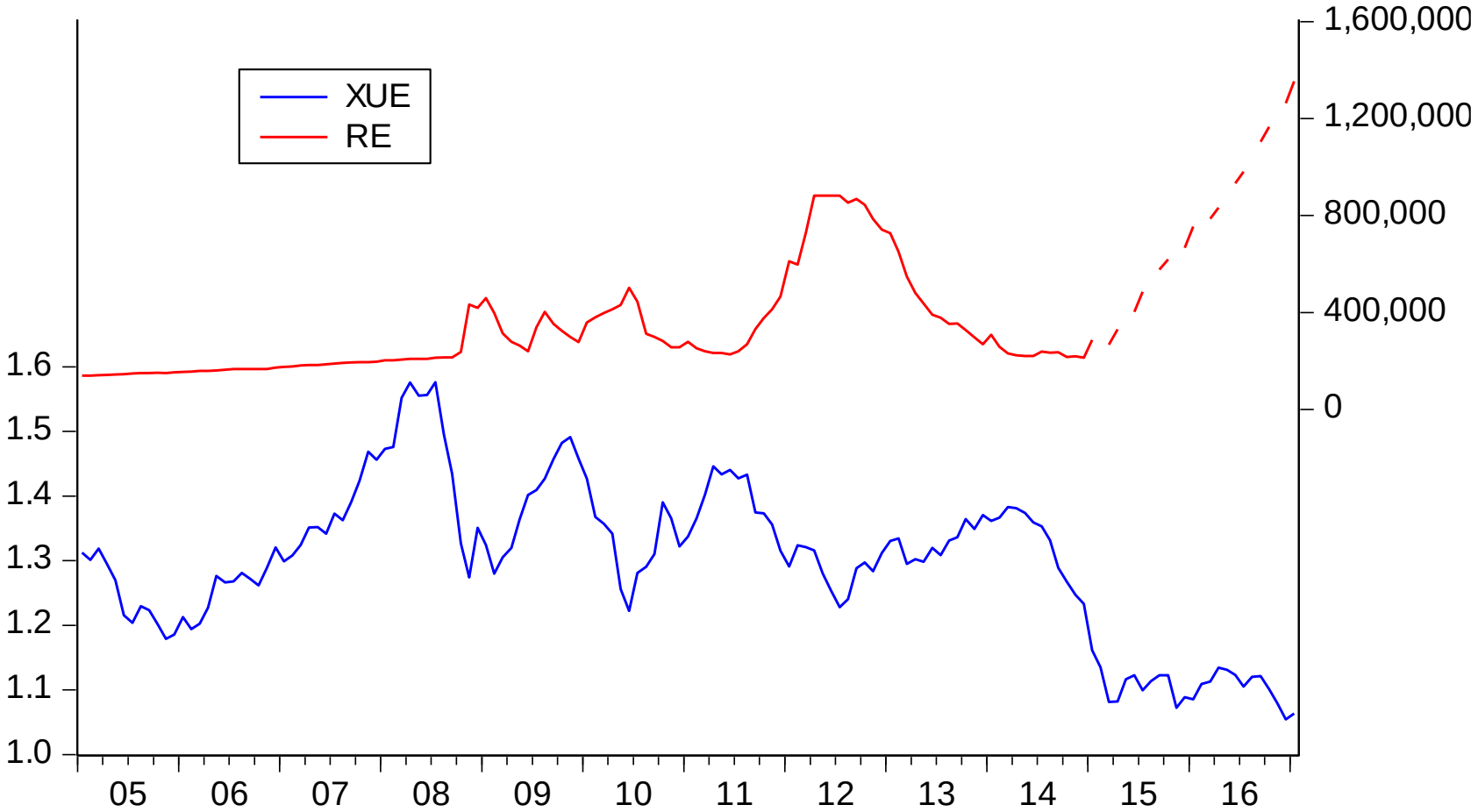
Yen Dollar Exchange Rate & Reserve Balances at Fed(R_U), BOJ(R_J),ECB(R_E)

Source: Taylor (2019)



Euro-Dollar Exchange Rate & Reserve Balances: Fed(R_U), BOJ(R_J), ECB(R_E)

Source: Taylor (2019)



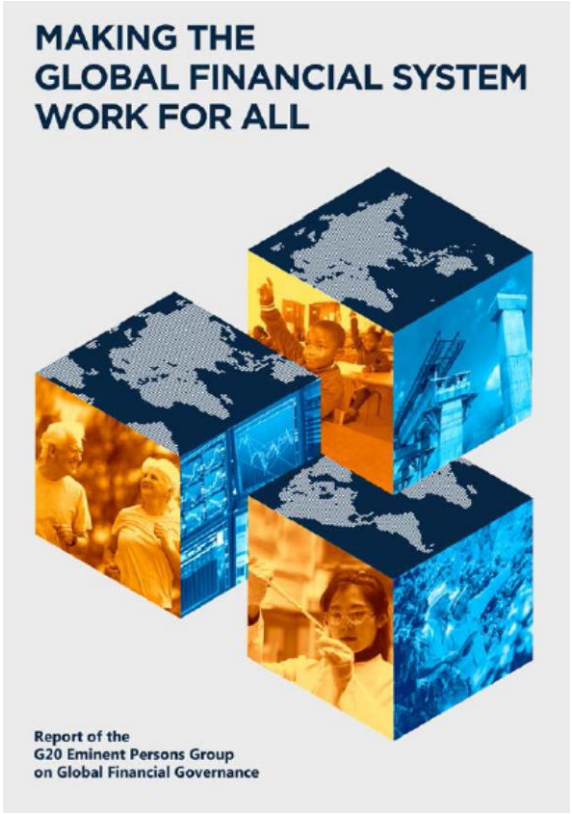
The Euro-Dollar Exchange Rate and Reserve Balances at the ECB

International Policy Responses

- Increased use of capital controls
  - Ghosh, Ostry, and Qureshi (2017): countries re-imposed "capital controls to stem inflows in the wake of historically unprecedented accommodative monetary policies" by Fed, ECB and BOJ
  - IMF Institutional View
  - However, capital controls can have adverse effects.
- Competitive devaluations
- Political instability due to concerns about "currency manipulation."

International Monetary Reform

- Principles
  - Open capital markets
  - Flexible exchange rates between countries or blocs
  - Rules-based monetary policy
- Getting from here to there
  - EPG report to G20
    - End capital controls
  - each central bank follows its own rules-based monetary policy and a global rules-based monetary system emerges



With Fed Normalizing, International Monetary Reform Could Follow

- Each central bank would describe & commit to strategy
- Attractive because each country can choose its own strategy and contribute to global stability.
- But more macro model evaluations are essential
  - Macro Model Data Base could play a key role

Implications for Research

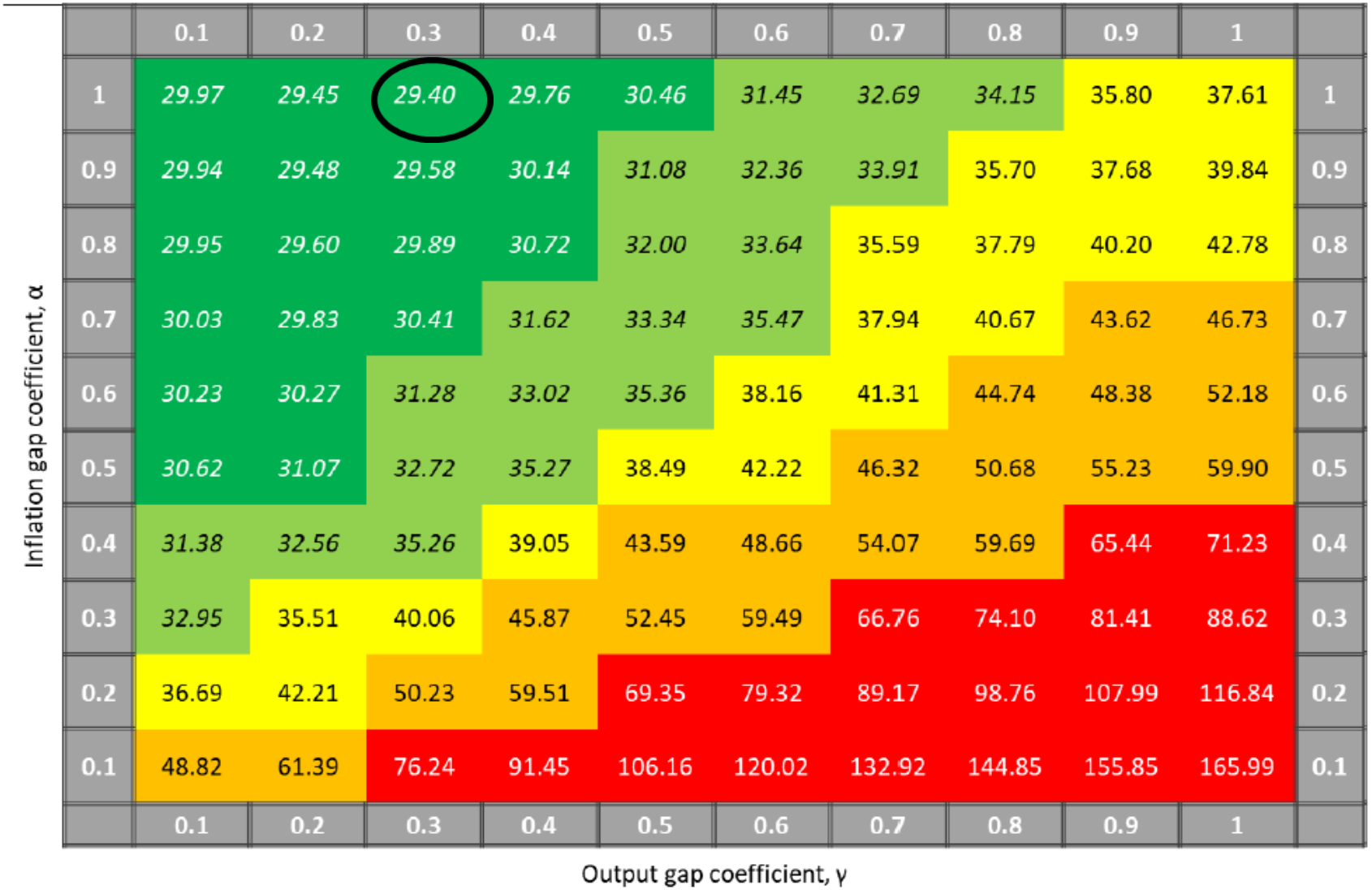
- Strategies and rules look good while they last
  - Even *expectations* of a return to rules has benefits.
- What can be done? What can econometricians do? What econometric research ideas can help?
- Here are some ideas:
  - Robustness of policy rules
  - How differences in models affect rules
  - How changes in models affect rules
  - Design models to analyze rules
  - Interface between rules and decisions
  - Rules for instruments versus forecast targeting

Need for Robustness Studies

- Especially important for newly proposed rules
- Bernanke, Kiley and Roberts (2019) look at FRB/US.
- Nikolsko-Rzhevskyy, Papell, and Prodan (2018) also look at the Smets-Wouters US model and compare.
  - They simulate rules using 100 different values of φ_y and φ_π
- The results are <u>completely opposite in the two models</u>:
  - Smets-Wouters, rule with the lowest loss: $\varphi_y = 0.3$ and $\varphi_\pi = 1.0$.
  - FRB/US model, rule with the lowest loss: $\varphi_y = 1.0$ and $\varphi_\pi = 0.1$.
- An amazingly large difference between policy models

Losses With Different Rules

Figure 12. 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	

Source: Nikolsko-Rzhevskyy, Papell, and Prodan (2018)

Losses with Different Rules

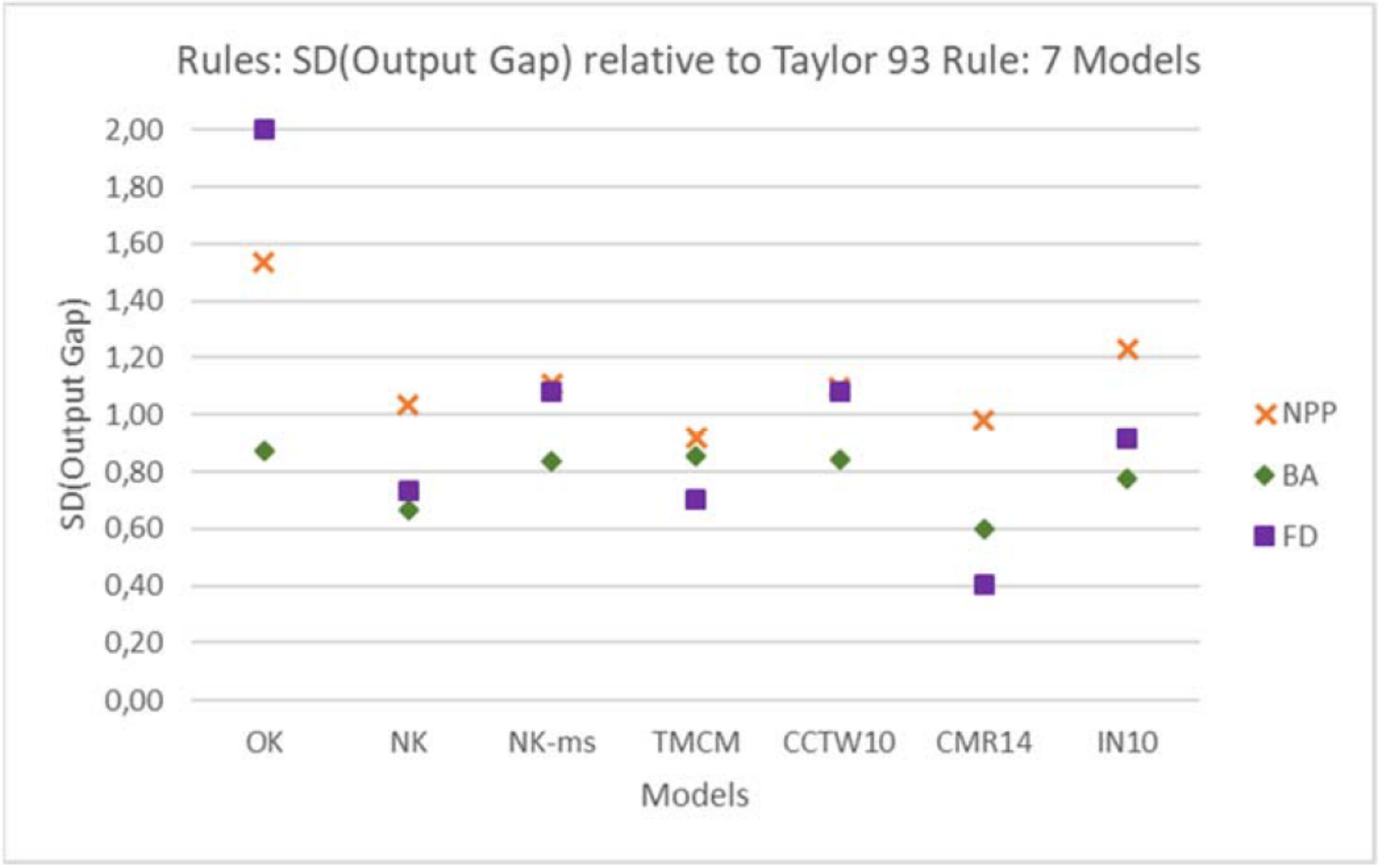
Figure 13. FRB-US Model:

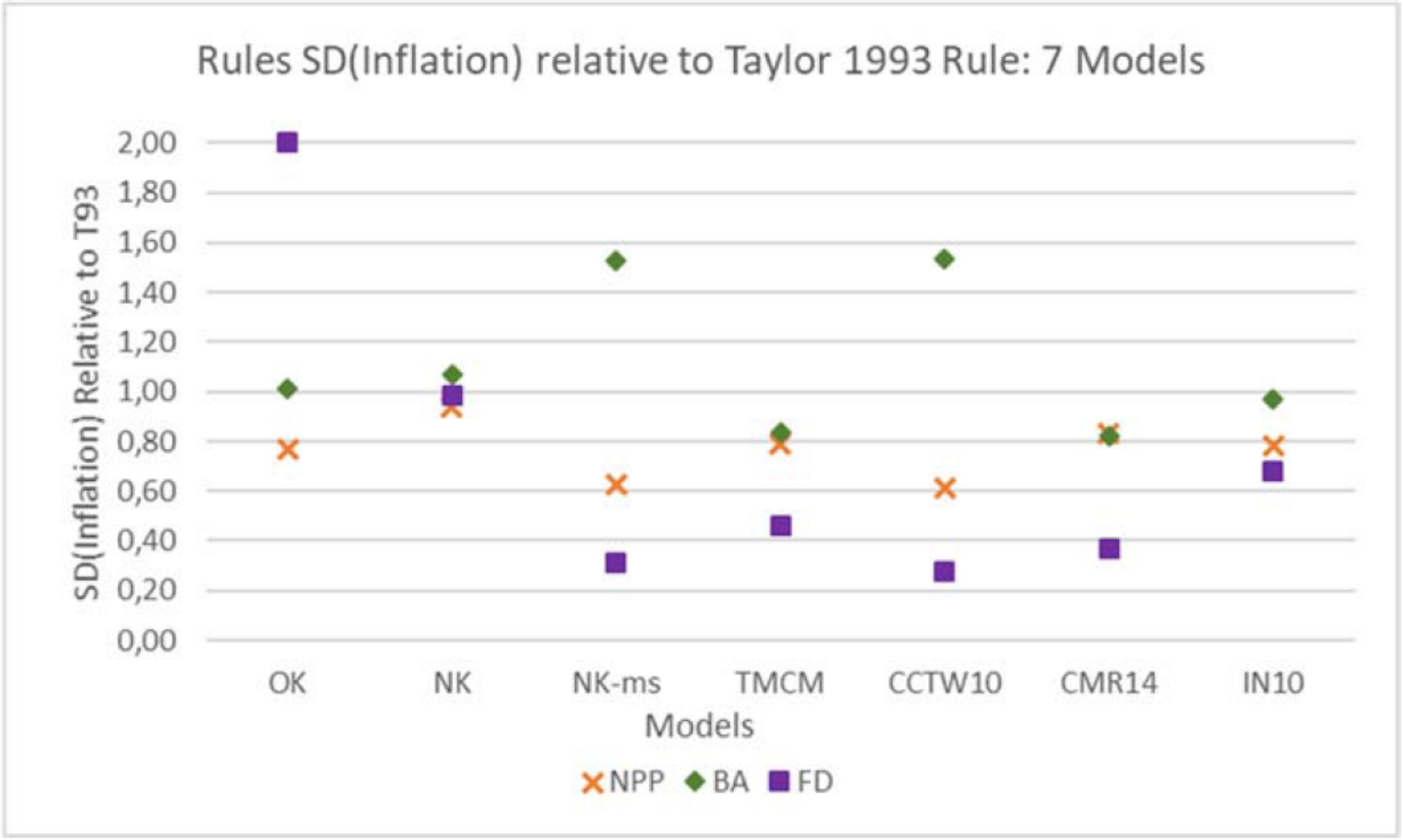
α \ γ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
1	70.54	68.39	66.60	65.14	63.97	63.05	62.36	61.88	61.57	61.44
0.9	70.04	67.86	66.05	64.58	63.40	62.49	61.80	61.33	61.04	60.92
0.8	69.57	67.36	65.52	64.04	62.85	61.95	61.27	60.81	60.53	60.42
0.7	69.13	66.88	65.02	63.52	62.33	61.43	60.76	60.31	60.04	59.95
0.6	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

Source: Nikolsko-Rzhevskyy, Papell, and Prodan (2018)

Example: Checking for robustness

- Cochrane, Taylor, Wieland (2019) rules in Fed *Report*
- Used 7 structural models (Macro Model Data Base)
  - OK: small 3-equation old-Keynesian model
  - NK: small 3-equation new-Keynesian model
  - SW: Smets Wouters (2007) medium-size policy model
  - TMCM: Taylor (1993) multi-country model
  - CCTW10: Cogan, Cwik, Taylor and Wieland (2010)
  - CMR14: Christiano-Motto-Rostagno (2014), adds frictions
  - IN10: Iacoviello and Neri (2010) adds housing market
- Results….


Rules: SD(Output Gap) relative to Taylor 93 Rule: 7 Models
SD(Output Gap)
2,00
1,80
1,60
1,40
1,20
1,00
0,80
0,60
0,40
0,20
0,00
OK
NK
NK-ms
TMCM
CCTW10
CMR14
IN10
Models
NPP
BA
FD


Rules SD(Inflation) relative to Taylor 1993 Rule: 7 Models
SD(Inflation) Relative to T93
2,00
1,80
1,60
1,40
1,20
1,00
0,80
0,60
0,40
0,20
0,00
OK
NK
NK-ms
TMCM
CCTW10
CMR14
IN10
Models
NPP
BA
FD

How Model Differences Affect Policy Rules

- If equilibrium interest rate is down by 1%
  - Then reduce intercept in Taylor Rule by 1%.
- Many changes: new distributional channels (Auclert(2016)), behavioral considerations (Gabaix (2016)), integration of finance and macro
- If slope of "Phillips curve" is down (curve got flatter, so that gap has a smaller effect on inflation)
  - Then reduce the coefficient on output in Taylor Rule
  - But how much?
    - Bullard (2018) reduced by same amount: factor of 10, from 1 to .1
  - However, the coefficient on output in policy rule is only partly due to the slope of Phillips curve…

Consider a model and a policy rule

Laurence Ball "Efficient Rules for Monetary Policy"

$$y_t = -\beta r_{t-1} + \lambda y_{t-1} + \varepsilon_t$$

Slope changes

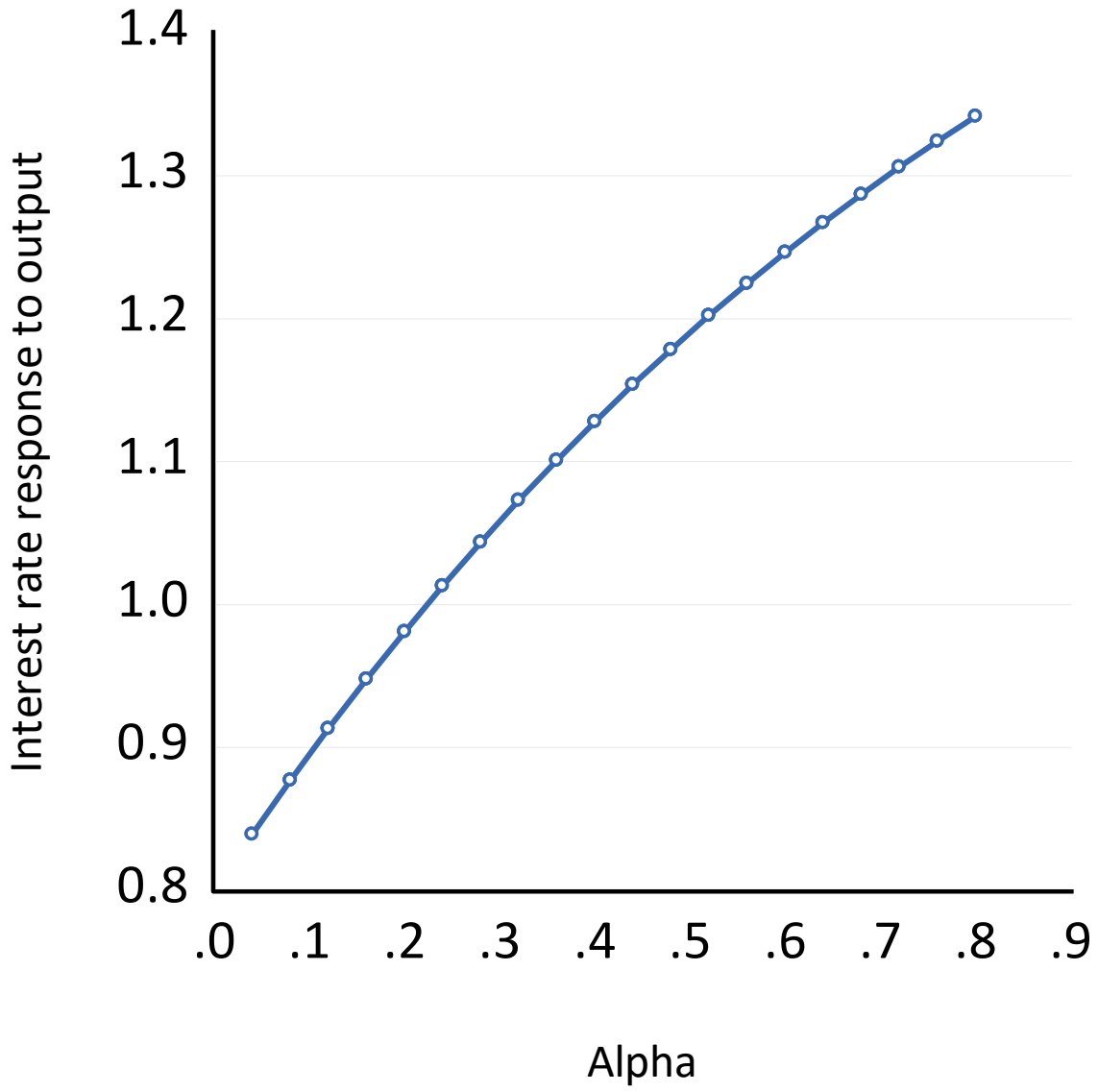
$$\pi_t = \pi_{t-1} + \alpha y_{t-1} + \eta_t$$

$$r_t = [(\lambda+\alpha q)/\beta] y_t + [q/\beta]\pi_t$$

$$\min[\mathrm{var}(y_t) + \mu \mathrm{Var}(\pi_t)]$$

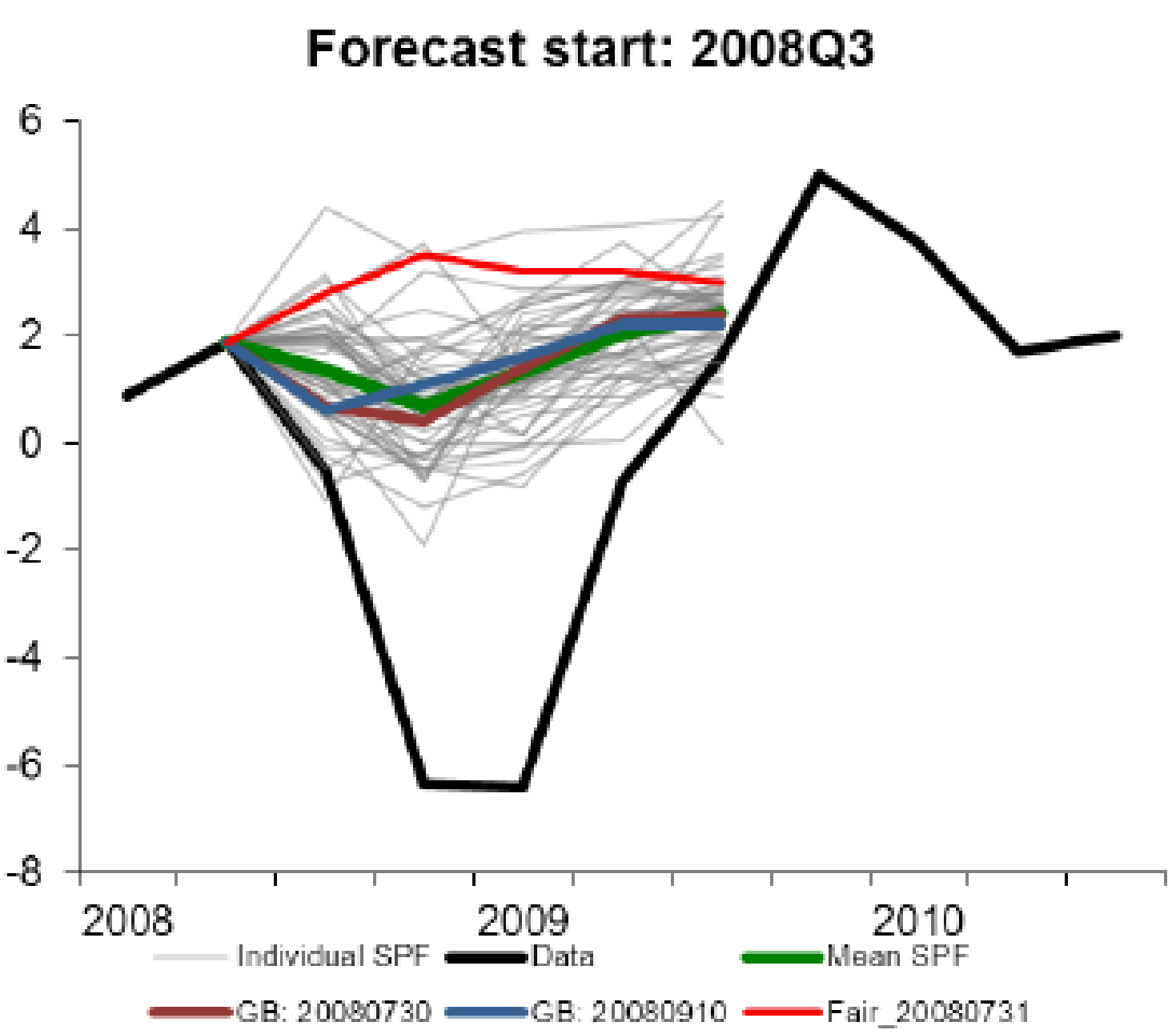
$$q = -\mu\alpha + (\mu^2\alpha^2+4*\mu)^{.5})$$

$\beta=1.0$, $\lambda=0.8$, $\alpha = [.04,\ldots,\mathbf{0.4},\ldots,0.8]$


1.4
1.3
1.2
1.1
1.0
0.9
0.8
Interest rate response to output
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
Alpha

How Model Changes Affect Policy Rules

- "The large drop in output was completely unexpected from the point of the view of the DSGE model" (Linde, Smets, Wouters (2016)). See Chart.
- Need unlikely combination of shocks, or new relationships:
  - Financial accelerator; makes a small difference DG—de Graeve
  - CMR --Christiano, Motto, Rostagno is better
  - Iacoviello (2005) Iacoviello &Neri (2010) borrowing constraints
- New forecast competition with Macro Model Data Base
  - Binder, Farkas, Sun, Taylor, Wieland, Wolters,


Forecast start: 2008Q3
6
4
2
0
-2
-4
-6
-8
2008
2009
2010
Individual SPF
Data
Mean SPF
GB: 20080730
GB: 20080910
Fair_20080731

Design Models to Analyze Rules

- Thinking about the policy rule as the main objective of policy research helps keep policy on track.
- Other models—perhaps BAVRs or other VAR variants —could focus more on forecasting issues.
- The answers to questions of scope, size and type depend on the purpose of the model. To find rules or tradeoff curves, smaller and focused models are often sufficient.

Interface Between Rules and Decisions

- Important to find ways to relate actual policy to the policy rules. Not an easy problem.
- U.S. legislation may provide some guidance.
  - Would require that Fed "describe the strategy or rule of the FOMC for the systematic quantitative adjustment" of policy instruments.
- As if the central bank would put the strategy in a glass lockbox for several years with the supposition that it would not be changed for several years.
  - The central bank of course could change its strategy
- There are other ways to deal with the interface.
  - Charles Plosser and Jeff Lacker argue that Fed could simply explain regularly how policy rules are used

Instrument Rules versus Forecast Targeting & Constrained Discretion

- Forecast Targeting
  - Woodford (2012):"Forecasting Targeting as a Monetary Policy Strategy"
  - Example

$$(\pi_{t+h,t} - \pi^*) + \phi x_{t+h,t} = 0$$

- Constrained discretion: goals only.
  - Constrained discretion is an appealing term, but it does not induce rules-based policy as the term suggests.

Conclusion

- History of Econometric Research for Monetary Policy
  - Path space, rules space, retrogression, revival
- Research has Big Impact on Economic Performance
- Key Features of the Revival
  - Instrument rules
  - Explained by disappointment & effective lower bound
  - New measures of discretion
  - Little impact of quantitative easing
- Implications
  - Need for robustness to different models and parameters
  - Need for international models to evaluate rules
  - Need work with quantitative easing as an instrument in a rule