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The Macroeconomic Effects of State-Contingent Ending of Reinvestment[1]

I. Introduction and Summary

The FOMC raised the federal funds rate above the effective lower bound (ELB) in December 2015. Since then, the Committee has said that it anticipates continuing to reinvest repayments of principal on securities held in the System Open Market Account (SOMA) "until normalization of the level of the federal funds rate is well under way." In this memo, we analyze differences in the policy mix (meaning the level of the federal funds rate and the size of the balance sheet) and in macroeconomic outcomes when using two different types of policies for ending reinvestment. Specifically, we compare outcomes from adopting a state-contingent policy for ending reinvestment—when the federal funds rate has passed either 1½ or 2½ percent—to those from a policy with a fixed date for ending reinvestment—the end of 2017.[2]

Previous staff analysis of reinvestment policy examined how different strategies for ending reinvestment would influence real activity, inflation, and interest rates under the staff's baseline economic projection and under an alternative, adverse, economic scenario.[3] In this memo, we broaden the scope of previous staff work by using stochastic simulations to consider a large set of scenarios. Examining the FRB/US model's responses to a wide range of stochastic shocks allows us to construct probability distributions for future economic conditions and the

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[2] The accompanying memo "Changing the FOMC's Reinvestment Policy: Approaches and Considerations" focuses on how to operationalize the cessation of reinvestment.
[3] Kathryn Chen, James Clouse, Jane Ihrig, Beth Klee, Erin Syron Ferris, Julie Remache, and Brett Rose, "Reinvestment Considerations," Memorandum to the Federal Open Market Committee, Board of Governors of the Federal Reserve System and Federal Reserve Bank of New York, July 21, 2015, outlines similar strategies in the context of an illustrative scenario. See also Christopher Erceg, Elizabeth Klee, Bernd Schlusche, and Robert Tetlow, "Alternative Approaches to Ending Reinvestment," Memorandum to the Federal Open Market Committee, Board of Governors of the Federal Reserve System, Division of International Finance and Division of Monetary Affairs, September 8, 2015.

size of the balance sheet that result from using the inertial Taylor (1999) rule to set the federal funds rate while adopting either a fixed-date or state-contingent policy for ending reinvestment.

We consider state-contingent reinvestment policies under which full reinvestment of principal repayments of Treasury and agency mortgage-backed securities (MBS) in the SOMA portfolio continues until the end of the year during which the federal funds rate passes 1½ or 2½ percent and then reinvestment stops immediately, completely, and permanently.[4] For contrast, we also consider a fixed-date policy, according to which reinvestment stops immediately, completely, and permanently in the last quarter of 2017, the same quarter assumed in the January Tealbook, regardless of macroeconomic conditions at that time.

Before turning to the results, we emphasize that the exercises in this memo should be viewed as a first step in exploring the macroeconomic effects of reinvestment rules in a stochastic setting. In particular, we have, as yet, been unable to run stochastic simulations of the FRB/US model while allowing for the possibility that, in the event of a serious downturn or worsening economic outlook, the Committee could respond by reversing a previous decision to end reinvestments, by undertaking a new large-scale asset purchase program, by offering forward guidance about the future course of monetary policy, or by cutting the federal funds rate much more aggressively than would be prescribed by the inertial Taylor rule before the onset of a binding ELB.[5]

Our results show that macroeconomic outcomes are nearly identical regardless of the policy for the cessation of reinvestment, in almost all scenarios generated by the stochastic simulations using the FRB/US model. The state-contingent policies modestly reduce the frequency and severity of ELB episodes relative to the fixed-date policy. This requires maintaining a larger balance sheet than otherwise. For example, the median difference between

[4] As noted in the January-February FOMC Minutes, "the Open Market Desk's surveys of dealers and market participants pointed to some change in expectations for FOMC reinvestment policy, with more respondents than in previous surveys anticipating a change in policy when the federal funds rate reaches 1 to 1½ percent."

[5] As discussed in Deborah Leonard, David López-Salido and Fabio Natalucci, "Balance Sheet Considerations for the Federal Reserve's Long-Run Framework," Memorandum to the Federal Open Market Committee, Board of Governors of the Federal Reserve System and Federal Reserve Bank of New York, October 24, 2016, different balance sheet tools can be used to achieve macroeconomic objectives when the policy rate is at the ELB. However, active use of the balance sheet away from the ELB poses uncertainties around the ability to manage multiple tools—the current and expected policy rate, and the size and composition of the balance sheet—and the degree of substitutability among them.

the size of the balance sheet under the 2½ percent rule and the fixed-date policy is $1.5 trillion in 2020 when the economy is hit by a sequence of adverse shocks that result in the federal funds rate returning to the ELB and consequently remaining below 1½ percent (or 2½ percent) for the next few years. Still, in such scenarios, the unemployment rate is at most 12 basis points lower under the 1½ percent policy, and 18 basis points lower under the 2½ percent policy, when compared with the fixed-date policy. Inflation outcomes are little changed.

II. Results

We conduct the stochastic simulations using a linearized version of the FRB/US model, with a baseline for real activity, inflation and interest rates constructed to match the January Tealbook projection.[6] In the simulations, the federal funds rate is governed by the intercept-adjusted inertial version of the Taylor (1999) rule. The FRB/US simulations are combined with the model used for balance sheet and income projections in Tealbook B, in which the term premium effects are endogenous.[7]

Table 1 summarizes the probability distribution of the timing of the end of reinvestment under each of the two state-contingent approaches. Inasmuch as the federal funds rate in the January Tealbook projection reaches roughly 1½ percent in 2017:Q4, it is not surprising that around half of the stochastic simulations record a federal funds rate below 1½ percent at that time and, therefore, delay the cessation of reinvestment under the 1½ percent policy. The end of reinvestment is further delayed under the 2½ percent policy.

Table 1: Probability reinvestments have ended by each year end (percent)

	1½ percent policy	2½ percent policy
2017	49	6
2018	81	51
2019	92	77
2020	96	88
2021	98	93

[6] A full description of the simulation methodology is provided in Technical Appendix A.
[7] In these simulations, market participants and price and wage setters understand the future evolution of the policy mix.

The distribution of simulated outcomes is presented in Figure 1, where we report the interquartile range and median for the fixed-date policy (in black), for the 1½ percent policy (in red), and for the 2½ percent policy (in blue).[8] As shown in the upper-left panel of the figure, the median balance sheet size under the 1½ percent policy (the red dots) is modestly higher after 2018 than under the fixed-date policy (the black squares). Because the other half of the distribution of federal funds rate outcomes exceeds 1½ percent in 2017:Q4, the lower boundary of the interquartile range for the balance sheet under the 1½ percent policy is nearly identical to the fixed-date policy. When we instead set the threshold to 2½ percent, the probability of having ended reinvestment by 2018 and 2019 is appreciably lower than under the 1½ percent policy, so the balance sheet distribution is shifted upward.

Maintaining a larger balance sheet under the state-contingent policies implies that term premium effects are more negative than under the fixed-date policy, as shown in the middle-left panel. The lower term premiums help stimulate the economy. However, because the federal funds rate is set by the inertial Taylor (1999) rule, it systematically responds to resource slack and inflation. Consequently, the stimulus provided by a larger balance sheet is partially offset by the endogenous reaction of the federal funds rate.[9] As a result, the state-contingent policies are associated with only modestly lower longer-term interest rates, as shown in the middle-right panel. This offset is most apparent in Figure 2, which, in order to isolate the effects of the different reinvestment policies, plots the distribution of *differences* in outcomes between the state-contingent policies and the fixed-date policy, given the same sequence of economic shocks. In particular, the differences in balance sheet size that are mentioned above imply small differences in term premium effects (middle-left panel) of less than 10 basis points. By comparison, the distribution of differences in the nominal 10-year Treasury yield (middle-right

[8] During the years between the cessation of reinvestment and normalization of the size of the balance sheet, given the known pattern of redemptions of Treasury securities, the distribution of the balance sheet size is to a large extent determined by MBS prepayment rates, which are projected using the standard staff MBS prepayment model. Of course, actual prepayments could differ from the model forecasts. Most of the prepayment uncertainty is associated with situations where interest rates are lower, implying a possibility for higher prepayments.

[9] Note that the offset to the term premium effect provided by endogenous movements in the funds rate is not specific to the inertial Taylor 1999 rule. Rather the offset is a general effect that would occur as long as market participants expect the FOMC to respond systematically to movements in real activity and inflation along the lines implied by most standard policy rules, inertial or not.

panel) is concentrated around somewhat smaller values, reflecting the offsetting movements in the federal funds rate.

Given the small differences in long-term interest rates, macroeconomic outcomes under the state-contingent reinvestment policies are almost always close to those attained under the fixed-date policy. In particular, the bulk of the distributions for the unemployment rate (bottom-left panel) and core PCE inflation (bottom-right panel) are only slightly more favorable than under the fixed-date policy.

Relative to some outside estimates, the outcomes in our FRB/US-based distribution may appear unrealistically benign. In particular, the interquartile range of the federal funds rate is well above the ELB at the end of all years, while one might argue that the probability of a recession in the next three years is appreciable and that, in those circumstances, the federal funds rate would very likely return to the ELB. As shown in Table A in Technical Appendix A, the probability of a binding ELB in any year, under any policy, is less than 5 percent.[10]

The small size of policy effects discussed above could stem from two sources: the stochastic simulations in FRB/US may underrepresent economic conditions in which policy effects would be large or we may underestimate the size of the policy effects given economic conditions. A prominent example is when the ELB is binding, since differences between outcomes under the state-contingent reinvestment policies are likely to be larger because there is no immediate offset from the federal funds rate. In Technical Appendix B, we argue that the policy effects when the ELB binds are robust to misspecification of the stochastic shock processes that might cause the ELB to bind. Subsequently, we will thus focus on *differences* in outcomes across reinvestment policies, *conditional* on the federal funds rate being constrained at the ELB. We find that, even conditional on the ELB binding for two or three years in

[10] This low probability estimate compared to some outside estimates reflects in part properties of the baseline projection and of the assumed interest rate rule. For example, the December SEP baseline features a more gradual increase in the federal funds rate. Stochastic simulations around that baseline would naturally show a greater incidence of ELB events and a lower probability of having ceased reinvestment by any given quarter. Moreover, the Committee's historical reaction to recessions is more vigorous than the inertial rule would prescribe. Accordingly, the combination of the proximity to the ELB embedded in the SEP baseline and a non-inertial reaction to recessions might well imply a substantially larger probability of being constrained by the ELB. Even so, the differences between the macroeconomic implications of the three reinvestment strategies would remain small.

expectation, the differences in macroeconomic outcomes across the reinvestments policies considered in the memo are modest. As a result, even if our simulations featured more frequent ELB events, our estimates of the most likely outcomes would not be much more favorable than we report in the memo.

To illustrate the improvement in outcomes that state-contingent policies can achieve relative to the fixed-date policy, we display in Figure 3 distributions of differences in outcomes for the subset of simulations that are associated with a return of the federal funds rate to the ELB under the fixed-date policy in the given quarter. As can be seen in the upper-right panel, the additional stimulus provided by the state-contingent reinvestment policies is not large enough to avoid reaching the ELB in the median case. In 2018, in at least 75 percent of the scenarios, the balance sheet is more than $500 billion larger under the state-contingent policies than under the fixed-date policy. The distribution of differences in balance sheet size moves to much higher values in 2019 and 2020, as the balance sheet normalizes rapidly in the Tealbook forecast and therefore under the fixed-date policy. Over the three-year period starting in 2018:Q1, the median balance sheet size difference reaches $1.5 trillion.

In the ELB scenarios, the larger balance sheet is not immediately offset by a higher federal funds rate. Thus, the term premium effects translate into larger declines in the nominal 10-year Treasury yield in 2018 and 2019. These observations can be seen in the top four panels of Figure 3. Under the 2½ policy, the relation between the distribution of term premium effects and the distribution of 10-year Treasury yields is less tight, as the stimulus provided by that policy is sufficient to keep the federal funds rate above the ELB in a subset of these cases, permitting immediate offset through a higher federal funds rate. Nevertheless, in the median scenario, the nominal 10-year Treasury yield in these cases is more than 20 to 30 basis points lower under the state-contingent policies, compared to fixed-date policy.[11]

[11] We note that, as shown in Table A in Technical Appendix A, a subset of ELB events that occurs under the fixed-date policy are avoidable under the state-contingent policies, with the probability of a binding ELB in the final quarter of 2018 falling from 4½ percent under the fixed-date policy to around 3¾ under the 1½ percent policy and to 3½ percent under the 2½ percent policy. Indeed, for the 2½ percent policy, the share of the avoidable ELB events exceeds 25 percent, as is illustrated by the upper boundary of the interquartile range in 2018 and 2019.

Even in these cases, the differences in macroeconomic outcomes are modest. The largest median differences in the unemployment rate are 12 basis points under the 1½ policy and 18 basis points under the 2½ policy. Inflation outcomes are little changed.

III. Some Conclusions

Subject to the aforementioned caveats that necessarily apply to any model-based analysis, the main lessons from these simulations are:

- Over the entire set of simulations, the *median* differences in balance sheet size are up to $525 billion larger under the 1½ percent policy relative to the fixed-date policy ($660 billion under the 2½ percent policy). The difference in the size of the balance sheet implies slightly more downward pressure on term premiums that is partially offset by a slightly higher federal funds rate path than under the fixed-date policy. Under the state-contingent rules, the *median* difference of the macroeconomic outcomes is very small, as less accommodative interest rate policy offsets the effects of running a larger balance sheet.

- For those simulations in which the federal funds rate returns to the ELB, increasing the cessation threshold leads to a median difference in the size of the balance sheet of up to $1.5 trillion over the three-year period starting in 2018. When the federal funds rate is constrained by the ELB, the payoff of a flexible cessation date *does* appear in the real economy: unemployment runs about 10 and 15 basis points lower under the 1½ and 2½ percent policies, respectively, than under the fixed-date policy. The differential effects on inflation outcomes are very small. All told, the upside of delaying the cessation of reinvestment until normalization of the level of the policy rate is considered to be well under way appears to consist only in the provision of some insurance against the recurrence and length of ELB episodes.

Technical Appendices

A. Simulation methodology

As in the "Simple Policy Rules Simulations" of the Monetary Policy Strategies section of Tealbook A, we assume model-consistent expectations for asset prices and wage-and-price setting and VAR-based expectations for the remaining variables in the model. With regard to federal funds rate policy, we model the federal funds rate as following an inertial version of the Taylor (1999) rule, with a modified intercept, as in the staff baseline. We further assume that the intercept of the Taylor rule is exogenous at its January Tealbook baseline values.

The stochastic simulations are obtained by conducting 5,000 runs of the FRB/US model using the estimated historical residuals. More specifically, our procedure involves sampling with replacement from the FRB/US residuals from 1969 to 2015 to proxy for a set of possible macroeconomic shocks to the economy, and then applying those residuals to the baseline paths to generate ranges of possible outcomes. Balance sheet effects on term premiums are obtained via the standard balance sheet model, taking as inputs the realized paths of relevant economic conditioning variables. We impose the $500 billion long-run reserve balance scenario incorporated in the January Tealbook.

To approximate the effect of a reinvestment cessation policy that is contingent on the federal funds rate, we calculate term premium effects under the assumption of a fixed reinvestment end date in the fourth quarter of each year from 2017 to 2021. We then collect the scenarios in which the federal funds rate does not attain the posited threshold under the assumption that reinvestment ceases at the end of 2017. We replace these scenarios with scenarios that are similar except that the assumed cessation date is 2018. We iterate this procedure through 2021. In this way, we construct an alternative data set such that scenarios in which macroeconomic shocks are adverse—in the sense that the resulting federal funds rate is low—are assigned more permissive cessation dates.

Table A: Probability of the ELB binding in the final quarter of the year (percent)

	fixed-date	1½ percent policy	2½ percent policy
2017	4.1	3.8	3.7
2018	4.4	3.7	3.6
2019	3.5	2.9	2.7
2020	3.4	2.9	2.6

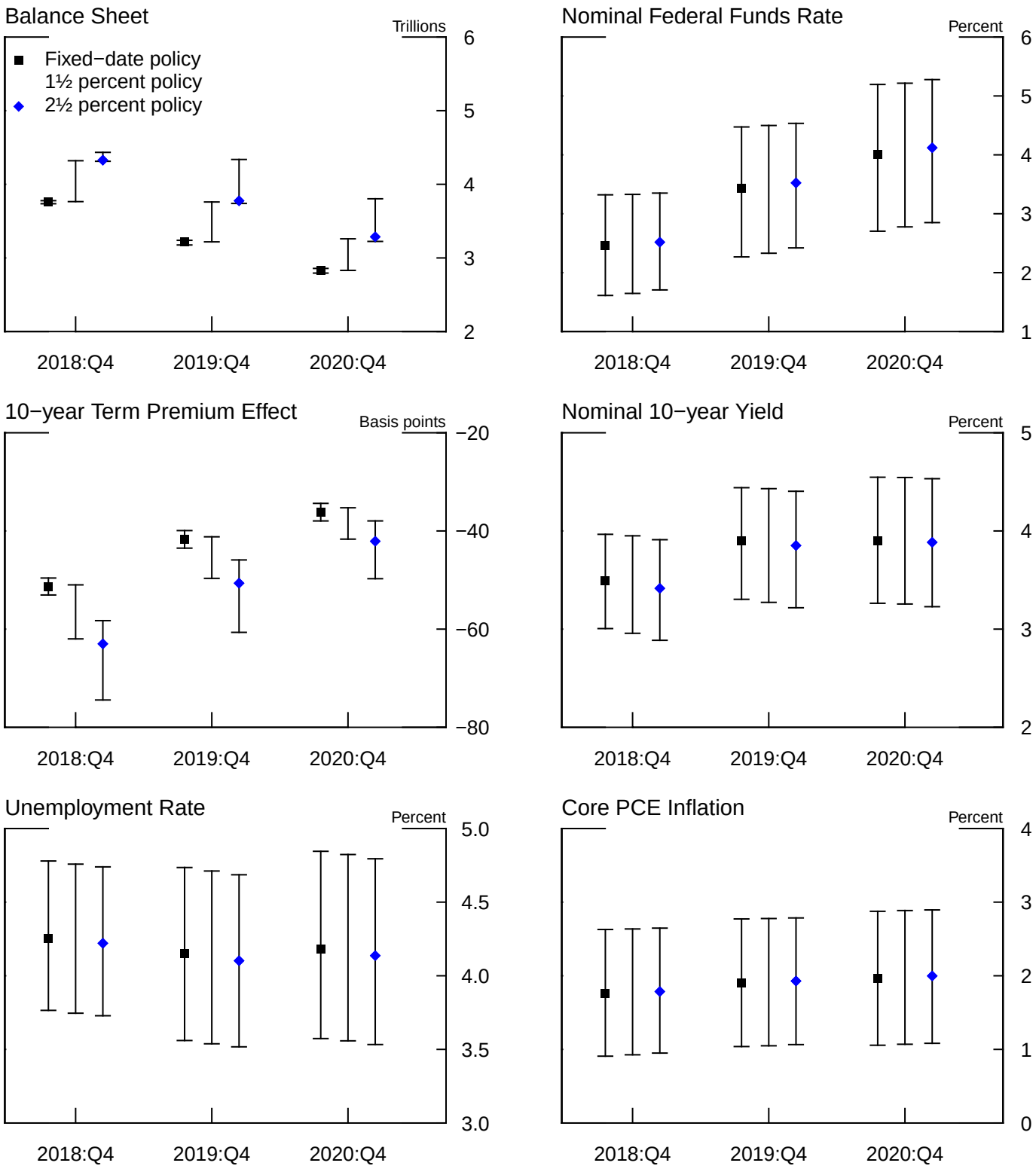
Note: Simulations are centered around the January 2017 Tealbook forecast, with the response of the federal funds rate to shocks being governed by the inertial Taylor rule.

B. Robustness of reinvestment policy effects under misspecification of the distribution of shocks

As noted in the text, we argue that the impact of a binding ELB on differences in outcomes between alternative reinvestment policy rules is robust to misspecification of the stochastic shocks that result in the ELB binding. Because we solve the model under perfect foresight at every date, the difference in outcomes in simulations when the ELB is imposed, relative to those in which the ELB is not enforced, is entirely characterized by the degree to which the ELB results in deviations of the federal funds rate from the rule governing its unconstrained behavior. Formally, this degree is measured by the residuals in an equation linking the federal funds rate to the prescriptions of its reaction function, given the expected path of its arguments. With current staff estimates of the output gap, these residuals reached their widest level in 2009:Q3, at -0.66 percent. In our simulations, a reaction function residual of this size would be well within the interquartile range of the distribution of ELB events. With regard to the path of the federal funds rate itself, in our simulations, the bulk of ELB episodes last for several years, a reasonable duration for recessionary episodes that do not reach the proportions of the financial crisis.

Figure 1

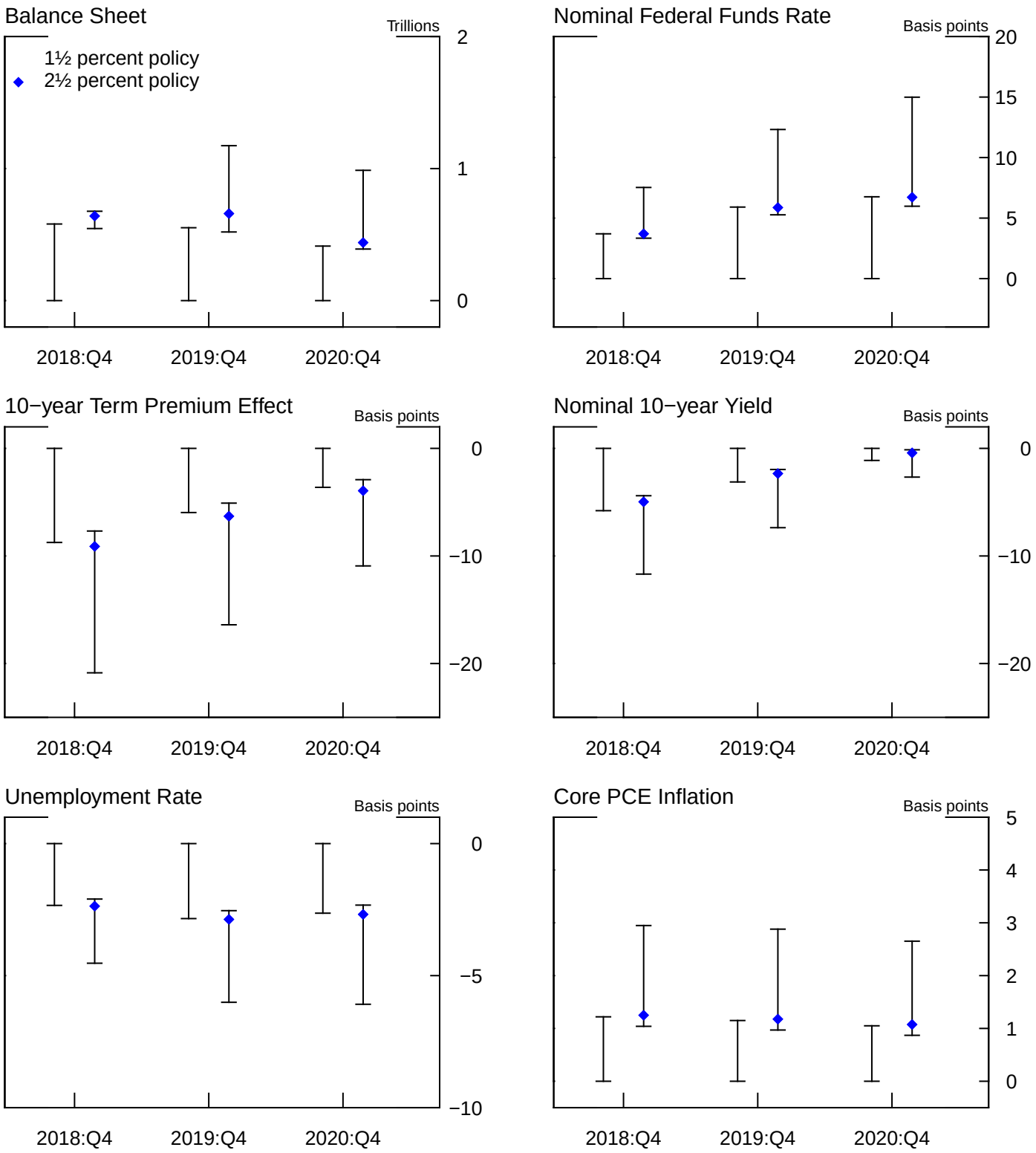
Monetary Policy Mix and Macroeconomic Outcomes



Note: Effects of alternative policies for cessation of reinvestment on the distributions of monetary policy instruments and macroeconomic outcomes under stochastic simulations. The symbols represent the medians and the whiskers represent the interquartile ranges.

Figure 2

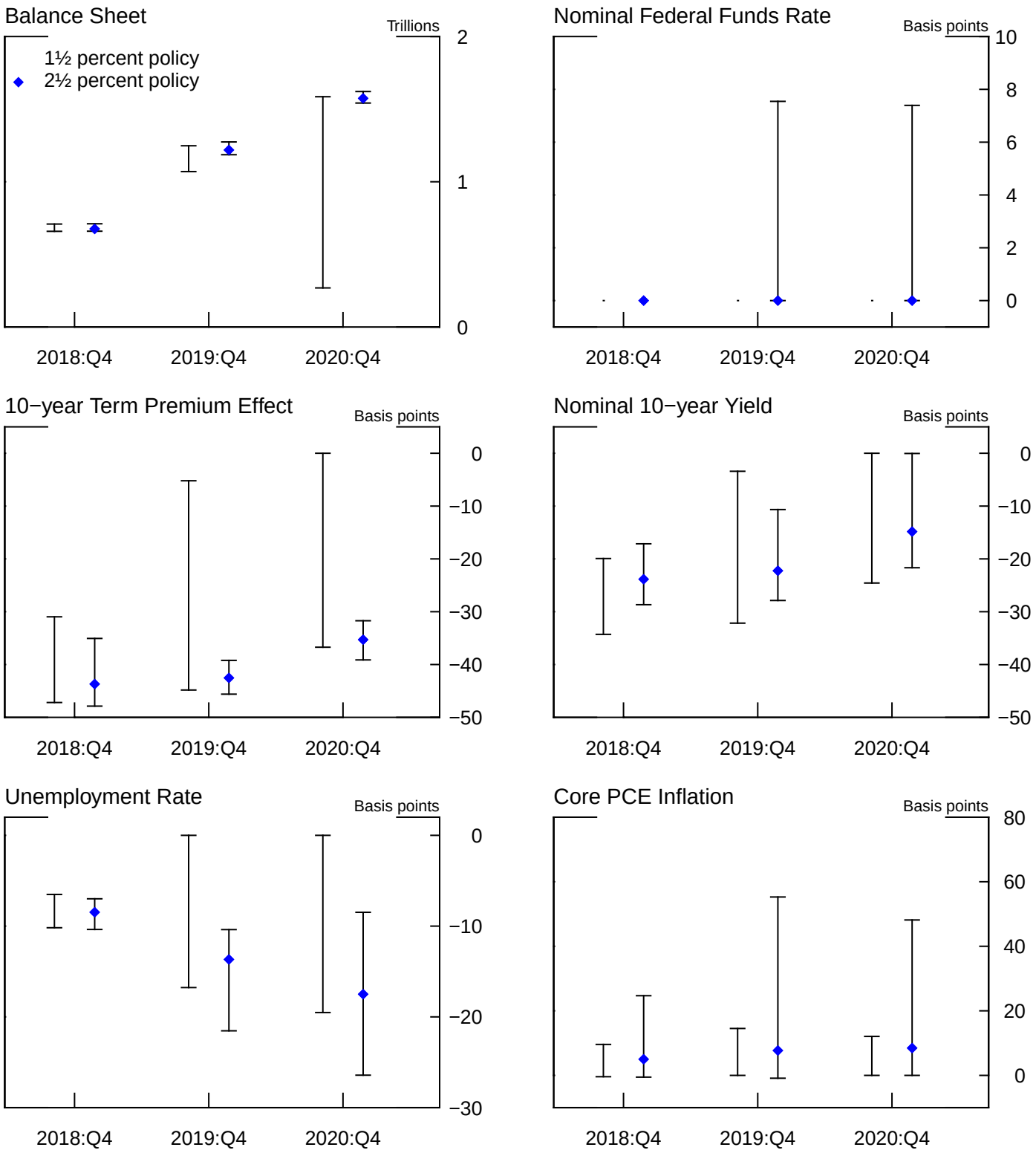
Differences in Monetary Policy Mix and Macroeconomic Outcomes



Note: This figure shows differences in outcomes under the state−contingent reinvestment policies as compared to the fixed−date policy. The symbols represent the medians and the whiskers represent the interquartile ranges.

Figure 3

Differences in Monetary Policy Mix and Macroeconomic Outcomes at the Effective Lower Bound



Note: This figure shows differences in outcomes under the state−contingent reinvestment policies as compared to the fixed−date policy, for the cases in which the effective lower bound binds under the fixed−date policy in the given quarter. The symbols represent the medians and the whiskers represent the interquartile ranges.