Rethinking Monetary Policy Rules *

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Abstract

The Taylor rule has been a staple of monetary economics for the past three decades, and is often used as benchmark for evaluating monetary policy. In the present paper I argue that the rule's focus on a short term nominal interest rate may lead to incorrect assessments of the adequacy of monetary policy. I show how a rule for the long real rate, arguably a better indicator of the monetary policy stance, may be a more useful tool both in modelling and in empirical assessments of monetary policy.

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Over the past three decades, the Taylor rule (Taylor (1993)) has become a popular tool for thinking about monetary policy, providing both a simple description of central bank behavior as well as a benchmark for evaluating policy. Its influence extends well beyond academic work. Despite its huge popularity, however, the Taylor rule's ability to describe U.S. monetary policy has diminished significantly since John Taylor's seminal contribution, and more so after the financial crisis. This illustrated in Figure 1, drawn from a recent paper by Nakamura, Riblier and Steinsson (2025) which documents extensively the large empirical deviations from a variety of versions of the Taylor rule. In fact, as shown in Figure 2, a cursory look at the joint evolution of the Federal Funds rate target and inflation in recent years raises doubts about whether even the Taylor principle –a requirement for equilibrium determinacy in a broad class of models– was satisfied. A similar conclusion may be drawn from the recent experience in the Euro area, as illustrated in Figure 3.

In the present paper I argue that the Taylor rule's focus on the short-term nominal rate may have increasingly become a limitation in an environment where monetary policy operates through a broader set of instruments and channels, and where the short-term nominal rate can give a misleading picture of the stance of monetary policy. This problem is particularly apparent during periods when policy rates are constrained by the zero lower bound and central banks turn to non-conventional tools like forward guidance and asset purchases. These policies work primarily by affecting longer-term interest rates, which are more directly relevant for consumption and investment decisions. A framework centered on short-term nominal rates may therefore be ill-equipped to capture the true degree of monetary accommodation in such circumstances. That observation may also be relevant away from the zero lower bound, to the extent that central banks adjust only gradually the policy rate in response to developments in the economy, make extensive use of communications to influence expectations about future policy rates and/or engage in large scale purchases or sales of assets in order to affect the long end of the yield curve.

After a brief background on the Taylor rule in section 1, section 2 builds on the analysis in Nakamura et al. (2025) to uncover some of the pitfalls of the Taylor rule as a tool for assessing the adequacy of monetary policy. I particular it is shown that in an economy where monetary policy is conducted optimally (under discretion or commitment), an econometrician estimating a simple Taylor-type rule may be misled into concluding that monetary policy is fundamentally flawed. Estimates of a such a rule using U.S. data for the past three decades are shown to yield indeed that apparent conclusion.

To address this limitation, in section 3 I propose shifting attention toward rules that describe policy in terms of *real* interest rates. I start by focusing on simple rules for the short-term real rate. First I show how those rules can be easily embedded in a standard macro model, I derive their requirements for equilibrium uniqueness and discuss some of their advantages relative to a conventional nominal rate rule. Second, using the same framework as in section 2, I show how the use of a short-term real rate rule as a tool to assess monetary policy helps overcome the limitations of a nominal rule uncovered in Section 2 when the central bank is optimizing under discretion. However, that is not the case more generally. Under an optimal policy with commitment, for example, a negative comovement between the short-term real rate and inflation is shown to emerge under a broad range of parameter configurations. That observation would clearly appear as a red flag to an external observer as to the adequacy of monetary policy, even though it is actually the best possible policy available.

As an alternative, in Section 4 I explore the properties of rules expressed in terms of the long-term real interest rate. The latter variable summarizes better the overall financial conditions faced by households and firms when making consumption and investment, thus providing a more comprehensive and economically meaningful measure of the stance of monetary policy. It is shown that a rule based on a long real rate can replicate the desirable properties traditionally associated with the Taylor rule, such as stabilizing inflation and economic activity. Most importantly, the analysis of the outcomes under optimal monetary policy shows that a focus on the behavior of the long term real rate and its comovement with inflation provides a more robust approach to assessing the adequacy of monetary policy than the alternatives considered earlier. This is particularly true, of course, in periods in which short-term rates are against the zero lower bound and where standard Taylor-rule interpretations will mechanically imply an overly constrained policy stance.

Section 5 reports estimates of two empirical interest rate rules for the U.S., based respectively on the short-term nominal rate and a long-term real rate The findings from that exercise illustrate clearly the differences in the assessment of the adequacy of U.S. monetary policy in recent years that can result from using the two alternative approaches discussed above. Section 6 concludes.

1 The Taylor Rule: Background

The Taylor rule, which generically refers to a mapping from a measure of inflation and economic activity to a short-term nominal interest rate, has long been a staple of monetary economics, both in theoretical models as well as in empirical work. It has its origins in the numerical rule proposed in Taylor (1993) as a good approximation of Fed policy in the early years of Greenspan's tenure:

$$i_t^{(a)} = 4 + 1.5(\pi_t^{(a)} - 2) + 0.5\widehat{y}_t$$

where $i_t^{(a)}$ is the (annualized) Federal funds rate, $\pi_t^{(a)}$ is (annualized) inflation and $\widehat{y}_t$ denotes the (percent) deviation of log GDP from a trend.

On the modelling front, a Taylor-type rule is the default choice in order to complete the description of aggregate demand in New Keynesian models. In its simplest version it takes the form:

$$i_t = \rho + \phi_\pi \pi_t + \phi_y \widehat{y}_t + v_t \tag{1}$$

where one-period nominal interest rate i_t is interpreted as the instrument of monetary policy (i.e. the policy rate) where $\phi_\pi \geq 0$ and $\phi_y \geq 0$ are policymaker's choices, and v_t follows an exogenous process and is interpreted as an exogenous monetary policy shock.

While Taylor originally intended his namesake rule as a *descriptive* tool, the latter eventually attained a *normative* status, i.e. it came to be seen as describing how monetary policy should be conducted. The reasons for this are twofold. Firstly, the rule provided a good description of Fed policy during a period characterized by low and stable inflation and unusually mild fluctuations in output and employment. In addition, a rule like (1), with a suitable choice of coefficients, was also shown to perform reasonably well when embedded in a standard New Keynesian model. As a result, the Taylor rule came to be seen as a guidepost for good policy, and has often been used for the purposes of monetary policy assessment in a variety of economies and sample periods, with deviations from the Taylor rule generally interpreted as an indicator of a policy that is too tight or too loose given observed macroeconomic conditions. Taylor himself has been a forceful advocate of that normative use.[1]

In that context, an important aspect of the Taylor rule has often been emphasized: the need for the inflation and output coefficients to be "sufficiently large," so as to imply a more than one-for-one eventual response of the policy rate in the face of a hypothetical permanent increase in inflation. That property is known as the Taylor principle.[2] When the rule is embedded in the textbook three-equation New Keynesian model the Taylor principle condition takes the form:

$$\phi_\pi + \frac{1-\beta}{\kappa}\phi_y > 1$$

where β is the discount factor and κ is the output coefficient in the New Keynesian Phillips curve.[3]

Failure to meet that condition leads to the emergence of multiplicity of equilibria and the possibility of fluctuations driven by self-fulfilling revisions in expectations independent of fundamental shocks (i.e. sunspot fluctuations).[4] In models that are less forward-looking than the standard New Keynesian model and/or with endogenous deanchoring of long run expectations, failure to meet the Taylor principle often leads to explosive inflation paths or non-existence of an equilibrium.[5] The evidence on recent monetary policy displayed in Figures 2 and 3 raises indeed the possibility that the Taylor principle has not been respected in recent years.

2 Pitfalls in the use of Taylor Rules for Policy Assessment

Taylor-type rules, as exemplified by (1), have significant limitations as guideposts for the assessment of the quality or suitability of monetary policy in a given economy and historical period. In particular, one can show that (a) optimal monetary policy is not generally implementable by means of a simple Taylor rule, and (b) even in the cases in which optimal policy can be implemented by a Taylor-type rule the *observable outcomes* of that policy do not always satisfy the Taylor principle. Accordingly, observed deviations from the Taylor rule or even from the Taylor principle should not be interpreted as *prima facie* evidence of "bad monetary policy."

Next I illustrate the previous points using the basic New Keynesian model. In doing so I adopt and extend the analysis in Nakamura, Riblier and Steinsson (2025) and my discussion thereof (Galí (2025)).

Consider the canonical optimal monetary policy problem analyzed in Clarida, Galí and Gertler (1999):

$$\min \ \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\pi_t^2 + \vartheta \widehat{y}_t^2 \right)$$

[1] See, e.g. Taylor (2012).

[2] See Woodford (2001)

[3] See Bulard and Mitra (2002).

[4] Clarida, Galí and Gertler (2000).argued that the macro instability that characterized the U.S. economy in the pre-Volcker era may have been a consequence of a monetary policy that failed to respond with sufficient strength to fluctuations in inflation, thus violating the Taylor principle.

[5] See e.g. Dupraz and Marx (2025).

subject to:

$$\pi_t = \beta \mathbb{E}_t\{\pi_{t+1}\} + \kappa \widehat{y}_t + u_t \tag{2}$$

$$\widehat{y}_t = \mathbb{E}_t\{\widehat{y}_{t+1}\} - \frac{1}{\sigma}(\widehat{i}_t - \mathbb{E}_t\{\pi_{t+1}\} - z_t) \tag{3}$$

where (2) is a standard New Keynesian Phillips curve augmented with an exogenous cost-push shock u_t that is assumed to follow an $AR(1)$ process.[6] Equation (3) is the dynamic IS equation, where z_t can be interpreted as a generic aggregate demand shock. It is implicitly assumed throughout that the efficient level of output is constant, so that $\widehat{y}_t$ can be interpreted as the welfare-relevant output gap. Accordingly, z_t corresponds to the efficient rate of interest, i.e. the one that supports the efficient level of output (consistent with $\widehat{y}_t = 0$). Next I discuss the solution to the above problem under two alternative assumptions: commitment and discretion. The reader can find a detailed discussion, including derivations, in Galí (2015, chapter 5).

2.1 Optimal Policy under Discretion

Under discretion the central bank takes expectations as given and solves each period a static problem of the form

$$\min \pi_t^2 + \vartheta \widehat{y}_t^2$$

subject to

$$\pi_t = \kappa \widehat{y}_t + v_t$$

where $v_t \equiv \beta \mathbb{E}_t\{\pi_{t+1}\} + u_t$ is taken as given. The solution to the problem above, combined with (2) and (3) implies a path for inflation, output and the nominal rate given by

$$\pi_t^* = \frac{\vartheta}{\kappa^2 + \vartheta(1 - \beta\rho_u)} \, u_t \tag{4}$$

$$\widehat{y}_t^* = -\frac{\kappa}{\kappa^2 + \vartheta(1 - \beta\rho_u)} \, u_t \tag{5}$$

$$\widehat{i}_t^* = \frac{\vartheta\rho_u + \sigma\kappa(1 - \rho_u)}{\kappa^2 + \vartheta(1 - \beta\rho_u)} u_t + z_t \tag{6}$$

where the asterisk is used to stress the fact that this is the outcome consistent with the solution to the optimal policy problem. Combining (4) and (6) yields the following relation between the nominal rate and inflation under the optimal policy:

$$\widehat{i}_t^* = \left[\rho_u + \frac{\sigma\kappa}{\vartheta}(1 - \rho_u)\right] \pi_t^* + z_t$$

As is well known, guaranteeing that the optimal outcome is the only equilibrium requires that the central bank reacts with sufficient strength to any deviation from the latter.[7] If $\sigma\kappa > \vartheta$, the simple Taylor-type rule

$$\widehat{i}_t = \left[\rho_u + \frac{\sigma\kappa}{\vartheta}(1 - \rho_u)\right] \pi_t + z_t$$

[6] See, e.g.. Galí (2015) for a detailed derivation.

[7] See, e.g. Galí (2015, chapter 5)

will implement the optimal allocation as a unique equilibrium. By contrast, if $\sigma\kappa \leq \vartheta$, the rule above will not satisfy the Taylor principle so multiple equilibria will arise, only one of which is the desired one. As discussed in Galí (2015) and Nakamura et al. (2025) the previous problem can be overcome by adopting the rule

$$\widehat{i}_t = \left[\rho_u + \frac{\sigma\kappa}{\vartheta}(1-\rho_u)\right]\pi_t + z_t + \varphi_\pi(\pi_t - \pi_t^*) \tag{7}$$

with $\varphi_\pi > \left(1 - \frac{\sigma\kappa}{\vartheta}\right)(1-\rho_u)$. If the central bank adopts the previous rule, $\pi_t = \pi_t^*$ obtains in equilibrium, and the last term on the right-hand side of (7) vanishes.

Accordingly, and independently of parameter values, the following relation between the policy rate and inflation will be observed when the central bank implements the optimal policy:

$$\widehat{i}_t = \left[\rho_u + \frac{\sigma\kappa}{\vartheta}(1-\rho_u)\right]\pi_t + z_t$$

Note that the previous relation is consistent with the generic Taylor rule specification in (1). Furthermore, since z_t is uncorrelated with π_t, the previous relation can be consistently estimated using OLS. Fitting a Taylor rule to interest rate and inflation data generated by such an economy may lead to misleading conclusions about the adequacy of monetary policy for at least two reasons.

Firstly, under the assumption that $\sigma\kappa < \vartheta$ –a condition which may very well be satisfied for plausible parameter values- the estimated rule will suggest that the Taylor principle is not satisfied, a misleading claim as long as $\varphi_\pi > \left(1 - \frac{\sigma\kappa}{\vartheta}\right)(1-\rho_u)$ holds. Secondly, the (possibly large) fitted disturbances to the rule may be misinterpreted as exogenous monetary policy shocks that may induce unnecessary instability; paradoxically, however, the seeming disturbances correspond to adjustments in the nominal rate in order to match changes in the efficient rate of interest. Thus, rather than generating unnecessary instability, such seeming deviations from the rule prevent inefficient fluctuations in inflation and output.

2.2 Optimal Policy under Commitment

Under commitment, the optimal policy gives rise to the following equilibrium behavior for the price level and output:

$$\widehat{p}_t^* = \delta\widehat{p}_{t-1}^* + \delta u_t \tag{8}$$

$$\widehat{y}_t^* = \delta\widehat{y}_{t-1}^* - \frac{\kappa\delta}{\vartheta}u_t \tag{9}$$

where $\widehat{p}_t \equiv p_t - p_{-1}$ and $\delta \in (0,1)$ is a function of underlying parameters. On the other hand, the nominal rate must satisfy the following relation along the equilibrium path:

$$\widehat{i}_t^* = \left(\frac{\sigma\kappa}{\vartheta} - 1\right)(1-\delta)\widehat{p}_t^* + z_t$$

where, for simplicity it is assumed that $\rho_u = 0$.

If $\sigma\kappa > \vartheta$ the desired outcome can be implemented as a unique equilibrium by means of a price level targeting rule of the form

$$i_t = \left(\frac{\sigma\kappa}{\vartheta} - 1\right)(1-\delta)\widehat{p}_t + z_t$$

with the positive coefficient on the price level guaranteeing the uniqueness of the equilibrium.[8]

On the other hand, if $\sigma\kappa \leq \vartheta$ the previous rule would not guarantee a unique equilibrium and, hence, the implementation of the desired outcome. The following augmented rule would however overcome that problem:

$$i_t = -\left(1 - \frac{\sigma\kappa}{\vartheta}\right)(1-\delta)\widehat{p}_t + z_t + \phi_p(p_t - p_t^*) \tag{10}$$

for any $\phi_p > \left(1 - \frac{\sigma\kappa}{\vartheta}\right)(1-\delta)$. Under the previous rule, $p_t = p_t^*$ for all t will hold in equilibrium, so that the last term on the right hand side will vanish. Accordingly, and independently of parameter values the following relation between the nominal rate and the price level will be observed:

$$i_t = \left(\frac{\sigma\kappa}{\vartheta} - 1\right)(1-\delta)\widehat{p}_t + z_t \tag{11}$$

The previous example is an illustration of an optimal policy which cannot be implemented by means of a simple Taylor-type rule. An econometrician estimating a simple rule $i_t = \phi_\pi \pi_t + v_t$ using OLS would obtain an (asymptotic) estimate of the inflation coefficient given by

$$\widehat{\phi}_\pi \to \frac{1}{2}\left(\frac{\sigma\kappa}{\vartheta} - 1\right)(1-\delta)$$

That estimate may take a value less than unity and may even be negative, leading to the mistaken conclusion that the policy regime is not even consistent with the minimum desideratum of equilibrium uniqueness.

Alternatively, and taking first difference of both sides of (11):

$$\Delta i_t = \left(\frac{\sigma\kappa}{\vartheta} - 1\right)(1-\delta)\pi_t + \Delta z_t \tag{12}$$

Rule (12) is an example of a first-differenced Taylor rule, and can be estimated consistently using OLS. Similar rules have often been discussed in the literature (Rotemberg and Woodford (1999), Orphanides and Wieland (2013)), and can be viewed as a limiting case of an inertial or partial adjustment rule. Under a rule of the form $\Delta i_t = \phi_p \pi_t + \Delta z_t$ a positive value for coefficient ϕ_p can be shown to be a requirement for equilibrium uniqueness. Note, however, that the optimal policy considered above will imply a negative inflation coefficient whenever $\sigma\kappa < \vartheta$, not an implausible condition. The observation of such a negative comovement in an actual economy –combined with the uncovering of a potentially large disturbance Δz_t– may once again mislead an analyst to conclude that the policy rule in place is inadequate, if not terribly wrong. Such a conclusion would be unwarranted, given that the observed outcome is indeed the best among all feasible ones.[9]

[8] It is easy to check that the condition for local determinacy in the basic New Keynesian model when the central bank follows the rule

$$i_t = \phi_p \widehat{p}_t + z_t$$

is given by $\phi_p > 0$.

[9] Nakamura et al. (2025) illustrate the previous point by estimating a Taylor rule (in levels) using data simulated by an NK model under the optimal policy with commitment. When ϑ is sufficiently large their estimated coefficient on inflation becomes negative, in a way consistent with the analytical findings presented here.

The previous discussion has made clear the limitations of conventional Taylor-type rules for the short term nominal rate as tools for the assessment of monetary policy. Next I discuss the potential advantages of rules based on the real interest rates, as an alternative to the dominant approach.

3 An Alternative Approach: Real Rate Rules

The fact that most central banks have adopted a short term nominal rate as the instrument of monetary policy, in terms of which decisions are made, may suggest at first thought that a monetary policy rule should also be specified in terms of that variable, in both theoretical and empirical applications. That conclusion is, however, far from obvious.

Firstly, standard theoretical considerations on the determinants of aggregate demand make clear that if monetary policy is to have an effect on output it must do so through its ability to influence current and anticipated real interest rates. Through the lens of the model there is no other channel at work. Accordingly, it would seem a natural choice for the central bank to adopt, even if implicitly, a rule for the real rate. This is feasible for, in the presence of nominal rigidities, the central bank should be able to steer the real rate at will, at least locally. It also seems desirable, since it is only through changes in the real rate that the central bank can have an influence on macro variables. Thus, the real rate is one stage closer to the variables the central bank cares about than the nominal rate.

It should be clear, however, that through the lens of the model there is an equivalence between both formulations: given a rule for the nominal rate, one can trivially derive the corresponding rule for the real rate, and viceversa, using the identity linking the two, i.e. $r_t \equiv i_t - \mathbb{E}_t\{\pi_{t+1}\}$. In other words, the adoption of one of the two rules does not expand the set of feasible outcomes relative to the other. That equivalence notwithstanding there are at least two advantages of specifying a monetary policy rule directly in terms of the real interest rate. The first has to do with a simplification of the analysis of a model's equilibrium. The second pertains to the assessment of monetary policy. Below I discuss those in turn.[10]

3.1 Equilibrium under a Short-Term Real Rate Rule: A Brief Detour

In order to illustrate some of the properties of real rate rules consider the following simple rule:

$$\widehat{r}_t = \phi_y \widehat{y}_t + \widehat{r}_t^x \tag{13}$$

with $\phi_y \geq 0$ and where $\widehat{r}_t^x$ is a time-varying intercept to be specified below. The previous rule can be motivated by the desire of the central bank to stabilize output fluctuations.

When combined with (**??**), the real rate rule (13) allows us to determine equilibrium output without the need to specify the supply side of the model and, in particular, the equation

[10] A significant number of authors have assumed a real rate rule in their models, including a constant real rate (Woodford (2011), Auclert et al. (2023)), an exogenous process for the real rate (Debortoli and Galí (2025)), or a real rate rule with an endogenous component (Angeletos et al. (2025)). A rule for the real rate is also a key ingredient of the "new approach" advocated in Romer (2000).

describing inflation. Equilibrium output must satisfy the difference equation

$$\widehat{y}_t = \frac{\sigma}{\sigma + \phi_y}\mathbb{E}_t\{\widehat{y}_{t+1}\} + \frac{1}{\sigma + \phi_y}(z_t - \widehat{r}_t^x)$$

where z_t denotes a generic demand shock following an $AR(1)$ process. A necessary and sufficient condition for a locally unique solution to the above difference equation is $\phi_y > 0$, in which case:

$$\widehat{y}_t = \frac{1}{\sigma(1-\rho_z) + \phi_y} z_t - \frac{1}{\sigma(1-\rho_v)} \sum_{k=0}^{\infty} \left(\frac{\sigma}{\sigma + \phi_y}\right)^k \mathbb{E}_t\left\{\widehat{r}_{t+k}^x\right\}$$

Under the assumption that $\widehat{r}_t^x$ is an exogenous monetary policy shifter following the process

$$\widehat{r}_t^x = \rho_r \widehat{r}_{t-1}^x + \varepsilon_t^r$$

the above expression can be rewritten more compactly as a function of the current :

$$\widehat{y}_t = \frac{1}{\sigma(1-\rho_z) + \phi_y} z_t - \frac{1}{\sigma(1-\rho_r) + \phi_y} \widehat{r}_t^x$$

Rules like (13) that involve output only are more general than they may seem at first sight. Consider a central bank that seeks to implement a particular state-contingent output path $\{y_t^*\}$. The latter may be the outcome of an optimal policy problem involving additional target variables (e.g., inflation) and constraints (e.g., some version of a Phillips curve), as in the examples analyzed above. It can be easily checked that the desired output path is implemented as a unique equilibrium by adopting the rule

$$\widehat{r}_t = \phi_y(y_t - y_t^*) + \widehat{r}_t^x$$

for any $\phi_y > 0$ and with the intercept $\widehat{r}_t^x$ given by

$$\widehat{r}_t^x = \sigma \mathbb{E}_t\{\Delta y_{t+1}^*\} + z_t$$

Note that the previous analysis made no reference to inflation, and hence it can be viewed as robust to a wide range of sticky price models implying different (and possibly complex) relationships between inflation and economic activity.

This is no longer true if instead one assumes a rule of the form:

$$\widehat{r}_t = \phi_\pi \pi_t + \phi_y \widehat{y}_t + \widehat{r}_t^x \tag{14}$$

where $\phi_\pi \geq 0$ and $\phi_y \geq 0$. In that case, and in order to solve for the model's equilibrium, equations (**??**) and (14) have to be supplemented with a third equation describing the relation between inflation and output. A prominent example of the latter is given by the New Keynesian Phillips curve, which in its simplest version takes the form:

$$\pi_t = \beta \mathbb{E}_t\{\pi_{t+1}\} + \kappa \widehat{y}_t \tag{15}$$

After substituting (14) into (**??**) we can represent the equilibrium dynamics by the system:

$$\begin{bmatrix} \widehat{y}_t \\ \pi_t \end{bmatrix} = \mathbf{A} \begin{bmatrix} \mathbb{E}_t\{\widehat{y}_{t+1}\} \\ \mathbb{E}_t\{\pi_{t+1}\} \end{bmatrix} + \mathbf{B} \; [z_t - \widehat{r}_t^x] \tag{16}$$

where

$$\mathbf{A} \equiv \frac{1}{\sigma + \phi_y + \kappa\phi_\pi} \begin{bmatrix} \sigma & -\beta\phi_\pi \\ \sigma\kappa & \beta(\sigma + \phi_y) \end{bmatrix}$$

$$\mathbf{B} \equiv \frac{1}{\sigma + \phi_y + \kappa\phi_\pi} \begin{bmatrix} 1 \\ \kappa \end{bmatrix}$$

The solution to the previous system is locally unique if and only if the two roots of **A** lie inside the unit circle. A necessary and sufficient condition is given by:

$$\kappa\phi_\pi + (1-\beta)\phi_y > 0 \tag{17}$$

which is satisfied as long as $\phi_\pi > 0$ and/or $\phi_y > 0$. Note that the previous condition has a clear connection to the conventional Taylor principle, for it implies that a hypothetical permanent increase in inflation (and hence in output, given (15)) will be met by an increase in the real interest rate, i.e. by an increase in the nominal rate more than one-for-one relative to the increase in (expected) inflation.

If condition (17) is satisfied one can solve for equilibrium output and inflation as a function of current and expected future values of z_t and $\widehat{r}_t^x$, by iterating (16) forward. Under the additional assumption that those exogenous driving forces follow an $AR(1)$ process a solution can be obtained in terms of their current values using the method of undetermined coefficients, and the analysis proceeds as in the case of a rule for the nominal rate.

There is a subtle difference, however, between the conventional analysis using a nominal rate-based Taylor-type rule like (1) and its real rate counterpart (14) that is worth noting. In the latter, equilibrium uniqueness obtains for arbitrarily small values of ϕ_π and ϕ_y. As a result, one can look at the effects of an arbitrary exogenous path of the real interest rate on output and inflation by focusing on the limiting case of $\phi_\pi = \phi_y = 0$ and setting the desired path for $\widehat{r}_t^x$. By contrast under a rule like (1) it is not possible to evaluate the impact of a given exogenous path of the nominal rate, for the latter will be invariably affected by the endogenous response of output and inflation given the impossibility of choosing arbitrarily small values of ϕ_π and ϕ_y while preserving equilibrium uniqueness.[11]

3.2 Real Rate Rules for Monetary Policy Assessment

Next I illustrate the advantages of real rate rules for the assessment of monetary policy using as a benchmark an economy operating under an optimal monetary policy, as analyzed above.

Consider first the case of optimal monetary policy with *discretion*. The observed relation between the short term real rate and inflation implied by that policy is given by

$$\begin{aligned} \widehat{r}_t &= \left[\rho_u + \frac{\sigma\kappa}{\vartheta}(1-\rho_u)\right]\pi_t + z_t - \mathbb{E}_t\{\pi_{t+1}\} \\ &= \frac{\sigma\kappa}{\vartheta}(1-\rho_u)\pi_t + z_t \end{aligned} \tag{18}$$

where I have made use of the fact that $\mathbb{E}_t\{\pi_{t+1}\} = \rho_u\pi_t$ under the optimal policy. Note that the inflation coefficient will always be positive and will thus meet the Taylor principle

[11] Galí (2011) shows how to do so, but the approach requires departures from Taylor rule.

criterion corresponding to a real rate rule, and given by condition (17) above. An econometrician estimating rule (18) will not be misled into thinking that the policy in place does not satisfy the conditions for a unique equilibrium, even in the case of $\sigma\kappa < \vartheta$, in contrast with the nominal rate rule discussed above.

In fact, the central bank itself may adopt (18) itself as a policy rule to implement the optimal policy outcome as a unique equilibrium. Note that relative to its nominal counterpart (7), the real rate rule (18) does not require an off-equilibrium term independently of parameter values. This seems a clear advantage since such an off-equilibrium response may not be viewed as credible given that it is never observed.

What if the central bank follows an optimal monetary policy under *commitment*? Note that in that case the equilibrium real rate must satisfy:

$$\begin{aligned} \widehat{r}_t^* &= \sigma \mathbb{E}_t\{\Delta y_{t+1}^*\} + z_t \\ &= -\frac{\sigma\kappa}{\vartheta}\mathbb{E}_t\{\pi_{t+1}^*\} + z_t \end{aligned}$$

In the particular case considered above with $\rho_u = 0$ we have $\mathbb{E}_t\{\pi_{t+1}^*\} = -(1-\delta)\widehat{p}_t^*$ and hence

$$\widehat{r}_t^* = \frac{\sigma\kappa}{\vartheta}(1-\delta)\widehat{p}_t^* + z_t$$

It can be easily be checked that such an optimal path can be implemented as a unique equilibrium by means of the following price level targeting real rate rule

$$\widehat{r}_t = \frac{\sigma\kappa}{\vartheta}(1-\delta)\widehat{p}_t + z_t$$

or, alternatively, by its first-differenced version in terms of inflation

$$\Delta r_t = \frac{\sigma\kappa}{\vartheta}(1-\delta)\pi_t + z_t$$

An econometrician estimating a (mis-specified) real rate rule of the form $r_t = \rho + \phi_\pi \pi_t + v_t$ will obtain an (asymptotic) estimate $\phi_\pi = \frac{1}{2}\frac{\sigma\kappa}{\vartheta}(1-\delta) > 0$, and correctly conclude the rule is consistent with a unique equilibrium. The same conclusion will be reached if the (now correctly) specified first-differenced rule is estimated. In both cases the assessment contrasts with that based on a conventional nominal Taylor rule.

The previous conclusion, however, does not generalize to the case of serially correlated cost-push shocks, with $0 < \rho_u < 1$. To see this, note that in that case $\mathbb{E}_t\{\pi_{t+1}^*\} = -[1-(\delta+\rho_u)]\widehat{p}_t - \delta\rho_u\widehat{p}_{t-1}$ implying an equilibrium real rate

$$\widehat{r}_t^* = \frac{\sigma\kappa}{\vartheta}[1-(\delta+\rho_u)]\widehat{p}_t^* + \frac{\sigma\kappa}{\vartheta}\delta\rho_u\widehat{p}_{t-1}^* + z_t$$

An econometrician estimating a real rate rule of the form $r_t = \rho + \phi_\pi \pi_t + v_t$ will obtain an (asymptotic) estimate

$$\widehat{\phi}_\pi \to \frac{1}{2}\frac{\sigma\kappa}{\vartheta}[1-(\delta+\rho_u) - \delta\rho_u]$$

which will be negative for sufficiently large ρ_u, leading to the mistaken conclusion of inadequacy of the monetary policy rule in place.

Why does the optimal policy imply a negative comovement between the real rate and inflation in this case? I The reason for this "anti-natural" comovement can be grasped by looking at the responses of the short term real rate and inflation in response to a positive cost push shock, shown in Figure 4 as red lines with squares. Note that in response to the inflationary shock, the real rate goes down and remains below its initial value for several periods, thus generating the negative comovement with inflation that would be captured by the OLS estimate. The lower real rate is needed in order to support the desirable gradual decline of output (and consumption) during that period.

The possibility that inflation and the real rate comove negatively in response to some shocks, as illustrated by the above example, calls into question the usefulness of simple real rate rules as a benchmark for the assessment of the adequacy of monetary policy. Below I show how the use a long real rate rule can overcome some of these problems.

4 Long Term Real Interest Rate Rules

Consider an infinitely-lived bond paying one unit of the consumption bundle each period (i.e. a real consol). As shown in the appendix, and to a first approximation, the yield on that asset, $\widehat{r}_t^L$, is equal to a weighted average of current and expected future one-period real interest rates

$$\widehat{r}_t^L = (1-\beta)\sum_{k=0}^{\infty}\beta^k \mathbb{E}_t\{\widehat{r}_{t+k}\}$$

Henceforth I refer to $\widehat{r}_t^L$ as the *long real interest rate* or the *long rate*, for short. In a standard model with a representative agent, that rate plays a prominent role in determining aggregate consumption. In particular, the log-linearized consumption function can be written as:

$$\begin{aligned}
\widehat{c}_t &= (1-\beta)\sum_{k=0}^{\infty}\beta^k \mathbb{E}_t\{\widehat{y}_{t+k}\} - \frac{\beta}{\sigma}\sum_{k=0}^{\infty}\beta^k \mathbb{E}_t\{\widehat{r}_{t+k}\} + \frac{\beta}{\sigma(1-\beta\rho_z)}z_t \\
&= (1-\beta)\sum_{k=0}^{\infty}\beta^k \mathbb{E}_t\{\widehat{y}_{t+k}\} - \frac{\beta}{\sigma(1-\beta)}\widehat{r}_t^L + \frac{\beta}{\sigma(1-\beta\rho_z)}z_t
\end{aligned}$$

Similarly, in model of investment subject to convex adjustment costs, the lo-linearized investment function takes the form:

$$\widehat{x}_t - \widehat{k}_t = \eta\widehat{q}_t$$

where

$$\begin{aligned}
\widehat{q}_t &= [1-\beta(1-\delta)]\sum_{k=0}^{\infty}\beta^k \mathbb{E}_t\{\widehat{r}_{t+1+k}^K\} - \sum_{k=0}^{\infty}\beta^k \mathbb{E}_t\{\widehat{r}_{t+k}\} \\
&= [1-\beta(1-\delta)]\sum_{k=0}^{\infty}\beta^k \mathbb{E}_t\{\widehat{r}_{t+1+k}^K\} - \frac{1}{1-\beta}\widehat{r}_t^L
\end{aligned}$$

where $\widehat{r}_t^K$ is the marginal revenue product for the agent firm carrying out the investment and capital accumulation and η is inversely related to the curvature of adjustments costs evaluated at the steady state.

The previous equations make clear that $\widehat{r}_t^L$ is a sort of sufficient statistic for the stance of monetary policy. Monetary policy will affect aggregate demand and output if and only if it manages to change the long real rate. Central bank decisions regarding policy instruments (e.g. the short term nominal rate) must take into account, explicitly or implicitly, its impact on the long real rate for it is the latter that will determine the effect of those decisions on output and other macro variables.

Given the previous consideration it seems natural to model monetary policy directly in terms of a rule for the long real rate. In the remainder of this section I revisit the equilibrium of the basic NK model under a long rate rule and discuss some of the advantages of using the long real rate for the assessment of monetary policy.

4.1 Equilibrium under a Long Rate Rule

The simplest case arises if one is willing to assume that the central bank adjusts the real rate only in response to fluctuations in output. Consider the rule:

$$\widehat{r}_t^L = \phi_y \widehat{y}_t + \widehat{r}_t^x \tag{19}$$

where $\phi_y \geq 0$. In equilibrium, after imposing $\widehat{c}_t = \widehat{y}_t$ we have

$$\widehat{y}_t = \frac{\sigma(1-\beta) + \beta\phi_y}{\sigma(1-\beta)+\phi_y} \mathbb{E}_t\{\widehat{y}_{t+1}\} - \frac{1}{\sigma(1-\beta)+\phi_y}\left(\widehat{r}_t^x - \mathbb{E}_t\{\widehat{r}_{t+1}^x\}\right) + \frac{1-\beta}{\sigma(1-\beta)+\phi_y} z_t$$

Local uniqueness requires $\phi_y > 0$. In that case, and assuming for simplicity that $\widehat{r}_t^x$ follows an $AR(1)$ process, equilibrium output is given by

$$\widehat{y}_t = -\frac{1-\beta\rho_r}{\sigma(1-\beta)(1-\rho_r)+(1-\beta\rho_r)\phi_y}\widehat{r}_t^x + \frac{1-\beta}{\sigma(1-\beta)(1-\rho_z)+(1-\beta\rho_z)\phi_y} z_t$$

On the other hand, note that the long real rate consistent with full stabilization of output requires $\widehat{r}_t^x - \mathbb{E}_t\{\widehat{r}_{t+1}^x\} = (1-\beta)z_t$ or, more compactly:

$$\widehat{r}_t^x = \frac{1-\beta}{1-\beta\rho_z} z_t$$

In order to support $\widehat{y}_t = 0$ as the unique equilibrium the central bank may adopt the rule

$$\widehat{r}_t^L = \frac{1-\beta}{1-\beta\rho_z} z_t + \phi_y \widehat{y}_t$$

with an arbitrary $\phi_y > 0$.

Alternatively, one may want to consider a Taylor-type rule for the long rate of the form:

$$\widehat{r}_t^L = \phi_\pi \pi_t + \phi_y \widehat{y}_t$$

where $\phi_y \geq 0$ and $\phi_\pi \geq 0$, and where for simplicity I am ignoring exogenous policy shocks. In that case solving for the equilibrium requires a specification of the relationship between inflation and output. Under the assumption of a conventional New Keynesian Phillips Curve of the form

$$\pi_t = \beta \mathbb{E}_t\{\pi_{t+1}\} + \kappa \widehat{y}_t$$

the equilibrium dynamics for output can be shown to be described by the difference equation:

$$\widehat{y}_t = \frac{\sigma(1-\beta)+\beta\phi_y}{\sigma(1-\beta)+\phi_y+\kappa\phi_\pi}\mathbb{E}_t\{\widehat{y}_{t+1}\} + \frac{1-\beta}{\sigma(1-\beta)+\phi_y+\kappa\phi_\pi}z_t$$

The necessary and sufficient condition for local uniqueness is now given by

$$\kappa\phi_\pi + (1-\beta)\phi_y > 0$$

which is identical to the corresponding condition in the case of a rule for the short real rate.

When the previous determinacy condition is satisfied equilibrium output and inflation are given by

$$\widehat{y}_t = \frac{1-\beta}{\sigma(1-\beta)(1-\rho_z)+(1-\beta\rho_z)\phi_y+\kappa\phi_\pi}\, z_t$$

We thus see that the analysis of equilibrium under a long rate rule is both feasible and often even simpler than its counterpart under a nominal rate rule, for one does not need to rely on the method of undetermined coefficients to solve for the equilibrium in closed form.

4.2 Long Rate Rules for Monetary Policy Assessment

Next I illustrate the advantages of long rate rules for the assessment of monetary policy using as a benchmark an economy operating under an optimal monetary policy, as analyzed above.

Consider again the case of optimal policy with *discretion* in the context of the canonical monetary policy problem introduced above. The equilibrium short-term real rate under the optimal policy is given by

$$\widehat{r}_t = \frac{\sigma\kappa}{\vartheta}(1-\rho_u)\pi_t + z_t$$

Accordingly, the long rate will be given by

$$\widehat{r}_t^L = \frac{\sigma\kappa}{\vartheta}\frac{(1-\beta)(1-\rho_u)}{1-\beta\rho_u}\pi_t + \frac{1-\beta}{1-\beta\rho_z}z_t$$

Note that the coefficient on inflation is always positive, so the optimal outcome can be implemented with a rule of this form as a unique equilibrium. The previous long rate rule can be estimated consistently with OLS. An econometrician estimating such a rule will not be misled into thinking that the policy in place does not satisfy the determinacy condition. This was also the case for the short real rate rule, but it stands in contrast with the case of estimates of a nominal rate rule when $\sigma\kappa < \vartheta$.

In the case of optimal policy with commitment the analysis is a bit more involved and its details are relegated to an appendix. When the optimal outcome is implemented as a unique equilibrium (independently of the rule that implements it) the observed long real rate will satisfy:

$$\widehat{r}_t^L = \frac{\sigma\kappa}{\vartheta}\Omega[1-(\delta+\rho_u)+\beta\delta\rho_u]\,\widehat{p}_t + \frac{\sigma\kappa}{\vartheta}\Omega(1-\beta)\delta\rho_u\,\widehat{p}_{t-1} + \frac{1-\beta}{1-\beta\rho_z}z_t$$

where $\Omega \equiv \frac{1-\beta}{(1-\beta\rho_u)(1-\beta\rho_z)} > 0$

It is clear that in this case a simple empirical long rate rule of the form $\widehat{r}_t^L = \phi_\pi \pi_t + v_t$ will be mis-specified. Yet, OLS estimates of ϕ_π can be shown to converge to

$$\widehat{\phi}_\pi \to \frac{\sigma\kappa}{2\vartheta}\Omega[1 - (\delta + \rho_u) + \delta\rho_u(2\beta - 1)]$$

which is guaranteed to be positive independently of ρ_u, given β sufficiently close to unity, as it will be the relevant case.[12] Hence an econometrician using a rule for the long term real rate will generally not be misled into believing it is inconsistent with a unique equilibrium when the central bank follows an optimal policy with commitment.

Figure 4 illustrates the previous observations, by displaying the impulse responses to a positive cost push shock under the optimal policy under discretion and commitment. Note that the long real rate and inflation comove positively under both discretion and commitment.

5 Empirical Evidence

Table 1 shows OLS estimates of ϕ_π in the empirical interest rate rule for the U.S. economy

$$i_t = \phi_0 + \phi_\pi \pi_t + \phi_t t + v_t$$

where i_t is the Federal funds rate and π_t denotes inflation, both annualized. The left panel uses CPI inflation, while the right panel uses core PCE inflation. A time trend is added as a regressor. Data are quarterly and the sample period starts in 1991Q3 and ends in 2024Q4. The starting date is constrained by the availability of inflation forecasts data used in an alternative specification below. Note that the sample period also excludes most of the period analyzed in the original Taylor (1993) paper.

The baseline estimates reported in Table 1 point to a coefficient well below unity, suggesting that not even the Taylor principle was satisfied during this period. This is also the case when the ZLB period is dummied out, suggesting that the findings of a weak response of the policy rate to inflation cannot be explained exclusively by the zero lower bound.

Table 2 shows comparable estimates of ϕ_π based on the long term real rate rule

$$r_t^L = \phi_0 + \phi_\pi \pi_t + \phi_t t + v_t$$

where r_t^L is constructed as the difference between the yield on 10 year Government bonds and the 10-year ahead inflation forecast from the Survey of Professional Forecasters. The estimates for ϕ_π are now positive (and significantly so) when the full sample period is used. When the ZLB periods are dummied out, the inflation coefficient estimates for "normal times" are also significantly positive, though insignificantly different from zero during the ZLB episodes.

The previous findings illustrate clearly the differences in the assessment of the adequacy of U.S. monetary policy in recent years that result from using the two alternative approaches discussed above.

[12] Note that $1 - (\delta + \rho_u) + \delta\rho_u > 0$ must hold given $0 \leq \rho_u < 1$ and $0 \leq \delta < 1$.

6 Conclusion

This paper has argued that the Taylor rule, while often used as a benchmark for monetary policy evaluation, may be ill-suited for that purpose. I have identified the rule's focus on a short term nominal interest rate as the main reason for possible misled assessments of the adequacy of monetary policy. This is particularly true in an environment where monetary policy operates through a broader set of instruments and channels. On the other hand, a Taylor-type rule expressed in terms of the long real rate, arguably a better indicator of the monetary policy stance, may be a more useful tool both in modelling and in empirical assessments of monetary policy.

The previous dichotomy is illustrated empirically by presenting evidence on the strength of the Fed response to changes in inflation based on two simple empirical rules: one for the short term nominal rate and the other for the long term real rate. Estimates of the more conventional nominal rate rule suggest that not even the Taylor principle has been met during this period. By contrast, estimates of the long real rate rule are consistent with a unique equilibrium, at least during normal times.

Overall, the paper calls for a rethinking of how economists model and evaluate monetary policy. Rather than abandoning rule-based approaches, it advocates adapting them to reflect the realities of modern central banking. Placing long-term real interest rates at the center of the analysis would make both theoretical modelling and empirical assessments more aligned with how monetary policy actually influences the economy.

References

Angeletos, George-Marios, Chen Lian, and Christian K. Wolf (2024): "Can Deficits Finance Themselves?," *Econometrica* 92(5), 1351-1390.

Auclert, Adrien, Matthew Rognlie, and Ludwig Straub (2024): "The Intertemporal Keynesian Cross." *Journal of Political Economy* 132(12), 4068-4121.

Bullard, James, and Kaushik Mitra (2002): “Learning About Monetary Policy Rules,” *Journal of Monetary Economics*, vol. 49, no. 6, 1105-1130.

Clarida, Richard, Jordi Galí, and Mark Gertler (1999): “The Science of Monetary Policy: A New Keynesian Perspective,” *Journal of Economic Literature*, vol. 37, 1661-1707.

Clarida, Richard, Jordi Galí, and Mark Gertler (2000): “Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory,” *Quarterly Journal of Economics*, vol. 105, issue 1, 147-180.

Debortoli, Davide, Jordi Galí, and Luca Gambetti (2020): "On the empirical (ir) relevance of the zero lower bound constraint," *NBER Macroeconomics Annual* 34(1), 141-170.

Debortoli, Davide and Jordi Galí ():

Dupraz, Stéphane and Magali Marx (2025): "Keeping Control over Boundedly Rational Expectations," unpublished manuscript.

Galí, Jordi (2011): "Are Central Banks’ Projections Meaningful?" *Journal of Monetary Economics* 58 (6-8), 537-550.

Galí, Jordi (2025): "Commentary on ’Beyond the Taylor Rule’," Jackson Hole Economic Policy Symposium, forthcoming.

Galí, Jordi (2025): "Rethinking the New Keynesian Model," work in progress.

Nakamura, Emi, Venance Riblier and Jón Steinsson (2025): "Beyond the Taylor Rule," Jackson Hole Economic Policy Symposium, forthcoming.

Orphanides, Athanasios (2003): “The Quest for Prosperity Without Inflation,” Journal of Monetary Economics 50, no. 3, 633-663.

Orphanides, Athanasios and Volker Wieland (2013): “Complexity and Monetary Policy,” *International Journal of Central Banking* 9, issue S1: 167–203.

Romer, David (2000): "Keynesian Macroeconomics without the LM Curve," *Journal of Economic Perspectives* 14(2), 149-169.

Rotemberg, Julio and Michael Woodford (1999): "Interest Rate Rules in an Estimated Sticky Price Model," in Taylor, J. (ed.) Monetary Policy Rules, University of Chicago Press

Taylor, John B. (1993): "Discretion versus policy rules in practice." Carnegie-Rochester Conference Series on Public Policy. North-Holland, 195-214.

Taylor, John B. (2012): "The Great Deviation." in E.F. Koenig, R. Leeson and G.A. Kahn (eds.), *The Taylor Rule and the Transformation of Monetary Policy*, Hoover University Press, 163-172.

Vestin, David (2006): "Price-level versus Inflation Targeting," *Journal of Monetary Economics*, 53(7), 1361-1376.

Woodford, Michael (2001): “The Taylor Rule and Optimal Monetary Policy,” American Economic Review vol. 91, no. 2, 232-237.

Woodford, Michael (2003): Interest and Prices: Foundations of a Theory of Monetary Policy, Princeton University Press.(Princeton, New Jersey).

Table 1. Empirical Interest Rate Rules

U.S. evidence,1991Q3-2024Q4

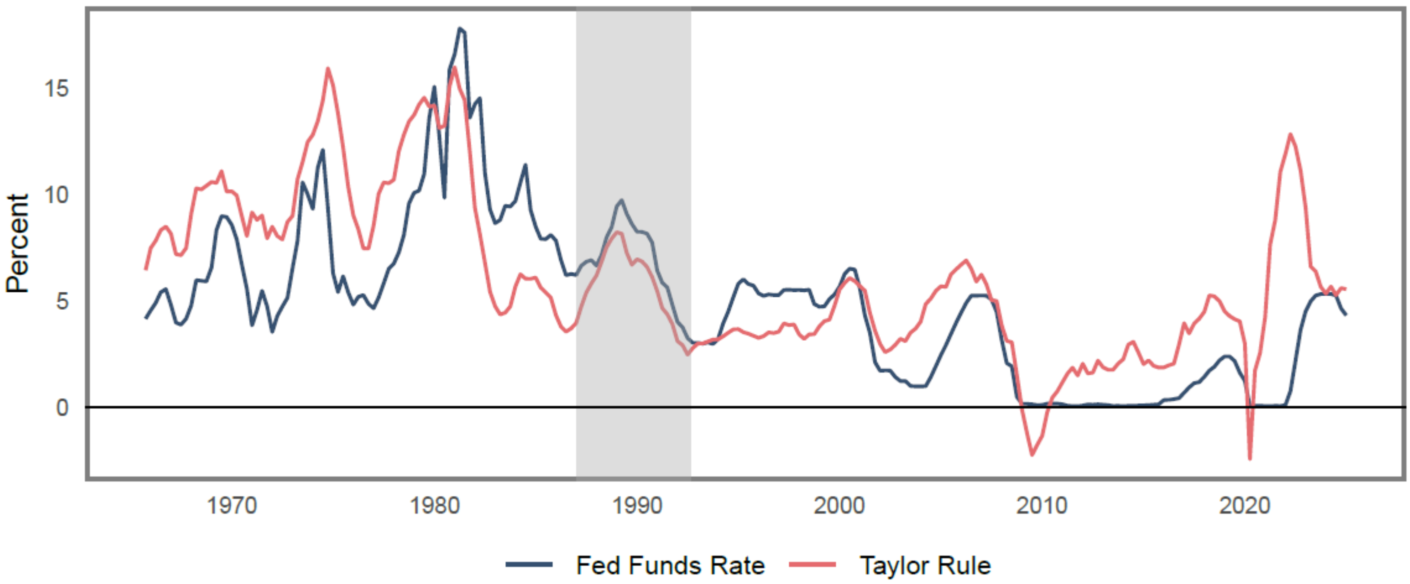
	CPI		Core PCE	
π_t	0.15^{***} (0.05)	0.33^{***} (0.09)	0.43^{***} (0.15)	0.68^{***} (0.17)
$\pi_t * ZLB_t$		-0.57^{***} (0.10)		-1.03^{***} (0.14)
R^2	0.28	0.41	0.29	0.49

Table 2. Empirical Long Real Rate Rules

U.S. evidence, 1991Q3-2024Q4

	CPI		Core PCE	
π_t	0.07^{***} (0.02)	0.14^{***} (0.04)	0.19^{**} (0.07)	0.30^{***} (0.17)
$\pi_t * ZLB_t$		-0.25^{***} (0.10)		-0.46^{***} (0.06)
R^2	0.65	0.71	0.66	0.75

Figure 1



Note: drawn from Nakamura, Riblier and Steinsson (2025, Figure 4)

Figure 2

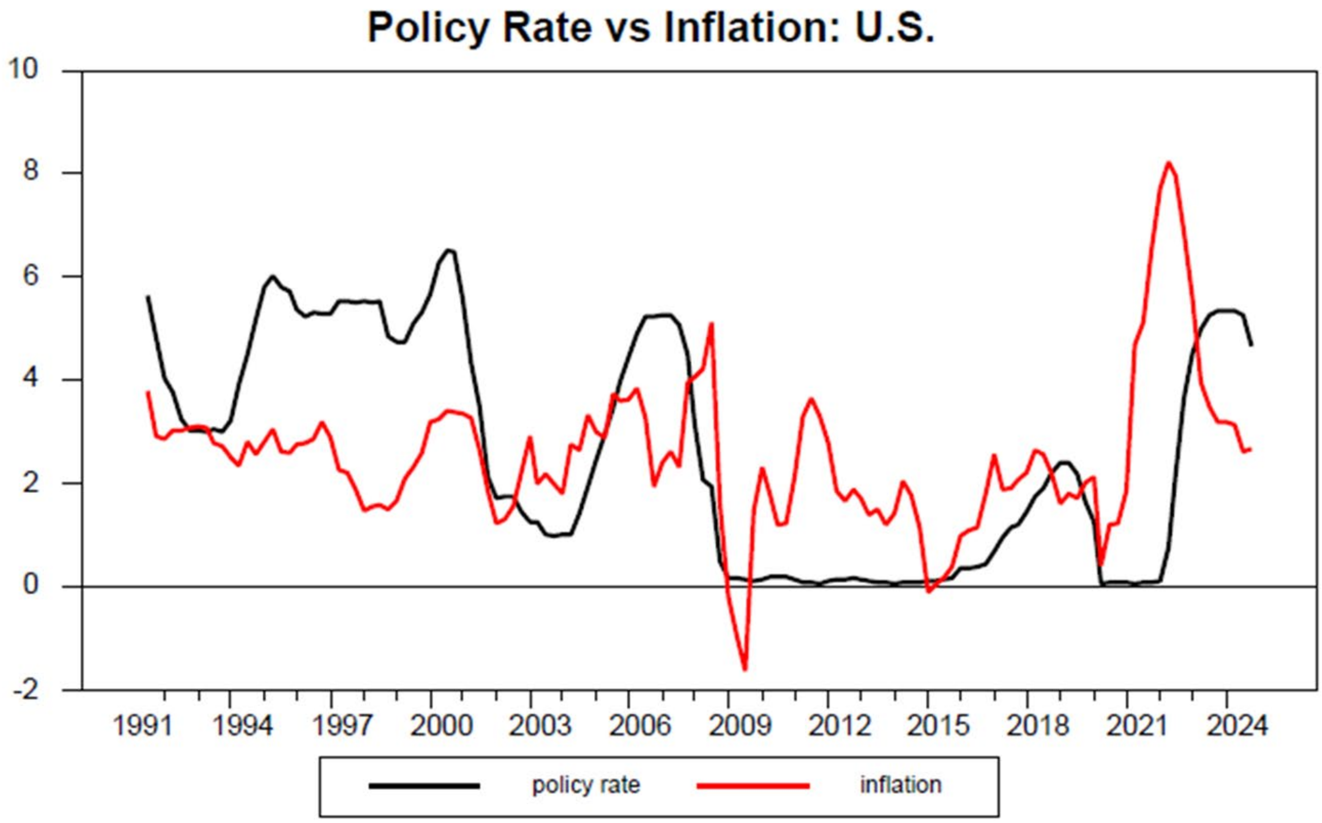


Figure 3

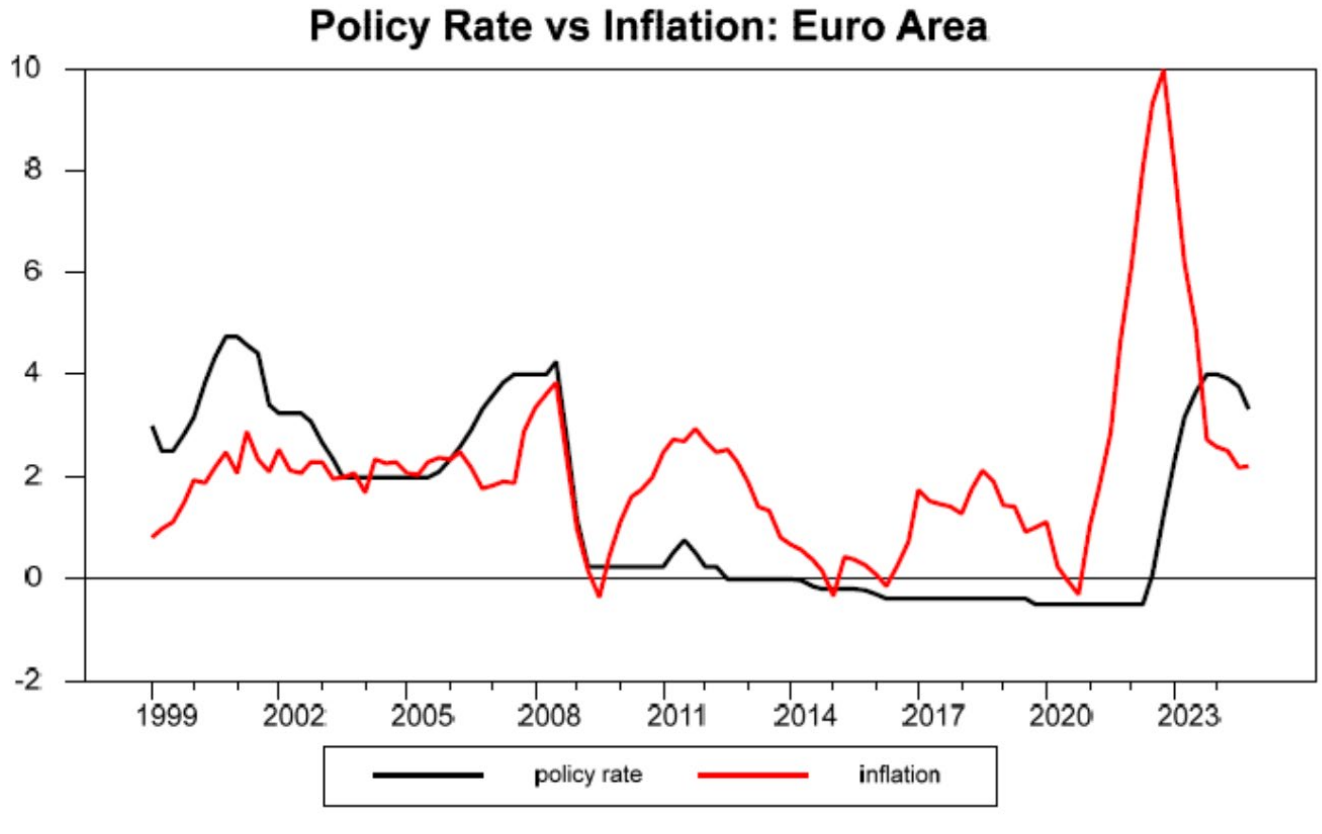
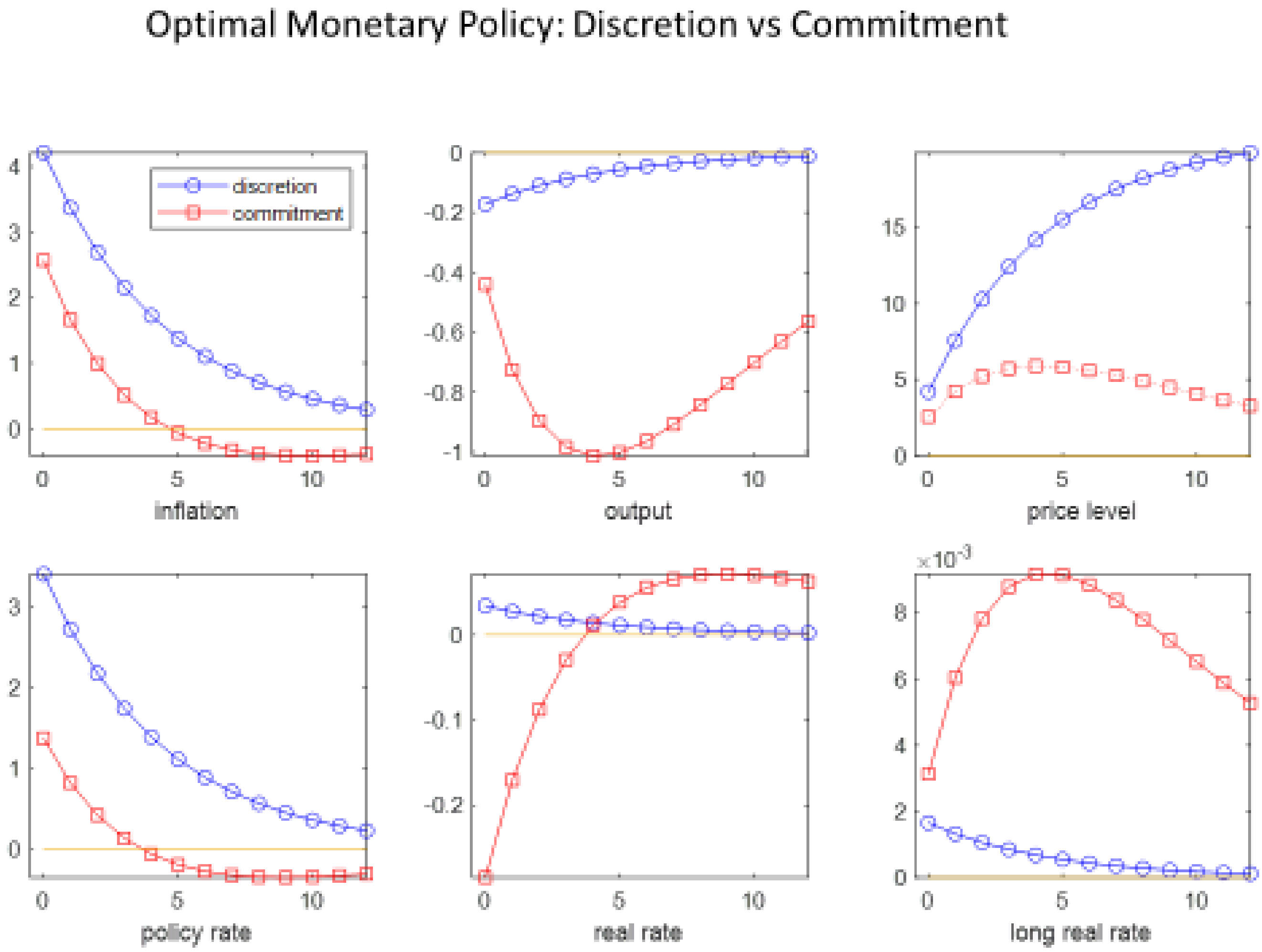


Figure 4



Optimal Monetary Policy: Discretion vs Commitment
discretion
commitment
inflation
output
price level
policy rate
real rate
long real rate
×10^-3