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A Wedge in the Dual Mandate: Monetary Policy and Long-Term Unemployment*

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Abstract

In standard macroeconomic models, the two objectives in the Federal Reserve's dual mandate—full employment and price stability—are closely intertwined. We motivate and estimate an alternative model in which long-term unemployment varies endogenously over the business cycle but does not affect price inflation. In this new model, an increase in long-term unemployment as a share of total unemployment creates short-term tradeoffs for optimal monetary policy and a wedge in the dual mandate. In particular, faced with high long-term unemployment following the Great Recession, optimal monetary policy would allow inflation to overshoot its target more than in standard models.

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1 Introduction

The Federal Reserve's statutory dual mandate to achieve the goals of full employment and price stability has been a crucial element in the formulation and conduct of U.S. monetary policy. However, although not always appreciated, the term "dual" means more than just the existence of *two* objectives, for it also connotes a link between those goals. The Federal Open Market Committee's (FOMC) Statement on Longer-Run Goals and Monetary Policy Strategy (2014) describes this link:

> In setting monetary policy, the Committee seeks to mitigate deviations of inflation from its longer-run goal and deviations of employment from the Committee's assessments of its maximum level. These objectives are generally complementary. However, under circumstances in which the Committee judges that the objectives are not complementary, it follows a balanced approach in promoting them, taking into account the magnitude of the deviations and the potentially different time horizons over which employment and inflation are projected to return to levels judged consistent with its mandate.

That is, the achievement of full employment is viewed as closely intertwined with the achievement of price stability. Indeed, in standard macroeconomic models, employment and inflation move in the same direction in response to demand-type shocks. This positive comovement, or complementarity, underlies the so-called divine coincidence of monetary policy, in which the central bank can simultaneously stabilize both employment and inflation by altering a single policy instrument—the short-term nominal interest rate. In contrast, supply-type shocks, which push employment and inflation in opposite directions, disrupt this complementarity and lead to tradeoffs for monetary policy that must be balanced. In this paper, we introduce a wedge in the dual mandate that gives demand shocks some of the attributes of a supply shock, thus leading to monetary policy objectives that are less complementary and to greater tradeoffs for monetary policymakers over time.[1]

The wedge we introduce is based on the prevalence of long-term unemployment and its distinct properties. For Europe, a well-established literature has argued that the long-term unemployed are less attached to the labor market than the short-term unemployed and, consequently, have little influence on wage and price determination. More recently, a variety of studies have highlighted this same phenomenon in the United States, including Stock (2011), Gordon (2013), Krueger, Cramer, and Cho (2014), Watson (2014), and the Economic Report

[1] Another aspect of the close connection between both parts of the dual mandate in the standard framework arises because the full employment goal is taken as equivalent to the level of employment consistent with price stability. Or, in the usual terminology, the natural rate of unemployment is equivalent to the non-accelerating inflation rate of unemployment, or NAIRU. See, for example, footnote 17 in the analysis of Yellen (2012).

of the President from the Council of Economic Advisers (2014, pp. 82-83). Given the unprecedented spike in long-term unemployment in the wake of the Great Recession, this research concludes that long-term unemployment has much less influence on inflation than short-term unemployment. Although far from dispositive, this evidence suggests that the measure of slack relevant for determining U.S. inflation may also be more narrowly focused on short-term unemployment than total unemployment.

If the long-term unemployed have little or no effect on wages and prices, a key question for policy is whether the yardstick for measuring full employment should be similarly adjusted. That is, should policymakers focus on closing the short-term unemployment gap or, to the same effect, adjust the natural rate of total unemployment upward to completely offset the greater number of long-term unemployed. So far, the available evidence does not support such an approach. As stated by Federal Reserve Chair Janet Yellen (2014), the long-term unemployed remain relevant for assessing slack because they "look basically the same as other unemployed people in terms of their occupations, educational attainment, and other characteristics." That is, the evidence suggests that the long-term unemployed are able and willing to work and only differentiated by the duration of their joblessness.

Indeed, rather than narrowing the definition of slack, some Fed policymakers have instead indicated that they are considering a *more expansive* measure for assessing full employment than just the total unemployment rate. Notably, Yellen (2014) argues for a broad view of full employment that includes not just the short- and long-term jobless in the benchmark unemployment count but also takes account of the number of discouraged job-seekers and part-time employees who want full-time work.[2] This broad definition implies an even greater separation between the slack relevant for forecasting inflation and the slack relevant for assessing full employment.[3] It is thus consistent in spirit with the alternative framework that we propose, and the use of this expanded definition of slack would amplify our quantitative results. Still, for our analysis, we only consider a wedge in the dual mandate resulting from the long-term unemployed and leave for future research consideration of a more expansive definition of full employment.

[2]Similarly, the minutes of the FOMC meeting on January 29, 2014, noted that several participants "pointed out that broader concepts of the unemployment rate, such as those that include nonparticipants who report that they want a job and those working part time who want full-time work, remained well above the official unemployment rate, suggesting that considerable labor market slack remained despite the reduction in the unemployment rate."

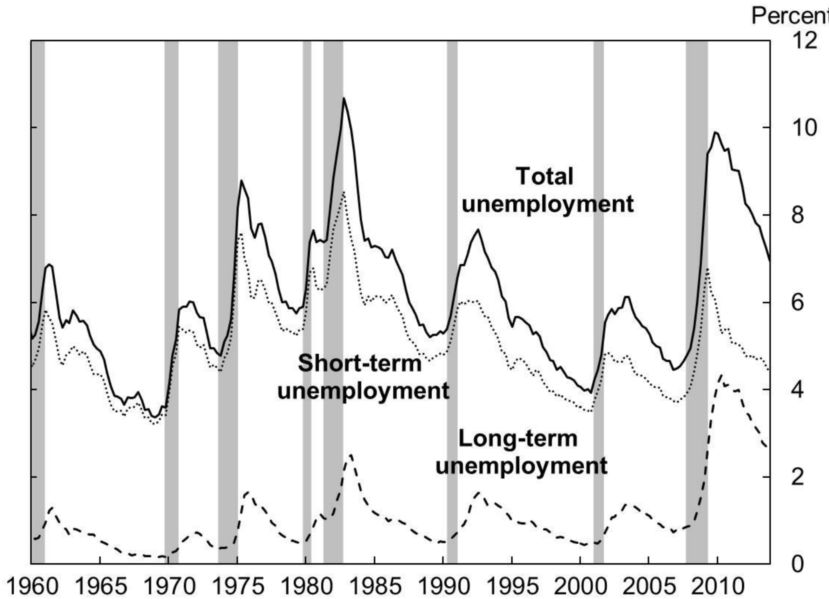
[3]Assuming, for example, that involuntary part-term employees are not integral to wage determination (and the Phillips curve) perhaps because by expressing a desire for more hours of work at their current wage, part-time workers have lost bargaining power.

We begin our investigation of these issues by first describing how short- and long-term unemployment can be integrated into a simple model built with three macroeconomic relationships. The first of these relates the short-term unemployment share of total unemployment to the overall business cycle. Although this relationship, which determines an endogenous, countercyclical short-term share, is new to the literature, it is both intuitive and well supported in the data. The second equation determines inflation and is consistent with the literature noted earlier that finds that short-term unemployment is the best measure of inflationary gaps in European and U.S. Phillips curves. The third equation is a rudimentary traditional IS curve or Euler equation that relates unemployment to the nominal short-term interest rate, which is the monetary policy instrument. Of course, our simple empirical structure is far from a definitive treatment or the final word on these issues. However, our evidence, along with earlier work, seems to support these macroeconomic relationships as plausible ones that are worthy of further consideration and policy analysis.

Given this simple structure, we then investigate its implications for monetary policy. We compare optimal monetary policy in this alternative model in which the short-term unemployment share is determined endogenously and only the short-term unemployed affect inflation to optimal policy in a standard model without those features. From the perspective of the dual mandate, transitory movements in the short-term unemployment share create a wedge between the unemployment rate relevant for inflation and that relevant for characterizing maximum employment. This wedge creates a tradeoff for monetary policy because it is not feasible to attain both objectives simultaneously. In our empirical policy analysis, we find that movements in the short-term unemployment share can create sizable monetary policy tradeoffs. In particular, we use model simulations to show that following the Great Recession, when the short-term unemployment share was at a historic low, the optimal monetary policy would allow inflation to rise well above levels implied by the standard model and indeed to overshoot the inflation target for a time.

The paper is structured as follows. Section 2 describes the variation in the share of short- and long-term unemployment over time in the broader context of the economy. Section 3 discusses the relevance of long-term unemployment for monetary policy in a theoretical setting. Section 4 provides an empirical analysis of monetary policy and long-term unemployment. Section 5 concludes.

Figure 1: Unemployment rate by duration



Note: Shaded bars are NBER recessions.

2 Long-term unemployment and the macroeconomy

Here we consider in broad terms how long-term unemployment fits into the overall economy from a macroeconomic perspective. First, we examine how cyclical variation induces fluctuations in long-term unemployment. Then we consider how long- and short-term unemployment may have different effects on price inflation. Finally, we estimate a simple link between total unemployment and the real interest rate. Again, we do not view this as a comprehensive or final analysis of these issues. Instead, these simple empirical relationships motivate our theoretical analysis and provide a basic empirical calibration of macroeconomic regularities for our quantitative policy exercise. The thrust of our results do not depend on the specific functional forms adopted.

2.1 Long-term unemployment and the business cycle

One extraordinary feature of the U.S. labor market in the aftermath of the Great Recession was the large and persistent rise in the duration of unemployment. As a result, on average, unemployed job seekers searched much longer for work than in the past. The run-up in the duration of job search is evident in Figure 1, which plots the total, short-term, and long-term unemployment rates, denoted u_t, s_t, and l_t.[4] All three unemployment rates rose precipitously as a result of the 2007-2009 recession. However, while the total unemployment rate never exceeded its post-World War II peak reached in the early 1980s, the long-term unemployment rate jumped to an unprecedented level, and in 2010, the long-term unemployment rate was almost twice as high as its peak in earlier postwar recessions.

As shown by the solid line in Figure 2, as long-term unemployment has become more prevalent, short-term unemployment as a percentage of total unemployment has trended down. The short-term unemployment share has also been highly cyclical—posting sizable drops around every recession—and this cyclical sensitivity has been increasing over time. Most telling is that the 1990 and 2001 recessions had relatively large incidences of long-term unemployment, despite being relatively short and shallow macroeconomic contractions. The increasing importance of long-term unemployment in the United States largely reflects the postwar evolution of labor force demographics and labor market institutions and occupations. Notably, an aging population and women's rising labor force attachment have shifted the composition of unemployment toward longer spells (e.g., Aaronson et al. 2010 and Valletta 2011). The increasing share of job losses that are permanent separations rather than temporary layoffs has also contributed to longer durations (e.g., Groshen and Potter 2003). The diminished use of temporary layoffs in turn may reflect the decline of the share of workers in unions and in manufacturing jobs. The growing cyclical variation in long-term unemployment following the three most recent recessions also reflects the sluggish initial gains in employment—the so-called jobless recoveries—with associated low job creation and job finding rates.[5]

Although the number of long-term unemployed has surged in recent years, the latest episode is actually consistent with the gradual evolution of the share of short- and long-term unemployment over time. Notably, a simple time-trending model can capture both the secular and cyclical movements in the duration of unemployment. To model the past half century of the U.S. short-term unemployment share, which we denote as $\theta_t = s_t/u_t * 100$, consider the regression:

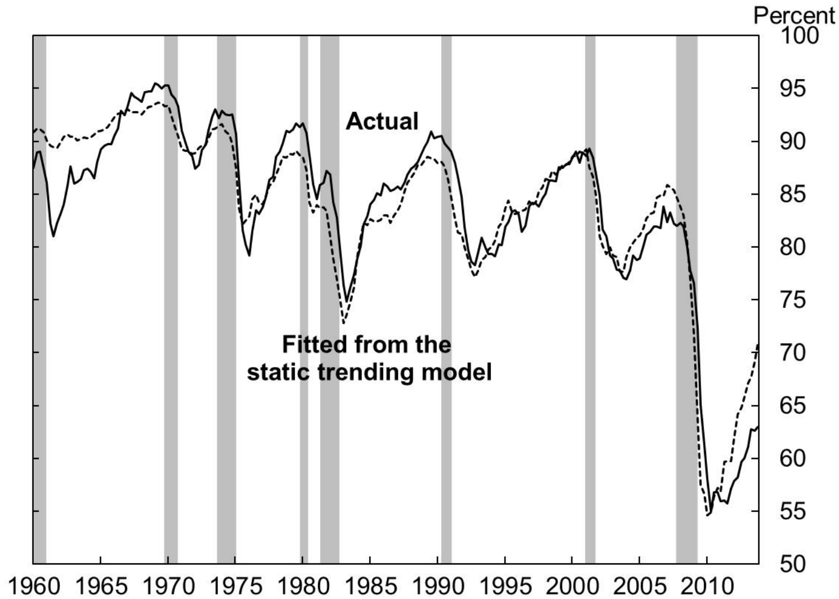
$$\theta_t = \mu_0 + \delta_0 * rgap_{t-1} + \mu_1 * TIME + \delta_1 * rgap_{t-1} * TIME + \rho * \theta_{t-1} + \epsilon_t, \tag{1}$$

where μ_0, μ_1, δ_0, δ_1, and ρ are estimated coefficients, and $TIME$ is a time trend that equals 1

[4]We follow the U.S. literature and use a 6-month threshold to delineate short- from long-term unemployment as in, for example, Aaronson et al. (2010) and Valletta (2013). Specifically, s_t (l_t) is measured as the number of jobless looking for work for 26 weeks or less (more than 26 weeks) as a percentage of the labor force. Research on European long-term unemployment often uses a one-year threshold.

[5]Farber and Valletta (2013) also argue that the enhanced availability of extended unemployment benefits following recent recessions can explain a fraction of the elevated long-term unemployment.

Figure 2: Short-term unemployment as a percentage of total unemployment



Note: Shaded bars are NBER recessions.

in 1960:Q1 and 216 in 2013:Q4, which are the beginning and end of our sample. The resource gap, $rgap_{t-1}$, that we use as a cyclical indicator is the difference between the unemployment rate and the Congressional Budget Office (CBO) estimate of the underlying long-term natural rate of unemployment.[6] We will discuss the natural rate in detail below, but for now, we simply take the unemployment gap, which we denote as $\tilde{u}_{t-1}$, as a good measure of the macroeconomic fluctuations at a cyclical frequency. (Essentially identical results are obtained from using other indicators of the business cycle, such as the output gap or industrial capacity utilization.)

Table 1 provides estimates of three variations of equation (1) that have different sets of regressors. The first column shows estimates of a "static" version that regresses θ_t on a constant and $\tilde{u}_{t-1}$. This simple regression provides a benchmark for calibrating our other results. Its estimated parameters imply a sample average short-term unemployment share of almost 86 percent of total unemployment. In addition, the average sample cyclical sensitivity is about 4.7, that is, each percentage point increase in the unemployment gap is associated with a 4.7 percentage point reduction in the short-term share. However, the static regression does not capture the growing secular and cyclical importance of long-term unemployment

[6]The CBO estimates this natural rate for use in its analysis of potential output, so it incorporates only long-lasting structural factors and excludes fluctuations in aggregate demand. See CBO (2014). We lag this gap to help avoid the simultaneity of having current unemployment on both sides of the equation.

Table 1: Short-term unemployment share (θ_t) regression

	Variations of Regression		
	Static	Static trending	Dynamic trending
Constant	85.94 (0.523)	91.03 (1.011)	22.02 (3.26)
θ_{t-1}			0.76 (0.035)
$\tilde{u}_{t-1}$	-4.73 (0.668)	-0.79 (0.565)	-0.41 (0.16)
$\tilde{u}_{t-1} * TIME$		-0.025 (0.0042)	-0.006 (0.0015)
$TIME$		-0.043 (0.0078)	-0.010 (0.0030)
Total long-run cyclical effect as of 2013:Q4	-4.73	-6.17	-7.20
R^2	.70	.90	.99
SER	4.91	2.83	1.02

Notes: Heteroskedastic and autocorrelation consistent standard errors in parentheses. Estimation sample is from 1960:Q1 to 2013:Q4.

over time. These evolutionary changes are captured in the "static trending" regression that includes terms that interact the constant and the unemployment gap with a time trend (the second and third regressors in equation (1)). These two trend interaction terms are highly statistically significant and substantially improve fit, so the R^2 jumps from 0.7 to 0.9. This very close fit is evident in Figure 2, which displays the fitted values of the static trending regression as a dashed line.[7] The cyclical sensitivity implied by the static, trending regression increased substantially over the sample, ranging from -0.77 in 1960:Q1 to -6.17 in 2013:Q4. The most recent estimate of that sensitivity is shown in the row just above the R^2.[8]

Given the autocorrelated fitting errors evident in Figure 2, the final regression variation adds a lagged dependent variable, and estimates of the resulting "dynamic trending" specification are shown in the final column of Table 1. In this most general specification, the R^2 reaches an impressive 0.99. At the end of the sample, the long-run cyclical effect (calculated as $(\delta_0 + \delta_1 * 216)/(1 - 0.76)$) implies that a 1 percentage point increase in the unemployment gap is associated with about a 7.2 percentage point drop in the short-term unemployment share. It is this estimate of the current cyclical sensitivity of θ_t that we will employ in Section 3 to investigate the monetary policy implications of our model with short-term unemployment.

[7] In contrast, the fitted values from the static regression without a time trend (not shown) clearly overpredict cyclical fluctuations in θ_t in the first half of the sample and underpredict those fluctuations in the second half.

[8] The total cyclical effect as of 2013:Q4 is calculated from the estimated coefficients as $\delta_0 + \delta_1 * 216$.

2.2 Long-term unemployment and inflation

Since the late 1980s, a number of researchers have found evidence that wage and price determination are little affected by variation in long-term unemployment. There are two potential underlying rationales for this reduced effect on inflation. On the one hand, the long-term unemployed may be less tied to the labor market because they grow discouraged and search less intensely for a job (e.g., Krueger and Mueller, 2011). The long-term unemployed are also viewed as less desirable applicants, as there is much casual and econometric evidence that employers view a long ongoing spell of unemployment as a negative signal for hiring (e.g., Eriksson and Rooth, 2014). In the extreme, the long-term unemployed may be essentially segmented from the active labor market with little role in the setting of wages and prices.[9] In Europe, where long-term unemployment has long been prevalent, considerable evidence has accumulated over the past three decades that long-term unemployment has little if any influence on wages and prices. Early on, Nickell (1987) and Manning (1994) found a significant association between wage inflation and short-term unemployment but not long-term unemployment. In addition, Llaudes (2005) estimated Phillips curves that allow for different reactions of inflation to short- and long-term unemployment rates for a sample of 19 OECD countries. He found that in most Western European countries, the long-term unemployed appeared largely detached from the wage bargaining and price setting process.

In contrast, in the United States, there have been no comparable long-established results documenting the differential effect of short- and long-term unemployment on inflation. Of course, as noted above, until very recently, long-term unemployment was a minor element in U.S. labor dynamics. Therefore, it was hard to discern whether U.S. and European inflation dynamics appeared to differ because there was very little independent variation in U.S. long-term unemployment or because the wage and price determination mechanism in the United States truly did not distinguish between short- and long-term unemployment. With the surge of U.S. long-term unemployment following the Great Recession, the first consideration—the observation problem—has largely disappeared and the issue of whether the United States is "like Europe" in exhibiting a weak link between long-term unemployment and inflation could be addressed to a much greater extent than in the past. Accordingly, there has been a resurgence of research on the role of unemployment duration in determining inflation in the United States. Early on, Stock (2011) noted that distinguishing between long- and short-term unemployment had the potential to account for the puzzling lack of disinflation following the Great

[9]Cast in terms of the insider-outsider labor market models, the long-term unemployed, as outsiders, are separated from the active labor market and have little influence on wage bargaining, while the newly unemployed or employed insiders have some influence regarding compensation.

Recession. Following this same logic, Gordon (2013) finds that short-term unemployment performs better than total unemployment in predicting price inflation since the start of the financial crisis and Great Recession in 2007.[10] Finally, Krueger, Cramer, and Cho (2014) and the Council of Economic Advisers (2014, pp, 82-83) come to a similar conclusion using simple specifications that consider wage dynamics as well as price dynamics.

We examine the differential role of short- and long-term unemployment using a standard expectations-augmented Phillips curve for quarterly core PCE price inflation (measured at an annual rate in percent):[11]

$$\pi_t = \alpha + \beta_1 * \pi_{t-1} + \beta_2 * \pi_{t-2} + (1 - \beta_1 - \beta_2) * \pi lr_{t-1} + \kappa * igap_{t-1} + \eta_t, \tag{2}$$

where α, β_1, β_2, and κ are estimated coefficients. In this equation, inflation, π_t, depends on two lags of past inflation, a survey-based measure of long-run inflation expectations, πlr_{t-1}, and a cyclical indicator, $igap_{t-1}$, of the inflationary gap relevant for forecasting future price inflation. The lags of inflation capture medium and high frequency dynamics, while the long-run inflation expectations capture the low-frequency stochastic trend component of U.S. inflation.[12]

Table 2 provides estimates of three variants of equation (2) that use different measures of the inflationary gap. The first column uses as that indicator $\tilde{u}_{t-1}$, which as noted above is the difference between the total unemployment rate and the CBO's measure of the underlying long-run natural rate. This measure of unused labor market resources is statistically significant, and in economic terms, a percentage point of unemployment gap reduces annualized inflation by about 0.13 percentage point in the next quarter. The second and third columns estimate the Phillips curve using the short-term unemployment gap, denoted $\tilde{s}_{t-1}$, which is the difference between the short-term unemployment rate and a non-accelerating inflation rate of short-term unemployment, denoted NAIRU-S, and the long-term unemployment gap, denoted $\tilde{l}_{t-1}$, which

[10] Gordon (2013) continues his investigation—started in the late 1970s—of U.S. inflation dynamics using a Phillips curve that has displayed remarkable continuity and fit over time. Gordon's inflation specification has evolved a bit over time. For example, in recent decades, fluctuations in food and energy prices are allowed to have a lower pass-through to consumer price inflation than earlier in the sample.

[11] The Phillips curve used by Gordon (2013) includes about 20 additional regressors for supply shocks as well as very long lags of past inflation. Our results are little changed by including these control variables (and the regression standard error falls by about 10 percent). Our results are also essentially unaffected by replacing the long-run inflation expectations variable with a long distributed lag of past inflation. In both cases, we prefer to use our simple structure in our monetary policy analysis below to highlight the policy implications of the separation of the long-term unemployed from price determination.

[12] Using long-run inflation expectations to anchor inflation dynamics is common, and we follow Reifschneider, Wascher, and Wilcox (2013) in using a series based on long-run expected inflation in the Survey of Professional Forecasters and the Hoey survey since 1980 and, before that, on a long moving average of actual inflation.

Table 2: Inflation regression

	Three measures of *igap*		
	Total	Short-term	Split
π_{t-1}	0.591 (0.106)	0.580 (0.106)	0.580 (0.106)
π_{t-2}	0.246 (0.096)	0.262 (0.092)	0.264 (0.093)
πlr_{t-1}	0.162 (0.064)	0.158 (0.062)	0.156 (0.062)
$\tilde{u}_{t-1}$	-0.133 (0.039)		
$\tilde{s}_{t-1}$		-0.246 (0.065)	-0.251 (0.071)
$\tilde{l}_{t-1}$			0.012 (0.058)
constant	0.059 (0.054)	0.036 (0.052)	0.033 (0.0569)
R^2	.87	.87	.87
SER	0.792	0.785	0.787

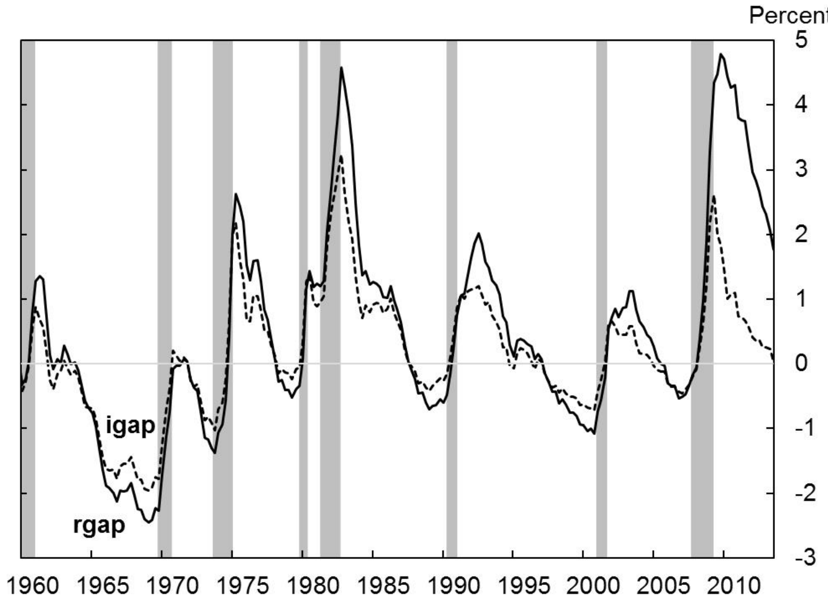
Notes: Heteroskedastic and autocorrelation consistent standard errors in parentheses. Estimation sample is from 1960:Q1 to 2013:Q4.

is the difference between the long-term unemployment rate and a non-accelerating inflation rate of long-term unemployment, denoted NAIRU-L.[13] Comparing the columns in Table 2, it's clear that the short-term unemployment gap is a much more important determinant of inflation than the long-term unemployment gap—consistent with the accumulating evidence noted above. As shown in the third column of Table 2, which splits $\tilde{u}_{t-1}$ into short- and long-term unemployment gaps, after controlling for short-term unemployment, long-term unemployment has no residual information. Its coefficient is not significantly different from zero (with the wrong sign), and formally, the hypothesis of the equality of the $\tilde{s}_{t-1}$ and $\tilde{l}_{t-1}$ coefficients in Table 2 can be rejected at the 1 percent level.

Figure 3 plots $rgap_t = \tilde{u}_{t-1}$ and $igap_t = \tilde{s}_{t-1}$—the traditional unemployment resource gap and the short-term unemployment inflationary gap. Over the entire earlier part of the sample, the two gaps are closely correlated, which accounts for the past difficulty in discerning a different effect on U.S. inflation of short- and long-term unemployment. The largest deviations between these gaps are recorded in the years since 2010, which reflects the significant run-up

[13]To construct NAIRU-S and NAIRU-L, we distribute the CBO's total unemployment natural rate according to the trend in the share of short-term unemployment in total unemployment (θ_t). That is, NAIRU-S at date t is the CBO natural rate multiplied by the fitted θ_t trend (calculated as $\mu_0 + \mu_1 * t$) from the static trending regression. We obtained very similar results using estimates of NAIRU-S from Watson (2014), who estimates a time-varying NAIRU-S embedded in an estimated Phillips curve that, as in Gordon (2013), includes additional regressors for supply shocks and long lags of past inflation.

Figure 3: Total unemployment *rgap* and short-term unemployment *igap*



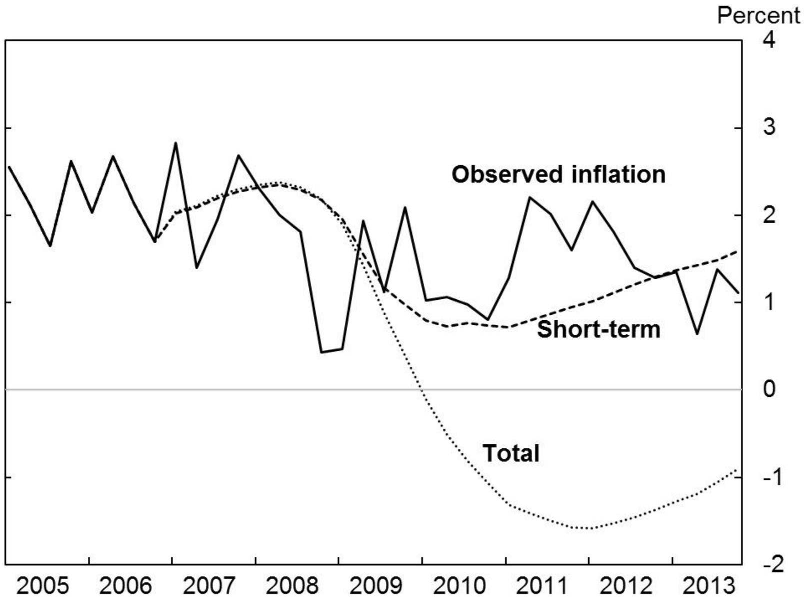
Note: Shaded bars are NBER recessions.

in long-term unemployment during that period, and it is this episode that provides the recent power in discerning the lack of long-term unemployment's effect on inflation.

Similar in-sample results are provided in a much simpler specification in Krueger, Cramer, and Cho (2014) and in a more comprehensive specification in Gordon (2013). Gordon (2013) also argues that for highly inertial autoregressive models like the Phillips curve a better technique for model assessment is dynamic simulation, which produces multi-step-ahead forecasts in which the lagged inflation variable is generated endogenously. As in Gordon (2013), we obtain a clear differentiation between the total unemployment and short-term unemployment measures of the inflation gap using dynamic simulations. In Figure 4, we run dynamic simulations of inflation starting in 2006:Q4 using the total and short-term regression estimates from Table 2. The Phillips curve using $\tilde{s}_{t-1}$—the dashed line—tracks the restrained downshift in inflation very well. In contrast, the Phillips curve using $\tilde{u}_{t-1}$—the dotted line—undershoots actual inflation by 2 to 3 percentage points starting in 2009.

All in all, a fairly good case can be made that inflation dynamics in the United States are related to short-term unemployment and that the long-term unemployed appear to exert little pressure on wages and prices. In a European context, of course, such a differentiation would not be surprising given the long history of evidence to that effect. Still, no result regarding

Figure 4: Dynamic forecasts of inflation using short-term and total unemployment



the empirical Phillips curve—even its existence—seems to be established incontrovertibly.[14] For example, Kiley (2014) employs data for U.S. metropolitan regions to argue that short- and long-term unemployment exert equal downward pressure on price inflation. At the very least though, the preponderance of U.S and international evidence suggests that monetary policymakers should consider the ramifications of a wedge between the amount of resource slack and the inflationary gap, a topic we examine below.

2.3 Unemployment and interest rates

For our monetary policy analysis, the final requisite relationship is between unemployment and the short-term interest rate. As a first approximation, we assume a simple empirical formulation of the standard IS curve or Euler equation that relates the total unemployment gap to a real interest rate:

$$\tilde{u}_t = \underset{(0.07)}{1.57} * \tilde{u}_{t-1} - \underset{(0.07)}{0.62} * \tilde{u}_{t-2} + \underset{(.010)}{.028} * ((i_{t-1} - \pi_{t-1} + i_{t-2} - \pi_{t-2})/2 - \underset{(0.62)}{2.25}) + \zeta_t \qquad (3)$$

where i_t is the quarterly average federal funds rate in percent. This equation relates the overall unemployment gap to two lags of the gap and the average real interest rate over the past two

[14]Many of the variations and hypotheses regarding empirical Phillips curves are painstakingly examined by Mavroeidis, Plagborg-Møller, and Stock (2014).

quarters. The coefficients (and standard errors in parentheses) are estimated over the sample from 1960:Q1 through 2007:Q4, and the $R^2 = 0.97$ and $\sigma_\zeta = 0.24$. The early sample end date is chosen to avoid the period when short-term interest rates were constrained by the zero lower bound.[15] Although in this formulation, interest rates affect aggregate demand, with the cyclical variation in the short-term unemployment share, interest rates will also have a differential effect on long- and short-term unemployment that we explore below.

3 Monetary policy: theoretical analysis

The preceding section provided some evidence for two possible features of the economy: that short-term rather than total unemployment influences price setting, and that the short-term share of total unemployment is procyclical. This section characterizes optimal monetary policy in the context of a highly stylized static model that also displays these two attributes. The theoretical framework employed is very simple, which facilitates derivation of analytical results. The next section explores the quantitative implications for monetary policy using a dynamic model that is calibrated to the empirical results in section 2. Although it is not possible to derive analytical results for that dynamic empirical model, it allows us to gauge the quantitative import of the implications for optimal monetary policy.

3.1 Stylized static model

Our stylized static model economy is described by equations for the aggregate unemployment rate, the short-term unemployment rate, the inflation rate, and the short-term nominal interest rate. Consistent with much research and central bank practice, we assume that the central bank sets the short-term nominal interest rate to minimize the weighted sum of squared deviations of the inflation rate from its target rate and the squared deviations of the aggregate unemployment rate from its natural rate. Given the distinction between short-and long-term unemployment in the model developed in this paper, we need to make further assumptions regarding the implications of the short-term unemployment share on the natural rate of aggregate unemployment. We assume the natural rate of aggregate unemployment is unaffected by transitory movements in the short-run unemployment share. That is, transitory movements in the short-run unemployment share have nominal effects, but do not directly affect the equilibrium of the real side of the economy. In the parlance of DSGE models, we view the effect of

[15] Rudebusch and Svensson (1999) provide support for an almost identical empirical aggregate demand relationship. Also, see Fuhrer and Rudebusch (2004) for discussion of the evidence for expectations in the Euler equation.

time variation in the short-term unemployment share on inflation dynamics as an additional type of nominal friction that does not affect natural rates.[16]

Specifically, the central bank's objective is to minimize the quadratic loss:

$$\mathcal{L} = \tilde{\pi}^2 + \lambda \tilde{u}^2, \tag{4}$$

where $\tilde{\pi}$ denotes the deviation of the inflation rate from its target level and $\tilde{u}$ is the deviation of the aggregate unemployment rate from its natural rate. The parameter $\lambda \geq 0$ is the fixed weight the policymaker places on unemployment stabilization relative to inflation stabilization. The target inflation rate is assumed to be constant.

The aggregate unemployment rate is determined by a stylized IS equation:

$$\tilde{u} = \eta \tilde{i} + v, \tag{5}$$

where $\tilde{i}$ denotes the deviation of the short-term interest rate from its natural rate, and v is a demand shock.[17] For analytical convenience, the unemployment rate is assumed to be positively related to the nominal interest rate, rather than the real interest rate, but this assumption does not materially affect the main results. The inflation rate is determined by:

$$\tilde{\pi} = -\kappa \tilde{s} + e, \tag{6}$$

where $\tilde{s}$ is the deviation of the short-term unemployment rate from its natural rate, and e is an inflation shock.

The share of aggregate unemployment made up of short-term unemployed, denoted by θ, is assumed to be negatively related to the deviation of the aggregate unemployment rate from its natural rate, as follows:

$$\theta = \bar{\theta} - \delta \tilde{u} + z, \tag{7}$$

where $\bar{\theta}$ is the steady-state level of θ, and z is a short-term unemployment share shock. This equation abstracts from the restriction that θ is constrained to be between 0 and 1. In the following, we consider environments where the range of variation in θ does not reach these bounds. By definition, the short-term unemployment rate is given by: $s \equiv \theta u$. This can be

[16] In addition, we assume that in the absence of shocks, it is possible to achieve both aggregate unemployment and inflation goals; that is, the steady state of the economy is not characterized by distortions as in Barro and Gordon (1983).

[17] In this model, each shock is assumed to be mean zero with finite variance and independent of the other shocks.

rewritten as follows:

$$\tilde{s} = \theta\tilde{u} + \theta\bar{u} - \bar{s}, \tag{8}$$

where $\bar{u}$ and $\bar{s}$ are the natural rates for aggregate and short-term unemployment, respectively. The steady-state value of θ is assumed to satisfy the following condition: $\bar{\theta} = \bar{s}/\bar{u}$. This implies that the steady-state short-term and aggregate unemployment rates equal their respective natural rates.

3.2 Optimal monetary policy: exogenous θ

We first consider the case of strictly exogenous variation in θ, that is, $\delta = 0$. The central bank is assumed to observe the three shocks v, e, and z before setting the short-term interest rate.[18] Given the structure of the model and the central bank's objective function, the optimal policy decision can be equivalently described as choosing the deviation of the unemployment rate from its natural rate. After substitutions, the central bank's objective can be rewritten as:

$$\mathcal{L} = (\lambda + \kappa^2\theta^2)\tilde{u}^2 + (2\kappa^2\theta\bar{u}z - 2\kappa\theta e)\tilde{u} + e^2 + \kappa^2\bar{u}^2z^2 - 2\kappa\bar{u}ze. \tag{9}$$

Taking the derivative with respect to $\tilde{u}$ yields the first-order condition describing the optimal setting for the deviation of the unemployment rate from the natural rate, denoted $\tilde{u}^*$:

$$\tilde{u}^* = \frac{\kappa\theta}{\lambda + \kappa^2\theta^2}e - \frac{\kappa^2\theta\bar{u}}{\lambda + \kappa^2\theta^2}z. \tag{10}$$

Substituting for short-term unemployment yields the optimal value of the deviation of the short-term unemployment rate from its natural rate, denoted by $\tilde{s}^*$:

$$\tilde{s}^* = \frac{\kappa\theta^2}{\lambda + \kappa^2\theta^2}e + \frac{\lambda\bar{u}}{\lambda + \kappa^2\theta^2}z. \tag{11}$$

Substituting for inflation yields the optimal value of the deviation of the inflation rate from its target, denoted by $\tilde{\pi}^*$:

$$\tilde{\pi}^* = \frac{\lambda}{\lambda + \kappa^2\theta^2}e - \frac{\lambda\kappa\bar{u}}{\lambda + \kappa^2\theta^2}z. \tag{12}$$

In response to shocks to demand and inflation, optimal policy displays two textbook principles of monetary policy. First, it completely offsets the effects of a demand shock, regardless of the central bank's weight on unemployment stabilization in its objective function (i.e., v

[18] In this section, we abstract from the zero lower bound on nominal interest rates and any other factors that might constrain movements in the short-term interest rates.

does not show up in the first-order conditions). The demand shock in this model creates a "divine coincidence" of goals, where unemployment and inflation stabilization are perfectly aligned and there is no tradeoff between the two objectives. Second, the inflation shock, e, creates a short-run tradeoff between the two goals, and the optimal levels of unemployment and inflation depend on the degree of concern for unemployment stabilization. In the limiting case of $\lambda = 0$, where the policymaker cares only about inflation, the optimal policy acts to create a deviation of short-term unemployment from its natural rate that completely offsets the shock's effect on inflation. For $\lambda > 0$, the optimal policy partially offsets the effect of a positive (negative) inflation shock on inflation by raising (lowering) the unemployment rate. This response reflects the standard tradeoff between the inflation and unemployment objectives inherent with an inflation shock.

The z shocks to θ create a tradeoff between the inflation and unemployment goals and act like inflation shocks (of the opposite sign) in their implications for optimal monetary policy. When θ deviates from its steady-state level, it creates a wedge between the aggregate unemployment rate that the central bank cares about and the short-term unemployment rate that affects inflation. In the case of a positive shock to θ ($z > 0$), a given aggregate unemployment rate implies a higher short-term unemployment rate and a lower inflation rate. In response to such a shock, if $\lambda > 0$, optimal policy calls for a lower aggregate unemployment rate and a lower inflation rate. That is, it acts just like a *negative* inflation shock. Similarly, a negative shock to θ calls for an increase in aggregate unemployment and inflation. As in the case of an inflation shock, the magnitude of the response of unemployment and inflation depends on the relative weight on unemployment in the loss function. In the limiting case of $\lambda = 0$, the optimal response to a shock to θ is to move aggregate unemployment so that the short-term unemployment rate remains at its natural rate, which keeps the inflation rate at its target.

Exogenous variation in the value of θ has one additional implication for optimal policy. Because θ affects the slope of the Phillips curve with respect to aggregate unemployment, it changes the optimal response to an inflation shock. In the case of $\lambda = 0$, the optimal increase in the unemployment rate is decreasing in the value of θ because a given movement in unemployment has a larger effect on inflation and therefore a smaller move is needed. More generally, the effect of θ on the magnitude of the optimal response to an inflation shock cannot be signed a priori. If $\lambda > 0$, there is a countervailing effect of a larger unemployment effect on inflation improving the inflation-unemployment tradeoff. This tends to make the optimal response larger when θ is higher. The net effect of these two influences depends on model parameters. In any case, there is an asymmetry in the responses to shocks that depends on the value of θ.

3.3 Optimal monetary policy: endogenous θ

We now consider the case of endogenous variation in θ; that is: $\delta > 0$. As before, the optimal policy fully offsets demand shocks. After incorporating the endogenous behavior of θ, the loss is given by:

$$\mathcal{L} = \lambda \tilde{u}^2 + \Big(-\kappa(\bar{\theta} - \delta\tilde{u} + z)\tilde{u} - \kappa\bar{u}(-\delta\tilde{u} + z) + e \Big)^2. \tag{13}$$

After expanding and collecting terms, this yields the following expression:

$$\begin{aligned} \mathcal{L} &= \kappa^2\delta^2\tilde{u}^4 \\ &- \left[2\kappa^2\delta(\bar{\theta} - \delta\bar{u} + z)\right]\tilde{u}^3 \\ &+ \left[\lambda + \kappa^2(\bar{\theta} - \delta\bar{u} + z)^2 - 2\kappa^2\delta\bar{u}z + 2\kappa\delta e\right]\tilde{u}^2 \\ &+ \left[-2\kappa^2\delta\bar{u}^2 z + 2\kappa^2\bar{u}(\bar{\theta} + z)z - 2\kappa(\bar{\theta} + z)e + 2\kappa\delta\bar{u}e\right]\tilde{u} \\ &+ e^2 + \kappa^2\bar{u}^2 z^2 - 2\kappa\bar{u}ez. \end{aligned} \tag{14}$$

The resulting first-order condition is given by:

$$\begin{aligned} 0 &= 2\kappa^2\delta^2\tilde{u}^3 \\ &- \left[3\kappa^2\delta(\bar{\theta} - \delta\bar{u} + z)\right]\tilde{u}^2 \\ &+ \left[\lambda + \kappa^2(\bar{\theta} - \delta\bar{u} + z)^2 - 2\kappa^2\delta\bar{u}z + 2\kappa\delta e\right]\tilde{u} \\ &- \kappa(\bar{\theta} - \delta\bar{u} + z)e + \kappa^2\bar{u}(\bar{\theta} - \delta\bar{u} + z)z. \end{aligned} \tag{15}$$

This equation describing the optimal policy is a cubic equation in $\tilde{u}$. Given the nonlinear nature of the model economy, one must pay attention to the second-order condition and select the root to this equation that yields the smallest loss. Of course, for the special case of $\delta = 0$, the higher-order terms drop out leaving the same condition for optimal policy as before.

Relative to the model with purely exogenous variation in θ, the decreasing marginal effectiveness of policy for higher unemployment rates has countervailing effects on the optimal setting of policy, and it is not in general possible to analytically sign the net effect. The first effect calls for greater policy response to counteract the diminishing marginal effectiveness of unemployment on inflation. The second, offsetting effect calls for a lesser response because the tradeoff has worsened in terms of the marginal costs of aggregate unemployment in reducing inflation. The sign of the net effect of these effects depends on the weight on unemployment gaps in the loss function, λ, and the sensitivity of inflation to aggregate unemployment.

Although it is not possible in general to characterize the effects of endogenous time-variation in θ on optimal policy and outcomes, the local first-order dynamics of this system in the vicinity of the steady state are nearly the same as the model with $\delta = 0$. That is, in the vicinity of the steady state, the qualitative results from the model with only exogenous variation in θ carry over to the model with endogenous variation, and endogenous variation in θ primarily affects higher-order terms. In the case of an inflation shock, the first-order effect on the optimal setting of $\tilde{u}$, evaluated at $e = z = 0$, is given by:

$$\left.\frac{d\tilde{u}}{de}\right|_{e=z=0} = \frac{\kappa(\bar{\theta} - \delta\bar{u})}{\lambda + \kappa^2(\bar{\theta} - \delta\bar{u})^2}. \tag{16}$$

The term $\bar{\theta} - \delta\bar{u}$ now appears in both the numerator and denominator of the expression. A corresponding change occurs in the first-order response to a shock to θ.

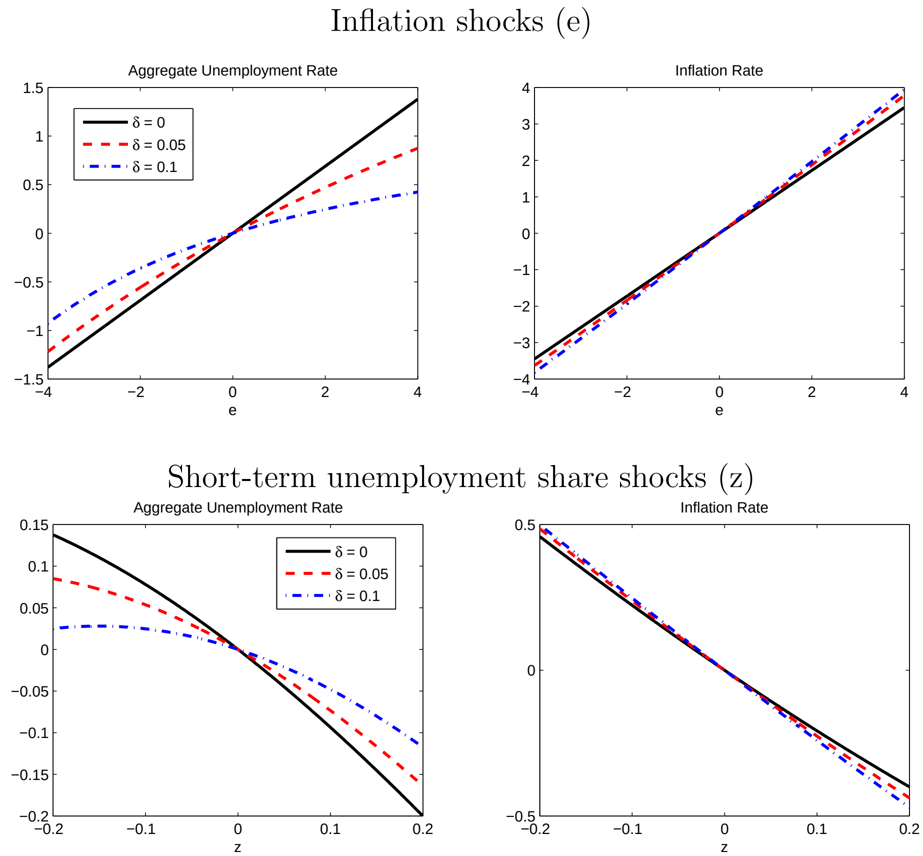
In addition, one can fully characterize the implications for optimal policy in the special case of $\lambda = 0$. The goal of the central bank is then to equate the inflation rate to its target, if that is feasible. The response of the short-term unemployment share to the aggregate unemployment rate, however, creates a nonlinearity in the relationship between aggregate unemployment and the inflation rate, which limits the ability of monetary policy to offset large shocks that raise the inflation rate. Specifically, there is a level of $\tilde{u}$ at which inflation actually rises with a further increase in $\tilde{u}$. It is clearly never optimal to exceed this threshold, given by: $\overline{\tilde{u}} = \frac{\bar{\theta} - \delta\bar{u} + z}{2\delta}$. When the combination of shocks to inflation and the short-term unemployment share call for an even higher unemployment rate, the optimal policy sets $\tilde{u} = \overline{\tilde{u}}$ and the inflation rate exceeds the target. The role of $\overline{\tilde{u}}$ is seen in the optimality condition for monetary policy when the upper bound is not binding:

$$\tilde{u}^*(\lambda = 0) = \overline{\tilde{u}} - \left\{\overline{\tilde{u}}^2 - (e - \kappa\bar{u}z)/(\kappa\delta)\right\}^{0.5}. \tag{17}$$

Relative to the case of $\delta = 0$, optimal policy must take into account the effect of unemployment on the share of short-term unemployment and thereby on inflation. For example, in the case of a positive inflation shock, optimal policy boosts the aggregate unemployment rate, which in turn raises the share of long-term unemployed. As a result, on the margin, it takes more of an increase in aggregate unemployment to bring down inflation. In response to negative inflation shocks, policy lowers the unemployment rate, which boosts the short-term unemployment share. This channel increases the effectiveness of the policy action, and thus reduces the size of the reduction in unemployment needed to keep inflation on target.

More generally, one needs to numerically compute the implications for monetary policy.

Figure 5: Optimal monetary policy responses to shocks



Notes: The lines in the left-hand column of charts show the optimal deviations of the unemployment rate from its natural rate for the specified realization of the inflation shock, e. The lines in the right-hand column of charts show the corresponding optimal deviations of the inflation rate from its target level.

Figure 5 illustrates these theoretical results using a particular parameterization of the model with different values of δ. For this purpose, the following parameter values are used: $\lambda = 1, \kappa = 0.5, \bar{u} = 5$, and $\bar{\theta} = 0.8$.[19] For each shock, the optimal responses of the unemployment and inflation rates are computed, assuming the value of the other shocks are zero. The demand shock is not shown because the optimal policy perfectly offsets it. Note that these exercises are for illustrative purposes only. A more careful quantitative analysis is conducted in the next section using the dynamic empirical model. The black solid lines show the optimal outcomes for the model with $\delta = 0$. In this case, the optimal response to the inflation shock is linear

[19] In the model simulations, θ is computed as a share and is not multiplied by 100.

in the shock. In contrast, the optimal response of the unemployment rate to the shock to θ displays asymmetry, with the optimal response of the unemployment rate somewhat larger for positive shocks to θ than for negative shocks.

In this example, the endogenous responses of θ do not qualitatively change the nature of the optimal responses to the shocks, but do affect the quantitative results, especially for large shocks. The red dashed lines in the figure show the outcomes under optimal policy in the case of $\delta = 0.05$; the blue dash-dot lines show the corresponding results for the model with $\delta = 0.1$. There is an asymmetry in the response to the inflation shock and greater asymmetry in the optimal responses to the shock to θ. Given the nonlinear nature of the model, the degree of asymmetry can be sensitive to model parameters, especially the parameter describing the preferences of the central bank, λ.

4 Monetary policy: empirical analysis

The preceding section explored the qualitative implications of short-term unemployment affecting price setting in a stylized static model. In this section, we leverage the empirical results in Section 3 to gauge the quantitative importance of these effects. Specifically, we use a model has three estimated equations for the short-term unemployment share, inflation, and the total unemployment gap:

$$\begin{aligned}
\theta_t &= 19.9 - 1.76 * \tilde{u}_{t-1} + .76 * \theta_{t-1} + \epsilon_t, \sigma_\epsilon = 1.02; \\
\pi_t &= .58\pi_{t-1} + .26\pi_{t-2} + .16\pi lr_{t-1} - .25\tilde{s}_{t-1} + .04 + \eta_t, \sigma_\eta = .79; \\
\tilde{u}_t &= 1.57\tilde{u}_{t-1} - .62\tilde{u}_{t-2} + .027((i_{t-1} - \pi_{t-1} + i_{t-2} - \pi_{t-2})/2 - 2.16) + \zeta_t, \sigma_\zeta = .24.
\end{aligned}$$

The first equation is based on the dynamic trending regression results in Table 1 evaluated at the end of the sample (i.e., $TIME = 216$). The second equation is based on the inflation regression in Table 2 that uses the short-term unemployment rate to form the inflationary gap. The final equation is the simple estimated aggregate demand relationship given at the end of Section 2.

Because this short-term unemployment (STU) model is nonlinear, we are not able to use available methods to compute the optimal policy solution to the model. Instead, we characterize optimal policy in the simulations using the approach of optimal policy projections developed by Svensson and Tetlow (2005). Specifically, we compute model projections over a finite horizon assuming that all future innovations equal zero. Monetary policy is set period-by-period to minimize the discounted loss function:

$$\mathcal{L}_t = \sum_{j=0}^{\infty} \left\{ \beta^j (\tilde{\pi}_{t+j}^2 + \lambda \tilde{u}_{t+j}^2 + \psi (i_{t+j} - i_{t+j-1})^2) \right\}, \tag{18}$$

where β is a discount factor set arbitrarily close to unity (0.999), and ψ is the relative weight on squared first-differences in the nominal federal funds rate. The inflation target is assumed to be 2 percent, consistent with the statement by the Federal Open Market Committee (2014). The resource gap that the central bank strives to close is the deviation of the total unemployment rate from the natural rate of unemployment, which is the current estimate by the Congressional Budget Office (2014). We assume equal weights on the inflation and unemployment terms in the loss; that is, $\lambda = 1$. This approach to analyzing optimal policy has been used, for example, by Yellen (2012).

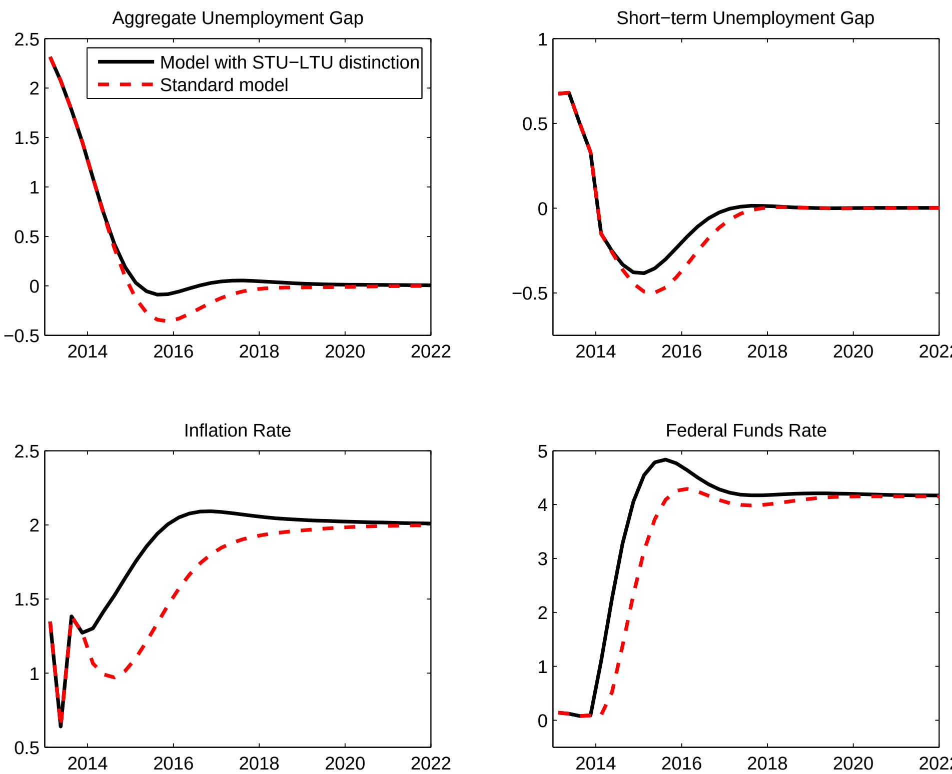
We also include a small penalty on interest rate changes that was absent in our theoretical model.[20] Specifically, we set $\psi = 0.1$. Inclusion of this term has an important implication for optimal policy: It is no longer optimal to immediately and fully offset demand shocks. Instead, in response to a demand shock, it is optimal to gradually bring the aggregate unemployment rate back to its natural rate. Given, the procyclical behavior of the short-term unemployment share, this gradualism implies that a demand shock will endogenously create a wedge between the unemployment and inflation goals. In particular, in the STU model with time-varying labor force heterogeneity, demand shocks will create tradeoffs for monetary policymakers.

We use model simulations starting from the end of our data sample and compare optimal policy and the evolution of the economy in the STU model to the alternatives in a standard macroeconomic model that does not distinguish between short- and long-term unemployment.[21] Because the recent period has been characterized by a very low short-term unemployment share, it provides an excellent case study of the potential magnitude of these effects. Note that these simple model-based simulations are presented to illustrate the quantitative importance of the distinction between short- and long-run unemployment. Importantly, they should not be viewed as realistic forecasts or depictions of potentially feasible outcomes over the simulation period because they ignore many other factors influencing the economic outlook. We simulate the model starting in the first quarter of 2014, taking the actual data

[20] Rudebusch (2006, 2013) cautions that a sizable penalty on interest rate volatility has very weak theoretical and empirical justifications.

[21] It should be noted that our results are somewhat conservative because we have fixed the coefficients of the short-term unemployment share equation to their values as of 2013:Q4 based on the dynamic trending regression. Instead, if recent trends toward more and more cyclically sensitive long-term unemployment continue, the effects we document will be larger.

Figure 6: Optimal monetary policy responses to shocks



Notes: The simulations begin in the first quarter of 2014. The standard model makes no distinction between short- and long-term unemployment.

through 2013 as initial conditions. In implementing this method, we truncate the simulation length to 200 periods. The algorithm uses a hill-climbing technique to find the jointly optimal setting of the federal funds rate in all periods.

The extremely low level of the short-term unemployment share that prevails at the start of the simulation creates a sizable tradeoff between unemployment and inflation that is absent in the standard model. Figure 6 shows the simulation results from the estimated model along with those from an otherwise standard model where the aggregate unemployment gap (the difference between the aggregate unemployment rate and its natural rate) affects inflation. To make the two models comparable, the coefficient on the aggregate unemployment gap in the inflation equation of the standard model is multiplied by the steady-state value of θ. At the end of 2013, there is only a modest short-term unemployment gap while the aggregate unemployment gap is relatively large. As implied by the theoretical model, this unusually low level of θ implies an optimal policy that pushes the inflation rate above the 2 percent target for a time, balancing these deviations against the benefit of reducing the aggregate unemployment gap. Optimal policy is somewhat more restrictive in our model than in the standard model, and the unemployment gap is accordingly modestly higher. These results are robust to alternative settings of the loss function parameters.

Although the simulation results are only illustrative, they reinforce the main conclusion from the theoretical analysis. Specifically, with a dual policy objective of minimizing both aggregate unemployment and inflation gaps, the optimal policy response to a shock to the short-term unemployment share balances misses in the inflation goal against those in the unemployment goal. According to our estimated model, during the recent recession and recovery, this tradeoff has been quantitatively important.

5 Conclusion

This paper has highlighted the amplified tradeoff between the objectives of full employment and mandate-consistent inflation that occurs when the long-term unemployed have little effect on inflation but are still included in the overall resource gap relevant for setting monetary policy. During the Great Recession and subsequent recovery, the share of short-term unemployment relative to total unemployment reached a historic low, and according to our empirical analysis, this created a sizable wedge between the Federal Reserve's dual objectives. Although this wedge is likely to be transitory, it does create a greater tradeoff for monetary policymakers.

As noted in the introduction, this issue is broader than the short- and long-term unemployment split studied here. During the recent recession and recovery, the number of discouraged jobless excluded from the unemployment rate and the number of part-time employees wanting full-time work have reached historic highs. If the true measure of labor underutilization included these individuals, even though they have little or no effect on wage and price setting, then the wedge in the Fed's dual mandate would be even wider. Based on the analysis in this paper, the implications are clear: Optimal policy should trade off a transitory period of excessive inflation (beyond what is calculated using this paper's model) in order to bring the broader measure of underemployment to normal levels more quickly.

Finally, while we have focused on the U.S. experience, the evidence for differences between short- and long-term unemployment is, if anything, stronger for many other countries. Extending the empirical analysis to these other countries where the effects are likely more prevalent is an important avenue for future research.

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