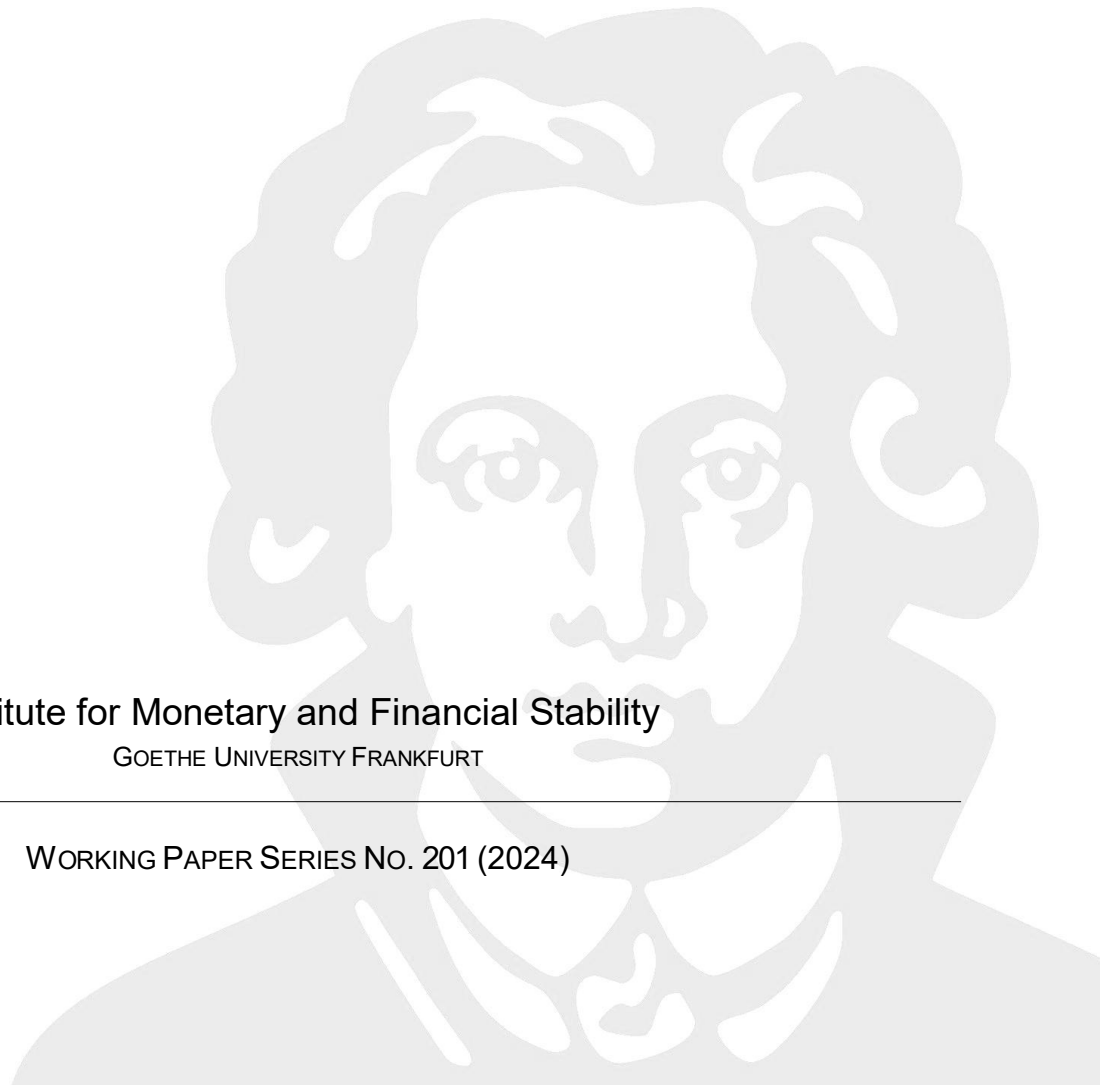BALINT TATAR, VOLKER WIELAND

Taylor Rules and the Inflation Surge:

The Case of the Fed

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Taylor Rules and the Inflation Surge: The Case of the Fed

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Abstract

The Federal Reserve has been publishing federal funds rate prescriptions from Taylor rules in its Monetary Policy Report since 2017. The signals from the rules aligned with Fed action on many occasions, but in some cases the Fed opted for a different route. This paper reviews the implications of the rules during the coronavirus pandemic and the subsequent inflation surge and derives projections for the future. In 2020, the Fed took the negative prescribed rates, which were far below the effective lower bound on the nominal interest rate, as support for extensive and long-lasting quantitative easing. Yet, the calculations overstate the extent of the constraint, because they neglect the supply side effects of the pandemic. The paper proposes a simple model-based adjustment to the resource gap used by the rules for 2020. In 2021, the rules clearly signaled the need for tightening because of the rise of inflation, yet the Fed waited until spring 2022 to raise the federal funds rate. With the decline of inflation over the course of 2023, the rules' prescriptions have also come down. They fall below the actual federal funds rate target range in 2024. Several caveats concerning the projections of the interest rate prescriptions are discussed.

Keywords: Monetary policy, interest rates, Federal Reserve, Taylor rule, New Keynesian macro-epidemic models.

JEL-Codes: E42, E43, E52

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1. The challenge

Since the start of 2024, the debate about the appropriate timing for monetary policy easing in the United States has intensified. After the surge in inflation in 2021 and 2022, the year of 2023 saw a steady decline in inflation rates. Some commentators see the Fed in danger of keeping monetary policy too tight for too long and risking a recession. Others warn that inflation is not vanquished as long as core measures remain significantly above the Fed's inflation objective and wage pressures continue to be strong.

Figure 1 shows the rise and fall of year-on-year inflation using five different measures: the consumer price index (CPI), the core CPI excluding energy and food prices, the deflator of personal consumption expenditures (PCE deflator), the core PCE deflator and the deflator of gross domestic product (GDP deflator).

Figure 1

The Inflation Surge in the United States

U.S. CPI, core CPI, PCE, core PCE and GDP deflator 2018-2024
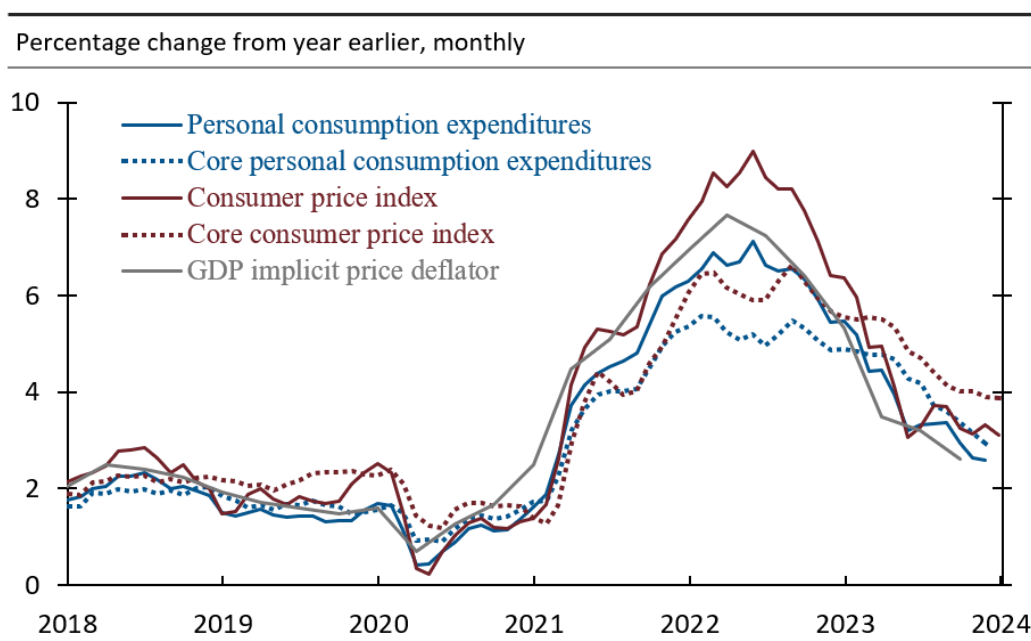
Notes: The chart shows the year-on-year percentage growth rate in the following different price measures: Personal Consumption Expenditures (PCE) deflator (solid blue line), Core PCE deflator (dotted blue line), Consumer Price Index (CPI) (solid red line), Core CPI (dotted red line) and the Implicit Price Deflator for the Gross Domestic Product (GDP) (solid grey line).

According to all five measures, inflation has declined substantially from its peak in 2022. Differences arise due to a number of factors. The measures of consumer prices include the prices of certain imports, while the GDP deflator measures the price level of domestically produced goods and services. The GDP deflator is, however, the broadest measure of domestic inflation as it comprises not only consumer goods and services, but also investment and government goods as

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well as services. The CPI and the core CPI are susceptible to substitution bias because they do not capture households' automatic shift to cheaper goods as prices increase. The consumption expenditure deflators incorporate this effect but such measures from national accounts are typically subject to greater revisions. The Fed is focusing on the consumption deflators in its communications and in the survey of members of the Federal Open Market Committee (FOMC) that it publishes regularly.

Overall, inflation seems to be well on course to return to the 2% inflation objective of the Federal Reserve. However, **Figure 1** also shows that the decline has slowed more recently and that core measures have declined somewhat less than overall measures of consumer price inflation.

Between March 2022 and September 2023, the Federal Reserve raised the target range for the federal funds rate from 0 to 1/4 percent to a range of 5-1/4 to 5-1/2 percent as shown in **Figure 2**. The standard rationale behind policy tightening is that it raises real interest rates. The resulting greater incentive to save dampens consumption demand. At the higher rate fewer investment projects are profitable, hence it also dampens investment demand. As a result, aggregate demand is brought closer in line with supply, thereby reducing opportunities for firms to pass on cost increases and raise product prices.

Figure 2

The Policy Tightening in the United States

Mid-point of Federal Funds Rate Target Range and Fed Funds Futures
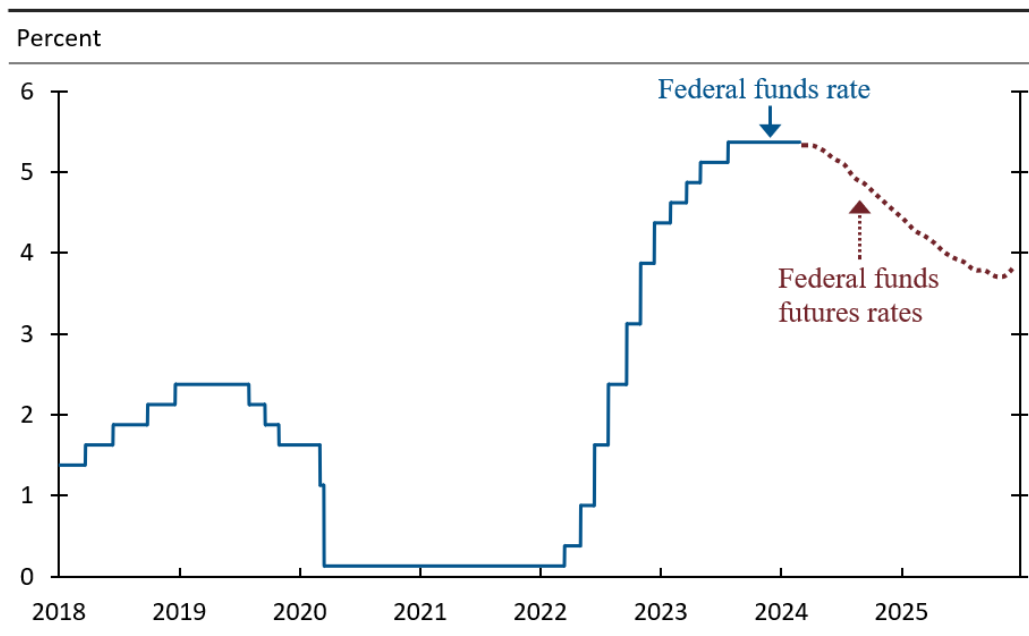
Notes: The blue line depicts the mid-point of the Federal Reserve's target range for the federal funds rate. The red dotted line indicates the federal funds futures rates from March 1, 2024.

Clearly, the policy tightening began much later than the rise of inflation. Perhaps for this reason, it proceeded very quickly. Not surprisingly, the Fed has been confronted with the critique that

policy got off track and responded too late to the increase in inflation (see, for example, Bordo, Cochrane and Taylor 2023 and the contributions therein). Since the end of September 2023 monetary policy has remained on hold. The Fed has kept the target range at 5-1/4 to 5-1/2 percent. As of March 1, 2024, federal funds rate futures indicated that markets trade on the expectation of an impending change towards policy easing with interest rate cuts starting in spring of the year.

The early rise in inflation in 2021 had much to do with the expansionary monetary and fiscal policies during the coronavirus pandemic that lasted well beyond the recession of 2020 (see, for example, Reis 2023, Wieland 2023a and 2023b). Inflation rose further during 2022 due to the Russian war of aggression on Ukraine and the ensuing energy and food crisis. Since energy and certain food prices have come down, inflation has also declined. It is still an open question, however, how persistent this decline will be.

In this regard, it is instructive to compare the recent inflation surge to the rise of inflation in the early 1970s as shown in **Figure 3**. Inflation was already fairly high at the start of the 1970s possibly due to excessively loose monetary policy (see, for example, Orphanides 2003). But it rose quickly following the surprise attack on Israel that marked the start of the Yom-Kippur war of October 1973. Arab states imposed an oil embargo on Western countries including the United States and caused an energy crisis.

Figure 3

Comparing the 2021/22 Inflation Surge with the 1970s

U.S. CPI 2017-2024 vs U.S. CPI 1970-1980
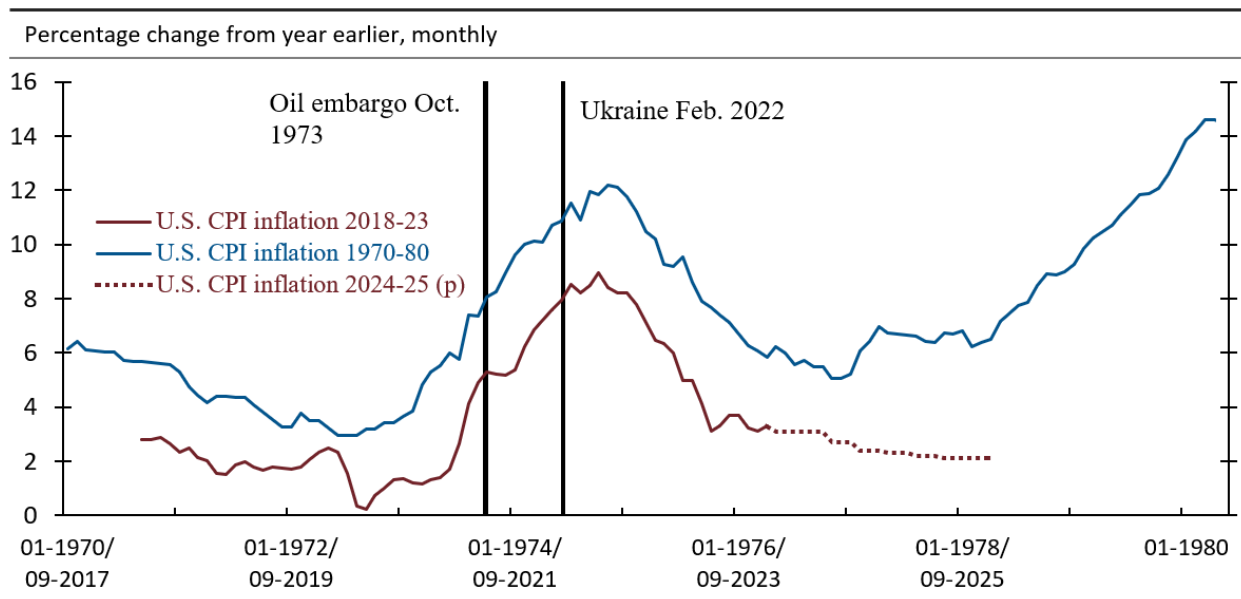
Notes: The blue line depicts the 12-month growth rate of the U.S. consumer price index from January 1970 to December 1980. The red line shows the 12-month growth rate of the CPI from September 2018 to January 2024. The dotted red line shows the median inflation forecast from the Survey of Professional Forecasters conducted by the Federal Reserve Bank of Philadelphia.

Figure 3 indicates several similarities between the two episodes. While, on average, inflation was two to three percentage points higher during the 1973/75 surge than in 2021/23, the speed of the rise and decline of inflation was quite similar. Comparing CPI measures, inflation rates moved up and down in parallel when aligned in the figure. Accordingly, neither the rise of inflation in 2021/22, nor the decline of inflation in 2023 was unusually fast.

By 1976, the inflation rate had more than halved. It had come down from a peak of 12 percent to below 6 percent and was declining. Similarly, by January 2024 the inflation rate has more than halved. It has come down from a peak of 8 percent to below 4 percent. And it is projected to slowly decline further, approaching 2 percent next year. By contrast, the decline in inflation in the mid1970s came to a halt and was later followed by another surge.

This historical experience gives some support to those who call for sticking to the current level of policy rates for longer so as to make sure that inflation returns to the target for good, or if that does not happen, to be ready for further tightening. Yet, having made the mistake of tightening policy too late, should not be a reason for subsequently making the mistake of easing too late. Given that monetary policy rules published by the Federal Reserve have signaled the need for policy tightening early on in 2021, these rules should be of interest as guideposts regarding the appropriate timing of policy easing.

2. The Rules in the Fed's Monetary Policy Report

In 2017, the Federal Reserve included a policy rules section as a standard feature in its Monetary Policy Report. It contained five different interest rate rules. The rules' interest rate prescriptions have been updated since then. Following the 2020 monetary policy strategy review, the Fed dropped one rule and added a new one. All five rules are variants of the rule proposed in Taylor (1993).

Figure 4 reproduces the chart with historical funds rate prescriptions from the policy rules considered by the Fed in its February 2020 Monetary Policy Report. It shows that the policy rules considered therein provided several useful signals to policy makers over time. On some occasions the Fed policy coincided with the prescriptions from the rules. For example, the policy easing in 2002/03 as well as in 2008/09 moved in lockstep with the rules shown in the chart.

There are other episodes, however, when the rules prescribed an earlier policy response than actual Fed policy. For example, the Taylor rule and two of its variants called for the Fed to raise interest rates earlier and faster in the years 2002 to 2005, that is, during the sub-prime housing boom and ahead of the global financial crisis. At that time, an earlier policy tightening could have helped slow down the housing boom that set the stage for the crisis (see, for example, Taylor 2007, Kahn 2010).

In 2009 and afterwards, multiple rules called for a negative funds rate. This could be interpreted as a signal that unconventional policy measures such as asset purchases are called for. Indeed, the Fed started its quantitative easing policy at that time.

Figure 4

Funds Rate Prescriptions from Policy Rules

The Federal Reserve's Monetary Policy Report, February 2020
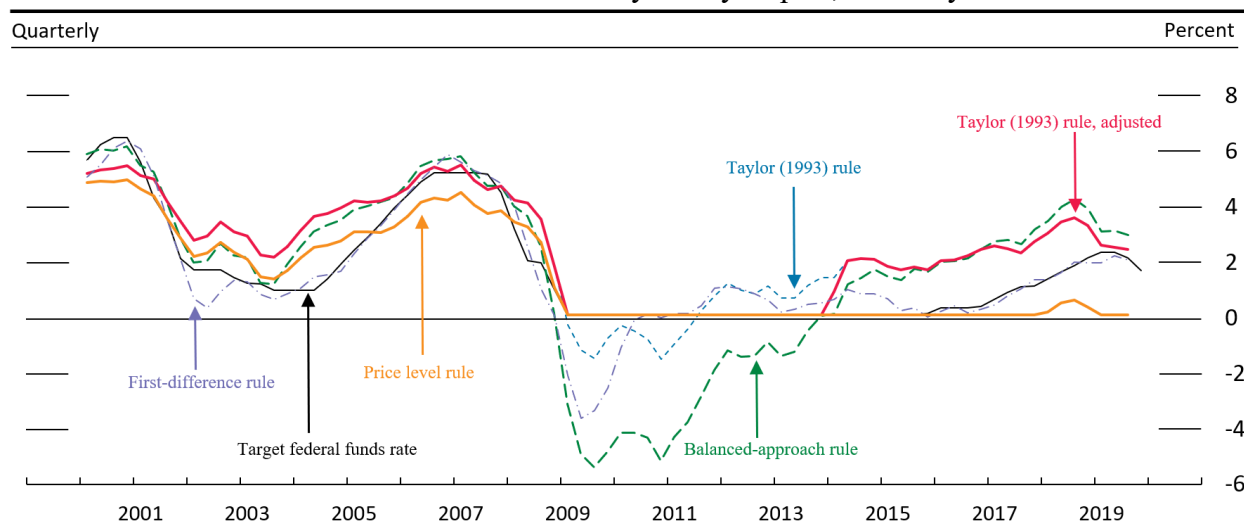
Notes: As explained in the Monetary Policy Report of the Board of Governors of the Federal Reserve System, the rules use historical values of the federal funds rate, core personal consumption expenditures (PCE) inflation, and the unemployment rate. Quarterly projections of longer-run values for the federal funds rate and the unemployment rate are derived through interpolations of biannual 6-to-10-year-ahead projections from Blue Chip Economic Indicators. The longer-run value for inflation is taken as 2 percent. The target value of the price level is the average level of the price index for PCE excluding food and energy in 1998 extrapolated at 2 percent growth per year. The data extend through 2019:Q3, with the exception of the midpoint of the target range for the federal funds rate data, which go through 2019:Q4. Sources: Federal Reserve Bank of Philadelphia; Wolters Kluwer, Blue Chip Economic Indicators; Federal Reserve Board staff estimates; Monetary Policy Report of the Board of Governors of the Federal Reserve System (Feb. 2020)

The *Taylor (1993) rule* then recommended lift-off into positive territory by 2012. Yet, given the effective lower bound on nominal interest rates it had been proposed to adjust policy so as to keep interest rates lower for longer than in the absence of this bound.[1] Such an adjustment is incorporated in the *Taylor (1993) rule, adjusted* that prescribed a lift-off in 2014 along with the so-called *Balanced-approach rule*. This timing was still quite a bit earlier than the policy tightening that started in 2016. Exiting from very low interest rates early but slowly can help reduce risks for financial stability. These risks include interest rate risk on bank balance sheets built-up during the period of low interest rates as well as potential asset price reversals.[2] In the event the tightening from 2016 to 2018, which proceeded relatively slowly, neither led to deflation nor significant financial disruption.

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[1] See, in particular, Orphanides and Wieland (2000), Reifschneider and Williams (2000) and Evans et al (2015) for expositions of the "lower for longer" approach to account for deflation risk.

[2] At the time, such financial stability risks were highlighted, for example, by the Bank for International Settlements, Annual Report 2015, Chapter I, Is the unthinkable becoming routine? and the German Council of Economic Experts Annual Report 2015/16, Chapter 5.1, Stability risks from low interest rates.

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Following the Federal Reserve's strategy review, which was completed in August 2020, the rule labeled "*Price level rule*" was dropped and a new rule termed "*Balanced-approach-shortfalls rule*" was added. **Table 1** shows the rules menu considered from February 2021 onwards.

Table 1

The Fed's Monetary Policy Rules since February 2021

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

Notes: R_t^{T93}, R_t^{BA}, R_t^{SBA}, R_t^{T93adj} and R_t^{FD} represent the values of the nominal federal funds rate prescribed by the Taylor (1993), balanced-approach, balanced-approach (shortfalls), adjusted Taylor (1993), and first-difference rules, respectively. R_t denotes the realized nominal federal funds rate for quarter t, π_t is the 4-quarter price inflation for quarter t, u_t is the unemployment rate in quarter t. r_t^{LR} is the level of the neutral real federal funds rate in the longer run that is expected to be consistent with sustaining maximum employment and inflation at the Federal Open Market Committee's 2 percent longer-run objective, π_t^{LR}. u_t^{LR} is the rate of unemployment expected in the longer run. Z_t is the cumulative sum of past deviations of the federal funds rate from the prescriptions of the Taylor (1993) rule when that rule prescribes setting the federal funds rate below an effective lower bound (ELB) of 12.5 basis points.

The first rule is the *Taylor (1993) rule*. It sets the level of the nominal funds rate as a function of the long-run equilibrium real interest rate, r^{LR}, the long-run inflation objective, π^{LR}, the current inflation rate and the output gap. The original 1993 specification used the GNP deflator and the deviation of GNP from its long-run trend. A current version could use instead the GDP deflator and the real GDP gap. Taylor, originally, used 2% for the inflation target and for the long-run real interest rate. This is close to the long-run averages of the real interest rate and real growth.

The Fed changes the inputs. The unemployment gap, that is, the difference between the long-run natural rate and the current unemployment rate, is used in place of the output gap. At the same time, the Fed doubles the response coefficient. While Taylor (1993) uses 0.5 on the output gap, the Fed uses 1.0 on the unemployment. The reason given is Okun's law. This so-called law suggests that a 2% deviation of output from potential coincides with an opposite change in unemployment of one percentage point (see, e.g., Okun 1962, Ball et al. 2013). As a measure of inflation, the Fed uses the core PCE deflator. With regard to r^{LR}, the Fed uses the Blue Chip Economic Indicators (BCEI) median for the longer-run neutral real interest rate. This is the 3-month Treasury bill rate projected 6 to 10 years ahead and deflated by the corresponding projected annual change in the price index for gross domestic product. The long run value for inflation, π^{LR}, is taken as 2 percent. With respect to u^{LR} the Fed uses the BCEI median unemployment rate projected 6 to 10 years ahead.

The second rule is what the Fed calls the *balanced-approach rule*. It is a variant of Taylor's rule with a higher weight on real activity relative to inflation. Accordingly, it doubles the coefficient on the unemployment gap to 2.0. The *balanced approach (shortfalls) rule* was added as a result of the strategy review. The "shortfalls" concept implies that the Fed will only respond to shortfalls from maximum employment, which is the highest level of employment the economy can sustain without generating unwelcome inflation, but not react when employment exceeds this assumed long-run natural level. In other words, it will cut the interest rate when the unemployment rate exceeds the estimate of the long-run natural rate, but it will not tighten when the unemployment rate falls below that estimate.

The fourth rule is the *adjusted Taylor (1993) rule*. It keeps interest rates lower for longer in order to make up for the period during which interest rate prescriptions from the *Taylor (1993) rule* were negative. Otherwise, it corresponds to the Taylor (1993) rule. Finally, the *first-difference rule* focuses on the change rather than the level of the interest rate. Thus, it does not require an estimate of the long-run equilibrium interest rate r^{LR}. The rule implies raising (lowering) the funds rate above (below) the prevailing rate when inflation is above (below) target or the unemployment gap is increasing (falling). Each quarter, the interest rate prescription is calculated with respect to last quarter's actual funds rate. It is not simulated forward dynamically.[3] This explains why it remains close to the actual funds rate in **Figure 4**.

3. Policy rule prescriptions during the corona crisis and the inflation surge

Next, we proceed to discuss the funds rate prescriptions from the five rules shown in **Table 1** for the period from 2018 to 2023. In addition, we compute projections from these rules for the years 2024 and 2025. The results are shown in **Figure 5**. For the period from 2018:Q1 to 2023:Q1 the figure reproduces the values reported in the June 2023 Monetary Policy Report. For 2023:Q2 to 2023:Q4 we calculate the values based on the available data for inflation, unemployment and interest rates. From 2024:Q1 onwards we project the prescriptions implied by the policy rules using the median of the FOMC projections from the December 2023 survey.

Questions about the implications of the policy rules in the pandemic

The funds rate prescriptions reflect the deep recession caused by the coronavirus pandemic in 2020 and the surge in inflation from 2021 onwards. In 2020, the prescriptions from the Taylor rule dropped by about 10 percentage points and those from the balanced-approach rules by 20 percentage points. The Fed's Monetary Policy Report from February 2021 concluded from these findings: "*These deeply negative prescribed policy rates show the extent to which policymakers' ability to support the economy through cuts in the policy rate was constrained by the effective*

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[3] See Cochrane, Taylor and Wieland (2020) for further discussion.

lower bound during the pandemic-driven recession—a constraint that helped motivate the FOMC's other policy actions at the time, including forward guidance and asset purchases."

Figure 5

Funds rate prescriptions from the post-corona rules menu
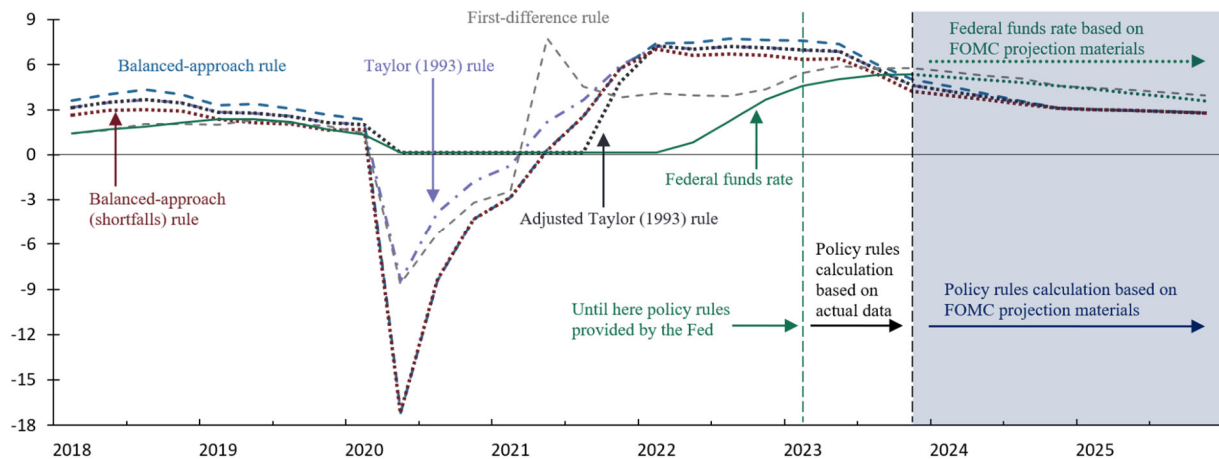
Notes: The rules use historical values of core personal consumption expenditures inflation, the unemployment rate, and, where applicable, historical values of the midpoint of the target range for the federal funds rate. Quarterly projections of longer-run values for the federal funds rate and the unemployment rate used in the computation of the rules' prescriptions are derived through interpolations of biannual projections from Blue Chip Economic Indicators. The longer-run value for inflation is set to 2 percent. The rules' prescriptions are quarterly, and the federal funds rate data are the monthly average of the daily midpoint of the target range for the federal funds rate. From 2018:Q1 to 2023:Q1 all values prescribed by the policy rules as well as the federal funds rate stem from the Monetary Policy Report of the Board of Governors of the Federal Reserve System (June 2023). From 2023:Q2 to 2023:Q4 the original chart available in the latter publication was extended by the authors based on available data in January 2024. From 2024:Q1 onwards the calculation of the values prescribed by the policy rules are based on the economic projections of the Federal Open Market Committee (FOMC) available in the Projection Materials published in conjunction with the FOMC meeting held on December 12–13, 2023; quarterly values were derived by interpolation of the median values referring to the fourth quarter of the year indicated or to the long run. Sources: Federal Reserve Bank of Philadelphia, Wolters Kluwer, Blue Chip Economic Indicators, Federal Reserve Board staff estimates, FRED, Board of Governors of the Federal Reserve System and authors' calculations.

The large drop was short-lived, however, and the resulting V-shaped movement in funds rate prescriptions rather extreme. Even if interest rate policy was unconstrained, the Fed would have been unlikely to first lower and then raise the funds rate by 20 percentage points within little more than a year. In our view, a more thorough inspection is necessary to assess what conclusions could have been drawn from the prescriptions of these policy rules during the pandemic.

The sharp movement in funds rate prescriptions results from the data used for the resource gap and the associated response coefficient. In the United States, the pandemic caused a deep but brief recession in the first half of 2020. GDP fell by about 10 percent in the first two quarters of that year and quickly recovered thereafter. The unemployment rate increased from 3.5 percent in

February 2020 to 14.8 percent in April 2020. By December 2020, it had already fallen again to 6.7 percent. Thus, the unemployment gap that the Fed uses as an input for the rules in the second quarter of 2020 is a bit below -9 percent. It is shown together with the inflation gap computed with the core PCE deflator in **Figure 6**. With these inputs, the Taylor (1993) rule calculated in the Fed's report indicates a funds rate of -8.4 percent in the second quarter of 2020, and the balanced-approach rule a rate of -17.2 percent.

Figure 6

The gaps
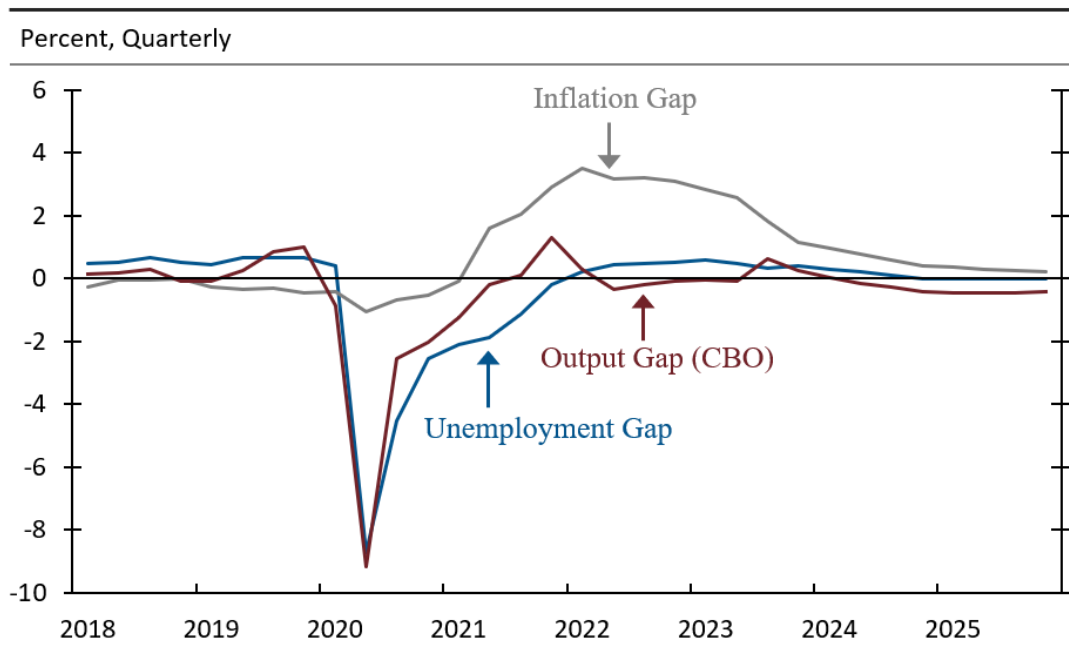
Notes: The figure shows our calculations of the unemployment gap (blue line) and the inflation gap (grey line) that serve as inputs for the policy rules shown in the Federal Reserve's Monetary Policy Report. We project these gaps into the future on the basis of the median projection of the FOMC survey from December 2023. Additionally, the figure shows the output gap estimate produced by the Congressional Budget Office along with its estimate of long-run potential GDP.

However, the drop in the funds rate prescription would be much smaller, if one were to use a standard output gap measure together with Taylor's original response coefficient of 0.5. For example, the output gap estimated by the Congressional Budget Office for the second quarter of 2020 was a bit above 9 percent as shown in Figure 6. Thus, it would have contributed only about – 4 1/2 percentage points to the Taylor rule prescription, or double that in case of the balanced rule. The CBO output gap also closed more quickly than the unemployment gap used by the Fed. Clearly, the Fed's assumption that the output gap is typically twice the size of the unemployment gap is not appropriate for the period of the pandemic. The so-called Okun's law did not apply in the pandemic. In fact, this could be observed in real time as data on unemployment rates and GDP became available. It would have been better to use an output gap measure for the rules. Also, Taylor (1993) used the output gap and not the unemployment gap. Alternatively, the factor

of 2 used by Fed to scale up the response of the Taylor (1993) rule to the unemployment gap should have been adjusted downwards during the pandemic.

In our view, however, an even greater adjustment to the output gap or response coefficient on that gap is needed during the period of the pandemic. This is important, because as noted in the Fed's report the extent of the decline in policy rule prescriptions below the effective lower bound on nominal interest rates helped motivate the large-scale asset purchases conducted during and after the pandemic. And the extent and duration of monetary and fiscal support policies is likely to have played a role in the subsequent rise of inflation.

One of the reasons for including an output gap in Taylor rules is that it helps predict future inflation. Interestingly, however, the deep coronavirus recession did not cause a comparable drop in the inflation rate. In the United States, inflation measured by the CPI or PCE briefly fell to about half a percentage point in the first half of 2020 (see **Figure 1**). Then it rose again and reached 5.7 (PCE) and 6.7 percent (CPI) by the end of 2021. The Russian attack on Ukraine in February 2022 and the ensuing energy crisis only added more fuel to the fire.

Thus, it is highly doubtful whether the gap between actual GDP and its long-run potential of beyond -9 percent in the first half of 2020 was a plausible indicator of the actual divergence of aggregate demand and aggregate supply and the disinflationary pressures at that time. Instead, we propose to take into account a model-based concept of the output gap that appropriately captures the supply-side effects of the pandemic.

The pandemic had a similar impact on aggregate demand and aggregate supply. Consumers and workers feared infection with COVID-19 and reduced contact-intensive consumption and work hours. Employers shut down contact-intensive production to avoid spreading the virus at the workplace, dismissed workers, or let them work from home. Governments implemented lockdowns to further reduce the risk of infections. As a result, demand and supply of contact-intensive goods and services largely moved in lock-step, first sharply down and then back up. Hence the relevant gap indicating disinflationary pressures from the pandemic was much smaller than the deviation from long-run potential.

To quantify the importance of these effects, it is helpful to consider the new class of macro-epidemic models developed during the coronavirus pandemic. Such models incorporate the dynamics of a pandemic in a structural framework with forward-looking and optimizing households and firms.[4] As an example, we use the New-Keynesian macro-epi model of Eichenbaum, Rebelo and Trabandt (2022) to simulate the consequences of an epidemic for the output gap, inflation and interest rates under Taylor's rule (see also Wieland 2023b).

As shown in **Figure 7** consumers and workers reduce consumption and work hours in order to avoid infection. Real GDP falls by about 8 percent similar to the 2020 recession. As the epidemic comes to an end, consumption and hours worked rise again quickly.

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[4] A new model database developed by a team led by Mathias Trabandt and Volker Wieland allows simulating and reproducing many of these models. It is available at https://www.epi-mmb.com.

Inflation declines by a bit more than half a percentage point. This magnitude is in line with the actual impact of the COVID-19 pandemic on inflation in 2020. The relevant output gap is defined in the model as the difference between the level of actual real GDP and real GDP that would prevail if the price level was completely flexible. This model-based gap is attributed to price rigidities arising from staggered wage and price contracts.

Figure 7

Simulation of an epidemic in a New-Keynesian macro-epi model
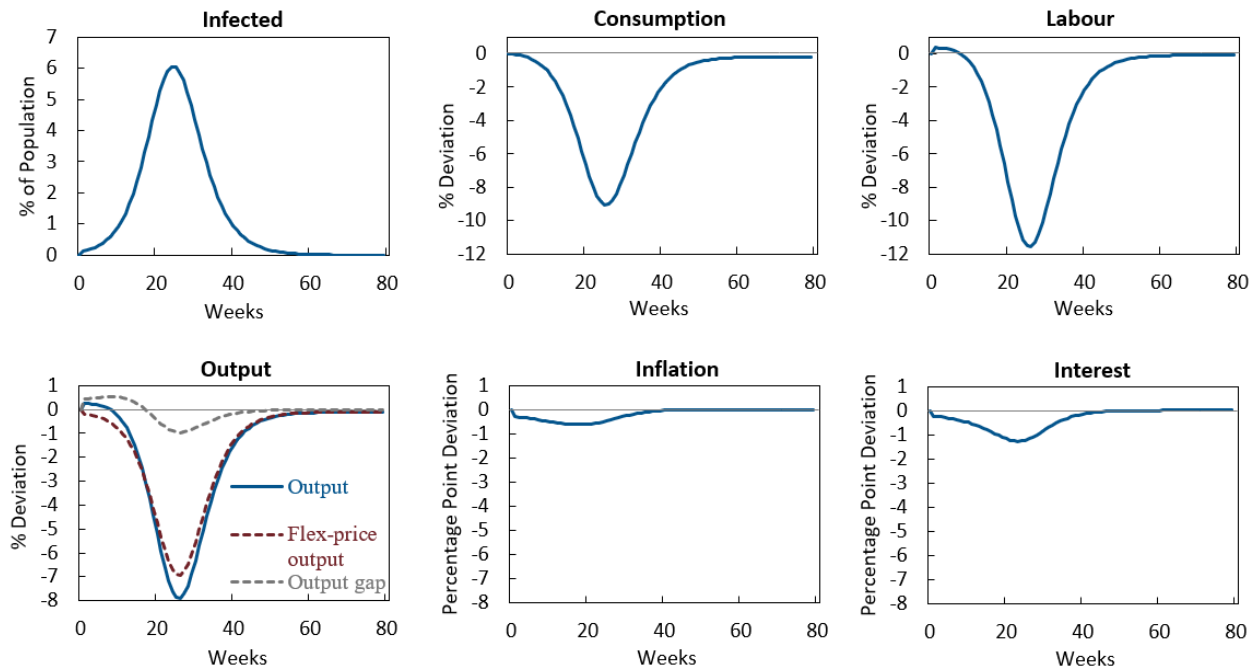
The bottom-left panel shows GDP (blue line), flex-price GDP (red dashed line) and the implied output gap. This gap is about -1 percent at the trough of the recession, that is, roughly 1/8 of the deviation of GDP from its long-run steady state. In the model, monetary policy is assumed to follow Taylor's (1993) rule and to respond to the model-based output gap. As a result, the rule prescribes an interest rate cut of one and a quarter percentage points.

*Adjusting the resource gap to account for supply side effects of the pandemic*

We conclude that the resource gap used for the rules in the Federal Reserve's Monetary Policy Report should be adjusted during the period of the coronavirus pandemic to better reflect the impact on aggregate supply. Thus, we would propose to use a model-based measure of potential

GDP. In fact, the first macro-epi models were developed during the pandemic and model simulations of the likely impact of an epidemic were published at that time.

As a simple short-cut, we propose to adjust the resource gap used in the policy rules by a factor of 1/8 during the coronavirus pandemic.[5] **Figure 8** reproduces the five policy rules considered in the Fed's Report with this adjustment. The policy rules still prescribe a significant monetary policy easing in 2020. However, the funds rate prescriptions only briefly turn negative. For the Taylor (1993) rule and the balanced-approach rule they decline towards -0.8 and -1.9 percent, respectively. This can be interpreted as a call for quantitative easing at the time of the recession as argued in the Federal Reserve's Report of February 2021. This signal for additional asset purchases is, however, much less pronounced and shorter-lived than in the Fed's Report.

Figure 8

Funds rate prescriptions with adjusted pandemic output gap and FOMC projections
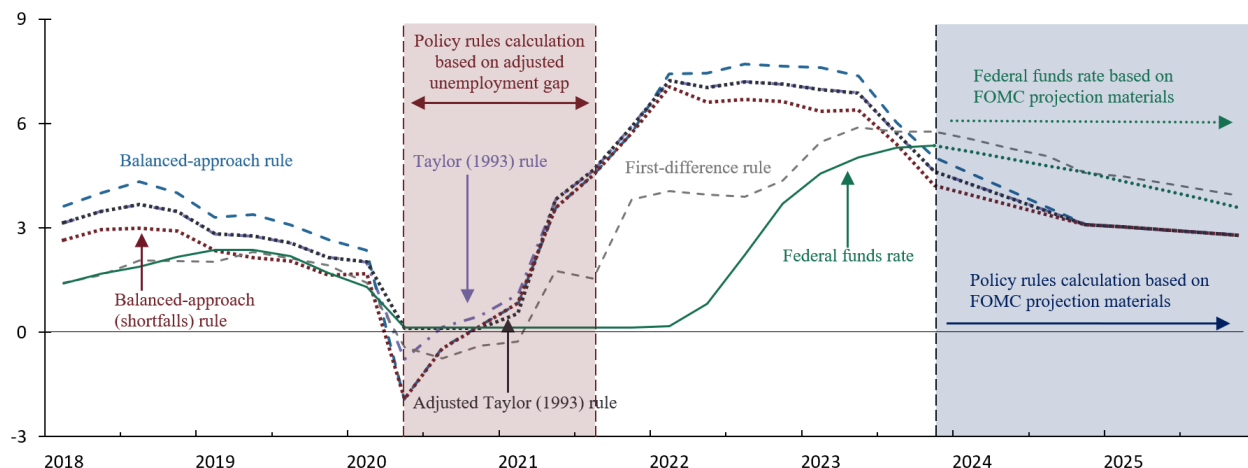
Notes: From 2018:Q1 to 2023:Q1 all values prescribed by the policy rules as well as the federal funds rate stem from the Monetary Policy Report of the Board of Governors of the Federal Reserve System (June 2023). From 2020:Q2 to 2021:Q3 the values provided in the latter publication were corrected by adjusting the resource gap to 1/8 of its original value From 2023:Q2 to 2023:Q4 the original chart available in the latter publication was extended by the authors based on available data in January 2024. From 2024:Q1 onwards the calculation of the values prescribed by the policy rules are based on the economic projections of the Federal Open Market Committee (FOMC) available in the Projection Materials published in conjunction with the FOMC meeting held on December 12–13, 2023; quarterly values were derived by interpolation of the median values referring to the fourth quarter of the year indicated or to the long run. Sources: Federal Reserve Bank of Philadelphia, Wolters Kluwer, Blue Chip Economic Indicators, Federal Reserve Board staff estimates, FRED, Board of Governors of the Federal Reserve System and authors' calculations.

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[5] Such an adjustment is also consistent with early research on efficient simple interest rate rules under uncertainty about the output gap. As shown in Smets (2002) output gap uncertainty reduces the efficient response to the estimated output gap relative to inflation in restricted instrument rules such as the Taylor rule.

The inflation surge and the Taylor principle

The policy rules signal the need for a lift-off of the federal funds rate already at the start of 2021 as shown in **Figure 7**. During that year, the funds rate prescriptions rise quite quickly along with the rise of inflation. Except for the first-difference rule, the resource gap does not play a significant role for the policy rule prescriptions during 2021, whether adjusted as we propose for the pandemic or not. Instead, the main driver is the Taylor principle that is embodied in the policy rules. According to this principle, the central bank needs to tighten interest rates more than one-for-one with inflation or inflation expectations in order to bring inflation back under control. This principle is a key feature of monetary policy in Keynesian and New-Keynesian models, where it is necessary for inflation to settle on the central bank's target.

Importantly, the policy rules from the Fed's Report clearly signaled the need to tighten policy well ahead of the Fed's decision to raise the funds rate in spring 2022. In this regard, the rules again proved their usefulness as a guidepost for monetary policy. If the Fed had responded to the rise of inflation earlier than it did, it could have moved more slowly by spreading the tightening over a longer period. This would have made it easier for the financial sector to adjust to higher interest rates, for example, by allowing banks more time to strengthen their capital and liquidity positions and to account for potential losses due to asset price reversals. Thus, the financial sector would have been in a better position to weather the turbulences following the Silicon Valley Bank collapse in spring 2023. Also, the Federal Reserve and the U.S. Treasury might not have had to resort to such massive support measures for the banking sector as they did.

Throughout 2022, the federal funds rate prescriptions shown in **Figure 7** were stabilizing at a high level. In 2023, they have come down quite a bit owing to the slowdown of inflation.

When to start interest rate cuts?

By the fourth quarter of 2023, the prescriptions from the Fed's version of the Taylor (1993) rule and the balanced-approach rules have fallen somewhat below the current federal funds rate target of 5 ¼ to 5 ½ percent. Thus, for the first time in a long while, these rules can be used to argue in favor of a shift in Fed policy towards interest rate cuts. This is of particular interest, because these rules provided an early signal for the need of policy tightening in 2021. Hence, we proceed to inspect this finding more closely.

First, we use the FOMC projections for core PCE inflation and the unemployment rate published in December 2023 to project values for the interest rate prescriptions from the rules into the future. In the course of 2024, the Taylor rule prescriptions decline well below the future path for the federal funds rate predicted by FOMC members. The first-difference rule does not decline as much, because it is computed relative to the current target range of 5 ¼ to 5 ½ percent for all periods in the future. By the end of year, the Taylor rule and the balanced-approach rule stand at 3% as shown in **Table 2**. By the end of 2025, they reach 2.8%. Interestingly, FOMC members anticipate less of a decline of the federal funds rate. According to the survey, the median

projection reaches 3.6% by end of 2025. It seems they have a different policy reaction function in mind.

Table 2

Projections of policy rule prescriptions for 2024 and 2025

	Policy Rule	2024				2025			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
r^{LR} = 0.5%	Taylor (1993) rule	4.2	3.9	3.5	3.1	3.0	3.0	2.9	2.8
	Balanced-approach rule	4.5	4.1	3.6	3.1	3.0	3.0	2.9	2.8
	Balanced-approach (shortfalls) rule	3.9	3.7	3.4	3.1	3.0	3.0	2.9	2.8
	Adjusted Taylor (1993) rule	4.2	3.9	3.5	3.1	3.0	3.0	2.9	2.8
	First-difference rule	5.6	5.3	5.1	4.6	4.5	4.3	4.1	4.0
r^{LR} = 1.8%	Taylor (1993) rule	5.5	5.2	4.8	4.4	4.3	4.3	4.2	4.1
	Balanced-approach rule	5.8	5.4	4.9	4.4	4.3	4.3	4.2	4.1
	Balanced-approach (shortfalls) rule	5.2	5.0	4.7	4.4	4.3	4.3	4.2	4.1
	Adjusted Taylor (1993) rule	5.5	5.2	4.8	4.4	4.3	4.3	4.2	4.1
	First-difference rule	5.6	5.3	5.1	4.6	4.5	4.3	4.1	4.0
	Federal Funds Rate FOMC projections	**5.2**	**5.0**	**4.8**	**4.6**	**4.4**	**4.1**	**3.9**	**3.6**

Notes: The calculation of the values prescribed by the policy rules are based on the economic projections of the Federal Open Market Committee (FOMC) available in the Projection Materials published in conjunction with the FOMC meeting held on December 12–13, 2023; quarterly values were derived by interpolation of the median values referring to the fourth quarter of the year indicated or to the long run. Source: Board of Governors of the Federal Reserve System and authors' calculations.

We note three caveats. First, inflation, unemployment and interest rate projections are often far off the mark. Thus, the projections of the funds rate prescriptions from the rules are associated with a great degree of uncertainty. The focus of policymakers should be on the near-term prescriptions from the policy rules.

A second caveat concerns the measure of inflation. As shown in Figure 1, current values of the core CPI are quite a bit higher than the core PCE and stand near 4%. However, the GDP deflator, which provides a broader measure of domestic is below the core PCE.

A third caveat concerns the value used for the long-run real interest rate. The median long-run FOMC projection for the nominal federal funds rate is 2.5%. The median long-run projection for inflation is 2%. Thus, the implied long-run equilibrium real interest rate r^{LR} is 0.5%. This estimate is on the low side. A popular estimation methodology follows Laubach and Williams

(2003) and Holston, Laubach and Williams (2017). Recent estimates by these methods have come in between .8 and 2 percent.[6] Yet, these estimates are highly uncertain and variable (see Beyer and Wieland 2019).

A key factor influencing the long run equilibrium real interest rate is the long-run growth rate of real GDP. The CBO's long-run projections estimate potential growth of 1.8 percent. While excess saving may have pushed equilibrium real rates substantially below real growth rates in the past fifteen years, this effect is likely to wane due to the upward trend in government borrowing and the reduction in saving by retiring babyboomers. Thus, we use 1.8 percent as an upper value of r^{LR}. The resulting projections of policy rule prescriptions are also shown in **Table 2**. They decline below the current funds rate target range by the third quarter of 2024. This timing is close to the median FOMC funds rate projection.

4. Conclusions

In our view, the regular publication of interest rate prescriptions from Taylor rules is a very commendable practice of the Fed that ought to be followed by other central banks. A substantial body of research has shown that such rules deliver good performance in model-based evaluations of monetary policy and match up well with actual policy during periods of good macroeconomic performance.[7] As pointed out in this paper, the rules shown in the Fed's report provided multiple useful signals in the past. On many occasions, these signals aligned with Fed action, while in some cases the Fed opted for a different route. The use of such rules in policy communication can improve the public policy debate. At the least, they provide a starting point for a rational discussion of the benefits and drawbacks of deviating from the benchmark defined by the rules.

We draw the following conclusions from our analysis of the period of the coronavirus pandemic and the subsequent inflation surge in this paper:

As stated in the Fed's report, the deeply negative prescribed policy rates during the pandemic-driven recession served to indicate the extent to which the Fed's ability to support the economy through policy rate cuts was constrained by the effective lower bound and helped motivate other policy measures such as asset purchases and forward guidance. However, the Fed's calculations significantly overstate the extent of this constraint, because it uses the unemployment gap relative to the long-run natural rate and doubles the reaction coefficient.

First, we point out that the deviation of unemployment from its long-run natural rate was very similar to the deviation of output from its long-run potential with about 9 percent in absolute value. Thus, it is not appropriate to double the response coefficient on the unemployment gap during the coronavirus period. Okun's law, which the Fed cites for justification, does not hold in this period.

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[6] Regular updates are made available by the Federal Reserve Bank of New York at their R-Star website.
[7] See, for example, Taylor 1993, 1999, Taylor and Williams 2011, Wieland et al 2014 and references therein.

Furthermore, we make use of a New-Keynesian macro-epi model to show that the deviation between actual GDP and its long-run potential (or actual unemployment from its long-run natural rate) was not a plausible indicator of the actual divergence of aggregate demand and aggregate supply and the disinflationary pressures during the coronavirus pandemic. Instead, we propose to take into account a model-based concept of the output gap that appropriately captures the supply-side effects of the pandemic. Based on the simulation of the model, we propose to use a simple adjustment factor of 1/8 on the output (or unemployment gap) in the policy rules for 2020, the year of the pandemic. As a result, the funds rate prescriptions only briefly turn negative, and the signal for additional asset purchases is much less pronounced and shorter-lived than in the Fed's Report.

The policy rules signal the need for a lift-off of the federal funds rate already at the start of 2021. During that year, the funds rate prescriptions increase rapidly along with inflation. This is a result of the Taylor principle that is embodied in the policy rules. Thus, the policy rules from the Fed's Report clearly signaled the need to tighten policy well ahead of the Fed's decision to raise the funds rate in spring 2022 and again proved their usefulness.

Over the course of 2023, U.S. inflation rates have declined substantially. As of the start of 2024, the Federal Reserve, Fed watchers and market participants are debating whether it is time for the Fed to ease monetary policy, whether it should have done that already, or whether interest rates need to stay high for longer in order to avoid that inflation persists above target or rises again. Interestingly, four out of five rules already indicate a funds rate setting below the current target range of of 5 ¼ to 5 ½ percent in the first quarter of 2024. A note of caution is in order, however, given that the calculation is based on a perceived long-run equilibrium real interest rate of only half a percent. Taking into account that the long-run real equilibrium rate may be quite a bit higher, the resulting interest rate prescriptions decline below the current target range closer to the summer.

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