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ABSTRACT

Labor Force Participation and Monetary Policy in the Wake of the Great Recession*

In this paper, we provide compelling evidence that cyclical factors account for the bulk of the post-2007 decline in the U.S. labor force participation rate. We then proceed to formulate a stylized New Keynesian model in which labor force participation is essentially acyclical during "normal times" (that is, in response to small or transitory shocks) but drops markedly in the wake of a large and persistent aggregate demand shock. Finally, we show that these considerations can have potentially crucial implications for the design of monetary policy, especially under circumstances in which adjustments to the short-term interest rate are constrained by the zero lower bound.

JEL Classification: E24, E32, E52 and J21

Keywords: labor force, policy tradeoffs, simple rules and unemployment rate

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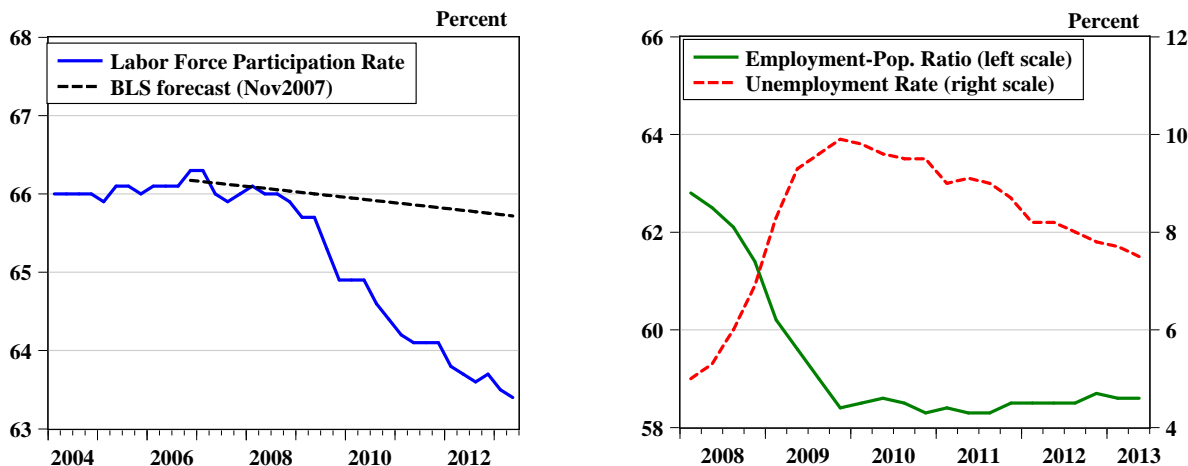
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Figure 1: Labor Market Developments in the Wake of the Great Recession



Note: In the left panel, the solid line denotes the actual evolution of the labor force participation rate from 2004:Q1 to 2013:Q2, and the dashed line denotes the projected path for the decade ending in 2016 that was published by the BLS in November 2007. In the right panel, the solid line denotes the ratio of employment to the civilian noninstitutionalized population 16 years and older (left scale), and the dashed line denotes the civilian unemployment rate (right scale).

1 Introduction

A longstanding and well-established fact in labor economics is that the labor supply of prime-age and older adults has been essentially acyclical throughout the postwar period, while that of teenagers has been moderately procyclical; cf. Mincer (1966), Pencavel (1986), and Heckman and Killingsworth (1986). Consequently, macroeconomists have largely focused on the unemployment rate as a business cycle indicator while abstracting from movements in labor force participation.¹ Similarly, the literature on optimal monetary policy and simple rules has typically assumed that unemployment gaps and output gaps can be viewed as roughly equivalent; cf. Orphanides (2002), Taylor and Williams (2010).

In this paper, we reconsider such conventional wisdom in light of labor market developments since the Great Recession. As shown in Figure 1, the labor force participation rate has fallen about 2-1/2 percentage points – a striking contrast to the modest decline that

¹For example, the now-classic paper by Nelson and Plosser (1982) analyzed the time series behavior of an array of macroeconomic indicators, including aggregate employment and the unemployment rate, but did not consider any measure of labor force participation.

was projected by the Bureau of Labor Statistics in November 2007 just prior to the onset of the recession. Given the dropoff in labor force participation, the employment-to-population ratio has remained close to its pre-crisis trough even as the unemployment rate has returned roughly halfway back from its peak.

Our paper provides compelling empirical evidence that cyclical factors account for the bulk of the recent decline in the labor force participation rate (henceforth LFPR). We then proceed to formulate a stylized New Keynesian model in which households' labor market exit and reentry decisions are associated with significant adjustment costs. Our model analysis highlights how policy rules that respond to broader measures of labor market slack that include the cyclical component of participation may have very different implications for how the economy recovers from a deep recession than "standard" rules that focus on the unemployment gap.

More specifically, our analysis of state-level employment data indicates that cyclical factors can fully account for the post-2007 decline of 2 percentage points in the LFPR for prime-age adults (that is, 25 to 54 years old). We define the participation gap as the deviation of the LFPR from its trend path as implied solely by demographic considerations, and we find that as of early 2013 this gap stood at around 2 percent—roughly the same magnitude as the unemployment gap (that is, the deviation of the unemployment rate from its longer-run normal rate). Indeed, our analysis suggests that the participation gap and the unemployment gap each account for roughly half of the current employment gap, that is, the shortfall of the employment-to-population rate from its pre-crisis trend.

Our empirical analysis is broadly consistent with a number of other recent studies. Aaronson, Davis, and Hu (2012) estimated statistical models for 44 demographic groups (based on age, gender, and educational attainment), incorporating birth cohort effects and other controls, and showed that only one-fourth of the decline in the LFPR since 2008 was attributable to demographic factors. Using a multivariate Beveridge-Nelson decomposition, Van Zandweghe (2012) found that cyclical factors accounted for 50 to 90 percent of the de-

cline in the LFPR, depending on which measure of unemployment was used in constructing the filter. Sherk (2012) analyzed micro data from the Current Population Survey (CPS) and found that demographic factors only accounted for one-fifth of the post-recession decline in LFPR. Finally, Hotchkiss and Rios-Avila (2013) estimated a behavioral model of labor supply using CPS micro data and concluded that the decline in LFPR since the Great Recession was more than fully explained by the deterioration in labor market conditions.²

We develop a simple extension of the workhorse New Keynesian model (e.g., Woodford 2003) that can account qualitatively for the stylized facts that: i) decreases in labor force participation appear relatively modest in most post-war recessions, but ii) protracted recessions may eventually induce large declines in participation. Our model implies that labor force participation responds inversely to the unemployment rate, but that the response is gradual due to high adjustment costs of moving between the market and “home production” sectors.³ In normal recessions that are fairly transient in duration, the employment gap is largely driven by sharp but short-lived movements in the unemployment rate: labor force participation doesn’t move much due to adjustment costs. However, a deep and protracted recession may eventually cause a sizeable decline in the LFPR. Importantly, to the extent that labor force participation responds very gradually to the unemployment rate, labor force participation may remain well below trend even as the economy begins recovering and the unemployment gap closes.

A second key feature of our model is that the labor force participation gap enters the Phillips Curve in addition to the unemployment gap. A large negative participation gap induces labor force participants to reduce their wage demands, although our calibration implies that the participation gap has much less influence than the unemployment rate quantitatively.⁴ An important implication of this modified Phillips Curve is that inflation

²See Daly, Elias, Hobijn, and Jorda (2012) for further analysis and discussion.

³We adopt an alternative decentralization of the workhorse New Keynesian model so that changes in aggregate demand operate along the extensive margin of unemployment rather than the intensive margin of hours worked.

⁴The implication that individuals who have left the labor force exert relatively little influence on wages is similar in spirit to that of the “insider-outsider” models of Blanchard and Summers (1986) and Blanchard

would remain below baseline following a recession even after the unemployment gap closes, at least while the participation gap remains negative.⁵

The possibility that deep recessions may generate large cyclical swings in labor force participation has important implications for monetary policy design: should monetary policy respond to the cyclical component of labor force participation in some way, or focus more exclusively on the unemployment rate as suggested by a large literature focused on the Great Moderation? To address this question, we use our model to analyze several alternative monetary policy strategies against the backdrop of a deep recession that leaves labor force participation well below its long-run potential level. In our simulations, the deep recession reflects that the zero lower bound precludes monetary policy from lowering policy rates enough to offset a negative aggregate demand shock; once the shock dies away sufficiently, policy responds according to a non-inertial Taylor rule.

A key result of our analysis is that a monetary policy can induce a more rapid closure of the participation gap through allowing the unemployment rate to overshoot its long-run natural rate (i.e, unemployment falls below the natural rate). Quite intuitively, keeping unemployment persistently low draws cyclical non-participants back into labor force more quickly. Given that the cyclical non-participants exert some downward pressure on inflation, some overshooting of the long-run natural rate actually turns out to be consistent with keeping inflation stable in our model. However, a more aggressive strategy of employment gap targeting boosts inflation – at least to some degree – by requiring unemployment to remain lower for even longer. Thus, there is some tradeoff between stabilizing inflation and broad measures of resource slack that include participation.

Policy rules that respond to broad measures of labor market slack share some characteristics of optimal *full commitment* policy strategies insofar as both imply some overshooting of

and Diamond (1994). In the latter class of models, the long-term unemployed have a comparatively small influence on wage bargaining, reflecting that firms would prefer to hire workers with more recent work experience, and that the long-term unemployed search less intensively.

⁵Equivalently, a deep recession causes a *fall* in the short-run natural rate of unemployment, since unemployment must fall below its long-run natural rate to offset the deflationary pressure associated with the participation gap.

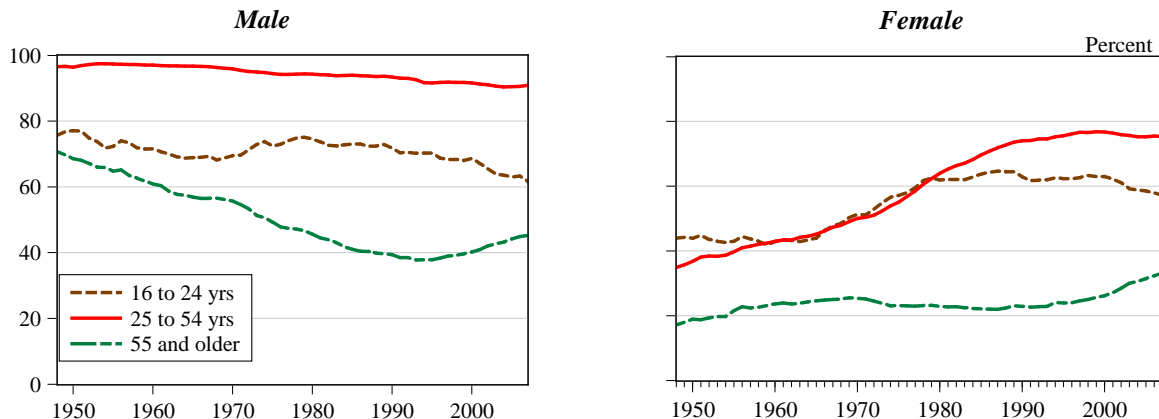
the unemployment rate and inflation as the economy recovers.⁶ Even so, we stress that the overshooting of the unemployment rate in our analysis occurs under a *non-inertial* Taylor rule, and reflects that the participation gap remains sizeably negative even after the unemployment gap (which recovers faster) has closed. By contrast, a policy of strictly stabilizing the unemployment rate generates monotonic convergence of the unemployment gap, and implies a much slower recovery in labor force participation and below-target inflation.

Overall, we view our paper as pointing out how labor market slack arising in the wake of deep recessions may not be well summarized by the unemployment rate (given the substantial lag in the response of participation), and consequentially, the monetary rules developed for the Great Moderation period may have to be adapted to account for broader measures of slack. Of course, as we emphasize below, our model does not incorporate a number of factors that may influence the tradeoff between employment gap and inflation stabilization, and hence the results of our analysis should be interpreted very cautiously in contemplating the practical design of monetary policy.

The remainder of this paper is organized as follows. Section 2 presents our empirical analysis. Section 3 describes the specification and calibration of our model. Section 4 characterizes the dynamics of the LFPR under a benchmark monetary policy rule. Section 5 considers the sources of monetary policy tradeoffs and gauges the performance of simple rules as well as commitment-based strategies. Section 6 shows that these results do not hinge on a particular calibration of the structural parameters. Section 7 concludes.

⁶See Eggertsson and Woodford (2003) for a detailed characterization of optimal policy in the workhorse New Keynesian model under a binding zero bound constraint.

Figure 2: Demographic Trends in Labor Force Participation, 1948 to 2007



Note: This figure depicts annual data regarding the labor force as a share of the civilian noninstitutionalized population (in percent) for each of the specified demographic groups over the period from 1948 to 2007.

2 Empirical Analysis

In this section, we document the essentially acyclical behavior of the LFPR during *normal times* (that is, the postwar period from 1948 to 2007), and then we examine the extent to which the post-crisis decline in the LFPR is attributable to demographic vs. cyclical factors.

2.1 Labor Force Participation during Normal Times

Labor economists have long been aware of the pitfalls of using aggregate data to characterize the behavior of labor supply, not only because those characteristics can differ so markedly across demographic groups but because the magnitude of such differences can change so dramatically over time. Such considerations are clearly evident in Figure 2, which depicts the evolution of the LFPR for specific demographic groups over the period from 1948 to 2007.⁷ Of course, many volumes have been written about postwar trends in U.S. labor supply.⁸ Therefore, we will simply highlight a few broad features that will be salient for our

⁷Appendix Figure A1 depicts the postwar evolution of the composition of the labor force by age and gender.

⁸See Autor (2010), Macunovich (2010), and Moffitt (2012) for analysis and discussion of trends in labor force participation prior to the onset of the Great Recession.

subsequent analysis.

Prime-Age Males (25 to 54 years) comprised about 37 percent of the labor force in 2007. The LFPR for prime-age males declined very gradually—about a tenth of a percentage point per year—from the late 1940s through the early 2000s. Expansions in the Social Security Disability Insurance (SSDI) program account for a substantial portion of that decline, because most individuals who start receiving disability benefits never reenter the labor force; increased incarceration rates also appear to have played a significant role.⁹ However, those trends appear to have subsided over the half-decade prior to the Great Recession; that is, the LFPR for prime-age males was stable at around 90.5 percent from 2003 to 2007.

Prime-Age Females (25 to 54 years) comprised about 31 percent of the labor force in 2007. The LFPR for prime-age females picked up gradually during the 1950s and 1960s, accelerated during the 1970s and 1980s, and then flattened out at a plateau of around 75 percent—more than twice as high as in 1948. Interestingly, micro data indicates that the wage and income elasticities of labor force participation for married females also dropped markedly over the postwar period, reaching levels that are broadly similar to those of prime-age males.¹⁰

Youths (aged 16 to 24 years) comprised about 15 percent of the labor force in 2007. The LFPR for male youths has been on a fairly steep downward trend since the 1970s, primarily reflecting increasing rates of enrollment in post-secondary education. The LFPR for female youths generally tracked that of prime-age females during the 1960s and 1970s but then flattened out and eventually started trending downward, moving roughly in parallel with the LFPR for male youths.¹¹

Older Adults (aged 55 years and above) comprised 17 percent of the labor force in 2007. The LFPR for older males declined gradually over the course of four decades to a trough of around 40 percent in the mid-1990s, while the LFPR for older females picked up slightly

⁹See Leonard (1979), Juhn (1992), Gruber (2000), Bound and Waidmann (2002), Autor and Duggan (2003, 2006), and Moffitt (2012).

¹⁰See Goldin (2006), Heim (2007), and references therein.

¹¹See Smith (2011) and references therein.

in the 1950s and then remained fairly steady at around 25 percent through the mid-1990s. Since then, the LFPR for older adults—both male and female—has been trending upwards, apparently reflecting ongoing improvements in their overall health and ability to continue working even into the so-called “golden years.”

Figure 2 also seems broadly consistent with the conventional wisdom that labor force participation has been practically acyclical throughout the postwar period. Indeed, even the steep recession of 1981-82 is barely visible in this figure. At any rate, any cyclical fluctuations in these time series have evidently been swamped by the demographic trends. Thus, we now focus more specifically on characterizing the cyclical behavior of labor force participation by applying the HP filter (with a smoothing parameter of 1600) to quarterly data on the LFPR and the unemployment rate over the period 1948:Q1 to 2007:Q4. The standard deviation of the HP-filtered LFPR series is 0.24 percent—much smaller than the standard deviation of 0.8 percent for the HP-filtered unemployment rate. Nonetheless, the correlation coefficient of -0.35 is statistically significant and indicates that labor force participation does indeed tend to move systematically, though modestly, during normal business cycles.

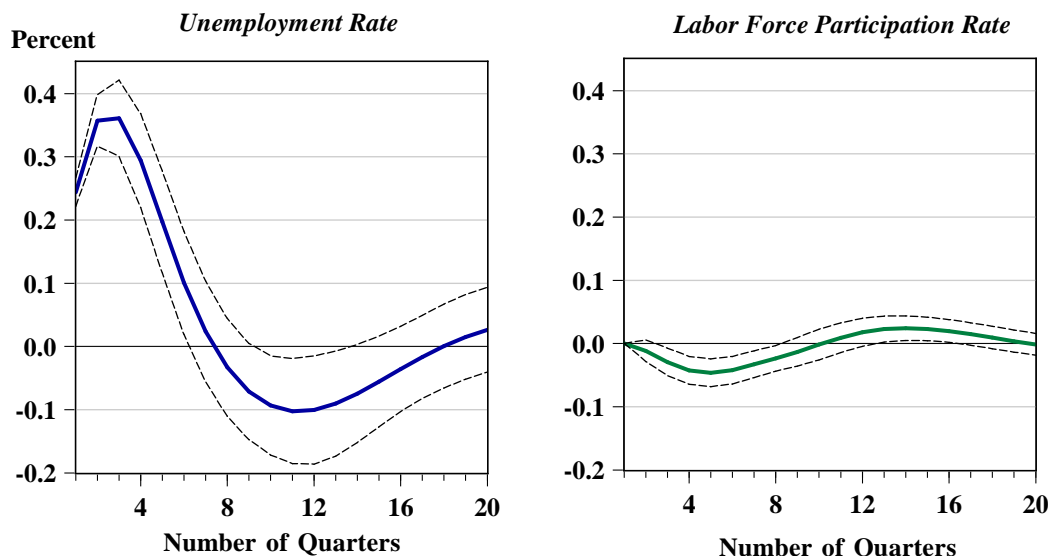
To shed more light on these cyclical dynamics, we estimate a bivariate vector autoregression (VAR) using the filtered unemployment and LFPR series, and then we compute the impulse response of each variable to an orthogonalized unemployment rate shock of one standard deviation.¹² As shown in Figure 3, the peak decline in the LFPR is only -0.04 percent, an order of magnitude smaller than that of the peak for the unemployment rate.¹³ In effect, the cyclical movement in the LFPR would remain practically invisible—less than a tenth of a percentage point—even if the shock were twice as large.

Figure 3 also highlights the extent to which the LFPR exhibits even more inertia than

¹²The impulse responses shown here are computed from a bivariate VAR with lags of order 1, 2 and 7 (chosen using an exclusion test procedure), but the results are not sensitive to alternative choices for the lag order. We have also confirmed that the results are robust to estimating the VAR using the raw data rather than the HP-filtered series, although in that case the orthogonalized unemployment shock also embeds shifts in the natural unemployment rate.

¹³As shown in Appendix Figure A2, the impulse response of the LFPR for prime-age adults is quantitatively similar to that shown in Figure 3 for the aggregate LFPR, whereas the LFPR for youth exhibits much greater cyclicity and markedly less persistence, and the LFPR for older adults is truly acyclical.

Figure 3: The Cyclical Dynamics of the LFPR During “Normal Times”



Note: This figure depicts the impulse responses from a bivariate VAR estimated using quarterly data on the HP-filtered unemployment rate and LFPR over the period 1948:Q1 to 2007:Q4. In each panel, the solid line denotes the response of the specified variable to an orthogonalized unemployment rate shock of one standard deviation, and the dashed lines depict 95 percent confidence bands based on 10,000 Monte Carlo replications.

the unemployment rate. In particular, the peak response for the unemployment rate occurs within a couple of quarters, whereas the peak response for LFPR takes roughly twice as long. Indeed, at a horizon of 6-7 quarters, the unemployment rate has declined all the way to its cyclical trough, whereas the LFPR is just starting to recover.

Evidently, the highly inertial behavior of the LFPR accounts for its practically acyclical behavior during normal times; i.e., even a sharp recession (like that of 1981-82) hasn't had much impact on the LFPR because the subsequent recovery has been V-shaped. Nonetheless, these same inertial dynamics also imply that the LFPR might well exhibit a much larger cyclical response under circumstances in which a deep recession was followed by a very slow recovery and hence a protracted period of relatively high unemployment.

2.2 Labor Force Participation Since the Great Recession

As we have already noted above in discussing Figure 1, the LFPR declined by about 2-1/2 percentage points over the period from 2008:Q1 through 2013:Q2. Thus, the crucial task is to gauge the extent to which that decline reflects cyclical vs. demographic factors. To address this issue, we first consider the post-crisis evolution of the LFPR for specific demographic groups, and then we perform regression analysis using data on LFPR and unemployment for U.S. states. Finally, we explore the issue of hysteresis by examining the extent to which macroeconomic conditions may have contributed to a greater incidence of workers becoming SSDI beneficiaries and effectively departing permanently from the labor force.

In our view, the labor force projections published by the BLS in November 2007 serve as an invaluable resource in assessing the influence of demographic factors on the subsequent decline in the LFPR.¹⁴ In making such projections, BLS staff consider detailed demographic groups using state-of-the-art statistical procedures in conjunction with micro data from the Current Population Survey (CPS) and various other sources, including interim updates from the U.S. Census Bureau.

Moreover, the timing of the November 2007 projections seems virtually perfect in terms of accomplishing our objective. At that point, most forecasters anticipated a further continuation of the Great Moderation and hence that the macroeconomy would simply move along its balanced-growth path over subsequent years. Consequently, the projected path for the labor force was closely linked to demographic factors that tend to be inertial and predictable. In retrospect, of course, the NBER dated the Great Recession as having begun just one month later, and hence those BLS projections effectively encompassed all of the pre-recession data.

As of November 2007, the BLS projected that the aggregate LFPR would decline mod-

¹⁴The aggregate labor force projections that the Congressional Budget Office (CBO) published in January 2007 were revised only modestly that summer and were very similar to the projections that the BLS published in November; i.e., the LFPR was expected to edge down only slightly over the coming half-decade. In contrast, the analysis of Aaronson et al. (2006) concluded that demographic factors were likely to push down the LFPR quite markedly by 2012.

Table 1: Demographic Factors and the Recent Evolution of the LFPR

Demographic Group	Population Share			Labor Force Participation Rate		
	2007	Change (2007 to 2012)		2007	Change (2007 to 2012)	
	<i>Actual</i>	<i>Projection</i>	<i>Actual</i>	<i>Actual</i>	<i>Projection</i>	<i>Actual</i>
<i>16 to 24 yrs</i>	16.1	-0.9	-0.2	59.4	-0.9	-4.5
<i>25 to 54 yrs</i>	54.2	-2.0	-3.1	83.0	0.3	-1.5
<i>55 to 64 yrs</i>	14.0	1.3	1.8	64.0	1.5	0.5
<i>65 and older</i>	15.6	1.7	1.6	15.4	2.6	3.1
<i>Total</i>	100	0	0	66.1	-0.3	-2.4

Note: The columns labelled “Projection” refer to the BLS labor force projections published in November 2007.

estly (about 0.3 percentage point) over the half-decade from 2007 to 2012. That outlook reflected two key demographic trends, namely, the aging of the U.S. population, and the ongoing rise in the labor force participation of older adults. Indeed, in the article by Toossi (2007) in which these BLS projections were presented and discussed, the subtitle effectively captured both of those trends: *More Workers in their Golden Years*.

Regarding the first key factor, the BLS projected substantial changes in the age composition of the civilian noninstitutionalized population aged 16 years and above, as shown in Table 1. In particular, by 2012 the shares corresponding to youths and prime-age adults were expected to shrink by about 1 and 2 percentage points, respectively, while the share of older adults were projected to rise accordingly. Thus, if the labor force participation rate for each age category had been expected to remain constant at 2007 levels, those aging patterns would have implied a downward shift of about a percentage point in the aggregate LFPR.

Regarding the second key factor, the BLS projected that the participation rates of older adults would continue rising notably over coming years, consistent with the trends that had prevailed since the mid-1990s (as noted above in the discussion of Figure 2). Specifically, the LFPR for older adults (aged 55 and above) was projected to rise 2 percentage points by 2012. As for other major demographic groups, the BLS projected that the LFPR for youth would continue trending downward, while the LFPR for prime-age females would edge upward modestly and that of prime-age males would remain essentially flat—again, consistent with

our discussion of the patterns shown in Figure 2. All else equal, these trends in age-specific LFPRs would have pushed up the aggregate LFPR by about 0.7 percentage points.

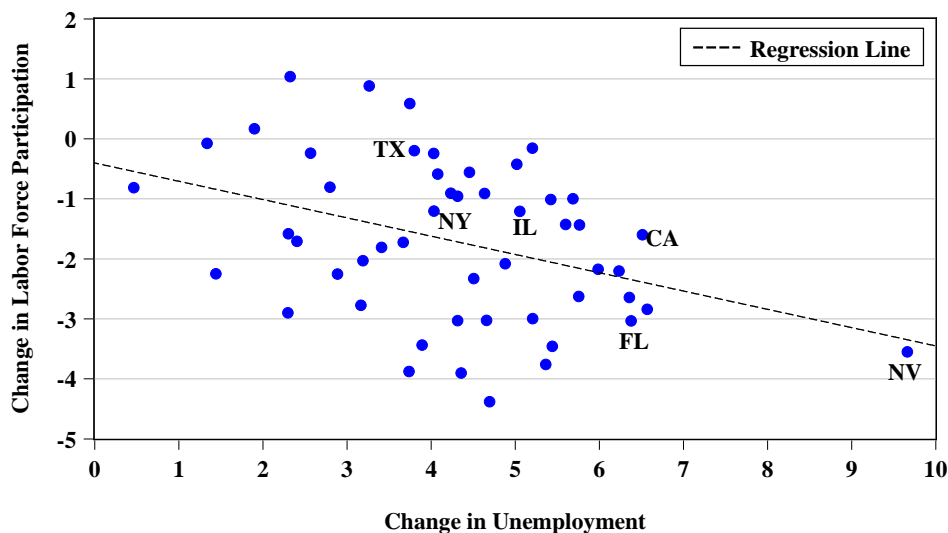
Of course, even demographic patterns are not perfectly predictable. Table 1 shows that the actual 5-year changes in the population shares for several broad age groups have turned out to be noticeably different from what was projected in 2007; i.e., the share of prime-age adults is a full percentage point lower than expected, while the shares for youths and for 55-to-64-year-olds are correspondingly higher. Nonetheless, these revisions only have modest implications for the aggregate LFPR, because the revised population shares essentially just reinforce the influence of the two key factors noted above. Specifically, using the actual 2012 population shares to reweight the age-specific LFPR projections implies a decline of about 0.6 percentage points in the aggregate LFPR, which still only a fourth as large as its actual decline of 2-1/2 percent.

By contrast, as evident from the final columns of Table 1, the forecast errors for key age-specific LFPRs are large and systematic. In particular, the decline in the LFPR for youths was much steeper than the BLS had projected in November 2007, and the LFPR for prime-age adults dropped markedly rather than edging up slightly as expected. Meanwhile, the LFPR for older adults rose roughly in line with its projected path.

2.3 Distinguishing the Role of Cyclical vs. Structural Factors

The preceding analysis underscores a crucial question: Why did the LFPR for prime-age adults decline by nearly two percentage points over the period from 2008 to 2012, given that the rate for this demographic group had been essentially stable over the preceding half-decade? In principle, that development might reflect some exogenous change in the labor-leisure preferences of prime-age adults—effectively comprising an unanticipated downward shift in their *labor supply*—though it should be noted that such a rapid pace of decline would have been unprecedented for both prime-age males and females, at least since the end of WWII. The obvious alternative is that this shift in prime-age LFPR was *not* a mere

Figure 4: State-Level Data on Unemployment and LFPR for Prime-Age Adults



Note: The vertical axis refers to the change in the labor force participation rate for prime-age adults (25 to 54 years) between 2007 and 2012, and the horizontal axis refers to the change in the unemployment rate for that demographic group between 2007 and 2010. The dots refer to each of the U.S. states and Washington DC. Labels annotate the observations for Nevada and the five largest states by population (California, Florida, Illinois, New York, and Texas). The dashed line depicts the regression results described in the text.

coincidence but instead was caused by the Great Recession and its aftermath; that is, prime-age adults dropped out of the labor force as a consequence of a large and persistent shortfall in *labor demand*. Such an interpretation would seem to conflict with the essentially acyclical characteristic of prime-age LFPR throughout the postwar period, but of course the depth of the Great Recession and the sluggishness of the subsequent recovery also stand in marked contrast to all other postwar business cycles.

As with many other empirical issues, the diversity of experiences across U.S. states turns out to be highly informative for distinguishing between these two hypotheses.¹⁵ For example, the Great Recession had modest effects on the economic activity of the rural states and fairly moderate effects on certain states such as Massachusetts and Minnesota. In con-

¹⁵Clark and Summers (1982) explored the relationship between the *levels* of LFPR and unemployment using cross-sectional data from the 1970 U.S. Census. Aaronson, Fallick, Figura, Pingle, and Wascher (2006) analyzed a panel of annual data for U.S. states over the period 1990 to 2005 and found a statistically significant relationship between the LFPR and the contemporaneous unemployment rate, using lagged unemployment rates as instruments.

trast, many other states experienced practically catastrophic outcomes: During 2008-2009, the unemployment rate for prime-age adults rose more than 6 percentage points in Arizona, California, and Florida and nearly 10 percentage points in Nevada. If the post-2007 decline in prime-age LFPR simply reflected an exogenous shift in labor supply, we would expect that decline to exhibit a roughly uniform pattern apart from essentially random cross-sectional variation. On the other hand, if the drop in prime-age LFPR is indeed linked to shortfalls in labor demand, then we would expect the variation in outcomes across states to be systematically related to the cross-sectional distribution of changes in prime-age unemployment rates.

Thus, to gauge the relative important of cyclical vs. structural factors, we estimate the following linear regression using ordinary least squares:

$$\Delta LFPR_i = \alpha + \beta \Delta UNEMP_i + \varepsilon_i \quad (1)$$

where $\Delta LFPR_i$ denotes the change in the LFPR for prime-age adults in state i over the period 2007 to 2012, and $\Delta UNEMP_i$ denotes the change in the unemployment rate of prime-age adults in that state over the period from 2007 to 2010; each series is constructed using annual average data and is measured in percentage points. In this formulation, the slope coefficient β captures the extent to which the state-level variations in prime-age LFPR tend to be associated with changes in prime-age unemployment, while the intercept α captures the extent to which prime-age LFPR exhibited a general decline across states that was unrelated to the evolution of prime-age unemployment. The results of this regression are shown in the first column of Table 2, with heteroskedasticity-consistent standard errors shown in parentheses below each coefficient estimate.

These regression results provide stark evidence that cyclical factors have been crucial in explaining the recent decline in prime-age LFPR. The coefficient on the lagged change in prime-age unemployment is highly significant (t-statistic of -3.9); that is, the state-level data exhibit a strong negative correlation between changes in LFPR and lagged changes in

Table 2: Regression Analysis of State-Level Data for Prime-Age Adults

Explanatory Variable	All U.S. States (including Washington DC)			41 Larger States (excluding Nevada)		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Intercept</i>	-0.40 (0.42)	-0.41 (0.42)	—	-0.18 (0.55)	-0.18 (0.56)	—
$\Delta Unemp$ (2007-2010)	-0.30 (0.08)	-0.27 (0.11)	-0.39 (0.03)	-0.33 (0.10)	-0.31 (0.14)	-0.37 (0.03)
$\Delta Unemp$ (2010-2012)	—	0.10 (0.24)	—	—	0.08 (0.26)	—

Note: In each regression, the dependent variable is the change in the LFPR for prime-age adults in a given state over the period 2007 to 2012. Each regression equation includes the change in the annual average unemployment for prime-age adults in that state over the period from 2007 to 2010. The regressions in columns 1, 2, 4 and 5 also include a regression intercept. The regressions in columns 2 and 5 also include the change in the prime-age unemployment rate from 2010 to 2012. Standard errors are adjusted for heteroskedasticity (White 1980) and are given in parentheses.

unemployment for prime-age adults. In contrast, the regression intercept is not statistically significant from zero (t-statistic of -0.97), indicating that the data provides no support whatsoever for structural interpretations of the drop in prime-age LFPR. Given the regression coefficient of about 0.3 and that the unemployment rose about 5 percentage points nationally during the Great Recession, our state-level regressions imply a subsequent drop of about 1.5 percentage points in the national average LFPR for prime-age adults. In effect, the state-level data indicates that the aggregate decline in prime-age LFPR over the period from 2007 to 2012 can be *fully* explained by the persistent shortfall in labor demand.

Of course, before reaching any definitive conclusions, it is essential to consider the extent to which these results are robust to alternative specifications of the regression equation.¹⁶ For example, the second column of Table 2 shows that the coefficient estimates from our

¹⁶In addition to the results reported in Table 2, we have also confirmed that the results are broadly robust to a wide range of alternative specifications and estimation methods, including alternative definitions of the explanatory variables (e.g., timespans ending in 2009 or 2011), weighting of the observations by population size (either total or prime-age), and panel estimation with time-specific and state-specific effects.

benchmark regression are practically invariant to the inclusion of an additional explanatory variable, namely, the change in prime-age unemployment over the period from 2010 to 2012; moreover, the coefficient on that additional variable is negligible in size and statistically insignificant. These results indicate that the decline in prime-age LFPR from 2007 to 2012 was relatively greater in those states that experienced the largest increases in prime-age unemployment during the Great Recession and its immediate aftermath but has not been significantly affected by the relative pace of recovery across states since 2010. Indeed, that finding is broadly consistent with our characterization of the prime-age LFPR as highly inertial—a characteristic that will play a key role in the formulation of the DSGE model described in Section 3 below.

We have also confirmed that the regression results are robust to excluding potentially influential observations from the sample. In particular, as evident from Figure 4, the observation for Nevada stands out dramatically from the rest of the points in the scatterplot, and hence it is important to determine whether the coefficient estimates are affected by that particular observation. Moreover, since our benchmark regression places equal weight on all U.S. states (including Washington DC), one might wonder whether those results are sensitive to the exclusion of states with relatively small populations. Thus, the right panel of Table 2 reports the results for the sample of 41 largest states (excluding Nevada) for which the prime-age population in 2007 exceeded 500,000 people. Notably, these results are virtually identical to those reported in the left panel of the table.

2.4 Gauging the Potential for Hysteresis

Having concluded that the post-2007 decline in LFPR is mainly attributable to the Great Recession and its aftermath, we now turn to the issue of hysteresis. More specifically, to the extent that persistent shortfalls in labor demand have caused a large number of prime-age adults to leave the labor force, what is the likelihood that those individuals will remain permanently out of the labor force vs. re-engaging in the labor market once jobs become

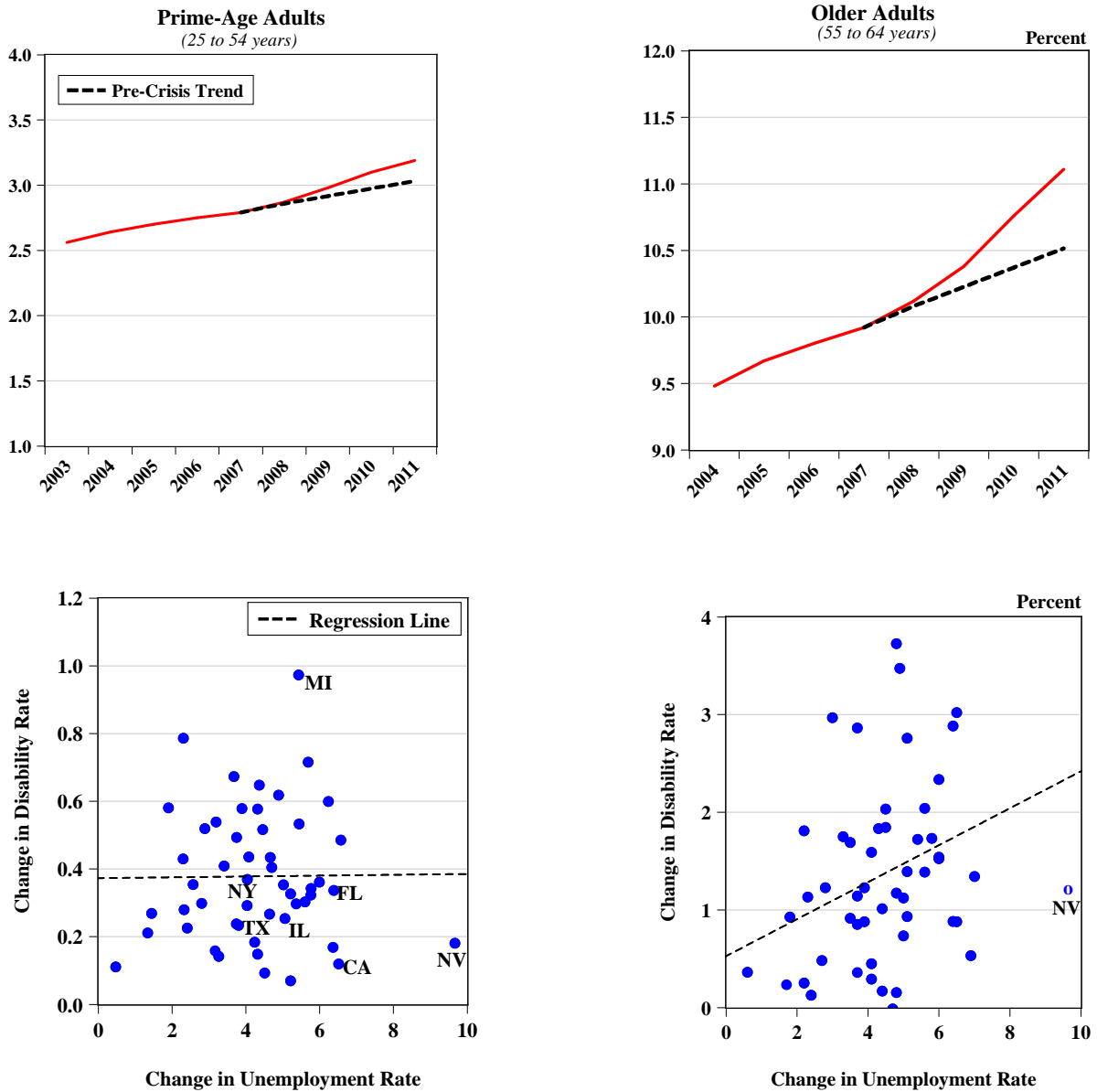
more readily available? Similarly, given the sharp increase in the number of youths who have refrained from entering the labor force since the onset of the Great Recession, what are the prospects that they will join the labor force over coming years? Of course, no definitive answers to these questions can be provided at this stage, but it does seem worthwhile to examine the available evidence on several specific factors, namely, educational enrollment, permanent disability, and retirement. Thus, we now consider the relevance of these factors for each major age group:

Youths (16 to 24 years). Monthly data from the CPS indicates that the educational enrollment rate for this demographic group jumped four percentage points from 2007 to 2011, essentially accounting for nearly all of the decline in the youth LFPR. By contrast, there has been practically no change in the incidence of SSDI beneficiaries under age 25. (Only a tiny fraction of youths not in the labor force describe themselves as “retired.”)¹⁷

Prime-Age Adults (25 to 54 years). CPS data indicates that the educational enrollment rate of prime-age adults rose about 0.6 percentage points from 2007 to 2011, accounting for nearly a third of the overall decline in the prime-age LFPR. Over that period, there was also a slight increase—about a tenth of a percentage point—in the number of prime-age adults describing themselves as “retired.” As shown in the upper-left panel of Figure 5, the number of prime-age workers in the SSDI program (expressed in proportion to the civilian noninstitutionalized population of this age group) was trending upward gradually over the half-decade from 2003 to 2007 and then accelerated noticeably. By the end of 2011, the incidence of permanent disabilities was about 0.4 percentage points higher than in 2007 and about 0.2 percentage points higher than one might have predicted based on its pre-crisis trend. As evident from the lower-left panel, the variations across U.S. states are essentially uncorrelated with changes in state-level unemployment, suggesting that the

¹⁷According to the SSA’s latest annual report, there were 167,651 SSDI beneficiaries who were aged 16 to 24 years old as of December 2011, an increase of about 34,000 since December 2007—a miniscule change relative to the total population of about 38 million in this age group. This total number of SSDI beneficiaries includes those designated as “workers” (whose eligibility is linked to their own work experience prior to becoming disabled) as well as those designated as “adult children” (who became permanently disabled prior to age 22 and whose eligibility was based on the work experience of the person’s parents).

Figure 5: The Incidence of Permanent Disabilities



Note: In the upper-left panel, the solid line depicts the number of prime-age workers receiving Social Security disability benefits (that is, beneficiaries aged 25 to 54 years, not including widowers or adult children) during December of each calendar year from 2003 through 2011, expressed as a percentage of the civilian noninstitutionalized population aged 25 to 54 years, and the dashed line denotes the projected values from fitting a linear trend over the period 2003 to 2007. The upper-right panel provides corresponding information for older adults, that is, the number of disabled workers 55 to 64 years old as a share of the civilian noninstitutionalized population for that age group. In each of the lower panels, the vertical axis refers to the change in the disability rate for that demographic group between 2007 and 2011, the horizontal axis refers to the change in the unemployment rate for that group between 2007 and 2010, and the dashed line depicts the regression results as described in the text.

increase in the number of prime-age SSDI beneficiaries may primarily reflect changes in the screening process.¹⁸ Nonetheless, these factors only explain about half of the post-2007 decline of about 2 percentage points in the prime-age LFPR. Evidently, the remainder represents roughly a million individuals who have given up searching for a job and instead are engaged in other activities such as child care, home renovation projects, etc.

Older Adults (55 years and above). As shown above in Table 1, the LFPR for adults 55 to 64 years old has risen only modestly since 2007—a full percentage point lower in 2012 than the BLS had projected as of November 2007. The upper-right panel of Figure 5 points to one potentially important factor, namely, an acceleration in the number of workers aged 55 to 64 years old who have become SSDI beneficiaries. Moreover, as shown in the lower-right panel, state-level variations in unemployment exhibit a strong positive correlation with state-level changes in the number of SSDI beneficiaries in this age group, suggesting that cyclical conditions may have been quite significant in affecting workers’ decisions to apply for SSDI rather than remain in the labor force. By contrast, the LFPR for adults aged 65 years and older has risen notably over the past few years to a level in 2012 that was about a half percentage point *higher* than had been projected based on its pre-crisis trend—a development that seems consistent with widespread anecdotes about individuals who postponed their retirement in response to the drop in housing and financial wealth that was associated with the Great Recession. In effect, the average LFPR for all adults 55 years and above remains roughly in line with its pre-crisis trend, at least partly because the increased incidence of SSDI beneficiaries aged 55 to 64 has been offset by the greater incidence of working adults aged 65 and above.

In summary, this analysis suggests that the degree of hysteresis in the aggregate LFPR is likely to be moderate over coming years. A substantial proportion of the recent drop in the LFPR reflects individuals who have chosen to expand their educational attainment in ways that would presumably enhance their employment opportunities over time. Moreover,

¹⁸As shown in the figure, the regression line fitted to this data is nearly horizontal, reflecting the fact that the slope coefficient is close to zero (and not statistically significant).

some prime-age adults would presumably consider rejoining the labor force if they perceived a substantial improvement in the prospects for finding a job. Unfortunately, in light of previous empirical work, it seems likely that those older adults who have recently become SSDI beneficiaries will remain permanently out of the labor force, although even that outlook might be affected by how labor market conditions evolve over coming years.

2.5 Assessing the Employment Gap

We now proceed to consider the implications of the foregoing discussion for assessing the magnitude of the employment gap ($EGAP_t$), that is, the percentage deviation between civilian employment (E_t) and its “natural” (or long-run sustainable) level (E_t^*) as a share of the civilian noninstitutionalized population (POP_t). In particular, the employment gap satisfies the following relationship:

$$EGAP_t = (1 - u_t^*) (LFPR_t - LFPR_t^*) - LFPR_t^* (u_t - u_t^*) - (u_t - u_t^*) (LFPR_t^* - LFPR_t) \quad (2)$$

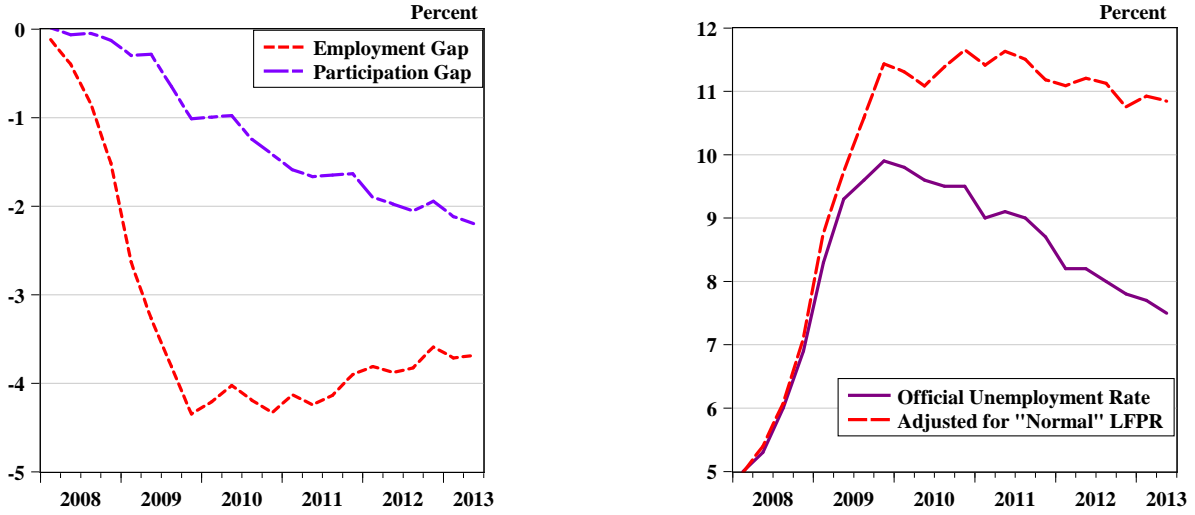
where $LFPR_t$ refers to the actual labor force participation rate, $LFPR_t^*$ denotes its *structural* rate based solely on demographic trends, u_t refers to the unemployment rate, and u_t^* denotes the natural rate of unemployment (or NAIRU).¹⁹ To facilitate the discussion, it is convenient to define the participation gap as $LFGAP_t = LFPR_t - LFPR_t^*$, while the unemployment gap is given by $(u_t - u_t^*)$. The final term in equation (2) is simply the product of these two gaps and is generally negligible compared with the preceding terms in that equation. Consequently, the employment gap can be closely approximated as the weighted sum of the participation gap and the unemployment gap:

$$EGAP_t \simeq (1 - u_t^*) (LFPR_t - LFPR_t^*) - LFPR_t^* (u_t - u_t^*) \quad (3)$$

Thus, the employment gap becomes more negative as the participation rate declines relative to its natural rate, or if the unemployment rate rises relative to the NAIRU. The two gaps

¹⁹Note that E_t^* is simply defined as $E_t^* = LFPR_t^* (1 - u_t^*)$.

Figure 6: The Magnitude and Composition of the Employment Gap



Note: In the left panel, the employment gap refers to the percent deviation between U.S. civilian employment and its natural level (solid line), and the participation gap refers to the deviation of the LFPR from the projected path published by the BLS in November 2007 (dashed line), where the latter is scaled by the proportionality factor $(1-u^*)$. In the right panel, the “official” unemployment rate (solid line) refers to the series U3 as published by the BLS, and the unemployment rate under “normal” LFPR (dashed line) refers to the unemployment rate that would prevail if LFPR had actually followed the trajectory that the BLS projected in November 2007.

are multiplied by the proportionality factors $(1 - u_t^*)$ and $LFPR_t^*$, respectively. In effect, the weight on the participation gap is slightly below unity (say, 0.95), whereas the weight on the unemployment gap is substantially smaller (say, 0.67) because the incidence of unemployment is measured as a fraction of the labor force whereas the participation rate is constructed in terms of the civilian noninstitutionalized population. To operationalize this formula, we take the trend path $LFPR_t^*$ as projected by the BLS in November 2007, and we use the Congressional Budget Office’s 10-year-ahead unemployment rate forecast as the value of u_t^* .

As shown in the left panel of Figure 6, the employment gap expanded sharply during the Great Recession to a peak above 4 percent by mid-2009, corresponding to a shortfall of nearly 10 million jobs. At that point, the unemployment gap accounted for the bulk of the employment gap, while labor force participation remained roughly in line with its pre-crisis trend. This panel also underscores the excruciatingly sluggish nature of the recovery. The

employment gap has only narrowed modestly over the past few years, because the steady widening of the participation gap has been roughly comparable in magnitude to the decline in the unemployment gap.²⁰ Indeed, it is evident that as of mid-2013, the participation gap accounted for roughly half of the employment gap. The gradual widening of the participation gap is consistent with the foregoing evidence – from VARs as well as state-level data – of a protracted response of the LFPR to employment conditions.²¹

An alternative way of representing the employment gap is to consider what level of unemployment would prevail if those individuals who dropped out of the labor force due to cyclical factors had instead continued searching actively for work. In particular, we can construct an “adjusted” measure of the unemployment rate U_t^a that would prevail if the LFPR followed its “normal” trajectory based solely on structural factors:

$$U_t^a = U_t + (1 - u_t^*)(LFPR_t - LFPR_t^*)/LFPR_t^* \quad (4)$$

where U_t denotes the conventional measure of unemployment (which the BLS refers to as U3). By comparing equations 3 and 4, it is evident that the adjusted unemployment rate conveys the same information as the employment gap, but the former is gauged in terms of the structural path of the labor force whereas the latter is gauged in terms of the civilian noninstitutionalized population.

As shown in the right panel of Figure 6, the adjusted measure of unemployment climbed to around 11-1/2 percent by the end of 2009—about 1.5 percentage points higher than the conventional measure of unemployment. Moreover, the adjusted unemployment rate remained close to its post-recession peak through mid-2011 and subsequently declined only modestly.

²⁰The BLS classifies individuals as “marginally attached” to the labor force if they have searched for a job within the past year (but not within the past month) and indicate that they would like a job and are available to work at the present time. As shown in Appendix Figure A5, such individuals only comprise a modest fraction of the overall participation gap.

²¹While the empirical analysis in this paper focuses on the United States, Howard, Martin, and Wilson (2011) found that recessions in industrial economies over the 1960-2010 period were usually accompanied by a gradual but eventually sizeable drop in the labor force participation rate (based on an event study analysis of 46 recession episodes). The LFPR typically remained well below its pre-crisis trend even five years after the onset of recession.

In effect, the conventional measure of unemployment appears to have significantly overstated the actual extent of labor market recovery in the wake of the Great Recession.

3 Model Specification

In this section we describe a New Keynesian model with endogenous labor force participation. Our formulation of the participation decision draws on the literature that incorporated home production into macro models (e.g., Benhabib, Rogerson, and Wright (1993) and Greenwood and Hercowitz (1993)). In the spirit of the home production literature, labor supply decisions are made by a representative household which chooses to allocate labor between the market and home (or non-market) sectors based on the relative return to working in either sector. However, while the home production literature focused on how relative productivity differentials between market and non-market activities affect labor flows, our New Keynesian framework is suited to analyzing how weak demand conditions in the market sector – associated with high unemployment and a low return to working – affect labor force participation.

A second key feature of our model is the inclusion of adjustment costs of moving labor between the market and home production sectors (with the home production sector corresponding to individuals who have left the labor force). Adjustment costs help account for why relatively transient spells of unemployment – the experience of most post-war recessions – appear to cause only small changes in participation, while deep recessions may eventually cause large changes in the labor force participation rate. Because the participation rate is a slowly evolving state variable, participation may remain low or even fall as the economy recovers and unemployment drops; as we highlight in the next section, this divergence between the participation rate and unemployment rate may have crucial implications for monetary policy.

Notwithstanding a number of technical assumptions described below, our framework at-

tempts to capture in a simple way the traditional Keynesian notion that weak aggregate demand leads to unemployment, and that labor force participation is likely to respond sluggishly. On the unemployment dimension, our model in effect reinterprets the “hours gap” of the workhorse New Keynesian model along the extensive margin of unemployment.²² An alternative approach would be to model unemployment and labor force participation in a full scale search model; while this seems desirable in general, recent research by Veracierto (2008) and Shimer (2011) suggests that a fairly rich and complicated model structure may be required to account for empirically plausible patterns of comovement between output, unemployment, and labor force participation.²³

3.1 Households

Our model assumes that a representative household allocates “families” between the market and home production sectors. Each family is itself comprised of many members (i.e., a continuum). Assuming a continuum of such families on the unit interval, the representative household chooses a fraction L_{Ft} to work in the market sector, and $1 - L_{Ft}$ to work in the home production sector; thus, L_{Ft} is the labor force participation rate.

This decentralization involving families with a continuum of individual members is convenient for introducing unemployment into the model. Similar to Gali (2011), we assume that individual family members can be regarded as ordered sequentially based on their disutility of working during the period, with individual h experiencing a disutility of work of $\chi_0 h^\chi$ if hired to work in the market sector during the period (with all workers working the same fixed number of hours), and zero disutility otherwise. Importantly, the ‘type’ of each family member is revealed each period only after the labor force participation decision has been made,

²²The workhorse New Keynesian model in fact is a special case of our model in which the labor force participation rate is fixed.

²³For example, both Veracierto (2008) and Shimer (2011) find that the unemployment rate varies *procyclically* if prices and wages are fully flexible. Shimer finds that incorporating sticky (real) wages helps account for the correct pattern of procyclical participation and a countercyclical unemployment rate, but only provided that the disutility of unemployment is roughly commensurate with that of working (if the disutility of unemployment is considerably smaller, then unemployment is procyclical even with the wage rigidities).

so that individual family members cannot be allocated to the market and nonmarket sector based on their individual (dis)taste for market work: the representative household moves the entire family to one sector or the other. In order to satisfy the economywide employment demand for $N_t = L_{Ft} H_{mt}$ workers, each of the L_{Ft} families in the market sector hires those members with the lowest disutility of work during the period. The total disutility of work to a family in the market sector is given by $V(H_{mt}) = \chi_0 \int_0^{H_{mt}} h^\chi dh = \frac{\chi_0}{1+\chi} H_{mt}^{1+\chi}$, where H_{mt} is the number of family members employed; or equivalently, H_{mt} is the employment rate of the labor force (reflecting that all families behave identically), and $1 - H_{mt}$ the unemployment rate.

The representative household, which maximizes the utility of all “families” in the economy, has a utility functional of the form:

$$\mathbb{E}_t \sum_{j=0}^{\infty} \beta^j \epsilon_{dt+j} \left\{ \begin{array}{l} \frac{1}{1-\sigma_C} (C_{t+j} - \psi_c C_{t+j-1}^a)^{1-\sigma_C} - L_{Ft+j} \frac{\chi_0 H_{mt+j}^{1+\chi}}{1+\chi} + \frac{\gamma_G}{1-\sigma_G} L_{Ht+j}^{1-\sigma_G} \\ -0.5\phi_G \left(\frac{L_{Ft+j}}{L_{Ft+j-1}} - 1 \right)^2 L_{Ft+j} \end{array} \right\} \quad (5)$$

where the discount factor β satisfies $0 < \beta < 1$, and ϵ_{dt} is a shock to the discount factor. All consumption, including both market consumption C_t and home production L_{Ht} , is pooled across families so that all families enjoy equal consumption (as do all individuals within a family). The period subutility function over consumption allows for the possibility of external habit persistence in consumption, with C_{t-1}^a denoting lagged aggregate consumption. The period disutility of work reflects that each family allocated to market production sector experiences a disutility of $V(H_{mt}) = \frac{\chi_0}{1+\chi} H_{mt}^{1+\chi}$, so that the cumulative disutility of the L_{Ft} working families is $L_{Ft} \frac{\chi_0 H_{mt}^{1+\chi}}{1+\chi}$. Home production yields a period utility benefit $M(L_{Ht}) = \frac{\gamma_G}{1-\sigma_G} L_{Ht}^{1-\sigma_G}$ that rises in the number of families allocated to that sector (i.e., $L_{Ht} = 1 - L_{Ft}$) minus adjustment costs incurred from shifting resources across sectors (the last term). The adjustment costs are assumed to be quadratic, and may be either internal, or external if the lagged labor force is taken as given by the representative household.

The representative household’s budget constraint in period t states that its expenditure

on goods and net purchases of (zero-coupon) government bonds must equal its disposable income:

$$P_t C_t + B_{G,t} - (1 + i_{t-1}) B_{G,t-1} = W_t N_t + \Gamma_t \quad (6)$$

Here $B_{G,t}$ are purchases of bonds that promise a nominal return of $(1 + i_t)$ in the following period, $W_t N_t$ is (nominal) wage income and Γ_t is income from profits. Total employment of the representative household N_t is the product of employment rate of each household working in the market sector H_{mt} and the labor force participation rate L_{Ft} , i.e., $N_t = H_{mt} L_{Ft}$.

The first order condition for the employment rate H_{mt} is simply given by:

$$\frac{dV(H_{mt})}{dH_{mt}} = \chi_0 H_{mt}^\chi = \frac{W_t}{P_t} \lambda_t \quad (7)$$

For each working family, equation (7) defines the threshold disutility of work such that all family members with a disutility below this level choose to work, while all other members remain unemployed. This condition is exactly equivalent to that in the standard New Keynesian model which equates the marginal disutility of working to the real wage; the only difference is that here the marginal disutility is interpreted along the extensive margin of employment, rather than the intensive margin of hours worked. Thus, a shortfall in aggregate demand is interpreted as reducing the employment rate relative to its flexible price level, rather than reducing hours worked relative to its level under flexible prices.

Abstracting from adjustment costs, the first order condition for labor force participation L_{Ft} is given by:

$$\left\{ \lambda_t \frac{W_t}{P_t} H_{mt} - V(H_{mt}) \right\} = \frac{dM(L_{ht})}{dL_{ht}} = (1 - L_{ft})^{-\sigma_G} \quad (8)$$

Equation (8) implies that the representative household chooses to allocate families to market production up to the point at which marginal return to market work equals the marginal cost in terms of foregone household production $\frac{dM(L_{ht})}{dL_{ht}}$. The marginal return to allocating another family to market work – in brackets on the left hand side – equals the family's total wage income (expressed in utils) minus the total disutility $V(H_{mt})$ that the family would

experience from working in the market sector. Noting that $V(H_{mt}) = \frac{dV(H_{mt})}{dH_{mt}} \frac{H_{mt}}{1+\chi}$ (reflecting the isoelastic specification of $V(H_{mt})$) and using equation (7)), $V(H_{mt})$ may be expressed as $V(H_{mt}) = \lambda_t \frac{W_t}{P_t} \frac{H_{mt}}{1+\chi}$. Substituting into equation (8) and using (7) yields:

$$\left\{ \frac{\chi}{1+\chi} \lambda_t \frac{W_t}{P_t} H_{mt} \right\} = \frac{\chi}{1+\chi} \chi_0 H_{mt}^{1+\chi} = (1 - L_{ft})^{-\sigma_G} \quad (9)$$

Thus, absent adjustment costs, labor force participation L_{ft} varies directly with the employment rate H_{mt} . Quite intuitively, factors that increase the return to market work – and hence boost the employment rate – also increase labor force participation, so that households adjust on both margins. As we discuss below, adjustment costs slow the response of labor force participation to employment changes.

Finally, the optimal bond holding choice of the representative household implies the condition:

$$\lambda_t = E_t \left(\beta \frac{\epsilon_{dt+1}}{\epsilon_{dt}} \right) \lambda_{t+1} \frac{1 + i_t}{1 + \pi_{t+1}} \quad (10)$$

where the marginal utility of consumption is given by $\lambda_t = (C_t - \psi_c C_{t-1}^a)^{-\sigma_C}$, and π_t is the inflation rate $(\frac{P_t}{P_{t-1}} - 1)$.

3.2 Firms

On the production side, we assume a familiar setting with a continuum of monopolistically competitive firms to rationalize Calvo-style price stickiness. Each firm has a production function that depends on capital $K_t(f)$ and labor $N_t(f)$ of the form:

$$Y_t(f) = K_t(f)^\alpha N_t(f)^{1-\alpha} \quad (11)$$

While the aggregate capital stock is fixed, capital may be freely allocated across the f firms, implying that real marginal cost, $MC_t(f)/P_t$ is identical across firms and equal to

$$\frac{MC_t}{P_t} = \frac{W_t/P_t}{MPL_t} = \frac{W_t/P_t}{(1-\alpha) K^\alpha N_t^{-\alpha}}. \quad (12)$$

Each monopolistically competitive firm faces a downward-sloping demand curve of the form $Y_t(f) = \left[\frac{P_t(f)}{P_t} \right]^{\frac{-(1+\theta_p)}{\theta_p}} Y_t$, where θ_p determines the elasticity of substitution between the differentiated goods, and equals the net markup. Given Calvo-style pricing frictions, firm f that is allowed to reoptimize its price ($P_t^*(f)$) solves the usual problem:

$$\max_{P_t^*(f)} \mathbb{E}_t \sum_{j=0}^{\infty} \xi_p^j \psi_{t,t+j} \left[(1 + \pi)^j P_t^*(f) - MC_{t+j} \right] Y_{t+j}(f)$$

where $\psi_{t,t+j}$ is the stochastic discount factor (the conditional value of future profits in utility units, i.e. $\beta^j \mathbb{E}_t \frac{\lambda_{t+j} P_{t+j}}{\lambda_t P_t}$). To allow for the possibility of structural persistence in inflation, we implement in practice a well-known variant in which a fraction ν of those firms that do not receive a signal to re-optimize mechanically adjust their price in line with past inflation.

The aggregate resource constraints for the economy imply that output equals consumption: i.e., $Y_t = C_t$, and that the supply of capital and labor used by the monopolistically competitive firms sum to the relevant aggregates, i.e., $\int K(f)df = K$ and $\int N_t(f)df = N_t$.

3.3 The Log-Linearized Model

Given that prices are sticky, output and employment in our model are demand-determined. Aggregate demand in the log-linearized version of our model can be expressed in terms of the familiar “New Keynesian” IS curve²⁴:

$$n_t - n_t^* = (n_{t+1|t} - n_{t+1|t}^*) - \frac{1 - \alpha}{\hat{\sigma}_c} (i_t - \pi_{t+1|t} - r_t^*), \quad (13)$$

In this equation, n_t is employment and n_t^* is the “natural” or “potential” level of employment that would prevail under fully flexible prices, with each variable expressed as log percent deviation from its steady state value.²⁵ Thus, the employment gap $n_t - n_t^*$ depends inversely

²⁴For expositional simplicity, we abstract from habit persistence in describing the log-linearized equations (though do allow for habit persistence when generating the model simulations).

²⁵More generally, the variables in the log-linearized equations are measured as percent or percentage point deviations from their steady state level. The superscript ‘*’ denotes the level of a variable that would prevail under completely flexible prices, which we refer to as the “natural” or potential level (e.g., u_t^* is the natural rate of unemployment). We use the notation $y_{t+j|t}$ to denote the conditional expectation of a variable y at period $t + j$ based on information available at t , i.e., $y_{t+j|t} = \mathbb{E}_t y_{t+j}$.

on the deviation of the real interest rate ($i_t - \pi_{t+1|t}$) from its natural rate r_t^* , as well as on the expected employment gap in the following period.²⁶ The interest sensitivity of the employment gap depends both on the household's intertemporal elasticity of substitution in consumption $\frac{1}{\sigma_c}$ and directly on the labor share.²⁷ Given that employment is simply proportional to output (i.e., $n_t = (1 - \alpha)y_t$), equation (13) may be expressed equivalently in terms of the output gap $y_t - y_t^*$.

Consistent with our discussion in Section 2, our model implies that a first order log approximation to the employment gap can be expressed as:

$$n_t - n_t^* = (1 - u^*)(l_{ft} - l_{ft}^*) - l_f(u_t - u_t^*), \quad (14)$$

Thus, the employment gap may turn negative due to either a negative labor force participation gap ($l_{ft} - l_{ft}^*$), or because unemployment rises above its natural rate (i.e., a positive unemployment rate gap $u_t - u_t^*$). In what follows, it will be convenient to couch our discussion in terms of a “scaled” labor force participation gap $(1 - u^*)(l_{ft} - l_{ft}^*)$ or scaled unemployment gap $l_f(u_t - u_t^*)$: the scaled gap simply translates the effects of a change in either gap into commensurate units, i.e., into effects on the employment gap.²⁸

The price-setting equation specifies the inflation rate π_t to depend both on expected inflation and marginal cost mc_t :

$$\pi_t - \nu\pi_{t-1} = \beta(\pi_{t+1|t} - \nu\pi_t) + \kappa_p mc_t, \quad (15)$$

Given the Calvo-Yun contract structure, the composite parameter κ_p depends inversely on the mean contract duration ($\frac{1}{1-\xi_p}$), while the quasi-difference specification for inflation re-

²⁶The natural level of employment n_t^* and natural real interest rate r_t^* may be expressed in terms of the shocks as: $n_t^* = \left(\frac{1+\phi_m}{\chi+(1+\phi_m)(\alpha+(1-\alpha)\hat{\sigma}_c)}\right) [(1 - \hat{\sigma}_c)z_t + \hat{\sigma}_c\varepsilon_c\varepsilon_{ct}]$; and

$r_t^* = \hat{\sigma}_c \left(1 - \frac{1}{\phi_{mc}\hat{\sigma}_c}\right) \left[(1 - \alpha)(n_{t+1|t}^* - n_t^*) + \varepsilon_c(\varepsilon_{ct} - \varepsilon_{ct+1|t}) \right] + \varepsilon_d(\varepsilon_{dt} - \varepsilon_{dt+1|t})$.

²⁷In equation (13), the composite parameter $\hat{\sigma}_c$ is defined as $\hat{\sigma}_c = \frac{\sigma_c}{1-\varepsilon_c}$, where ε_c is the mean level of the consumption taste shock (since this is assumed to be negligible in magnitude, $\hat{\sigma}_c \approx \sigma_c$).

²⁸Thus, the actual labor force participation rate must fall by $\frac{1}{1-u^*}$ to reduce the employment gap by one percentage point, while the unemployment rate must rise by $\frac{1}{l_f}$ percentage points.

flects that we allow for some degree of dynamic indexation of price contracts.²⁹

A novel feature of the aggregate supply block is that marginal cost mc_t depends both on the unemployment rate gap and the labor force participation gap:

$$mc_t = \frac{w_t}{p_t} - MPL_t = \psi_u l_f (u_t^* - u_t) + \psi_l (1 - u^*) (l_{ft} - l_{ft}^*), \quad (16)$$

Equations (16) and (15) together imply that inflation falls relative to target if there is slack in *either* labor market resource gap, i.e., if either $u_t > u_t^*$, or if $l_{ft} < l_{ft}^*$. The implication that a negative cyclical participation gap would exert at least *some* downward pressures on wages and marginal cost seems reasonable, especially to the extent that it reflected a falloff in the participation rate of younger and geographically mobile members of the population.

The Phillips Curve implied by our model (i.e., equations (16) and (15)) clearly resembles that associated with the “insider-outsider” models of the labor market that were pioneered by Blanchard and Summers (1986) and Blanchard and Diamond (1994). An important feature of this class of models is that the longer-term unemployed affect wages by less than the newly unemployed; and empirical applications attempting to differentiate between these groups in estimating price- or wage-Phillips Curves typically found support for this prediction (e.g., see Blanchard 1991). Drawing on this literature, it seems plausible that cyclical non-participants in our model would have relatively little influence on wages and marginal cost relative to labor force participants – a feature that we impose in our calibration (i.e., ψ_u is much larger than ψ_l).

Although our model literally imposes that the coefficient ψ_u on the scaled unemployment gap exceed the coefficient on the scaled participation gap ψ_l , the model can be calibrated flexibly so that the gap between coefficients approaches zero as the elasticity of labor supply becomes arbitrarily high (noting $\psi_u = \chi + \psi_l$, and recalling that χ is the inverse Frisch elasticity of labor supply).³⁰ This flexibility clearly seems desirable given substantial uncertainty about the relative importance of each gap in affecting marginal costs. The reason why the

²⁹The composite parameter κ_p is defined as $\kappa_p = \frac{(1-\xi_p)(1-\beta\xi_p)}{\xi_p}$.

³⁰The composite parameter $\psi_l = \alpha + (1 - \alpha)\hat{\sigma}_c$

unemployment gap coefficient is *generally* higher in our model reflects that the participation gap only affects marginal cost through a wealth effect on wages and due to diminishing returns to production; whereas the unemployment gap – in addition to working through these channels – also affects wages through its effect on the disutility of work. For example, in the special case of a linear production function ($\alpha = 0$) and no taste shocks, the log-linearized version of equation (7) is given by:

$$mc_t = -\chi l_f(u_t - u_t^*) + \hat{\sigma}_c c_t = -(\chi + \hat{\sigma}_c) l_f(u_t - u_t^*) + \hat{\sigma}_c(1 - u^*)(l_{ft} - l_{ft}^*), \quad (17)$$

Thus, the participation gap enters only through the wealth effect term $\hat{\sigma}_c c_t$, which captures how (say) lower participation reduces consumption and hence shifts out the wage schedule. The log-linearized equation describing how the labor force participation gap responds dynamically to the unemployment rate gap is given by:

$$l_{ft} - l_{ft}^* = \mu_1(l_{ft-1} - l_{ft-1}^*) + \mu_2(l_{ft+1|t} - l_{ft+1}^*) - \phi_m(u_t - u_t^*), \quad (18)$$

The long-run response hinges on the composite parameter ϕ_m , which itself depends on the relative degree of curvature of the disutility of work schedule to the home production schedule: for example, as the home production function becomes more concave (higher σ_G), the responsiveness of participation to a change in the return to market work is diminished.³¹ The general form of equation (18) implies that both current and future unemployment rate gaps may affect the response of current labor force participation. However, we mainly focus on the specification with external adjustment costs which implies that labor force participation follows a simple AR(1) (with the lag coefficient μ_1 , and the forward lead $\mu_2 = 0$). This specification has the appeal of simplicity, and seems reasonably plausible empirically.

In our baseline model, we assume that the policy rate i_t follows a simple Taylor rule

³¹The parameter ϕ_m is defined as $\phi_m = \frac{1+\chi}{\sigma_G \left(\frac{l_f}{1-l_f} \right)}$.

subject to the zero lower bound:

$$i_t = \max(-i, \gamma_\pi \pi_t + \gamma_n(n_t - n_t^*) - \gamma_u(u_t - u_t^*) + \epsilon_{it}), \quad (19)$$

In addition to inflation, the policy rate is assumed to react either to the unemployment rate gap $u_t - u_t^*$, to the employment gap $n_t - n_t^*$, or possibly both. The policy rule is assumed to be non-inertial, though it is worth noting that a policy rule reacting to the employment gap may be regarded as responding indirectly to labor force participation, which is a state variable. We also consider optimal policies with full commitment in Section 4.

3.4 Calibration of Structural Parameters

To run our benchmark simulations, we calibrate the model as follows. We set the discount factor $\beta = 0.995$, and the steady state net inflation rate $\pi = .005$; this implies a steady state interest rate of $i = .01$ (i.e., four percent at an annualized rate). We set the parameter $\hat{\sigma}_c$ determining the interest elasticity of employment demand equal to unity (with the scale parameter on the consumption taste shock $\varepsilon_c = 0.01$), the capital share parameter $\alpha = 0.3$, and the Frisch elasticity of labor supply $\frac{1}{\chi} = 0.25$. These parameter values imply that $\psi_l = 1$ and $\psi_e = 4$ in the marginal cost expression (16), so that a one percentage point rise in the participation gap boosts marginal cost by 1/5th as much as a one percentage point fall in the unemployment gap.³² Conditional on these parameters, we calibrate the adjustment cost parameter φ_G on labor force participation and the curvature parameter of the home production function σ_G to imply that the reduced form parameters μ_1 and ϕ_m in the labor force participation equation (18) equal 0.97 and 0.06, respectively; thus, labor force participation responds very slowly to the unemployment rate.

The price contract duration parameter ξ_p is set to 0.98, implying a very low degree of

³²To our knowledge, there has been little empirical work estimating the role of the participation gap compared to the unemployment gap in affecting marginal costs and inflation. As noted above, our calibration seems consistent qualitatively with the implications of estimated insider-outsider models, although it seems most plausible that cyclical non-participants would put even less downward pressure on wages than the long-term unemployed.

responsiveness of inflation to marginal cost of .0005. We will later use the model to compare the performance of alternative policy rules following large adverse shocks which cause policy rates to be pinned at the zero lower bound for a long duration. Given the simple structure of the model, long price contracts are required to allow the model to generate plausible variation in inflation, and also to solve the model numerically under the some of the rules considered.³³ In future research, it would be useful to modify the model to include sticky wages as well as prices; wage rigidities would damp the responsiveness of inflation to unemployment, and allow for more realistic price contract durations.

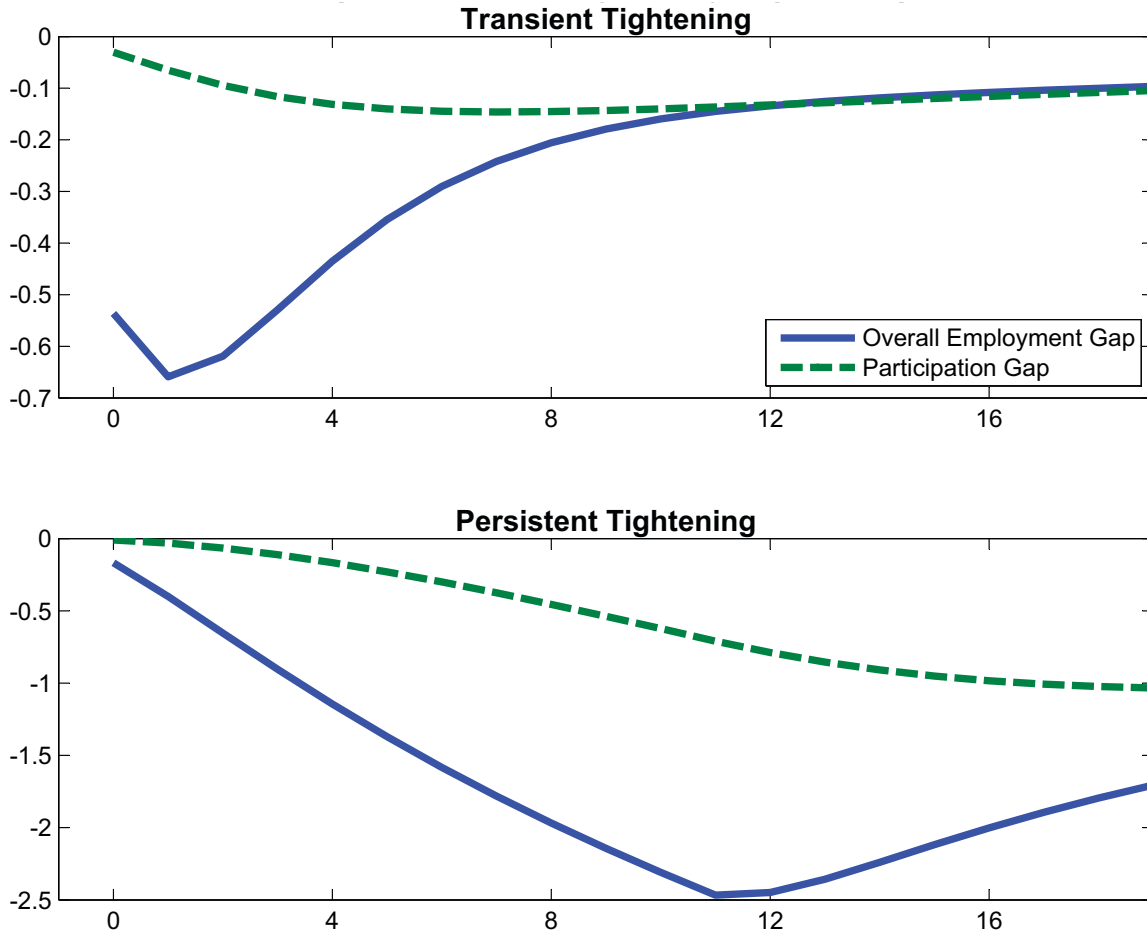
4 Capturing the Dynamics of the LFPR

Now we consider the extent to which our model can account – at least qualitatively – for the key stylized facts that were documented in the preceding empirical analysis. To illustrate the cyclical behavior of the LFPR during “normal” times, the upper panel of Figure 7 shows the effects of a fairly transient shock ϵ_{it} to the monetary policy rule (19) in a context where its prescriptions are not constrained by the zero lower bound. Specifically, the monetary shock is assumed to follow an AR(1) process with a autoregressive parameter of 0.7, and the size of the innovation is scaled so that the policy rate rises 100 basis points on impact. This shock reduces employment by a bit less than one percent, with habit persistence in consumption accounting for the slightly hump-shaped trajectory.³⁴ Importantly, the substantial near-term fall in the employment rate is driven almost entirely by a rise in the unemployment rate (not

³³Eggertson (2008) highlights how a prolonged liquidity trap can cause a depression due to a collapse in expected inflation; to avoid what he terms a “black hole,” the Phillips Curve slope must be below a critical value that varies directly with the expected duration of the liquidity trap. While the critical value is specific to his two state Markov framework, the intuition that the Phillips Curve slope must be sufficiently flat clearly applies to our model.

³⁴In Figure 7, the monetary rule is calibrated so that $\gamma_\pi = 2$, and $\gamma_u = 0.25$ (equal to unity if the interest rate is annualized). The coefficient on the unemployment gap may be interpreted as corresponding to the standard Taylor rule coefficient of 0.5 on the output gap under the assumption of an Okun’s law coefficient of 0.5 relating the unemployment gap to the output gap.

Figure 7: The Response of the Labor Market to Monetary Policy Shocks



shown, but is given by the gap between the employment rate and labor force participation).³⁵ Labor force participation does exhibit a very persistent longer-run decline that contributes to a correspondingly persistent decline in the employment gap, but this variation is quite small by comparison with the near-term effect.

By contrast, our model can generate a much larger decline in labor force participation in response to a large and highly persistent decline in aggregate demand. This is illustrated in the lower panel of Figure 7, which depicts a persistent monetary tightening implemented through a sequence of monetary policy innovations lasting for three years (with the shocks

³⁵Our simulations (and those below) report the scaled unemployment gap and the scaled labor force participation gap. Hence, the difference between the employment gap and participation gap reflects the contribution of the higher unemployment rate to the employment gap.

having a first-order autocorrelation of 0.9). About half of the employment gap at a horizon of 5 years is attributable to a drop in labor force participation, which seems roughly in line with the U.S. experience in the aftermath of the Great Recession. Moreover, as the economy recovers and the unemployment rate starts to fall (note that the gap between the lines begins narrowing after twelve quarters), labor force participation continues to decline and accounts for progressively more of the employment gap. We consider below how this divergence between gaps can have major implications for monetary policy.

This contrast is directly attributable to the fact that in our benchmark specification, the scaled LFPR follows an AR(1) process in which the unemployment rate acts as the forcing variable:

$$l_{ft} = \mu_1 l_{ft-1} - \phi_m u_t, \quad (20)$$

Consequently, even though Figure 7 depicts the effects of exogenous monetary policy shocks, it is evident that aggregate demand shocks can induce broadly similar results. Moreover, the case of a protracted monetary tightening helps illustrate how a protracted period at the zero lower bound – which operates like a sequence of adverse monetary shocks – can generate a large and highly persistent decline in labor force participation.

5 The Design of Monetary Policy Rules

5.1 Policy Tradeoffs

A familiar result based on the workhorse New Keynesian model – highlighted by Goodfriend and King (1997) and dubbed “divine coincidence” by Blanchard and Gali (2005) – is that monetary policy faces no tradeoff between stabilizing inflation and unemployment. Thus, in response to an adverse demand shock that temporarily boosted the unemployment rate above its natural rate, inflation would return to target as soon as u_t reverted back to u_t^* ; and a policy of strictly targeting the unemployment gap would yield the same outcome as a

policy that strictly targeted inflation.³⁶

In our framework, a large negative labor force participation gap – presumably caused by a deep recession – can markedly affect monetary policy tradeoffs relative to the workhorse New Keynesian model, at least under the plausible conditions satisfied by our benchmark calibration. One condition is that labor force participation responds gradually to the unemployment rate: recalling Figure 7, a sluggish response means that labor force participation can remain depressed even as the economy recovers and unemployment rate approaches u_t^* . A second condition is that the unemployment gap affects inflation by relatively more than the participation gap, so $\psi_u > \psi_l$.

Assuming these conditions hold, there are several key dimensions along which the implications of our model diverge from the workhorse New Keynesian model. First, as can be inferred from equation (16), stabilizing the unemployment gap ($u_t = u_t^*$) does not suffice in stabilizing inflation at target if the participation gap is negative (or more generally, non-zero). This reflects that a negative labor force participation gap puts at least some downward pressure on marginal cost and hence inflation even if $u_t = u_t^*$.

A second and closely related implication of our model is that a policy of aggressively targeting inflation in the wake of a persistently negative labor force participation gap requires the unemployment rate to “overshoot,” i.e., fall below the long-run natural rate for some time. To see this, note that the Phillips Curve equation (15) requires that discounted marginal cost must be zero ($\sum_{j=0}^{\infty} \beta^j mc_{t+j} = 0$) for inflation to be stable. Consequently, in the absence of any structural inflation persistence, we obtain:

$$\sum_{j=0}^{\infty} \beta^j \psi_u l_f (u_{t+j} - u_{t+j}^*) = \sum_{j=0}^{\infty} \beta^j \psi_l (1 - u^*) (l_{ft+j} - l_{ft+j}^*), \quad (21)$$

Thus, the unemployment rate must on average overshoot the natural rate ($u_t < u_t^*$) by enough to balance the deflationary pressure arising from current and expected future negative participation gaps (the right hand side of equation 21). The implication that unemployment

³⁶We are assuming implicitly that monetary policy is forced to depart from the strict targeting rule for some time (say because of a binding zero bound constraint), so that the demand shock boosts unemployment.

must fall below the natural rate to keep inflation stable in our model is tantamount to a fall in the short-term natural rate of unemployment.³⁷

A third key implication is that a policy of aggressively targeting the employment gap puts upward pressure on inflation. From equation (14), setting $n_t = n_t^*$ requires that:

$$l_f(u_t - u_t^*) = -(1 - u^*)(l_{ft} - l_{ft}^*) \quad (22)$$

In other words, any shortfall in participation ($l_{ft} < l_{ft}^*$) must be fully offset by a fall in unemployment relative to the natural rate. To the extent that the negative participation gap puts less downward pressure on inflation than the unemployment gap, so $\psi_l < \psi_u$ (assuming both gaps are scaled to have similar effects on the employment gap), balancing the gaps equally as implied by (22) puts upward pressure on inflation. Thus, as we explore further below, while monetary policy can achieve a faster recovery by targeting the employment gap, such a policy typically involves the tradeoff of higher inflation.

Our model implies that there is no tradeoff between employment gap and inflation stabilization in two special cases; both are extreme, but nonetheless useful for gauging how monetary policy tradeoffs are likely to vary as the calibration is modified along these dimensions. One case occurs if labor force participation responds contemporaneously to the current unemployment gap, which is implied if the adjustment cost parameter $\varphi_G = 0$. Because the unemployment gap and participation gaps are each simply proportional to the employment gap $n_t - n_t^*$, marginal cost and hence inflation also depend only on $n_t - n_t^*$, and our model becomes observationally equivalent to the New Keynesian model. Accordingly, monetary policy would face no tradeoff between stabilizing inflation and the employment gap; and it would be immaterial whether monetary policy responded to the unemployment gap or employment gap. Quite intuitively, this special case highlights that the choice of a gap to target – the unemployment gap vs. the employment gap – should be less consequential to the extent that the participation gap responds relatively quickly to unemployment.

³⁷Clearly, this contrasts with the “no tradeoff” result in the New Keynesian model, which implies that inflation is stabilized through bringing unemployment back to its natural rate (with no required overshooting).

Similarly, there is no tradeoff between stabilizing the employment gap and inflation if $\psi_l = \psi_u$.³⁸ In this case, the upward pressure on inflation associated with pushing unemployment below the natural rate is exactly offset by downward pressure arising from the cyclical nonparticipants.³⁹ As suggested by this special case (and demonstrated below), a relatively large coefficient on the participation gap (ψ_l close to ψ_u) means that employment gap targeting should be associated with less inflationary pressure.

5.2 Simple Policy Rules

Our qualitative analysis above suggests that monetary policy must allow the unemployment rate to fall below its long-run natural rate to keep inflation stable, but faces a potential tradeoff in pursuing a more aggressive policy of stabilizing the employment gap. This section illustrates some dynamic implications using simulations of our model under both a non-inertial Taylor rule and under an “optimal” policy rule derived from minimizing an intertemporal loss function.

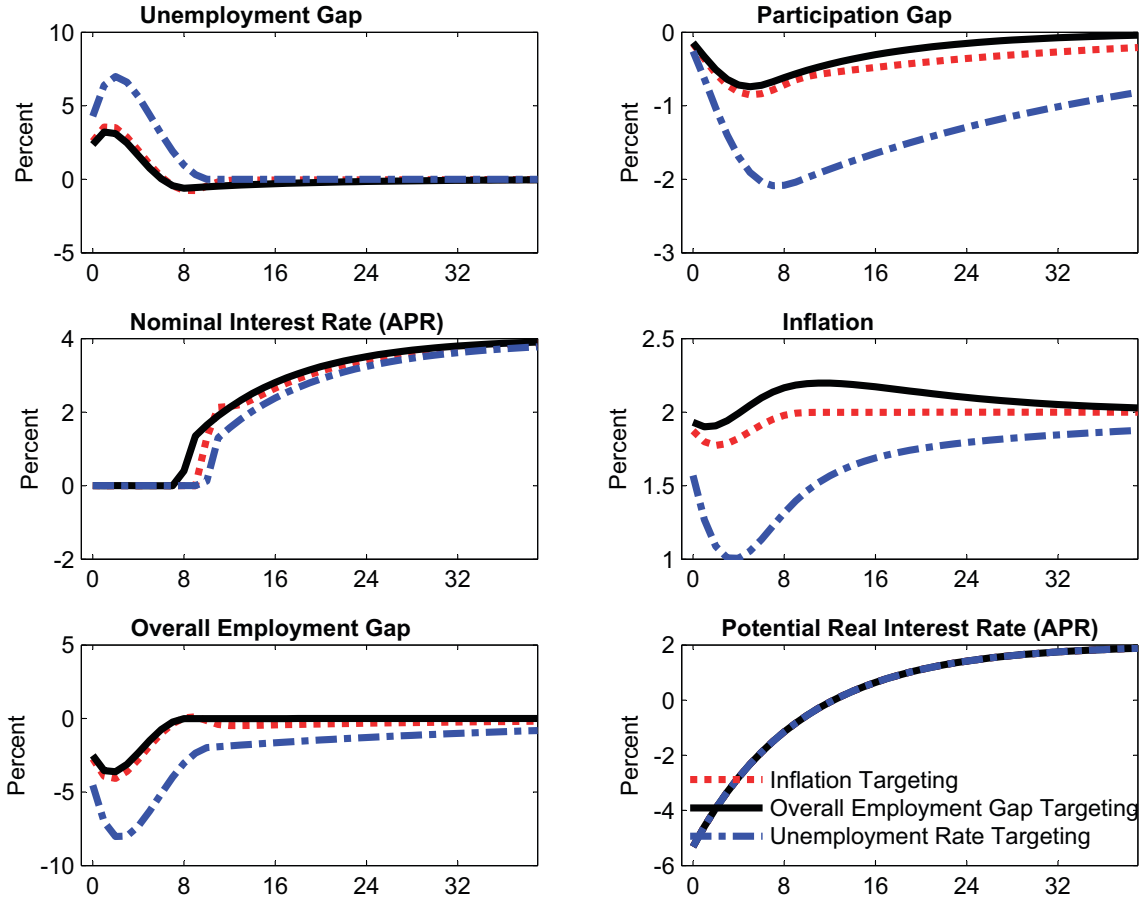
We generate initial conditions for our simulations by assuming that the economy is buffeted by a persistent adverse demand shock that pins the policy rate i_t at its zero lower bound for roughly two years. In all of our simulations, the shock consists of a persistent change in the discount factor ε_{dt} that causes the natural real interest rate r_t^* to fall sharply.

The dash-dotted blue lines in Figure 8 show the effects of the demand shock under a Taylor rule that aims to fully stabilize the unemployment rate at its long-run potential rate ($u_t = u_t^*$); thus, the Taylor rule given by equation (19) is calibrated with a very large coefficient γ_u that would completely insulate the real economy from this demand shock if the zero bound constraint were not binding. Because the zero bound does bind in our simulation, the unemployment rate u_t rises far above u_t^* (panel 1), the participation rate falls persistently

³⁸In our model, this occurs as the Frisch elasticity of labor supply tends toward infinity.

³⁹This special case highlights how the “no tradeoff” result applies the employment gap, and not to the unemployment gap (as in the workhorse New Keynesian model). A large coefficient ψ_l on the participation gap in the marginal cost relation would imply substantial downward pressure on inflation under a rule targeting the unemployment gap.

Figure 8: Model Behavior under Alternative Policy Rules



(panel 2), and inflation declines well below target (panel 4). As the shock wears off and the natural real interest rate rises, this policy rule implies a smooth convergence of u_t to u_t^* .⁴⁰ Moreover, while the unemployment rate gap converges within 10 quarters, the effects on labor force participation are much longer-lived. The highly persistent negative participation gap puts downward pressure on inflation, so that inflation remains below target well after the unemployment rate gap has closed.

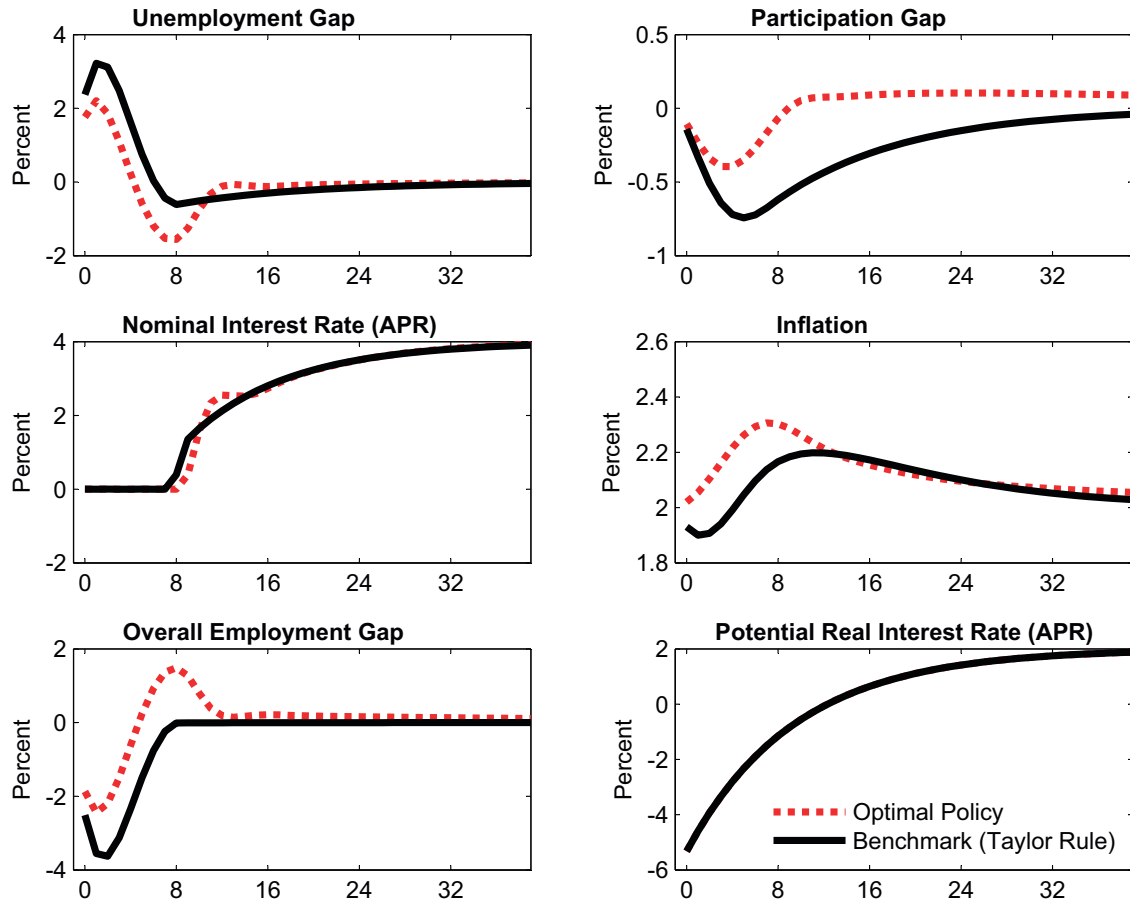
Figure 8 also shows the implications of alternative policy rules aimed at strictly stabilizing inflation – the dashed red lines – or the overall employment gap $n_t - n_t^*$ – the solid black lines (achieved by setting γ_π or γ_n to arbitrarily large values, respectively). Consistent with

⁴⁰The figures plots interest rates and inflation in levels, mainly to highlight the zero bound constraint on nominal rates. Real variables are simply depicted as a percent deviation from their steady state level.

our previous discussion, the rule that attempts to stabilize inflation implies an eventual overshooting of the unemployment rate gap as the economy recovers (i.e., $u_t < u_t^*$). Quite intuitively, pushing the unemployment rate below the long-run NAIRU helps counterbalance the downward pressure on inflation arising from a persistently negative participation gap. The rule that attempts to stabilize the overall employment gap n_t is even more aggressive insofar as it aims to allow the unemployment rate to overshoot by enough to *fully offset* the negative participation gap (recalling equation 14). Given the larger coefficient on the unemployment gap relative to the participation gap in the Phillips Curve, inflation rises persistently above target as the economy recovers. This policy rule not only promotes a faster recovery in both unemployment and participation than the other rules considered, but also mitigates the initial downturn in employment and inflation following the adverse shock.

The idea that an aggressive policy can spur a faster recovery in slow-moving state variables extends well beyond our model in which the participation rate is the only pre-determined state variable. For example, in a model with endogenous capital accumulation, the capital stock would also recover more slowly than control variables such as investment or hours worked (much like the labor force participation rate in the lower panel of Figure 7). A monetary policy rule that in effect responded to the “capital stock gap” – the deviation of the capital stock from its level under flexible prices – would induce the same sort of overshooting of controls as evident in Figure 8 for the unemployment rate, and have similar qualitative implications for inflation. Characterizing such tradeoffs in an empirically realistic model would seem a fruitful subject for future research. Of course, the extent to which a capital stock gap or housing gap influenced the course of policy would depend heavily on policymaker objectives. Thus, a central bank’s willingness to tolerate higher inflation to close an employment gap may differ considerably from its willingness to accept higher inflation in order to close a capital stock gap, particularly if the central bank viewed its objectives as more closely linked to employment.

Figure 9: Optimal Policy under Commitment



5.3 Commitment-Based Strategies

The implications of the employment targeting rule shown in Figure ??—in which unemployment eventually falls below its natural rate and inflation rises above target—are broadly similar to those implied by the optimal commitment policy in the face of the ZLB; cf. Eggertsson and Woodford (2003). These results show that a non-inertial policy rule may induce undershooting of unemployment along with some overshooting of inflation. In effect, a policymaker in our model who cares about inflation and total employment—not just the unemployment rate—would be inclined to follow a policy that allows inflation to exceed its target for a while in order to promote a faster narrowing of the participation gap.

Of course, the employment targeting rule considered above is non-inertial and hence can-

not capture potentially substantial gains that may be associated with a commitment-based strategy. While deriving a utility-based welfare function is beyond the scope of this paper, the potential benefits of a commitment-based strategy can be illustrated with a quadratic loss function that simply involves the squared employment gap and the squared inflation gap.⁴¹ We then proceed to derive the targeting rule under commitment that optimizes this objective function; this “optimal” policy rule embeds history dependence (as in the literature on commitment-based strategies) and hence provides a contrast with the non-inertial rules considered above.

As seen in Figure 9, the “optimal” policy rule involves an eventual overshooting of the employment gap and thereby provides considerably more monetary stimulus than a non-inertial rule. Consequently, the unemployment gap exhibits even more undershooting while the participation rate exhibits overshooting as the economy recovers. This behavior clearly contrasts with the non-inertial employment targeting rule, which implies monotonic convergence of the employment gap and the participation gap, albeit at different speeds.

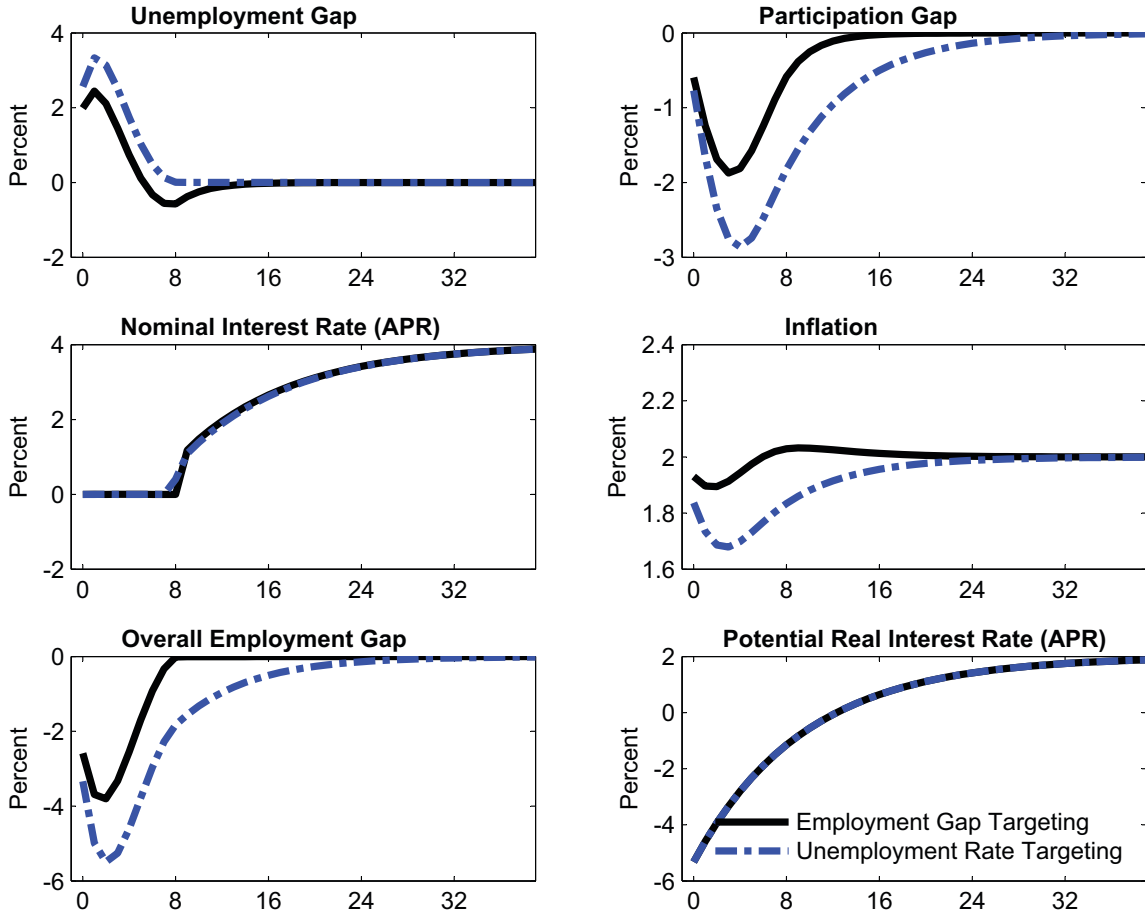
6 Robustness

In this section we examine the policy implications of alternative settings for three key structural parameters in our model: (1) the speed of adjustment of the LFPR; (2) the slope of the New Keynesian Phillips curve; and (3) the responsiveness of inflation to the participation gap.

Speed of Adjustment of the LFPR. A key determinant of the relative performance of different rules is the speed at which labor force participation responds to falling unemployment as the economy recovers. Under our baseline calibration in which labor force participation responds very gradually, employment gap targeting is much better than unemployment gap targeting in generating a faster labor market recovery, albeit at the cost

⁴¹For technical reasons, we also place a small weight on changes in the short-term nominal interest rate.

Figure 10: Implications of a Less Inertial Participation Gap

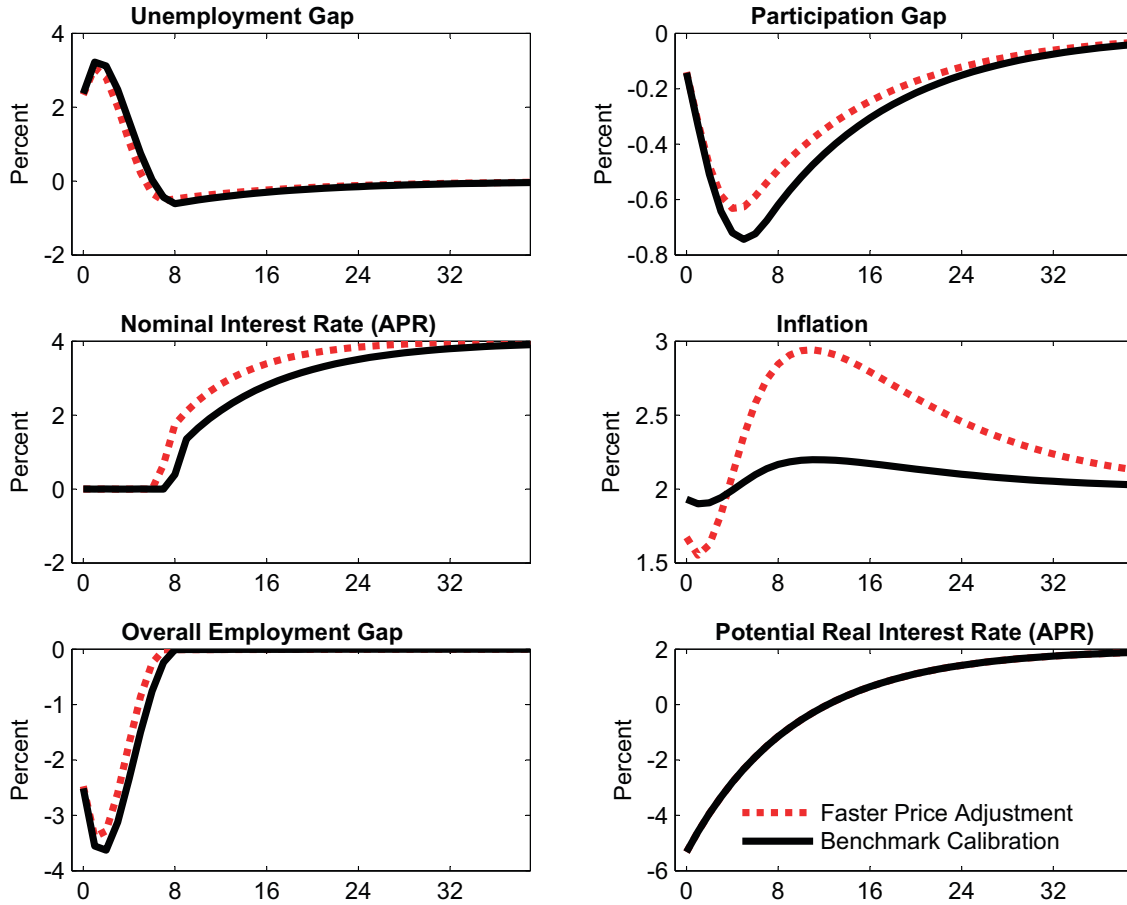


of somewhat higher inflation. In essence, pushing the unemployment persistently below the NAIRU is what is required to bring people back into the labor market. But given limited experience with deep and protracted recessions during the post-war period – even taking account of state-level evidence – there is admittedly substantial uncertainty about how labor force participation is likely to respond to a recovering economy.

As shown in Figure 10, the distinction between targeting employment vs. unemployment becomes less significant if the LFPR responds more rapidly to the unemployment rate.⁴² In particular, when the parameter μ_1 is calibrated at 0.85 (a substantially smaller value than in our benchmark calibration), then labor force participation rebounds fairly quickly even

⁴²As noted above, the distinction between these two rules disappears completely in the case where there are no adjustment costs at all.

Figure 11: Implications of a Steeper New Keynesian Phillips Curve



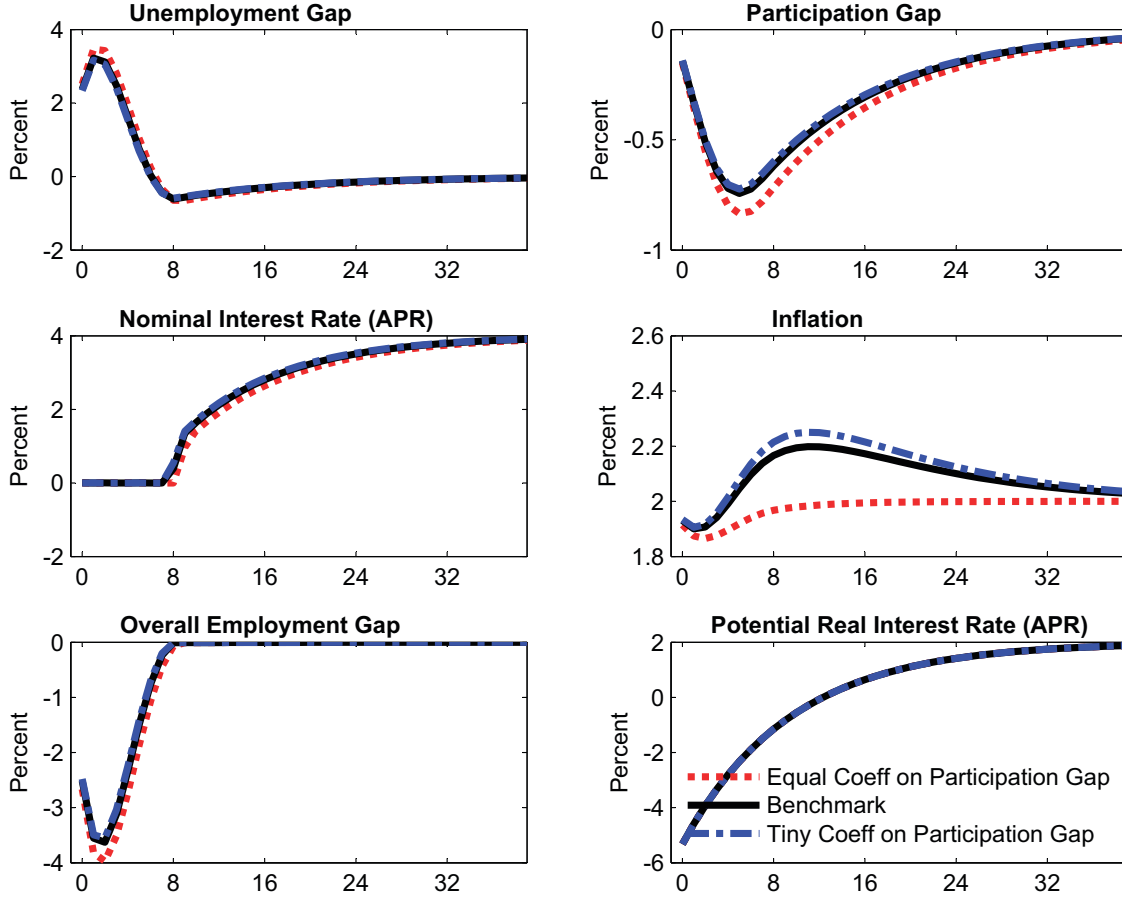
when the unemployment rate converges monotonically rather than undershooting its natural rate.⁴³

Slope of the NKPC. Under the employment targeting rule, inflation would tend to rise substantially further as the economy recovered if the slope of the NKPC were steeper. This scenario is illustrated in Figure 11, which compares our benchmark calibration with an alternative in which the NKPC slope parameter κ_p is several times larger.⁴⁴ Inflation rises to around 3 percent under this alternative and remains persistently above target.

⁴³The pace of adjustment of the participation gap to unemployment also affects the outcomes for inflation, as can be seen by the outcomes under employment gap targeting across Figures 8 and 10.

⁴⁴This is achieved by setting the contract duration parameter $\xi_p = .95$ rather than 0.98 as in our baseline.

Figure 12: Inflation Responsiveness to the Participation Gap



Responsiveness of Inflation to the Participation Gap. Figure 12 considers alternative assumptions about the degree of segmentation in wage-setting behavior. First, we consider the case where individuals who have dropped out of the labor force have no influence at all on the current inflation rate; that is, the NKPC coefficient on the participation gap (ψ_l) is set arbitrarily close to zero.⁴⁵ The trajectory for inflation is only slightly higher in this case, reflecting the fact that this coefficient has a relatively small value even in our benchmark calibration. Second, we consider the case where marginal cost depends on the overall employment gap, and hence inflation is equally responsive to the participation gap and the unemployment gap (that is, $\psi_l = \psi_u$). In this case, the employment targeting rule

⁴⁵The NKPC coefficient on the unemployment gap (ψ_u) remains unchanged.

also succeeds in keeping inflation close to target; that is, there is effectively no policy tradeoff between promoting these two objectives.

7 Conclusions

In this paper, we have drawn on both U.S. and state-level evidence to show that much of the decline in the LFPR since 2007 is due to cyclical factors. In light of that evidence, we have extended the workhorse New Keynesian model to incorporate endogenous movements in labor force participation, and we have used this model to investigate the monetary policy implications of targeting alternative measures of resource slack. In the case of a severe and highly persistent decline in aggregate demand, the central bank can promote a faster recovery in LFPR and hence in total employment by allowing the unemployment rate to drop temporarily below its natural rate.

Under our benchmark calibration of the structural parameters, there is only a mild tradeoff between the monetary policy objectives of fostering the economic recovery and keeping inflation on target. Specifically, the undershooting of the unemployment rate exerts moderate upward pressure on unit labor costs, which in turn results in modestly higher inflation. We have also examined how the policy tradeoff is affected by alternative calibrations of several key parameters, including the slope of the New Keynesian Phillips Curve, the sensitivity of market wages to the participation gap, and the dynamic response of the participation gap to the unemployment gap.

Unfortunately, there is a scarcity of empirical work characterizing how labor compensation is affected by cyclical movements in the participation rate. That paucity of evidence is not surprising given that the U.S. economy has only rarely experienced a deep recession followed by a protracted recovery. Therefore, more empirical work is clearly warranted; indeed, micro data could be invaluable in illuminating the factors that influence households' labor force participation decisions.

Finally, our modeling framework abstracts from a number of other factors that may be highly relevant in determining the appropriate course of monetary policy. For example, Orphanides (2002) and others have highlighted the pitfalls of targeting a natural unemployment rate that is too low, and uncertainty about the natural rate of unemployment might well be elevated in the wake of a deep recession. In a parallel vein, it would be desirable to gauge the degree of uncertainty regarding the magnitude of the participation gap and to analyze the robustness of alternative simple rules in the context of uncertainty about both the unemployment gap *and* the participation gap.

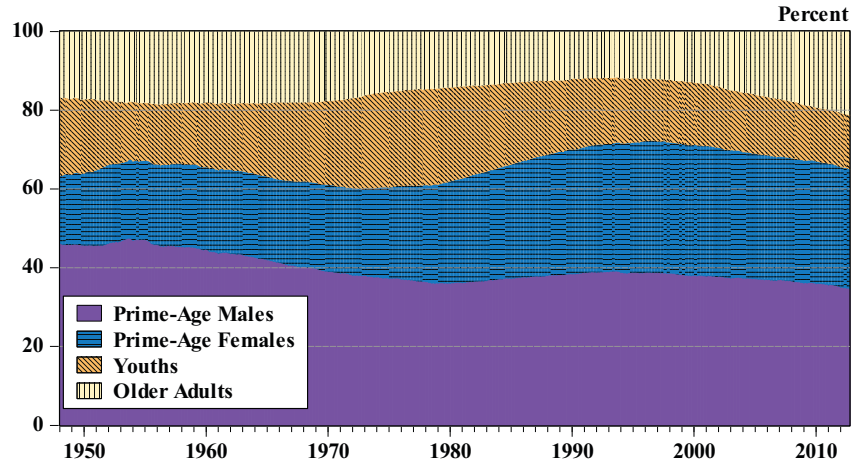
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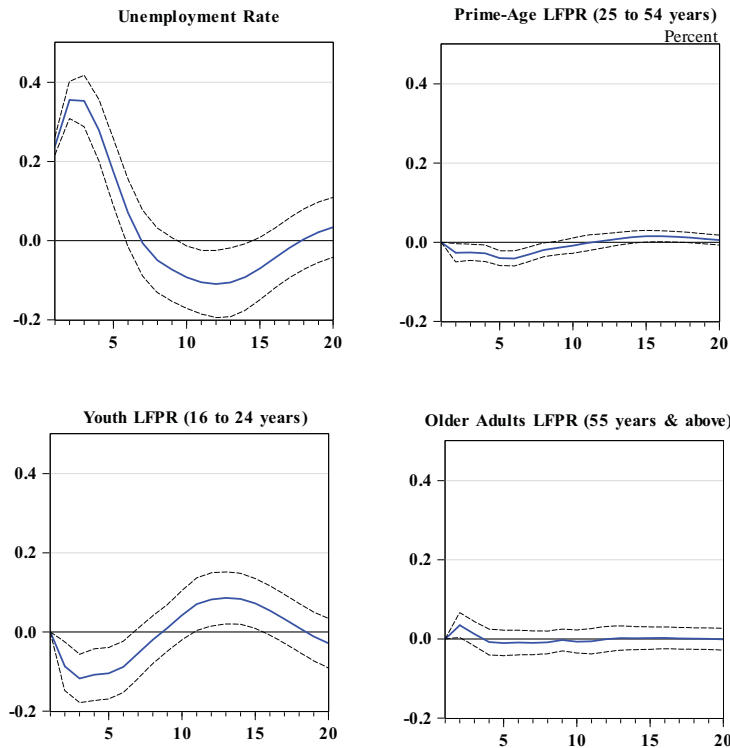
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Appendix Figure A1: Demographic Composition of the Labor Force



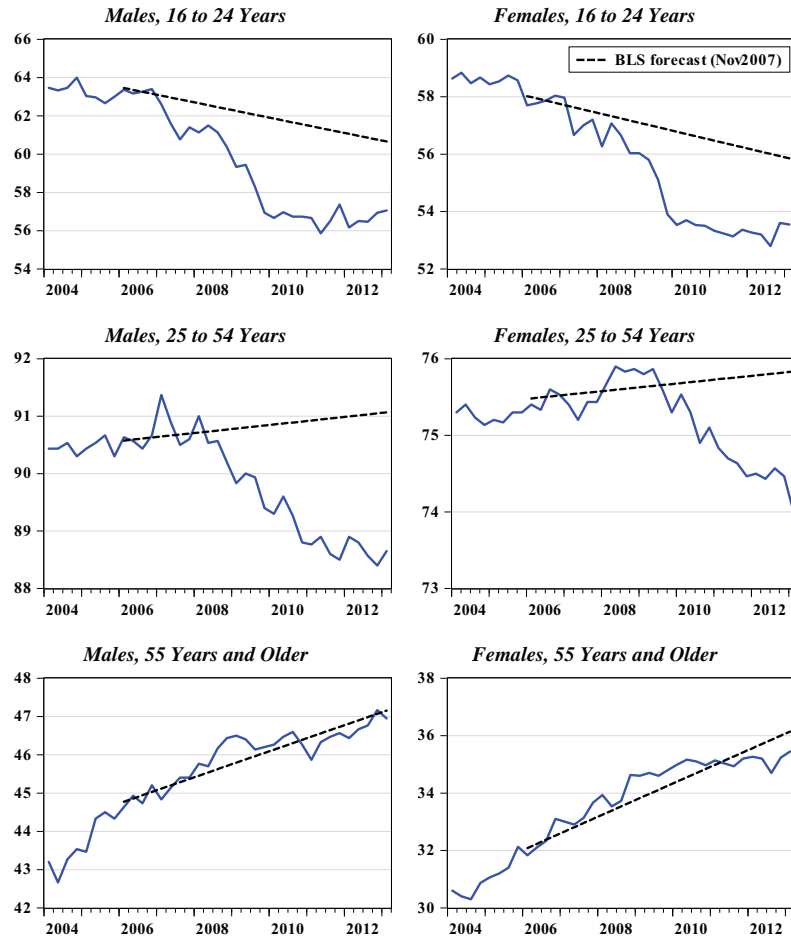
Note: This figure depicts the demographic composition of the labor force (in percent) from 1948 to 2012. The solid area denotes the share of prime-age males (25 to 54 years old), and the horizontal-dashed area denotes the share of prime-aged females (25 to 54 years). The diagonal-dashed and vertical-dashed areas denote the shares for youths (16 to 24 years) and older adults (55 years and above), respectively.

Appendix Figure A2: Cyclical Dynamics of the LFPR by Age Group



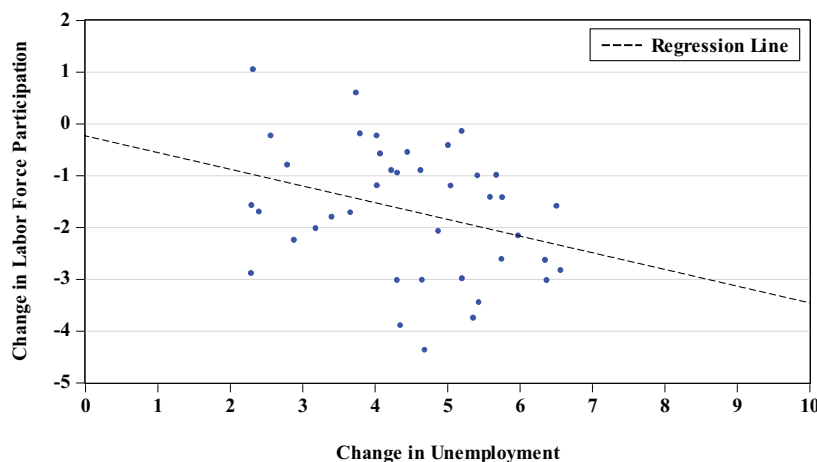
Note: This figure depicts the impulse responses from a VAR estimated using quarterly data on the unemployment rate and the labor force participation rates for three demographic groups (prime-age adults, youths, and older adults) over the period 1948:Q1 to 2007:Q4. In each panel, the solid line denotes the response of the specified variable to an orthogonalized unemployment rate shock of one standard deviation, and the dashed lines depict 95 percent confidence bands based on 10,000 Monte Carlo replications.

Appendix Figure A3: Labor Force Participation by Age and Gender



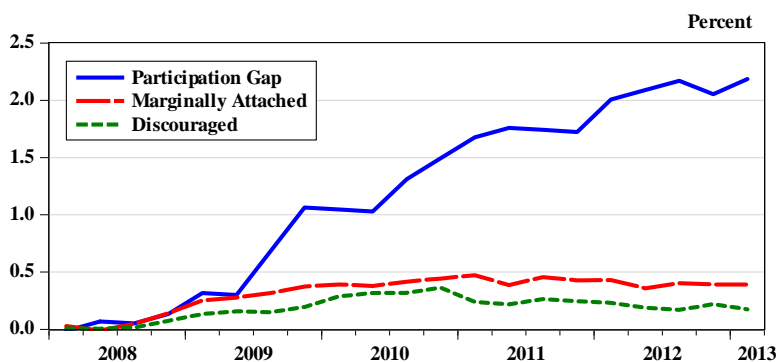
Note: In each panel, the solid line denotes the actual evolution of the labor force participation rate (in percent) for the specified demographic group from 2004:Q1 to 2013:Q1, and the dashed line denotes the linear trend for the decade ending in 2016 that was projected by BLS staff and published in the November 2007 issue of the Monthly Labor Review.

Appendix Figure A4: Data from Larger States (excluding Nevada) Regarding Unemployment and Labor Force Participation of Prime-Age Adults



Note: The vertical axis refers to the change in the labor force participation rate for prime-age adults (25 to 54 years) between 2007 and 2012, and the horizontal axis refers to the change in the unemployment rate for that demographic group between 2007 and 2010. The observations correspond to 40 states that had more than 500,000 prime-age adults as of December 2007; i.e., this sample excludes Nevada (for reasons discussed in the text) as well as Alaska, Delaware, Hawaii, Montana, North Dakota, Rhode Island, South Dakota, Vermont, Wyoming, and Washington DC. The dashed line depicts the regression obtained using these 40 data points.

Appendix Figure A5: Gauging the Degree of Attachment to the Labor Force



Note: The solid line denotes the deviation between the actual LFPR and its trend path as projected by the BLS in November 2007. The short-dashed and long-dashed lines denote the post-2007 changes in the incidence of “discouraged job-seekers and in the incidence of individuals who are “marginally attached to the labor force, respectively, measured as a share of the civilian noninstitutionalized population aged 16 and above. “Marginally attached refers to persons not in the labor force who want a job, are available now, and have looked for work sometime in the past year but not in the past month. “Discouraged refers to persons not in the labor force who want a job and are available now and who have looked for work sometime in the past year but who are not currently searching because they believe there are no jobs available for which they would qualify.