GETTING MONETARY POLICY BACK ON TRACK

EDITED BY
Michael D. Bordo, John H. Cochrane,
and John B. Taylor

THIRTY-YEAR ANNIVERSARY OF THE TAYLOR RULE

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The Taylor Rule at Thirty

Richard H. Clarida

It is a privilege to participate once again in this annual Hoover Institution Monetary Policy Conference. The theme of this year's conference is especially timely given sharp hawkish policy pivots since last year's Hoover conference by the Fed and other major central banks as they've tried to get back on track and ahead of the curve after presiding over the sharpest sustained surge in inflation in forty years. I will have something to say toward the end of my remarks about recent events and, specifically, the "get back to where you once belonged" theme, but my welcome assignment on this panel is to offer some thoughts on the Taylor rule (TR) at thirty, and I am honored and humbled to do so.

When John Taylor called in March to extend the invitation, I, of course, accepted on the spot, but being an economist, I also recognized that writing a paper and preparing remarks for a fifteen-minute presentation on the TR at thirty would be an exercise in constrained optimization. After all, that is less than one minute per year! It then occurred to me that I could perhaps organize my remarks not by chronology but instead by the many extensions of the original Taylor rule paper that have been developed over the past thirty years and applied across various fields in economics, including but not confined to monetary theory, macroeconometrics, international finance, asset pricing, and yes, the fiscal theory of the price level. But of course, the influence of the TR paper on each of these fields is vast—it does, after all, have thirteen thousand Google Scholar citations—and has stimulated so many papers and

books that I am simply unable to survey today. Instead, if you permit me, I will draw on my remarks and papers presented at previous Hoover conferences to offer a certainly selective and unabashedly personal thirty-thousand-foot perspective on the Taylor rule at thirty.

Let me set the scene with a very brief—and certainly selective—review of the evolution over the past sixty years of professional thinking about monetary policy. I will begin with Milton Friedman's landmark 1968 American Economic Association presidential address, "The Role of Monetary Policy" (Friedman 1968). This article is, of course, most famous for its message that there is no long-run, exploitable trade-off between inflation and unemployment. And in this paper, Friedman introduced the concept of the "natural rate of unemployment," which we now call u^*. What is less widely appreciated—at least outside these walls—is that Friedman's article also contains a concise but insightful discussion of [Knut] Wicksell's "natural rate of interest"—r^* in today's terminology—the real interest rate consistent with price stability.

But while u^* and r^* provide key reference points in Friedman's framework for assessing how far an economy may be from its long-run equilibrium in labor and financial markets, they play absolutely no role in the monetary policy rule. Instead, he advocates his well-known K-percent rule, which proposes that central banks should aim for and deliver a constant rate of growth of a monetary aggregate. This simple rule, he believed, could deliver long-run price stability without requiring the central bank to take a stand on, model, or estimate either r^* or u^*. Although he acknowledged that shocks would push u away from u^* (and, implicitly, r away from r^*), Friedman felt the role of monetary policy was to operate with a simple quantity rule that did not itself introduce potential instability into the process by which an economy on its own would converge to u^* and r^*. In Friedman's policy framework, u^* and r^* are economic destinations, not policy rule inputs.

Of course, I do not need to elaborate for this audience that the history of K-percent rules is that they were rarely tried, and when they were tried in the 1970s and the 1980s, they were found to work much better in theory than in practice. Velocity relationships proved to be empirically unstable, and there was often only a very loose connection between the growth rate of the monetary base—which the central bank could control—and the growth rate of the broader monetary aggregates, which are more tightly linked to economic activity. Moreover, the macroeconomic priority in the 1980s in the United States, the United Kingdom, and other major countries was to do "whatever it takes" to break the back of inflation and to restore the credibility squandered by central banks that had been unable or unwilling to provide a nominal anchor after the collapse of the Bretton Woods System.

By the early 1990s, thanks to Paul Volcker, the back of inflation had been broken, and thanks to Alan Greenspan, the conditions for price stability had been achieved, and the time was right for something to fill the vacuum in central bank practice left by the realization that monetary aggregate targeting was not, in reality, a workable monetary policy framework. Although it was mostly unspoken, there was a growing sense at the time that a simple, systematic framework for central bank practice was needed to ensure that the hard-won gains from breaking the back of inflation were not given away by shortsighted monetary experiments that were poorly executed, such as had been the case in the 1970s.

That vacuum, of course, was filled by John Taylor with the classic 1993 paper, "Discretion versus Policy Rules in Practice." For this audience, and at this conference, I will not need to remind you of the enormous impact this single paper had not only on the field of monetary economics but also—and more importantly—on the practice of monetary policy. For our purposes today, I will note that the crucial insight of Taylor's paper was that, whereas a central bank could pick the "K" in a K-percent rule on its own, without any

reference to the underlying parameters of the economy (including r^* and u^*), a well-designed rule for setting a short-term interest rate as a policy instrument should, Taylor argued, respect several requirements.

First, the rule should anchor the nominal policy rate at a level equal to the sum of its estimate of the neutral real interest rate (r^*) and the inflation target. Second, to achieve this nominal anchor, the central bank should be prepared to raise the nominal policy rate by more than one-for-one when inflation exceeds the target (the Taylor principle). And third, the central bank should lean against the wind when output—or, via an Okun's law relationship, the unemployment rate—deviates from its estimate of potential (u^*). In other words, whereas in Friedman's K-percent policy rule u^* and r^* are destinations irrelevant to the choice of k, in the Taylor rule—and most subsequent Taylor-type rules—u^* and r^* are necessary inputs. As [Michael] Woodford (2003) demonstrates theoretically, the first two requirements for a Taylor-type rule are necessary to be consistent with the objective of price stability. The third requirement—that monetary policy lean against the wind in response to an output or unemployment gap—not only contributes to the objective of price stability but is also obviously desirable from the perspective of a central bank like the Fed that has a dual mandate.

The Taylor approach to instrument-rule specification has been found to produce good macroeconomic outcomes across a wide range of macroeconomic models. Moreover, in a broad class of both closed (Clarida, Galí, and Gertler 1999; Galí and Monacelli 2008) and open economy (Clarida, Galí, and Gertler 2001 and 2002) dynamic stochastic general equilibrium, or DSGE models, Taylor-type rules can be shown to be optimal given the underlying microfoundations of these models. This in itself is a remarkable achievement. And when they are not strictly optimal, Taylor rules are very often found to be robust in that they produce near-optimal outcomes with modest information requirements on the full

structure of the economy, as would a fully optimal rule. I said modest instead of minimal because, of course, using a TR in practice to set policy rates does require the central bank to take a stand on the key inputs of r^* and u^*. Another desirable feature of Taylor rules is that when embedded in DSGE models, a policy that respects the Taylor principle rules out multiple stationary equilibria for inflation. Also, DSGE monetary models with TR reaction functions are learnable (Bullard and Mitra 2002; Evans and Honkapohja 2003; Marcet and Sargent 1989) in the sense that linear least squares learning about the parameters of the model will eventually converge to the true unique RE (rational expectations) equilibrium. In some of my own research on what it means for monetary policy to be data dependent, which I began while on the Board of Governors of the Federal Reserve System, I've studied a DSGE plus TR setup where the central bank—and agents—use optimal Bayesian updating to learn about the unobserved level of long-run potential output. In the model, the level of potential output is subject to infrequent Hamilton-type regime switches between low and high. With this simple structure, the model under optimal Bayesian updating (with perceived laws of motion that equal actual laws of motion, period by period) features "perpetual" learning. An interesting result is that overconfidence can be very costly if the central bank incorrectly believes there can be no Markov switch in potential output.

Taylor's original paper was, of course, an exercise in both positive and normative economics. It not only wrote down what a good policy rule should look like, but it also made the case that Fed policy during the Greenspan disinflation more or less tracked such a rule (see figure 2.1).

Taylor's original formulation of the TR assumed that r^* was equal to 2% and that the Fed should aim to keep inflation at 2%. This was, of course, nearly twenty years before the Fed adopted a formal inflation target of 2% and at a time, 1993, when US inflation had last printed 2% twenty years earlier. Strikingly, over the

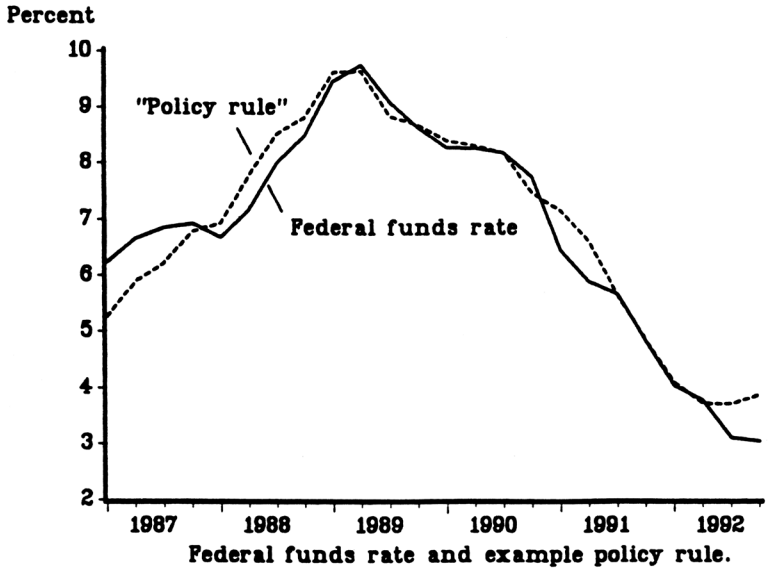

FIGURE 2.1. Federal Funds Rate and Example Policy Rule.
Fed policy during the Greenspan disinflation era more or less tracked the policy rule.
Source: Taylor (1993). Reprinted with permission from Elsevier.

ensuing fifteen years, US inflation averaged 2%, the federal funds rate averaged 4%, and the ex post real funds rate averaged 2%!

The finding that a Taylor rule could account for Fed policy during the early Greenspan years spawned its own research agenda to formulate and try to identify in time series data empirical Taylor-type rules that could account for broad swings in policy rates in the US, Europe, and Japan (Clarida, Galí, and Gertler 1998 and 2000; Clarida and Gertler 1997). This literature also embedded empirical "forward-looking" Taylor-type rules into a vector autoregressive (VAR) framework. In particular, if the policy is a function of expected inflation, and expected inflation, in turn, is a linear function, the n variables in the VAR with m lags, so then under an FLTR (forward-looking Taylor rule), the policy rate in the VAR will be a function of the n variables with m lags. When staring at

the interest rate equation in a VAR, it may at first glance appear, as it did to us, to represent an ad hoc kitchen sink specification of a central bank reaction function. But look closer and think harder, and you see that the FLTR placed testable restrictions—actually cross-equation restrictions—on the reduced form coefficients in the policy rate equation in the VAR. Figure 2.2 is taken from Clarida, Galí, and Gertler (1998) and plots the FLTRs against the actual policy rates in the United States, Germany, and Japan during those halcyon days when Germany still had the deutsche mark, the Bank of Japan was worried that inflation was too high, and the zero lower bound (ZLB) was but a footnote. I vividly recall presenting an early version of this work at the [Deutsche] Bundesbank in 1996 with Otmar Issing in the audience. When I asked Otmar if the Bundesbank—which at that time still publicly explained their policy in terms of the quantity theory—was formulating policy with reference to the Taylor rule, he replied, "I won't concede it, but I don't dispute it."

The fact that Taylor-type rules can, away from the ZLB, empirically help to account for the mapping from macro data to policy rates means that they can be an essential input to asset pricing models of yield curves and currencies in academia and fixed income markets. Indeed, I first became aware of Taylor's 1993 paper not from an economics professor but from a bond trader who was using it to build yield curve models for Citibank! After all, bond yields reflect the expected path of short rates, and if central banks set short rates based in part on a Taylor-type rule, bond yields will embed the joint dynamics of inflation and output gap data as filtered by the Taylor rule (Ang and Piazzesi 2003). The same is true for exchange rates. Real exchange rates, for example, reflect in part the expected path of real short rate differentials, and if central banks set short rates based in part on a Taylor-type rule, then real exchange rates will embed the joint dynamics of inflation and output gap data as filtered by the Taylor rule (Clarida, Galí, and Gertler 2001; Clarida 2014; Engel and West 2006). In sum, Taylor

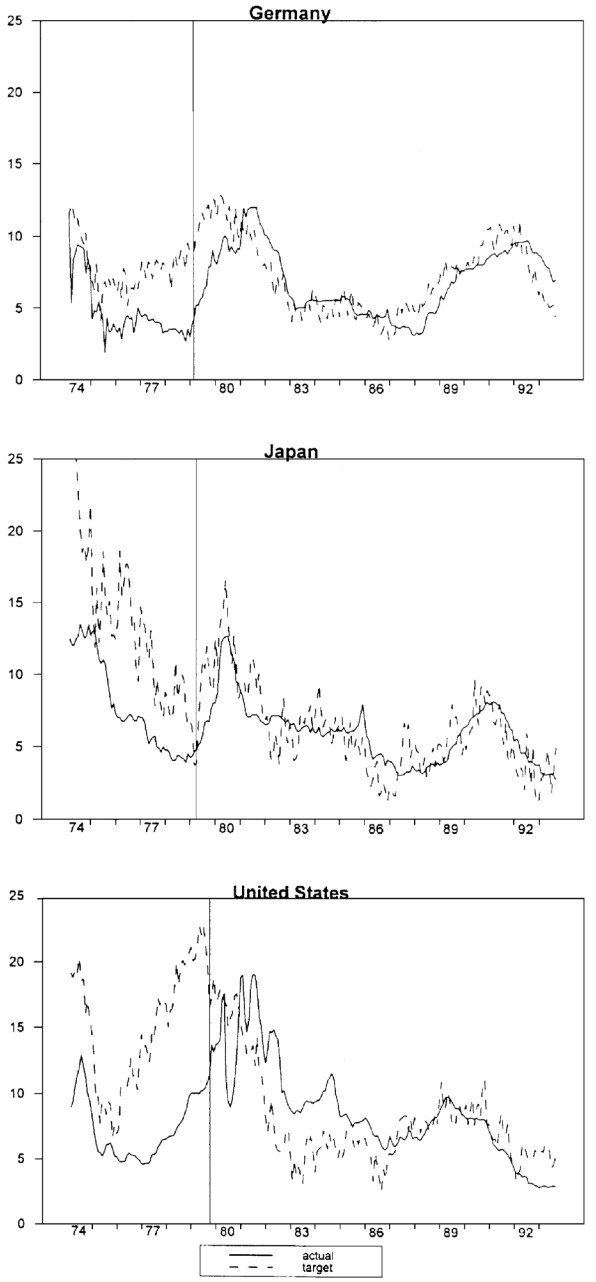

FIGURE 2.2. G3 Interest Rates: Target vs. Actual.
FLTRs plotted against the actual policy rates in the United States, Germany, and Japan indicate some correlation with the Taylor rule.
Source: Clarida, Galí, and Gertler (1998). Reprinted with permission from Elsevier.

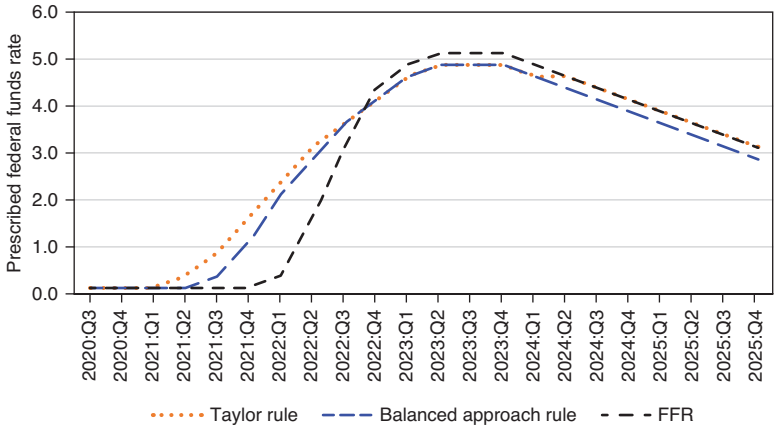

FIGURE 2.3. A Straightforward Way of Adding Policy Rules to the SEP. How using the inertial policy rules would have worked in the March 2023 SEP. Source: Papell and Prodan (2023).

rules are today ubiquitous in any economics literature in which macro factors and asset prices are objects of interest.

Turning now from theory and econometrics to policy in practice, Taylor-type rules are also, based on my experience, ubiquitous, at least in the briefing books staff prepare for Fed officials ahead of each monetary policy meeting, and are usually, but not always, featured in the Fed's semiannual *Monetary Policy Report* to Congress. Recent research from Papell and Prodan (2023) suggests a straightforward way that policy rules could be added to the Summary of Economic Projections (SEP) itself. Figure 2.3 shows how this would have worked in the March 2023 SEP using inertial policy rules, as are favored by many policymakers as a reference.

It is important to note how the policy paths are constructed. At each calendar date before June 2023, the policy rule paths are computed using actual data available to the Fed at dates before the most recent SEP, along with model-consistent values for the lagged policy rate (not actual policy rates) in the inertial rule.

As I explained at last year's Hoover conference and as is evident in the figure, certainly by the fall of 2021, monetary policy rules I consult, based on my research with Mark Gertler and Jordi Galí (Clarida, Galí, and Gertler 1999 and 2000)—for example, as highlighted in a presentation I delivered (virtually) to a Hoover seminar in January 2021 (Clarida 2021)—were indicating that lift-off from the effective lower bound was or soon would be warranted. In the event, the Federal Open Market Committee (FOMC) began to pivot in the fall of 2021 to end quantitative easing earlier than had been expected, commence rate hikes sooner than had been expected, signal a faster pace of policy normalization than had been previously projected, begin balance sheet normalization much sooner and at a much faster pace than was the case following the Great Financial Crisis, and to accelerate rate hikes to the fastest pace in forty years. Interestingly, the conditions the committee laid out in its September 2020 forward guidance for lifting off—that inflation had reached 2% and maximum employment had been achieved—were met by the December 2021 FOMC meeting, just three months after they were met by the balanced approached Taylor rule: the unemployment rate fell to 3.9% in December 2021 and as of at least August 2021, it was clear that under the Fed's own projections, inflation would more than average 2% over time.

There is much more to say, but I have now exhausted my fifteen minutes, so let me conclude by wishing the Taylor rule a very, very happy thirtieth birthday, and here's to many more.

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3

Naming the Taylor Rule

John Lipsky

Introduction

It is a great pleasure to participate in this terrific conference, and I feel honored to be included in such a great panel and to discuss a topic that is particularly important to me, that is, the Taylor rule on the occasion of its thirtieth anniversary.

Time is short, and my fellow panelists are renowned, so I will restrict my opening remarks to addressing a few critical but burning questions—ones I know you have wondered about for some time. First: How did the Taylor rule get its name? Second: How did a modest proposal contained in a paper delivered at an academic conference become known worldwide, seemingly instantaneously? And third: What happened to Salomon Brothers, and what did the Taylor rule have to do with it?

Taking the First Issue First: The Taylor Rule and Its Name

My guess is that you have never thought about this, and even if you had, you would have concluded: "Of course, John Taylor concocted it; why wouldn't it be called the Taylor rule?"

No matter, you've probably never wondered why everyone calls transparent cellophane adhesive tape Scotch Tape or why facial tissues are referred to everywhere as Kleenex. It turns out that Scotch Tape was developed by a fellow named Richard Drew,

who allegedly had Scottish bosses.[1] With regard to Kleenex, let me assure you that you don't really want to know the advertising logic that went into creating the now iconic and ubiquitous brand name.

But think about it. All of you who know John Taylor (and I presume that's pretty much everyone here) know him well enough to be sure that he's about the last person on earth who would have named the Taylor rule the Taylor rule. Not his style, to say the least.

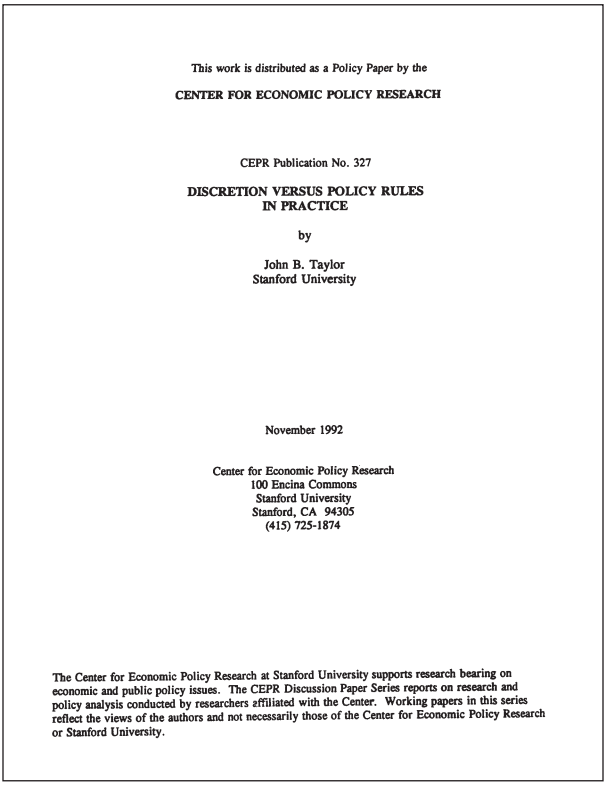
Here's the title page of the original paper (see figure 3.1) containing the rule that Taylor wrote for the Center for Economic Policy Research here at Stanford University.[2]

Did any of you attend the conference where it was first presented or read it when it was first published? Note the historical aspect of the cover page. The Center for Economic Policy Research (or CEPR) was then modestly housed at 100 Encina Commons. Yes indeed, that's the predecessor of today's Stanford Institute for Economic Policy Research (or SIEPR), located comfortably in the wonderful Gunn Building just across the way. Like the Hoover Institution, Stanford, and Silicon Valley, SIEPR has come a long way from CEPR in Encina Commons.

I did not attend the Carnegie-Rochester conference where the "Discretion versus Policy Rules in Practice" paper was first presented, but I did read it when it was published by CEPR. At the time, I was the newly appointed chief economist of Salomon Brothers.

To me, the monetary policy rule contained in the paper was—to mix metaphors—music to my ears. My Salomon Brothers economic research colleagues and I were convinced that the Federal Reserve's policy had veered off course by failing to tighten policy during the course of 1993, and Taylor's policy rule formulation provided another arrow for our quiver.

Here (in figure 3.2) you can see one formulation of the rule, arrayed in contrast to the actual federal funds rate. We made this



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DISCRETION VERSUS POLICY RULES
IN PRACTICE

by

John B. Taylor
Stanford University

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Center for Economic Policy Research
100 Encina Commons
Stanford University
Stanford, CA 94305
(415) 725-1874

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FIGURE 3.1. Title Page of the Original Paper Introducing the Taylor Rule. The origin story for the Taylor rule begins with an unpublished paper presented at an academic conference.

Source: Center for Economic Policy Research (now Stanford Institute for Economic Policy Research, or SIEPR).

argument about the federal funds rate a centerpiece of our annual economic and market analysis "Prospects for Financial Markets," published by Salomon Brothers in December 1993 with the title "Keeping Inflation Low in the 1990s."

In this report, we made the claim that the Fed had veered off course, citing Taylor's article, highlighting "a recent study indicating that until last year, the Fed's policy actions were consistent with an implicit 2% inflation target, but that its failure to hike

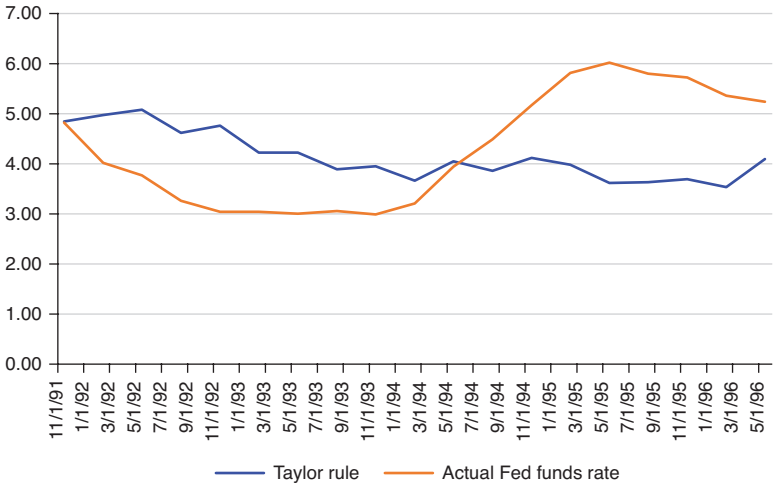


FIGURE 3.2. Actual Fed Funds Rate and Taylor Rule.
From too loose to too tight: Fed Policy Rates 1991–96.
Source: Taylor Rule Utility, Federal Reserve Bank of Atlanta (Atlantafed.org).

rates during the past year has called into question the stringency of the Fed's policy goals." And we footnoted this quote from the Carnegie-Rochester paper.

As far as we can ascertain, this is the first independent reference to Taylor's paper—at least outside of an academic context. Also, while the federal funds rate at the time was about 3%, we calculated that it should be realized at about 4.125% or so, utilizing the formulation in the conference paper to corroborate our claim.

Next up was Fed chair Alan Greenspan's Congressional Testimony of January 31, 1994.[3] Suffice it to say that what we at Salomon economic research heard the chair say was, "We are going to raise rates, and we are going to begin any minute now." In contrast, the press reports about the testimony—as were typical—reveled in telling everyone that you never could make head nor tail of the chairman's Delphic remarks. At Salomon Brothers, however,

TABLE 3.1. Fed Rate Hikes 1994–95: Engineering a Soft Landing. The attempt to engineer a soft landing resulted in a terrible year for long-duration bonds as many traders were unprepared for the rate increases.

FOMC Meeting Date	Rate Change (bps)	Federal Funds Rate
February 1, 1995	+50	6.00%
November 15, 1994	+75	5.50%
August 16, 1994	+50	4.75%
May 17, 1994	+50	4.25%
April 18, 1994	+25	3.75%
March 22, 1994	+25	3.50%
February 4, 1994	+25	3.25%

Source: Federal Reserve Board.

my colleagues and I virtually ran around the trading floor, yelling, "The Fed is coming, the Fed is coming!"

Well, the Fed hiked the federal funds rate by 25 basis points on February 4, 1994, beginning a tightening cycle that would extend until February 1995, encompassing a rise in the federal funds rate from 3% to 6%. In other words, using the Taylor calculations, the Fed went from too loose to too tight in the space of about a year. Parenthetically, the core personal consumption expenditures (PCE) deflator was about 2.25% year over year in January 1994 and about the same rate a year later.

Even more unnerving—at least for financial market participants—was the accompanying bond market rout (see table 3.1). When Chair Greenspan spoke on January 31, the ten-year Treasury bond yield was 5.94%. It peaked on October 31 at 8.04%. In fact, precedent would have suggested that the Fed's first 50 basis points of tightening would have produced a bond yield backup of about half that magnitude or roughly 25 basis points.

In 1994, by contrast, ten-year bond yields backed up by nearly a full percentage point in response to the first 50 basis point rise in the federal funds rate. Traders' lack of experience with a Federal

Reserve tightening environment in the context of large holdings of mortgage-backed securities (MBS), and their negative convexity, set off a wave of Treasury bond selling by traders seeking to control their duration risk.

My Salomon Brothers economic research colleagues and I eventually became convinced that the Fed had overdone the tightening and that the bond market sell-off also was overdone. In the meantime, however, Salomon Brothers bond trading desks—especially the MBS traders—had lost copious amounts of money in their portfolios on a mark-to-market basis. As Salomon Brothers research analysts, we were mortified to realize that our bond trading colleagues simply hadn't believed our Fed analysis and were unprepared for the bond market consequences. I'll return to this theme a bit later.

As we subsequently built our case with regard to both Fed policy and bond market valuations, as my former Salomon Brothers colleague Robert DiClemente reminded me recently, we made our arguments based on comparing the actual federal funds rate to a "neutral" or "hypothetical equilibrium" rate, footnoting the Carnegie-Rochester paper every time. In making client presentations, we routinely would include what we referred to as Taylor rule calculations.

Finally, in mid-1995, we decided to summarize the burgeoning discussion regarding monetary policy rules in a compact form for our clients. The result was a monetary policy research paper, "Policy Rules Shed New Light on Fed Stance," which Salomon Brothers published in June 1995. In it, we introduced the topic in a generic fashion and highlighted a list of alternative policy rules, giving pride of place to the work of John Taylor and his rule. We then went on to emphasize the usefulness of what we called "Taylor's Rule." As far as we know, this was the first use in print of this personalized nomenclature, which since has become a universal practice.

Why Did the Taylor Rule's Fame Spread So Far and So Fast?

One key lesson from investment banking is that the right deal at the right time and the right price will be snapped up in a flash. I think (and at the time, probably hoped) that Salomon Brothers economic research had attracted some attention with our vindicated call on the Fed's belated tightening (this despite our trading colleagues' failure to believe us). We then spent a fair amount of time in 1994 arguing that the Fed was overdoing it, as was the yield backup in the Treasury bond market. Perhaps we gained a bit of street credibility, having called it both ways, as it were. And we consistently referred to the Taylor rule (by now using the name as a matter of course) as providing useful guidance.

In any case, other Wall Street economists quickly followed suit—that is, utilizing the Taylor rule as a basis for their analysis. They, along with some journalists and even some scholars, began to challenge central bankers to defend or explain their policy moves (or lack of same) by reference to the Taylor rule. Before you knew it, virtually everyone everywhere was using it. And even some skeptics—who tended to view its practical usefulness as a short-term artifact of "right place, right time" rather than something that would retain validity over time—seem to be coming back to utilizing the Taylor rule as a practical policy guide.

In investment banking terms, it was much more durable than simply the right deal at the right time. It continues to demonstrate its relevance thirty years on.

What Happened to Salomon Brothers?

I don't want to bore you with a detailed story. Suffice it to say that the firm's self-image as the world's preeminent securities trading firm simply didn't survive the 1994 trading losses. Remember

that Lew Ranieri—the pioneer of the mortgage-backed bond market—was long gone (from Salomon Brothers), and John Meriwether and his original crew of proprietary traders—made famous by author Michael Lewis's book *Liar's Poker*—were by and large up in Greenwich (and London and elsewhere) doing business as Long-Term Capital Management, and still convincing investors that they possessed the Midas touch, at least until they didn't, but that came later.[4]

So what followed after the 1994 bond debacle wasn't pretty. In 1985, Salomon Brothers CEO John Gutfreund appeared on the cover of *Business Week* (then a big deal) with the caption, "The King of Wall Street." Imagine the implications of this title at a time when I doubt that the firm totaled more than two thousand five hundred employees, soup to nuts. Only a decade later—encompassing a few nontrivial missteps—the firm had lost momentum and didn't appear to have a viable long-term strategy. Along came Sandy Weill and Smith Barney, and then Citigroup.[5] And the rest is history.

If only Salomon Brothers's vaunted bond traders had paid attention in January 1994 to the message of the Taylor rule, even in its infancy, perhaps they still would be the "Kings of Wall Street." But we'll never know.

Thus, despite the 1993–94 prescience of the Salomon Brothers economics research team, the firm is no more. At the same time, the Taylor rule—that helped guide Salomon analysts and countless others right from its infancy—continues to thrive and hopefully will contribute to getting policy back on track everywhere, following a period of unprecedented challenges.

Notes

1. Scotch Tape was invented by Richard Drew, a 3M engineer, in 1925. The official story from the brand lacks specificity as to where the name came from. See Scotchbrand.com.

2. John B. Taylor, "Discretion versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy* 39 (1993): 195–214. Amsterdam: North-Holland.
3. US Congress, Joint Economic Committee. Testimony of Alan Greenspan, Chair of the Federal Reserve Bank. 103rd Cong., 2nd sess., January 31, 1994.
4. Michael Lewis, *Liar's Poker: Rising through the Wreckage on Wall Street* (New York: W. W. Norton & Company, 1989). Long-Term Capital Management L.P. was founded in 1994. The leveraged hedge fund went bankrupt in 1998.
5. Salomon Brothers was acquired by Travelers Group, which owned Smith Barney, in 1997. When Travelers Group merged with Citicorp in 1998, it became part of Citigroup, which used the name for its combined investment banking operations, Salomon Smith Barney. In 2003, the division rebranded as Citigroup Global Markets.

4

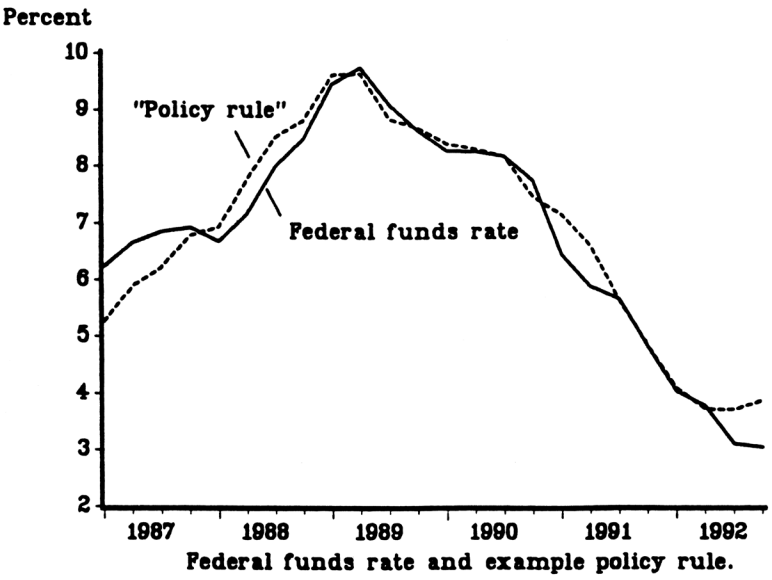
The Taylor Rule at Thirty: Still Useful to Get the Fed Back on Track

Volker Wieland

It is a great pleasure for me to celebrate the thirtieth anniversary of the famous Taylor rule with you at this conference. I can even say I was right there at its birth. At least, the first footnote of John Taylor's "Discretion versus Policy Rules in Practice" in the Carnegie-Rochester Conference Series states that helpful comments and research assistance were provided by Craig Furfine, Ben McCallum, John Williams, and Volker Wieland (see Taylor 1993a). Craig, John, and I were working as research assistants for John Taylor at the time.

Nowadays, I teach about policy rules in general and Taylor's rule in particular in my courses on macro and monetary policy. Typically, students have already heard about it. But many of them think that it is an exercise in description. Considering figure 4.1 (the original figure from Taylor 1993a), this is not surprising. Students see this as a reaction function estimated to fit the data on interest rates, output, and inflation in the late 1980s and early 1990s.

Yet, the coefficients of the policy rule are round numbers that do not look like estimates, and there are no standard errors reported. Upon reading the abstract or introduction of the article, it quickly becomes clear that the process of arriving at figure 4.1 was the other way around. Taylor used macroeconomic models to identify a type of feedback rule that performed well across a new class of models. Only then did he go on to compare a representative rule with actual Fed decisions.



$$r = p + .5y + .5(p - 2) + 2$$

where

r is the federal funds rate,
p is the rate of inflation over the previous four quarters
y is the percent deviation of real GDP from a target.

FIGURE 4.1. The Original Taylor Rule: John Taylor's Seminal Contributions. Figure from John Taylor's original paper, with definition of Taylor rule. Source: Taylor (1993a). Reprinted with permission from Elsevier.

The abstract explains this very clearly. Accordingly, "econometric policy evaluation research" had shown that "good policy rules typically call for changes in the federal funds rate in response to changes in the price level or changes in real income." Taylor's objective was to "preserve the concept of such a policy rule in a policy environment where it is practically impossible to follow mechanically any particular algebraic formula that describes the policy rule." He focuses on "a hypothetical but representative policy rule much like that advocated

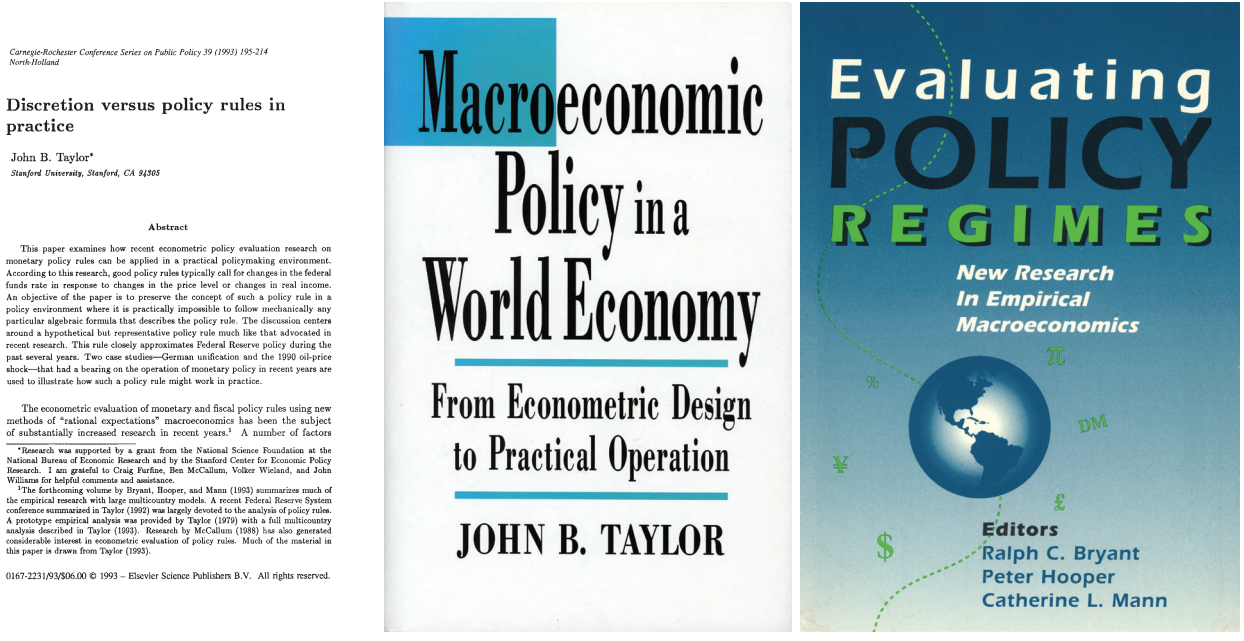
in (then) recent research" and explains that it closely approximates Federal Reserve policy during the preceding several years.

So, Taylor was coming from new research using the methods of rational expectations macroeconomics to deliver lessons and tools for practical policymaking. As to the sources for this research, the footnote in the photo of the abstract shown in figure 4.2 refers to the two books also shown.

Both of them were published in 1993. The volume edited by Bryant, Hooper, and Mann (1993), three former Federal Reserve economists, summarized a substantial body of empirical research with large multi-country models, one of them, the model of the G7 economies presented in Taylor (1993b). The latter is an early-generation New Keynesian model with rational expectations and nominal rigidities due to overlapping wage contracts. Taylor (1993a) distills lessons from this body of research in the form of a feedback rule for the federal funds rate that comes close to actual Federal Reserve decision making from 1988 to 1993.

But John Taylor's contributions to macroeconomics go far beyond the 1993 article and the book. In the late 1970s and early 1980s, he already built the foundations for this as well as subsequent research on economic policy evaluation. I will focus on a selection of three seminal contributions here. Each of them introduced a household name to monetary macroeconomics: Taylor contracts, Taylor curves, and the Fair-Taylor method.

"Aggregate Dynamics and Staggered Contracts," published in the *Journal of Political Economy* in 1980, laid the foundations for analyzing the real effects of monetary policy under rational expectations. Until then, rational expectations macro had pushed the line that only monetary policy surprises would change real GDP and employment. Taylor (1980) changed that by deriving the real effects of anticipated monetary policy under overlapping wage or price contracts. It was the key step toward the New Keynesian Phillips curve that is used today.



Carnegie-Rochester Conference Series on Public Policy 39 (1993) 195-214
North-Holland

Discretion versus policy rules in practice

John B. Taylor*
Stanford University, Stanford, CA 94305

Abstract

This paper examines how recent econometric policy evaluation research on monetary policy rules can be applied in a practical policymaking environment. According to this research, good policy rules typically call for changes in the federal funds rate in response to changes in the price level or changes in real income. An objective of the paper is to preserve the concept of such a policy rule in a policy environment where it is practically impossible to follow mechanically any particular algebraic formula that describes the policy rule. The discussion centers around a hypothetical but representative policy rule much like that advocated in recent research. This rule closely approximates Federal Reserve policy during the past several years. Two case studies—German unification and the 1990 oil-price shock—that had a bearing on the operation of monetary policy in recent years are used to illustrate how such a policy rule might work in practice.

The econometric evaluation of monetary and fiscal policy rules using new methods of "rational expectations" macroeconomics has been the subject of substantially increased research in recent years.[1] A number of factors

*Research was supported by a grant from the National Science Foundation at the National Bureau of Economic Research and by the Stanford Center for Economic Policy Research. I am grateful to Craig Furfine, Ben McCallum, Volker Wieland, and John Williams for helpful comments and assistance.

[1]The forthcoming volume by Bryant, Hooper, and Mann (1993) summarizes much of the empirical research with large multicountry models. A recent Federal Reserve System conference summarized in Taylor (1992) was largely devoted to the analysis of policy rules. A prototype empirical analysis was provided by Taylor (1979) with a full multicountry analysis described in Taylor (1993). Research by McCallum (1988) has also generated considerable interest in econometric evaluation of policy rules. Much of the material in this paper is drawn from Taylor (1993).

Macroeconomic Policy in a World Economy

From Econometric Design to Practical Operation

JOHN B. TAYLOR

Evaluating POLICY REGIMES

New Research In Empirical Macroeconomics

Editors
Ralph C. Bryant
Peter Hooper
Catherine L. Mann

FIGURE 4.2. A Representative Rule Emerging from Macro Model Comparisons.
Left to right: abstract page from Taylor (1993a), reprinted with permission from Elsevier; cover of Taylor (1993b), reprinted with permission from W. W. Norton; and cover of Bryant, Hooper, and Mann (1993), reprinted with permission from Rowman & Littlefield Publishing Group Inc.; permission conveyed through Copyright Clearance Center Inc.

In "Estimation and Control of a Macroeconomic Model with Rational Expectations," published in *Econometrica* in 1979, Taylor estimated a prototype macro model with rational expectations empirically and computed optimal policy rules. Taylor (1979) first reported so-called Taylor curves that showed the policy trade-off between the standard deviation of inflation and the standard deviation of the output gap.

Finally, "Solution and Maximum Likelihood Estimation of Dynamic Nonlinear Rational Expectations Models," published by Ray Fair and John Taylor in *Econometrica* in 1983, presented the tools for solving and estimating the new class of models. Together the three papers provided the necessary theoretical and methodological innovations that made the development of a new generation of practical policy models with rational expectations and nominal rigidities possible. Solving these models required the introduction of feedback rules for policy, because solving them involved computing the expectations of future policy decisions. Such rules still form an essential part of macro models and policy analysis today. They have become known as Taylor rules or Taylor-style rules.

Starting with Jan Tinbergen and Ragnar Frisch, who received the first Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 1969 for "having developed and applied dynamic models for the analysis of economic processes," there have been a number of Nobel Prizes awarded for advances in macroeconomics and economic policy. The prize awarded to Milton Friedman in 1976 included the dedication "and for his demonstration of the complexity of stabilization policy." Robert Lucas was recognized in 1995 "for having developed and applied the hypothesis of rational expectations . . . and deepened our understanding of economic policy." In 2004, Finn Kydland and Edward Prescott followed with a prize for "the time consistency of economic policy and the driving forces behind business cycles." In 2011, the prize was given to Thomas Sargent and Christopher Sims "for their empirical research on cause and effect in the macroeconomy."[1]

Yet, as outlined above, monetary macroeconomics has undergone a major transformation and this scientific progress has had important implications for policy. Thus, in my humble opinion, it is time to recognize the huge progress in monetary macroeconomics, the advances in New Keynesian modeling of real effects of monetary policy, and the design of feedback rules for stabilization policy with a wide impact on policy practice. The lessons for rule-based policy, in particular, remain valid and highly relevant today. I would say it is time for a prize to be given "for modeling the linkages between the real and monetary sides of the macroeconomy and developing effective rules for stabilization policy."

Taylor Rules in Macro Models and Policy Practice

In modern macro models with rational expectations and nominal rigidities, households and firms behave in a forward-looking, optimizing manner. A model solution needs to account for endogenous policy reactions and determine expectations and policy jointly. These models typically include rules for monetary policy that respect the so-called Taylor principle, which states that the nominal interest rate changes more than one-for-one with inflation or inflation expectations—at least over the medium run. Similarly, these models include feedback rules for fiscal policy that stabilize debt-to-GDP ratios. Such a fiscal policy implemented via a tax or transfer rule allows monetary policy to achieve price stability.

Taylor (1993a) emphasized the case for rule-based policy. Rule-based policy is predictable and predictable policy is more effective because it exploits the expectations channel of policy transmission. To illustrate the power of the expectations channel, I ran two simulations in the Taylor (1993b) multi-country model using the Macroeconomic Model Data Base.[2] First, I consider a onetime surprise deviation ε from Taylor's original rule shown in equation (1).

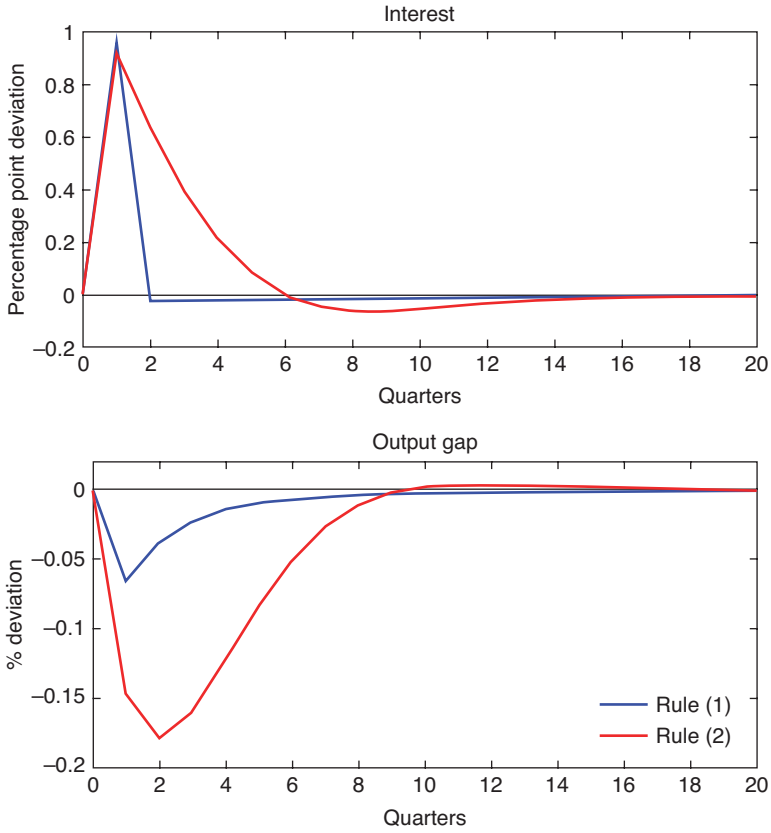


FIGURE 4.3. Impulse Responses to a Policy Shock in Taylor's (1993b) Multicountry Model.

Source: Macroeconomic Model Data Base, https://www.macromodelbase.com.

$$r_t = a_0 + 1.5p_t + 0.5y_t + \varepsilon_t \tag{1}$$

The size of the deviation is one percentage point. As a consequence, the federal funds rate (blue line in figure 4.3, top panel) rises for one quarter by about one percentage point and drops back down to the initial level by the second quarter. The impact on GDP is very small at little more than 5 basis points and remains short lived (blue line in figure 4.3, bottom panel).

Next, I add the lagged federal funds rate r_{t-1} to the rule with a reaction coefficient of 0.8, as shown in equation (2).

$$r_t = a_0 + 0.8r_{t-1} + 1.5p_t + 0.5y_t + \varepsilon_t \quad (2)$$

As a consequence, the increase in the federal funds rate following the temporary deviation ε persists for a longer time (red line in figure 4.3, top panel). The interest rate returns to the initial level by the fifth quarter. While the initial deviation is unexpected, the subsequent endogenous persistence is predictable. Via the expectations channel, it contributes to an outsized effect on real GDP. The decline in GDP is about three times larger and longer-lasting than in the case without endogenous interest rate persistence (red line in figure 4.3, bottom panel), even though the peak of the interest rate is the same, and it declines only a bit more slowly.

In the 1990s and 2000s, monetary models were developed further to include more stringent microeconomic foundations. They became known under the acronym DSGE (dynamic stochastic general equilibrium) models. Still, these models assume rational expectations and include policy rules as well as nominal rigidities due to staggered wage and price contracts. The first medium-sized New Keynesian DSGE model for the US economy was developed by Lawrence Christiano, Martin Eichenbaum, and Charles Evans in 2001 and ultimately published in Christiano et al. (2005). This model was estimated by matching the impulse response of a monetary shock in the structural model to the impulse response of a monetary surprise in a vector autoregression (VAR) model. Smets and Wouters (2003 and 2007) proposed and applied Bayesian methods that proved much more practical for estimating such New Keynesian DSGE models.

Christiano et al. (2005) used a simple Taylor rule with interest rate persistence (equation 3) to conduct simulations of their model.

$$r_t = a_0 + 0.8r_{t-1} + 0.3p_t + 0.08y_t + \varepsilon_t \quad (3)$$

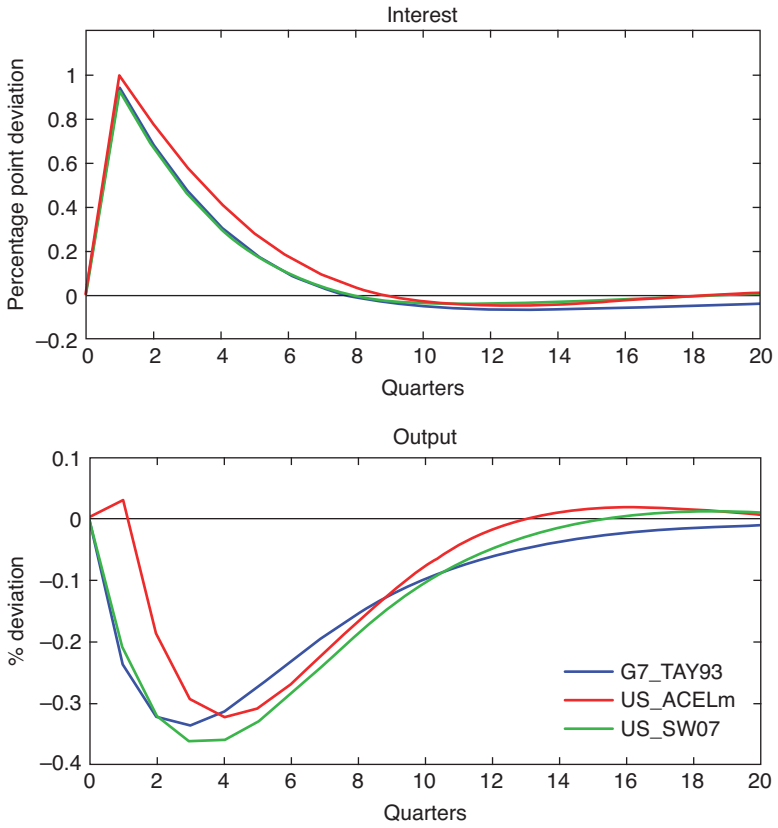


FIGURE 4.4. Impulse Responses to a Policy Shock in DSGE Models and Taylor. Simulation of monetary policy shock under rule (3) in three models: G7_TAY93 (model of G7 economies, Taylor 1993b); US_ACELm (version of model of US economy US_SW07, Christiano et al. 2005); Smets and Wouters (2007) model of US economy. Acronyms as in Macroeconomic Model Data Base.

Source: Macroeconomic Model Data Base, https://www.macromodelbase.com.

Interestingly, the effects of policy shocks in these New Keynesian DSGE models turned out to be very similar to the effects of such shocks in the multi-country model of Taylor (1993b). Figure 4.4 shows the impulse responses when the federal funds rate is set according to equation (3) in the Christiano et al. (2005), Smets and Wouters (2007), and Taylor (1993b) models.

In all three models, interest rates rise for a sustained period in response to the policy shock. This causes a reduction of about 35 basis points in real GDP within three quarters. Wieland et al. (2016) extended the comparison to consider many new macro-financial DSGE models that were developed after the Global Financial Crisis of 2007–9. These models include financial frictions in corporate investment financing, housing finance, and banking capital. Comparisons of monetary policy shocks in those models indicate somewhat sharper effects on economic activity than in the earlier generation of DSGE models. The Macroeconomic Model Data Base allows one to conduct many more model and policy comparisons of this type.

Taylor (1993a) puts great emphasis on the need for testing the robustness of policy rules across different models. This strategy for identifying useful policy rules was pursued in a large number of subsequent research contributions. Some examples to which I contributed include Levin et al. (1999 and 2003) and Taylor and Wieland (2012) for the United States and Orphanides and Wieland (2013) for the Euro area. Table 4.1, which reproduces table 4 from Taylor and Wieland (2012), indicates one of several possible approaches for achieving robustness—namely, model averaging.

We consider a standard ad hoc central bank loss function that includes the variances of inflation, the output gap, and the change in the federal funds rate. Then, we search for the rule that maximizes the average loss for the three New Keynesian models with rational expectations used in the simulation in figure 4.4. The optimization is carried out for 2-, 3-, and 4-parameter rules that respond to inflation, the current and preceding output gap, and the lagged interest rate. Optimized parameters are shown in table 4.1. Such 3- and 4-parameter rules typically perform better than 2-parameter rules. The coefficient on the lagged interest rate is slightly above unity. Thus, they are very close to first-difference

TABLE 4.1. Searching for Robust Policy Rules: The Example of Model Averaging.

Optimized Model-Averaging Rules

$$\text{Objective: Min} \sum_{m \in M} \frac{1}{3}(\text{Var}(\pi_m) + \text{Var}(y_m) + \text{Var}(\Delta i_m));$$

$$\text{Rules: } i_t = \rho i_{t-1} + \alpha \pi_t + \beta_0 y_t + \beta_1 y_{t-1} + \beta_\Delta \Delta y_t$$

Set of Equally Weighted Models: $M = \{SW, TAYLOR, ACEL\}$	ρ	α	β_0	β_1	β_Δ
2-Parameter Rule (Gap)		2.75	0.52		
3-Parameter Rule (Gap)	1.05	0.41	0.23		
3-Parameter Rule (Growth)	1.09	0.20			0.76
4-Parameter Rule (Gap)	1.06	0.19	0.67	–0.59	

Source: Taylor and Wieland (2012).

or change rules. Yet, 2-parameter rules perform more robustly if one were to add models with backward-looking or adaptive expectations (see Cochrane et al. 2020). First-difference rules tend to induce explosive behavior in such models.

Moving to policy practice, I should note that the Taylor rule and other rules of this type almost immediately became part of regular briefing materials prepared for the Board of Governors and the Federal Open Market Committee (FOMC). Board researchers such as Glenn Rudebusch, Andrew Levin, Brian Madigan, John C. Williams, and Athanasios Orphanides right away engaged in research on Taylor rules. I joined them as a young Board economist and helped prepare a regular rules package from 1996 onwards. Far beyond the Fed, policy rules quickly became a standard tool to be presented to central bank decision makers around the world.

The Federal Reserve eventually introduced a policy rules section as a regular part of its monetary policy report. I think that is an excellent practice and would suggest the same for other central banks, such as the European Central Bank. Table 4.2 reproduces the prepandemic rules menu from the Fed's monetary policy report (see Federal Reserve Board 2020).

TABLE 4.2. The Fed's Prepandemic Rules Menu.

Taylor (1993a) 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 (1993a) 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	$R_t^{FD} = R_{t-1} + 0.5(\pi_t - \pi^{LR}) + (u_t^{LR} - u_t) - (u_{t-4}^{LR} - u_{t-4})$

Notes: R_t^{T93}, R_t^{BA}, R_t^{T93adj}, R_t^{PL}, and R_t^{FD} represent the values of the nominal federal funds rate prescribed by the Taylor (1993a), balanced-approach, adjusted Taylor (1993), price-level, and first-difference rules, respectively.

R_t denotes the realized nominal federal funds rate for quarter t, π_t is the four-quarter price inflation for quarter t, u_t is the unemployment rate in quarter t, and r_t^{LR} is the level of the neutral real federal funds rate in the longer run that is expected to be consistent with sustaining maximum employment and inflation at the FOMC's 2% longer-run objective, π^{LR}. In the addition, u_t^{LR} is the rate of unemployment expected in the longer run. Z_t is the cumulative sum of past deviations of the federal funds rate from the prescriptions of the Taylor (1993a) rule when that rule prescribes setting the federal funds rate below zero. $PLgap_t$ is the percent deviation of the realized level of prices from a price level that rises 2% per year from its level in a specified starting period.

The Taylor (1993a) rule and other policy rules are generally written in terms of the deviation of real output from its full capacity level. In these equations, the output gap has been replaced with the gap between the rate of unemployment in the longer run and its actual level (using a relationship known as Okun's law) to represent the rules in terms of the FOMC's statutory goals. The rules are implemented as responding to core PCE inflation rather than to headline PCE inflation because current and near-term core inflation rates tend to outperform headline inflation rates as predictors of the medium-term behavior of headline inflation.

Source: Federal Reserve Board (2023).

The menu includes the original Taylor (1993a) rule and several variants. However, the Fed uses the unemployment gap in place of the output gap. It doubles the respective response coefficient from 0.5 to 1.0 to account for the smaller degree of variation in the unemployment gap. The so-called balanced-approach rule doubles that coefficient again, raising it to 2.0. The adjusted Taylor (1993a) rule simply keeps interest rates lower for longer after a period of negative rates. The price-level rule keeps Taylor's coefficients but replaces the inflation gap with a price-level gap, that is the deviation from a price-level trend. Finally, there is also a first-difference rule.

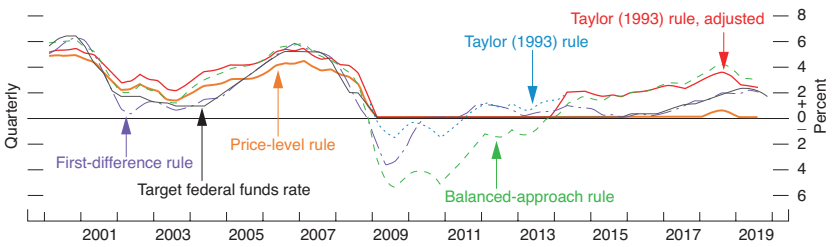


FIGURE 4.5. Federal Funds Rate Prescriptions from the Prepandemic Rules Menu.

Notes: The rules use historical values of core personal consumption expenditures (PCE) inflation, and the unemployment rate. Quarterly projections of longer-run values for the federal funds rate and the unemployment rate are derived through interpolations of biannual six-to-ten-year-ahead projections from Blue Chip Economic Indicators. The longer-run value for inflation is set to 2%. The target value of the price level is the average level of the price index for PCE excluding food and energy in 1998 extrapolated at 2% growth per year. The data extend through Q3 2019, with the exception of the midpoint of the target range for the federal funds rate data, which go through Q4 2019.

Sources: Federal Reserve Board (2020), from Federal Reserve Bank of Philadelphia; Wolters Kluwer, Blue Chip Economic Indicators; Federal Reserve Board staff estimates.

Interestingly, the rules in the prepandemic menu provided several useful signals to policy. This can be seen in figure 4.5, which reproduces the chart with historical federal funds rate prescriptions from the rules menu. First, the Taylor rule and two variants called for the Fed to raise interest rates earlier and faster ahead of the Global Financial Crisis in the years 2002 to 2005. This could have slowed down the housing boom that set the stage for the crisis (see Taylor 2007). Second, several of the rules called for lowering the federal funds rate into negative territory in 2009. This could be taken as a signal of the need for quantitative easing. In fact, the Fed initiated quantitative easing at that time. Third, the Taylor rule and some variants prescribed a substantial lift-off into positive territory by 2014, which is a good bit ahead of the tightening from the end of 2016 onwards. Raising rates earlier could have helped reduce the buildup of risks in the financial sector from the long period of low interest rates.

TABLE 4.3. The Fed's Postpandemic Rules Menu.

Taylor (1993a) rule	$R_t^{T93} = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) + (u_t^{LR} - u_t)$
Balanced-approach rule	$R_t^{BA} = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) + 2(u_t^{LR} - u_t)$
Balanced-approach (shortfalls) rule	$R_t^{BAS} = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) + 2min\{(u_t^{LR} - u_t), 0\}$
Taylor (1993a) adjusted	$R_t^{T93adj} = max\{R_t^{T93} - Z_t, ELB\}$
First-difference rule	$R_t^{FD} = R_{t-1} + 0.5(\pi_t + \pi^{LR}) + (u_t^{LR} - u_t) - (u_{t-4}^{LR} - u_{t-4})$

Note: For variable definitions please see the note to table 4.2.

From COVID-19 to the Inflation Surge and How to Get Back on Track

Following the Federal Reserve's strategy review that was completed in August 2020, the rules menu was changed. The price-level gap version of the Taylor rule was dropped. Instead, a balanced-approach (shortfalls) rule was added. This rule implemented the newly adopted concept that the Fed would only respond to shortfalls from maximum employment. Hence, the rule reacts when the unemployment rate exceeds the estimate of the long-run natural rate but not when it falls below that estimate. Table 4.3 and figure 4.6, respectively, show the Fed's postpandemic rules menu and the resulting federal funds rate prescriptions (see Federal Reserve Board 2023).

Figure 4.6 focuses on the years 2017 to 2023. There are two major events driving the federal funds rate prescriptions—the start of the pandemic in 2020 and the surge of inflation from 2021 onwards. As a result, the Taylor prescriptions dropped deeply into negative territory in 2020 and then quickly rose to high positive levels in 2021, reaching about 7% by 2022.

The pandemic caused a deep but short-lived recession in the first half of 2020. GDP declined by about 10% in the first two quarters of the year and quickly recovered after that. The unemployment rate rose from 3.5% in February 2020 to 14.7% in April 2020. By the

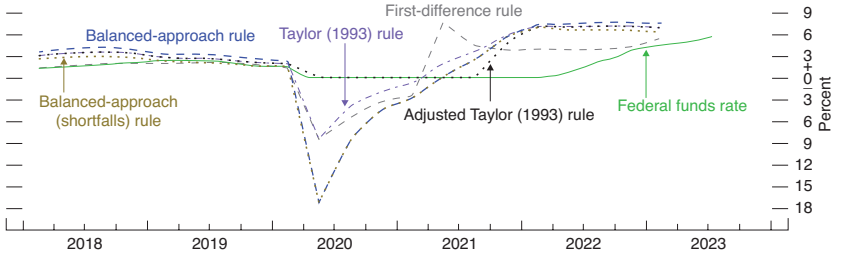


FIGURE 4.6. Federal Funds Rate Prescriptions from the Postpandemic Rules Menu.

Notes: The rules use historical values of core personal consumption expenditures inflation, the unemployment rate, and, where applicable, historical values of the midpoint of the target range for the federal funds rate. Quarterly projections of longer-run values for the federal funds rate and the unemployment rate used in the computation of the rules' prescriptions are derived through interpolations of biannual projections from Blue Chip Economic Indicators. The longer-run value for inflation is set to 2%. The rules' prescriptions are quarterly, and the federal funds rate data are the monthly average of the daily midpoint of the target range for the federal funds rate.

Sources: Federal Reserve Board (2020), from Federal Reserve Bank of Philadelphia; Wolters Kluwer, Blue Chip Economic Indicators; Federal Reserve Board staff estimates.

end of the year, it returned to 6.7%. The resulting unemployment gap is huge. Accordingly, the Taylor (1993a) rule in the Fed's chart called for a federal funds rate of −8.5% and the balanced-approach rule for a rate of −17% in the second quarter of 2020. For comparison, the output gap calculated by the Congressional Budget Office dropped to −11% in the second quarter of 2020. Hence, a Taylor rule computed based on such output gaps would also have called for a deeply negative federal funds rate.

Since negative rates are not possible on this scale, this could be interpreted as a call for massive quantitative easing and fiscal support. And this is indeed what happened. Purchases of government debt and other assets boosted the Fed balance sheet from about 20% to 35% of GDP. Furthermore, the Trump and Biden administrations implemented fiscal transfers—in particular, to the unemployed—on a scale never seen before.[3] Personal current

transfer receipts rose from $3.2 trillion to $5.6 trillion, a 70% increase in the second quarter of 2020, and again from $3.8 trillion to $6 trillion in the first quarter of 2021 (a 60% increase). In parallel and partly as a consequence, US personal income rose from $19 trillion in the first quarter of 2020 to $20.5 trillion in the second quarter (a 7.6% increase) and from $19.8 trillion to $22.1 trillion in the first quarter of 2021 (an 11.6% increase). Essentially, these fiscal interventions were money financed. The same occurred in other advanced economies. The governments issued debt, but central banks bought up the debt, issuing money instead and thereby increasing their balance sheets. Thus, there was a major money-financed stimulus in the United States and other advanced economies.

Interestingly, the unprecedented deep recession and output gap did not cause a comparable drop in the inflation rate into negative territory. In the United States, inflation measured by the consumer price index (CPI) or personal consumption expenditures index (PCE) briefly fell to about half a percentage point in the first half of 2020. Then it rose again and reached 5.7 % (PCE) and 6.7% (CPI) by the end of 2021. The Russian attack on Ukraine in February 2022 and the ensuing energy crisis only added more fuel to the fire that had started before. At this point, one may well ask whether the expansionary monetary and fiscal interventions were not excessive. Similarly, one may question whether the huge resource gaps were plausible indicators of the actual divergence of aggregate demand and aggregate supply in 2020, given that they used trend-based measures for the supply side.

It is important to recognize that the pandemic had a similar impact on aggregate demand and supply. As consumers and workers feared infection with COVID-19, they reduced contact-intensive consumption and work hours. Employers shut down contact-intensive production to avoid the spread of the pandemic at the

workplace, dismissed workers, or let them work from home if possible. Governments implemented lockdowns to further reduce the risk of infections. Consequently, both demand and supply of contact-intensive goods and services moved in lockstep, first sharply down and then back up. These behavioral responses are also embedded in the new class of epidemic-macro models. Such models incorporate the dynamics of a pandemic in a DSGE framework with forward-looking and optimizing households and firms. A new model database developed by a team led by Mathias Trabandt and myself allows for the simulation and reproduction of many of these models.[4] Here, I use the New Keynesian macro-epi model of Eichenbaum, Rebelo, and Trabandt (2022) to simulate the impact of an epidemic on the output gap, inflation, and interest rates under a Taylor rule. Figure 4.7 shows the outcomes given the initial spread of infections and parameterizations of the model authors. The x-axis for each panel represents the timeline in weeks. To lower the risk of infection, consumers and workers reduce consumption and work hours. GDP declines by about 8%, similar to the 2020 recession. As the infected recover and the spread of the pandemic ends, consumption and hours worked rise again quickly.

Interestingly, inflation only declines by a little more than half a percentage point. This is rather surprising given the deep recession of more than 8% of GDP relative to the steady-state level of GDP. However, this corresponds rather well with the actual impact of the COVID-19 pandemic on inflation in 2020. The reason is that aggregate supply declines almost as much as aggregate demand. The relevant gap is defined in the model as the difference between the so-called flexible-price level of GDP, that is, the level of economic output that would be realized if the price level were completely flexible. It differs from actual GDP in the model due to price rigidities arising from staggered wage and price contracts. The middle-right panel shows both measures together

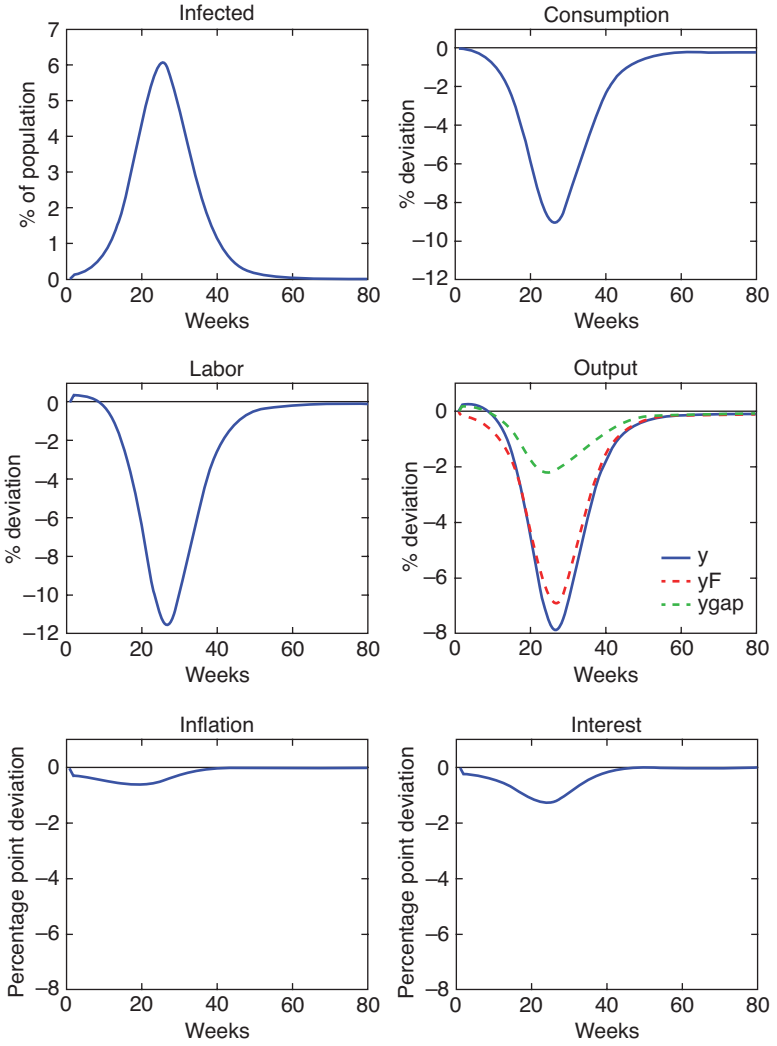


FIGURE 4.7. Simulation of an Epidemic in a New Keynesian Epi-Macro Model.
Source: Epidemic-Macro Model Data Base, https://www.epi-mmb.com.

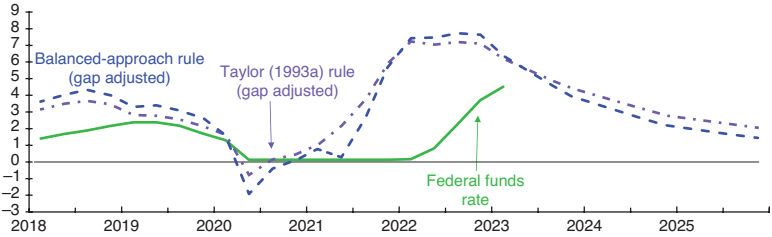


FIGURE 4.8. Taylor Rule with Adjusted Pandemic Output Gap and FOMC Projections.
Source: Author's calculations.

with the resulting output gap, which falls to about –1% at the depth of the recession. This output gap is included in the Taylor rule. Hence the prescribed interest rate cut is little more than one percentage point.

From the perspective of the analysis with the macro-epi model, the resource gap used in the Fed's rule menu during the coronavirus pandemic should be adjusted to better reflect the largely parallel movement of demand and supply. Figure 4.8 replicates two of the rules from the Fed's menu with the unemployment gap in 2020 adjusted by a factor of one-eighth. The rules are then projected forward for the remainder of 2023 to 2026 using the FOMC's projections for inflation and the unemployment rate.

The two rules still prescribe a monetary policy easing in 2020. The federal funds rate prescriptions briefly turn negative at –1% and –2%, respectively. This can still be interpreted as a call for quantitative easing at the time of the recession. Yet, it is much less pronounced than in the chart shown in the Fed's monetary policy report. The federal funds rate prescriptions quickly return to positive territory. In 2021, the prescribed federal funds rates rose quite rapidly along with inflation. The main driver is the Taylor principle embodied in both policy rules. The central bank needs to tighten interest rates more than one-for-one with inflation or inflation expectations to bring inflation back under control.

Importantly, the rules clearly signaled the need to tighten policy well ahead of the Fed's decision to increase the federal funds rate in spring 2022. Again, the Taylor rule proved its usefulness as a guidepost for monetary policy. If the Fed had responded to the rise of inflation earlier than it did, it could have spread the tightening over a longer period. This might have made it easier for the financial sector to adjust to higher interest rates, for example, by allowing banks more time to strengthen capital and liquidity positions and to account for potential losses due to asset price reversals. Thus, the financial sector could have been better positioned to weather the troubles we observed in spring 2023.

At this point, the federal funds rate prescriptions shown in figure 4.8 have been stabilizing at a high level thanks to the slowdown in inflation. Since the summer of 2022, the Fed has moved rapidly, bringing the federal funds rate closer to the rule's prescriptions. Additional tightening may still be necessary, as the trend change in headline inflation is not yet reflected in core inflation.

Looking forward, the FOMC projections for inflation and unemployment rates indicate that Taylor rule prescriptions could soon decline. Of course, this depends on whether the US economy proceeds along the path predicted by these projections. Importantly, the speed of decline also depends on the long-run projections for inflation and interest rates that signal FOMC members' perspectives on steady-state growth and real interest rates. At this point, the relevant estimate of the long-run real interest rate, the so-called r-star, embodied in the FOMC projections remains rather low. The median is 0.5%. If the economy returns to a higher trend growth path, the equilibrium real interest rate could well be higher. In this case, such Taylor rule projections would not decline as far, as figure 4.8 suggests.

In sum, even after thirty years, the Taylor rule remains a very useful guidepost to help the Fed get back on track, and it is encour-

aging that the Fed keeps including such policy rules in its official communications.

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Notes

1. All quotes found at Nobel Prize website, https://www.nobelprize.org/prizes/lists/all-prizes-in-economic-sciences.
2. This software tool and model archive, which contains more than 150 macroeconomic models is described in Wieland et al. (2016) and available from https://www.macromodelbase.com.
3. Starting in March 2020, the Coronavirus Aid, Relief, and Economic Security Act (CARES Act) provided onetime Economic Impact Payments of up to $1,200 per adult for eligible individuals and $500 per qualifying child under age 17. The payments were reduced for individuals with adjusted gross income (AGI) greater than $75,000 ($150,000 for

married couples filing a joint return). For a family of four, these Economic Impact Payments provided up to $3,400 of direct financial relief. Two subsequent rounds of such payments followed in December 2020 and March 2021. See US Department of the Treasury, "Policy Issues" at https://home.treasury.gov, accessed July 22, 2023.

4. The Epidemic-Macro Model Data Base is available at https://www.epi-mmb.com. Epidemic dynamics introduce a crucial nonlinearity in the macro-epi model. Hence the simulations require a nonlinear solution method. The macro-epi model database uses a version of the Fair and Taylor (1983) method that is implemented in the Dynare model solution software (see Adjemian et al. 2022, 72; and Dynare website, https://www.dynare.org).

GENERAL DISCUSSION

JOHN COCHRANE (INTRODUCTION): That was wonderful. Thanks to Condi [Rice] for reminding us that we're lucky to study easy questions like inflation and bank runs.

This is the panel on the Taylor rule at thirty, celebrating John [Taylor]'s 1993 paper "Discretion versus Policy Rules in Practice."

Disclaimer: John didn't want us to do this. This was Mike Bordo's idea, my enthusiastic second, and John's reluctant, "Okay, if you guys really have to." John's a very modest guy, but we can't not celebrate this moment.

What is the Taylor rule? If inflation rises one percentage point, central banks should raise interest rates by about 1.5 percentage points, and if the output gap rises one percentage point, they should raise interest rates a half a percentage point. Like all great ideas, this one had precursors. Knut Wicksell wrote a book in the 1890s with something like that idea in it, in complicated German prose. The Bank of England long raised interest rates to defend the gold standard. Bennett McCallum showed in 1981 how interest rates that rise more than one-for-one with inflation solve a multiple-equilibrium problem of rational expectations models, and that principle was well embedded in New Keynesian models by the early 1990s. John had already contributed to that. But this paper is what really made the Taylor rule important and brought it to life.

What's important about the Taylor rule? First, the previous nearly universal doctrine was that the central bank cannot and should not target interest rates. In his famous 1968 AEA [American Economic Association] address, Milton Friedman

said that the economy is unstable under an interest rate target. Try it, and inflation will blow up. Target money growth. [Thomas] Sargent and [Neil] Wallace, in 1975, wrote that an interest rate target will lead to indeterminacy, sunspots, and multiple equilibria.[1] Target money growth instead.

But the Fed and other central banks don't target money growth. They target interest rates and have done so for decades.

How does our world work? Well, the Taylor rule, raising interest rates more than one-for-one with inflation, repairs both Friedman's and Sargent and Wallace's problems. In these theories, the Taylor rule leads to an economy that is both stable and determinate. The Taylor rule was the central ingredient that we need to add to all preexisting theories to even talk about central banks that target interest rates, which our central banks do. So it was a great theoretical advance.

The Taylor rule is also, and perhaps primarily, empirical. John's 1993 paper was primarily about empirical and historical work. John noticed that in periods like the 1980s, with good macroeconomic performance, interest rates hewed pretty closely to the Taylor rule, while in periods like the 1970s, with recessions and inflation, interest rates did not respond as much to inflation. Many others refined these observations. Rich Clarida is here, and he, Jordi Galí, and Mark Gertler wrote a very famous paper showing, by careful regressions, that when the Fed started following a Taylor rule in the 1980s, the inflation got much better.

John's 1993 paper really brought the Taylor rule from theory and from an empirical characterization to a prescription. It was not just, this is how the Fed has behaved when times have been good, but how the Fed should behave. The crucial part is the second part of the title, "in practice." John showed in simple terms how the Taylor rule should work.

A deeply important feature of the Taylor rule is that it is robust. It is not just the optimal rule in a particular model or

class of models, and thus dependent on that model's particular assumptions. In fact, the Taylor rule is not optimal in most models. Most models have complicated optimal rules but very different rules across models. The Taylor rule, by contrast, is pretty darn good in all models. Old-fashioned IS-LM models? The Taylor rule is pretty darn good. New Keynesian rational expectations models, which are totally different? The Taylor rule is still pretty darn good but for totally different reasons. I now do fiscal theory of the price level, a third category of model. Guess what? Though fiscal theory is a totally different model, the Taylor rule is pretty darn good, again.

Is the Taylor rule a "rule?" Well, it's sort of a rule and sort of not a rule. One of the great calumnies that John has had to fight against for thirty years is that he says, "Just replace the Fed with a computer." No. One of the most important and unsung parts of John's advocacy of the rule is his view of how it should be used and implemented. It's not a mechanical rule. It's a strategy. It's a benchmark. It gives the Fed accountability and predictability. It helps communication. Sure, deviate from the rule, but explain why and when you will come back to the rule. People think that economics is hard because of the equations. They're wrong. Translating the equations and adapting them to practical policy advice is the hard part. John's advocacy of the rule as part of a realistic monetary policy strategy is, I think, one of his greatest contributions and that of the 1993 paper.

But yes, it is a "rule" in that it's there to help guide expectations. We all understand that inflation is quiet when people know what to expect of the Fed. If we live in a society with stable institutions and know what to expect of the future, things are much better today. I think this is the general point and might summarize what Condi was just saying about foreign policy.

So it is a "rule" in that sense. The Taylor rule replaces a money-growth rule or a gold standard as a way of telling people, over

the long run, what the Fed is going to do. It's also precommitment. Milton Friedman had the great analogy of a shower where you turn on the water and it gets too hot, then you turn it off and it gets too cold. That's discretion. And a lot of John's point was that rules, rather than discretion, are a "rule" in the sense they precommit the Fed to do things that it might not want to do ex post.

A rule is like a mandate. As you know, the Fed has a mandate: pay attention to inflation and employment. These happen to be pretty much the things in the Taylor rule—employment statistics and John's output gap work in just about the same way. A mandate tells the Fed the things it should pay attention to but also all the things the Fed should not pay attention to. Limited scope is vital for an independent agency in a democracy. The Taylor rule does much of the same, quantitatively. Yes, focus on inflation and output. But ignore the hundreds of problems that occupy Fed officials and tempt them to economic and financial fine-tuning or micro-planning.

The Taylor rule is, of course, amazingly influential. Andy Levin remarked that it has achieved the final measure of economic immortality: like the Modigliani-Miller theorem or Black-Scholes formula, you refer to the Taylor rule without the date following the name. And that's why we're here. The Taylor rule is at the heart of all monetary economics that talks about central banks with interest rate targets, which is how our central banks do things. It's at the heart of all our current understanding and doctrines of how central banks should operate when they're doing things well. And we come together once a year to remind central banks of that fact.

But it's not an eternal verity, not quite yet ready to be carved in marble on the front of the Hoover Institution next to $MV = PY$. How do we use the Taylor rule today? How does its advice adapt to different shocks—financial, fiscal, real, pandemic, trade

shocks—different conditions and an evolving economy—low real interest rates, changing measures of natural unemployment or potential output, the zero bound, and so forth? How quickly should the interest rate follow the rule—how "inertial" should the rule be, and how much should it weight the previous [federal] funds rate? How do we interpret evolving history and experience? We are here again today to debate active research questions, not just to once a year say, "Fed, follow the Taylor rule!"

So with that preamble, let's go. I think I'll take it in the order we've got here. Rich [Clarida], why don't you go next, and then John [Lipsky] and then Volker [Wieland]?

* * *

COCHRANE: Great job, panelists. We have time for questions. We'll take two or three questions and then give quick responses so that everyone gets a chance.

HARALD UHLIG: Harald Uhlig from the University of Chicago. The relationship between the Taylor rule and the federal funds rate right now is very interesting. Let me make a back-of-the-envelope calculation. Inflation is around 5%, and the federal funds rate is around 5%. That means that the real rate is currently around zero. This strikes me as considerably below a neutral level. Of course, one may wish to appeal to interest rate smoothing, as you showed, Richard [Clarida]. Still, when Paul Volcker fought inflation in the early 1980s, he chose to set the funds rate to a much higher number. Of course, if one follows a policy of raising the federal funds substantially now, I can see inflation coming down and, therefore, the nominal interest rates coming down eventually. But I am wondering whether in order to get back on track, we need to first raise the federal funds rate considerably more than where it currently stands. And it looks to me like the Taylor rule tells us that we ought to do that.

DAVID PAPELL: I'd like to highlight the differences between, on the one hand, inertial and noninertial rules and, on the other hand, Taylor rules and balanced-approach rules. With both Rich Clarida's results for inertial rules and Volker Wieland's results for noninertial rules, there is not much difference between Taylor rules and balanced-approach rules. While the difference between the two rules was important after 2009, what is important now is the difference between noninertial and inertial rules. At the time of lift-off from the effective lower bound in March 2022, the prescriptions with the inertial rules were about 200 basis points above the actual federal funds rate while the prescriptions with the noninertial rules were about 800 basis points above the actual rate.

As of March 2023, while the prescriptions with the noninertial rules were still about 250 basis points above the federal funds rate, the prescriptions with the inertial rules were actually 25 basis points below the rate. The large gaps with inertial rules are completely gone. As Rich Clarida showed, the Taylor rule prescriptions are very close to the federal funds rate projections for 2023 and equal to the projections in 2024 and 2025.

COCHRANE: Let's take responses quickly. We have current policy, real rates are still negative, why is inflation going down, and accounting for where is the Fed in real-time inertial versus noninertial rules?

RICHARD CLARIDA: I'll be very quick. The practice is typically to think about policy options in the inertial space, both because that describes past history pretty well—that was my work twenty years ago—and also because it has some desirable properties in a lot of models, because you basically get the bond market to do your work for you.

But you're right. It makes a big difference initially in terms of measuring how far behind the curve the central bank is, and

this is crucially dependent on what is the benchmark rule. I'll just leave it at that.

VOLKER WIELAND: As Harald said, if you use an ex-post short-term real interest rate, we're just at zero. So that doesn't seem like that much, and would call for raising it more. If you instead plug in a near-term inflation forecast, say market based or the Fed's forecast, you're in positive territory. In terms of risk management, the bigger risk right now is not to have inflation come down. The relevant measure is core inflation. Core inflation is about 5.5% in the United States and also in the euro area. But the difference between the US and the euro area is that headline inflation is still higher in the euro area, and core inflation hasn't declined. In the US, there has been some decline followed by stagnation of core inflation. So I think right now policymakers should really look at core inflation.

In Frankfurt, I keep referring to the Fed positively, because the ECB policy rate is still at 3.25% while we also have 5.5% core inflation. And now with the banking stress, it's harder to raise policy rates. So the ECB is even further behind. At the ECB, they shouldn't be talking about pausing. In my view, they need to get up to 4 or 5%.

It is interesting to compare the current situation to 1973 by aligning the attack on Ukraine with the Yom Kippur War in 1973. That was the attack on Israel and the oil embargo. When you do that, you'll find that in the period before the start of the war, policy was much more expansionary in the current episode. That is because in 2021, inflation was rising, while interest rates were kept constant. Thus, real rates fell in 2021. Yet in 2022, there was a very sharp rise in the nominal rate, which brings the real rate back to at least zero. Policy is much more reactive in the current episode than in 1973–74, not in terms of the level but in terms of the steepness of the rate rise.

COCHRANE: Sebastian, you're next.

SEBASTIAN EDWARDS: Sebastian Edwards. That was very interesting. I assign a number of John [Taylor]'s works to my students. And every year since 2009, the piece they like the most is a little book called *Getting Off Track*. So John was worrying about that since that time. And in it is the famous graph that shows that the Fed got behind the curve, and that generated the construction boom and made the crisis much worse.

But then [Alan] Greenspan went out and said, "Well, that's the conundrum." And we did hike rates eventually. And nothing happened to the ten-year rate, which is really the one that matters as a transmission mechanism. So many people. And many of my students at the time were saying, "Well, maybe the Taylor rule is still a nice rule. But since there is a conundrum, which is here to stay because of the saving gluts or whatever, the Taylor rule has lost its power." And now we see that the rate has gone up by—the federal funds rate—by almost as much as at that time, 500 basis points. And there's no conundrum. The ten-year has gone up by 300 basis points. Right? So what's the difference between now and then, and why? So that's what I think is an interesting question and would like to take advantage of this great panel to have some comments on that.

COCHRANE: Andy Levin.

ANDREW LEVIN: I'm Andrew Levin from Dartmouth College. I just want to add a couple of facts to the really great comments by the panelists. John Cochrane has mentioned Google citations. I think what marks a truly monumental work is the point at which people don't even bother to include the citation. It's sufficient to simply say "the Taylor rule," and everyone knows what you're talking about. So those references to the Taylor rule aren't even counted as Google Scholar citations.

For example, in 2007, the Dallas Fed held a conference in honor of John Taylor. Don Kohn, who was at the time the vice chair

of the Federal Reserve, gave a talk entitled "Taylor Rules Rule." And at that time, we used a Google search and found that tens of millions of web pages contained the phrase "Taylor rule." At this point, about fifteen years later, I'm guessing that the tally is probably "billions and billions," kind of like McDonald's hamburgers.

In fact, Google now has a feature called "trends," which indicates that the trend in searches for the phrase "Taylor rule" is now at an all-time high. That's really remarkable, because lots of Nobel Prize–winning papers have been influential for a decade or two and then kind of faded away, whereas John Taylor's work continues to rise in importance.

Now, elaborating on John Lipsky's comments, it's essential to remind everyone about John Taylor's business card. In the 1990s, John Taylor had the Stanford Business Card Office add the Taylor rule to the back of his business cards. And so every time he would meet with people in the private sector, you know, he'd flip over the card and give a brief explanation of the Taylor rule. And that played a significant role in its rapid dissemination. Indeed, those business cards should be kept in mind in documenting the history of the Taylor rule.

COCHRANE: Chris Erceg.

CHRISTOPHER ERCEG:[2] This was a very interesting panel. There's clearly a lot of interest in how monetary policy should respond to financial conditions. Last fall, we saw that financial conditions eased despite very tight monetary policy, which was somewhat surprising, and subsequently have seen some tightening of financial conditions, especially in the last couple of months. So with that in mind, I was wondering about your perspectives on a spread-adjusted Taylor rule. The difference would be that relative to the original Taylor rule, monetary policy would ease preemptively if financial conditions tightened and credit spreads rose in order to insulate output and inflation from the shock. Thanks.

COCHRANE: While the microphone makes it over to that side of the room, I would summarize: We have a conundrum. Should Taylor rules pay attention to long-term interest rates, which reveal inflation expectations, or interest rates with default spreads in them, which of course are what matter for borrowing? And have interest rates lost their power to do much these days?

CLARIDA: Okay, I'll jump in quickly. Excellent points. I've had many—thought a lot about them. I get nervous, and especially after my time with the Fed, I get nervous about getting too high frequency on the r-stars, you know, because in my mind, in [Michael] Woodford model's r-star changes every second, right? So I like to have, in my own mind, think of an anchor, for communication. I do agree that you can't take a stand on a neutral policy rate even in a steady state unless you have a view on the equilibrium term. Because no one borrows at the federal funds rate except people who shouldn't, right? But everybody who borrows does so at five, ten years and so, you know, I would get nervous about the term-*premium move* today. Let's change policy, but having a view of what is the steady-state anchor, you do. And then that gets into the conundrum situation. Right?

So, the conundrum was, we did this on the federal funds rate, but the steady-state term premium is lower, and I think that is relevant. To me, you want to put it in a real model, but at some sense in a steady-state condition that the term premium is higher, you can get by with a shorter riskless short rate, because the term premium is doing some of your work and vice versa. One thing with expected inflation, it's a little bit easier than it was when we started. There is a TIPS [Treasury Inflation-Protected Securities] market. Your real-rate interest rates on a TIP now are 1.8%. So yeah, Michigan Survey, Survey of Professional Forecasters. We can start with market-based real rates and they are 1.8% right now.

COCHRANE: Brian Sack and then Mike Boskin.

BRIAN SACK: Hi, I'm Brian Sack, no affiliation at the moment. So I want to ask a question, and it's been covered here a little bit. I understand the advantages of the Taylor rule are its simplicity and its robustness. But if you could choose one variable to add to your policy rule, I'm curious what it would be. I think some of the other questions maybe provide some potential answers—from Sebastian, maybe it's term premia or longer-term interest rates; from Chris, maybe it's the financial conditions index–type measure. But more broadly, are those what you would add, or would you add something else?

MICHAEL BOSKIN: I just wanted to add a few reflections, and then second the question about credit conditions, or ask you to go a little bit deeper into that. But I was really appreciative of his former students talking about its intellectual history, because the Taylor rule didn't come out of nothing. Actually, John's thesis advisor was T. W. Anderson, a very famous time-series statistician, who also taught economics. And so from early on, he was interested in this interaction of econometric estimation, dynamic model solution, and policy evaluation.

I think it's also worth mentioning that he had an association with Alan Greenspan when he was in New York and had conversations with him. He had long conversations with Milton [Friedman], which turned into arguments about what the proper rule was, and so on. He also wrote a very important chapter in the Economic Report of the President when he was on the CEA [Council of Economic Advisers], which, as I understand it, was the first mention that monetary policy should be rules based. That was the formulation we came up with, it wasn't whether it was a specific rule but whether it should be anchored in a rule. And we got feedback from the Fed when we circulated the chapter that wasn't complimentary, but we included it anyway.

I then would add, he wrote a very prominent principles book and started teaching simple macroeconomics in Econ 1 with an embedded monetary policy rule. And I think that was really, really important, because most of macroeconomics was done—here's what's going on, now the Fed will do something. There was no interaction at all. And I thought that was really important. I used that book when I taught Econ 1 some years ago, and it was, I think, a big teaching breakthrough.

There are many things I could go on about, but I think it's really important to emphasize that this has been a continuum, and the Taylor rule—as tremendously important as it is, and by the way as deserving of a Nobel Prize—I think it's important to realize this, what he's done continuing in that, and continues to teach, continues to do research. The one part I want to emphasize that hasn't been mentioned, coming primarily from the fiscal side myself, is that John, John Cogan, and Volker wrote an important paper, remarkable in real time, they estimated the government expenditure multiplier coming from the 2009 stimulus of about 0.6. That's exactly the number that Valerie Ramey came up with a decade later in an exhaustive meta-analysis of all the research that had been done in the years following, which she called the renaissance of fiscal research. So they nailed it in real time, which is very, very impressive.

COCHRANE: Thank you, Mike. I guess we have to close, so we'll do a lightning round. If you get to add one variable to the Taylor rule, which would it be? And "none" is also an acceptable answer!

WIELAND: I think it does make sense to include first-difference rules in the menu of rules, even if they're not as robust. So that would be adding the lagged interest rate. Because if you do that, then you don't need a view of where the long-run equilibrium is, which can also lead you off track.

JOHN LIPSKY: And my answer is: none. But please let me add two thoughts. First, apologies, I didn't mention the card. However, the main point is that the Taylor rule became so prominent so quickly not via advertising but because it was so powerful conceptually and so useful practically. Almost immediately, everyone started asking each other to use it as a benchmark. The speed of its spread was incredible and essentially unprecedented, in my experience. I would also like to add that it seems we're still grappling with how to interpret the effects of the imposed economic shutdown in response to the pandemic. At this time, goods prices in the United States are increasing on the margin by less than 2% at an annual rate. Rent is a problematic measure; we know the data are backward looking. If anybody's in the property market, they know that rents and house prices at present are going down, not up. The real crux of the matter right now is to try to understand the labor market data. It appears that the labor share of GDP has been declining. In that case, how are wages causing inflation? And many indicators, including the TIPS market, suggest that wage pressures are expected to fade away, essentially on their own. I think most analysts don't agree with that expectation. Just parenthetically, most analysts and most models haven't had a very good recent run with regard to their forecasts of inflation, among other things. So, we'll see.

CLARIDA: I'll shake it up. I would drop a variable. It's so hard to measure potential output, it can lead to such mischief. Clarida, Galí, Gertler said you can do very well if you just focus on getting r-star right and getting inflation right.[3] If we knew the output gap, of course, you can put it in, but we don't. And as I said, it can lead to mischief. So I would just drop it.

COCHRANE: An inflation target! All right. Thank you very much. We'll move on to the next panel.

Notes

1. Thomas J. Sargent and Neil Wallace, "'Rational' Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule," *Journal of Political Economy* 83, no. 2 (April 1975): 241–54.
2. The views expressed in this discussion are those of the author and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.
3. Richard Clarida, Jordi Galí, and Mark Gertler, "The Science of Monetary Policy: A New Keynesian Perspective," *Journal of Economic Literature* 37, no. 4 (December 1999): 1661–707.