Taylor Rules and the Inflation Surge

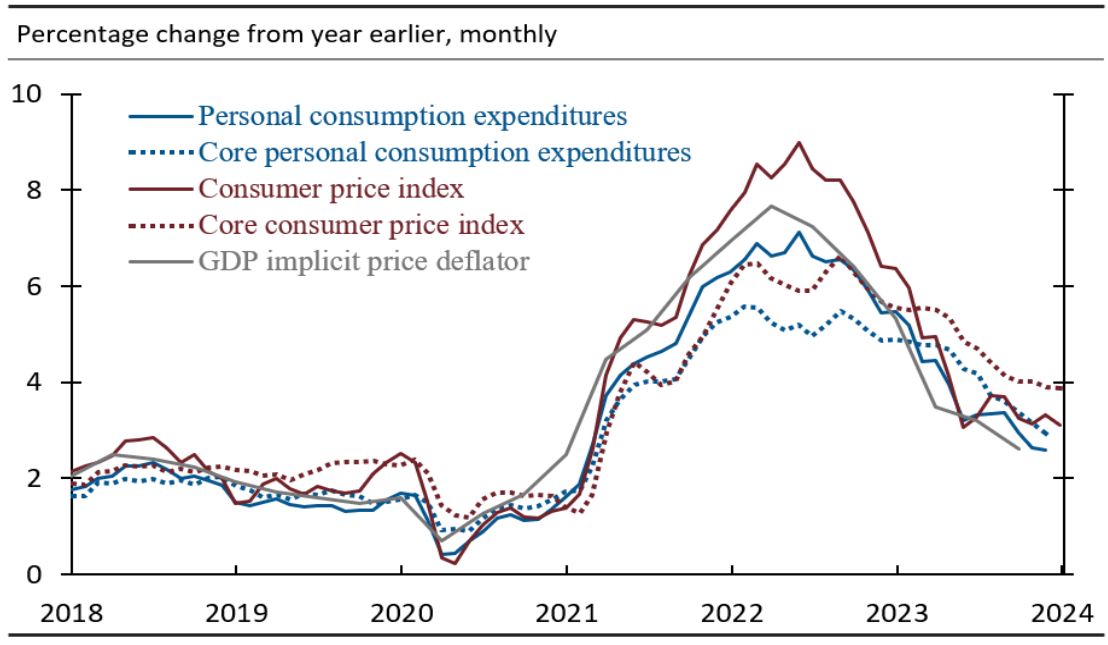
Seminar of the Economic Policy Working Group
Hoover Institution, Stanford
April 17, 2024

Taylor rules and the inflation surge of 2021-23

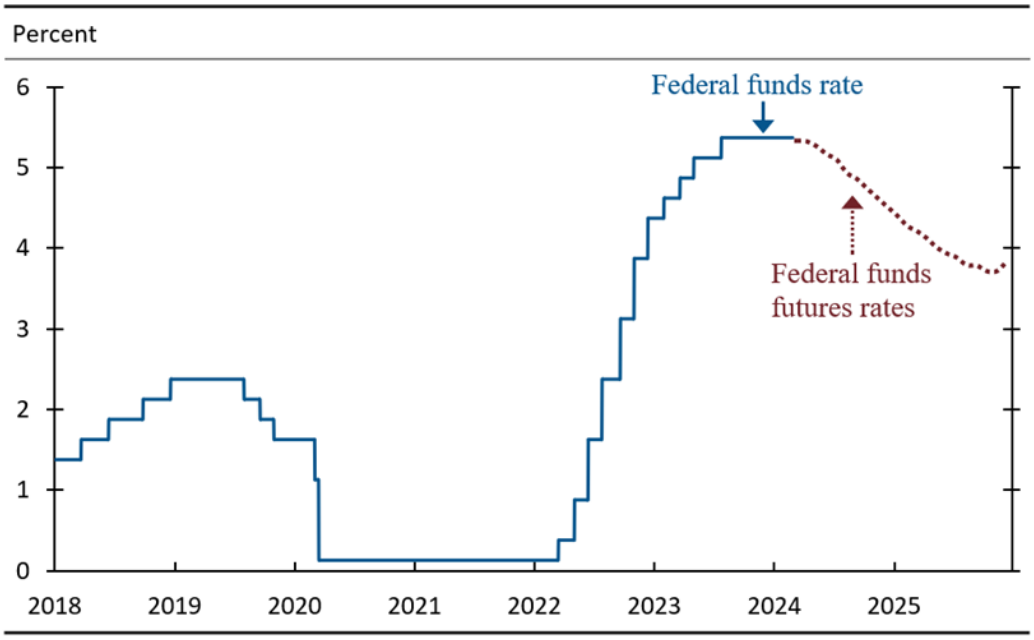
1. The policy challenge
2. Taylor rules in the Fed's report
3. Interpreting the Fed's rules in the coronavirus recession
4. The inflation surge and the Taylor principle: Fed behind the curve
5. Projecting the rules into the future and R-Star

1. The policy challenge

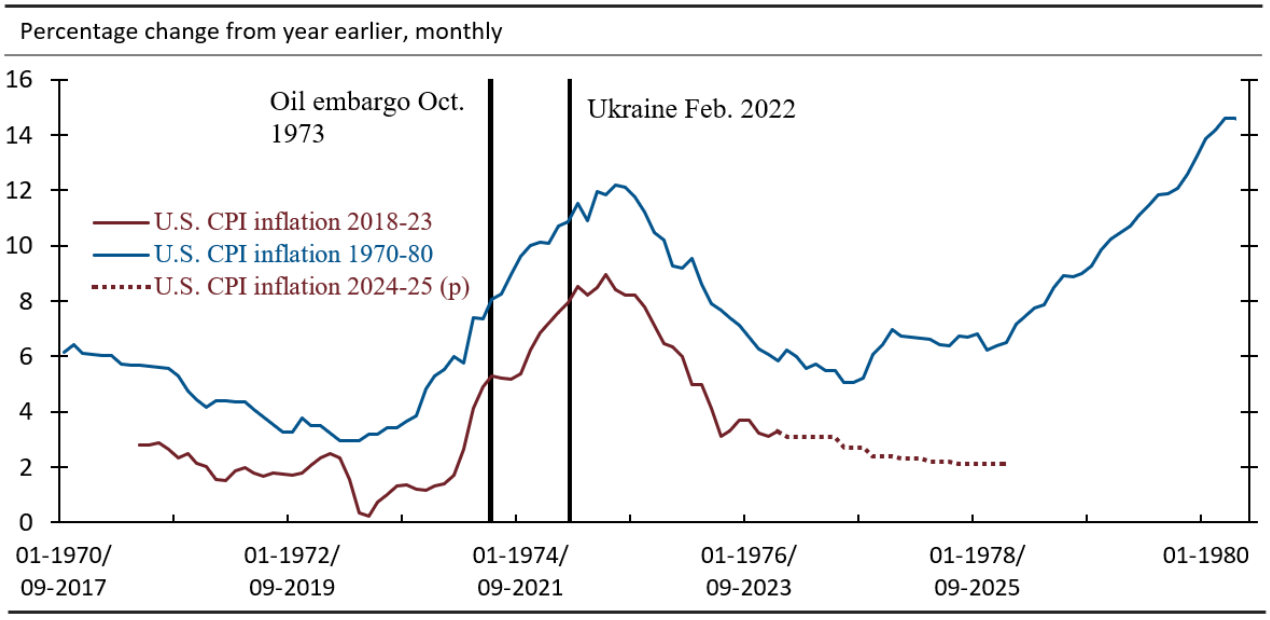
The inflation surge in the United States



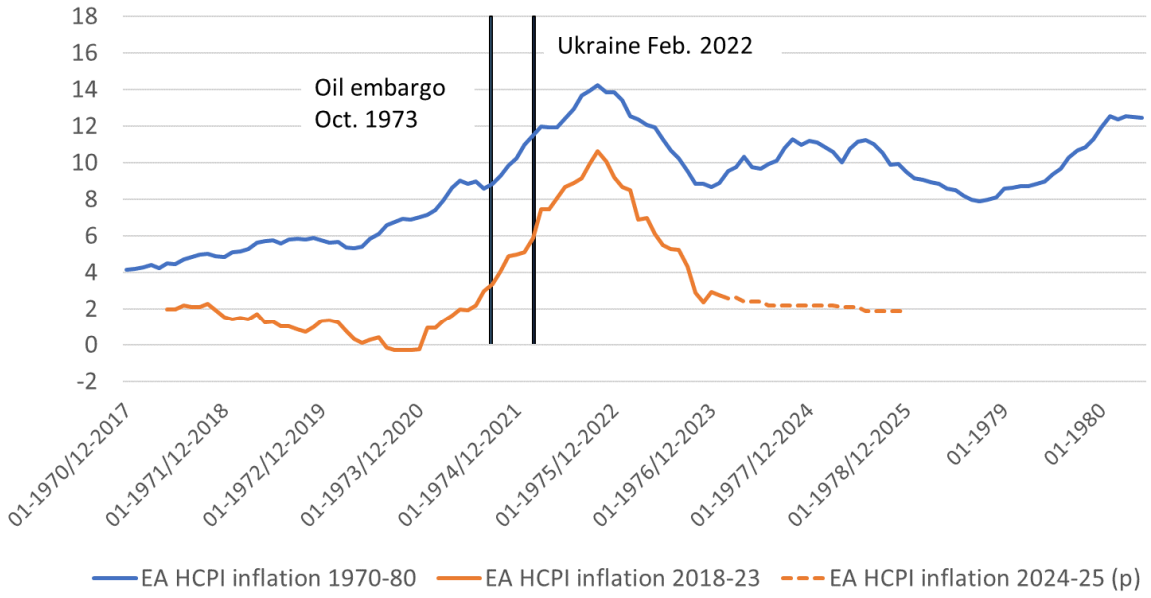
The policy tightening in the United States



The challenge: 2021/22 vs 1970s

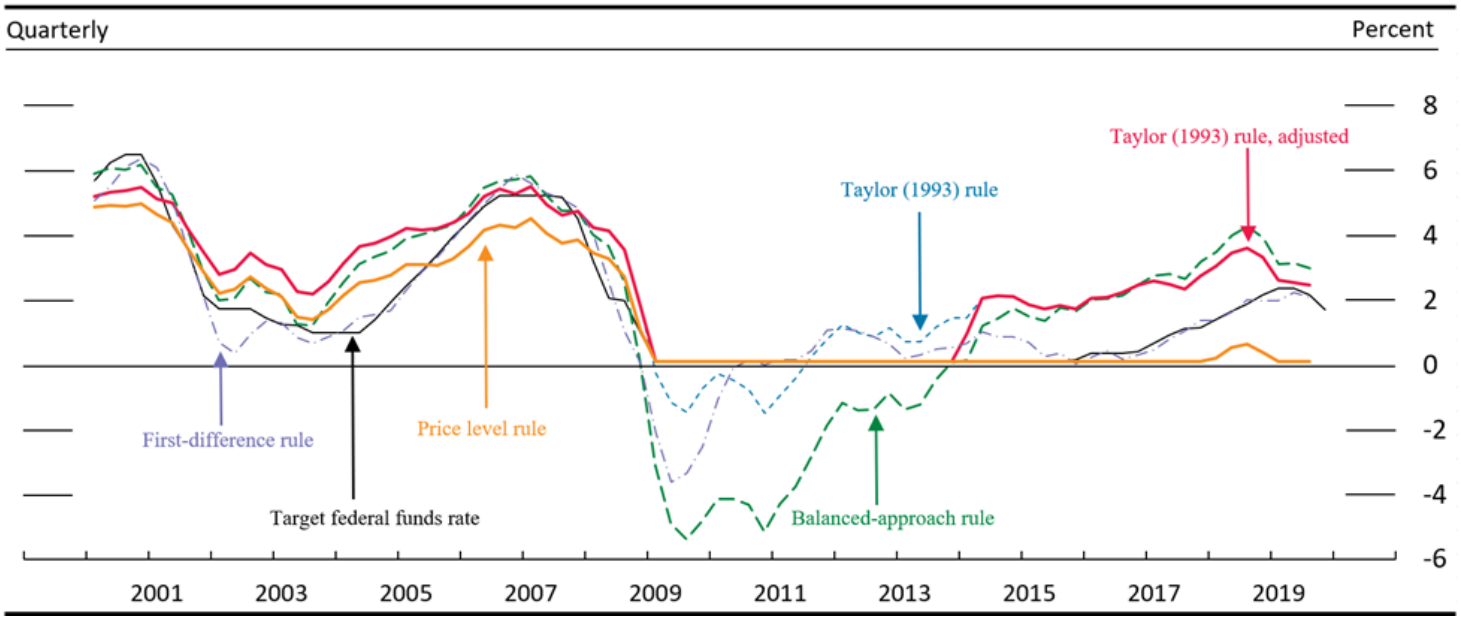


The case of the euro



2. Taylor rules in the Fed's report

Funds rate prescriptions from policy rules
The Federal Reserve's Monetary Policy Report, February 2020



The Fed's rules menu: Pre-Covid

Taylor (1993) rule	$R_t^{T93} = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) + (u_t^{LR} - u_t)$
Balanced-approach rule	$R_t^{BA} = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) + 2(u_t^{LR} - u_t)$
Adjusted Taylor (1993) rule	$R_t^{T93\,adj} = maximum\ \{R_t^{T93} - Z_t, 0\}$
Price-level rule	$R_t^{PL} = maximum\ \{r_t^{LR} + \pi_t + (u_t^{LR} - u_t) + 0.5(PLgap_t), 0\}$
First-difference rule	$R_t^{FD} = R_{t-1} + 0.5(\pi_t - \pi^{LR}) + (u_t^{LR} - u_t) - (u_{t-4}^{LR} - u_{t-4})$

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

The Fed‘s Taylor 1993 rule

$$R_t^{T93} = r_t^{LR} + \pi_t + 0.5(\pi_t - \pi^{LR}) + (u_t^{LR} - u_t)$$

The Fed changes the inputs and adjusts coefficients

- Unemployment gap—difference between the long-run natural rate and the current unemployment rate—is used in place of the output gap.
- Fed doubles the response coefficient. While Taylor (1993) uses 0.5 on the output gap, the Fed uses 1.0 on the unemployment gap. Reason given: Okun’s law suggests a 2% deviation of output from potential coincides with an opposite change in unemployment of 1 pp. (Okun 1962, Ball et al. 2013).
- For inflation, Fed uses the core PCE deflator.
- r^{LR}: Blue Chip Economic Indicators (BCEI) median for the longer-run neutral real interest rate. (3-month T-bill rate projected 6 to 10 years ahead and deflated by the corresponding annual change in GDP deflator)
- π^{LR}: 2%, u^{LR} BCEI median unemployment rate projected 6 to 10 years ahead.

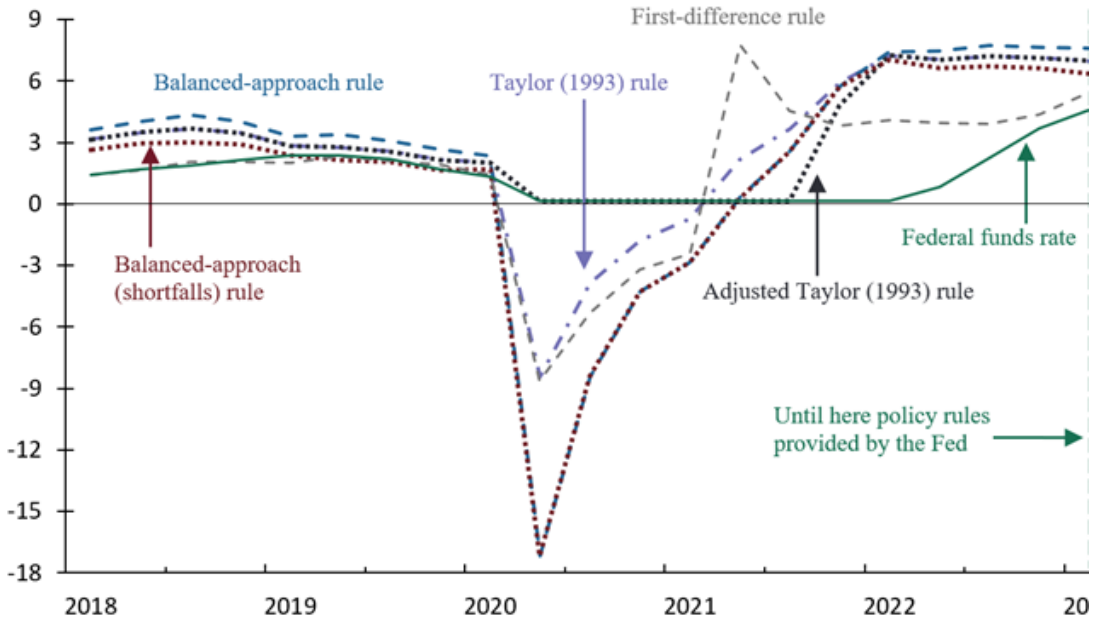
3. How to interpret the Fed's rules in the coronavirus recession

After the strategy review: The Fed's 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	$R_t^{FD} = R_{t-1} + 0.5(\pi_t - \pi_t^{LR}) + (u_t^{LR} - u_t) - (u_{t-4}^{LR} - u_{t-4}$

- Dropped price level rule. Added short-falls rule, asymmetric on u^{LR}-u

Policy rules chart after Fed strategy review, Feb 2021



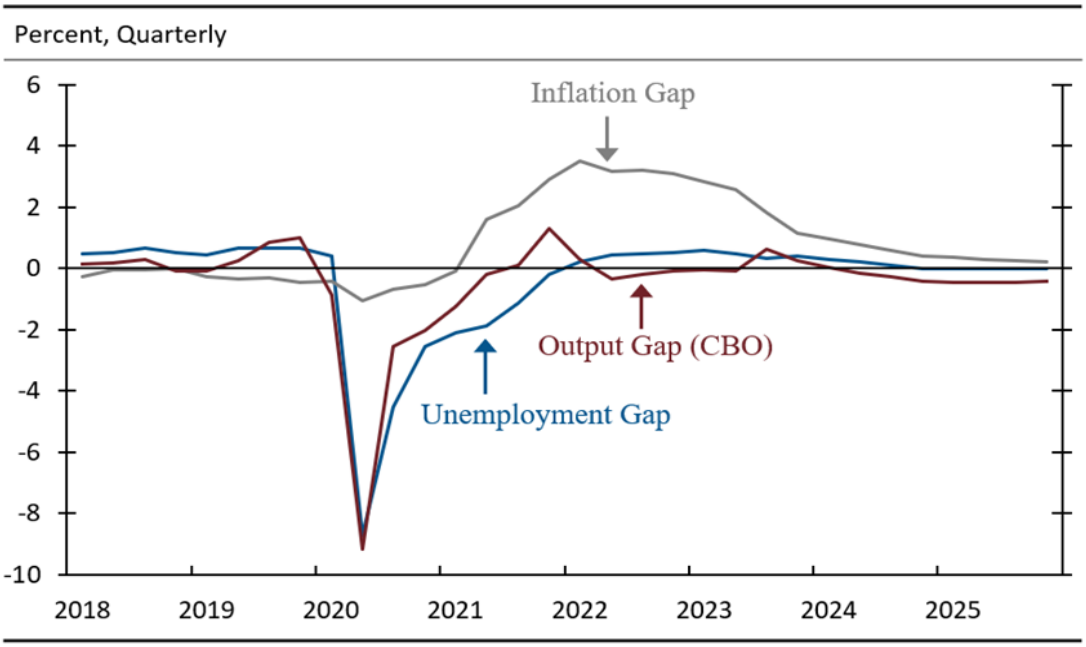
Fed‘s interpretation of rules in COVID-19 period

- 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 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.*”

But …

- large drop short-lived; resulting V-shaped movement in funds rate prescriptions rather extreme; Even if policy was unconstrained, Fed would have been unlikely to first lower and then raise the funds rate by 20 percentage points within little more than a year.
- More thorough inspection 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.
- GDP fell by about 10 percent in the first two quarters of that year and quickly recovered thereafter. Unemployment rate increased from 3.5% in Feb 2020 to 14.8% in April 2020. By December 2020 it was back to 6.7% percent. Ugap used by Fed in 2020Q2 s a bit below -9 percent.

The gaps



First, check so-called „Okun‘s law“ again

- 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.
- CBO output gap in 2020Q2 a bit above 9 percent, would have contributed only about – 4 1/2 percentage points to the Taylor rule prescription. Also, CBO output gap closed more quickly than Fed’s u-gap.
- Fed’s assumption that the y-gap double the size of u-gap is not appropriate for the period of the pandemic. The so-called Okun’s law did not apply in the pandemic.
- Use output gap instead or adjust the factor of 2 used by Fed to scale up the response of the Taylor (1993) rule to the unemployment gap downwards during the pandemic.

Why is it important to re-consider resource gap in pandemic

- Adjustment important, because Fed interpreted the decline in policy rule prescriptions below the effective lower bound on nominal interest rates as motivation for 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.
- Taylor rules include output gap partly because it helps predict future inflation. Interestingly, however, the deep coronavirus recession did not cause a comparable drop in the inflation rate. In the U.S., inflation measured by the CPI or PCE briefly fell to about 0.5% 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
- Doubtful whether the deviation of GDP from its long-run potential of -9 percent in 2020 Q2 plausible indicator of the actual divergence of aggregate demand and aggregate supply and disinflationary pressures at that time.

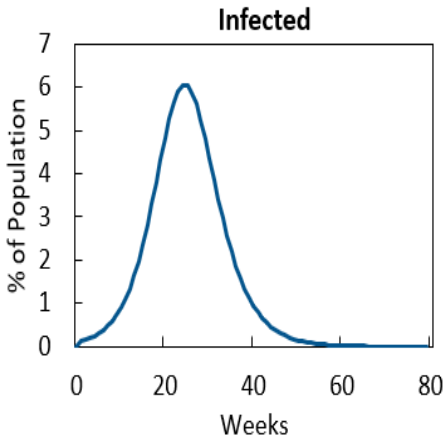
Take into account supply-side effects of pandemic

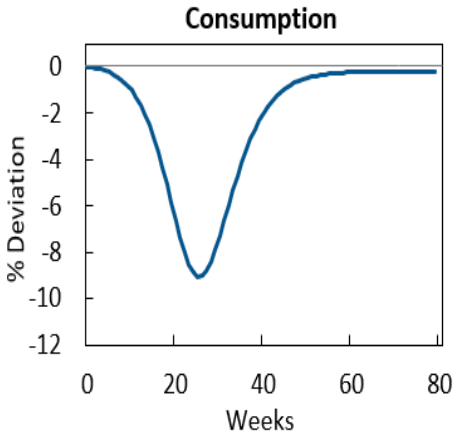
- Instead, we propose to take into account a model-based concept of the output gap that appropriately captures the supply-side effects of the pandemic.
- Pandemic had a similar impact on aggregate demand and aggregate supply.
- Consumers and workers feared infection with COVID-19 and reduced contact-intensive 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.

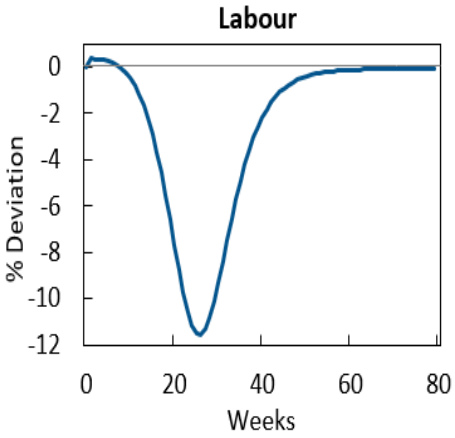
To quantify the effect

- 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.
- 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).

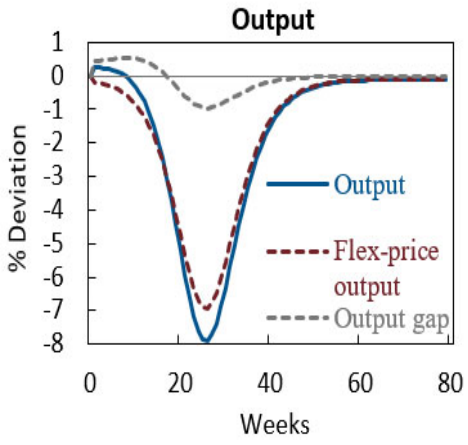
Simulation of an epidemic in a New-Keynesian macro-epi model

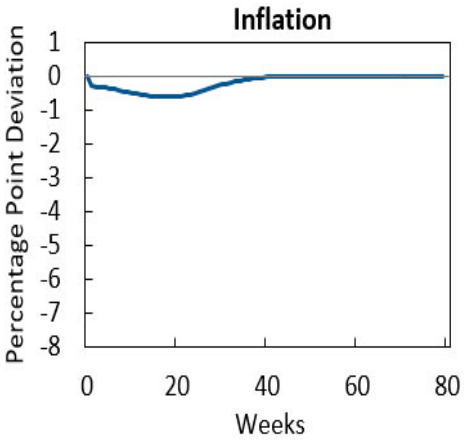


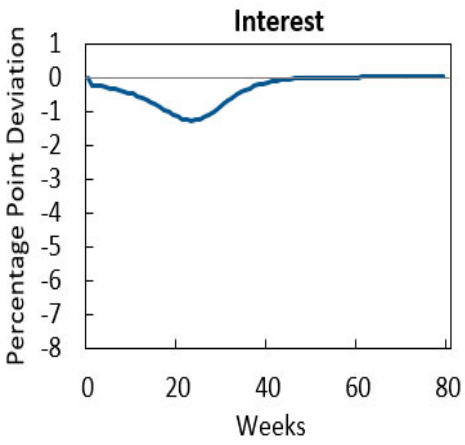




Simulation of an epidemic in a New-Keynesian macro-epi model



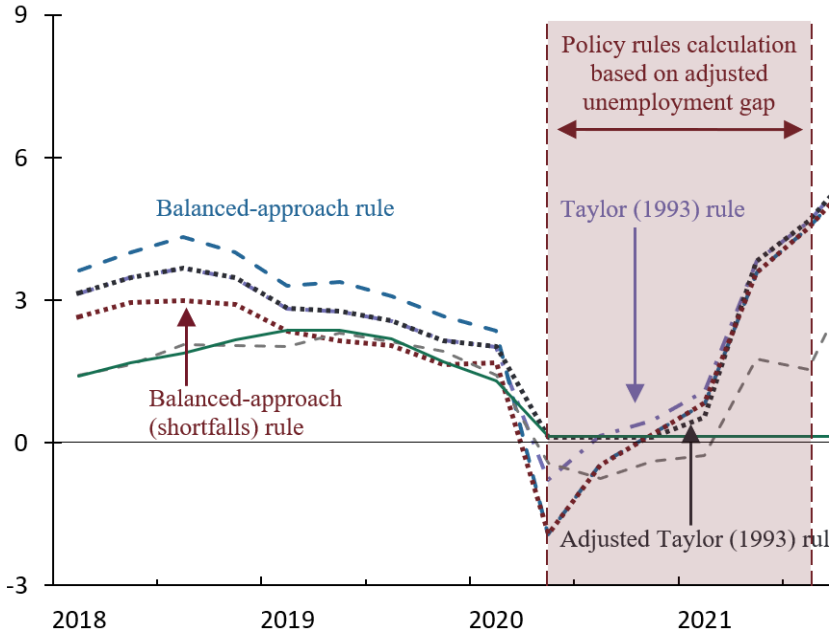




Need to adjust resource gap in the pandemic

- 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.

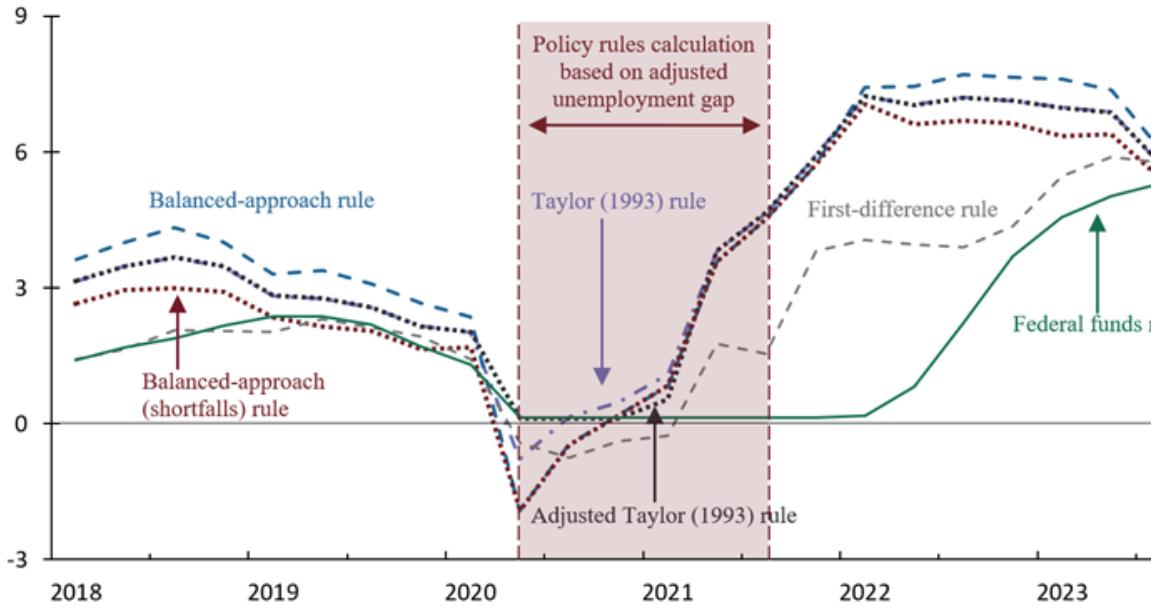
Corona gap adjusted in Taylor rule and BA rule



1/8 corona pandemic output gap (20:1-21:1)

4. The inflation surge and the Taylor principle: Fed behind the curve

The Fed‘s rules and the Taylor principle: Fed behind the curve



The inflation surge and the Taylor principle

- Policy rules signal need for a lift-off of the federal funds rate already at the start of 2021.
- 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.
- Main driver is the Taylor principle. Accordingly, 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.
- 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

Advantages of reacting earlier

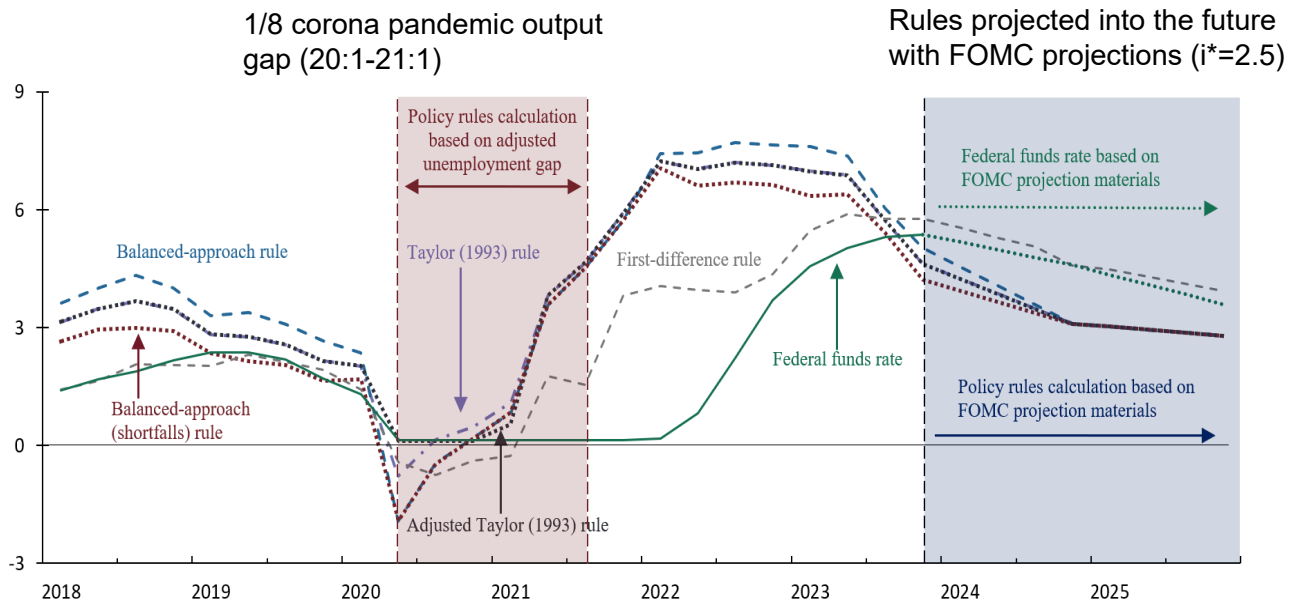
- Rules from the Fed's Report clearly signalled the need to tighten policy well ahead of the Fed's decision to raise the funds rate in spring 2022. Rules again proved their usefulness as a guidepost for monetary policy.
- If the Fed had responded to the rise of inflation earlier than it did, it could 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.

5. Projecting the rules into the future and R-Star

When to start interest rate cuts?

- Throughout 2022, the federal funds rate prescriptions were stabilizing at a high level. In 2023, they have come down quite a bit owing to the slowdown of inflation
- 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. We proceed to inspect this finding more closely.
- 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.

Inflation surge and Taylor principle: Policy behind the curve



Projections of FOMC members

Percent

Variable	Median[1]				Central Tendency[2]			
	2024	2025	2026	Longer run	2024	2025	2026	Longer run
Change in real GDP	2.1	2.0	2.0	1.8	2.0–2.4	1.9–2.3	1.8–2.1	1.7–2.0
December projection	1.4	1.8	1.9	1.8	1.2–1.7	1.5–2.0	1.8–2.0	1.7–2.0
Unemployment rate	4.0	4.1	4.0	4.1	3.9–4.1	3.9–4.2	3.9–4.3	3.8–4.3
December projection	4.1	4.1	4.1	4.1	4.0–4.2	4.0–4.2	3.9–4.3	3.8–4.3
PCE inflation	2.4	2.2	2.0	2.0	2.3–2.7	2.1–2.2	2.0–2.1	2.0
December projection	2.4	2.1	2.0	2.0	2.2–2.5	2.0–2.2	2.0	2.0
Core PCE inflation[4]	2.6	2.2	2.0		2.5–2.8	2.1–2.3	2.0–2.1	
December projection	2.4	2.2	2.0		2.4–2.7	2.0–2.2	2.0–2.1	
Memo: Projected appropriate policy path								
Federal funds rate	4.6	3.9	3.1	2.6	4.6–5.1	3.4–4.1	2.6–3.4	2.5–3.1
December projection	4.6	3.6	2.9	2.5	4.4–4.9	3.1–3.9	2.5–3.1	2.5–3.0

NOTE: Projections of change in real gross domestic product (GDP) and projections for both measures of i

Projections of FOMC members

Percent

Variable	Median[1]			
	2024	2025	2026	Longer run
Change in real GDP	2.1	2.0	2.0	1.8
December projection	1.4	1.8	1.9	1.8
Unemployment rate	4.0	4.1	4.0	4.1
December projection	4.1	4.1	4.1	4.1
PCE inflation	2.4	2.2	2.0	2.0
December projection	2.4	2.1	2.0	2.0
Core PCE inflation[4]	2.6	2.2	2.0	
December projection	2.4	2.2	2.0	

Projections of FOMC members

Memo: Projected appropriate policy path				
Federal funds rate	4.6	3.9	3.1	2.6
December projection	4.6	3.6	2.9	2.5

Projections

- 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.

When to start interest rate cuts? What if long-run r (r-star) is different?

	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**

When to start interest rate cuts? What if r-star higher and closer to potential growth

	Policy Rule	2024			
		Q1	Q2	Q3	Q4
r^{LR} = 0.5%	Taylor (1993) rule	4.2	3.9	3.5	3.1
	Balanced-approach rule	4.5	4.1	3.6	3.1
	Balanced-approach (shortfalls) rule	3.9	3.7	3.4	3.1
	Adjusted Taylor (1993) rule	4.2	3.9	3.5	3.1
	First-difference rule	5.6	5.3	5.1	4.6

When to start interest rate cuts? What if r-star higher and closer to potential growth

r^{LR} = 1.8%	Taylor (1993) rule	5.5	5.2	4.8	4.4
	Balanced-approach rule	5.8	5.4	4.9	4.4
	Balanced-approach (shortfalls) rule	5.2	5.0	4.7	4.4
	Adjusted Taylor (1993) rule	5.5	5.2	4.8	4.4
	First-difference rule	5.6	5.3	5.1	4.6
	Federal Funds Rate FOMC projections	**5.2**	**5.0**	**4.8**	**4.6**