August 30, 2019

**Alternative Strategies: How do they work? How might they help?[1]**

## I.     Introduction

The FOMC's current monetary policy framework can be summarized by the following features.  The dual mandate of maximum employment and price stability represents the main *goal* of the framework, with an explicit numerical inflation objective and a corresponding numerical estimate related to the employment leg of the mandate. According to the Statement on Longer-run Goals and Monetary Policy Strategy, the FOMC *strategy* is to pursue a balanced approach in addressing deviations of employment and inflation from their goals, with an explicit acknowledgement of the importance of the balance of risks, including risks to the financial system.  This strategy has been largely interpreted as an implicit adherence to a "bygones-be-bygones" approach, in which policymakers react to their best estimate of current economic conditions and the medium-term outlook, without explicitly responding to the history of inflation and employment. The FOMC's *monetary policy tools* used to achieve the mandated goals include communications and monetary policy instruments that have already been employed by the Committee (conventional interest rate policy, forward guidance, and balance sheet policies).

A number of ongoing structural developments in the U.S. economy have tested the ability of the current monetary policy framework to deliver on the FOMC's dual mandate.  The neutral real interest rate has likely fallen, implying less "policy cushion" – less leeway to lower the federal funds rate in the event of a downturn – and thus a greater likelihood of reaching the effective lower bound (ELB).  In addition, inflation appears to have been less responsive to resource slack (a flatter "Phillips curve") in recent years, suggesting that policymakers will find it more difficult to move inflation towards the Committee's 2 percent longer-run objective.  Moreover, inflation has persistently fallen below 2 percent, potentially leading to some slippage of long-term inflation expectations relative to their levels prior to the Great Recession.  These developments raise the question of whether the current framework will serve the Committee well in addressing future downturns.

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This memo and the companion memo "How Robust are the Alternative Strategies to Key Alternative Assumptions" explore whether adjustments to the current monetary policy *strategy* could strengthen the FOMC's ability to fulfill its dual mandate goals. The analysis largely focuses on a class of *makeup strategies* in which policymakers seek to stabilize average inflation around the inflation target over some horizon.[2] In pursuing such strategies, the Committee would at times use its monetary policy tools – communications, the federal funds rate, and unconventional policies – to deliberately target rates of inflation that deviate from 2 percent on one side so as to offset past inflation deviations from 2 percent on the other side. Thus, by adopting a makeup strategy, the FOMC would abandon the "bygones-be-bygones" approach.

The academic literature suggests that makeup strategies offer three potential benefits.[3] First, makeup strategies naturally imply a desire to commit to a "lower-for-longer" path for the policy rate in episodes when the ELB significantly impairs the conduct of monetary policy and may cause extended periods of below-target inflation. Commitments to a "lower-for-longer" path provide more accommodative financial conditions, boosting aggregate demand and reducing deviations of inflation from its target even while the ELB binds. Second, (credible) makeup strategies foster expectations of more stable inflation, on average, thus reducing the sensitivity of inflation to transient developments. Third, the systematic materialization of stable inflation rates under makeup strategies may better anchor longer-term inflation expectations, inducing a virtuous circle.

The effectiveness of a makeup strategy depends on both the details of the strategy and the structural features of the economic environment. In this memo, we first describe how makeup strategies work and study the implications of key institutional decisions such as the *length* of the makeup window (i.e. how long of a history of past deviations to consider) and the *(a)symmetry* of the makeup (i.e. under what conditions to engage the makeup strategy). We then use simulations from several macroeconometric models to provide a quantitative assessment of specific makeup strategies that have been put forward in the economic literature.

The main findings of this memo can be summarized as follows. First, makeup strategies generally improve macroeconomic stability compared to a "bygones-be-

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[2] In addition to inflation, makeup strategies may also be specified to make up for past misses of other variables from medium- and long-run objectives, such as output, employment, or (notional) interest rates.
[3] See, for instance, Bernanke (1999), Reifscheinder and Williams (2000), Svensson (2001), Eggertsson and Woodford (2003), Kiley and Roberts (2017), Hebden and Lopez-Salido (2018), Bernanke, Kiley, Roberts (2019), Mertens and Williams (2019). Notwithstanding the popularity of makeup strategies in academic debates, the historical record is thin of actual central bank experiences with makeup strategies. A notable exception is the attempt of the Riksbank to target the price level during the Great Depression of the 1930s. See Berg and Jonung (1999) for an account of this episode.

bygones" approach. Second, the size of these gains is moderate across the models and strategies considered here, with longer makeup windows yielding somewhat larger gains. Third, the practical implementation of these strategies faces a number of challenges that would have to be surmounted for the full benefit of these strategies to be realized.

II.      **The Design of a Makeup Strategy: The Choice of Makeup Measure**

We begin by laying out key features regarding the design of makeup strategies. To keep the exposition specific, we consider average inflation targeting (AIT) strategies that seek to undo past deviations of inflation from its 2 percent long-run goal over a window of fixed length.[4] The design of a makeup strategy revolves around two central aspects:

1) The length of the makeup window. As time advances, inflation misses that occurred further in the past eventually drop out of the window and become bygones. Strategies that make up deviations of inflation over very long windows can approximate price-level targeting (PLT) strategies.[5] In the context of an inflation shortfall during an ELB episode, larger windows are associated with more pronounced lower-for-longer interest rate paths. Correspondingly, the length of the makeup window controls the additional stimulus to aggregate demand and the speed with which inflation returns to and, possibly, overshoots its objective.

2) The symmetric *vs* asymmetric nature of the makeup. Under a symmetric AIT strategy, policymakers will stimulate the economy when average inflation has been below the 2 percent objective, but also constrain it when average inflation has been above 2 percent. If policymakers' appetite for slowing the economy today because past inflation has averaged above 2 percent differs from their appetite for stimulating the economy because past inflation has averaged below 2 percent, they may wish to consider asymmetric strategies.

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[4] Other makeup strategies, such as price-level targeting (PLT) strategies or shadow rate strategies are discussed as appropriate. PLT strategies aim to offset the cumulative deviation of inflation from the 2 percent objective since a fixed reference date. Following Reifschneider and Williams (2000), a shadow rate strategy expresses the makeup objective in terms of the forgone policy accommodation due to the ELB. Implicitly, shadow rate strategies aim to make up with respect to both inflation and employment.

[5] Under PLT, the price-level gap measures the cumulative deviations of inflation from 2 percent since a given reference date and hence the length of the makeup window expands over time. As highlighted by Nessén and Vestin (2005), an AIT strategy with a very long window into the past will evidently keep track of (most of) the inflation deviations that enter the price-level gap and hence indicate a similar degree of makeup as the price-level gap.

While we define the asymmetry of the makeup strategies with regard to inflation deviations from its longer-run objective, the economic literature has also considered "temporary" makeup strategies that are triggered by the occurrence of ELB episodes.[6] In demand-driven recessions with low inflation and a binding ELB, asymmetric and temporary strategies would deliver very similar outcomes. However, in different economic circumstances, asymmetric and temporary strategies may imply different prescriptions. For instance, during a period of prolonged low unemployment but below-target inflation, an AIT strategy would prescribe lower interest rates than a temporary AIT strategy (which would not be triggered).[7]

*The length of the makeup window*

We illustrate how the length of the makeup window under AIT strategies affects economic outcomes in a mild demand-driven recession scenario with a binding ELB.[8] We construct the scenario using the version of the FRB/US model in which financial market participants as well as wage and price setters fully appreciate the implications of the alternative monetary policy strategies for macroeconomic outcomes. By contrast, the agents responsible for consumption and investment decisions are modelled as forming expectations using time-series models that are *not* updated to reflect changes in macroeconomic dynamics induced by the alternative rules.[9]

Throughout the analysis, we implement monetary policy strategies through simple rules that deliver prescriptions for the federal funds rate. In particular, we consider the inertial version of the Taylor (1999) rule as an approximation to the current monetary policy framework and three makeup rules with different window length.[10] The first two (AIT) rules respond one-for-one to the cumulative inflation misses from 2 percent (starting in 2019Q4) over a four-year and an eight-year rolling window, respectively. For reference, the third rule fully responds to all inflation misses accumulated starting in 2019Q4, thus implementing a price-level targeting (PLT) strategy.[11] We assume that

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[6] See, for instance, Evans (2012), Bernanke (2017), and Bernanke et al. (2019).

[7] Another difference may lie in the ability of economic agents to learn about these strategies. Svensson (2019) argues that policymakers may be more successful in communicating to the public strategies that are always in operation than strategies that are pursued only under special circumstances.

[8] Appendix B provides a complete description of our simulation methodology.

[9] These assumptions allow for announcements regarding monetary policy to rapidly affect asset prices, in line with empirical evidence that credible forward guidance is very quickly reflected in financial markets, while not attributing unrealistically high degrees of sophistication to households.

[10] Under the inertial Taylor (1999) rule, the current prescription for the federal funds rate is derived from the current values of core inflation and a measure of economic slack, and the lagged realized value of the federal funds rate.

[11] Appendix A provides the details on implementing AIT and other makeup strategies through simple rules. The parameter values of these rules are generally taken from the literature and are not necessarily "optimal" from the perspective of standard welfare criteria for a given theoretical model. For instance, the value of

policymakers abstain from using additional monetary policy tools, such as balance sheet policies, to facilitate the comparison across different strategies.

Exhibit 1 presents the simulation results for the mild recession scenario. Owing to a sequence of negative shocks that, starting in 2019Q4, pushes down demand and inflation, the economy falls into recession. Under the inertial Taylor rule, the federal funds rate reaches the ELB by mid-2021 and remains at that level until late 2023. The unemployment rate rises 2 percentage points to above 5.5 percent by 2022 while inflation drops from 1.6 percent in 2019 to 1.2 percent in 2021.

The three makeup rules call for notably lower paths of the policy rate than the inertial Taylor rule and imply lower real interest rates at short and long horizons.[12] The ELB spell is longer under makeup rules with longer windows of past inflation misses. Lower nominal rates and somewhat higher inflation expectations associated with longer makeup windows cause steeper declines in real short- and long-term interest rates (such as the real 10-year Treasury yield). Hence, strategies with longer makeup windows better contain the rise in the unemployment rate and the drop in inflation during the depth of the recession, thus returning inflation to 2 percent sooner than under the inertial Taylor rule. Under PLT, and to a much lesser extent under AIT, inflation rises above 2 percent later in the simulation while the unemployment rate falls well below its value in the long run.

The different performance of the three makeup rules stems from the different treatment of past inflation misses. The lower-right panel labeled "Rule-Specific Cumulative Inflation Gaps" reports the value of the cumulative inflation deviation from 2 percent, given the specific window associated with each makeup rule. The inflation gaps in 2019Q4 are, by assumption, zero and start turning negative as inflation drops below 2 percent. Under the PLT rule, the makeup window and the associated inflation gap expand over time. By contrast, under the AIT rules, past inflation misses eventually fall outside the makeup window and become bygones, whether or not they have been offset. For instance, under the four-year AIT rule the cumulative inflation gap starts closing as early as in 2024, as the larger inflation misses accumulated at the beginning of the scenario become bygones. Given the unresponsiveness of inflation to activity in the FRB/US model, under AIT rules inflation is slow to return to 2 percent, especially under short makeup windows. As a result, by the time policymakers could conceivably allow

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the coefficient on the makeup measure controls the strength of the makeup strategy. A coefficient higher than one, as assumed here, would improve the stabilizing effects of the strategy but may also result in higher volatility of the prescribed federal funds rate. Similarly, in estimated models where shocks that move inflation and economic activity in opposite directions play a prominent role, the performance of the economy can be quite sensitive to the value of the coefficient capturing the response to economic slack.

[12] Although the different agents in the FRB/US model do not hold the same expectations about all future variables, they are assumed to hold identical views about the real interest rates at all horizons.

inflation to exceed 2 percent, the inflation gaps have largely closed and the AIT rules call for hardly any inflation overshooting.

Strategies with longer makeup windows keep inflation closer to 2 percent through (the promise of) extended lower-for-longer policy rate paths, raising credibility issues. For instance, in the scenario, the PLT rule and, to a lesser extent, the eight-year AIT rule require future policymakers to keep the federal funds rate below its neutral level for almost twenty years to allow inflation to run above the Committee's 2 percent objective and close the price gap. However, the public may be skeptical about whether policymakers would adhere to such a policy rate path in the future, especially as inflation approaches 2 percent and the benefits of the makeup strategy have been reaped. Hence, the choice of the makeup window needs to balance an additional important tradeoff between macroeconomic stabilization and credibility. Shorter makeup windows may be more credible, but they return inflation less rapidly to 2 percent (which may cast doubts on policymakers' commitment to their longer-run inflation objective). Longer makeup windows may lead to better stabilization outcomes but require credible promises about the course of monetary policy in the distant future.

*The symmetric vs asymmetric nature of the makeup*

Policymakers do not need to respond symmetrically to persistent deviations of inflation above and below target. While the stimulating effects of promising lower policy rates after a sequence of inflation shortfalls will most likely be welcomed by market participants and the broader public, the restraining effects of promising elevated policy rates when average inflation is above 2 percent may be unpopular. In addition, given the potential downward bias of inflation due to the ELB, pursuing an asymmetric strategy that does not aim to offset past inflation in excess of 2 percent may help the Committee to reduce this bias and to better anchor long-term inflation expectations. Finally, a symmetric strategy with a long makeup window may constrain the desire to act promptly at the onset of a recession if inflation has averaged above 2 percent over the makeup window.

To illustrate some potential pitfalls of symmetric strategies, we revisit the mild recession scenario but assume that policymakers need to address a positive initial inflation gap accumulated over the previous eight years.[13] In Exhibit 2, we compare the economic outcomes under a symmetric eight-year AIT rule with a positive inflation gap to those associated with the same AIT rule with no initial inflation gap (standing in for an asymmetric strategy). Under the symmetric AIT rule, policymakers *raise* the federal

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[13] To generate the positive cumulative inflation gap under the AIT rule, we simply calculate the deviations of inflation from 2 percent in past eight years and flip the sign of such deviations.

funds rate in the early phases of the recession in their attempt to make up for accumulated above-target inflation readings and delay lowering the federal funds rate to the ELB. Starting in 2027Q4, the path of the federal funds rate closely resembles its counterpart under the AIT rule with no initial gap as past inflation outcomes in excess of 2 percent have fully dropped out of the eight-year window.

The lower degree of monetary accommodation under the AIT rule with a positive initial inflation gap implies worse macroeconomic outcomes. The peak in unemployment exceeds the peak in unemployment under the baseline Taylor rule. Inflation dynamics under the two makeup rules are very similar because, in the FRB/US model, the Phillips curve is extremely flat and small differences in policy rates have little effect on inflation. In models that feature greater sensitivity of inflation to interest rates, however, the differences in inflation outcomes are likely to be more pronounced. More generally, this scenario highlights that symmetric makeup strategies may exacerbate policy tradeoffs in recessions associated with high inflation.

III.    **The Quantitative Gains Associated with Makeup Strategies**

The stabilization gains of a selected makeup strategy depend on a variety of institutional and economic features, including the ability of the central bank to influence inflation expectations, the credibility of the makeup strategy, the slope of the Phillips curve, and the responsiveness of aggregate demand to interest rates. In this section we compare the performance of makeup strategies across three models, namely the baseline FRB/US model, a variant of the FRB/US model, and the DGS-FHD model, a modified version of the dynamic general equilibrium model developed by Del Negro, Giannoni and Schorfheide (2019).[14] The latter two models feature greater, yet empirically plausible, sensitivity of the economy with respect to interest rates than the baseline FRB/US model.[15] In addition, the DGS-FHD model attributes a larger portion of inflation fluctuations to shocks that move unemployment and inflation in opposite directions.

*The performance of AIT rules at the ELB across models*

Exhibit 3 shows the ranges of outcomes for the four-year AIT rule and the eight-year AIT rule across models, together with the outcomes shown previously in Exhibit 1 for the baseline FRB/US model. We construct the recession scenario to yield identical outcomes under the inertial Taylor rule in all three models.

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[14] Appendix C provides details on the DGS-FHD model.
[15] Many of the macroeconomic models found in the academic literature feature much greater sensitivity of the economy than is commonly considered plausible by policymakers.

The two additional models considered here imply somewhat stronger effects of the AIT strategies on the unemployment rate than in the baseline FRB/US model. Under the eight-year AIT rule, the peak in the unemployment rate can be up to an additional 50 basis points lower. Later in the scenario, the unemployment rate can dip below 3 percent in these models while it stays above 3.5 percent in the baseline FRB/US model. The range of inflation outcomes across models, by contrast, is much narrower as the Phillips curve is very flat in all models. In the models considered here, the four-year AIT rule is not very successful in stabilizing inflation by more than the inertial Taylor rule. The eight-year AIT rule can be somewhat more successful in stabilizing inflation, at least in some of the alternative models.

*Macroeconomic outcomes under makeup strategies*

We conduct stochastic simulations under a range of likely economic situations using the FRB/US and the DGS-FHP models to quantify the stabilization gains of makeup strategies compared to a "bygones-be-bygones" approach. In these simulations, the model economies experience shocks to supply and demand from distributions estimated from the historical data. We broaden the set of makeup strategies to include symmetric and asymmetric versions of the eight-year AIT rule discussed in Section II, temporary versions of the AIT and the PLT that are engaged at the ELB, and the shadow rate rule proposed by Reifschneider and Williams (RW).

Table 1 reports the losses computed using the standard equal-weights loss function for the five makeup rules relative to the losses for the inertial Taylor (1999) rule in the two models.[16] Table 2 presents the underlying statistics used to construct these losses. These tables provide three main results. First, makeup strategies show uniformly lower losses compared to the inertial Taylor rule. Second, the gains quantitatively vary with the sensitivity of aggregate demand to interest rates and the importance of shocks that drive fluctuations in unemployment and inflation in opposite directions. In the FRB/US model, aggregate demand and inflation respond little to interest rates and, consequently, all makeup rules deliver similarly modest effects. In addition, because variations in unemployment and inflation contribute equally to the loss under the inertial Taylor rule (as shown in the first row of Table 2), rules that address more directly deviations caused by the ELB perform marginally better (such as asymmetric AIT and, to a larger extent, temporary rules activated at the ELB and shadow rate rules). In the DGS-FHP model, where aggregate demand and inflation respond more to interest rates, some makeup rules deliver significant stabilization gains. In addition, because inflation variations contribute more to the loss under the inertial Taylor rule (Table 2), rules that respond more aggressively to deviations in inflation from 2 percent deliver larger gains

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[16] Appendix A.9 provides details on the equal-weights loss function.

(such as the symmetric AIT rule).  Lastly, asymmetric/temporary rules push the long-run inflation rate up (Table 2), suggesting that these strategies have the potential to create an inflation buffer in environments where the ELB induces material deflationary bias.

Our analysis points to smaller stabilization gains from the adoption of makeup strategies compared to some academic studies.[17]  As discussed, a higher sensitivity of the economy to interest rates, a steeper Phillips curve, and a smaller role of shocks that drive inflation and unemployment in opposite directions ("supply shocks") provide greater scope for monetary policy stabilization and thus larger gains from makeup strategies. Similarly, a lower neutral real interest rate and a larger implied incidence of the ELB allow for larger gains.  These details, as well as the assumed responsiveness of the policy rule to inflation, resource slack, and the makeup measure, also affect the relative performance of different strategies in providing stabilization gains.

## IV.     **Communication of Makeup Strategies: Some Practical Challenges**

The adoption of a makeup strategy is likely to involve a number of adjustments in the Committee's communications.  Policymakers may want to provide details on the makeup measure, the evolution of the makeup measure over time, and how *changes* in the makeup measure affect the appropriate path of policy.  Similarly, policymakers may decide to indicate the systematic relationship between the *level* of the makeup measure and the future path of monetary policy while clarifying the relationship between the makeup strategy and the 2 percent inflation objective.

We next discuss some practical challenges that may emerge with these communications.  In our view, a relevant communication tradeoff associated with makeup strategies is that greater transparency about the details of the strategy may increase the understanding and the support of the public, and thus the effectiveness of the strategy itself, at the cost of reducing policymakers' flexibility in the future.

*Details of the makeup measure*

One key decision associated with makeup strategies is whether to give a numerical value of the makeup window or to give a range of windows.  For instance, under the latter, the Committee may state that, in assessing the need for additional monetary accommodation at the ELB, the FOMC looks at inflation averages between four and eight years. If, coming out of an ELB episode, inflation were to move up towards its 2 percent goal earlier than anticipated, policymakers could argue in favor of

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[17] See, for instance, Bernanke et al (2019), Hebden and López-Salido (2018), and analysis based on a standard 3-equation New-Keynesian model.

abandoning further makeup by pointing to the improvements in average inflation measures with shorter windows. More generally, emphasizing a range of inflation averages would allow the FOMC to retain some discretion, while articulating the need to tilt policy in response to low-frequency movements in inflation.[18] Similarly, while policymakers may have a clear preference for pursuing an asymmetric makeup strategy, they may appreciate the flexibility of pointing to moving averages of inflation if inflation readings have been above 2 percent for some time.

*Evolution of the makeup measure and their implications for appropriate monetary policy*

To ensure the effectiveness of a makeup strategy, policymakers may want to consider communicating to the public on a regular basis how changes in the makeup measure affect the appropriate path of policy. This communication may include providing concrete guidance on the sign and magnitude of the past inflation misses that drop out of the makeup measure in a given period or the near future. As discussed in Section II, for instance, these facets of the strategy provide information on the expected degree of inflation overshooting (if any). Similarly, the makeup measure could feature oscillations – for example due to fluctuations in energy prices – which would require detailed communication to avoid perception of an unwarranted change in the policy path.

*Relationship between the makeup measure and future monetary policy*

If the gains of the makeup strategy suggested by macroeconomic models are to be realized, agents in the economy must be able to understand the implications of the expected path of the makeup measure for the conduct of monetary policy. In the context of our model simulations, this is easily achieved by augmenting the policy rule from which policymakers are assumed to derive prescriptions for the federal funds rate to include a makeup measure. In reality, policymakers may find it more challenging to provide guidance to the public on how the current and future levels of the makeup measure translate into future policy actions. Some inspiration on how to communicate the policy implications of makeup strategies to the public can be taken from Svensson's (2019) suggestion of forecast targeting. Under forecast targeting, the central bank can reveal its systematic policy response by adjusting a published policy rate path in response to incoming information in the direction consistent with fulfilling its mandate. For example, when new information shifts up the inflation forecast, policymakers may raise the policy rate path relative to the one published previously. Once economic agents

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[18] While it would be novel for the Committee to consider a range of inflation measures in pursuing its inflation objective, the FOMC already considers a wide range of indicators of the labor market to assess progress towards the objective of maximum employment.

understand this response and deem it credible, financial conditions may shift in the appropriate direction, even before the central bank takes action.[19]

*Relationship between makeup strategy and dual mandate*

When augmenting the existing framework with a makeup component for inflation, policymakers may find it helpful to carefully distinguish between their strategy for inflation and their long-run inflation goal and to repeatedly remind the public of this distinction. For instance, while an AIT strategy *responds* to a rolling window of cumulative past deviations of inflation from its objective, pursuing an AIT strategy does not *ensure* that average inflation over that window or any other will be equal to 2 percent. In addition, targeting a specific average inflation rate does not imply that both this average inflation rate and the current (short-term) inflation rate stand near 2 percent simultaneously. As a result, the public may perceive the strategy as a failure even if it works as designed.

Relatedly, the public may perceive tensions between the FOMC's strategy and its goals if policymakers define their makeup strategy in terms of core inflation, but continue to judge headline inflation to be "most consistent over the longer run with the Federal Reserve's statutory mandate" in its "Statement on Longer-Run Goals and Monetary Policy Strategy".[20] For instance, when the selected moving average of core inflation is near 2 percent, current headline inflation may not be. Moreover, even if the long-run inflation objective were expressed in terms of core inflation to eliminate some of the tensions between strategy and goals, the Committee may find itself exposed to intense public questioning in times of large energy price increases that strongly move up headline inflation but have little and delayed influence on core inflation.[21]

Exhibit 4 shows in the top panel the evolution of the eight-year moving averages of headline and core inflation between 2000Q1 and 2019Q2. Due to the run-up in energy

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[19] The box "Monetary Policy Rules and Systematic Monetary Policy" in the February (2019) *Monetary Policy Report* describes how the FOMC currently conducts systematic monetary policy. That description bears remarkable resemblance with Svensson's ideas about communicating the "reaction function" under forecast targeting. For more information, see https://www.federalreserve.gov/monetarypolicy/2019-02-mpr-part2.htm#xsubsection-1543-1b598f5f.

[20] A similar tension already arises under the current framework. Policymakers have repeatedly stressed core PCE inflation to be a better indicator of future headline PCE inflation than headline PCE inflation itself when relating their policy decisions to the inflation outlook. Periodic large shifts in the prices of food and energy relative to all other goods lead to one-time jumps in headline inflation. If these shifts are persistent, the spike in headline inflation will disappear. If these shifts are transitory, there is also no implication for the net direction of inflation over time.

[21] In the summer of 2008, financial market commentators pointed to high headline inflation to argue against monetary easing.

prices before the Great Recession, the eight-year moving average in headline inflation remained above 2 percent until early 2013. By contrast, the eight-year average of core inflation was below 2 percent throughout the entire time period shown. As a result, a symmetric strategy focused on the eight-year moving average of headline inflation would have been notably tighter than actual policy during much of the Great Recession. An asymmetric strategy focused on the eight-year moving average of headline inflation would have not been notably tighter than actual policy but this strategy would still not have facilitated communication with the public about any forward guidance. Makeup strategies based on core inflation would have avoided the problematic recommendations derived from a headline-based strategy.[22] As shown in the lower panel of Exhibit 4, similar issues arise at shorter windows for average inflation.

V.    **Conclusions**

Our quantitative analysis suggests that credible makeup strategies may provide moderate stabilization gains in the context of an economy characterized by higher incidence of the ELB and an extremely flat Philips curve. Our overview of the practical implementation of these strategies suggests a number of considerations relevant for realizing the full benefit of these strategies. Because these strategies work by leveraging both expectations and the transmission channels of monetary policy, their effectiveness depends on a range of structural features, some of which are explored in greater detail in the companion memo.

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[22] However, with the eight-year average of core inflation below 2 percent throughout the entire period shown, the pursuit of a core-inflation based AIT strategy would have called for lower values of the federal funds rate than the Committee deemed appropriate in the past.

**Table 1: Relative expected loss values under alternative rules in 2029Q4**

|  | FRB/US | DGS-FHP |
|---|---|---|
| Taylor rule | 1.00 | 1.00 |
| AIT (8 years) | 0.97 | 0.76 |
| A-AIT (8 years) | 0.95 | 0.84 |
| T-AIT (8 years) | 0.93 | 0.97 |
| T-PLT | 0.90 | 0.83 |
| RW | 0.92 | 0.96 |

Notes: Staff calculations using stochastic simulations of the FRB/US and DGS models around the June 2019 SEP-consistent baseline. Relative expected loss is defined as the expected loss under the alternative rule divided by the expected loss of under the Taylor rule. AIT (8 years) is Average Inflation Targeting with an eight-year makeup window. A-AIT is Asymmetric AIT. T-AIT is Temporary AIT. T-PLT is Temporary Price Level Targeting. RW is the Reifschneider-Williams shadow rate rule.

**Table 2: Mean outcomes and standard deviations under alternative rules in 2029:Q4**

| | FRB/US | | | | DGS-FHP | | | |
| | Unemployment | | Inflation | | Unemployment | | Inflation | |
| | Mean | Std | Mean | Std | Mean | Std | Mean | Std |
| Taylor rule | 4.25 | 1.24 | 1.97 | 1.01 | 4.22 | 0.80 | 1.96 | 1.70 |
| AIT (8 years) | 4.31 | 1.32 | 1.98 | 0.85 | 4.17 | 0.83 | 1.97 | 1.41 |
| A-AIT (8 years) | 4.13 | 1.24 | 2.17 | 0.93 | 3.91 | 0.55 | 2.18 | 1.59 |
| T-AIT (8 years) | 4.14 | 1.22 | 2.08 | 0.93 | 4.02 | 0.48 | 2.06 | 1.67 |
| T-PLT | 4.14 | 1.21 | 2.12 | 0.91 | 4.20 | 0.44 | 2.15 | 1.60 |
| RW | 4.16 | 1.20 | 2.05 | 0.95 | 4.15 | 0.74 | 1.97 | 1.69 |

Notes: Staff calculations using stochastic simulations of the FRB/US and DGS models around the June 2019 SEP-consistent baseline. AIT (8 years) is Average Inflation Targeting with an eight-year makeup window. A-AIT is Asymmetric AIT. T-AIT is Temporary AIT. T-PLT is Temporary Price Level Targeting. RW is the Reifschneider-Williams shadow rate rule.
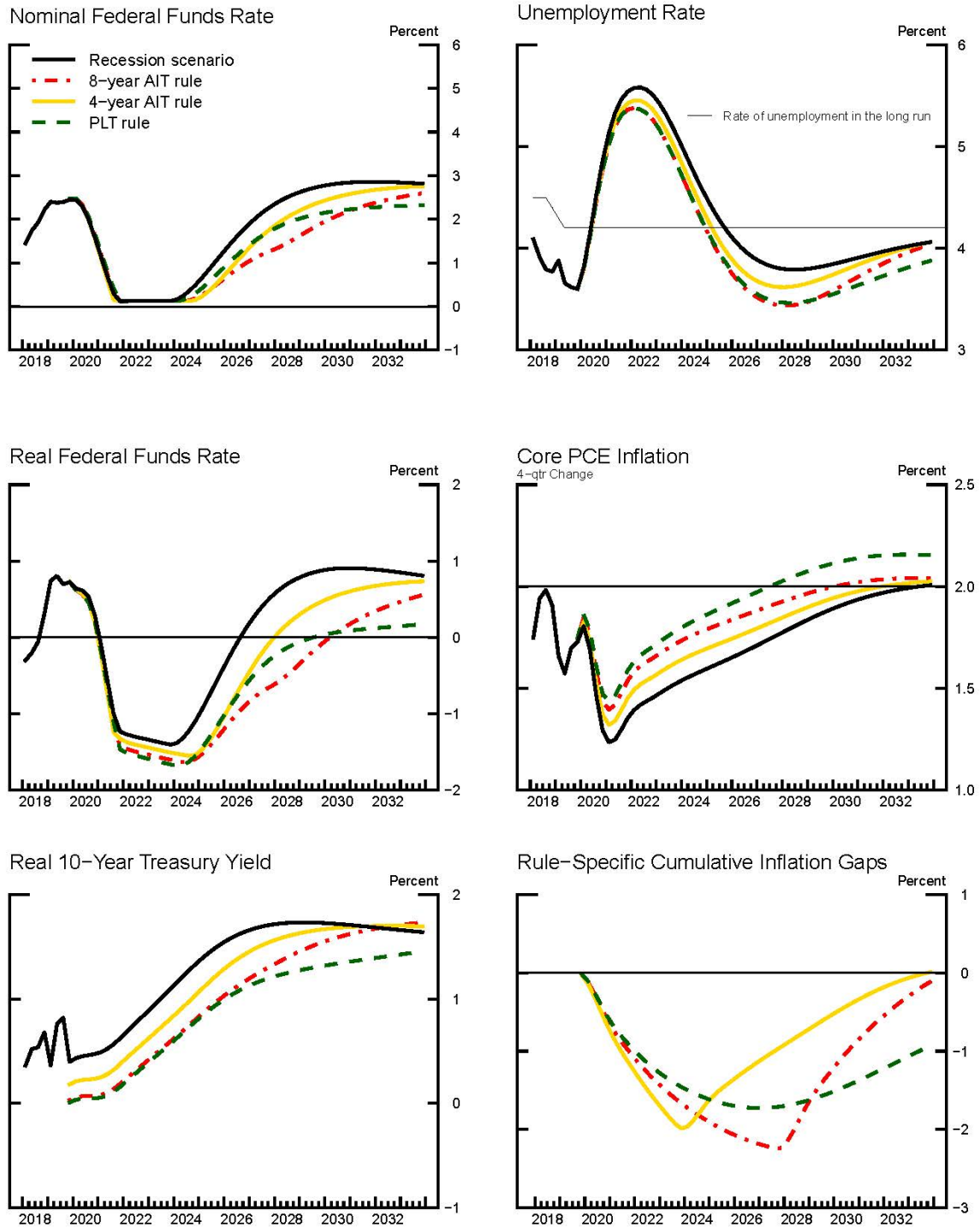
**Exhibit 1. A Mild Recession Scenario**

Nominal Federal Funds Rate
Percent

- —— Recession scenario
- –·–· 8–year AIT rule
- —— 4–year AIT rule
- – – – PLT rule

Unemployment Rate
Percent

Rate of unemployment in the long run

Real Federal Funds Rate
Percent

Core PCE Inflation
4–qtr Change
Percent

Real 10–Year Treasury Yield
Percent

Rule–Specific Cumulative Inflation Gaps
Percent

## Exhibit 2. A Mild Recession Scenario with a Positive Inflation Gap

Nominal Federal Funds Rate

Percent

Recession scenario
8-year AIT rule asymmetric
8-year AIT rule symmetric

Unemployment Rate

Percent

Rate of unemployment in the long run

Real Federal Funds Rate

Percent

Core PCE Inflation

Percent
4-qtr Change

Real 10-Year Treasury Yield

Percent

Rule-Specific Cumulative Inflation Gaps

Percent
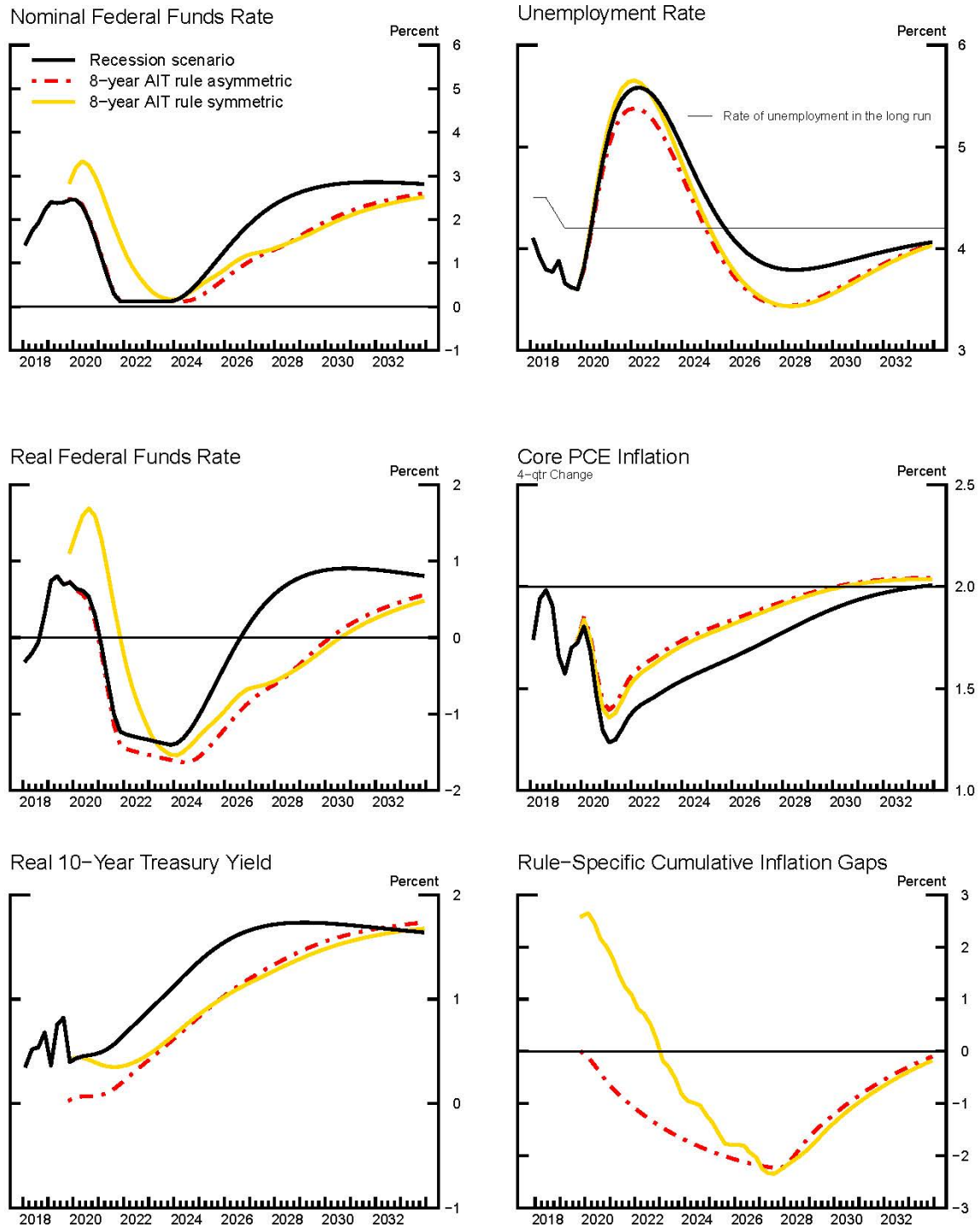
## Exhibit 3. The Performance of AIT Rules across Models

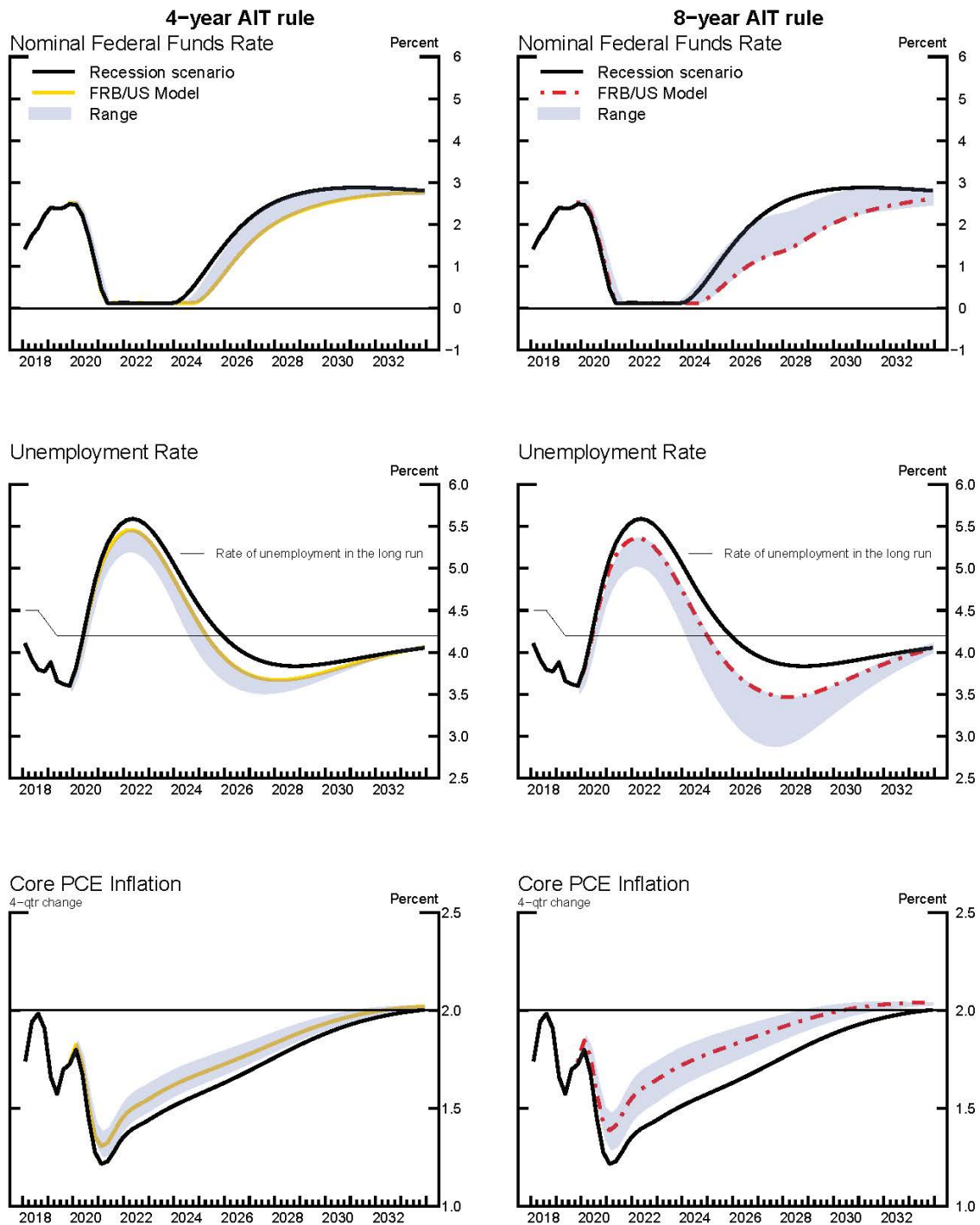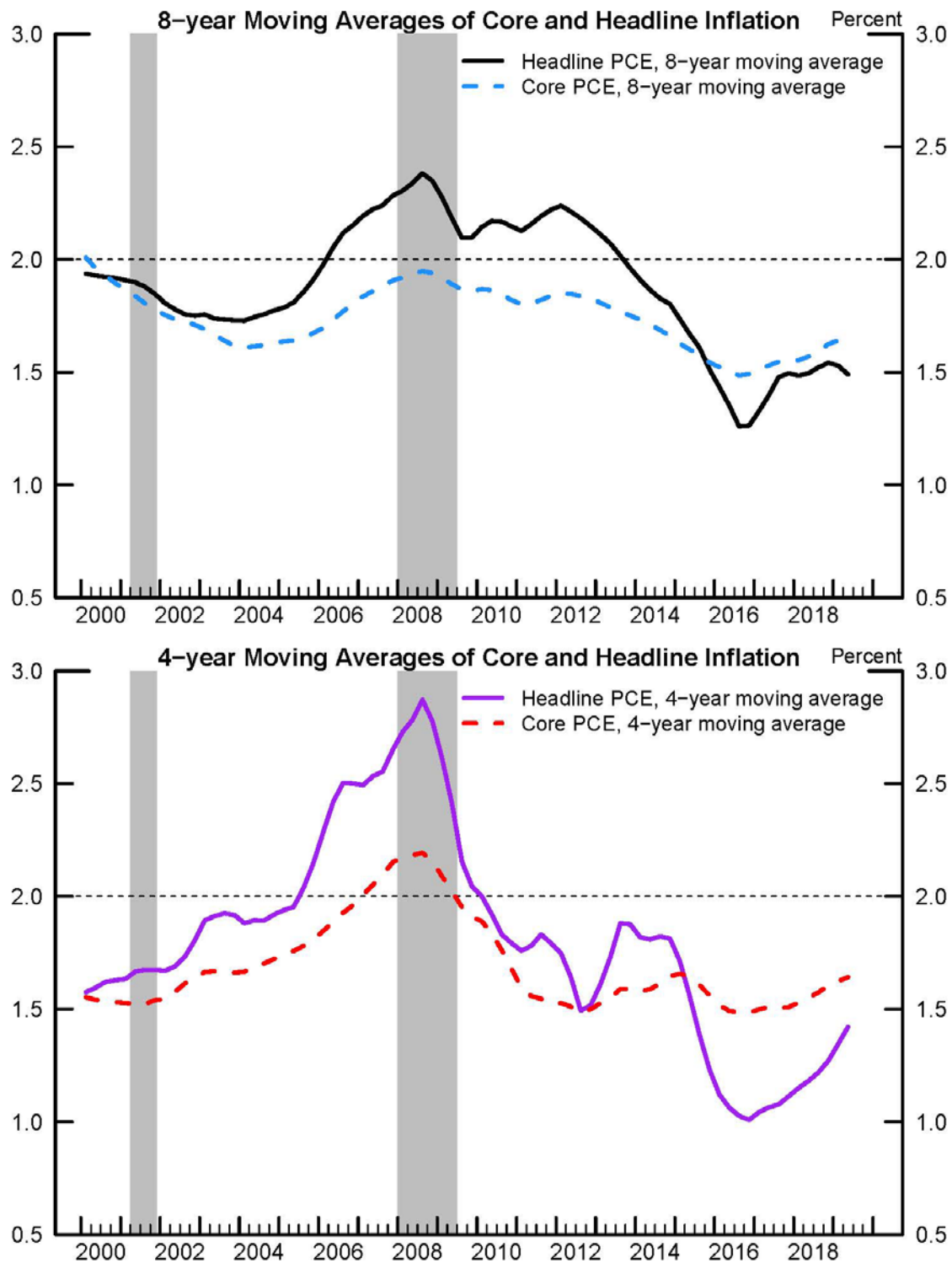**4-year AIT rule**

**8-year AIT rule**

**Exhibit 4. Moving Averages of Headline and Core Inflation**



Source: Federal Reserve Bank of St. Louis.

**References**

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**Appendix A. Description of Alternative Rules**

So far we have discussed the strategies in terms of the essential features of their underlying monetary policy framework. In this Appendix, we describe the specific monetary policy rules that we used when evaluating the performance of the strategies in FRB-US and the DGS-FHP model. In all simulations, the effective lower bound ($R^{ELB}$) is assumed to be equal to 0.125 percent.

**A.1    Flexible Inflation Targeting:** When monetary policy is unconstrained, the federal funds rate is set according to an inertial Taylor rule. When monetary policy is constrained, the federal funds rate equals the effective lower bound. Formally, the flexible inflation targeting rule sets the federal funds rate such that the federal funds rate ($R_t$) equals $\max(R^{ELB}, R_t^{Taylor})$, with $R_t^{Taylor}$ defined as follows:

$$R_t^{Taylor} = 0.85 R_{t-1} + 0.15\left(r^* + \pi_t + ygap_t + 0.5(\pi_t - \pi^{LR})\right),$$

where $r^*$ is the longer-run level of the equilibrium real interest rate, $ygap_t$ is a measure of economic slack, $\pi_t$ is the four-quarter change in the core PCE price level, and $\pi^{LR}$ is the 2-percent long-run objective. Note that the inertial term depends on the *realized* value of the federal funds rate ($R_{t-1}$), rather than the prescribed (possibly infeasible) $R_{t-1}^{Taylor}$. Henceforward, even though this rule corresponds to an expanded inertial Taylor rule, for ease of exposition we will refer to it as the inertial Taylor rule.

**A.2    Average Inflation Targeting:** When monetary policy is unconstrained, the federal funds rate is set according to a modified inertial Taylor rule. The modification consists of reacting to the gap between average quarterly inflation at an annual rate, T-year-$\bar{\pi}_t$, and the 2-percent long-run objective. When monetary policy is constrained, the federal funds rate equals the effective lower bound. To summarize, the flexible inflation targeting rule sets the federal funds rate such that the federal funds rate ($R_t$) equals $\max(R^{ELB}, R_t^{AIT})$ ), where $R_t^{AIT}$ is defined as follows:

$$R_t^{AIT} = 0.85 R_{t-1} + 0.15\left(r^* + \pi_t + ygap_t + T \,(\text{T-year-}\bar{\pi}_t - \pi^{LR})\right),$$

with T denoting the length of the time window measured in years. Note that this strategy is equivalent to an inertial Taylor rule when T equals 1. When T=4 the rule corresponds to an AIT strategy with a four year makeup window. When T=8 the rule corresponds to an AIT strategy with a four year makeup window. As the length of the window increases, the rule puts more weight on deviations of average inflation from the long-run objective.

**A.3    Asymmetric Average Inflation Targeting:**  In this strategy policymakers' appetite for slowing the economy today because past inflation has averaged above 2 percent differs from their appetite for stimulating the economy because past inflation has averaged below 2 percent.  We capture this feature by assuming that when average inflation under the desired makeup window is below 2 percent the policymaker follows the rule specified in A.2 and when average inflation under the desired makeup window is above 2 percent the policy maker reverts back to the Taylor rule prescription.  That is:

$$R_t = \begin{cases} \max(R^{ELB}, R_t^{AIT}) \; if \;\; \text{T-year-}\bar{\pi}_t < 0 \\ \max(R^{ELB}, R_t^{Taylor}) \; if \; \text{T-year-}\bar{\pi}_t \geq 0. \end{cases}$$

**A.4    Temporary Average Inflation Targeting:**  When monetary policy is unconstrained, the federal funds rate is set according to the inertial Taylor rule described in A.1.  When monetary policy is constrained or the inflation gap is negative set the policy rate as under an asymmetric inflation targeting strategy with the average inflation gap set equal to zero in the periods before the ELB binds.

**A.5    Price Level Targeting (PLT):**  When monetary policy is unconstrained, the federal funds rate is set according to a modified inertial Taylor rule.  The modification consists of reacting to the gap between the log of core PCE price level ($p_t$) and the log of the target price-level path ($p_t^*$).  The latter is price level that would prevail if inflation had been equal to an annual rate of 2 percent since a reference date ($p_0^*$).  When monetary policy is constrained, the federal funds rate equals the effective lower bound.  The rule can be summarized by $R_t = \max(R^{ELB}, R_t^{PLT})$, where

$$R_t^{PLT} = 0.85 R_{t-1} + 0.15(r^* + \pi_t + ygap_t + (p_t - p_t^*)).$$

**A.6    Temporary PLT (TPLT):**  When monetary policy is unconstrained, the federal funds rate is set according to a modified inertial Taylor rule.  The modification aims at offsetting only those inflation misses that have occurred since the first period of an ELB episode (t1).  The misses keep accumulating until the cumulative shortfall of inflation is made up.  To fix ideas, it is useful to refer to the cumulative misses as a price-level gap ($Z_t$), where

$$Z_t = \begin{cases} 0, & if \; R_{t-1} \geq 0 \; and \; Z_{t-1} \geq 0 \\ \beta_n Z_{t-1} + (\pi_i - \pi^{LR}), otherwise, \end{cases}$$

where $\beta_n = 1$.

**A.7    Shadow Rate:** This strategy – proposed by Reifschneider and Williams (2000) – consists of reducing the policy rate prescription of a standard Taylor rule by the cumulative forgone accommodation $(\tilde{Z}_t)$, until exhausted. Measuring the shortfall in accommodation requires specifying an unconstrained monetary policy rule. Formally, from the first quarter in which the ELB binds, $\tilde{Z}_t$ evolves according to:

$$\tilde{Z}_t = \tilde{Z}_{t-1} + R_t - R_t^{Taylor},$$

until $\tilde{Z}_t$ would rise above zero, at which point it becomes zero until the next ELB episode. The monetary policy rule is then:

$$R_t = max\{R_t^{Taylor} + \tilde{Z}_t, R^{ELB}\}.$$

**A.8    Average Inflation Targeting over the Long Run:** When monetary policy is unconstrained, the federal funds rate $(R)$ is set according to a modified inertial Taylor rule. The modification amounts to reacting to the gap between current year-over-year inflation $(\pi_t)$ and the 2-percent long-run objective $(\pi^{LR})$ plus an inflation buffer $(\delta > 0)$. The size of the buffer must be chosen in order that inflation averages the 2-percent objective, that is $E(\pi_t) = \pi^{LR}$. When monetary policy is constrained, the federal funds rate equals the effective lower bound. The following equation summarizes the rule:

$$R_t = max\{0.85R_{t-1} + 0.15(r^* + \pi_t + ygap_t + 0.5(\pi_t - (\pi^{LR} + \delta))), 0\}.$$

**A.9    Loss Function:** The equal-weights loss function embeds the assumption that policymakers discount the weighted sum of squared inflation gaps, squared unemployment gaps, and squared changes in the federal funds rate with a quarterly discount factor:

$$L_t = (1/(T+1)) \sum_{\tau=0}^{T} \beta^\tau \{ (\pi_{t+\tau}^{PCE} - \pi^{LR})^2 + (ugap_{t+\tau})^2 + (R_{t+\tau} - R_{t+\tau-1})^2 \}.$$

The discount factor is usually set to 0.99.

## Appendix B.  FRB/US Simulation Methodology[23]

Unless otherwise noted, we perform our simulations using the linearized version of the FRB/US model under the following set of assumptions:

- The baseline economic projection is consistent with the median responses of FOMC participants in the June 2019 Summary of Economic Projections, retrieved from the public FRB/US data.
  - o To construct this baseline projection, we interpolated annual SEP information to a quarterly frequency and assumed that, beyond 2021 (the final year reported in the June 2019 SEP), the economy transitions to the longer-run values in a smooth and monotonic way.  We also posited economic relationships to project variables not covered in the SEP.  For example, we assume an Okun's law relationship to recover an output gap from the deviation of the median SEP unemployment rate from the median SEP estimate of its longer-run value.
  - o The projection is consistent with longer-run values of the unemployment rate and inflation of 4½ percent and 2 percent, respectively.
  - o We impose an ELB of 12.5 basis points, a value equal to the mid-point of the lowest range for the federal fund rate implemented by the FOMC during the global financial crisis.
- We specify the model equations as follows:
  - o We assume that price setters, wage setters, and financial market participants form model-consistent expectations; all other agents project future variables using small systems of equations and historical data.
  - o We assume that the term premiums in the model do not respond to resource slack.
  - o Because we run stochastic simulations over many years, we assume that trend government spending is twice as responsive to the output gap as in the standard version of FRB/US.  This alternative assumptions helps ensure that simulations produce stable solutions over long horizons.
- We perform stochastic simulations of the model using an approach similar to that implemented in the Risks and Uncertainty section of Tealbook A to derive uncertainty bands around the staff projection.
  - o We sample from the model's equation residuals from the 1969–2016 period.
  - o To ensure consistency with the frequency and severity of historical economic downturns, we sample recessions with the same probability as in the data and, when a recession occurs, we draw the entire sequence of equation residuals associated with one of the historical recessions.

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[23] The simulation methodology used here is identical to that employed in the July 2019 memo to the FOMC entitled "Monetary Policy Options at the Effective Lower Bound: Assessing the Current Policy Toolkit" and this appendix is largely taken from that memo.

- o We scale down mark-up shocks to lower their variance by half, which helps limit occurrences of ELB episodes driven by falls in inflation unrelated to developments in real economic activity.  This change is motivated by our judgment that historical innovations to inflation were more volatile than innovations to inflation going forward because the FOMC lacked an explicit inflation objective over most of the sample period.
- o In order to have reasonably small sampling uncertainty for tail event statistics, we perform stochastic simulations using 20,000 draws.

**Appendix C:  Del Negro, Giannoni and Schorfheide Model Specification**

This Appendix describes the version of the DGS model (DGS-FHP) that we use in Section III.  The model structure and parameter settings are those corresponding to the estimates reported in the published paper.

In order to attenuate the implausibly large effects of forward guidance in this model (as in most models in this class), we modify the forward-looking optimality conditions for households and firms such that all expectations appearing in household optimality conditions are multiplied by an additional 0.95 compared to their standard coefficients, while the coefficient on lead inflation in the Phillips curve is multiplied by 0.9.[24]  These modifications of the model are roughly in the spirit of Woodford (2019).

Similar to what we do with the FRB/US model simulations, we scale the standard deviation of price Phillips curve shocks by 0.25 to bring the standard deviation of core inflation under the Taylor rule roughly in line with the historical average between 1975 and 2019.

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[24] A more detailed discussion of the FHP version of the model can be found Nakata et al. (2019).