June 7, 2013

Assessing the Recent Decline in the Unemployment Rate
and its Implications for Monetary Policy
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The unemployment rate in the second quarter of this year is on track to average ¾ percentage point less than what the staff had anticipated in the September 2012 Tealbook. (Compare the black and red lines in the top left panel of figure 1.) Given the absence of any material change in our assumptions for the natural rate of unemployment as of the April Tealbook, the surprise in the unemployment rate has translated into a roughly equivalent reduction in the gap between the actual and natural unemployment rates (the blue and red lines in the upper right panel of figure 1), with attendant implications for monetary policy.

However, the continued downside surprises in actual unemployment have led us to revisit our assumptions for the natural rate and potential output for the June Tealbook projection. In brief, we now attribute some of the unexpected decline in the unemployment rate to an earlier-than-expected decline in the natural rate of unemployment rather than viewing it all as a narrowing of the unemployment gap. In particular, we now assume that the natural rate declined about ¼ percentage point more through the end of 2012 than we had previously assumed, and we anticipate that it will fall a little more quickly over the remainder of the forecast period, reaching our unrevised estimate of its long-run level of 5¼ percent by the end of 2015. We have attributed this more-pronounced downward trajectory in the natural rate to both improvements in labor-market functioning and some additional permanent withdrawals from the labor force.

The faster decline in the natural rate is only one of the ways in which we could have modified our supply-side assumptions in order to better explain recent developments in the labor market, and one purpose of this memo is to explore some plausible alternative explanations and their implications for monetary policy. We start by describing, in more detail than is possible in Tealbook Book A, the changes we made to our supply-side assumptions. We then contrast the adjustments we made in the Tealbook forecast with a pair of alternative explanations for these recent developments that roughly bracket the range of possible implications for our reading of slack in the economy. We then use the FRB/US model to illustrate the implications of these alternative scenarios for monetary policy.

An Okun's Law Framework

A useful starting point for thinking through the evolution of labor market conditions is Okun's law. A simple version of Okun's law equates the unemployment rate gap, specifically the

difference between the unemployment rate, u_t, and the natural rate of unemployment[1], u_t^*, to the level of the GDP gap, expressed as the difference between GDP, y_t, and potential GDP, y_t^* (both output variables being measured in natural logarithms), plus an error term, ε_t:

$$(1) \qquad u_t - u_t^* = \beta(y_t - y_t^*) + \varepsilon_t$$

Typically β has been estimated to be about -½, so that when output is below its potential level the unemployment rate is above the natural rate, and the unemployment rate gap is about half the size of the output gap.[2]

Conditional on our assumptions for the natural rate and potential output, the two measures of slack may deviate, a feature captured by the error term ε. Our understanding of these errors is enhanced by decomposing the output gap as in equation (2) into the gaps in productivity, $q_t - q_t^*$, and labor input, which is the sum of the gaps in the participation rate, $lfp_t - lfp_t^*$, in the workweek, $ww_t - ww_t^*$, and the negative of the unemployment rate gap. Equation (2) also includes a residual v_t

$$(2) \qquad y_t - y_t^* = (q_t - q_t^*) + (ww_t - ww_t^*) - \underbrace{(u_t^* - u_t) + (lfp_t - lfp_t^*)}_{e-e^*} + v_t$$

As before, the asterisks denote the unobserved structural or trend values of the variables.[3] Note that together the labor force participation rate and (up to a transformation) unemployment rate gaps form the employment gap, $e_t - e_t^*$, to which we will return below. Because labor productivity is measured for the nonfarm business sector and the unemployment rate and participation rate are available only for the aggregate economy, the residual, v_t, captures the effects of the sectoral differences, among other things.[4]

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[1] When defining the unemployment rate gap, we use the "effective" natural rate, which includes the estimated effects on the unemployment rate of the extended and emergency benefit programs.

[2] The staff's working version of Okun's Law model allows for a dynamic relationship between the unemployment rate gap and the current and lagged values of the GDP gap. The coefficients on the GDP gap terms sum to about negative ½.

[3] As typically specified, the gap accounting includes the employment rate gap, which is the negative of the unemployment rate gap. To simplify the discussion we specified equation (2) in terms of the negative of the unemployment rate gap.

[4] These differences between the NFB sector and the aggregate economy can be important, as the NFB sector has a more pronounced cyclical pattern than the other sectors of the economy. The more complete accounting that the staff uses is an identity where the GDP gap is the sum of the gaps in the components shown as well as the gaps in the ratios of output and employment in the NFB sector to the total economy. These omitted ratios are represented here by the residual. Peter Clark (1983) shows that the more complete version of equation (2) that the staff uses holds because the gaps in each of the components can be represented as a function of the GDP gap and its lags, with

Over the course of the business cycle, each of these elements moves relative to its trend. An ordinary Okun's law equation like equation (1) attempts to embody the typical cyclical relationship between the unemployment rate gap and the GDP gap in the single coefficient β, subsuming the usual relationships among the underlying gaps (labor force participation, the work week, and so forth).[5] Unusual movements in any combination of the underlying gaps can result in a nonzero error in equation (1). (Indeed, even an error of zero may reflect unusual movements that cancel each other out.) In other words, when movements in GDP and the unemployment rate appear to be at odds, the explanation may be related to atypical movements in some combination of the productivity, work week or participation rate gaps or to mis-estimation of u* or y*.[6]

Revised Supply-Side Assumptions for the June Tealbook

In our view, the unemployment rate rose more during and immediately following the recession and fell more quickly during the recovery than could easily be explained by the simple Okun's law relationship in equation (1), conditional on reasonably smooth paths for potential output and the natural rate of unemployment. We judge that firms reacted to the plunge in economic activity and the accompanying heightened uncertainty by cutting employment more than would normally have been consistent with the fall in actual production. Moreover, as real GDP began to recover, firms responded to the increase in demand, to a greater than usual extent, by increasing productivity rather than by adding workers. However, as the recovery has continued, we think that firms have brought their workforces and labor productivity back towards more sustainable levels, causing the unemployment rate to decline by more than could be explained by the closing of the GDP gap. In the April 2013 Tealbook, we assumed that the unemployment rate had fallen enough by the end of 2012 so that the unemployment rate gap and the GDP gap provided consistent signals about slack in the economy.

In accordance with this hypothesis, we assumed a substantially lower level of potential output (and structural productivity) than would have been necessary to make Okun's law fit from 2008 through 2012. That is, under our assumptions in the April Tealbook, an unusually large and persistent Okun's law error (a positive ε in equation (1)) opened up during the recession (as indicated by the space between the black and blue lines in the lower left panel of figure 1), which began to close in late 2010 and was essentially gone by the end of 2012.

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cross-equation restrictions on the coefficients on the contemporaneous GDP gap and on the sum of the residuals in each equation. Note that we assume potential population growth equals actual population growth.

[5] Equation (1) has typically provided an adequate representation of the average co-movement of aggregate output and the unemployment rate, and one that requires fewer assumptions about difficult-to-estimate trends in other components. However, this has not been the case in recent years, which is why we have placed greater emphasis on the elements in the gap accounting in equation (2). Nevertheless, we continue to assume that as the effects of the economic crisis fade, the parsimony of equation (1) will again be a virtue.

[6] In addition, there may be many other reasons for an error in equation (1), including measurement errors in GDP or the unemployment rate, and changes over time in the value of β or in the dynamic structure of the relationships.

In addition, we assumed that the natural rate of unemployment rose from 5 to 6 percent during the recession, both because much of the rise in the actual unemployment rate was concentrated among permanent job losers, and because studies of the Beveridge curve (e.g. Barnichon and Figura (2011)) pointed to a decline in labor market match efficiency. We have also attributed some of the increase and subsequent decrease in the unemployment rate to the effects of the extended and emergency unemployment insurance benefit programs.

However, even conditional on our downward-revised path for potential output, the unemployment rate fell more in the first quarter of this year than would be suggested by Okun's law, and, based on our current projection for real GDP this pattern seems to have continued into the second quarter. To better account for the decline in the unemployment rate since the middle of last year, we have made additional revisions to our supply-side assumptions for the June Tealbook: We now assume that the natural rate of unemployment is on a more pronounced downward trajectory than we had previously assumed, due both to somewhat greater improvement in labor market functioning and a slightly steeper pace of decline in the trend labor force participation rate. These supply-side revisions imply that both the unemployment rate gap and the GDP gap were a little wider at the end of last year than we had previously assumed and that less of the recent decline in the unemployment rate reflected a narrowing of labor market slack.

We have assumed for some time that as the labor market recovered, the natural rate of unemployment would gradually move down to near its pre-recession level as labor market functioning improved and some unemployed workers permanently left the labor force. In fact, we lowered the trajectory of the natural rate of unemployment a bit for the January Tealbook. As noted above, we have further altered our assumptions and have the decline starting in early 2011 rather than in 2012 (see the lower right panel of figure 1.) As a result of these adjustments, the unemployment rate gap is ¼ percentage point wider at the end of 2012 than in the April Tealbook. (Compare the black and blue lines in the top right panel of figure 1.) Moreover, we now expect the natural rate to reach our estimate of its long-run level of 5¼ percent by the end of 2015, two years earlier than we had projected in the April Tealbook.

The evidence supporting improvement in labor-market functioning is mixed. As shown in the top left panel of figure 2, estimates of the degree of mismatch across industries and occupations, such as those constructed by Sahin et al. (2012) and by Lazear and Spletzer (2012), suggest that labor market functioning has improved considerably. In addition, the amount of permanent job loss (the top right panel), which has historically been associated with greater difficulty in matching to a new job, has receded, although it remains somewhat elevated. In contrast, the Beveridge Curve has not yet shifted back toward its pre-recession locus, and related estimates of matching efficiency, such as those constructed by Barnichon and Figura (2011), shown in the middle left panel, suggest that there has been little improvement in the natural rate since late 2010. Despite the ambiguity, we have taken some signal from this evidence that the increase in structural unemployment induced by the recession has diminished.

The evidence supporting a steeper decline in the trend labor force participation rate is also mixed. The labor force participation rate has fallen by more than we were expecting, and the latest reading is ¼ percentage point below what we were projecting in the September 2012 Tealbook. Although we do not have a precise explanation, it seems possible that some individuals who are near the end of their planned working years may have accelerated their retirements and that others have applied for and begun to receive Social Security Disability Insurance (SSDI) payments. Because such withdrawals are likely to be concentrated among those who would have the greatest difficult finding acceptable jobs even after a full economic recovery, their withdrawal would not only lower the trend participation rate but would also lower the natural rate of unemployment, leaving a larger unemployment rate gap than under current assumptions. However, rates of exit out of the labor force from unemployment have not been especially elevated in the demographic groups we would expect to be most likely to accelerate retirement. As to disability, there has been a large increase in the number of recipients of SSDI since the recession began. However, most of this appears to be a continuation of the secular upward trend. (See the middle right panel of figure 2.) While there does appear to have been a cyclical increase in the number of applicants for disability payments (not shown), given historical approval rates, this does not imply a large increase in the number of recipients. Furthermore, while we view recipients of SSDI as contributing to a lower trend participation rate because few persons leave the SSDI program once they have begun to receive payments, it is possible that under the current extraordinary circumstances, a greater number than is typical could return to work once labor demand improves sufficiently.

In any event, we have marked down our estimate of the level of the trend participation rate at the end of last year by 0.1 percentage point relative to the April Tealbook, accounting for about one-third of the downward revision to the natural rate of unemployment.

We view this revision to our assumed trend for the labor force participation rate as better balancing the risks in our projection between the possibility that more of the recent decline reflects trend factors and the possibility that more of the decline reflects an unusual cyclical response. However, this evidence is by no means conclusive. Below we will explore a scenario in which cyclical phenomena explain more of the decline in the labor force participation than we had assumed in the April Tealbook. Several bits of evidence led us away from incorporating that interpretation into the baseline projection. First, to explain the recent declines in participation as an unusually large cyclical response in the face of more than two years of rising employment and a falling unemployment rate would require that the participation rate lag the unemployment rate by more than has been the case historically.[7] Of course, this episode may be different because

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[7] For example, Erceg and Levin (2013) estimate that the typical lag is considerably shorter, on the order of two quarters.

of the extraordinarily long durations of unemployment. However, rates of labor force withdrawal for the long-term unemployed (shown in the bottom left panel of figure 2) are not particularly high relative to those with shorter durations of unemployment, suggesting that this is not the case. Second, broader measures of labor underutilization from the BLS, such as U5 (shown in the bottom right panel of figure 2), which adds to the unemployed those who are marginally attached to the workforce), do not suggest unusual movements in discouragement. Third, the staff's model of labor force participation has, for some time, shown a lower level of, and steeper decline in, trend labor force participation than was built into the April Tealbook projection. Note, however, that several other estimates of the trend participation rate suggest a higher trend than we have assumed. For example, see Aaronson and Brave (2013).

From the perspective of our June Tealbook supply-side assumptions, the unemployment rate gap remains the best single measure of labor market slack. As noted above, there is much uncertainty about the trend in the participation rate, and thus the participation rate gap. Moreover, given the numerous influences on the participation rate, movements in the participation rate around any trend would be hard to explain. Given that history, we do not view the movements in the participation rate gap to be to be sufficiently out of line with the unemployment rate to significantly distort the signal sent by the latter. The employment-to-population ratio is an alternative measure of slack that takes into account the low level of the participation rate. However, the employment-to-population ratio is the product of the unemployment rate and the labor force participation rate, so the interpretation of the employment-to-population ratio depends upon one's view of the participation rate.[8]

We decided against a further downward adjustment to structural productivity and potential output in the current Tealbook projection, for several reasons. First, our downward adjustment to potential output as of the April Tealbook was consistent with the average historical effect of financial crises found in studies, such as Furceri and Mourougane (2012).[9] Second, under our April Tealbook assumptions, the level of productivity was still well above its trend at the end of last year, even as we assumed that the unemployment rate had moved back into line with the GDP gap. Given these considerations, steepening the decline in the natural rate of unemployment seemed the more appealing way to reconcile the evidence as neatly as possible.[10] Indeed, the low level of payroll employment relative to its pre-recession level seems more

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[8] For a general discussion of the unemployment rate as a summary of labor market conditions and a comparison to alternatives see the memo to the FOMC, "Assessing Conditions in the Labor Market", December 2012.

[9] A financial crisis and deep recession may reduce structural productivity by reducing capital formation and inhibiting permanent improvements in TFP by making it more difficult to finance the necessary investments and increasing uncertainty.

[10] It is also possible that the natural rate of unemployment didn't rise as much during the recession as we have assumed. In this case, the rise in unemployment during the recession was even more cyclically unusual, and the recent improvement would reflect the greater required normalization.

consistent with the greater labor market slack that is implied by the lower natural rate of unemployment that we now assume.

Alternatives to the Baseline Explanation

There are many possible characterizations of the recent behavior of the unemployment rate other than the one embodied in the staff forecast, which would lead to different assessments of the amount of slack in the economy and thus have different implications for monetary policy. Here we highlight two alternatives to the changes we have implemented for the June Tealbook that serve to illustrate a range of possible implications. In assessing the implications for slack and monetary policy, we compare these alternatives with the forecast in the April Tealbook.

More of the decline in the labor force participation rate is cyclical: The labor force participation rate has fallen about 2 percentage points (on a data-consistent basis) since the business cycle peak. Based on our assumptions in the April Tealbook, we attributed about two-thirds of this 2 percentage point decline to the downward trend in participation. However it is possible that less of the observed decline is attributable to the trend in participation and more reflects a reaction to the extended period of weak labor demand. (As noted above, under this explanation the labor force participation rate notably lags the business cycle in the current episode.) If we are experiencing a greater-than-usual cyclical response in the labor force participation rate, then to the extent that the potential workers who dropped out are a ready source of labor that could re-enter when conditions improve sufficiently, the unemployment rate would provide a misleading signal of the amount of slack in the labor market.[11] Moreover, because we would attribute less of the recent decline in the labor force participation rate to its trend, we would raise our estimate of trend participation and therefore also our estimate of potential output. Hence, consistent with equation (2), the output gap would be wider than under the staff's current assumptions for trend participation.

Conditional on our other assumptions in the April Tealbook, the unemployment rate gap in this scenario is smaller than would be expected given the GDP gap (that is, there is a negative Okun's law error) because the unemployment rate gap itself understates the amount of slack in the labor market. Thus, in this scenario the gap in the employment-to-population ratio—which combines both the unemployment rate gap and the participation rate gap—provides a better sense of labor under-utilization. Looking ahead, at some point as the economic expansion continues, the unemployment rate would be buoyed by people moving into the labor force, and should fall less

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[11] Unlike the changes we have implemented for the June Tealbook, where lower *trend* participation helped explain the downward revision to the natural rate of unemployment and the decline in the actual unemployment rate, the change discussed here is explicitly limited to an explanation for the decline in the actual unemployment rate.

than would be suggested by movements in the output gap alone, until eventually, the two gaps come back into their historical alignment.[12]

The level of structural productivity is lower than we assumed in April: At present, the level of real GDP is 8½ percent lower than it would have been had GDP grown at the potential rate the staff projected prior to the financial crisis. We have assumed that much of this lower level of economic activity represents lower potential GDP, largely reflecting a weaker assessment of structural productivity in the years since the onset of the crisis. However, while we have calibrated our downward revision to structural productivity based on past experience, every crisis is different and our uncertainty around this assumption is high. Thus, it is quite possible that the current level of structural productivity is even lower than we have assumed. To the extent this is true, the level of potential output is also lower than we had estimated in the April Tealbook, and the GDP gap is correspondingly narrower.

Conditional on our other assumptions in the April Tealbook, the unemployment rate gap in this scenario, which is not directly affected by the change to potential output, would indicate more slack in the economy than the GDP gap—in other words there would be a positive Okun's law error (the ε in equation (1)). In this case, firms would have made less progress in bringing their workforces back to more sustainable levels than we had assumed in April. Looking ahead, we would expect the unemployment rate to come down more quickly than would be suggested by the closing of the GDP gap, as firms increase their labor input, bringing labor productivity down to a more sustainable level.

Two Illustrative Scenarios

In this section we illustrate the significance for monetary policy of the two alternative interpretations of the surprises in labor market conditions that we think bracket the range of possibilities.

Our first scenario assumes that trend rate of labor force participation follows a higher path than in our baseline, beginning slowly in 2002 and growing to a difference of about 1 percentage point by the first quarter of 2013; the higher trend participation rate is also assumed to persist indefinitely. This revisiting of history implies that only about one third of the observed decline in the participation rate since the fourth quarter of 2007 is associated with a decline in trend participation, whereas in the baseline nearly two thirds of the observed decline is accounted for by trend. This results in a participation rate gap in the first quarter of 2013 that is approximately -1¾ percentage points, instead of -¾ percentage point as in the baseline. As discussed in the previous section, the relationship of the participation rate to the business cycle is also very

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[12] In the April Tealbook, we also assumed that the labor force participation rate gap would narrow during the projection period, but that this represented a "normal" cyclical improvement in participation.

different in this scenario than in our baseline thinking, with the participation gap notably lagging the cycle as measured by the unemployment rate gap.

Three implications arise from this alternative interpretation of history. First, the standard FRB/US model equation describing the evolution of the participation rate will not suffice to explain this reimagined history. Thus, an alternative model equation is substituted for the model's standard equation for labor-force participation to allow the participation rate gap to have a more pronounced cyclical character than has typically been the case historically, and to allow the participation rate to lag persistently behind the unemployment rate gap. Second, the atypical comovement of the participation rate gap relative to the unemployment gap implies that the unemployment rate, by itself, will not provide an accurate signal of labor market slack. As a consequence, it may no longer be appropriate to interpret the "maximum employment" half of Committee's dual mandate as equivalent to seeking the return of the unemployment rate to the natural rate.[13] When the participation gap is negligible, or when it moves together with the unemployment gap, the unemployment gap can ably stand in for an overall employment gap in the design of monetary policy; however, the scenario considered here is one example where this need not be the case.[14] Third, in this alternative interpretation the larger and more cyclically sensitive participation rate gap leaves more room for monetary policy to ameliorate labor market conditions than would otherwise be the case.

We consider optimal control simulations under this higher trend participation rate scenario, under two different objectives for monetary policy: In one instance, we maintain our usual assumption that the Committee seeks to minimize deviations of the unemployment rate from the natural rate of unemployment, in addition to the usual penalty on deviation of inflation from its target and a penalty on the change in the federal funds rate; in the other, we instead assume that the Committee chooses paths for the funds rate with the deviation of employment from trend employment in mind as the "maximum employment" leg of its mandate.[15] In both cases, we employ as the baseline the extended April 2013 Tealbook projection and assume that the Federal Reserve's balance sheet policies remain at their baseline paths.[16]

The information assumptions surrounding these simulations are the same as those in the optimal control exercises reported in Tealbook B: In all instances, we carry out these experiments using

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[13] This scenario is in the spirit of Erceg and Levin (2013).

[14] To operationalize the insufficiency of the unemployment rate as a summary statistic of resource utilization we also alter a few other equations of the FRB/US model's employment sector so as to "break" Okun's law in the model, thereby allowing the unemployment gap and output gap to vary over time to a certain degree. In terms of equation (1), this means that we are allowing ε to vary over time.

[15] As equation (2) shows, the employment gap is simply (a transformation of) the unemployment gap plus participation rate gap. In addition, given the assumptions that actual and potential population growth are identical, minimizing the employment gap can equivalently be thought of as minimizing the deviation of the employment-to-population ratio from its trend (or sustainable) ratio. Omitted from consideration here is anything to do with a work week gap.

[16] Note that the baseline used here assumes a higher natural rate of unemployment than in the June Tealbook.

the FRB/US model assuming agents form model consistent expectations, with complete policy credibility. These are strong assumptions that might overstate the ability of the Committee to achieve its objectives; that said, the virtue of this framework is that by construction our results do not depend on any explicit or implicit assumption of ignorance or myopia.[17] As a check against false confidence, we will discuss (but not show) simulation results where policy is governed by the inertial Taylor rule (with thresholds). Simple rules, like the inertial Taylor rule, are often advocated for their robustness properties, trading off the precision of optimal control, which exploits complete knowledge of the model and the baseline, for the breadth and ubiquity of the arguments that enter simple rules.

Figure 3 shows the optimal control solution for this scenario, along with the corresponding optimal path for the extended April Tealbook, for comparison.[18] Focusing first on results using the conventional unemployment-based optimal policy, the thick solid (blue) line in the bottom-right panel shows that the federal funds rate lifts off from the effective lower bound (ELB) in the first quarter of 2015, two quarters earlier than in the baseline optimal control results (the thin solid line). On average, growth in real GDP is stronger than in the baseline, and the unemployment rate declines more rapidly, despite a more rapid climb in the workforce. And yet, as the bottom-left panel shows, this more rapid expansion produces inflation that is tangibly lower, with the result that real interest rates are little different than in the baseline. This constellation of results arises because the higher participation rate trend, even though it has no implications, initially, for the unemployment gap, implies a higher level of potential output. Higher potential, in turn, implies higher target spending levels and thus a greater impetus to growth going forward; by the same token, the larger output gap puts more downward pressure on inflation.

The simulation using the employment-based optimal policy is shown by the thick dashed (green) lines. As the bottom-right panel shows, in this case, the liftoff of the funds rate from the ELB is prescribed for the fourth quarter of 2016—seven quarters later than under the unemployment-based optimal policy. Inflation differs little in the early going from the unemployment-based policy, so that real interest rates are substantially lower. Growth in real GDP soars for a time, and the unemployment rate, shown in the top-right panel, falls much faster than in either of the other two scenarios, overshooting the natural rate by significantly more. The unemployment rate bottoms out at 4½ percent at the end of 2016 after which it approaches the natural rate from

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[17] The exception to this is the assumption of full credibility the efficacy of which depends on either an established reputation or a "commitment technology" that binds future generations of the Committee to the promises of the present one. An exploration of this assumption is, however, beyond the scope of this memo.

[18] Because the April Tealbook baseline was constructed, in large part, with the standard model in mind, the standard model is also used for optimization for the baseline scenario shown here; in particular, optimization is carried out in the standard way such that the real variable that appears as the objective of optimization is the (discounted) unemployment rate gap. The optimal policy for the baseline shown in figure 3 and again in figure 4 differs slightly from what was shown in Part B of the April Tealbook because of small differences in the variables for which expectations are taken to be model consistent.

below.[19] These unemployment dynamics are intended to propel a more rapid recovery in the participation rate than would otherwise take place.[20] The employment-based optimal policy thus leads to monetary policy that is "lower for longer," arguably reaping noteworthy gains in employment and inflation.[21,22]

Our second scenario considers a case at the opposite end of the spectrum, in which goods market slack is notably less than what we have in the baseline. As noted above, the most likely scenario capturing this possibility entails even larger declines in structural productivity in recent history than we have built into the baseline, and consequently smaller shortfalls in resource utilization, all else equal. Specifically, this scenario assumes a (further) reduction in the growth rate of trend productivity over the period from 2009 to 2012, which leaves the level of structural productivity at the beginning of this year 1 percent lower than in the baseline. Private agents are assumed to understand that the reduction in the level of productivity will persist indefinitely and also that the growth rate going forward is unchanged relative to baseline. The shock introduces a dissonance between the output and unemployment rate gaps, but does not distort the measurement of labor market utilization *per se*. Accordingly, we narrow our focus to the unemployment-based optimal policy and the standard FRB/US labor market equations that impose Okun's law.

The results are summarized in figure 4, where the thick solid (blue) lines show the optimal policy under the alternative scenario, while thin solid lines represent the optimal policy for the extended Tealbook for April. The scenario is constructed such that the output gap starts out 1 percentage point narrower than in the baseline. This narrower output gap implies that the unemployment gap will close earlier than in the baseline. Accordingly, optimal policy is initially tighter, calling for departure from the ELB one year earlier, in the third quarter of 2014. The higher initial readings for the nominal funds rate do not last for long, however, as reduced inflation pressures, anticipated in 2017 and beyond, cause the pace of policy tightening beyond 2016 to slow. This path for the funds rate results in a more rapid decline in the unemployment rate than in the baseline, as shown in the top-right panel.[23]

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[19] Erceg and Levin (2013) obtain a broadly similar result, although the overshoot of unemployment they produce appears to be smaller but longer lasting than what we show here.

[20] In the baseline, the participation rate gap closes by the end of 2016. By contrast, the participation rate gap in the unemployment-based optimization scenario does not close until 2021, while under the employment-based optimal policy the gap closes early in 2018, not a great deal later than in the baseline despite starting from an initial gap that is nearly 1 percentage point wider.

[21] We say the gains are "arguable" because whether the employment-based optimal policy produces actual gains relative to the unemployment-based optimal policy is a judgment call on the appropriate loss function. The FRB/US model does not have the structure to make a definitive case on this question.

[22] The inertial Taylor rule proves to be too narrow in its consideration of resource utilization when the unemployment and output gaps do not move as closely together as they do in the baseline. In particular, the inertial Taylor rule with thresholds (not shown) renders significantly higher unemployment and lower inflation than either of the trend participation rate scenarios shown in figure 3.

[23] When governed by the inertial Taylor rule, the federal funds rate remains at the ELB until 2015:Q2—longer than is optimal—but climbs faster thereafter. Inflation is lower than optimal, resulting in higher real rates than otherwise,

This scenario, like the previous one, shows how certain shocks can induce contrary movements in goods market measures—GDP growth in this case, which is worse than in the baseline—and labor market measures like the unemployment rate, which is better than in the baseline. It follows that the extent to which a single summary statistic of resource utilization can adequately capture that state of demand deficiency will depend on the origins of the shocks that produce those economic conditions in the first place. The examples considered in this section focused on supply-side shocks. However, as our discussion of the baseline interpretation of the recent history makes clear, demand-side shocks can induce an Okun's law error as well. Since the real-time identification of shocks is, at best, difficult, a broad-based approach to assessing resource utilization and designing monetary policy would appear to be in order.
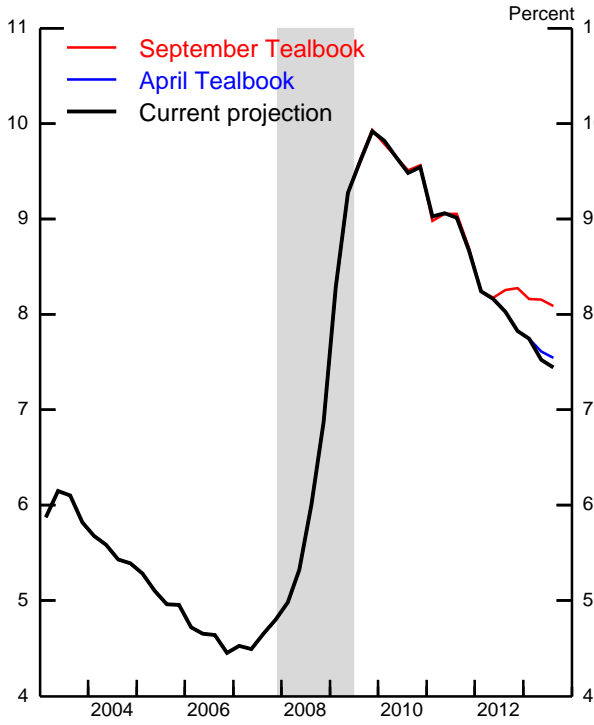
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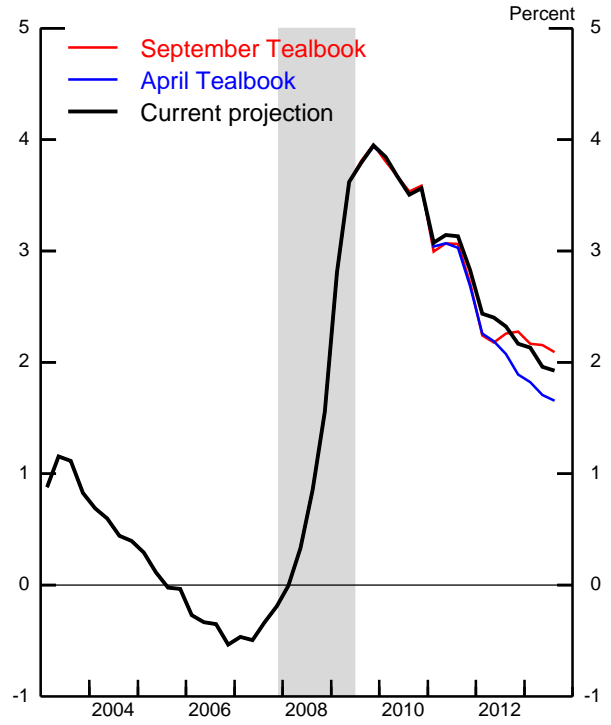
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and consequently, the unemployment rate does not overshoot the natural rate. Similarly, the output gap does not exceed zero during this decade.
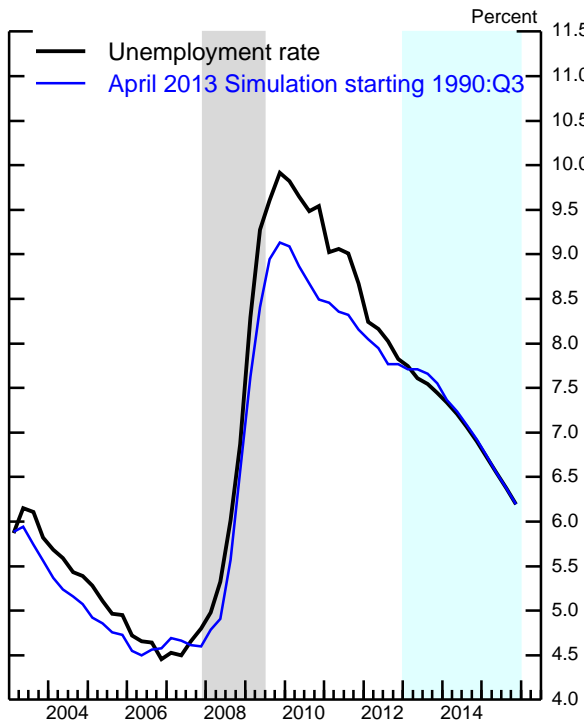
Figure 1
Okun's Law

Unemployment Rate

Legend:
- September Tealbook
- April Tealbook
- Current projection

Unemployment Rate Gap

Legend:
- September Tealbook
- April Tealbook
- Current projection

Okun's Law

Legend:
- Unemployment rate
- April 2013 Simulation starting 1990:Q3

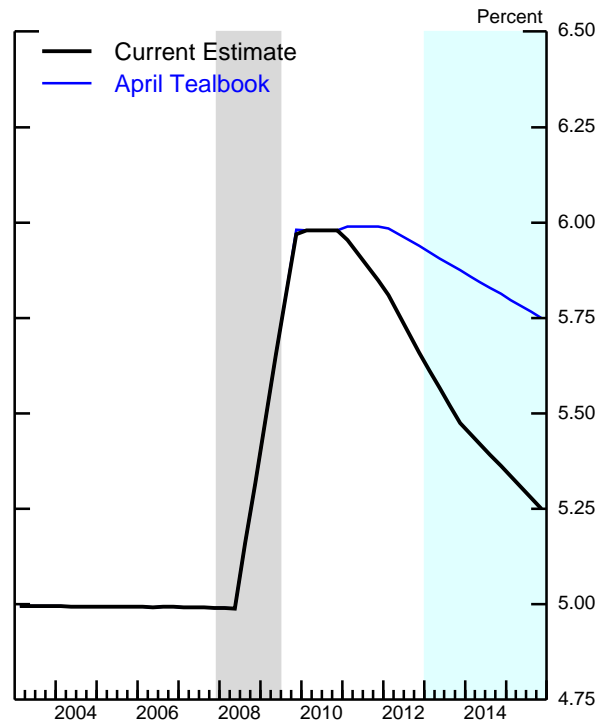### Natural Rate of Unemployment

Legend:
- Current Estimate
- April Tealbook

Figure 2
Indicators of Labor Market Functioning and Discouragement

Industry/Occupation Mismatch
(Contribution to the Unemployment Rate)

Permanent Job Losers

Barnichon-Figura Estimate of Matching Efficiency
(Contribution to the Unemployment Rate)

Note: Hollow dot is the average for April and May.

Social Security Disability Recipients

UN Transition Rate, by Unemployment Duration*

*Six-month moving averages of s.a. monthly data.

Unemployment Rate

* U-5 measures total unemployed plus all marginally
  attached to the labor force, as a percent of the labor force
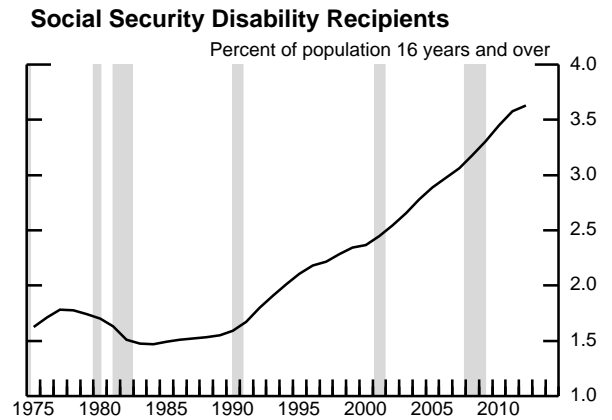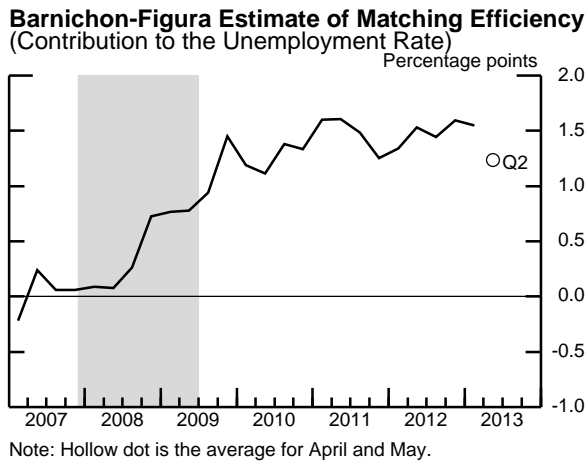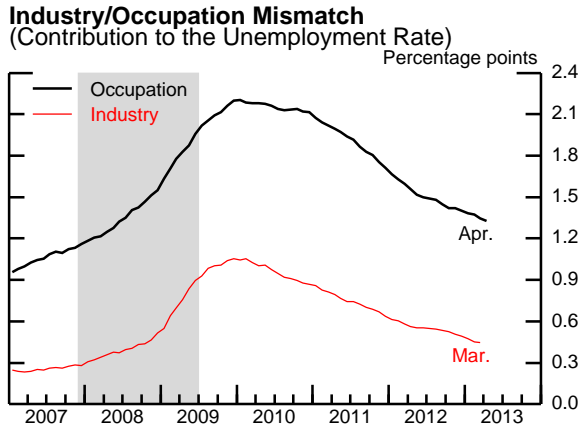 plus persons marginally attached

Figure 3

Optimal Control Simulations for Baseline and Alternative Trend Participation Scenario
(Optimization based on unemployment rate or employment rate, as indicated)

Real GDP — Q4/Q4 Growth

Civilian Unemployment Rate

Baseline (unemployment)
LFPR (unemployment)
LFPR (employment)

Natural Rate

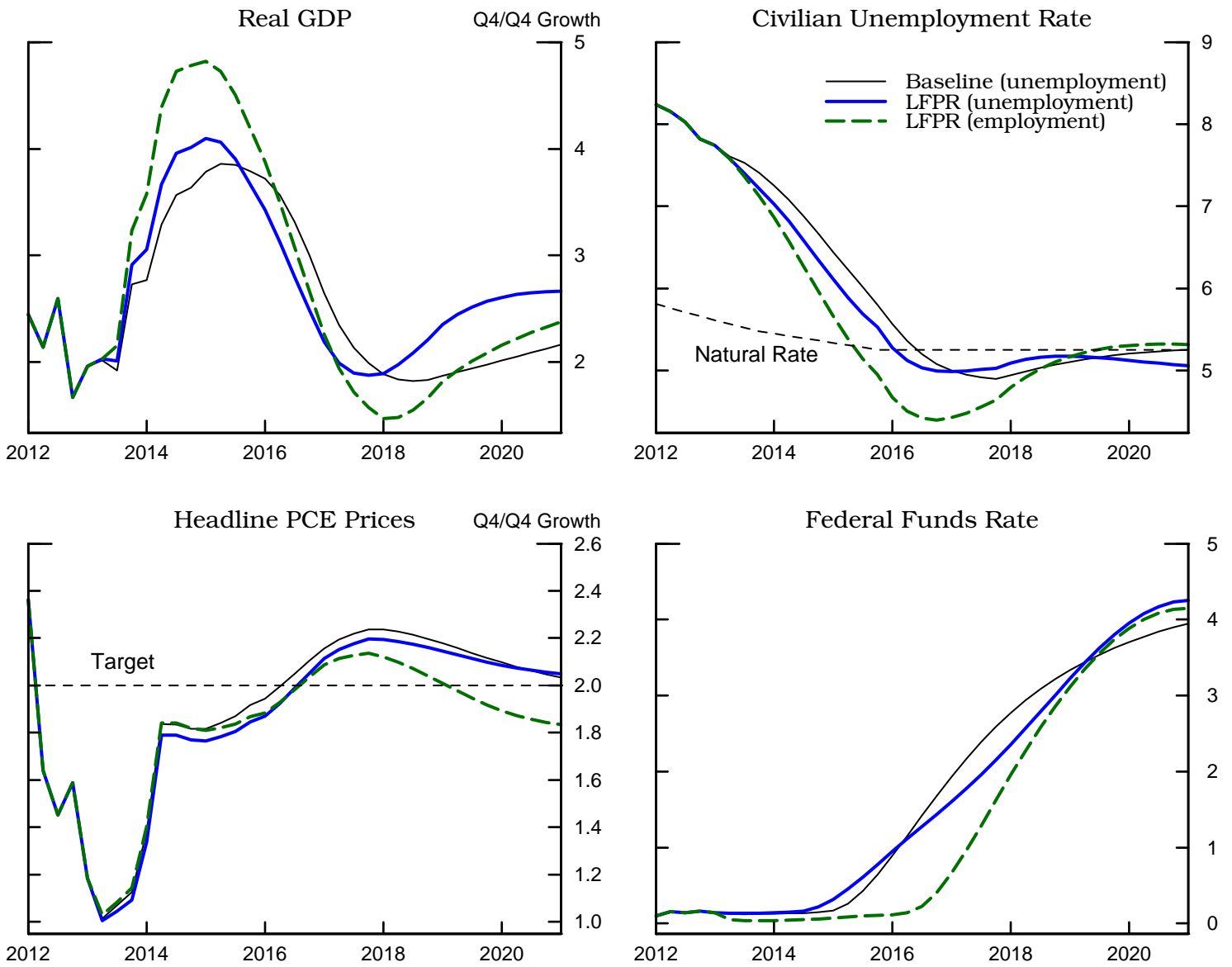Headline PCE Prices — Q4/Q4 Growth

Target

Federal Funds Rate

Figure 4

Optimal Control Simulations for Baseline and for a Shock Reducing Productivity Beginning in History
(Optimization based on unemployment rate)