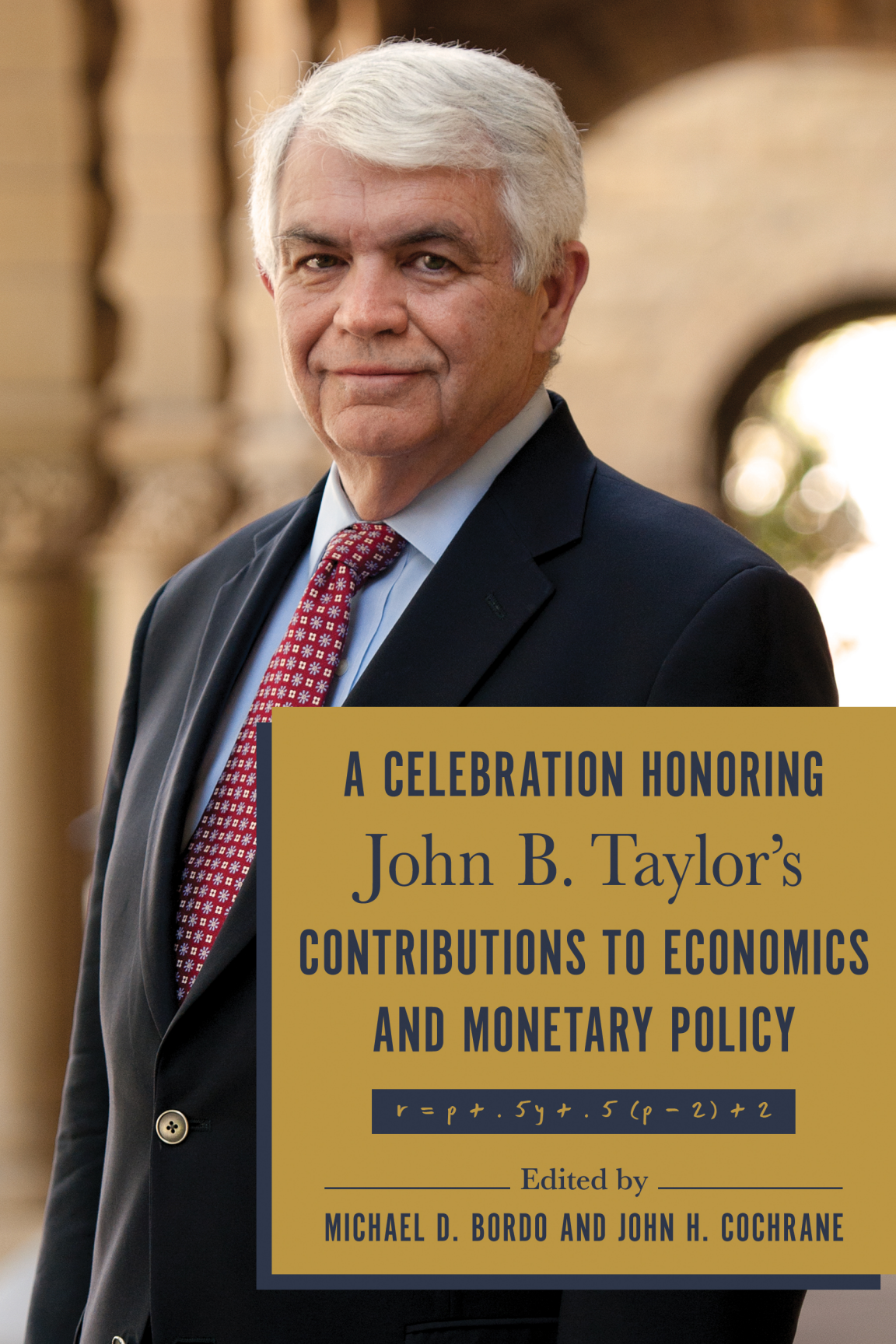
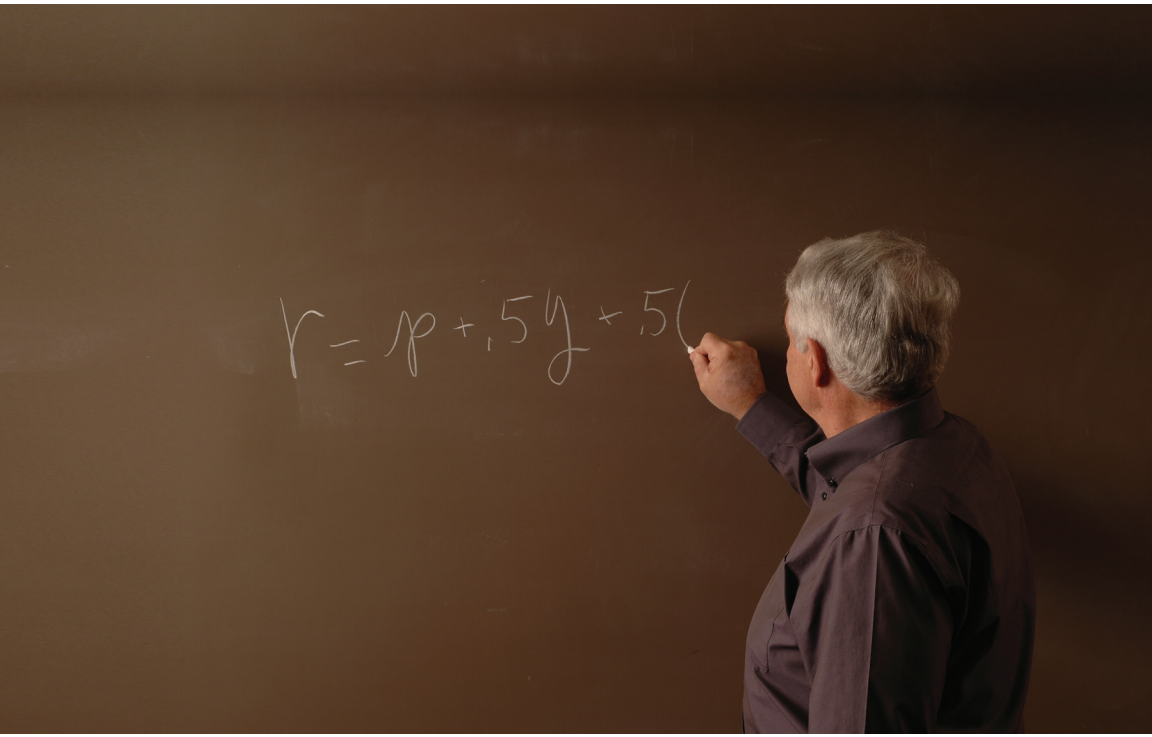


A CELEBRATION HONORING John B. Taylor's CONTRIBUTIONS TO ECONOMICS AND MONETARY POLICY

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

Edited by

MICHAEL D. BORDO AND JOHN H. COCHRANE



Cover photo for *The Taylor Rule and the Transformation of Monetary Policy*
Hoover Institution Press, 2012

The Taylor Rule in Macroeconomics

Introduction

David Papell

It is a pleasure to participate in the celebration in honor of John Taylor. I started working with him as a student at Columbia in the fall of 1978 and received my PhD in January 1981. He has been my mentor for almost fifty years, for which I will always be grateful.

The topic of this session is "The Taylor Rule in Macroeconomics." That is a Stanford story. I'm going to start, however, by taking a few minutes to talk about the prequel, which I will call "Macroeconomics for the Taylor Rule." That is a Columbia story.

In the mid-1970s, the dominant academic macroeconomic model was the New Classical model with rational expectations and flexible prices. An important implication of that model was the Sargent and Wallace (1975) policy ineffectiveness theorem, where systematic monetary policy had no real effects.

Economists quickly developed models with both policy effectiveness and rational expectations by incorporating either imperfect information or price and wage contracts, including John's 1977 *Journal of Political Economy* paper with Edmund Phelps, "Stabilizing Powers of Monetary Policy Under Rational Expectations." The problem with those models, however, was that policy effectiveness only lasted for either the time that it took for information to be revealed or the length of the contracts.

John Taylor's staggered contracts model showed that contracts as short as two periods could account for business cycles, provided that the contracts were not renegotiated at the same time. His 1979 *American Economic Review Papers and Proceedings* paper "Staggered Wage Setting in a Macro Model" elegantly demonstrated this insight using math no more advanced than the quadratic formula. This is the model that Columbia PhD students in the late 1970s called the New Keynesian model and John Cochrane calls the Old Keynesian model.

However, as John's 1980 *Journal of Political Economy* paper "Aggregate Dynamics and Staggered Contracts" demonstrates, these models became extremely complicated when the number of periods was greater than two. Guillermo Calvo, in typical fashion, made the model simpler by making it more complicated: replacing a low-order discrete time model with an infinite-order continuous-time model. The key, of course, was the memoryless stochastic process for the timing of price adjustment, better known today as the "Calvo fairy." When later combined with a forward-looking IS curve and a Taylor rule, this approach became the New Keynesian model.

John and Guillermo had different objectives. John was interested in developing models that could empirically account for US business cycles and was not concerned with either optimality or simplicity. Guillermo was concerned with both optimality and simplicity but was not concerned with realism. Together, they created a model that, with the addition of the Taylor rule, continues to be relevant today.

References

Calvo, Guillermo A. 1983. "Staggered Prices in a Utility-Maximizing Framework." *Journal of Monetary Economics* 12 (3): 383–98.

Phelps, Edmund S., and John B. Taylor. 1977. "Stabilizing Powers of Monetary Policy Under Rational Expectations." *Journal of Political Economy* 85 (1): 163–90.

Sargent, Thomas J., and Neil Wallace. 1975. "'Rational' Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule." *Journal of Political Economy* 83 (2): 241–54.

Taylor, John B. 1979. "Staggered Wage Setting in a Macro Model." *American Economic Review: Papers and Proceedings* 69 (2): 108–13.

Taylor, John B. 1980. "Aggregate Dynamics and Staggered Contracts." *Journal of Political Economy* 88 (1): 1–23.

5

The Taylor Rule Is (Almost) Everywhere in Monetary Economics

Richard H. Clarida

The two most consequential papers in monetary economics written over the past seventy-five years are Friedman (1968) and Taylor (1993). Friedman introduced the concept of a "natural rate of unemployment" and with it the associated construct of the vertical long-run Phillips curve. It also contains an insightful discussion of Wicksell's "natural rate of interest." But while u^* and r^* as they are known today provide key reference points in Friedman's framework for assessing how far an economy may be from its long-run equilibrium, they play absolutely no role in the famous k-percent monetary policy rule he advocates. 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. 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. The time was right for something and someone 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 to maintain price stability.

That vacuum, of course, was filled by the other most consequential monetary economics paper written in the past seventy-five years, Taylor (1993). A crucial insight of "Discretion Versus Policy Rules in Practice" 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 real economy (including r^* and u^*),

a well-designed rule for setting a short-term interest rate as a policy instrument should, John 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 whenever inflation exceeds target (the Taylor principle). And, third, the central bank should lean against the wind when activity deviates from its estimate of potential. 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 title of these remarks is "The Taylor Rule Is (Almost) Everywhere in Monetary Economics" and indeed it really is! The Taylor rule (TR) is ubiquitous in both Woodford's (2003) monetary and Cochrane's (2011) fiscal theories of the price level. It provides a parsimonious and rigorous empirical account of how good monetary policy is conducted by real-world central banks (at least when they are not constrained at the lower zero bound), and it represents optimal monetary policy in a class of workhorse New Keynesian models (as shown in Clarida, Galí, and Gertler 1999). Even more impressively, it is remarkably robust—as was certainly not the case with k-percent rules for money growth—in the sense it delivers very good, nearly optimal policy outcomes across a wide range of macroeconomic specifications and environments as was highlighted in Clarida et al., including in models of monetary policymaking and exchange rate determination in the open economy. As Monika Piazzesi will highlight, Taylor rules feature prominently in empirical macro finance models of yield curves and bond pricing. Finally, Taylor-type policy rules are everywhere in the briefing books that staff prepare to present economic forecasts and discuss policy options with policymakers.

One place where policy rules are currently absent is in public communication by many central banks—including the Fed—about the future path of the policy rate under either a baseline outlook or an alternative scenario. Research by Papell and Prodan (2024) suggests a straightforward way that policy rules could be added to the existing Summary of Economic Projections (SEP).

Figure 5.1 shows you how this approach 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 in the Papell–Prodan exercise. At each calendar date before 2023

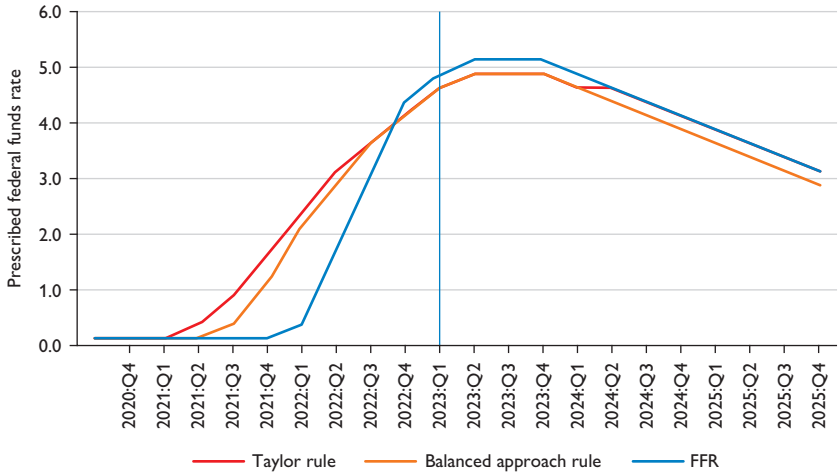


Figure 5.1. Taylor rule signals liftoff in September 2021; Fed lifts off in March 2022
Source: Papell and Prodan 2024

Q1, the policy rule paths are computed using actual data available to the Fed at dates up to the March 2023 SEP along with model-consistent values for the lagged policy rate (not actual policy rates) in the inertial rule. For dates following the "live" SEP—here, March 2023—the paths reflect the SEP on-the-date projections for inflation and unemployment. Friedman's u^* and r^* are set equal to their median longer-run values in the SEP. A similar exercise could and should be presented in a revamped SEP that included alternative scenarios to the SEP baseline. For example, the SEP could include projections conditional on slower productivity and labor force growth than is assumed in the baseline or a scenario in which both u^* and r^* are higher than committee consensus.

There is much more to say, but I am running out of time, so let me conclude by wishing the Taylor rule a very, very happy thirty-second birthday and another seventy-five years!

References

Clarida, Richard, Jordi Galí, and Mark Gertler. 1999. "The Science of Monetary Policy: A New Keynesian Perspective." *Journal of Economic Literature* 37 (4): 1661–707.

Cochrane, John H. 2011. "Michelson–Morley, Occam, and Fisher: The Radical Implications of Stable Inflation at the Zero Bound." NBER Working Paper No. 16636, January.

Friedman, Milton. 1968. "The Role of Monetary Policy." *American Economic Review* 58 (1): 1–17.

Papell, David H., and Ruxandra Prodan. 2024. "Policy Rules and Forward Guidance Following the Covid-19 Recession." *Journal of Financial Stability* 74: Article 101321.

Taylor, John B. 1993. "Discretion Versus Policy Rules in Practice." *Carnegie-Rochester Conference Series on Public Policy* 39: 195–214.

Woodford, Michael. 2003. *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton University Press.

6
The Taylor Rule

Monika Piazzesi

Thank you very much for having me on this panel. I learned about the Taylor rule from John in graduate school. For me, the Taylor rule was a revelation, because I had learned about money growth rates as an undergrad, and those had made little sense to me.

When I learned from John that this is how central banks act, it made perfect sense and had a huge influence on me. And then he invited me along, not long after, to a conference in 1998 in Islamorada, Florida. The conference took place at the Cheeca Lodge, a luxurious resort.

I was a grad student and thought I was in paradise. I also thought that I wouldn't tell anybody about this conference, because it's obviously where the cool people are. I concluded I must work on monetary economics, otherwise I am not going to get to the Cheeca Lodge. That's the first time I'd met Larry Christiano and many of those in the room here today. Those of you who were there won't remember me. I was the little graduate student who took notes at the conference, summarizing the discussions. But I remember very well that I saw you at the Cheeca Lodge.

So, where is the Taylor rule important? The New Keynesian model is the leading business cycle model for thinking about monetary policy. The Taylor rule is one of only three equations in that model. Therefore, the Taylor rule is obviously very important in macroeconomics. It describes how the Federal Reserve behaves based on its dual mandate. It makes perfect sense. The rule describes how we should think about what central banks are doing, and it's useful because persistent deviations from the Taylor rule signal potential problems.

For example, the years 2021–22 are a famous example of a large deviation from the Taylor rule. The Fed probably should have acted earlier in those years to fight inflation. Another area where the Taylor rule has had a

significant influence is finance. In finance, the Taylor rule is widely used by asset managers, particularly in fixed-income markets. Fixed-income strategies are essentially bets on future interest rates. Any successful fixed-income manager relies on risk premia.

Risk premia are the expected returns on long-term bonds over short-term rates. The risk premia are positive and vary over time. Asset managers time the market to buy long bonds when they expect to make high subsequent returns over the short rate. Premia represent time-varying deviations from the expectations hypothesis. To determine premia, we need to decompose long-term interest rates into expected future short rates over the life of the bond and "the rest," which is the risk premium.

Let me show you how the Taylor rule is helpful to think about future short rates, including now, after many years at the zero lower bound. The largest fixed-income asset manager, with over $2 trillion in assets under management, the Pacific Investment Management Company (PIMCO), published its "Cyclical Outlook" in January of this year (Wilding and Balls 2025). In the publication, you can see plots of the US policy rate, or the fed funds rate, together with the Taylor rule (figure 6.1). PIMCO plots the short rate alongside the policy rate for various countries, including the euro area, Canada, and the UK. For all four of these plots, the policymakers were slow to catch up with the Taylor rule during the years 2021–22. Policy makers were initially slow to respond but then caught up later. These figures compare the current policy rate of central banks with what the Taylor rule says it should be. The figures are useful for PIMCO because a high policy rate relative to the Taylor rule suggests that monetary policy has room for additional cuts.

You may be wondering what precise Taylor rule PIMCO is showing you. The fine print explains the coefficients used in the Taylor rule. Interestingly, it discusses the values of the coefficients A and B in front of inflation and the output gap. The authors tried out various coefficients and then plotted the median of the values:

> Note: We define the Taylor Rule as "policy rate = max (neutral real rate + inflation target + a*(core inflation − inflation target) + b* output gap, 0)". We consider six neutral rate estimates: two from internal PIMCO models and add +/−0.5% to each. We consider a=1.25 and 1.5; and b = 0.5 and 1.0. That gives 24 Taylor rule estimates in total. The

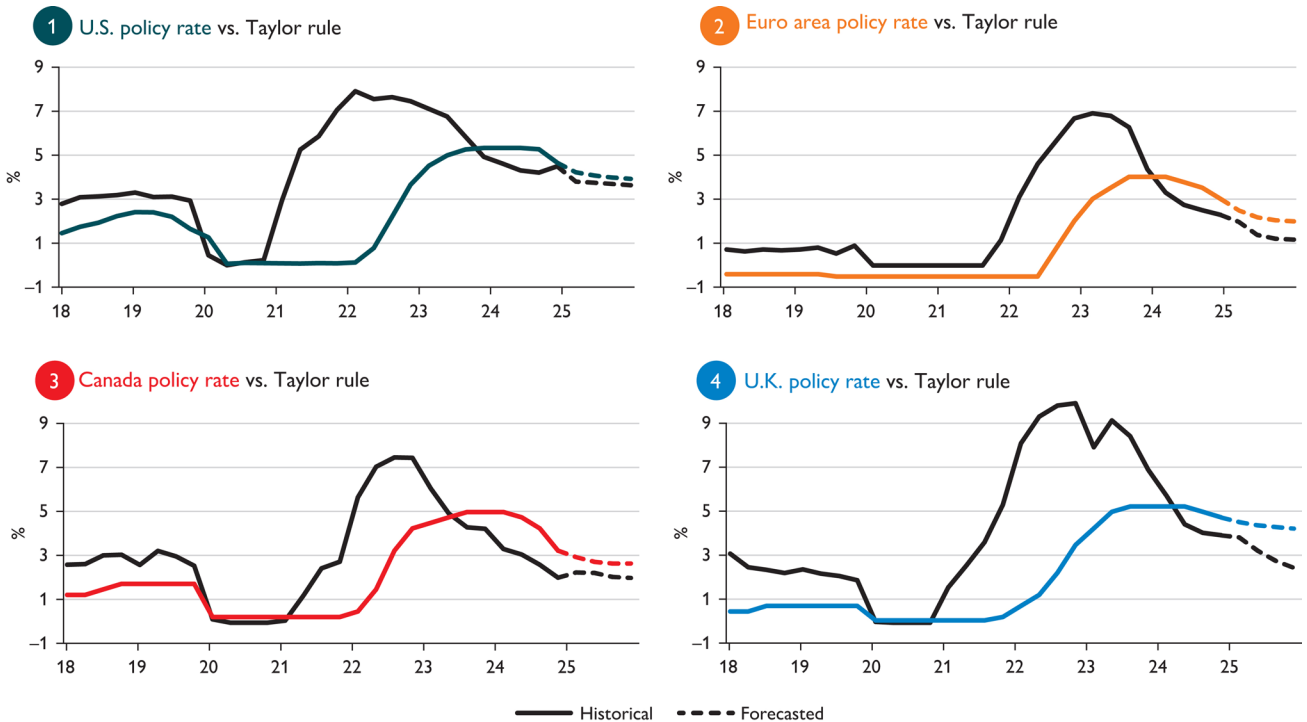


Figure 6.1. Rate-cutting cycles: Monetary policy rate rules leave room for additional cuts

Source: Wilding and Balls 2025

output gap is annual IMF WEO estimates up until 2023; for 2024, we use quarterly data, assuming NAIRU of 4.2% and Okun's law coefficient of 2). The estimates shown above represent the median of these various iterations. Policy rate forecasts based on market pricing and Taylor rule forecasts based on PIMCO estimates as of 8 January 2025. Source: Haver, PIMCO. Refer to Appendix for additional outlook and risk information.

Another example is a blog post from last year by Torsten Sløk, the chief economist at Apollo, who will speak at this conference tomorrow (Sløk 2024). In it, he plots the fed funds rate together with the Taylor rule (figure 6.2). Slok shows this figure to argue that the Fed should be cutting rates soon, because the Taylor rule is below the fed funds rate. This is a way of forecasting the Fed's behavior.

In all these examples, asset managers use the Taylor rule to forecast future short rates. They essentially assume that deviations from the Taylor rule are temporary, which makes sense if you think of the Fed using a Taylor rule and also smoothing interest rates. In this case, the interest rate today has some dependence on the interest rate last period plus a term that contains the Taylor rule:

$$r_t = \rho r_{\{t-1\}} + (1-\rho)\left[\phi_{\pi}\pi_t + \phi_y\left(y_t - y_t^p\right)\right] + \varepsilon_t$$

If the Fed behaves according to this rule, we can rewrite this equation as deviations from the Taylor rule:

$$r_t - \left[\phi_{\pi}\pi_t + \phi_y\left(y_t - y_t^p\right)\right] = \rho\left[r_{\{t-1\}} - \left[\phi_{\pi}\pi_t + \phi_y\left(y_t - y_t^p\right)\right]\right] + \varepsilon_t$$

These deviations are temporary. Therefore, the Taylor rule is a way of thinking about where the short rate will go. The approach is consistent with autocorrelated deviations that will eventually die out. And if the deviations are not temporary, we may start wondering whether this might be a policy mistake or something that we should at least discuss.

The equation is also useful to predict the future short rate over short or long horizons. Asset managers look at deviations of the fed funds rate from the Taylor rule today to forecast short rates even over long periods. That approach helps them to think about risk premia.

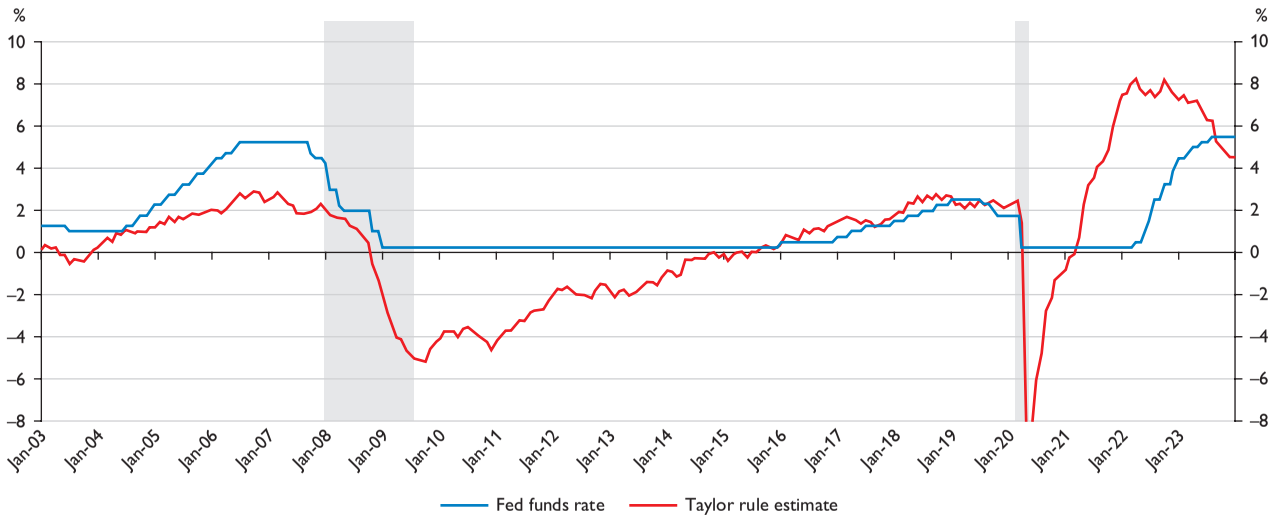


Figure 6.2. Fed funds rate versus where the Taylor rule indicates it should be, January 2024

Source: Sløk 2024

References

Sløk, Torsten. 2024. "Taylor Rule Points to a Fed Cut in March." *The Daily Spark* (Apollo). January 24. https://www.apolloacademy.com/taylor-rule-points-to-a-fed-cut-in-march.

Wilding, Tiffany, and Andrew Balls. 2025. "Cyclical Outlook: Uncertainty Is Certain." Pacific Investment Management Company (PIMCO). January 14. https://www.pimco.com/us/en/insights/uncertainty-is-certain.

7

The Enduring Influence of John Taylor

Lawrence J. Christiano

I'm honored to be part of this event celebrating John Taylor. More than that, I'm deeply grateful. We don't often get the chance to express our gratitude to someone who has profoundly shaped our lives. I feel fortunate to have this opportunity to thank John for his groundbreaking work, his mentorship, and his generosity—all of which have had a lasting impact on my career and life. Listening to others today, I'm struck by how often two qualities come up: kindness and toughness. I also associate these traits with John, and they have left a lasting impression on me. In my remarks, I will focus on John's intellectual contributions, especially the Taylor rule and its enduring influence.

John played a pivotal role in one of the most significant revolutions in macroeconomics—a revolution that began with the concept of rational expectations and continues to evolve. What made it transformative was not only the theoretical innovations but also the bridge it built between academic economists and central bank policymakers. Without that link, our discipline would have far less practical value. It's fun to do macroeconomics, and we're privileged that they pay us to do it. However, the enterprise wouldn't last long if we didn't provide something valuable to society to justify the resources invested in us. That value can take many forms: undergraduate teaching, public outreach, or policy advice. John has made significant contributions in all these areas. He has helped shape the foundations of modern macroeconomics, made rigorous analysis essential to central banking worldwide, taught undergraduates with clarity and insight, and communicated complex ideas in an accessible and meaningful way to broader audiences, including our political leaders. Today, we even heard how John made a lasting contribution to central banking in Iraq.

In the early days of modern macroeconomics, rational expectations models—particularly real business cycle models—suggested that monetary

policy was largely irrelevant. Unsurprisingly, that view didn't resonate with policymakers. John—along with other luminaries like Stanley Fischer, Guillermo Calvo, and Julio Rotemberg—brought monetary policy back into focus. By incorporating sticky prices and wages into dynamic models, they developed deep insights into how monetary policy could be designed to improve economic performance. This effort paved the way for a lasting collaboration between academics and central bankers.

Wherever I travel—whether in advanced economies or emerging markets—the influence of John's work is unmistakable. The Taylor rule is almost always the starting point for discussions of monetary policy. Its widespread adoption reflects not only its clarity but also its ability to capture something essential about how policy is actually made. Before John, central bankers often viewed each episode as unique and disconnected from a broader framework. The genius of the Taylor rule was to reveal the underlying structure: Central banks care about inflation and output. Policymakers saw the rule and immediately recognized themselves in it: "Yes, that's what we do." But John went further, offering not just a description of how monetary policy is currently conducted but also how it *should be* conducted. That insight led to what we now call the Taylor principle—the idea that the nominal interest rate should increase by more than one-for-one with inflation.

The Taylor principle is a cornerstone of modern macroeconomics. In New Keynesian models, it ensures a unique and stable equilibrium by anchoring inflation expectations and shielding the economy from self-fulfilling inflation scares. Even as macroeconomic theory moves beyond strict rational expectations, the stabilizing force of the Taylor principle remains central—especially in newer models that incorporate forms of bounded rationality, like learning.

To illustrate the stabilizing properties of the Taylor principle, it is sufficient to adapt the simple IS-LM diagram from undergraduate macroeconomics by adding a Phillips curve. Suppose a shock or rumor leads people to expect higher inflation. A given nominal interest rate then seems less burdensome, because faster expected price growth makes it easier for borrowers to repay their debts. This dynamic can fuel additional borrowing and spending, and—as labor and commodity markets tighten—push up inflation. In this way, there is a possibility that a rise in expected inflation could be self-fulfilling. Under the Taylor principle, the central bank raises the interest rate sharply, by more than the rise in expected inflation. The resulting contraction in planned spending slows the economy and helps bring inflation down. In anticipation of such a policy response, the initial rise in inflation expectations would

soon evaporate. After prolonged experience with the Taylor principle, the public may be reluctant to increase its inflation expectations in the first place.

So, without the Taylor principle, movements in expected inflation would be confirmed, and there would be volatility not just in inflation but also in aggregate economic activity, consumption, and investment. With the Taylor principle, expectations of inflation are more anchored, and the economy would be more stable. This logic holds both in rational expectations models and in newer models that incorporate learning or other departures from strict rationality.

The power of this idea—the Taylor principle—cannot be overstated.

Looking ahead, John's work remains as relevant as ever. As Monica Piazzesi and others have noted, the Federal Reserve's deviation from the Taylor rule in 2021–22 coincided with troubling inflation dynamics. It's hard not to see in that episode a validation of John's warnings—offered decades earlier—about the risks of departing from rules-based policy.

I am profoundly grateful to be part of this celebration of John's work—not only for his contributions to economics, but for the way he has conducted himself throughout his career: with toughness and, yes, great kindness.

8

The Taylor Rule in Macroeconomic Theory

John H. Cochrane

John Taylor's major contribution in his writing about the Taylor rule, such as the celebrated Taylor (1993), is not high theory. Rather, John's contribution was centrally to elaborate the famous rule as the foundation for a comprehensive and practical strategy for real-world monetary policymaking. John advocates the rule as a benchmark against which to measure deviations, to communicate central bank strategy and thereby stabilize expectations, and to help central banks to avoid panicked discretionary mistakes. He does not advocate a mechanical rule, despite many calumnies to the contrary.

John also has contributed deeply to the empirical understanding of monetary policy, for example, Taylor (1999). His "rule" did not develop from the chalkboard, looking at eigenvalues of models, but from the empirical observation that monetary policy performance was historically better when central banks reacted promptly to inflation. John spent years going to central banks, writing and speaking at conference after conference, listening to concerns, and elaborating how the rule works. The Taylor rule rightly inherits the mantle of the gold standard and Milton Friedman's money growth rule as the contemporary heart of rules-based policy. But Taylor's is better, more realistic, and more attuned to the practical needs of policymakers.

Nonetheless, the Taylor rule has had a deep *influence* on monetary theory, beyond John's own work. How is the overall level of prices determined? The answer once seemed simple: The government tied the value of the dollar to gold. But we no longer do that. In stepped monetarism: The government restricts the money supply. But we no longer do that, either. The Federal Reserve and other central banks target interest rates. There are no reserve requirements or other limits on inside money creation. In this circumstance, monetarists have a simple answer: The price level is not pinned down. The

central bank should target the money supply. Yet it does not, the price level is pinned down by something, and remarkably stable at that. We need a theory of inflation under *nominal interest rate targets* that continues to work with full interest on abundant reserves, and we need a more useful theory than just "the Fed should target the money supply." Taylor's rule is the foundation of that theory.

The Taylor rule is also remarkably *robust*. (This is a point that Taylor himself has made, for example, in Cochrane, Taylor, and Wieland [2020]). Any theory invites a specific optimal rule. That rule is usually much more complex than the Taylor rule, depending on more variables, and less clear how to operationalize. But the Taylor rule does pretty darn well in almost all theories. Since we don't know what theory is true—and a point of this essay will be to convince you that our ignorance is far greater than you might have thought—a rule that works pretty darn well, no matter what model, is awfully useful.

So let me show you these two points: how the Taylor rule is a crucial part of most economic models of inflation under interest rate targets, and how the Taylor rule works in a wide variety of models, by very different mechanisms. The Taylor rule is always the answer, though the questions keep changing. This robustness is often an insult, but not in this case—that is the sign of a desirably robust rule. (Much of this material is synthesized from Cochrane [2024], where you will find equations backing up all these statements.)

The Rule in Three Models

Adaptive Expectations, Monetarism, and Old Keynesian Models

Friedman (1968) famously proclaimed that inflation would be *unstable* under an interest rate target. If the Fed tried to peg interest rates, and if a bit of inflation broke out, then the Fed would be forced to print more money to keep interest rates from rising, raising inflation more. IS-LM adaptive expectations models, all the rage in the 1970s and in the policy world today, state the phenomenon a bit differently. When a little bit of inflation breaks out, the real rate is low, raising aggregate demand and provoking more inflation. The converse fear of a "deflation spiral" at the zero bound motivated much worry in central banking circles through the zero bound years in the United States and Europe and for three decades in Japan. More generally, monetarism decries monetary policy regimes like the one in which we live,

with passive or endogenous money or uncontrolled inside money. Don't target interest rates, target money growth, said Friedman. But central banks target interest rates. We need a theory that can describe what we see.

In this context, the Taylor rule, by raising the interest rate target more than one-for-one with inflation, *stabilizes* inflation. The situation is like a seal balancing a ball on its nose. The ball (inflation) is unstable and wants to roll off the seal's nose. But if the seal moves his nose in the direction the ball is falling, and more than one-for-one, the seal will get his nose under the ball and stabilize it. Taylor's rule makes an interest rate target possible and eliminates the instability of an interest rate peg.

(Wicksell [1898] is usually credited with the idea that a central bank can stabilize the price level by systematically raising and lowering interest rates. But he wrote in words and in German, and as far as I can tell his analysis was not part of contemporary thinking until Woodford [2003] credited him with inspiration. Reading Wicksell, I could never pin down the central question of just *how* he thought higher interest rates would lower inflation. Also, central banks under the gold standard routinely raised and lowered the discount rate to manage the value of their currency and foreign exchange flows, so interest rate targets have a long history.)

Rational Expectations and New Keynesian Models

With rational expectations, interest rate targets face a different puzzle, elucidated by Sargent and Wallace (1975). An interest rate peg is now stable; the economy will not spiral off on its own, and inflation will converge to wherever the Fed puts the nominal interest rate. But inflation is now *indeterminate* under an interest rate peg. There are multiple equilibria. Inflation is not pinned down by the economic model. It can bat around randomly, following "sunspot" equilibria in which inflation is whatever people expect it to be—in the classic tale going up and down depending on sunspots that have nothing to do with underlying economic forces. The nominal interest rate can nail down expected inflation, but unexpected inflation can be anything, and hence inflation is presumably volatile. Don't target nominal interest rates, target the money supply, monetarists repeat. But central banks target interest rates.

McCallum (1981) showed, however, that a central bank following a Taylor principle will induce instability, so only one of the multiple equilibria does not explode. Adding a criterion against nominal explosions, the Taylor principle solves the indeterminacy of rational-expectations models. By following a rule

with the Taylor principle, the central bank adds an *equilibrium-selection* policy to its *interest rate* policy. For a given path of interest rates, the Taylor principle amounts to a set of off-equilibrium threats that leave only one equilibrium standing.

Don't confuse indeterminacy with instability. They both can lead to volatility but in different ways. An unstable economy has one equilibrium, but it spirals off to hyperinflation or deflation. A stable indeterminate economy has multiple equilibria and can bat randomly among them.

The Taylor principle in the rational-expectations economy acts very differently from the Taylor rule in the adaptive-expectations economy. In the former, the central bank reacts to undesired inflation with *more* inflation, to deliberately induce instability. Real rates can be constant; the trick works in the flexible-price version of the model. In the latter, the central bank reacts to undesired inflation with *less* inflation going forward, and does so by inducing high real interest rates.

Fiscal Theory of the Price Level

The fiscal theory of the price level (for a summary, see Cochrane [2023]) solves Sargent and Wallace's indeterminacy in a different way. Given an interest rate target, only one equilibrium satisfies the condition that the real value of nominal debt equals the present value of future primary surpluses. Unexpected inflation, which was not pinned down before, devalues government debt, and unexpected inflation raises the value of government debt. So, the unexpected inflation or deflation is pinned down by the revision in the present value of surpluses required to repay the debt. Now an interest rate target, even an interest rate peg, is both *stable* and *determinate*. Inflation is also long-run neutral. Higher nominal interest rates must eventually result in higher inflation, just as higher money growth does.

In my view, this step finally completes our so-far-missing economic theory of inflation under interest rate targets. Permanently adaptive expectations throw out economics, and the experience of the zero-bound era throws out spirals. Central banks do not have "equilibrium selection strategies," in which they deliberately destabilize the economy, and the zero-bound era throws out sunspot volatility.

It seems we have lost the need for the Taylor rule, but we have not. Higher nominal interest rates can lower inflation today by raising it in the future. An unpleasant interest rate arithmetic holds. Other shocks such as a fiscal shock raise inflation temporarily, which leads to large output effects. If the central

bank responds to such inflationary shocks with higher interest rates, it can smooth inflation, which reduces output volatility. Random-walk inflation minimizes output, and a Taylor rule with a coefficient of just about one (in very simple models) achieves that result.

Three Models, Same Answer

In sum, the Taylor rule performs very well in three different sorts of models, though by vastly different mechanisms. The Taylor rule restores *stability* to both traditional monetarist models and IS-LM adaptive-expectations models. The Taylor rule restores *determinacy* to rational-expectations, New Keynesian models, but by the converse operation of taking an already stable economy and making it unstable. In both cases, it allows inflation control with an interest rate target rather than through control of money supply. The Taylor rule reduces inflation and output *volatility* in the "Fiscal Theory plus New Keynesian" model, though inflation is already stable and determinate.

This is a version of the general finding that the Taylor rule is not exactly optimal in any model, but it is very good in almost all models, even when they have deeply different mechanisms.

Trouble in Paradise

All is not well and settled, however, in the land of modern macroeconomics under interest rate rules. While the Taylor rule works just as Taylor explained in ad hoc adaptive-expectations models, rules with the Taylor principle behave in a fundamentally different way in the rational-expectations, forward-looking, New Keynesian models that have dominated academia and the equations of central bank research (if not quite the words used to describe those equations) for thirty-five years. (I write "rules with the Taylor principle" rather than "Taylor rules" to reflect this utterly different behavior.)

In these models, the Taylor principle does not serve as a stabilizing device to bring a spurt of inflation back down again. Instead, it serves as a destabilizing device, designed to explode the economy for all but one value of inflation. It is an "equilibrium selection" threat, not a stabilization device. And its operation is never seen in equilibrium. Data from a successful New Keynesian, Taylor principle economy do not display the Taylor principle.

The issue is easiest to demonstrate in the flexible-price version of the model (Cochrane 2011),

$$i_t = E_t \pi_{t+1}.$$

On its own, we see Sargent and Wallace (1975) indeterminacy. Unexpected inflation can be anything. There are multiple equilibria.

Then, in place of

$$i_t = \phi \pi_t + u_t,$$

rewrite the Taylor rule in the form suggested by King (2000),

$$i_t = i_t^* + \phi(\pi_t - \pi_t^*),$$

with $i_t^* = E_t \pi_{t+1}^*$. The two forms are equivalent and just amount to a rewriting of the disturbance u_t. For every $\{\pi_t^*\}$ you can construct the equivalent $\{u_t\}$, and vice versa.

With the King rule, equilibrium inflation follows

$$E_t\left(\pi_{t+1} - \pi_{t+1}^*\right) = \phi\left(\pi_t - \pi_t^*\right)$$

with $\phi > 1$, and the only nonexplosive equilibrium is

$$\pi_t = \pi_t^*.$$

The Taylor principle raises future inflation in response to inflation over target, to threaten hyperinflation for all but one equilibrium, and therefore, it is hoped, to select that one.

But all we see in equilibrium is $\pi_t = \pi_t^*$. We never see the variation that allows us to identify ϕ. Moreover, suppose that the disturbance follows an *AR(1)*: $u_t = \rho u_{t-1} + \varepsilon_t$ *or* $\pi_t^* = \rho \pi_{t-1}^* + \varepsilon_t$. Then, what we see in equilibrium is

$$i_t = \rho \pi_t.$$

We see a misidentified rule with coefficient less than one. A New Keynesian economy that follows the Taylor principle will not display the greater-than-one-for-one behavior that Taylor so nicely documented in the data.

In sum, then, in the dominant economic theory of inflation, the Taylor principle is an equilibrium-selection threat, not observed in equilibrium. The mechanism of the model is utterly different from the standard story that higher interest rates reduce aggregate demand and then inflation via a Phillips

curve. That the rule works in a constant, real-interest-rate, flexible-price model shows that distinction clearly. The mechanism is equilibrium selection. The central bank can just make us jump to an equilibrium with lower inflation.

Taylor's and Clarida, Galí, and Gertler's (2000) regressions, documenting $\phi<1$ in the 1970s and $\phi>1$ in the 1980s, do not measure the ϕ of the model. They measure the ϕ of the adaptive expectations or other models, and other parameters, but they do not measure the Taylor principle central to the New Keynesian model.

And if they did? Was the problem of the 1970s really indeterminacy, multiple equilibria, and sunspots, not too-loose and too-late policy (as Taylor has always said)? Did Paul Volcker really succeed by quashing multiple-equilibrium volatility? If so, why did that volatility not erupt at the zero bound when interest rates did not react at all to inflation for a decade in the United States, the United Kingdom, and Europe, and for thirty years in Japan? Is the central job of the central bank really equilibrium selection and fighting the scourge of multiple equilibria? If so, why is that fact completely absent from any words on any central bank website or in the speeches of any central bank official?

The problem gets worse. For higher interest rates to induce explosive inflation, it must be the case that higher interest rates raise inflation in the New Keynesian model. And they do. This is obvious in the flexible-price model given above, $i_t = E_t\pi_{t+1}$. Perhaps more surprising, higher interest rates raise inflation even with sticky prices. Inflation is a two-sided moving average of interest rates with positive coefficients, plus an equilibrium-selection shock. Higher interest rates only appear to lower inflation because the modelers (unintentionally) sneak in a negative equilibrium-selection shock along with the higher interest rates. In the above example, they specify a negative shock to π_t^* that coincides with the higher i_t. Equilibrium selection does all the work of lowering interest rates.

So, here we are. There is no respectable economic textbook model that represents conventional beliefs that higher interest rates lower inflation by slowly pushing inflation down going forward, least of all with "long and variable lags," and not by anything resembling the standard mechanism. The hope that New Keynesian economics would sprinkle holy water on IS-LM intuition is dashed. We can't even get the sign right. There is likewise no respectable economic textbook model that represents the conventional belief that higher interest rates raise the exchange rate.

The qualifiers matter. There are complex medium-scale models (e.g., Smets and Wouters 2007; Christiano, Eichenbaum, and Trabandt 2016) that produce something like the standard results, but with many modifications of the textbook model and still with nothing like the standard mechanism. The mechanism is still equilibrium selection. Higher real rates do not push down aggregate demand, output, and employment, and then inflation via a Phillips curve. And the complex models build on a textbook model that gets the sign wrong. Sprinkling the model with ad hoc ingredients, returning to 1970s adaptive expectations, can produce 1970s IS-LM-style results. But if indeed there is no simple, rational, supply-and-demand economic model that can produce the basic sign and operation of monetary policy, if it is all a conjuring trick of exploiting irrational expectations, then at least our certainty about the reliability of monetary policy—just how always and everywhere it operates—should be questioned.

Rules Rule

Empirical work has stagnated just as theory has. For forty-five years, we have largely run vector autoregressions (VARs) following Sims (1980), who finally solved the twenty-year debate about how to resolve whether the money-income correlation represents forward or reverse causality.

But as all marginal products decline with scale, so has this one. Monetary policy shocks are tiny, so we are in the same land as much of applied microeconomics, studying tiny variation that we hope is exogenous. The Fed never explains its actions as a random shock but always as a response to something. More deeply, the response to shocks against a stable rule is mostly beside the point. The "effects of monetary policy" are not the effects of monetary policy we want to know about. From 1970 to 1980, inflations, disinflations, and periods of good and bad outcomes are about *changing the rules*, not shocks against a stable rule. That is the whole point of John Taylor's empirical work, and the central crucial result of Clarida et al. (2000).

This fact represents a challenge and a tremendous opportunity. How do you measure changing rules and the effects of changing rules? In part by regressions with time-varying rules, but, as we have seen, those are tricky to interpret theoretically. I am drawn to more study of episodes. In Cochrane (2023, 2024), I point out that the zero-bound era, and the contrast between quantitative easing (QE) and COVID large-scale open-market operations, are about as clean natural experiments as we could wish for to distinguish theories. That comparison escapes the standard Markov-switching VAR exercise. History abounds with insightful episodes. But the answers are still ahead.

Rules still rule. The central insight from John Taylor and Bob Lucas is that in an economy with forward-looking people who learn from experience, you must think about policy in terms of rules and expectations, not "actions" and mechanistic responses. The real triumph of the 1970s was intertemporal economics versus static economics, and policy must be phrased in terms of a rule. Every action begets a tradition.

Concluding Comments

So we are in purgatory, not paradise. This is a challenge, but it is a wonderful opportunity. I tell young people: You are like a physicist in 1890. The consensus of the last thirty-five years has big holes in it. Basic simple questions are up for grabs. How we do theory and empirical work is up for grabs. It should be a great time to be the next John Taylor. And, as the 1970s and 1980s produced John, our public officials are finally giving us some variability to study!

References

Christiano, Lawrence J., Martin S. Eichenbaum, and Mathias Trabandt. 2016. "Unemployment and Business Cycles." *Econometrica* 84 (4): 1523–69.

Clarida, Richard, Jordi Galí, and Mark Gertler. 2000. "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory." *The Quarterly Journal of Economics* 115: 147–80.

Cochrane, John H. 2011. "Determinacy and Identification with Taylor Rules." *Journal of Political Economy* 119: 565–615.

Cochrane, John H. 2023. *The Fiscal Theory of the Price Level*. Princeton University Press.

Cochrane, John H. 2024. "Expectations and the Neutrality of Interest Rates." *Review of Economic Dynamics* 53: 194–223.

Cochrane, John H., John B. Taylor, and Volker Wieland. 2020. "Evaluating Rules in the Fed's Report and Measuring Discretion." In *Strategies for Monetary Policy*, edited by John H. Cochrane and John B. Taylor, 217–58. Hoover Institution Press.

Friedman, Milton. 1968. "The Role of Monetary Policy." *The American Economic Review* 58: 1–17.

King, Robert G. 2000. "The New IS-LM Model: Language, Logic, and Limits." *Federal Reserve Bank of Richmond Economic Quarterly* 86: 45–104.

McCallum, Bennett T. 1981. "Price Level Determinacy with an Interest Rate Policy Rule and Rational Expectations." *Journal of Monetary Economics* 8: 319–29.

Sargent, Thomas J., and Neil Wallace. 1975. "'Rational' Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule." *Journal of Political Economy* 83: 241–54.

Sims, Christopher A. 1980. "Macroeconomics and Reality." *Econometrica* 48: 1–48.

Smets, Frank, and Raf Wouters. 2007. "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach." *American Economic Review* 97: 586–606.
Taylor, John B. 1993. "Discretion Versus Policy Rules in Practice." *Carnegie-Rochester Series on Public Policy* 39: 195–214.
Taylor, John B. 1999. "A Historical Analysis of Monetary Policy Rules." In *Monetary Policy Rules,* 319–48. University of Chicago Press.
Wicksell, Knut. (1898) 1936. *Interest and Prices*. Mises Institute. https://mises.org/library/book/interest-and-prices.
Woodford, Michael. 2003. *Interest and Prices*. Princeton University Press.

GENERAL DISCUSSION

David Papell: John Cochrane's talk reminded me of the time that I sent him a paper to ask for comments. There was a statement in the paper that the Taylor principle was necessary and sufficient in Old Keynesian models, but sufficient but not necessary in New Keynesian models. John wrote back saying, "You're absolutely correct, but you should never put that in print, because nobody would ever understand it." Luckily, the referees didn't notice.

Andrew T. Levin: This is a really great panel. Thanks to all of you. I have questions for Monika Piazzesi and Richard Clarida. Monika, you were talking about financial institutions and how they need to think about systematic policy. What do they do when the Fed says, "We're just taking a meeting-by-meeting approach"?

Rich: When we think back about Silicon Valley Bank and how they apparently didn't realize that the Fed might need to raise rates, they were making decisions about their portfolio that turned out to have a lot of interest rate risk. You were describing alternative scenarios. I imagine here not only the alternative scenarios being used by the FOMC but also bringing them into the stress tests for at least some financial institutions. That would at least ensure the financial institutions are aware that the Fed hopes rates will stay low but that there is a scenario where the Fed may need to raise them. Monika, if you want to comment on that too, that would be great.

Harald Uhlig: From a Taylor rule perspective, the last three years are puzzling to me. Inflation went way up, and nominal interest rates didn't go up much. If you do a back-of-the-envelope calculation, then maybe nominal interest rates should have gone up to 12%, and that should have more quickly lowered inflation to where we are now.

Certainly the Fed didn't do anything close to that. So I'm curious, and maybe that will produce some differences among the panelists. What do you think made inflation come back? Was it the fiscal policy that got it back? Was it the fact that inflation is stable regardless of what monetary policy does? Was it some implicit threat that interest rates would rise sometime down the road if inflation wasn't willing to come back? Or was it that inflation expectations are simply anchored and monetary policy nowadays has little to do with that?

Laurence M. Ball: Thanks, actually, this is related to Harald's question. I'm confused about the optimal Taylor rule in today's environment. The result that the central bank should react more than one-for-one to inflation was optimal in the world in which the rule was developed, when we seemed to have backward-looking expectations and a Phillips curve with a coefficient of close to 1 on lagged inflation.

Now we live in a world of forward-looking but anchored expectations. How much does that change the Taylor principle or the Taylor rule? My intuition is that if expectations stay anchored, the Fed doesn't necessarily have to act more than one-for-one for every short-run movement in inflation. Maybe that's why the Fed didn't think it was essential to raise interest rates by as much as inflation went up in the short run after the pandemic.

I'm actually confused about what the panelists or what the inventor of the Taylor rule would say about its relevance with anchored expectations or how it should be modified.

Krishna Guha: As I think at least one of the panelists already mentioned, in practice, the Taylor rules that are used in monetary policy setting almost always have quite high inertial coefficients. And yet this was never part of the theoretical work. I'd be interested in what the panelists feel about the merits and demerits of the practice of inertia in central banking. Thank you.

Richard H. Clarida: With regard to the question about the failure of Silicon Valley Bank in March 2023, I had long since completed my tenure at the Fed by that time, so I have no firsthand basis for thinking that episode was or was not a stress test of the banking system. One of the other questions was in regard to the yield curve. I'd like to build on something Monika said in her remarks and also on her incredible body of work on this subject. One thing I've done over the years in modeling and interpreting the Treasury yield curve is

to use a macro factor model in which one of the factors is the Taylor rule residual. The Taylor rule residual turns out to be a very important macro factor. Taylor rules are embedded in the yield curve, as are central bank deviations from the Taylor rule.

Turning now to Larry Ball's question, at least during my time at the Fed, 2018 to early 2022, my thinking was then, and is now, that it does not make sense as a policymaker to take anchored inflation expectations for granted. I think the Fed and other central banks benefited in recent years from the fact that inflation spent most of the twenty-five years before the pandemic running below the 2% inflation target. That probably was quite useful toward keeping inflation expectations reasonably anchored during the postpandemic inflation surge.

Monika Piazzesi: I agree. I think right now we are seeing some de-anchoring of inflation expectations. Inflation expectations are rising. Together with the higher risk premia in fixed-income markets, I think we can conclude that the Fed's deviation from the Taylor rule during the recent high-inflation episode has created some uncertainty among households. Of course, there are many other developments that have been going on at the same time.

I believe it is easier to anchor inflation expectations by having a stable rule in place and deviating, as John Cochrane was saying earlier, only when there is a special reason that gives a reason for deviating. In this case, expectations among households and firms will incorporate rule-based decision making by the central bank.

John H. Cochrane: Harald asked: What happened? Why did inflation break out? I had graphs on the slides that are my answer to what happened, and the story fits just about perfectly.

Where did inflation come from? We had a one-time fiscal blowout. That leads to a one-time price level increase. Inflation goes away on its own, even if the Fed does nothing. The Fed raised rates a little bit, and that brought inflation back a little faster. We're done as far as an explanation of what happened.

The next question was about anchoring and inertial rules. The Fed keeps saying "anchored." I ask, "Anchored by what?" What is the Fed going to *do* if expectations rise? Give more speeches about anchoring? Expectations have to be anchored by a belief that if things get bad, the Fed will do something, that it will even repeat 1980–82 if it has to.

That's the heart of the Taylor rule now. You can't intone "anchoring" and never actually do anything. So I think part of what the Fed is doing by responding to inflation now is getting people to understand that it will repeat 1980–82 if inflation gets out of control, even if it costs a big recession, though nobody at the Fed actually will ever say that in public.

As to inertial rules, in lots of theories it doesn't really matter how slowly the Fed raises rates, so long as eventually it raises rates more than one-for-one. So as far as either what I call "stabilizing" in Old Keynesian models or "equilibrium selection" in New Keynesian models, both of those effects work with very large degrees of persistence. Given the noise in the data, some amount of persistence seems appropriate. Interest rates should not jump up and down on noisy initial data. I hope this isn't heresy, but some amount of persistence seems to make some sense.

Lawrence J. Christiano: I'll just say a couple of things. First, why inflation started and then stopped. I'd like to look through what I think are the eyes of John Taylor at what happened in this period from Biden's inauguration speech, when inflation took off, to a year later, when the Fed started raising rates.

He's here, and unfortunately he might disagree with me, but I see a sequence of positive monetary shocks coming from the Fed. People expected them to follow the Taylor rule, raising rates in response to inflation, and they didn't. They had a story about the deviation, but we can set that aside for a second.

So, we had a sequence of positive monetary shocks. Then, eventually, the sequence stopped. That explains, I think, why inflation started and then stopped. And it has nothing to do with the fiscal stuff. That explains in my mind why the economy was so powerful during the Biden administration. The Democrats weren't good at explaining this, but the economy was very strong.

One other thought I wanted to say is a little bit in response to John Cochrane, because he and I have also had many friendly food fights. John is the one person you can have a bitter fight with but it's fun. So he's an extraordinary personality, I think. I actually think he's like John Taylor a little bit. John Taylor can be tough, but there's always a friendliness in the background.

Anyway, this idea that monetary policy stabilizes the economy in the Taylor rule by threatening to blow up things is, I think, incorrect. In order to understand this idea, or to respond to it, you have to go back and ask, why would a rational expectations equilibrium even happen? And I think the best idea for that is Bob Lucas's idea, which is that it's interesting. Rational

expectations is the place you go when people like us make mistakes and slowly catch on. My example was designed to show how the Taylor rule works there. The Taylor rule gets expectations anchored by knocking people over the head a little bit when they're going in the wrong direction. Eventually you stop having their expectations go in the wrong direction.

The learning equilibrium is a stable process. The economy iterates the other way. You iterate in the forward direction, which is wrong and gives you explosions. Learning iterates in the other direction and stabilizes the economy.

Cochrane: This little exchange illustrates why macro is so fun. We have two very simple equations, and we can fight for twenty or thirty years about the interpretation of these equations. And we will keep at it.

Papell: Let me just thank the members of the panel and especially John Taylor for continuing to be an inspiration to us all.