How Asymmetric are the Risks in the Macroeconomic Outlook?[1]

Executive Summary

At least three features of current conditions may create asymmetries in the macroeconomic outlook. First, with the federal funds rate at the zero-lower bound (ZLB), monetary policy's ability to offset adverse demand shocks is limited. Second, policymakers may view risks to the equilibrium real interest rate as skewed to the downside, which could amplify downside risks associated with the ZLB. Both of these features could motivate additional accommodation to "insure" against downside risks. Finally, the possibility that hysteresis-induced scarring in the labor market can be unwound by an "overheated" labor market may suggest pursuit of additional accommodation could be desirable. We examine these issues and reach the following tentative conclusions:

- FRB/US-based stochastic simulations around the Tealbook baseline suggest that, despite the ZLB, risks are not noticeably skewed to the downside for economic activity or inflation. However, a DSGE model sees greater downside risks to economic activity.
- Downside risks are enlarged somewhat when we entertain the possibility that the equilibrium real interest rate could be lower than assumed in the staff projection over the medium term, thus increasing the likelihood of a prolonged episode at the ZLB.
- Overall, these results suggest that the insurance motive, in which additional accommodation is provided to insulate the economy against adverse shocks and an unexpectedly long duration at the ZLB, is not currently large if one's modal outlook and analytical framework are similar to those in the staff's April Tealbook projection.
- If stronger aggregate demand can stimulate improvements in labor supply through a reversal of hysteresis-type effects, a more accommodative monetary policy stance may promote healing in the labor market, pulling discouraged workers back into the labor force and helping unemployed workers find jobs. In this situation, policymakers may find it desirable to "gamble on growth," at least for a time, to explore the importance of such channels. That said, our simulations suggest it will be very difficult to discern if a growth gamble is paying off, as lower unemployment and higher inflation are likely to occur whether or not hysteresis is a factor.
- Other factors outside the scope of our model-based analysis—in particular, concerns related to financial stability and the possibility of unanchoring inflation expectations—may limit the desirability of more accommodative policy, even in those cases where such an approach may improve inflation and employment outcomes.
- Finally, our analysis is focused on outcomes around the Tealbook baseline. In this baseline, unemployment is expected to remain above the natural rate of unemployment and inflation is expected to remain below the Committee's 2 percent objective over the

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[1] Prepared by Oliver de Groot, Etienne Gagnon, and Michael Kiley.

next couple of years. However, the Tealbook baseline is fairly similar to the optimal control paths presented in the Tealbook—implying that, according to the FRB/US model, the Tealbook baseline cannot be improved much through additional accommodation (reflecting the lags between policy actions and activity, and the relatively slow and persistent dynamics of inflation).

The Issues

In the wake of the crisis, it was clear that considerable slack was present in the economy due to unusually high unemployment. As a result, highly accommodative policies were necessary to promote a return to the 2 percent inflation and maximum employment objectives. With the unemployment rate now having fallen below 6½ percent, focus has shifted to the determination of the date and pace at which policy accommodation might be reduced. In making these decisions, policymakers are confronted with the inherent uncertainty surrounding the evolution of the economy going forward, heightened concerns regarding downside risks to the equilibrium real interest rate in coming years (whether due to headwinds or long-run structural factors), and the possibility that protracted economic weakness caused scarring in the labor market that could be remedied through policy accommodation.

The Alternative Scenarios section of the Tealbook considers risks to the baseline, but does not focus on how risk factors may affect choices regarding monetary policy strategy. The Monetary Policy Strategy section of the Tealbook, on the other hand, focuses on implications of alternative simple rules (or optimal control) given the staff's baseline projection, but does not address strategic choices presented by risks to the outlook. We consider the implications of three potential asymmetries affecting the outlook. First, the central bank's limited ability to offset adverse demand shocks or disinflationary forces at the ZLB may create downside risk. Second, ZLB-induced asymmetric risks could be compounded by a persistently lower equilibrium real interest rate.[2] Third, hysteresis in the labor market may imply that more stimulative policies could structurally raise labor supply, albeit potentially at the cost of higher inflation.

In the staff's April projection, nominal short-term interest rates are expected to remain low for several years, and do not return to their longer-run levels until late 2017. With interest rates so low, monetary policy is less able to respond to adverse demand shocks, implying that such shocks may have unusually large negative consequences for economic activity and inflation. This situation may provide a motivation for policymakers to commit to a more accommodative policy stance than would typically be prescribed by estimates of resource utilization. That is, policymakers may wish to "insure" against downside risks to growth and inflation.

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[2] This possibility is highlighted in the April 2014 Tealbook, Book A, in a box titled "Alternative View: A Lower Long-Run Natural Rate of Interest."

Moreover, in the staff's April projection, the unemployment rate was forecast to remain above the natural rate until late 2016 while the labor force participation rate was projected to remain below trend until early 2017. While the staff's baseline natural rate of unemployment and trend labor force participation rate projection incorporate a small effect of the weak labor market in recent years on structural unemployment and participation, staff analyses of policy options typically assume that these effects cannot be reversed through monetary actions that attempt to "overheat" the labor market. If the effects of hysteresis can be reversed with more accommodative policy, policymakers may be motivated to consider a growth gamble. A more accommodative policy could lower the natural rate of unemployment and increase trend labor force participation (and thus increase total employment and output) if the diagnosis of reversible hysteresis is correct. On the other hand, a more accommodative policy will likely spur inflation. Moreover, even if the diagnosis of reversible hysteresis is correct, drawing workers back into the labor force involves higher wages and thus higher inflation, making it difficult to assess in real time if the growth gamble is paying off, and whether policymakers should cut their losses or stay the course in the face of persistently above-target inflation.[3]

A significant portion of past research on the monetary policy implications of uncertainty has concerned itself with the difficulty of measuring slack. The resulting policy prescriptions typically fall into two categories. The first prescription is to treat policymakers' best estimate of slack as if it corresponded to the true measure of slack—that is, effectively *ignoring* any uncertainty attached to this estimate. The second prescription is to *downweight* the role of slack in determining the stance of monetary policy.[4] By contrast, relatively little has been written about the monetary policy implications of asymmetric risks of the kind associated with the ZLB and potential hysteresis effects, which may call for approaches that are tantamount to *raising* the profile of slack in the determination of the policy stance, at least temporarily. Because of this apparent tension with the earlier research literature, we also consider how economic outcomes might differ if policymakers were to choose a policy strategy that downweights the level of slack and instead responds to the change in resource utilization.

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[3] Reifschneider, Wascher, and Wilcox (2013) present simulations in which a growth gamble is better than aiming for a measure of full resource utilization that abstracts from hysteresis effects. Part of our analysis uses their model to analyze the interaction between hysteresis risks and economic outlook, resource utilization, and equilibrium real interest rate uncertainty.

[4] The "ignore uncertainty" (or "certainty equivalence") prescription is formally derived in, for example, Svensson and Woodford (2003). The result rests on four assumptions: a linear-quadratic framework (with linear equilibrium conditions—an assumption clearly violated in the presence of the ZLB—and a quadratic monetary policy loss function), rational expectations, no-model uncertainty, and policymakers doing *optimal* policy. The "downweight the role of slack" prescription is shown in, for example, Orphanides and Williams (2002, 2007) and Ehrmann and Smets (2003). It rests on removing the no model uncertainty assumption above, which has two effects. First, simple rules, robust to model misspecification, are preferable to optimal policy. Second, model uncertainty means estimates of the natural rate of unemployment are no longer efficient because policies that are sensitive to imprecise measures of slack can generate large and persistent policy errors.

Asymmetry in the Staff Projection

Before turning to our model-based analysis of asymmetries (associated with the ZLB, the equilibrium real interest rate, and hysteresis), we examine the staff's model-based and judgmental assessment of asymmetric risks around the staff projection. This examination is important for the issues at hand: When the economy is far away from the ZLB, many of the issues we discuss would not be especially salient; therefore, it is useful to explore how far from "normal" the staff projection lies. In particular, we ask whether the potential for a persistently binding ZLB (and hence potentially limited ability for monetary policymakers to offset adverse demand or disinflationary supply shocks) implies that the risks to unemployment and inflation are tilted to the upside and downside, respectively.

Figure 1 reproduces a set of "fan charts" from the Risks and Uncertainty section of the April Tealbook. The fan charts present uncertainty bands around the staff's baseline projection derived from stochastic simulations of the FRB/US model taking as given that projection.[5] Table 1 reports the corresponding 70 percent confidence intervals through 2018, along with 70 percent confidence intervals through 2015 based on historical Tealbook forecast errors. Figure 1 and table 1 highlight that the FRB/US model and historical forecast errors do not have risks tilted toward above-baseline unemployment and below-baseline inflation. While there is a risk that the ZLB will bind persistently, the implications for unemployment and inflation are not large enough to affect the balance of risks noticeably.[6] This conclusion is consistent with the staff's judgmental assessment of the balance of risks in recent Tealbooks. The staff has viewed the risk around the unemployment and inflation projections as roughly balanced, and the risk to its real GDP growth forecast as tilted a little to the downside (partially reflecting asymmetries associated with the ZLB).

One reason for the apparent lack of asymmetries in the figure and table may be that the ZLB is not sufficiently binding: With the baseline projecting a continued recovery, an unusually severe sequence of adverse demand shocks could be required to make the ZLB bind tightly in the next few years. Nonetheless, there are reasons to believe that asymmetries may be larger than suggested in figure 1. First, the version of the FRB/US model used to generate figure 1 may understate the extent of asymmetry because it does not use forward-looking expectations and so does not feature a large role for expectations of a persistently-binding ZLB. Other models, such

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[5] In forming the Tealbook baseline, the staff assumed that the federal funds rate would first depart from the effective lower bound two quarters after the end of the asset purchase program and then follow the prescriptions of an inertial Taylor (1999) rule specified as $R_t = 0.85R_{t-1} + 0.15(2 + \pi_t + 0.5(\pi_t - \pi^*) + gap_t)$.

[6] Indeed, table 1 shows that the balance of risk for unemployment over the medium term is tilted modestly toward the downside, not the upside. To allay concerns that the absence of asymmetric risk in the April Tealbook is an inherent feature of the FRB/US model, even at the ZLB, it is worth noting that FRB/US stochastic simulations have featured significant asymmetric risk in the past. For example, in the March 2013 Tealbook, the baseline unemployment rate projection in 2017, at 5¼ percent, was well below the center of its 70 percent confidence interval, which ranged from 4 to 7¼ percent.

as dynamic stochastic general equilibrium (DSGE) models, have a larger role for such expectations and may generate greater asymmetries in risks. In addition, the FRB/US simulations do not contemplate the possibility that risks to the equilibrium real interest rate may be skewed to the downside (reflecting structural changes outside the FRB/US model) or that hysteresis-type mechanisms in the labor market imply that structural labor supply can be influenced by policy.

An Exploration of the Effect of the ZLB in a DSGE Model

DSGE models with a larger role for expectations may suggest larger risks than the FRB/US model because the expectation of a binding ZLB has larger effects in these models.[7] Our demonstration uses a medium-scaled DSGE model with financial frictions based on research and policy work at FRBNY.[8] As in the analysis using the FRB/US model, we take as given the staff's baseline projection. We then use stochastic simulations to generate the uncertainty around the staff's projection, drawing sequences of structural shocks to aggregate demand and supply as specified in the model. We assume that policymakers adjust the federal funds rate following the prescription of a simple inertial policy rule that depends on the deviation of inflation from the Committee's 2 percent objective and the perceived output gap. In particular, the rule implies that a 1-percentage-point increase in the perceived output gap (or, equivalently, a ½-percentage-point increase in the unemployment gap) eventually leads to a 1 percentage point increase in the federal funds rate. We also augment the model with noise in the measurement of economic slack perceived by monetary policymakers, which generates additional volatility in inflation and unemployment.[9] We incorporate slack misperception to connect with some of the literature on how mismeasurement in resource utilization should affect the choice of a policy strategy (an issue we discuss in more detail in an appendix).

The left column of figure 2 presents our findings. While the FRB/US model suggested fairly symmetric economic outcomes, there is some moderate downside skew to the output gap

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[7] We explored stochastic simulations in the FRB/US model assuming forward-looking behavior in financial markets (in contrast to the backward-looking expectations used in the Risks and Uncertainty section and in figure 1). This change did not result in asymmetric risks to unemployment (to the upside) or in inflation (to the downside). Partly as a result, and also due to a desire to ensure that the properties of one model do not drive any conclusions we reach, we turned to the analysis using a DSGE model. Chung, Herbst, and Kiley (2014) highlight how the large role of forward-looking behavior in DSGE models implies that the effects of persistently-binding ZLB episodes can greatly amplify the downside risks from certain shocks in these models (depending, in part, on the monetary policy strategy used to mitigate the effects of shocks).

[8] Coenen and Warne (2014) explore the role of the ZLB in generating asymmetry in the European Central Bank's New Area Wide model. The model we consider is part of the Federal Reserve's DSGE project. Its features and estimation are described in Del Negro, Giannoni, and Schorfheide (2014). Our simulations omit shocks to the inflation target to focus on uncertainty regarding resource utilization. Because the model's labor input is specified solely in terms of hours worked, we cannot directly simulate an uncertain natural rate of unemployment. Instead, we translate unemployment rate gap uncertainty into output gap uncertainty using an Okun's law in gap form with a coefficient of -2.

[9] We assume that uncertainty regarding the natural rate of unemployment (which in turn implies uncertainty about the unemployment gap and the output gap) extends back to 2011.

in these DGSE simulations: The mean output gap (shown in the middle-left panel with a dash-dot blue line) in 2015 is ¾ percent below the April Tealbook baseline (the dashed black line); in unemployment space, the percentage point difference amounts to about half as much, a modest amount. Inflation outcomes (shown in the bottom-left panel) show no noticeable asymmetries, largely reflecting the flatness of the Phillips curve. Indeed, the relatively flat Phillips curve in this model may be one reason for the overall modest degree of asymmetry in outcomes for the output gap, as severe deflationary outcomes appear unlikely in this model; some other DSGE models may be more susceptible to such deflationary outcomes, the lack of deflation since the Great Recession may be difficult to rationalize in such models.

The asymmetry in risks to resource utilization from the DSGE model arises despite the fact that policymakers are understood to follow a policy rule with a large response to resource utilization. Indeed, the asymmetry would be more pronounced if policymakers chose to downweight slack significantly. For example, the right column of figure 2 reports simulation results under the assumption that policymakers adjust the federal funds rate in response to the *change* in output rather than the level of output gap; we keep other parameters of the policy rule unchanged and assume that financial markets, households, and firms understand the policy strategy and view it as fully credible. The conditioning of policy on the change in resource utilization implies that, all else equal, the federal funds rate rises as soon as output grows at a rate above potential, even if resource utilization is depressed. Consequently, the output gap ignoring risks (that is, the solid black line labelled "simulation baseline" in the middle-right panel) is more negative in 2014 and 2015 than under the Tealbook baseline (the dashed black line). Moreover, the range of outcomes broadens considerably under the change rule, as can be seen from the tripling of the width of 70-percent confidence interval around the output gap from 2015 onward.

Overall, our DSGE results suggest that the presence of the ZLB can create moderate asymmetries in macroeconomic outcomes. Moreover, the simulations indicate that a strategy in which policy is adjusted in response to the change in the unemployment rate—perhaps on the view that uncertainty regarding the level of slack is now considerable—could have adverse consequences in the current context. This result is notable because a number of papers in the literature have recommended rules that respond to the change in activity measures when policymakers are uncertain about resource utilization.[10]

The Effect of a Lower Equilibrium Real Interest Rate

The confidence intervals around the Tealbook projection in the FRB/US model (reported in figure 1 and table 1) and in the DSGE model (shown in figure 2) are consistent with negligible and moderate asymmetries in risks, respectively. As such, they support the notion that more accommodative policies are needed to insure against downside risks only to the extent that policymakers place significant weight on the powerful role of expectations in the DSGE model.

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[10] See Orphanides and Williams (2002, 2007) and Ehrmann and Smets (2003).

The absence of more pronounced asymmetry in macroeconomic outcomes is due to the fact that ZLB episodes are neither sufficiently long nor sufficiently severe in most simulated paths to appreciably prevent longer-term real rates from falling in order to support activity. However, the Tealbook analysis and our above simulations may underestimate the likelihood that the ZLB will bind for an extended period by abstracting from the possibility that the equilibrium real interest rate could be lower than assumed in the staff projection over the next several years.[11] Similarly, the possibility that inflation could fail to return to the Committee's longer-run objective—if, for example, the recent weakness in core inflation readings became entrenched in longer-term inflation expectations—could also increase the risk of the ZLB constraining monetary policy in the future and therefore motivate more accommodative policies.[12]

We explore such risks by assuming that the staff projection is overly optimistic about the strength of aggregate demand for a given path of interest rates over the next 5 years. We posit that the equilibrium real interest rate will rise to only 1 percent later this decade, 1 percentage point less than assumed in the April Tealbook (while maintaining the assumption that the equilibrium real interest rate will return to 2 percent in the very long run). We then repeat the stochastic simulations using the FRB/US and DSGE models around this alternative baseline.

Figures 3 and 4 present the results for the DSGE model and FRB/US, respectively.[13] In each figure, the left column shows the simulations when policymakers fail to realize that the equilibrium real interest rate is lower than they had expected, with monetary policy being set according to an inertial policy rule consistent with an equilibrium real interest rate of 2 percent. Two results are common across the DSGE and FRB/US simulations: First, the output gap (unemployment) is persistently more negative (higher) and inflation is slower to return to 2 percent than in the staff's baseline projection. Second, there is only marginally more asymmetry in macroeconomic outcomes around these alternative paths despite a substantially lower federal funds rate path and a more persistently binding ZLB. In the DSGE model, as the middle-left panel of figure 3 shows, the difference between the deterministic and mean output gap in 2015 is 1 percentage point, ¼ percentage point greater than the skew around the Tealbook baseline shown in the middle-left panel of figure 2. The additional skew is even smaller for the FRB/US simulations in figure 4. These results imply that a lower equilibrium real interest rate over the next five years does not, in itself, generate significantly larger asymmetric risks—although it does present an important risk to the achievement of the Committee's objectives.

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[11] In March, the Committee introduced language in its statement alluding to such a possibility, saying that "even after employment and inflation are near mandate-consistent levels, economic conditions may, for some time, warrant keeping the target federal funds rate below levels the Committee views as normal in the longer run."

[12] For the June Tealbook, the staff will revise down the equilibrium real interest rate in the very long-run by ¼ percent, reflecting a downward revision to potential growth. In addition, Deb Lindner will be providing a memo to the FOMC describing the factors that might explain the persistently low level of inflation.

[13] In these simulations, we abstract from the natural rate of unemployment uncertainty that we incorporated in the figure 2 simulations.

Because these simulations show only moderate additional asymmetry, it is difficult to find strong support in these simulations for more accommodative policy based solely on the configuration of risk. However, the poor results for inflation and unemployment clearly call for an alternative policy strategy. One policy strategy that has been shown to mitigate the effects of equilibrium real interest rate uncertainty is to use a rule in which the *change* in the federal funds rate is related to the deviation of inflation from target and the unemployment gap. Under this strategy, the federal funds rate is held at zero until either inflation rises above 2 percent or unemployment falls below its natural rate. In this case, and under the assumption that the private sector is able to understand the policy strategy and assess the underlying strength of demand, the output gap closes (and the unemployment rate falls) faster and inflation returns to 2 percent (or somewhat above) more quickly because the private sector anticipates the effects of a lower equilibrium real interest rate on the federal funds rate path. In the DSGE simulations, the risks for the output gap are more centered on zero, although the size of the downside skew is larger in absolute terms. In FRB/US, this policy approach results in less downside skew.

Some Implications of Hysteresis

The possibility of labor market hysteresis presents different policy challenges. Hysteresis is a process in which persistent weakness in the labor market contributes a loss of skills or connections to the labor market for many potential workers, reducing the amount of employment consistent with a given rate of inflation.[14] In the presence of hysteresis, stronger aggregate demand may undo some of the damage to the labor supply by putting long-term unemployed and discouraged workers back to work. However, the transition to such a higher level of potential labor supply, during which economic activity may be pushed beyond its short-term potential, would likely involve a higher level of inflation.

It is difficult to gauge the extent to which hysteresis-type mechanisms may have been at work in recent years, but a number of developments point toward such mechanisms being economically important. For example, the corrosive effect of a persistently weak labor market may have led some discouraged workers to reduce their job search intensity or precipitated their exit from the labor force.[15] The staff's baseline forecast accounts for the presence of hysteresis effects by assuming that the natural rate of unemployment is currently about ¼ percentage point

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[14] An alternative view box in the January Tealbook highlighted the possibility that slack may be essentially zero at current levels of unemployment (although the box did not explore the role of hysteresis).

[15] Erceg and Levin (2013) show using a New-Keynesian model with home production how labor market slack can cause labor force participation to decline. The recent FEDS Note "Using Cross-State Variation to Assess the Potential for Additional Improvement in Measures of Labor Market Conditions" by Christopher Smith finds that workers who are out of the labor force but consider themselves marginally attached re-enter as labor market conditions improve. That said, part of the decline in labor force participation reflects structural factors such as demographics (Fujita, 2013). See also Blanchflower and Posen (2014) and the recent FEDS Note "Why is Involuntary Part-Time Work Elevated" (by Tomaz Cajner, Dennis Mawhirter, Christopher Nekarda and David Ratner).

higher than its longer-run value and that some of the projected declines in labor force participation due to demographic factors were hastened by the slump.

To the extent that the dis-association of the long-term unemployed and discouraged workers from the margin of slack relevant for wage pressure reflects continued weakness in activity, a stronger labor market could offset this damage over time. This possibility is not directly considered in the simulations reported in the Monetary Strategies section of the Tealbook because hysteresis effects are imposed exogenously on top of the FRB/US model. To explore this possibility, we expand the FRB/US model to make the extent of hysteresis effects an increasing function of labor market slack.[16] We assume that changes in the amount of employment consistent with a given rate of inflation are persistent, but that potential labor supply ultimately returns to the Tealbook baseline.[17] We then consider a monetary policy strategy targeted at lowering the unemployment rate to 4½ percent that could also lower the natural rate of unemployment, for a time, from 5¼ percent (the staff assumption over the next several years) to just below 5 percent and could marginally raise the trend labor-force participation rate. Conversely, we consider a policymaker that places low odds on the possibility of hysteresis, instead suspecting a significant degree of labor market damage; as a result, monetary policy strategy is predicated on a natural rate of unemployment of 6 percent.[18] Note that these two assumptions for the rate of unemployment pursued by policymakers are ¾ percentage point below and above, respectively, the staff Tealbook assumption for the longer-run natural rate.

Figure 5 presents outcomes under these two alternative policy strategies. Under the first strategy (reported in column A), unemployment falls a bit more rapidly and inflation approaches 2¼ percent under the modal outcome; this "high-pressure" economy lifts (household) employment by 1½ million relative to the Tealbook projection by 2018. Under the second strategy (reported in column B), monetary policy is tighter due to the perception of a smaller gap; inflation converges somewhat more slowly to 2 percent—reflecting tighter monetary policy—but nonetheless rises above the Tealbook projection by early next decade, as tighter monetary policy creates labor market damage and a higher natural rate of unemployment.

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[16] Because the hysteresis story involves a set of labor market factors absent from the simple DSGE model we have used, we focus here exclusively on simulations using the FRB/US model.

[17] In broad terms, we follow the approach in the December 2013 Tealbook and in Reifschneider, Wascher, and Wilcox (2013). However, these investigations primarily focus on the damage caused by high unemployment. We also assume that unemployment below the natural rate can improve labor market functioning. This effect is modest in size, however, because unemployment typically falls no more than 1 percentage point below the natural rate (in our simulations, or in the data), and hence the beneficial potential effects on labor market functioning pale in comparison to the adverse effects of a shock such as the Great Recession, when unemployment rose 4 percentage points (or more) above the natural rate.

[18] If the natural rate were perceived to be 6 percent, the interest rate rule would imply tightening immediately. We assume policymakers do not return to the interest rate rule until the unemployment rate falls below 6 percent, consistent with the notion from recent policy communications that short-term interest rates are unlikely to rise until next year.

Moreover, employment is 1½ million below the Tealbook baseline (essentially the opposite difference of the more stimulative strategy).

Some policymakers may find the first "growth gamble" strategy attractive, depending on how they weigh the additional inflation against the potential for higher employment. Importantly, the quantitative magnitudes are somewhat speculative, as it is difficult to calibrate hysteresis effects from historical data; indeed, we have assumed that both the natural rate of unemployment and the participation rate would converge to the same respective values under either strategy, on the idea that hysteresis-type damage to the labor market may be persistent but not permanent. Overall, the decision to pursue a lower level of the natural rate of unemployment involves carefully balancing the potential to persistently achieve higher employment against the costs of possibly higher inflation over the transition to a lower natural rate.

The pursuit of a "growth gamble" would also risk exacerbating inflation if the anticipated lowering of the natural rate of unemployment failed to materialize. In figure 5, column C, we consider a policymaker acting under the presumption that the decline in the natural rate can be hastened and the labor force participation boosted structurally (as in the growth gamble strategy we outlined in column A of figure 5) when, in fact, these developments are independent of monetary policy actions. In this context, monetary stimulus helps lower unemployment. However, overheating eventually raises inflation more notably above the Committee's 2 percent goal, to a modal level near 2½ percent.

We stress that the nature of hysteresis and the wide confidence bands around our FRB/US simulations make the task of using macroeconomic outcomes to infer whether hysteresis effects are present or not highly challenging. Because promotion of labor-market healing through stimulative policy (if even possible) requires an "overheated" labor market, inflation tends to rise when policymakers purse the growth gamble whether or not hysteresis effects are indeed present. Moreover, the confidence intervals suggest a wide range of outcomes are plausible. Combining these forces implies that policymakers will find it difficult to discern if a growth gamble is paying off or simply sowing the seeds of a persistent inflation problem.

The notion that more accommodative policies may be desirable to pull in displaced workers, while generating inflationary pressures, is motivated by the notion that a stronger labor market could reverse scarring through hysteresis-type channels. A somewhat different motivation with similar implications is the idea that the long-term unemployed are less relevant than short-term unemployed in gauging the amount slack important for inflationary pressures, but of equal concern from the employment side of the dual mandate.[19] T Under current

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[19] Gordon (2013), Krueger *et al.* (2014), and Rudebusch and Williams (2014) suggest, using macroeconomic data, that short-term unemployment is a better gauge of slack and more important for inflation dynamics than total unemployment. Kiley (2014) suggests some of the approaches taken in these papers have poor econometric properties and, using regional evidence, shows little differential effect of short- and long-term unemployment on

conditions, with the share of long-term unemployed at historically high levels, this may alter policymakers' inflation-activity trade-off. While the (total) unemployment gap, relevant for the full-employment part of the dual mandate may be large, the short-term unemployment gap, relevant for the inflation part of the dual mandate may be small, thus creating a tension for monetary policy. In this case, a balancing of the price stability and employment sides of the dual mandate may suggest that policy should tolerate higher inflation in order to achieve lower unemployment (relative to a case in which unemployment consisted mostly of short-term unemployed).[20]

Conclusions and Caveats

We have examined whether the ZLB and the possibility of hysteresis in the labor market might motivate more accommodative policy than would typically be appropriate given expectations for inflation and economic activity. Overall, our findings suggest little motivation for pursuing more growth if one accepts the staff's April Tealbook projection, but somewhat greater motivation if policymakers doubt the baseline forecast (in particular if they believe the equilibrium real interest rate will be slow to rise) or, perhaps, if they doubt the staff model of the economy (in the sense that they believe that hysteresis in the labor market implies that stimulative policy can substantially boost labor supply). In neither case does the motivation for aiming for higher growth reflect asymmetries linked to the zero lower bound conditional on the Tealbook baseline.

While our analysis discusses these two risks, there are other significant risks that require further careful consideration. We note two such issues:

- **Economic imbalances and financial stability:** More accommodative policies may, for example, lead to an overheating in interest-sensitive sectors—such as housing—despite unemployment above its natural rate or, perhaps more importantly, financial stability risks. Such factors may suggest caution when considering more accommodation.

- **Inflation expectations becoming unanchored:** The two models we have considered both feature a very flat Philips curve and relatively well-anchored private sector inflation expectations. In this regard, policy in these models is able to close the output gap (or potentially overheat the economy) without triggering a strong above-target inflation response. Policymakers may regard the slope of the Phillips curve and the lags in the transmission of monetary policy as uncertain, and may be concerned that more aggressive

inflation. The memo "Assessing the Downward Pressure on Prices and Wage Inflation: Does the Distinction between Long-Term versus Short-Term Unemployment Matter?" (by Katia Peneva and distributed to the FOMC on March 11, 2014) and the recent FEDS Note "The Effect of Labor Slack on Wages: Evidence from State-Level Relationships" (by Christopher Smith) reach a similar conclusion.

[20] Rudebusch and Williams (2014) present and estimate a model with these features and discuss policy implications of these mechanisms.

accommodation may bring about a much larger inflationary episode than these models view as likely.

References

Brainard, William C., 1967. "Uncertainty and the Effectiveness of Policy." *American Economic Review*, vol. 57, pages 411–25.

Blanchflower, David G. and Adam S. Posen, 2014. "Wages and Labor Market Slack: Making the Dual Mandate Operational." PIIE Policy Brief 14-10.

Chung, Hess, Edward P. Herbst, and Michael Kiley, 2014. "Effective Monetary Policy Strategies in New-Keynesian Models: A Re-Examination," NBER Chapters, in: NBER Macroeconomics Annual 2014, vol. 29.

Coenen, Günter and Anders Warne, 2013. "Risks to Price Stability, the Zero Lower Bound and Forward Guidance: A Real-Time Assessment," ECB Working Paper No. 1582.

Del Negro, Marco, Marc P. Giannoni, and Frank Schorfheide, 2014. "Inflation in the Great Recession and the New Keynesian Models", FRBNY Staff Report No. 618.

Erceg, Christopher J. and Andrew Levin, 2013. "Labor Force Participation and Monetary Policy in the Wake of the Great Recession," IMF Working Papers 13/245.

Ehrmann, Michael and Frank Smets, 2003. "Uncertain potential output: implications for monetary policy," *Journal of Economic Dynamics and Control*, vol. 27(9), pages 1611–1638.

Fujita, Shigeru, 2012. "Declining labor turnover and turbulence," Working Papers 11–44, Federal Reserve Bank of Philadelphia.

Gordon, Robert J., 2013. "The Phillips Curve is Alive and Well: Inflation and the NAIRU During the Slow Recovery." NBER Working Paper No. 19390.

Kiley, Michael T., 2014. "An Evaluation of the Inflationary Pressure Associated with Short- and Long-term Unemployment," Finance and Economics Discussion Series 2014–28, Board of Governors of the Federal Reserve System.

Krueger, Alan, Todd Cramer, and David Cho, 2014. "Are the Long-term Unemployed on the Margins of the Labor Market?" Papered prepared for the Brookings Panel on Economic Activity, March 20–21.

Orphanides, Athanasios, 2001. "Monetary Policy Rules Based on Real-Time Data," *American Economic Review*, vol. 91(4), pages 964–985.

Orphanides, Athanasios, Richard D. Porter, David Reifschneider, Robert Tetlow, and Frederico Finan, 2000. "Errors in the measurement of the output gap and the design of monetary policy," *Journal of Economics and Business*, vol. 52(1-2), pages 117–141.

Orphanides, Athanasios and David W. Wilcox, 2002. "The Opportunistic Approach to Disinflation," *International Finance*, vol. 5(1), pages 47–71.

Orphanides, Athanasios and John C. Williams, 2002. "Robust Monetary Policy Rules with Unknown Natural Rates," *Brookings Papers on Economic Activity*, vol. 33(2), pages 63–146.

Orphanides, Athanasios and John C. Williams, 2007. "Inflation targeting under imperfect knowledge," *Economic Review*, Federal Reserve Bank of San Francisco, pages 1–23.

Reifschneider, Dave, William Wascher, and David Wilcox, 2013. "Aggregate supply in the United States: recent developments and implications for the conduct of monetary policy," Finance and Economics Discussion Series 2013-77, Board of Governors of the Federal Reserve System.

Rotemberg, Julio and Michael Woodford, 1997. "An Optimization-Based Econometric Framework for the Evaluation of Monetary Policy," NBER Chapters, in: *NBER Macroeconomics Annual 1997*, vol. 12, pages 297–361.

Svensson, Lars E. O. and Michael Woodford, 2003. "Optimal Policy with Partial Information in a Forward-Looking Model: Certainty-Equivalence Redux," NBER Working Papers 9430.

Taylor, John B., 1999. "A Historical Analysis of Monetary Policy Rules," in John B. Taylor, ed., *Monetary Policy Rules*. University of Chicago Press, pages 319–341.

Table 1: Selected Tealbook Projections and 70 Percent Confidence Intervals Derived from Historical Tealbook Forecast Errors and FRB/US Simulations

(reproduced from April 2014 Tealbook)

Selected Tealbook Projections and 70 Percent Confidence Intervals Derived from Historical Tealbook Forecast Errors and FRB/US Simulations

Measure	2014	2015	2016	2017	2018
Real GDP					
(percent change, Q4 to Q4)					
Projection	2.8	3.2	3.1	2.6	2.1
Confidence interval					
Tealbook forecast errors	1.5-4.0	1.4-5.1	. . .	. . .	. . .
FRB/US stochastic simulations	1.6-4.0	1.6-5.1	1.4-5.1	.8-4.8	.1-4.2
Civilian unemployment rate					
(percent, Q4)					
Projection	6.2	5.6	5.1	4.8	4.8
Confidence interval					
Tealbook forecast errors	5.7-6.7	4.8-6.4	. . .	. . .	. . .
FRB/US stochastic simulations	5.6-6.8	4.6-6.5	3.9-6.3	3.4-6.0	3.4-6.0
PCE prices, total					
(percent change, Q4 to Q4)					
Projection	1.6	1.5	1.6	1.8	2.0
Confidence interval					
Tealbook forecast errors	.9-2.3	.3-2.7	. . .	. . .	. . .
FRB/US stochastic simulations	.9-2.3	.5-2.5	.6-2.7	.7-2.9	.9-3.2
PCE prices excluding					
food and energy					
(percent change, Q4 to Q4)					
Projection	1.5	1.7	1.8	1.9	2.0
Confidence interval					
Tealbook forecast errors	1.1-1.9	1.0-2.4	. . .	. . .	. . .
FRB/US stochastic simulations	1.1-2.0	1.0-2.4	1.0-2.6	1.0-2.8	1.0-3.0
Federal funds rate					
(percent, Q4)					
Projection	.1	1.1	2.3	3.4	4.0
Confidence interval					
FRB/US stochastic simulations	.1-.4	.1-2.1	.7-4.0	1.5-5.5	2.0-6.3

Note: Shocks underlying FRB/US stochastic simulations are randomly drawn from the 1969--2013 set of model equation residuals.
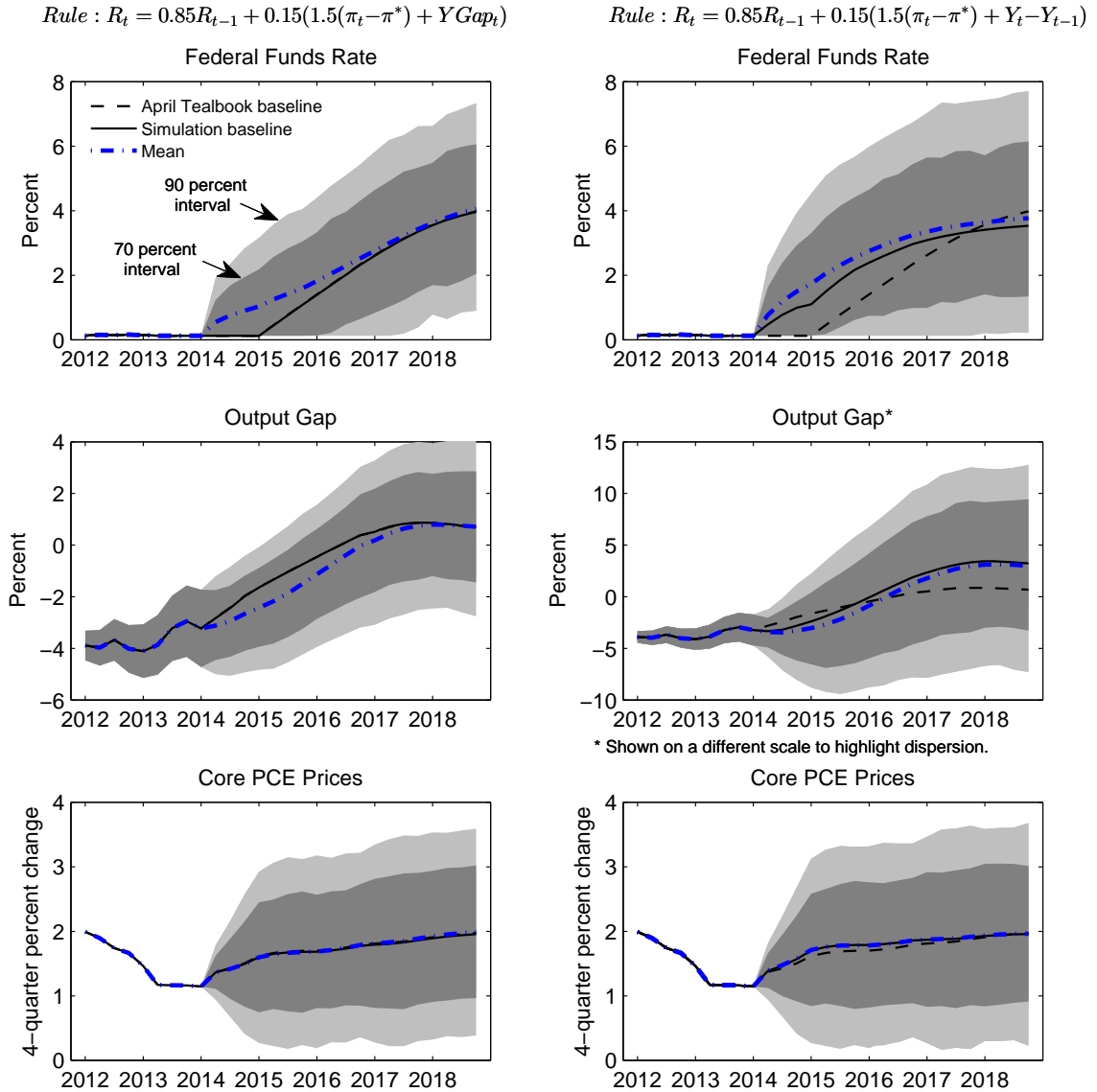
Intervals derived from Tealbook forecast errors are based on projections made from 1979 to 2013, except for PCE prices excluding food and energy, where the sample is 1981--2013.

. . . Not applicable. The Tealbook forecast horizon has typically extended about 2 years.

Figure 1: Forecast Confidence Intervals around the April Tealbook Baseline Forecast Derived from FRB/US Stochastic Simulations
(reproduced from April 2014 Tealbook)
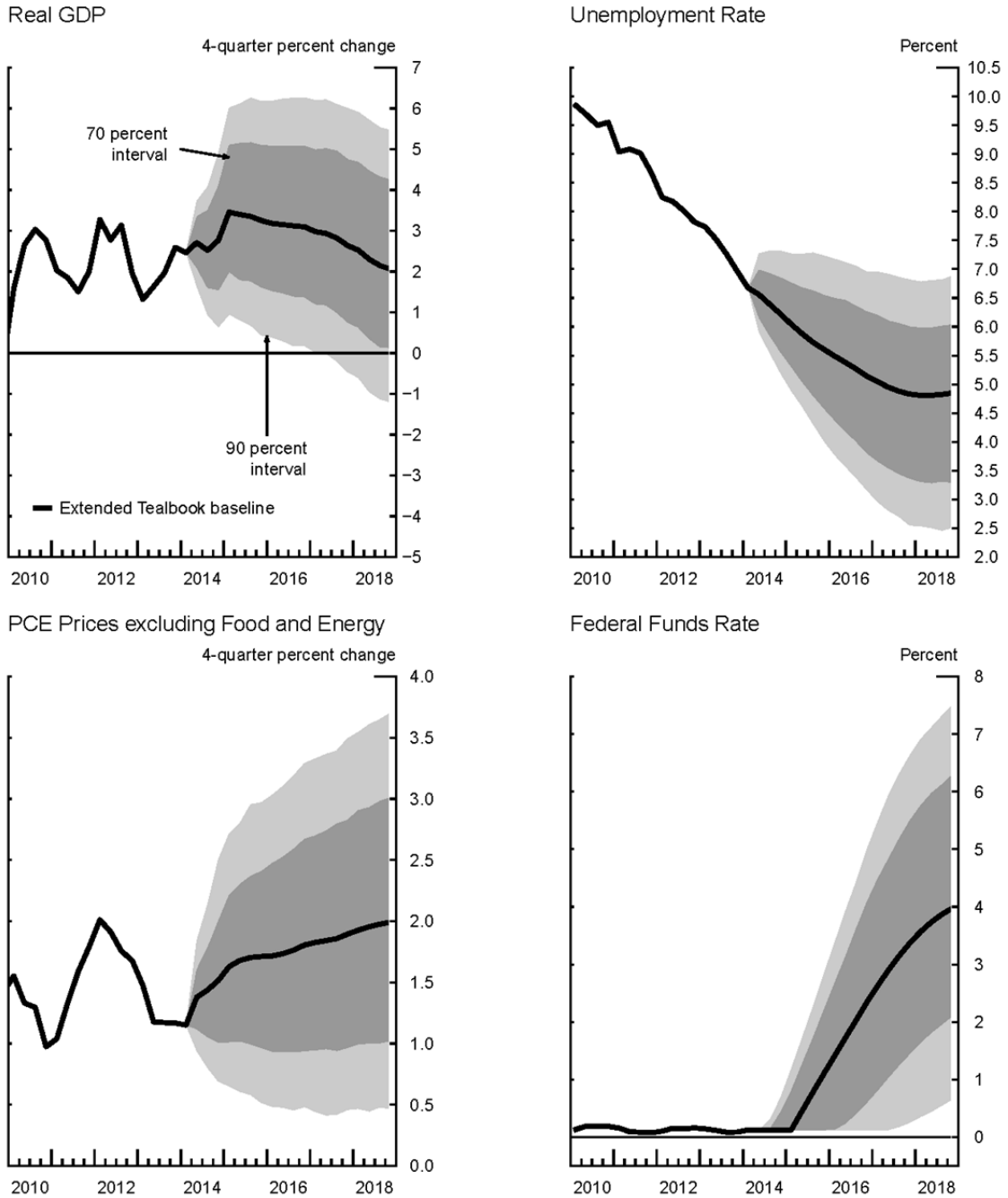
Figure 2: DSGE Model Simulations
around April Tealbook Baseline

$Rule: R_t = 0.85R_{t-1} + 0.15(1.5(\pi_t - \pi^*) + YGap_t)$

$Rule: R_t = 0.85R_{t-1} + 0.15(1.5(\pi_t - \pi^*) + Y_t - Y_{t-1})$

Federal Funds Rate

Federal Funds Rate

- - - April Tealbook baseline
— Simulation baseline
-·-· Mean

90 percent interval

70 percent interval

Output Gap

Output Gap*

* Shown on a different scale to highlight dispersion.

Core PCE Prices

Core PCE Prices

Note: In these simulations, we assume that uncertainty regarding the natural rate of unemployment extends back to 2011, thus explaining the "fan" around the output gap prior to 2014 in the bottom two panels.

Figure 3: DSGE model Simulations with
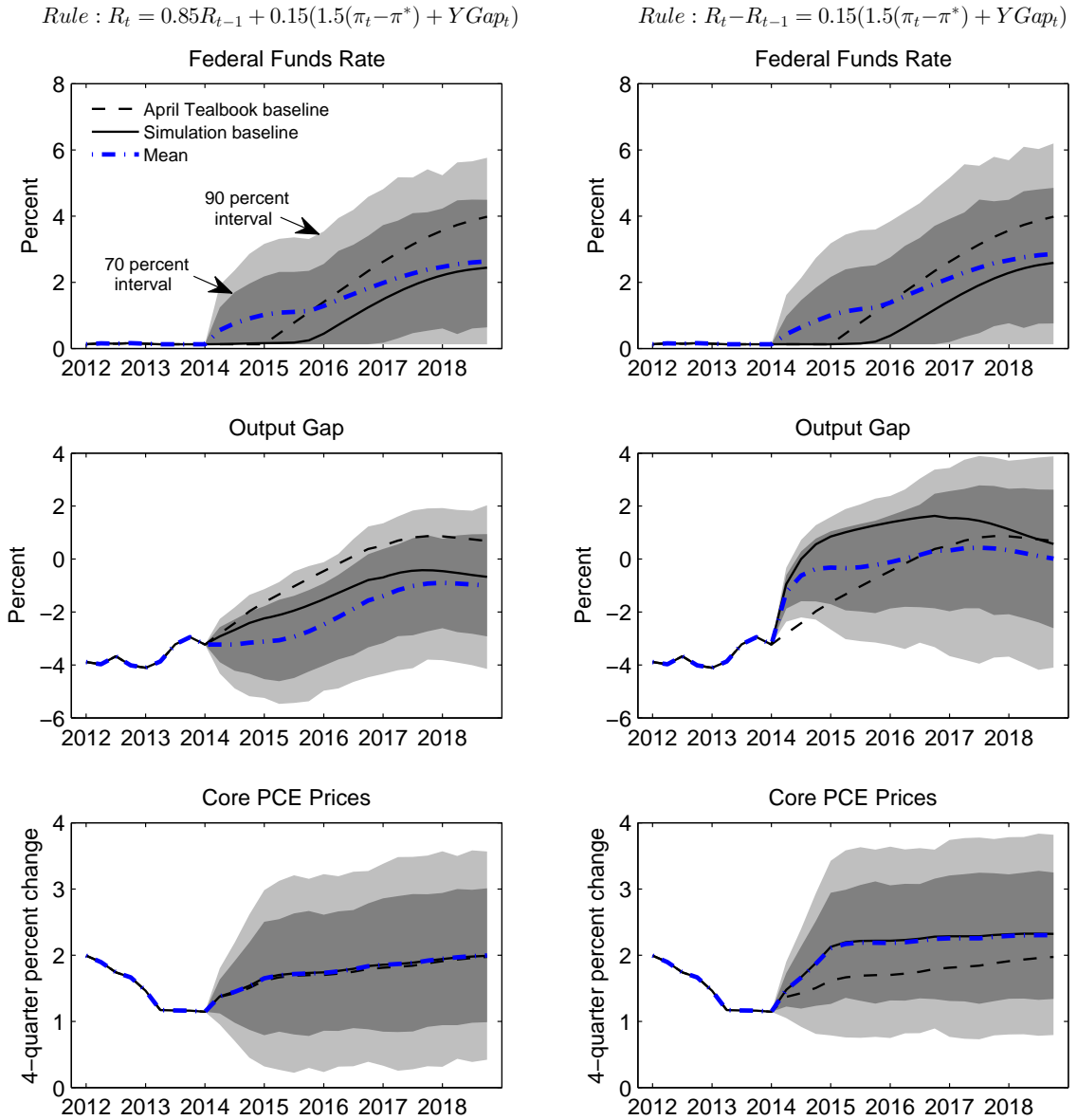**Depressed Equilibrium Real Interest Rate**

$Rule: R_t = 0.85R_{t-1} + 0.15(1.5(\pi_t - \pi^*) + YGap_t)$ $\qquad$ $Rule: R_t - R_{t-1} = 0.15(1.5(\pi_t - \pi^*) + YGap_t)$

Figure 4: FRB/US Simulations with Depressed Equilibrium Real Interest Rate

$Rule: R_t = 0.85R_{t-1} + 0.15(1.5(\pi_t - \pi^*) - 2UGap_t)$

$Rule: R_t - R_{t-1} = 0.15(1.5(\pi_t - \pi^*) - 2UGap_t)$

Federal Funds Rate

- - - April Tealbook baseline
——— Simulation baseline
—·—·— Mean

90 percent interval

70 percent interval

Federal Funds Rate

Unemployment Rate

Unemployment Rate

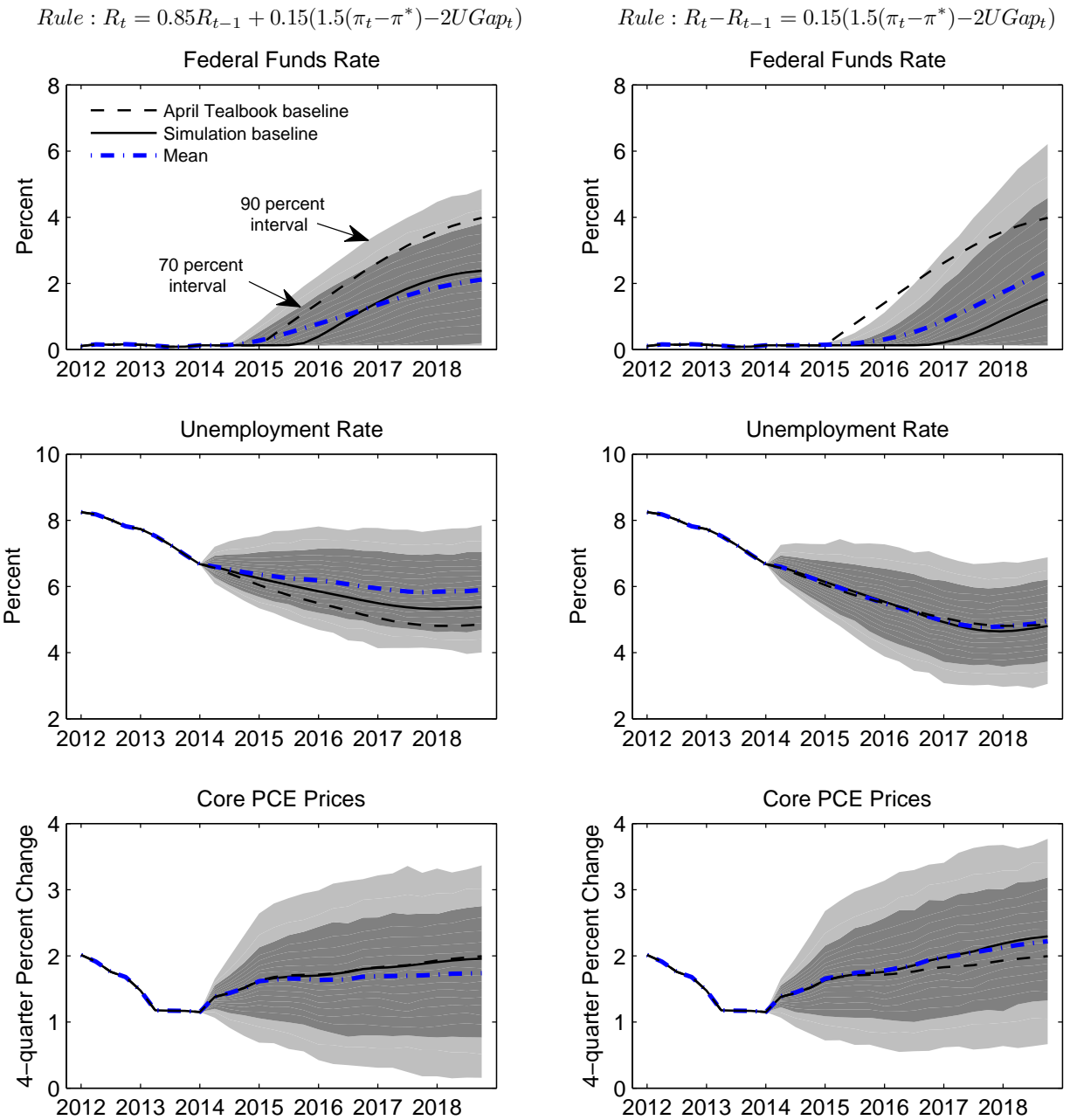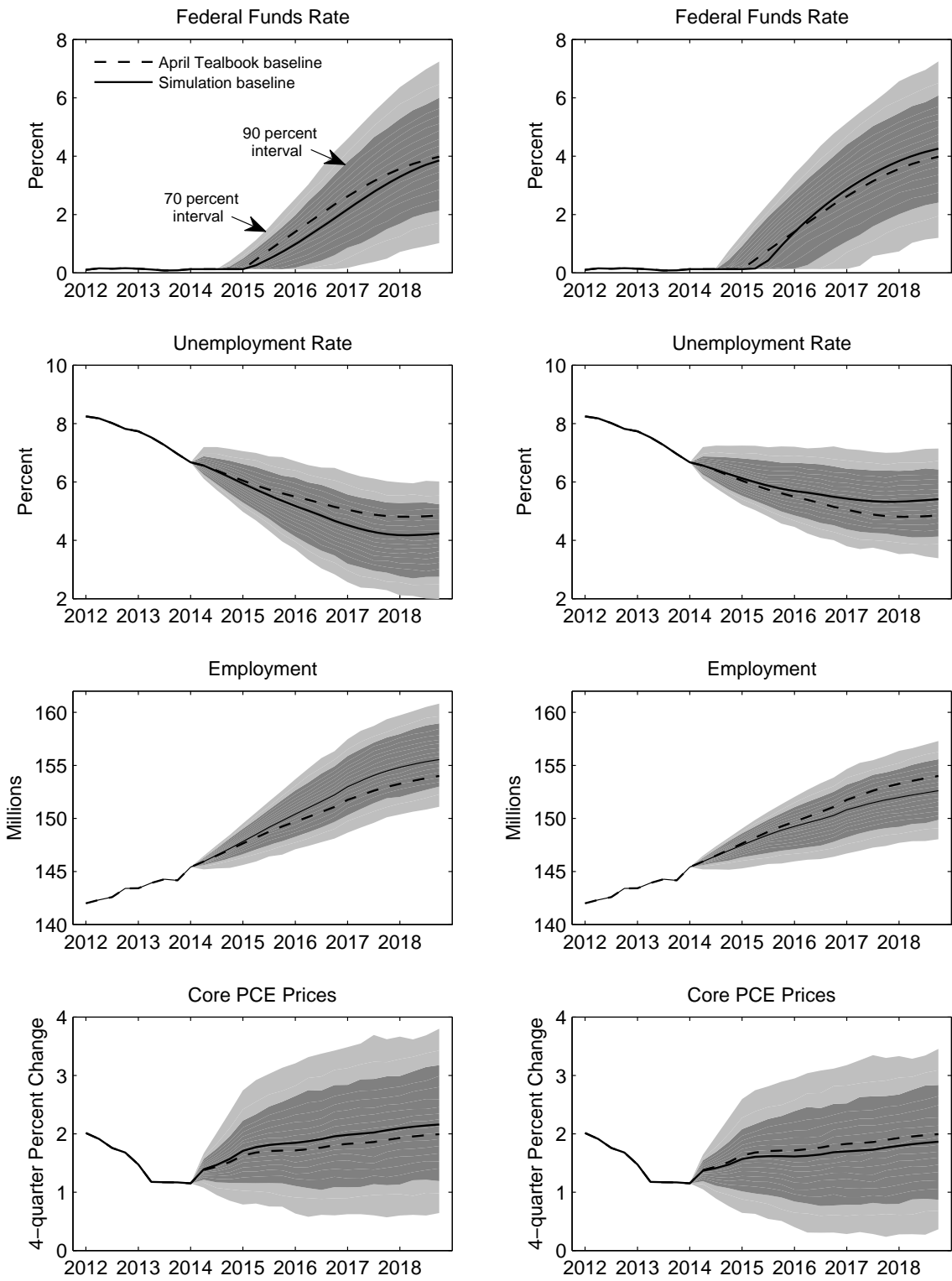### Core PCE Prices

Core PCE Prices

Figure 5: FRB/US Simulations with Hysteresis Effects

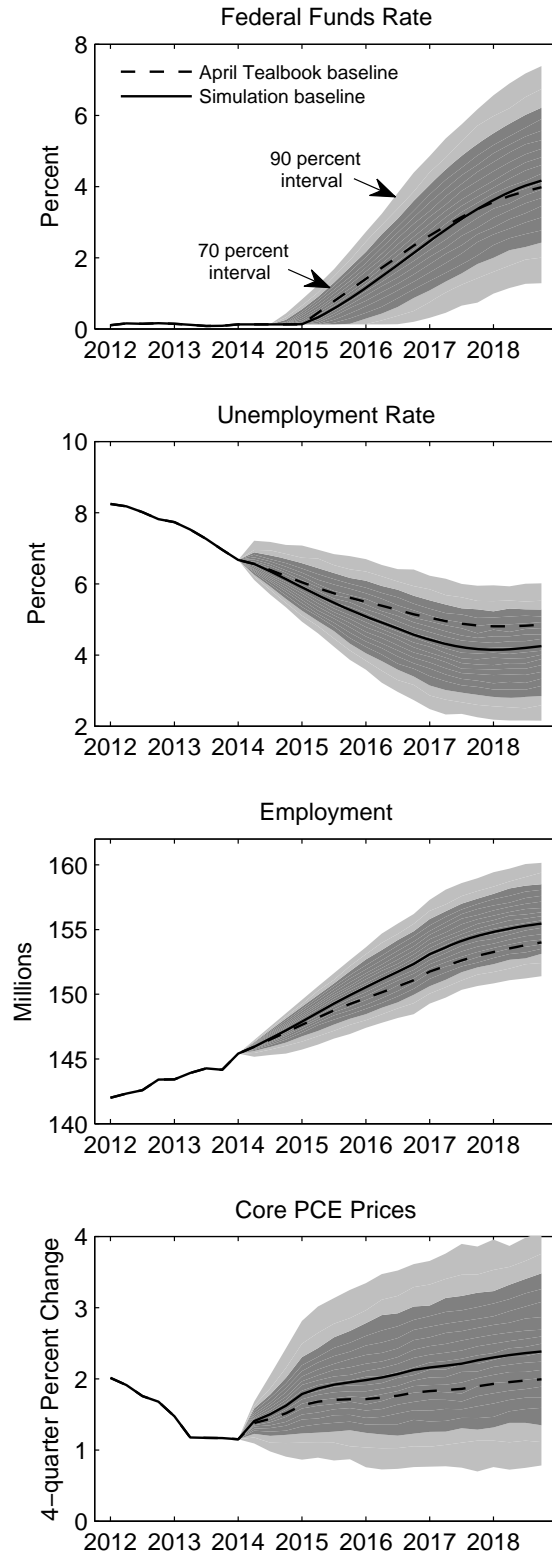**A. Policy Targets 4.5 Percent Unemployment Rate**   **B. Policy Targets 6 Percent Unemployment Rate**

Note: The policy rule is $R_t = 0.85R_{t-1} + 0.15(1.5(\pi_t - \pi^*) - 2UGap_t)$.

Figure 5 (continued): FRB/US Simulations with Hysteresis Effects

C. Policy Wrongly Assumes Presence of Hysteresis Effects

Federal Funds Rate

Unemployment Rate

Employment

Core PCE Prices

Appendix: Prescriptions Regarding Uncertainty in the Absence of the ZLB and Hysteresis Effects

This appendix discusses two results from the literature that were at the heart of debates about resource slack uncertainty and the conduct of monetary policy prior to the financial crisis. The first result, "certainty equivalence," states that policymakers operating in a linear-quadratic environment (described below) should conduct policy as if their best estimate of slack corresponded to the actual amount of slack, without regards to the uncertainty they attach to this estimate. The second result, "policy attenuation," applies to some deviations from the linear-quadratic framework. It asserts that policymakers should downweight indicators of slack as guides for monetary policy when slack uncertainty is considerable. In both cases, the uncertainty faced by policymakers originates from the random realization of shocks (sampling uncertainty) and policymakers' limited ability to identify the true state of the economy. By contrast, the uncertainty associated with a persistent decline in the equilibrium real interest rate or hysteresis effects considered in the memo stems primarily from possible breaks in economic relationships that have one-sided effects on macroeconomic outcomes.

A Certainty Equivalence Result

It has been common for economists to model an economy's equilibrium relations—Philips curve, IS curve, and so forth—as linear and to assume that the central bank's preferences over deviations of inflation and output from target are quadratic.[21] This "linear-quadratic" framework creates a stark prescription for optimal monetary policy: Policymakers should try to balance the expected deviations of inflation and unemployment from their target levels—where "expected" refers to the mathematical expectations operator or, in plain English, the forecast for the mean outcome. In this framework, tail risks affect policy solely through their influence on the mean forecast. Policymaker behavior is the same as it would be if they were certain that the mean forecast will come to fruition.

However, certainty equivalence no longer holds when the assumptions of the linear-quadratic framework are relaxed. For example, when the central bank sees unemployment in excess of the natural rate as being more costly, all else equal, than unemployment below the natural rate, then it is optimal to pursue unemployment rate outcomes that are below the best

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[21] The optimal control simulations presented in the Monetary Policy Strategies section of Tealbook, Book B, feature these quadratic preferences. Quadratic preferences over inflation and output are consistent with a second-order approximation of a New-Keynesian model's welfare function (see Rotemberg and Woodford (1997)). The optimal control simulations also include an interest rate smoothing term that improves the empirical fit and may help capture monetary policy considerations that are outside of the model, such as financial stability concerns or the mechanics of Committee decision making.

estimate of the natural rate.[22] Certainty equivalence also fails when equilibrium relations are nonlinear, such as the case of a binding ZLB considered in our memo, or when the effects of uncertainty about resource utilization do not enter the model additively. [23]

Policy Attenuation

The work of Orphanides and Williams (2002) argues that a central bank, uncertain about the true model of the economy, should adopt policy attenuation, placing relatively less weight on slack and more weight on inflation than would be desirable in the absence of uncertainty. Orphanides and Williams (2002) consider a small-scale rational expectation model in which the central bank observes a noisy measure of the time-varying natural rates of interest and unemployment. [24] Consistent with data revisions patterns, they assume that misperceptions of these natural rates tend to be large and persistent, so that the central bank may significantly over- or underestimate slack for several years.[25] Monetary policy takes the form of a simple rule that depends on inflation and the perceived unemployment gap. Private agents' behavior is described by a Phillips curve and IS curve that feature both forward-looking and backward-looking elements, consistent with private agents forming rational expectations and various unspecified frictions creating inertia in inflation and unemployment dynamics.

Certainty equivalence does not hold in this environment for two reasons. First, certainty equivalence applies to fully optimal policy, whereas Orphanides and Williams (2002) consider only simply policy rules. Second, the central bank is assumed not to know the true model of the economy (a reasonable assumption), thus preventing optimally-filtered estimates of slack.

Table 2 shows how economic outcomes deteriorate as uncertainty increases. Orphanides and Williams (2002) estimate their model on historical data to measure past misperceptions and calculate the counterfactual outcomes that the model predicts had the size of the misperceptions been scaled by a factor s. The exercise assumes that the Federal Reserve follows Taylor's (1999) simple rule with a weight of one half on inflation and two on the perceived unemployment rate gap. Importantly, the simulations do not impose the ZLB (and, as a result, allow nominal interest rates to become negative). As the degree of misperception increases, the unemployment gap $(u_t - u_t^*)$, inflation (π_t), and policy rate changes (Δf_t) become increasingly volatile. As a result, the central bank's "loss"—a weighted sum of inflation, unemployment gap and policy rate change variances—also rises quickly.

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[22] Similarly, Orphanides and Wilcox (2002) consider monetary policy preferences that are linear in the absolute deviation of output from target and quadratic in inflation from targeting which case the central bank solely stabilizes output whenever inflation is within some range of its objective.

[23] Brainard (1967) prescribes policy gradualism when there is uncertainty about the efficacy of policy, a form of multiplicative rather than additive uncertainty. Subsequent contributions, however, have questioned the generality of this result and its empirical importance.

[24] Similar policy attenuation results in the face of slack uncertainty are also presented in papers such as Orphanides, Porter, Reifschneider, Tetlow, and Finan (2000), and Ehrmann and Smets (2003).

[25] Orphanides (2001 and 2002) discusses the extent of historical revisions to slack estimates.

The losses shown in the table raise the question of whether policymakers could improve economic outcomes by varying the coefficients of its Taylor rule in response to rising uncertainty regarding slack. Orphanides and Williams (2002) demonstrate that policymakers could minimize losses by lowering the weight on the unemployment gap to near zero and increasing the weight on inflation. Thus, instead of ignoring uncertainty, the central bank attenuates its response to movements in the perceived natural rate as the uncertainty surrounding it rises. Orphanides and Williams (2002) have also demonstrate that policymakers may improve economic performance by following a policy strategy in which the nominal interest rate responds to changes in the unemployment rate, rather than the level of the unemployment gap. Such an approach lowers the adverse effects that would arise from policy adjustments in response to persistent mismeasurement in slack, while preserving some policy sensitivity to movements in economic activity.[26]

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[26] Indeed, this motivation underlies the inclusion of the "first difference rule" in the set of policy rules reported in the Monetary Policy Strategies section of Tealbook, Book B.
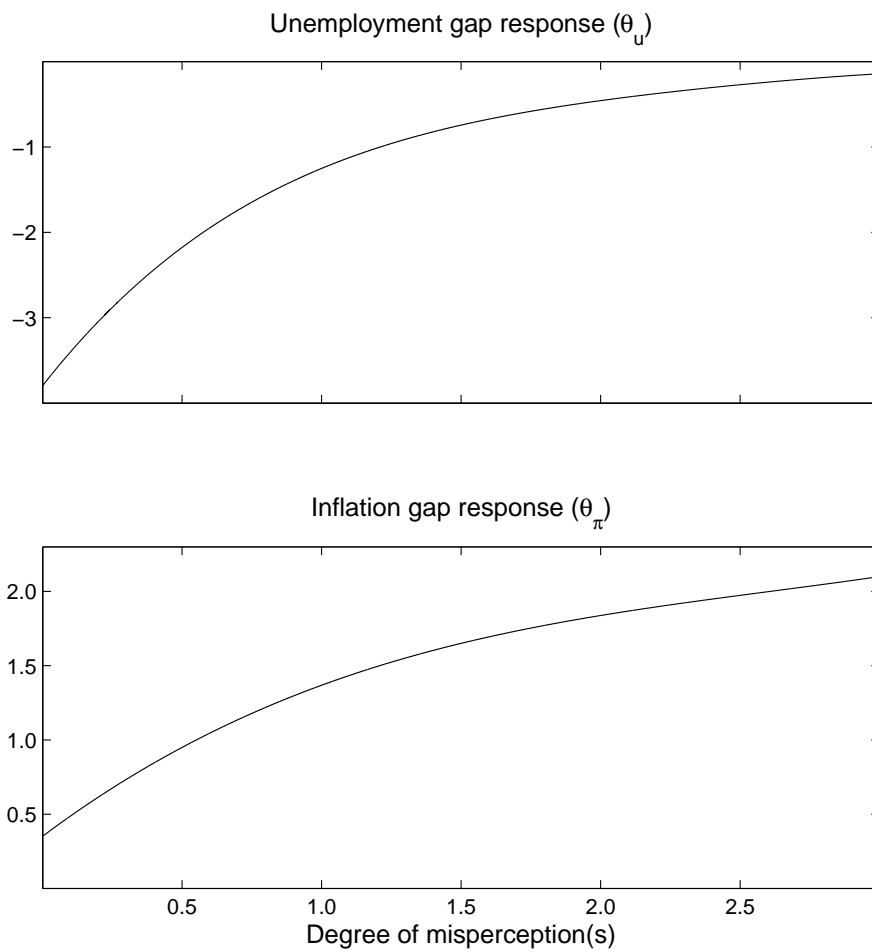
Table 2: Macroeconomic Performance under Taylor (1999) rule and Various Degree of Natural Rate Misperception

Uncertainty factor (λ)	Standard deviation			
	$u_t - u_t^*$	π_t	$\varDelta f_t$	Loss
s=0	0.71	2.03	2.89	1.64
s=1	0.77	4.13	2.91	4.32
s=2	0.91	7.28	3.56	11.89
s=3	1.09	10.57	4.59	24.36

Source: Orphanides and Williams (2002).

Note: The loss function is $\mathcal{L} = 0.2Var(\pi_t - \pi_t^*) + 0.8Var(u_t - u_t^*) + 0.05Var(\Delta f_t)$.

Figure 6: Optimal Policy Response Parameters under
Taylor Rules for Given Degrees of Natural Rate Misperception

Unemployment gap response (θ_u)

Inflation gap response (θ_π)

Degree of misperception(s)

Source: Orphanides and Williams (2002).