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Fed up with the Rules? Empirical Testing of Taylor Rule Variations in American Monetary Policy

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Abstract

This study empirically tests variation in the Taylor rule over forty years of U.S. monetary policy, recognizing the potential philosophical breakpoints between Fed chair-people. We test the standard rule alongside more inclusive alternatives, settling on a more intentional and complex version that more accurately models not only unemployment and inflation pressures but consumer sentiment and interest rate smoothing. We notice important deviations from even the most inclusive version of the Taylor Rule, deviations that correlate with changes in political philosophy and historic events.

Keywords: Taylor Rule, Output Gap, Inflation, Unemployment Rate, Personal Consumption Expenditure Chain-type Price Index, Consumer Sentiment

JEL CODES: (E52, E58, E71, P11)

1. Introduction

As the U.S. central banking system, the main responsibility of the Federal Reserve is to serve the public via appropriate monetary policy. The objectives are illustrated explicitly in the Federal Reserve Act, to "promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates" (Federal Reserve, 2021) and are frequently simplified to a dual mandate of stable prices and maximum employment. Especially in the current era, it could be important to recognize what an independent Federal Reserve might value as it wrestles with inflation and unemployment in the post-COVID era.

In 1993, economist John B. Taylor developed the Taylor Rule to assist central banks, in particular the U.S. Federal Reserve, in setting its monetary policy target through alterations in the real Federal Funds rate (Gabriel, 2022). The Taylor rule "prescribes a value for the Federal Funds rate—the short-term interest rate targeted by the Federal Open Market Committee (FOMC)—based on the values of inflation and economic slack such as the output gap or unemployment gap" (Federal Reserve Bank of Atlanta, n.d.). It is clear that the Taylor Rule is part of the U.S. monetary policy decision-making process (Kohn, 2007) but there are also critics both inside and outside of the U.S. Federal Reserve. It is frequently criticized for being too simplistic, for not including impending economic factors (Fernandez et al., 2010) and limiting preemptive actions (Orphanides, 2003). For example, in moments of sociocultural crisis (e.g. the aftermath of 9/11, the 2007 financial crisis, and the Covid-19 pandemic), the Federal Reserve lowered interest rates by more than what would be expected given the state of the output gap and inflation (Boissay et al., 2021). These deviations are understandable given that the Federal Reserve takes the full economic landscape into consideration, valuing not only stability but perhaps consumer sentiment and even leadership personality.

More recently, there is active continuing discussion about the Taylor Rule, including how best to estimate the parameters (Carvalho et al., 2021), which version is optimal to follow (Crowley & Hudgins, 2021), the actual size of recent American monetary responses using the Taylor Rule (Hofmann et al., 2024), the role of rules versus discretion (Dellas & Tevlas, 2022), the resolution of indeterminacy due to multiple equilibria using the Taylor Rule (Angeletos & Lian, 2023), evaluation of its usefulness in the presence of zero-lower-bound issues in modern contexts (Lombardi & Zhu, 2023), and exploration of how it would play out in the presence of counterfactual beliefs by the central bank (Brault et al., 2025).

This current paper contributes to that ongoing discussion by fitting relevant monthly data over forty years, evaluating not only how closely monetary policy follows the Taylor Rule but asking whether it deviates in predictable ways at predictable times. In particular, we consider nonlinearities (to address stability concerns), consumer sentiment (to address sociocultural responsiveness and even preemptive action), and leadership personality (to reflect changes in the chair-person role at the U.S. Federal Reserve). The following section reviews the relevant literature, building to Section III which builds the theoretical model variations and presents our data and estimation methodology, followed by the key results in Section IV. The final section presents conclusions and our reflections about the continuing usefulness of the Taylor

rule in various forms.

2. Literature Review

The Taylor rule suggests a real Federal Funds rate based on economic conditions such as the inflation rate and potential output, with a standard formula as follows:

$$r = p + 0.5y + 0.5(p - 2) + 2 \quad (1)$$

where r is the rule-recommended Federal Funds rate, p is the rate of inflation over the previous four quarters, and y is the percentage deviation of real GDP from a target. In practice, the real Federal Funds rate is expected to rise if inflation rises above the target rate of 2 percent, or if real GDP surpasses the estimated GDP for a given economic year (Okoye, 2018). In the case where both the inflation rate and GDP are within the expected target, r would be equal to 4 percent, which is 2 percent in real terms.

The original rule estimates inflation utilizing year-over-year changes in the GDP deflator, which of course includes international trade (Orphanides, 2003) while the deviation of real GDP from the FOMC's target level of GDP, usually referred to as the output gap, is measured as the excess of actual GDP over potential output. The weighted coefficients reflect monetary policy sensitivity to change in output or inflation. However, the standard Taylor rule can be difficult to measure in real time, so it is often considered instead as a backward-looking model, with a variety of contextual incarnations.

The Taylor rule was initially developed using data predating 1993, so it is perhaps no surprise that previous research has established that the nominal Federal Funds rate matches the Rule fairly well (Carlstrom & Fuerst, 2014). However, adherence was not uniform, and there is open debate about whether it still holds relevance (e.g., Neely, 2002) or whether discretionary monetary policy is preferable (Dellas & Tevlas, 2022). For example, in the aftermath of the attacks on the World Trade Center and the Pentagon September 11, 2001, the Federal Reserve reduced interest rates four times in the subsequent three months, perhaps in response to dramatic changes in consumer spending (and confidence) alongside investment spending (Neely, 2002). With the Phillips curve in mind, the FOMC digressed from the Taylor Rule but still bore in mind their dual mandate by reducing the risk of deflation and high unemployment (Groshenny, 2011). Other outstanding deviations from the Taylor rule include the year shortly after the 2007–2008 financial crisis and monetary policy responses to the COVID-19 pandemic. Emergency rate cuts were made in both cases when the effective Federal Funds rate was lowered to essentially zero percent. These rate cuts were not in line with the Taylor rule but were seen as necessary to ease the effects of the unprecedented times and to provide short-term economic relief to the large number of people experiencing joblessness in the United States.

Nonetheless, variants of the Taylor Rule have still been shown to have strong explanatory power even in the contemporary era (Carvalho et al., 2021). Fernandez et al. (2010) concluded that a version in which inflation was represented by inflation forecasts, the current output gap and the anticipated change in the output gap fits quite well. In contrast, Meyer and Tasci (2012) focus instead on unemployment rates directly rather than an imputed output gap.

Some versions include real exchange rates (Deniz et al., 2020) or emphasize the importance of boundary constraints on interest rate values (Lombardi & Zhu, 2023).

The importance of interest-rate smoothing or gradualism, usually modeled by including one or more lagged values of the Federal Funds rate as explanatory variables, has been emphasized in the current context (Fernandez et al., 2010), presumably to minimize market disruptions especially during periods of exogenous shock. That mindset has been confirmed by the Federal Reserve as a balance between gradualism and pre-emption (Kohn, 2007), with an emphasis on the public communication value of rule-based monetary policy.

Critics of the Taylor rule have cited its inability to account for forecasted, but still future, economic developments (Fernandez et al., 2010). A potential solution to this challenge is to include a leading indicator such as consumer sentiment (Liberto, 2021). This measure provides a sense of how consumers are feeling, how willing and able they are to spend given the current or impending state of the economy. While important for the economy, consumers are also notoriously inaccurate at predicting future economic outcomes during periods of instability (Federal Reserve Bank of St. Louis, 2021). Indeed, which version of the Taylor Rule is wisest to follow is a subject of continuing debate (Crowley & Hudgins, 2021).

Under Fed Chair Ben Bernanke, the measure of inflation was publicly changed to reflect Personal Consumption Expenditure (PCE) instead of previous more production-side measures (Marsh, 2022). Bernanke also explicitly altered the weight of the output gap coefficient, making monetary policy more responsive to economic conditions (Marsh, 2022). However, there is evidence that recent American monetary responses have changed the weights used in the Taylor Rule (Hofmann et al., 2024). We make use of these structural shifts, these changes in how the Taylor Rule has been (re-)interpreted over time, in our modeling section below.

3. Model and Data

We propose to model the simple Taylor Rule over time, using modeling and estimation informed by best practice in the literature (Carvalho et al., 2021):

$$EFFR = \alpha + \beta p + \gamma u + \varepsilon \tag{2}$$

where *EFFR* is the effective Federal Funds Rate, p is change in the Personal Consumption Expenditures Chain-type Price Index, and u is the unemployment rate. Although this formulation appears (and is indeed) simple, it is the official and standard Taylor Rule. However, first-differencing is advisable for stationarity and unit root considerations (clearly evident in our data as in other studies of monetary variables), so instead we estimate the first-difference versions of the equations:

$$\Delta EFFR = \alpha_0 + \beta_0 \Delta p + \gamma_0 \Delta u + \varepsilon \tag{3}$$

Notice that recent literature (e.g., Carvalho et al., 2021) confirms this formulation's estimation by OLS as best practice, because more elegant techniques such as instrumental variables (IV) run unacceptably high risks of invalid instruments due to the complexity of the macroeconomy. As a further exploration, we allow the values of β, γ and δ to differ by

political orientation of the Federal Reserve chairperson (based on whether they were appointed by a Democrat or Republican president), along with chair-specific effects so that Taylor Rule adherence can vary over time. So, we estimate the simple Taylor Rule as:

$$\Delta EFFR = \alpha_0 + \sum_{i=1}^{2} \beta_i \Delta p + \sum_{i=1}^{2} \gamma_i \Delta u + \sum_{i=1}^{5} \alpha_i + \varepsilon \quad (4)$$

Next, we include consumer sentiment as a potential third factor in a more complicated Taylor Rule so estimate:

$$\Delta EFFR = \alpha_0 + \beta_0 \Delta p + \gamma_0 \Delta u + \delta_0 \Delta CS + \varepsilon \quad (5)$$

where *CS* is the University of Michigan Consumer Sentiment Index, along with the potential politically tilted emphasis on each coefficient expressed as:

$$\Delta EFFR = \alpha_0 + \sum_{i=1}^{2} \beta_i \Delta p + \sum_{i=1}^{2} \gamma_i \Delta u + \sum_{i=1}^{2} \delta_i \Delta CS + \sum_{i=1}^{5} \alpha_i + \varepsilon \quad (6)$$

And finally, we propose a more complicated and inclusive Taylor Rule model that permits potential interest rate-smoothing in the form of lagged values of the dependent variable, both with and without differences between Fed chairs:

$$\Delta EFFR = \alpha_0 + \beta_0 \Delta p + \gamma_0 \Delta u + \delta_0 \Delta CS + \lambda_0 \Delta EFFR_{t-1} + \varepsilon \quad (7)$$

$$\Delta EFFR = \alpha_0 + \sum_{i=1}^{2} \beta_i \Delta p + \sum_{i=1}^{2} \gamma_i \Delta u + \sum_{i=1}^{2} \delta_i \Delta CS + \sum_{i=1}^{2} \lambda_i \Delta EFFR_{t-1} + \sum_{i=1}^{5} \alpha_i + \varepsilon \quad (8)$$

These last versions should relieve all remaining concerns about endogeneity by using lagged values alongside first differences.

All data are obtained from the Federal Reserve Economic Database (FRED), on a monthly basis for the period between December of 1977 and September of 2023, for 550 consecutive observations. The dependent variable, the Effective Federal Funds Rate (EFFR), is a volume-weighted median of overnight Federal Funds transactions across all transactions from central banks in the United States (Federal Reserve Bank of New York n.d.). For inflation, we use the PCE index following much of the literature (Haubrich & Millington, 2014; Curry, 2023), and for the output gap we use the unemployment rate. As consumer sentiment, we rely on the industry standard from the University of Michigan (Hayes, 2023). These are summarized statistically in Table 1 below.

The Effective Federal Funds Rate (EFFR) varies widely, with a standard deviation almost equal in size to its average value of 4.63 percent. The maximum rate occurred in 1981 during the anti-inflationary policies of Fed Chairperson Paul Volcker, and the minimum rate occurred during the height of the global COVID-19 pandemic and Federal Reserve quantitative easing (Labonte, 2021). There is obviously an occasional inverse relationship between unemployment and inflation (the short-run Phillips Curve), and both have notable peaks and troughs. Consumer sentiment varied a lot over this period, notably hitting lows

during the onset of the Financial Crisis and the COVID-19 Pandemic in June of 2008 and April of 2020, respectively. Over the past four decades, consumer sentiment has been negatively correlated with the Effective Federal Funds Rate (EFFR), the unemployment rate and the Personal Consumption Expenditure Chain-type Price Index. Outliers occur at negative EFFR rates during the spring of May of 1980 and winter of 1981, when the economy was suffering from a deep recession. During both periods, the Federal Reserve dramatically increased interest rates, potentially beyond what the Taylor rule prescribed, to combat rising price wages and price levels.

Table 1. Summary statistics of key variables

	Mean	Standard deviation	Minimum	Maximum
EFFR	4.63	4.08	0.05	19.10
Unemployment	6.11	1.76	3.40	14.70
PCE-based inflation	0.25	0.25	-1.18	1.23
Consumer sentiment	85.11	13.20	50.00	112.00

To enable specific effects by chairperson and political party, we coded when each Federal Reserve chair steered decisions, affiliating each with the political party of the nominating president under whom they were appointed. The first two chairs in our series are excluded by identity-specific variables (Arthur Burns as the basis for comparison and William Miller because his term was so short) but their terms are included along with their party affiliations.

4. Results

Our primary regression results are presented in Table 2, along with their Newey-West corrected errors to accommodate any residual heteroskedasticity and the autocorrelation of errors. The simple rule is in the first column (with chair-specific deviations in the second), the consumer sentiment extension appears in the third column (with chair-specific deviations in the fourth), and the full model with consumer sentiment and inflation smoothing is in the fifth column (with chair-specific deviations of that model in the sixth and final column).

Notice first that the simple Taylor Rule does not fit the data particularly well, partly because of chair-specific effects. Some of those are philosophical/political (Democrat-appointed chairs appear to respond to the unemployment rate while Republican-appointed chairs do not) but some of it appears to be related to the time period or specific identities of the chairs themselves. The inclusion of consumer sentiment adds some explanatory power to the model (at least for Republican-appointed chairs) but does not change much of the story overall.

Instead, the addition of interest smoothing improves the model noticeably, perhaps reducing omitted variable bias from our other versions. It appears that Republican-appointed chairs smooth more actively than Democrat-appointed chairs, and the use of that variable explains most of the chair-specific portion of the variation. Alternative models that include nonlinearities and interactions show much the same results.

Table 2. Regression results

	Simple Taylor				With consumer sentiment				With consumer sentiment and interest rate smoothing			
	Coeff.	t-test	Coeff.	t-test	Coeff.	t-test	Coeff.	t-test	Coeff.	t-test	Coeff.	t-test
Unemployment												
Overall	-0.091	1.14	---	---	-0.089	1.14	---	---	-0.042	0.68	---	---
Dem-appointed	---	---	-1.426	2.45**	---	---	-1.435	2.45**	---	---	-1.081	1.72*
Rep-appointed	---	---	-0.026	1.38	---	---	-0.024	1.44	---	---	0.019	1.54
Price level												
Overall	0.154	0.70	---	---	0.159	0.72	---	---	0.175	0.79	---	---
Dem-appointed	---	---	0.385	0.56	---	---	0.406	0.58	---	---	0.505	0.70
Rep-appointed	---	---	0.028	0.45	---	---	0.049	0.77	---	---	0.007	0.18
Consumer sentiment												
Overall	---	---	---	---	0.004	0.53	---	---	0.009	1.42	---	---
Dem-appointed	---	---	---	---	---	---	-0.013	0.42	---	---	0.002	0.08
Rep-appointed	---	---	---	---	---	---	0.008	2.43**	---	---	0.008	3.10***
Interest rate smoothing												
Overall	---	---	---	---	---	---	---	---	0.390	4.48***	---	---
Dem-appointed	---	---	---	---	---	---	---	---	---	---	0.316	3.03***
Rep-appointed	---	---	---	---	---	---	---	---	---	---	0.615	12.03***
Constant												
Overall	-0.003	0.13	0.153	1.96**	-0.003	0.13	0.134	1.55	-0.001	0.07	0.107	1.44
Volcker	---	---	-0.184	1.46	---	---	-0.161	1.06	---	---	-0.124	0.89
Greenspan	---	---	-0.164	2.07**	---	---	-0.145	1.64*	---	---	-0.105	1.33
Bernanke	---	---	-0.196	2.46***	---	---	-0.177	2.00**	---	---	-0.119	1.50
Yellen	---	---	-0.199	2.57***	---	---	-0.177	1.91**	---	---	-0.138	1.66*
Powell	---	---	-0.099	1.20	---	---	-0.075	0.83	---	---	-0.078	0.96
Observations		547		547		546		546		546		546
F-test		0.76		3.66***		0.58		3.65***		6.97***		14.89***

Note. * for 90 percent, ** for 95 percent, and *** for 99 percent confidence intervals.

5. Conclusion

While the simple Taylor Rule does not appear to inform or guide US monetary policy very closely, the components of extended versions are helpful in reflecting on political appointees to the Fed chair position. In particular, it appears that Democrat appointees pay more attention to the unemployment rate while Republican appointees pay more attention to consumer sentiment indices. Furthermore, both seem to reflect a degree of interest rate smoothing (distinctly more by Republican appointees) and neither seem to reflect much deference to the PCE-based rate of inflation.

Clearly, the Federal Reserve is aware of the Taylor Rule and benefits from the simple benchmarks it provides, even when they consciously choose to deviate from it (Kohn, 2007).

As said poignantly by those with experience in Federal Reserve decision-making,

> "Rules of thumb can be very useful. At their best, they can help us avoid huge mistakes—testing the bathwater with your elbow to save the baby from a scalding, for example. These rules are not complicated or ambiguous, which allows us to make snap decisions without costly errors. So, it's probably not a surprise that analysts attempt to use simple rules of thumb to describe economic phenomena. However, attempts to describe complex interactions in the economy with overly simple adages can lead to incorrect conclusions." (Meyer & Tasci, 2012).

Prior literature expresses the complexities in the modeling process of the independent variables within this study. For example, there are hundreds of ways to represent inflation, the output gap and consumer sentiment in the data. Based on the previous literature, a one period lag was chosen for the independent variables within this study, but the Federal Reserve could (and should) be making decisions utilizing data from more than just the previous period. Subsequent work could explore those options for the models we have estimated here. In the meantime, we hope to have cast some light on the nature of the political/philosophical and person-specific adherence to the Taylor Rule as displayed over the last fifty years of US monetary policy.

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