The Staff's Assessment of Economic Slack

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Introduction

The Board staff presents two closely related measures of economic slack in the Tealbook: the difference between the unemployment rate and a reference level that is sometimes referred to as the natural rate of unemployment (or NAIRU), and the difference between GDP and potential GDP. These estimates of slack are constructed for two purposes: first, to provide an indicator of demand-related inflationary pressures, and second, to gauge the degree of underutilization of available resources. These measures help to inform both components of the Federal Reserve's dual mandate.

Panel A of Figure 1 plots the staff's current estimate of the NAIRU against the actual unemployment rate.[1] The staff estimates that the NAIRU has risen by about a percentage point since the beginning of the recession, to about 6 percent—a level that is comparable to the estimates of a number of outside analysts, including the Organisation for Economic Co-operation and Development (OECD), the Congressional Budget Office (CBO), and participants in the Survey of Professional Forecasters (SPF).[2] As this increase in the natural rate is much smaller than the rise in the actual unemployment rate from the recent recession, in the staff's view a large and persistent unemployment gap opened up, implying a significant amount of underutilized resources in the economy.

In practice, the staff's measures of the unemployment gap and the output gap are closely related, as the procedures used to estimate the two gap measures link them through Okun's Law. The close association of these two measures of economic slack can be seen in panel B of Figure 1. Nevertheless, there are times when the unemployment gap and the GDP gap do not move in lockstep—for example, the staff judges that labor demand declined in 2009 by more than would have ordinarily been implied by the corresponding shortfall in real GDP growth relative to potential. As a result, the unemployment gap at the end of 2009 was somewhat wider than what its usual relation with the GDP gap would have implied. In most cases, however, the two gap measures are not intended to convey independent information about economic slack.

Estimating the NAIRU and potential GDP is difficult because there are many techniques and numerous types of data that can be used. Moreover, a great deal of uncertainty attends the estimates from any given technique, for at least four reasons. First, for any particular technique,

[1] The staff adjusts the NAIRU for the effects of extended and emergency unemployment benefits (EEB) on the premise that these benefits influence the measured unemployment rate but do not contribute equivalently to slack. The staff refers to the NAIRU adjusted for EEB effects as the "effective NAIRU." The effective NAIRU is shown by the blue line in panel A; for 2012 as a whole, the EEB effects average 0.2 percentage point.
[2] Specifically, the OECD's estimate of the NAIRU in 2012 is 6.1 percent, while the CBO's NAIRU (including the influence of EEB effects) stands at 6 percent. In the 2012:Q3 SPF, the median estimate was 6 percent.

tractability requires making strong assumptions and theoretical simplifications, and the best choice of specification is often not obvious. Second, any single technique ignores a large amount of potentially useful information. Third, the quality of the available data often falls short of the ideal. Finally, different approaches—at least implicitly—reflect different assumptions about the main sources of business cycle fluctuations and structural change, and their likely persistence. As a result, the staff looks at the results from a variety of techniques and uses a wide array of data to form judgmental estimates of slack and to assess the uncertainty that surrounds them. This note provides an overview and discussion of various types of analysis that we consider when producing our estimates of economic slack.

Methods for Assessing Economic Slack

In arriving at its estimates of structural unemployment and potential output, the staff weighs a variety of evidence regarding the functioning of the labor market, the behavior of inflation, and the evolution of output. This evidence is obtained from a set of techniques that range from formal statistical modeling to less-formal observation.

Evidence on labor market functioning

One approach to assessing slack examines the functioning of the labor market, with a principal focus on the determinants and behavior of unemployment; some of the most salient analyses are described here. Importantly, many of these techniques provide estimates of *changes* in the natural rate over time (in particular, since the beginning of the recession), but are less well suited for estimating its *level*. However, there is wide agreement among analysts that the natural rate was in the vicinity of 5 percent before the recession began (Weidner and Williams, 2011). Consequently, estimated changes in the natural rate provide a reasonable guide to its current level.

Since the onset of the recession there has been a large amount of permanent job loss (as opposed to temporary layoffs), which has raised concerns that the natural rate of unemployment may have risen at least temporarily. As noted by Knotek and Terry (2009), among others, permanent job losers take longer to become re-employed than do those on temporary layoff, and are more likely to change industries or occupations. Thus, the greater amount of permanent job loss seen in the recent recession suggests that there may have been an increase in frictional unemployment and in the degree of mismatch between the skills possessed by the unemployed and those demanded by potential employers.

If frictional or structural unemployment has risen from this or from other causes, it should be apparent in the relationship between unemployment and job vacancies. Over the course of a business cycle, movements in vacancies and unemployment tend to trace out a negatively sloped locus known as a Beveridge curve (see panel C of Figure 1). Shifts in the Beveridge curve toward or away from the origin are often interpreted as reflecting changes in structural unemployment. Recent data suggest that there may have been an outward shift in the curve and hence an increase in structural unemployment. However, the dynamics of unemployment and vacancies are complicated, and comparisons with previous recessions suggest caution in interpreting recent movements in this relationship (Tasci and Lindner, 2010).

In particular, apparent shifts in the Beveridge curve can be driven by factors that do not reflect structural unemployment, such as temporary bulges in the rate of job loss or the extended and emergency unemployment benefits mentioned in footnote 1. Standard theoretical derivations of the curve point to job-matching efficiency—the flow of hiring generated by a given amount of vacancies and unemployment—as one element that does influence structural unemployment. Therefore, we look at results from empirical "matching functions," often in conjunction with other data on gross flows among labor market states, to infer changes in matching efficiency. The staff tends to concentrate on the model of Barnichon and Figura (2011); related studies include those of Barlevy (2011), Daly, *et al.* (2012), and Veracierto (2011). As Veracierto (2011) notes, the estimates obtained from this type of model can be sensitive to variations in specification.[3] That said, the estimates preferred by these studies' authors tend to center around an increase in structural unemployment on the order of 1 percentage point.

A different approach to analyzing the relationship between unemployment and vacancies was taken by Blanchard and Diamond (1989), who used a structural VAR model of unemployment, vacancies, and the labor force to identify the sources of shifts in the Beveridge curve. Using their methodology to analyze the 2007-2009 recession and subsequent recovery suggests that shifts of the Beveridge curve associated with higher structural unemployment contributed a maximum of ¾ percentage point to the unemployment rate in early 2010; more recently, this contribution has declined to about zero.

Data on gross labor force flows can also be analyzed with reference to output rather than to vacancies, similar to how an Okun's Law model relates the unemployment rate to output. In this fashion, the model in Tasci (2011) extracts the trends in various labor force flows and uses them to compute an estimate of the natural rate of unemployment. According to the latest estimates from this model, the natural rate rose ¼ percentage point during the recession, and has already returned to its pre-recession level of about 5¾ percent.

If mismatch in the labor market has led to an excess supply of workers in some sectors and a shortage of workers in other sectors, then we would expect to see an atypical amount of variation in the vacancy-unemployment ratio across sectors. Şahin, *et al.* (2012) look for these imbalances across industries, occupations, and geographic areas, and conclude that as of late 2009, up to 1¾ percentage points of the increase in aggregate unemployment could be attributed to this source (a figure that has probably declined as the labor market has improved).[4] Mismatches between jobs and workers across sectors might be expected to also cause wage rates to rise relatively quickly in sectors with many vacancies and relatively slowly in sectors with an excess

[3] Moreover, evidence from cross-sectional relationships suggests that matching function models may overstate the degree of mismatch because of changes in firms' recruitment behavior during periods of low demand (Davis, Faberman, and Haltiwanger, 2012).

[4] Estevão and Tsounta (2011) try to assess mismatch more directly by comparing the skill requirements of jobs in each state to the skill levels of the state's population; they estimate a similar increase in structural unemployment, but conjecture that their results may largely reflect temporary shifts in industry mix.

of available workers. Rothstein (2012) fails to find evidence of this phenomenon, although data limitations make this task difficult.

The large increase in long-term unemployment since the onset of the recession has also raised concerns that long spells of unemployment may make individuals less desirable to employers and result in persistent unemployment—in the aggregate as well as for those individuals. The literature has found little historical evidence of such hysteresis in the United States, but it is possible that this episode, which has been much more severe than those previously analyzed, is different. For this reason, the staff monitors evidence on, among other things, how exit rates from unemployment to employment vary by duration of unemployment (so far, there appears to be little connection). The staff also weighs the results from studies such as Hornstein (2011), which assesses the contributions of changes in these exit rates and changes in the fraction of the unemployed who are prone to long unemployment spells to movements in overall unemployment. Hornstein (2011) finds that in general most of the increase in unemployment in recessions can be attributed to a decline in the exit rates of the long-term unemployed and an increase in the fraction of the unemployed who are long-duration types, which he interprets as due to structural factors such as mismatch. If history is a guide, however, these factors will subside as the aggregate economy recovers. Relatedly, Elsby, *et al.* (2011) compute an upper bound for the effects of long unemployment durations on structural unemployment; they find that if the transition rates for the long-duration unemployed (that is, those unemployed longer than one year) fail to recover at all while the transition rates of the shorter-duration unemployed return to pre-recession levels, the unemployment rate would fall to 6 percent, suggesting that the effects of long durations may have raised structural unemployment by at most about 1 percentage point.

This last counterfactual, in which the exit rates of the long-term unemployed remain depressed even after a general recovery of labor demand, highlights a general issue that arises in assessing how much structural unemployment may have increased during the recession: Many of the factors driving an estimated rise in structural unemployment, such as sectoral mismatch, may eventually reverse as the economy recovers. This possibility adds significant uncertainty to these estimates, and raises the question of whether an increase in unemployment arising from these factors is truly structural.

As a further check on our estimates of labor market slack, the staff considers more-circumstantial evidence; this evidence also suggests that a large amount of slack remains in labor markets. Notably, the index of job availability from the Conference Board survey (respondents who say that jobs are plentiful relative to those who say that jobs are hard to get) and the NFIB measure of firms with "hard to fill" job openings, both of which are closely correlated with the staff's unemployment gap, remain at levels suggesting that labor demand is weak (see panel D of Figure 1). In addition, the number of persons reporting that they are working part-time for economic reasons remains extraordinarily high, while the quit rate remains depressed.

Estimates of economic slack from Phillips curves

If inflation depends on slack, then we can use observed movements in inflation and real activity (real GDP or the unemployment rate) to infer the level of potential GDP or the NAIRU. One common way this is done involves fitting a conventional empirical inflation model (a Phillips curve) in which the level of the NAIRU (or potential output) is allowed to vary over time, either as a smooth function of calendar time or as a stochastic process that is estimated with a Kalman filter.

In practice, a large degree of statistical uncertainty surrounds estimates of slack obtained from this kind of approach. For example, Staiger, Stock, and Watson (1997) find that the 95-percent confidence interval for NAIRU estimates typically extends 1½ percentage points on either side of the point estimate, and is often even wider. In addition, NAIRU estimates *across* different empirical specifications of the Phillips curve also vary significantly, implying that uncertainty about the level of the NAIRU is even greater once model uncertainty is taken into account.

Combining output, labor market, and Phillips curve information to estimate economic slack

Fleischman and Roberts (2011) developed a multivariate model that combines information on output and the labor market with information from a Phillips curve. Specifically, the model includes data on inflation, real GDP, real nonfarm business income, the unemployment rate, the labor force participation rate, and aggregate worker hours, employment, and output in the nonfarm business sector. The model uses a Kalman filter to decompose each of these variables into trend, cycle, and idiosyncratic components, with the (unobserved) cycle assumed to be the same for all variables. From the model's perspective, the fact that the unemployment rate has been persistently high over the past several years while inflation has remained fairly stable suggests that the amount of slack in the economy has not been as large as that implied by an unchanged NAIRU. Accordingly, the model estimates that the NAIRU has risen since the beginning of the recession, with estimates for the current value of the NAIRU that center around 6¼ percent. (The sensitivity of this estimate to the model's specification is discussed below.)

Estimates of economic slack from DSGE models

Dynamic stochastic general-equilibrium models (DSGE models) are attractive frameworks for estimating slack because they combine equations characterizing the behavior of households, firms, and policymakers to form a system that provides an internally consistent description of aggregate spending, inflation, labor markets, and financial developments. These equations are, for the most part, derived from explicit microeconomic optimization problems; as a result, DSGE model-based estimates of slack can be linked to economic efficiency in a way that is more direct than is the case for time-series or judgmental approaches.

DSGE models can be used to generate output gap estimates for three commonly used slack concepts.

- *Beveridge-Nelson trend.* Following Beveridge and Nelson (1981), we can associate cyclical movements in a given variable with the variable's transitory fluctuations. Specifically, the cyclical component of a variable can be defined as the difference between its current value and the value it is expected to have in the far future after the latter has been adjusted for any (unconditional) trend growth. Under this definition, potential output corresponds to a "long-run trend," and will equal the level of output that is expected to obtain after any previous and current shocks have fully worked their way through the economy.[5]

- *Production function.* Some of the earliest approaches to estimating economic slack defined potential output as the level of production that would result if current capital and labor resources were fully employed. In a DSGE model, such an estimate is given by the model's aggregate production function when labor inputs and capital utilization rates are set equal to their steady-state levels. This measure of potential output is influenced by shocks to technology, but it will be affected by other shocks only to the extent that they affect either the level of the capital stock or steady-state labor input.

- *Natural rate of output.* The natural rate of output is the level of production that would result if wages and prices were fully flexible and there were no shocks to wage or price markups. Since nominal rigidities prevent the economy from being at its real-side equilibrium in the new-Keynesian framework that underpins many DSGE models, this concept provides an intuitive definition of potential output in these models.

We would emphasize that these gap concepts are *not* unique to the DSGE framework; rather, the point is that a particular DSGE model represents a characterization of the economy and its dynamics that can be usefully employed to compute these various gap measures. Indeed, the three gap concepts listed above have close parallels in the approaches that the staff and others take in estimating economic slack. The Beveridge-Nelson approach seeks to extract the sorts of long-run stochastic trends that other frameworks (such as the Fleischman-Roberts model) try to identify using a Kalman filter; likewise, the production function approach is similar to the growth accounting exercises that the CBO and others use to assess potential output. In addition, the intellectual underpinnings of the natural rate concept used in DSGE models—namely, Wicksell's theory of the natural rate of interest—are identical to what Friedman (1968) invoked in his analysis of the Phillips curve, which in turn provides the motivation for using inflation equations to generate estimates of the natural rate of unemployment.[6]

Panel A of Figure 2 plots the production function measure of the output gap from the Board's EDO model (which is the output gap measure that is used in the model's monetary policy rule), together with the Tealbook output gap.[7] The two gap estimates are correlated over history and have similar cyclical turning points. Nevertheless, notable differences do arise at times—for instance, relative to the staff gap the EDO model's production function gap sees output as being further above potential at the 2007 business cycle peak and not as far below potential in 2011. To compare alternative conceptual definitions of potential output and economic slack derived *within* a particular DSGE model, panel B of Figure 2 plots historical estimates of the output gap based on the three potential output concepts as implemented in the EDO model.[8] The three gap

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[5] See King, Plosser, Stock, and Watson (1991) and Rotemberg and Woodford (1996) for related examples.

[6] Friedman (1968) defined the natural rate of unemployment as "the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility, and so on."

[7] The staff and model-based gaps shown here are based on data that pre-date the July annual revision of the NIPAs.

[8] Kiley (2012) performs a similar exercise. It should be noted that there can be multiple ways to define the natural rate of output even in the context of a single DSGE model. In particular, once the current state of the economy (for

measures are highly correlated, and each implies cyclical movements that are roughly in line with the NBER's business cycle reference dates.[9] However, they also differ substantially at times—although the implications of those differences for monetary policy are often not obvious.

Because DSGE models are grounded in optimizing behavior—specifically, the utility maximization of a representative household—they can generate measures of economic slack that have welfare-based interpretations. Even so, these slack measures will often provide only a partial guide to policy. For example, the EDO model assumes nominal price and wage rigidities in two separate sectors of the economy. Eliminating these rigidities yields the natural rate of output—the efficient level of production, all else equal. Even so, it is not the case that monetary policy should focus exclusively on closing the natural rate gap: Because monetary policy cannot counter the effects of all of the rigidities simultaneously, a policy strategy designed to only reduce the natural rate gap would lead to sectoral distortions that would reduce social welfare.[10] (Indeed, only in very simple new-Keynesian models is the objective for monetary policy fully summarized by a desire to close the natural rate gap.)

In addition, it can be difficult to interpret exogenous shocks—and their implications for economic efficiency—in DSGE models. For example, the EDO model attributes a portion of the decline in output over the 2008-2009 period to an increase in imputed risk premiums for business and residential investment (this estimated increase likely reflects the more-restrictive credit market conditions seen during this period). In the EDO model, increases in these risk premiums depress the natural rate of output because they would have real effects even if wages and prices were fully flexible. However, to assess the policy implications of a decline in the natural rate of output from this source, one must take a stand on whether the increase in investment-specific risk premiums represents an efficient shift (such as a response to a change in the productivity of financial intermediaries) or an inefficient shift (such as a transitory increase in information frictions between borrowers and lenders that a "social planner" would prefer to offset).

Hence, while estimated movements in the natural rate of output can contain useful information for policymakers, measures of the output gap based on the natural rate concept cannot always be unambiguously interpreted, and will most likely provide an incomplete guide to policy actions and welfare. In addition, like any slack measure, estimates of the natural rate of output can depend importantly on the particular specification of a DSGE model. For example, both the EDO model and the DSGE model of Smets and Wouters (2007) allow for shifts in an *aggregate* risk premium, which change the rate of return on household assets. In these models, shocks to

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example, the current value of the capital stock) depends on past economic outcomes, then it will be necessary to decide whether the natural rate should be defined in terms of the *current* state of the economy, assuming that prices become flexible *from this point forward* (that is, taking history as given), or whether it should be defined in terms of the outcome that would have obtained had prices been flexible *at every point in time*—in the past, now, and in the future. (See Woodford, 2003, pp. 372-73.) The natural rate gap shown in Figure 2 uses the first definition, which takes history as given; had the second concept been used instead, the resulting gap measure would imply a 5½ percent shortfall of output relative to potential at the end of 2011.

[9] In EDO, differences between the Beveridge-Nelson and production function gaps solely reflect movements in the productive capital stock. Such cycles are modest but fairly persistent; for example, the rise in the capital stock during the 1990s technology boom boosts the production function measure of potential and implies a smaller gap by this definition over much of this period.

[10] This situation arises when there are sticky prices *and* wages (Erceg, Henderson, and Levin, 2000) or multiple sectors (Erceg and Levin, 2006; Aoki, 2001); both of these features are present in EDO.

this risk premium are neutral with respect to the natural rate of output (they are essentially similar to monetary policy shocks—exogenous changes in the federal funds rate—which have no effect on output if wages and prices are fully flexible). Moreover, this risk premium shock accounts for an important fraction of the decline in output over 2008-2009 and the resulting widening of the natural rate gap. In contrast, some DSGE models—such as those maintained at the Federal Reserve Banks of Philadelphia and Chicago—allow for shocks to the representative household's rate of time preference (which do affect the natural rate of output). All else equal, such differences in specification can result in important differences in the estimated natural rate of output over this period across the different models. In general, however, there is no *a priori* reason to prefer one modeling approach over another, which illustrates another difficulty associated with using this type of gap measure in a policy setting.

Summary

To summarize, after weighing all of the available evidence, the staff estimates that the natural rate of unemployment has risen by about a percentage point since the beginning of the recession and currently stands at about 6 percent. This implies an unemployment gap of more than 2 percentage points in the first half of 2012 (and a GDP gap of more than 4 percent). Of course, in response to new information and in view of the uncertainties summarized in the next section, we re-assess our estimates of slack on an ongoing basis.

The Uncertainty Surrounding Estimates of Economic Slack

As noted above, every technique for estimating economic slack is significantly limited in the variety of information it takes into account, the economic mechanisms it can represent, the quality of the data available, and the assumptions it employs to generate interpretable results. A few specific examples:

- Even a relatively broad model like Fleischman-Roberts does not take into account information on gross labor market flows.

- Techniques that rely on the historical persistence of shocks to identify trends may not be reliable when a shortfall in aggregate demand is atypically long-lasting.

- The data on job vacancies from the Job Opening and Labor Turnover Survey (JOLTS) only begin in 2001. For earlier periods, the literature relies on the Conference Board's measures of help-wanted advertising, which may suffer from inconsistencies over time and which began covering internet advertising only in 2005.

Indeed, the uncertainty surrounding the results obtained from even a single model—which takes the form of statistical uncertainty, estimation uncertainty, and specification uncertainty—can be substantial. For example, estimates of the NAIRU from the Fleischman-Roberts model can vary importantly with reasonable changes in specification. The version of the model cited above estimates that the NAIRU in 2012:Q2 was 6¼ percent. Under the baseline specification in Fleischman and Roberts (2011), the estimate is 6½ percent. Beginning from that baseline specification, but allowing the coefficient on the gap in the model's Phillips curve to change in the mid-1980s, yields an estimate for the NAIRU of about 6 percent. Changing the specification of the Phillips curve so that the equation uses a survey-based measure of inflation expectations (instead of assuming that longer-run inflation expectations are well-approximated by lagged inflation) yields a NAIRU estimate of about 5 percent, while replacing the core CPI in that specification with core PCE prices yields an estimate of 5¾ percent. Thus, modest changes in the model's specification can lead to estimates of the NAIRU that range from 5 to 6½ percent.[11]

Another source of uncertainty is variation in the concept of slack employed. An estimation technique that makes explicit use of inflation dynamics (for example, through the incorporation of an accelerationist Phillips curve into the model) suggests a NAIRU concept of slack, while a model of labor market functioning lends itself to a natural rate concept of slack with a potentially looser connection to inflation. Indeed, more than one concept of slack can be obtained from a particular model (as was noted in the discussion of DSGE models), and each concept of slack can have a different relation to inflation and manifest different cyclical dynamics.

Finally, the extent to which the changes in resource utilization that occurred during the recession will persist as the economy recovers—that is, the extent to which these changes are structural—is a major source of uncertainty. The interpretation of estimates of slack and their implications for policy depend critically on the likely persistence of the factors driving any change in the estimated level of full employment.

The numerous limitations and uncertainties inherent in any one model or analytical technique (or class of models or techniques) underscore why it is sensible to consider a wide range of information and a variety of approaches in drawing inferences about the level of slack.

The Role of Slack in the Staff's Inflation Framework

The staff views slack as just one of several important determinants of inflation. While the various empirical inflation models that the staff consults differ in important ways, the staff's basic framework for interpreting and projecting core inflation can be summarized with a stylized expectations-augmented Phillips curve of the form

$$\pi_t = \pi_t^e + \beta X_t + \gamma Z_t + \rho(\pi_{t-1} - \pi_t^e) + \varepsilon_t \qquad (0 < \rho < 1).$$

Here π denotes core inflation; π^e is the staff's judgmental estimate of the public's long-run inflation expectations (which is informed by survey and financial-market measures); X is a measure of slack (for example, the staff's measure of the unemployment gap); Z is a set of other influences, including changes in the relative prices of energy and imported goods and materials ("supply shocks"); and ε is a residual. To capture the sluggish adjustment of inflation to changes in expected inflation, slack, and other factors, the equation contains a lag (in practice, multiple

[11] Moreover, the results described in Mertens (2012) suggest that trend and cycle decompositions in models of this general sort can also be sensitive to whether the estimation procedure allows for stochastic volatility in the model's cyclical component.

lags) of core inflation; eventually, however, permanent changes in expected inflation pass through one-for-one into actual inflation.

The effect of slack or other factors on inflation depends importantly on whether these influences also affect inflation expectations. All else equal, an increase in slack pushes inflation lower. If long-run inflation expectations are well anchored—and the staff's assessment is that this has been the case in recent years—inflation will remain at this lower level as long as the unemployment gap holds steady; as the amount of slack diminishes, inflation will return to its original level. Hence, if no other influences are at work—and if expectations remain anchored—then a stable unemployment or output gap implies a stable rate of inflation; however, if slack is diminishing (increasing), then inflation will rise (fall), all else equal. Aside from these basic dynamics, core inflation can also vary over time as a result of movements in relative energy and import prices and in response to other types of shocks; indeed, these "other factors" account for most of the variation in inflation from year to year.

The staff's inflation framework contrasts with the so-called *accelerationist* model of inflation, in which inflation expectations are implicitly assumed to be formed as a distributed lag of past inflation rates with lag coefficients that sum to one. (The restriction on the sum of the lags reflects the assumption that permanent changes in average inflation are eventually fully reflected in agents' expectations.) In an accelerationist model, the influence of slack is cumulative: Inflation will continue to decline as long as any slack is present, and a *transitory* change in slack results in a *permanent* change in inflation because the initial change in inflation leaves a permanent imprint on inflation expectations.[12] Previously, the staff placed some weight on the projections of accelerationist-style models in producing the Tealbook inflation forecast. As it became more apparent that inflation expectations were well anchored (specifically, as survey and other measures of long-run expectations showed little net change during the recession and afterward), the staff moved away from the accelerationist view, and now place very little weight on these models.

Summary of Key Points

The staff evaluates a broad array of information and techniques in forming a judgmental assessment of the level of the natural rate of unemployment (or NAIRU) and potential output. Unfortunately, there is no theoretical definition of these two concepts that is unambiguously correct, and different definitions may be appropriate for different purposes. As a result the staff applies a less-precise operational definition that simultaneously serves as a gauge of demand-related pressure on inflation and as a level of activity and unemployment that corresponds to the full utilization of available resources, thus helping to inform both elements of the Federal Reserve's dual mandate.

[12] For this reason, it is technically incorrect to use the term "NAIRU" in the context of the staff's inflation framework. Strictly speaking, a NAIRU—which is the level of unemployment consistent with no change in inflation—is only defined in an accelerationist context; in the staff framework, *any* (constant) value of the unemployment gap is in principle consistent with a stable inflation rate. Since the use of the term "NAIRU" for the reference level of unemployment in an unemployment-gap measure is by now well established, the staff continue to use it in this looser sense (for example, in the Tealbook).

Estimates of the natural rate of unemployment and potential output, and associated levels of economic slack, can differ substantially depending upon which estimation techniques are used. Yet given the variety of information available and inherent limitations of each method, no single technique can be considered sufficient. Moreover, estimates of economic slack vary across different specifications of a single technique, and even within a single specification there may be wide confidence bands around an estimate. For these reasons, the staff draws on a large set of techniques and a broad range of evidence to construct our judgmental estimates of slack, while recognizing the uncertainty on both sides of these estimates.

The preponderance of the available evidence suggests that there is currently a large margin of slack in the economy. Furthermore, under the staff's interpretation of inflation dynamics—in which long-run inflation expectations have been and continue to be well anchored—this large margin of slack is consistent with the observed stability of core inflation and with the possibility that inflation will remain stable or even rise over the medium term.

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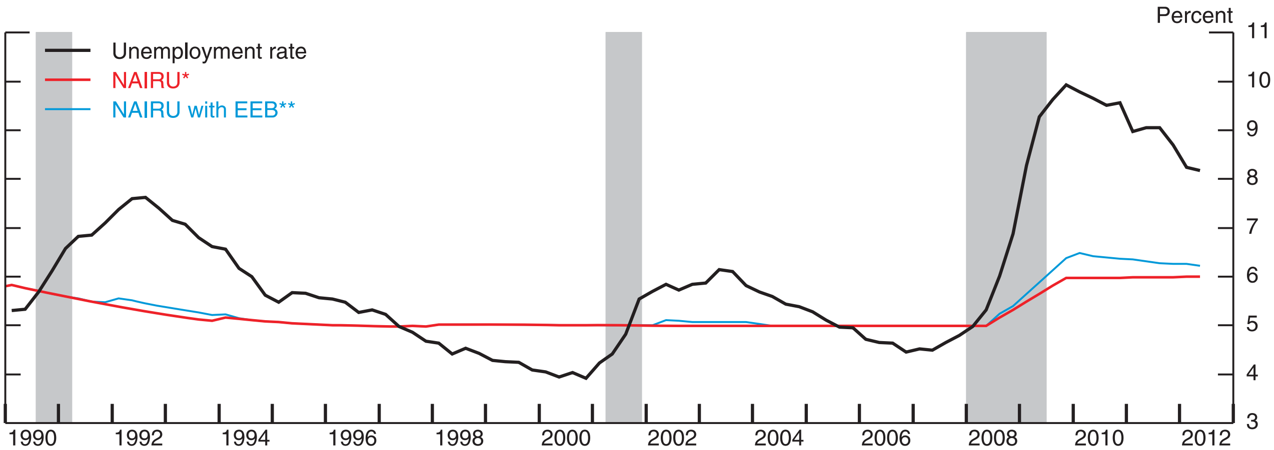
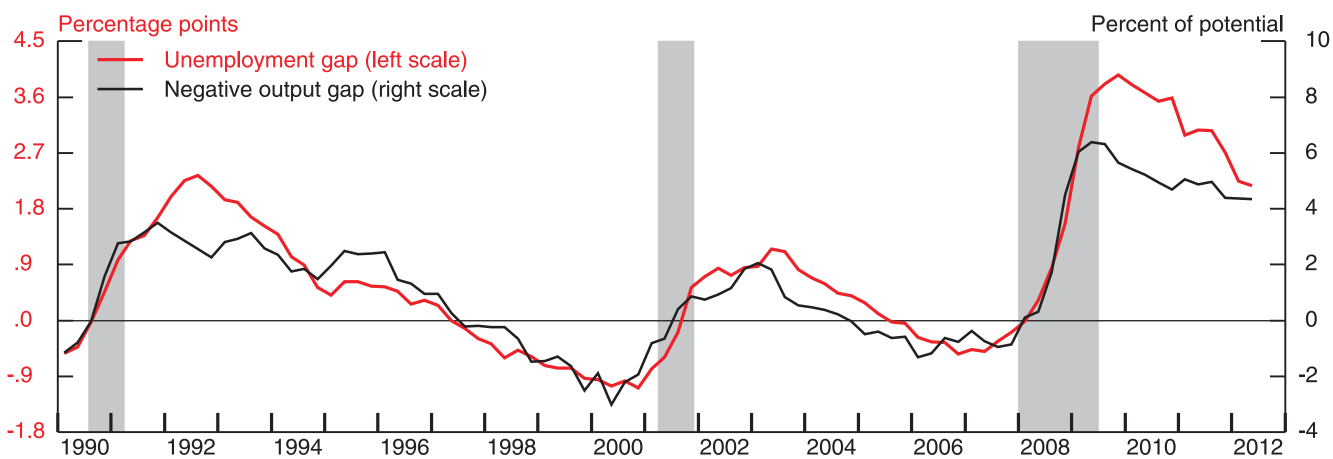
Figure 1: Measures of Slack

A. Unemployment rate and staff NAIRU

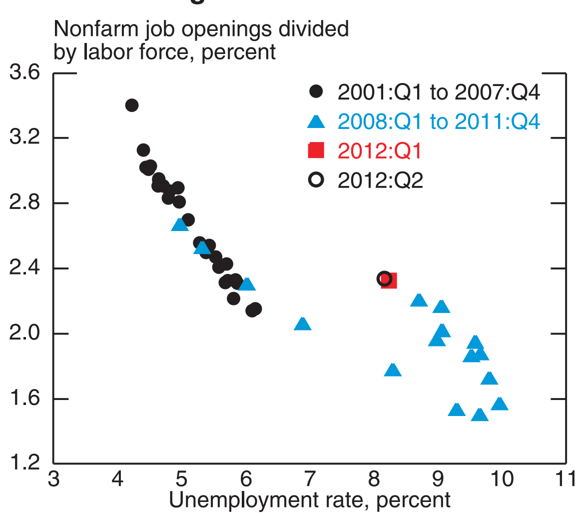


* Staff estimate.
** EEB refers to emergency unemployment compensation and state-federal extended benefits programs.

B. Unemployment gap and output gap



C. Beveridge curve*



* Job openings from the Job Openings and Labor Turnover Survey.

D. Alternative measures of labor market slack

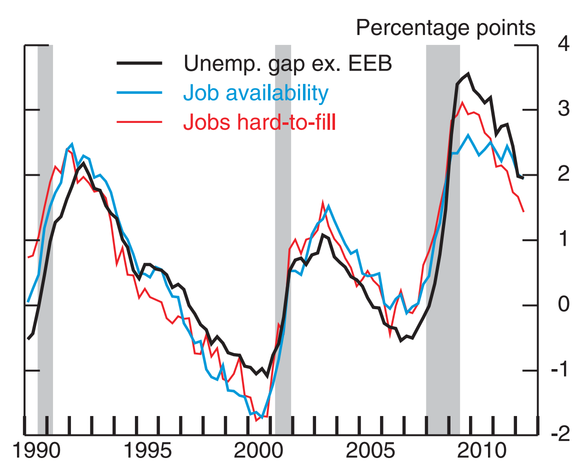
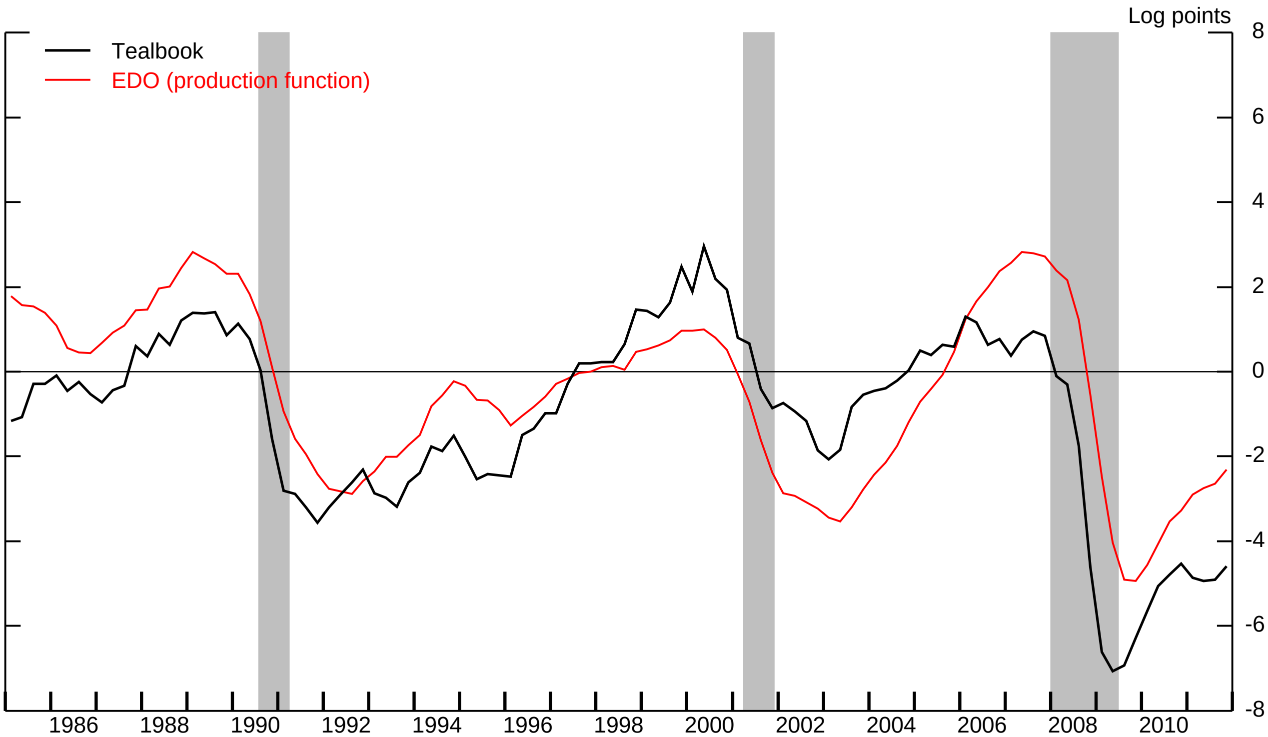


Figure 2: Estimates of the Output Gap

A. Tealbook and EDO (production function) gaps



B. EDO-based gap measures