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Monetary Policy Strategies for a Low-Rate Environment

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The level of nominal interest rates consistent with a neutral stance for monetary policy appears to be much lower than in the past. In a low-rate environment, the scope for monetary policy to respond to a slowing economy or unwanted disinflation may be constrained by the effective lower bound (ELB) on nominal rates, which (for the case of the United States, examined here) we take to be zero. Kiley and Roberts (2017), using simulation methods similar to those of the present paper, find that, under a policy rule estimated from historical data and the assumption that the neutral nominal interest rate is three percent, monetary policy may be constrained by the ELB as much as one-third of the time. This constraint in turn leads to inferior macroeconomic performance.

To address this issue, economists have made a number of proposals for modifying the Federal Reserve's monetary policy framework. Although details differ, these proposals generally involve policymakers committing in advance to keep rates "lower for longer" (L4L) when the ELB is hit. As Kiley-Roberts and other authors have shown, fully credible L4L policies could substantially ameliorate the ELB problem. In particular, during ELB episodes, such policies should lead to lower bond yields and higher expectations of inflation—both of which reduce long-term real interest rates—as well as to greater optimism about future growth, all of which should encourage spending and economic activity at the ELB.

The assumption of full credibility of the policy framework is probably too strong, however, especially during a period of transition to a new regime. Imperfect credibility poses several problems for L4L policies. First, if public expectations of future inflation and growth do not respond as hoped to central bank announcements, then these policies are likely to be less effective at providing accommodation during ELB periods. Second, if policymakers persist with low-rate policies despite their imperfect credibility, the inflation overshoot that ultimately results could lead to a costly un-anchoring of inflation expectations or other problems, such as a buildup of financial risks (Brainard, 2017).

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Consequently, before adopting L4L policies, policymakers should be confident that they would work reasonably well even if they are not fully credible with the public.

We study this issue using stochastic simulations of FRB/US, the Federal Reserve's principal simulation model. For a suite of alternative policy rules, including some leading L4L rules, and assuming that the normal level of nominal interest rates is three percent, we consider economic performance under two alternative descriptions of expectations formation. First, we consider "model-consistent expectations" (MCE), under which all private agents are assumed to know the structure of the economy, and, in particular, to understand and believe the monetary policy rule. The MCE assumption, used by Kiley-Roberts (2017), seems appropriate for situations in which a policy regime has been in place for some time.[1]

Second, alternatively, we consider the case in which only asset-market participants have model-consistent expectations (MCAP). Under MCAP, bond yields, equity prices, and the exchange rate are determined in a forward-looking manner, but expectations of income, inflation, and other nonfinancial variables are based on forecasts of a small-scale VAR model and, importantly, are assumed not to change when the policy rule changes. Arguably, MCAP better describes the situation during a transition to a new policy rule, about which financial market participants may have stronger incentives to be well informed than other agents.[2] Under each of these assumptions, we assess the effects of alternative policy regimes on macroeconomic outcomes and on the frequency of encounters with the ELB.

Briefly, we find that imperfect credibility reduces—but does not eliminate—the advantages of L4L rules. In general, the L4L rules that perform best strike a balance, providing adequate stimulus at the ELB while avoiding sizable overshoots of inflation and output.

I. Description of Simulations

As noted, our analysis is based on stochastic simulations of the Fed's FRB/US model, a detailed econometric model of the U.S. economy. For each policy rule and for each of the two alternative assumptions about expectations formation, we conducted 500 simulations of FRB/US, drawing shocks from those realized over the period 1970-2015 (i.e.,

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[1] Hebden and Lopez-Salido (2018) also consider a suite of L4L policy approaches under MCE in a small model, including versions of the temporary price-level targeting approaches we analyze, and reach broadly similar conclusions to those herein.

[2] See Reifschneider and Roberts (2006) and Brayton, Laubach, and Reifschneider (2014) for further discussion both of FRB/US and of these expectational assumptions.

bootstrapping residuals of the model). Each simulation is of 200 quarters. Results reported below are drawn from the second 100 quarters of each simulation, with the first 100 quarters used as a "burn in" period to establish initial conditions. All simulations assume a neutral nominal interest rate of three percent and an inflation target of two percent.

To gain further insight, for each policy rule and expectational assumption, we also simulated the economic and policy response to a large shock to consumption, sufficient to drive the economy to the ELB. Those results are discussed briefly below, with more details in the online appendix.

II. Policy Rules

We evaluated the performance of ten alternative policy rules, broken into four broad categories: baseline rules and three variants of L4L rules. For algebraic details and additional references, see the online appendix. The rules we studied are listed in Tables 1 and 2 below. All rules impose a non-negativity constraint (the ELB) on the implied policy rate.

For a baseline, we considered two variants of the standard Taylor rule, which relates the policy interest rate to deviations of inflation from target (the "inflation gap") and the output gap. The two variants are a so-called (1) balanced-approach Taylor rule (Taylor, 1999) and an (2) "inertial" Taylor rule that includes a lagged interest-rate term, with a coefficient of 0.85 in quarterly data. The inertial term implies slower adjustment of policy to economic developments.

The first group of L4L rules we considered includes three variants of flexible price-level targeting (PLT). The PLT framework has L4L features that theoretical analyses (e.g., Eggertsson and Woodford, 2003) suggest could help address the ELB constraint. These rules are "flexible" in that they take into account output gaps and inflation gaps as well as the deviation of the price level from trend (the "price level gap"). The three such rules we consider are: (1) a basic variant that augments the standard, non-inertial Taylor rule with the price-level gap; (2) an inertial version of the rule, which adds a lagged interest-rate term; and (3) a non-inertial variant in which the price level gap accumulates only during ELB episodes and is zero otherwise (analogous to temporary PLT; see below). In each of these variants, the price-level gap enters with the same (unit) weight as the output gap, so that these rules can also be interpreted as responding to nominal income gaps.

The second group of L4L strategies we studied are rules that set an economic threshold (here, defined in terms of inflation performance) as a necessary condition for leaving the ELB. The Fed's Federal Open Market Committee adopted a threshold approach in December 2012. As they tie policy actions directly to observable economic outcomes, threshold strategies may be relatively easy to communicate.

The first threshold-type policy we considered was temporary price-level targeting. As discussed by Bernanke (2017), under this rule, policymakers commit to deferring exit from the ELB at least until any shortfall in inflation over the entire ELB period is fully made up. Away from the ELB, this rule is the same as the inertial Taylor rule.

A potential drawback of temporary PLT is that, when the ELB episode is long and the associated inflation shortfall is large, it could imply a substantial overshoot of inflation after the ELB period ends. To mitigate that effect, we also considered variants of temporary PLT in which policymakers limit their inflation "lookback" periods to three years or to one year, respectively. For example, under temporary PLT with one-year memory, the threshold for liftoff from the ELB is that inflation over the previous year has been at or above target.

Finally, for our third group of L4L policies, we consider two variants of so-called shadow-rate policies. Policies of this type define a notional policy rate that may be negative—the shadow rate—and that reflects the policy accommodation forgone because of the ELB. The actual policy rate is then set to compensate for the forgone accommodation. Specifically, we consider a policy proposed by Reifschneider and Williams (2000), in which the policy rate prescribed by the Taylor rule is reduced by cumulative forgone accumulation, until the latter is exhausted. We also consider a shadow-rate rule described in Kiley-Roberts (20017), in which the *first difference* of the shadow rate depends on the sum of the inflation gap and the output gap, weighted by a parameter α. The actual policy rate is set equal to the shadow rate when it is non-negative and is zero otherwise. Following Reifschneider and Roberts (2006), we set $\alpha = 0.4$.

III. Simulation Results

Results of the stochastic simulations are reported in Tables 1 and 2. Table 1 provides results for the case of model-consistent expectations on the part of all private agents (MCE), while Table 2 results reflect the assumption that only asset-market participants have model-consistent expectations (MCAP).

[Insert Tables 1 and 2 about here]

For each rule and expectational assumption, the tables report: (1) the percentage of time spent at the ELB; (2) the mean duration, in quarters, of ELB episodes; (3) the mean output gap; (4) the mean inflation rate; (5) the root mean square deviation (RMSD) of the output gap from its target of zero; (6) the RMSD of inflation from its target of 2.0 percent. These are the same statistics reported by Kiley-Roberts (2017). In addition, the last column of each table reports an overall loss measure, equal to the sum of the squared deviations of inflation and output from their respective targets. Key takeaways from Tables 1 and 2 include the following:

First, as in previous studies, traditional policy rules, such as Taylor rules, perform relatively poorly when the neutral nominal interest rate is low, as assumed here. For example, under both expectational assumptions, both variants of the Taylor rule (lines 1-2 of the tables) exhibit frequent encounters with the ELB, with both output and inflation significantly below target, on average. The inertial variant of the Taylor rule performs worse than the standard, non-inertial rule.

Second, the performance of traditional policy rules is not much improved by the inclusion of the price level gap as a determinant of policy rates (lines 3-5). For example, in terms of the loss function, flexible PLT (lines 3-4) does not do noticeably better than the Taylor rules under MCE. Although output and inflation are closer to target on average under PLT rules, greater macroeconomic volatility offsets this benefit. In particular, the flexible PLT approaches stabilize inflation but worsen output gap volatility, indicating that FRB/US does not share the close connection between price and output stability present in many New Keynesian models (Eggertsson and Woodford, 2003). Flexible PLT also performs very poorly under the MCAP assumption, presumably reflecting the failure of the public's inflation expectations to adjust to the policy regime.

Third, although all three variants of threshold approaches based on the price-stability mandate (lines 6-8) perform reasonably well under both expectational assumptions, the best outcomes are achieved by variants of temporary PLT with shorter inflation lookback periods (shorter "memory"). Notably, temporary PLT with 1-year memory (line 8) delivers significant improvements over traditional rules under both expectational assumptions. One reason may be that variants of temporary PLT with shorter memory are less prone to the risk of a large overshooting of inflation. Interestingly, despite their lower-for-longer motivation, temporary PLT rules with shorter memories also result in less time spent at the ELB and shorter average ELB episodes. For those concerned that long periods of zero rates raise the risk of financial instability or other adverse side effects, this feature is attractive.

Fourth, shadow-rate rules do quite well in our simulations. The Reifschneider-Williams shadow-rate rule (line 9) performs similarly to the temporary PLT approaches with shorter memory. The Kiley-Roberts change rule (line 10) performs very well, which may owe to the sizable long-run policy responses to output and inflation deviations implied by the rule.[3]

Overall, our simulations confirm earlier results that, relative to traditional policy rules, L4L rules can deliver better economic outcomes when the neutral interest rate is low and the ELB is accordingly a concern. As expected, we also find that the advantage of L4L policies relative to traditional policies is generally somewhat less under the MCAP expectational assumption. Importantly, though, a number of L4L policies retain a substantial advantage over traditional rules even when expectations outside the financial sector do not adjust to a change in the policy framework.

IV. An Aggregate Demand Shock

To gain more intuition about the performance of alternative rules, we also used FRB/US to study (for each policy regime and expectational assumption) the responses of policy and the economy to a single large aggregate demand shock. Specifically, we studied the effects of a negative shock to consumer expenditures on nondurables and non-housing services that, under the standard Taylor rule and MCE, leads to a decline in output of nearly 8 percent and an ELB period lasting 20 quarters. Figures in the online appendix show the simulated responses to this shock of the output gap, inflation, the federal funds rate, inflation expectations, and the ten-year Treasury interest rate for each rule and each expectational assumption. Figure 1 below is illustrative: It shows the behavior of inflation during and after the ELB episode, under MCAP and for three policy rules: the inertial Taylor rule, inertial flexible PLT, and temporary PLT with one-year memory.

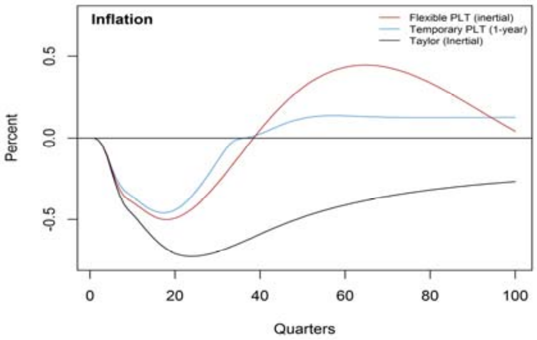

FIGURE 1: EFFECTS OF AGGREGATE DEMAND SHOCK ON INFLATION

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[3] Henderson and McKibbin (1993) are an early example of analyses demonstrating that rules with sizable responses to output and inflation perform well in FRB/US relative to traditional policy rules.

Figure 1 illustrates a general lesson from these simulations, which is that robust policy frameworks share two characteristics: First, they must provide sufficient stimulus at the ELB. Second, on the other hand, they must not involve so much stimulus as to result in excessively large overshoots in output and inflation after the liftoff from the ELB.

Taylor rules do poorly on the first of these criteria, at least for the scenario we consider. Figure 1 illustrates for the MCAP case: As the figure shows, following the hypothesized aggregate demand shock, the inertial Taylor rule provides insufficient stimulus, with inflation remaining below target more or less indefinitely. As figures in the online appendix show, for Taylor rules, the same pattern holds for inflation expectations and nominal interest rates, under MCE as well as MCAP.

In our simulations, L4L rules generally provide more stimulus at the ELB than traditional Taylor rules. Under MCE, most such rules return inflation and output to target quickly. Under the MCAP results show in Figure 1, however, some of these rules also lead to significant overshoots of inflation, the concern raised by Brainard (2017). For the case of flexible PLT with inertia, although inflation returns to target more quickly than under the Taylor rule, inflation ultimately overshoots its target, resulting in volatility in inflation expectations and interest rates (not shown).

In contrast, in our simulations, temporary PLT rules with short memory and shadow-rate rules keep inflation close to target both during and after ELB episodes, under both MCE and MCAP assumptions. Figure 1 illustrates for the case of temporary PLT with 1-year memory, under MCAP. As the figure shows, inflation returns quickly to target but does not overshoot. In general, robust rules will balance the need to provide enough stimulus at the ELB with the imperative of avoiding excessive overshoots, under both forward-looking and backward-looking expectational regimes.

V. Conclusion

Our principal finding is that, when neutral interest rates are low and the ELB is a potential problem, imperfect credibility of the policy regime reduces but does not eliminate the advantages of using “lower-for-longer” policies. However, to deliver good results, such policies should be calibrated to balance the imperatives of providing sufficient stimulus at the ELB and avoiding undesirably large overshoots of inflation and output.

We do not view our results as definitive on the question of which specific type of L4L policy is best, however. That choice depends not only on details such as model specification and parameter values but also on broader questions such as the ease of communicating alternative policies to the public. For example, arguably, threshold-type rules are easier to explain and communicate than shadow-rate rules, an advantage that in practice might outweigh the modest advantage of the latter in our simulations. Likewise, any change in a well-established policy framework has costs, which should be considered in the evaluation of alternative strategies.

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TABLE 1— STOCHASTIC SIMULATION RESULTS UNDER MCE

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation rate	RMSD of output gap	RMSD of inflation rate	Loss
1. Taylor	38.3	10.9	-1.1	1.2	3.5	2.2	17.2
2. Taylor (inertial)	33.6	20.7	-1.4	1.0	3.9	2.4	20.7
3. Flexible price-level target	32.6	8.5	-0.4	2.0	3.6	1.5	15.2
3. Flexible price-level target (inertial)	24.6	13.8	-0.6	2.0	4.4	1.5	21.8
5. Flexible temporary price-level target	17.6	12.9	0.3	2.4	3.4	1.6	14.5
6. Temporary price-level target	16.3	12.5	0.0	2.3	3.1	1.7	12.6
7. Temporary price-level target (3 yr memory)	15.6	11.2	0.3	2.4	2.7	1.6	9.6
8. Temporary price-level target (1 yr memory)	15.1	9.4	0.2	2.3	2.5	1.5	8.5
9. Reifschneider-Williams	28.1	10.1	0.2	2.1	2.4	1.6	8.0
10. Kiley-Roberts change rule	37.0	16.9	-0.1	2.1	1.9	1.4	5.7

Notes: Results based on 500 simulations of 100 quarters each. Loss = $\frac{1}{\mathrm{N}}\frac{1}{K}\,\Sigma_{j=1}^{\mathrm{K}}\Sigma_{t=1}^{\mathrm{N}}[(\pi_{t,j}-\pi^*)^2+\widehat{y_{t,J}}^2]$ for t, j period-simulations.

Source: Authors' calculations.

TABLE 2— STOCHASTIC SIMULATION RESULTS UNDER MCAP

	ELB frequency (percent)	Mean duration of ELB (quarters)	Mean output gap	Mean inflation rate	RMSD of output gap	RMSD of inflation rate	Loss
1. Taylor	39.1	13.3	-1.4	1.6	3.6	1.5	15.2
2. Taylor (inertial)	39.6	30.1	-2.2	1.4	4.9	1.8	27.4
3. Flexible price-level target	36.1	14.1	-0.1	2.0	5.7	1.5	34.3
4. Flexible price-level target (inertial)	44.0	34.2	-2.8	1.0	7.4	2.4	60.3
5. Flexible temporary price-level target	20.8	22.0	1.0	2.3	5.0	1.7	25.0
6. Temporary price-level target	21.7	16.1	0.2	2.2	3.8	1.3	16.1
7. Temporary price-level target (3 yr memory)	8.3	7.8	1.6	2.6	3.8	1.3	16.2
8. Temporary price-level target (1 yr memory)	11.2	8.6	1.0	2.4	3.0	1.2	10.7
9. Reifschneider-Williams	19.4	9.3	0.5	2.3	3.2	1.2	11.4
10. Kiley-Roberts change rule	42.3	21.8	0.0	2.0	2.1	1.0	5.3

Notes: Results based on 500 simulations of 100 quarters each. Loss = $\frac{1}{\mathrm{N}}\frac{1}{K}\,\Sigma_{j=1}^{\mathrm{K}}\Sigma_{t=1}^{\mathrm{N}}[(\pi_{t,j}-\pi^*)^2+\hat{y}_{t,j}^2]$ for t, j period-simulations.

Source: Authors' calculations.