

WP/13/245

# IMF Working Paper

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

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## IMF Working Paper

Research

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

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July 2013

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### Abstract

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 Numbers: E24, E32, E52, J21

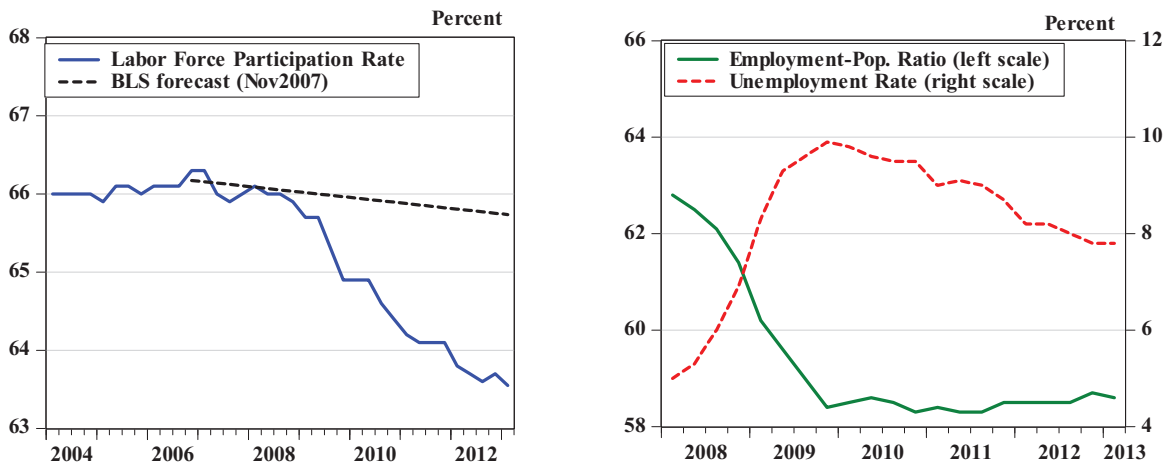
Keywords: labor force participation, unemployment, and monetary policy rules

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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:Q1, 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.<sup>1</sup> 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

<sup>1</sup>For 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.

has fallen about 2-1/2 percentage points – a striking contrast to the modest decline that 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 decline 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.<sup>2</sup>

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,<sup>3</sup> but that the response is gradual due to high adjustment costs of moving between the market and "home production" sectors. 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

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

<sup>3</sup>We 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.

quantitatively.<sup>4</sup> An important implication of this modified Phillips Curve is that inflation would remain below baseline following a recession even after the unemployment gap closes, at least while the participation gap remains negative.<sup>5</sup>

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.

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<sup>4</sup>The 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 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.

<sup>5</sup>Equivalently, 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.

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 the unemployment rate and inflation as the economy recovers.<sup>6</sup> 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.

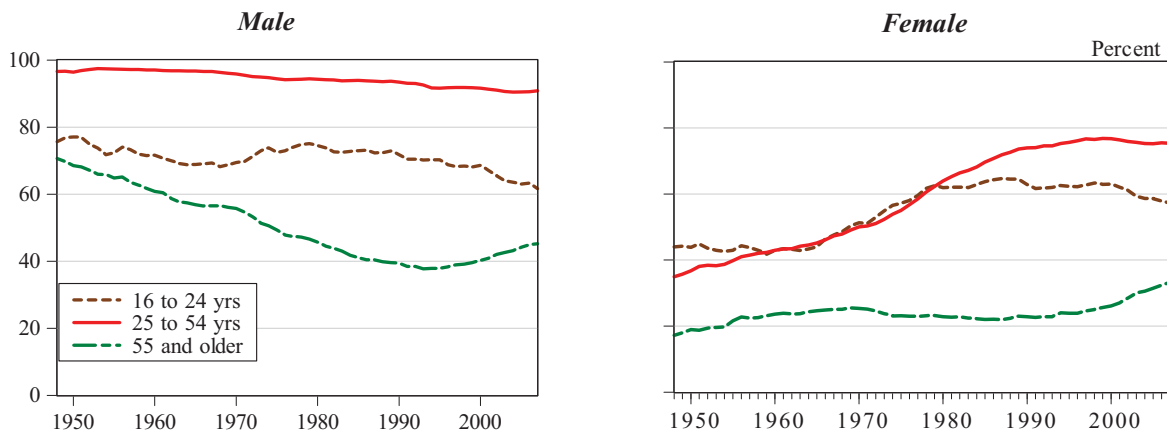
Overall, we view our paper as pointing out how labor market slack arising in the wake of deep recessions may not be well summarized by the unemployment rate (given the substantial lag in the response of participation), and consequentially, the monetary rules developed for the Great Moderation period 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 our New Keynesian model with labor force participation, discusses the calibration, and characterizes model behavior under a benchmark policy rule. Section 4 considers the implications of alternative monetary policy strategies, while Section 5 concludes.

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<sup>6</sup>See 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.<sup>7</sup> Of course, many volumes have been written about postwar trends in U.S. labor supply.<sup>8</sup> Therefore, we will simply highlight a few broad features that will be salient for our

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

<sup>8</sup>See 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.<sup>9</sup> 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.<sup>10</sup>

*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.<sup>11</sup>

*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

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

<sup>10</sup>See Goldin (2006), Heim (2007), and references therein.

<sup>11</sup>See 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, primarily reflecting 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.<sup>12</sup> 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.<sup>13</sup> 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.

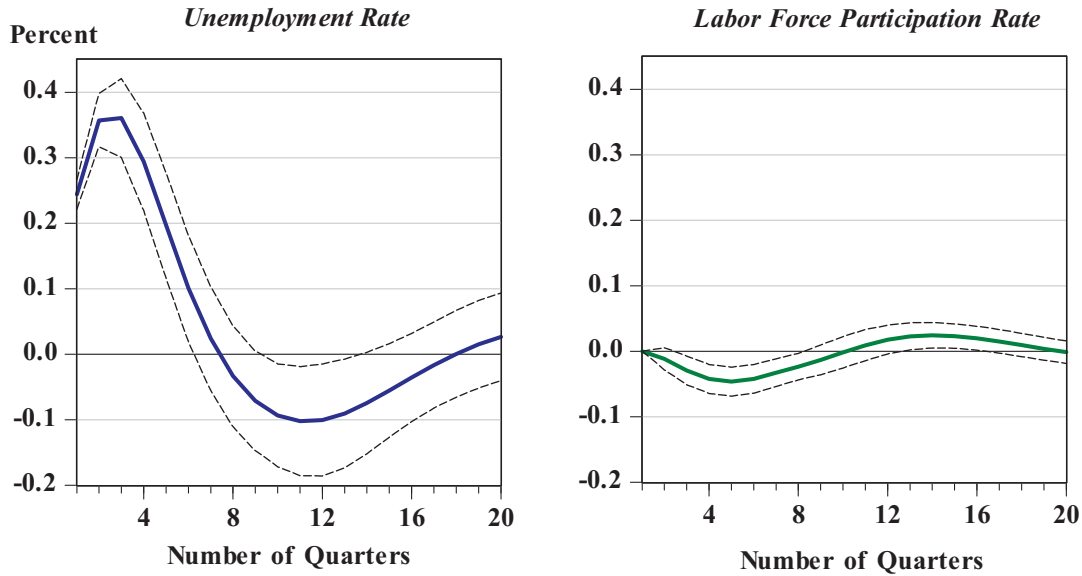
Figure 3 also highlights the extent to which the LFPR exhibits even more inertia than

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<sup>12</sup>The 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.

<sup>13</sup>As 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  $2\frac{1}{2}$  percentage points over the five-year period ending in 2013:Q1. 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. 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 modestly (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

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

<b>Demographic Group</b>	<b>Population Share</b>			<b>Labor Force Participation Rate</b>		
	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.

(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.

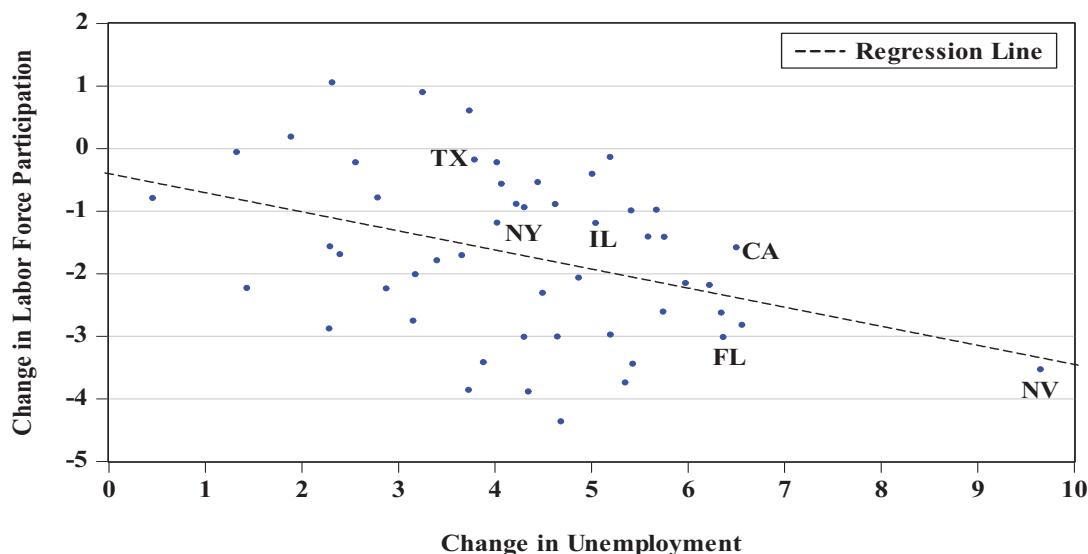
Of course, even demographic patterns are not perfectly predictable. Table 1 shows that the actual 5-year changes in the population shares for several broad age groups have turned out to be noticeably different from what was projected in 2007; i.e., the share of prime-age adults is a full percentage point 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 is still only a fourth as large as its actual decline of  $2\frac{1}{2}$  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 from 2008:Q1 to 2013:Q1, 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 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*.

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.

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.<sup>14</sup> 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 contrast,

<sup>14</sup>Clark 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.

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 importance 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  $\beta$  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  $\alpha$  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



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

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

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. Equations 2 and 5 also include the change in the prime-age unemployment rate from 2010 to 2012. Equations 1, 2, 4 and 5 also include a regression intercept. Standard errors are adjusted for heteroskedasticity (White 1980) and are given in parentheses.

data exhibit a strong negative correlation between changes in LFPR and lagged changes in 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 suggest a drop in the aggregate prime-age LFPR of about 1.5 percentage points. In effect, the state-level data indicates that the aggregate decline in prime-age LFPR since 2007 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.<sup>15</sup>

<sup>15</sup>In 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.

For example, the second column of Table 2 shows that the coefficient estimates from our 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:

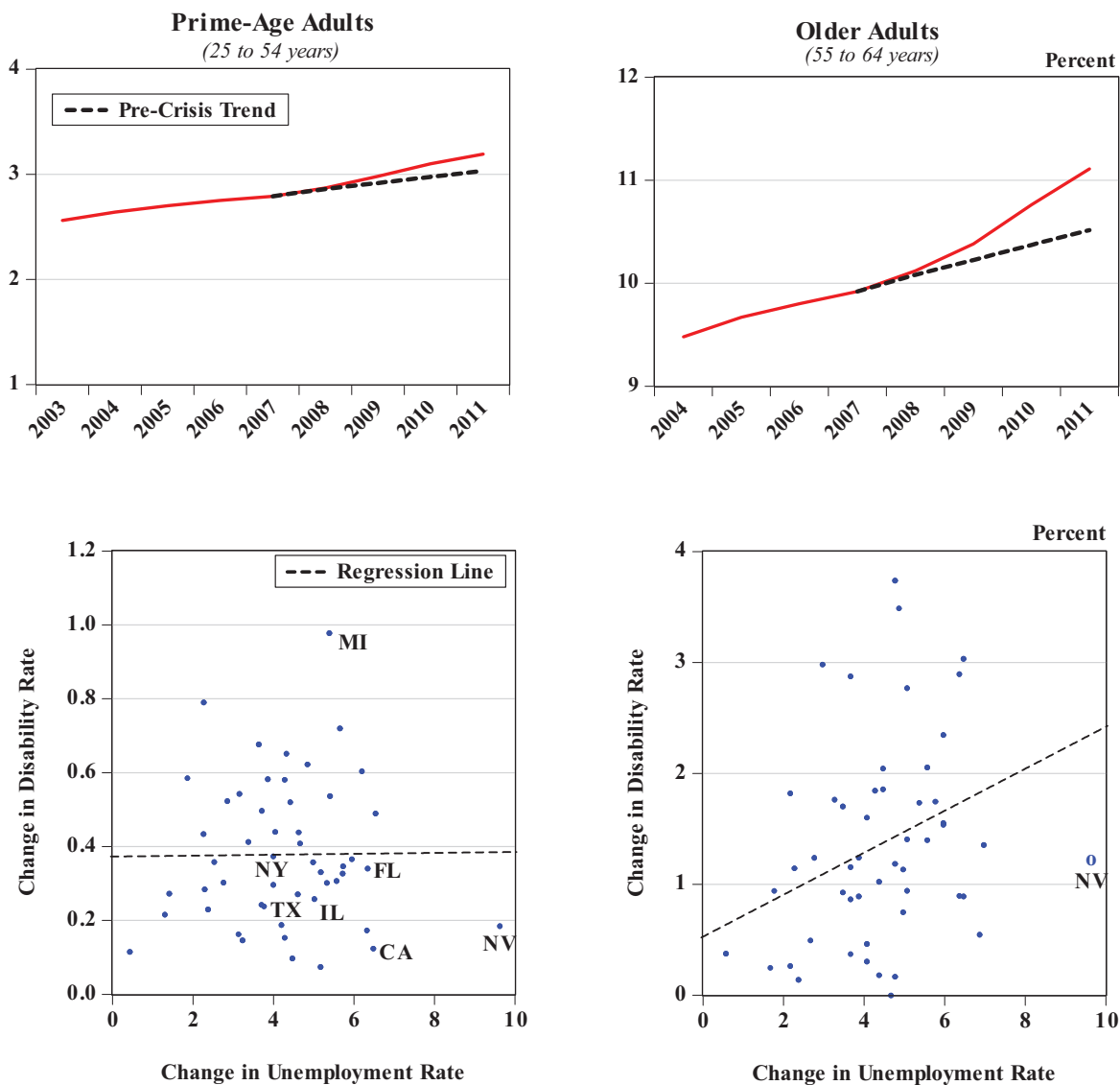
*Youths (16 to 24 years).* Monthly data from the CPS indicates that the educational enrollment rate for this demographic group jumped four percentage points from 2007 to 2011, essentially accounting for nearly all of the decline in the youth LFPR. By contrast, there has been practically no change in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

*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

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<sup>16</sup>According to the SSA's latest annual report, there was a total of 167,651 SSDI beneficiaries 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 for 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.

are essentially uncorrelated with changes in state-level unemployment, suggesting that the increase in the number of prime-age SSDI beneficiaries may primarily reflect changes in the screening process.<sup>17</sup> 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

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<sup>17</sup>As 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).

ways that would presumably enhance their employment opportunities over time. Moreover, 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:

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

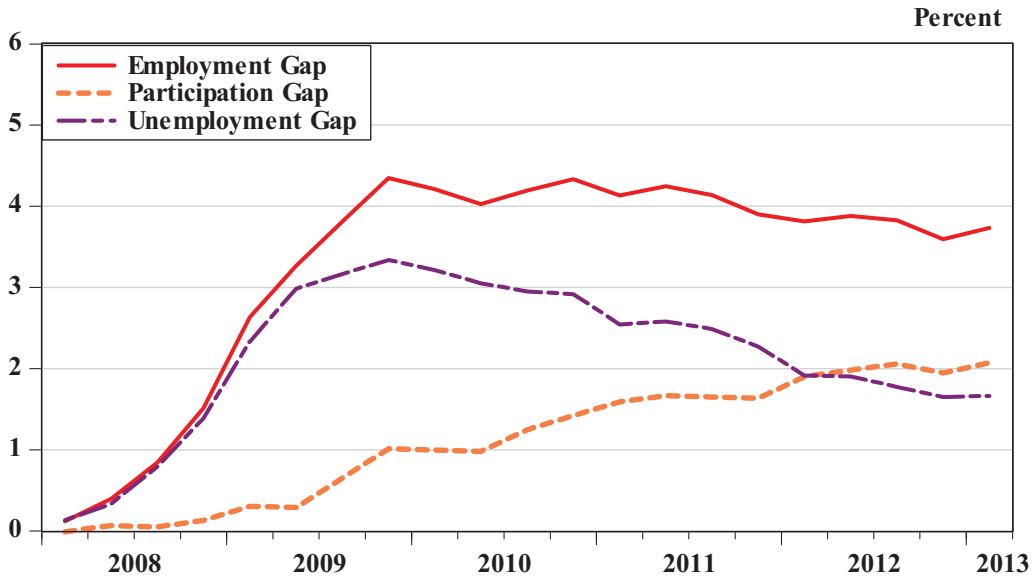
where  $LFPR_t$  refers to the actual labor force participation rate,  $LFPR_t^*$  denotes its “natural” level based solely on demographic trends,  $u_t$  refers to the unemployment rate, and  $u_t^*$  denotes the natural rate (or NAIRU).<sup>18</sup> To facilitate the discussion, it is convenient to define the participation gap as  $LF GAP_t = LFPR_t - LFPR_t^*$ , 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:

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

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<sup>18</sup>Note 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: The solid line denotes the employment gap, that is, the percent deviation between U.S. civilian employment and its natural level. As discussed in the text, this gap can be expressed in terms of two components: (1) the participation gap (short-dashes) is weighted by the proportionality factor  $(1-u^*)$ ; and (2) the unemployment gap (long-dashes) weighted by the proportionality factor  $LFPR^*$ . The employment and participation gaps are depicted in absolute values.

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 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 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 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.<sup>19</sup> 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 figure also underscores the excruciatingly sluggish nature of the recovery. The employment gap has only narrowed modestly over the past several years, because the steady widening of the participation gap has been comparable in magnitude to the decline in the unemployment gap.<sup>20</sup> Indeed, our analysis suggests that the participation gap and the unemployment gap each account for roughly half of the current level of the employment gap. The progressive expansion of the participation gap is consistent with the previous evidence – both from the VARs, and state-level data – of a very gradual response of the LFPR to employment conditions.<sup>21</sup>

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<sup>19</sup>The figure shows the absolute values of the employment and participation gaps.

<sup>20</sup>The 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.

<sup>21</sup>While 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.



### 3. A New Keynesian Model with Labor Force Participation

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 attempts 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.<sup>22</sup> An

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<sup>22</sup>The workhorse New Keynesian model in fact is a special case of our model in which the labor force

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.<sup>23</sup>

### 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, 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

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participation rate is fixed.

<sup>23</sup>For 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).

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:

$$\mathbb{E}_t \sum_{j=0}^{\infty} \beta^j \epsilon_{dt+j} \left\{ \begin{array}{l} \frac{1}{1-\sigma_C} (C_{t+j} - \psi_c C_{t+j-1}^a)^{1-\sigma_C} - L_{Ft+j} \frac{\chi_0 H_{mt+j}^{1+\chi}}{1+\chi} + \frac{\gamma_G}{1-\sigma_G} L_{Ht+j}^{1-\sigma_G} \\ -0.5\phi_G \left( \frac{L_{Ft+j}}{L_{Ft+j-1}} - 1 \right)^2 L_{Ft+j} \end{array} \right\} \quad (4)$$

where the discount factor  $\beta$  satisfies  $0 < \beta < 1$ , and  $\epsilon_{dt}$  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  $L_{Ft} \frac{\chi_0 H_{mt+j}^{1+\chi}}{1+\chi}$ . 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:

$$P_t C_t + B_{G,t} - (1 + i_{t-1}) B_{G,t-1} = W_t N_t + \Gamma_t \quad (5)$$

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  $\Gamma_t$  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:

$$\frac{dV(H_{mt})}{dH_{mt}} = \chi_0 H_{mt}^\chi = \frac{W_t}{P_t} \lambda_t \quad (6)$$

For each working family, equation (6) 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:

$$\left\{ \lambda_t \frac{W_t}{P_t} H_{mt} - V(H_{mt}) \right\} = \frac{dM(L_{ht})}{dL_{ht}} = (1 - L_{ft})^{-\sigma_G} \quad (7)$$

Equation (7) 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 (6)),  $V(H_{mt})$  may be expressed as  $V(H_{mt}) = \lambda_t \frac{W_t}{P_t} \frac{H_{mt}}{1+\chi}$ . Substituting into equation (7) and using (6) yields:

$$\left\{ \frac{\chi}{1+\chi} \lambda_t \frac{W_t}{P_t} H_{mt} \right\} = \frac{\chi}{1+\chi} \chi_0 H_{mt}^{1+\chi} = (1 - L_{ft})^{-\sigma_G} \quad (8)$$

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:

$$\lambda_t = E_t \left( \beta \frac{\epsilon_{dt+1}}{\epsilon_{dt}} \right) \lambda_{t+1} \frac{1 + i_t}{1 + \pi_{t+1}} \quad (9)$$

where the marginal utility of consumption is given by  $\lambda_t = (C_t - \psi_c C_{t-1}^a)^{-\sigma_C}$ , and  $\pi_t$  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:

$$Y_t(f) = K_t(f)^\alpha N_t(f)^{1-\alpha} \quad (10)$$

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

$$\frac{MC_t}{P_t} = \frac{W_t/P_t}{MPL_t} = \frac{W_t/P_t}{(1-\alpha) K^\alpha N_t^{-\alpha}}. \quad (11)$$

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  $\theta_p$  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  $\nu$  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. 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 curve<sup>24</sup>:

$$n_t - n_t^* = (n_{t+1|t} - n_{t+1|t}^*) - \frac{1 - \alpha}{\hat{\sigma}_c} (i_t - \pi_{t+1|t} - r_t^*), \quad (12)$$

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.<sup>25</sup> Thus, the employment gap  $n_t - n_t^*$  depends inversely on the deviation of the real interest rate ( $i_t - \pi_{t+1|t}$ ) from its natural rate  $r_t^*$ , as well as

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

<sup>25</sup>More 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 expected employment gap in the following period.<sup>26</sup> 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.<sup>27</sup> Given that employment is simply proportional to output (i.e.,  $n_t = (1 - \alpha)y_t$ ), equation (12) 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:

$$n_t - n_t^* = (1 - u^*)(l_{ft} - l_{ft}^*) - l_f(u_t - u_t^*), \quad (13)$$

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.<sup>28</sup>

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

$$\pi_t - \nu\pi_{t-1} = \beta(\pi_{t+1|t} - \nu\pi_t) + \kappa_p mc_t, \quad (14)$$

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

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<sup>26</sup>The 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  $r_t^* = \hat{\sigma}_c \left(1 - \frac{1}{\phi_{mc}\hat{\sigma}_c}\right) \left[(1 - \alpha)(n_{t+1|t}^* - n_t^*) + \varepsilon_c(\varepsilon_{ct} - \varepsilon_{ct+1|t})\right] + \varepsilon_d(\varepsilon_{dt} - \varepsilon_{dt+1|t})$ .

<sup>27</sup>In equation (12), the composite parameter  $\hat{\sigma}_c$  is defined as  $\hat{\sigma}_c = \frac{\sigma_c}{1-\varepsilon_c}$ , where  $\varepsilon_c$  is the mean level of the consumption taste shock (since this is assumed to be negligible in magnitude,  $\hat{\sigma}_c \approx \sigma_c$ ).

<sup>28</sup>Thus, 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.<sup>29</sup>

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:

$$mc_t = \frac{w_t}{p_t} - MPL_t = \psi_u l_f (u_t^* - u_t) + \psi_l (1 - u^*) (l_{ft} - l_{ft}^*), \quad (15)$$

Equations (15) and (14) 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 (15) and (14)) 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.,  $\psi_u$  is much larger than  $\psi_l$ ).

Although our model literally imposes that the coefficient  $\psi_u$  on the scaled unemployment gap exceed the coefficient on the scaled participation gap  $\psi_l$ , 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  $\chi$  is the inverse Frisch elasticity of labor supply).<sup>30</sup> This flexibility clearly seems desirable given substantial uncertainty

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

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



about the relative importance of each gap in affecting marginal costs. The reason why the 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 (6) is given by:

$$mc_t = -\chi l_f(u_t - u_t^*) + \hat{\sigma}_c c_t = -(\chi + \hat{\sigma}_c) l_f(u_t - u_t^*) + \hat{\sigma}_c(1 - u^*)(l_{ft} - l_{ft}^*), \quad (16)$$

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:

$$l_{ft} - l_{ft}^* = \mu_1(l_{ft-1} - l_{ft-1}^*) + \mu_2(l_{ft+1|t} - l_{ft+1}^*) - \phi_m(u_t - u_t^*), \quad (17)$$

The long-run response hinges on the composite parameter  $\phi_m$ , 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  $\sigma_G$ ), the responsiveness of participation to a change in the return to market work is diminished.<sup>31</sup> The general form of equation (17) 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  $\mu_1$ , 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

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

subject to the zero lower bound:

$$i_t = \max(-i, \gamma_\pi \pi_t + \gamma_n(n_t - n_t^*) - \gamma_u(u_t - u_t^*) + \epsilon_{it}), \quad (18)$$

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

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 (15), 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.<sup>32</sup> Conditional on these parameters, we calibrate the adjustment cost parameter  $\varphi_G$  on labor force participation and the curvature parameter of the home production function  $\sigma_G$  to imply that the reduced form parameters  $\mu_1$  and  $\phi_m$  in the labor force participation equation (17) equal 0.97 and 0.06, respectively; thus, labor force participation responds very slowly to the unemployment rate.

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

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<sup>32</sup>To 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.<sup>33</sup> 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.

The calibration of the monetary rule is described below.

### 3.5. The Dynamics of the LFPR

We next illustrate how our model can account – at least qualitatively – for some of the stylized facts about labor force participation mentioned in the introduction. In this vein, the upper panel of Figure 7 shows the effects of a fairly transient monetary policy shock  $\epsilon_{it}$  in the policy rule (18) assuming that monetary policy is unconstrained by the zero lower bound. The monetary shock follows an AR(1) with a persistence of 0.7, and is scaled so that the policy rate rises 100 basis points at impact. The shock depresses employment by about 0.7 percent at impact, with habit persistence in consumption accounting for the slightly hump-shaped response.<sup>34</sup> Importantly, the substantial near-term fall in the employment rate is driven almost entirely by a rise in the unemployment rate (not shown, but is given by the gap between the employment rate and labor force participation).<sup>35</sup> Labor force participation

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<sup>33</sup>Eggertson (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.

<sup>34</sup>In 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.

<sup>35</sup>Our 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.

does exhibit a very persistent longer-run decline that contributes to a “trendlike” decline in the employment gap, but this variation is small compared to the near-term effect.

Given that labor force participation simply follows an AR(1) in our benchmark specification – with the unemployment rate the forcing variable:

$$l_{ft} = \mu_1 l_{ft-1} - \phi_m u_t, \tag{19}$$

labor force participation can exhibit a large eventual drag on employment if shocks keep unemployment persistently above baseline. This is illustrated in the lower panel for a persistent monetary tightening implemented through a sequence of monetary policy innovations lasting for three years (with the shocks having a persistence 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.

As is clear from equation (19), real shocks that reduced demand very persistently would induce a similar path for labor force participation. Even so, the case of a protracted monetary tightening is insightful insofar as it captures how a protracted period at the zero lower bound – which operates like a sequence of adverse monetary shocks – can contribute to what appears to be a trendlike deterioration in employment.

## 4. The Design of Monetary Policy Rules

We begin this section with an overview of how monetary policy tradeoffs in our model are influenced by the labor force participation rate; this analysis is quite general insofar as it does not hinge on our particular calibration of key parameters.

## 4.1. 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.<sup>36</sup> As we discuss below, the workhorse model may be interpreted as making the implicit assumption that the participation gap moves *contemporaneously* with unemployment, so that the “no tradeoff” result also applies to the employment gap.

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 (15), 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  $u_t = u_t^*$ .

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<sup>36</sup>We 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.

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 (14) requires that discounted marginal cost must be zero ( $\sum_{j=0}^{\infty} \beta^j mc_{t+j} = 0$ ) for inflation to be stable, which implies:<sup>37</sup>

$$\sum_{j=0}^{\infty} \beta^j \psi_u l_f (u_{t+j} - u_{t+j}^*) = \sum_{j=0}^{\infty} \beta^j \psi_l (1 - u^*) (l_{ft+j} - l_{ft+j}^*), \quad (20)$$

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 20). The implication that 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.<sup>38</sup>

A third key implication is that a policy of aggressively targeting the employment gap puts upward pressure on inflation. From equation (13), setting  $n_t = n_t^*$  requires that:

$$l_f (u_t - u_t^*) = -(1 - u^*) (l_{ft} - l_{ft}^*) \quad (21)$$

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 (21) 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 sta-

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<sup>37</sup>For simplicity, this expression assumes no structural persistence in inflation.

<sup>38</sup>Clearly, 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).

bilization 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.

Similarly, there is no tradeoff between stabilizing the employment gap and inflation if  $\psi_l = \psi_u$ .<sup>39</sup> 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.<sup>40</sup> As suggested by this special case (and demonstrated below), a relatively large coefficient on the participation gap ( $\psi_l$  close to  $\psi_u$ ) means that employment gap targeting should be associated with less inflationary pressure.

## 4.2. Alternative 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. We next illustrate some dynamic implications using simulations of our model under both a non-inertial

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<sup>39</sup>In our model, this occurs as the Frisch elasticity of labor supply tends toward infinity.

<sup>40</sup>This 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  $\psi_l$  on the participation gap in the marginal cost relation would imply substantial downward pressure on inflation under a rule targeting the unemployment gap.

Taylor rule and under an “optimal” policy rule derived from minimizing an intertemporal loss function. The section concludes with robustness exercises that show how the inflation-employment gap tradeoff depends heavily on the speed at which labor force participation adjusts to the unemployment rate, on the Phillips Curve slope, and how wages respond to the participation gap.

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  $\varepsilon_{dt}$  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 (18) is calibrated with a very large coefficient  $\gamma_u$  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 (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  $u_t^*$ .<sup>41</sup> 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  $\gamma_\pi$  or  $\gamma_n$  to arbitrarily large values, respectively). Consistent with 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

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<sup>41</sup>The 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.



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 13). 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.

### 4.2.1. Robustness

**Different Rules when Participation Adjusts More Quickly.** 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 of 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. To the extent that participation responds more quickly to unemployment ( $\mu_1$  is lower), the disparity between a rule that responds to employment vs. unemployment becomes smaller.<sup>42</sup> This is illustrated in Figure 9, which compares the alternatives of employment and unemployment gap targeting for a lower calibration of  $\mu_1$  of 0.85. Under this calibration, the recovery in unemployment is followed by a fairly quick rebound in participation, even when unemployment isn't allowed to overshoot the potential rate.

**Tradeoffs under Employment Gap Targeting.** Under our benchmark calibration in Figure 8, the aggressive strategy of employment gap targeting not only succeeds better than unemployment gap targeting in generating a faster labor market recovery, but also performs better in keeping inflation close to target. Even so, this aggressive strategy could put more upward pressure on inflation under certain conditions, and thus imply a less favorable employment-inflation tradeoff than suggested by Figure 8.

First, inflation would rise by more as the economy recovered if the Phillips Curve slope were higher. This is illustrated in Figure 10, which compares our benchmark calibration

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<sup>42</sup>As noted above, the difference disappears completely in the special (though unrealistic) case of no adjustment costs.

with an alternative in which the Phillips Curve slope parameter  $\kappa_p$  is several times larger.<sup>43</sup> Inflation rises to around 3 percent under this alternative, and remains well above target for a protracted duration. While our benchmark calibration seems consistent with the resilience of inflation following the Great Recession, it remains possible that inflation behavior is better captured by a steeper Phillips Curve.

Second, inflation would rise by more if wages responded less to the participation gap (i.e., if non-participants put even less downward pressure on wages). This is shown in Figure 11, which compares our benchmark calibration to an alternative in which the responsiveness of inflation to the participation gap is set close to zero (while the responsiveness to the unemployment gap remains unchanged). Even so, because the relative size of the participation gap coefficient is quite small under our benchmark, the inflation response is only slightly higher under this alternative. Of course, with a higher coefficient on the participation gap – the alternative labelled “higher participation gap” sets the coefficient to be as large as on the unemployment rate gap – the upward pressure on inflation would be substantially muted.

Finally, a more gradual response of the participation gap to unemployment puts more upward pressure on inflation. This is apparent from comparing the different calibrations of the adjustment speed parameter  $\mu_1$  under employment gap targeting across Figures 8 and 9, and reflects that the unemployment rate undershoots more persistently – and by a larger margin – when participation responds more gradually.

#### 4.2.2. Comparison to Optimal Policy

Figure 12 shows how an optimal “full commitment” policy rule derived from quadratic loss function compares to the Taylor rule variant that strictly targets the employment gap (our benchmark). The quadratic loss function puts equal weight on the squared employment gap, inflation (when expressed at an annual rate), and on the change in the policy interest rate.

Clearly, the Taylor rule responses share some key characteristics of the optimal responses:

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<sup>43</sup>This is achieved by setting the contract duration parameter  $\xi_p = .95$  rather than 0.98 as in our baseline.

notably, under both rules, the unemployment gap and inflation persistently overshoot. These results illustrate that a “commitment-based” strategy is not a prerequisite for an overshooting of unemployment and inflation. Instead, our model produces unemployment overshooting because the policymaker in effect cares about the participation gap as well as the unemployment gap (and is willing to tolerate above target inflation to allow participation to rebound more quickly).

Despite these qualitative similarities, the optimal policy does provide considerably more stimulus by “promising” an eventual overshooting of the employment gap, so that  $n_t$  rises above  $n_t^*$ . Moreover, the participation gap also eventually overshoots as the economy recovers. This behavior clearly contrasts with the non-inertial Taylor rule, which implies smooth convergence of both the employment gap and participation gap from below.

## 5. Conclusions

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 (at least to the extent that there is a substantial lag in the response of participation). As a consequence, monetary rules developed for the Great Moderation period may have to be adapted to account for broader measures of slack.

We have used a simple extension of the workhorse to Keynesian model to investigate the tradeoff between stabilizing broader measures of labor market resource slack (the employment gap) and inflation. Some of the factors highlighted as influencing this tradeoff – including the slope of the Phillips Curve, the sensitivity of market wages to the participation gap, and the dynamic response of participation to unemployment – seem likely to remain of pivotal importance in more realistic modeling environments. However, relatively little empirical work has been done to characterize how market wages are affected by cyclical movements in participation, or in how participation responds to long periods of labor market slack. Although this paucity of evidence is unsurprising given limited experience with deep

recessions, more empirical work in these areas clearly seems warranted.

There are also many factors likely to affect monetary policy tradeoffs that are not captured by our simple modeling framework, but which seem highly relevant in practice for crafting an appropriate strategy. In particular, it would be desirable to take account of uncertainty about the natural rate of unemployment, which is likely to be especially pronounced in the wake of a deep recession (due to e.g, a deterioration in the matching function). Indeed, an extensive literature has emphasized the inflation risks of targeting a natural rate that is too low, including research by Orphanides (2002) linking the high inflation of the 1970s to natural rate misperceptions. In a parallel vein, it would also be desirable to devote more attention to the practical issue of how best to measure the participation gap, and to consider how measurement problems may affect the performance of policy rules oriented towards closing this gap.

## References

- Adam, Klaus, and Roberto M. Billi (2008). "Monetary Conservatism and Fiscal Policy." *Journal of Monetary Economics* 55(8), 1376-1388.
- Aaronson, D., Davis, J., Hu, L. 2012. "Explaining the Decline in the U.S. Labor Force Participation Rate." Chicago Fed Letter #296, Federal Reserve Bank of Chicago.
- Aaronson, D., Park, K., Sullivan, D. 2006, "The Decline in Teen Labor Force Participation," *Economic Perspectives*, Federal Reserve Bank of Chicago, 30:2-18.
- Aaronson, S., Fallick, B., Figura, A., Pingle, J., Wascher, W. 2006. "The Recent Decline in the Labor Force Participation Rate and Its Implications for Potential Labor Supply." *Brookings Papers on Economic Activity*, 69-134.
- Autor, D., Duggan, M. 2003. "The Rise in the Disability Rolls and the Decline in Unemployment." *Quarterly Journal of Economics*, 157-205.
- Autor, D., Duggan, M. 2006. "The Growth in the Social Security Disability Rolls: A Fiscal Crisis Unfolding." *Journal of Economic Perspectives*, 20:71-96.
- Autor, D. 2010. "The Polarization of Job Opportunities in the U.S. Labor Market." Washington DC: Center for American Progress.
- Benhabib, J., Rogerson, R., and Wright, R. 1991. "Homework in Macroeconomics: Household Production and Aggregate Fluctuations." *Journal of Political Economy* 99:6, 1166-1187.
- Blanchard, O., Summers, L. 1986. "Hysteresis and the European Unemployment Problem." In: S. Fischer, ed., *The NBER Macroeconomic Annual 1986*, vol 1, 15-78. Cambridge, Ma.: MIT Press.
- Blanchard, O. 1991. "Wage Bargaining and Unemployment Persistence." *Journal of Money, Credit, and Banking* 23:3 (Part 1), 277-292.
- Blanchard, O., Diamond, P. 1994. "Ranking, Unemployment Duration, and Wages." *Review of Economic Studies* 61:3, 417-434.
- Blanchard, O., Gali, J. 2010. "Labor Markets and Monetary Policy: A New-Keynesian Model with Unemployment." *American Economic Journal: Macroeconomics*, 2:2,1-30.
- Benhabib, J., Rogerson, R., and Wright, R. "Homework in Macroeconomics: Household Production and Aggregate Fluctuations." *Journal of Political Economy* 99:6, 1166-1187.
- Bound, J., Waidmann, T. 2002. "Accounting for Recent Declines in Employment Rates among Working-Aged Men and Women with Disabilities." *Journal of Human Resources*, 37:231-250.

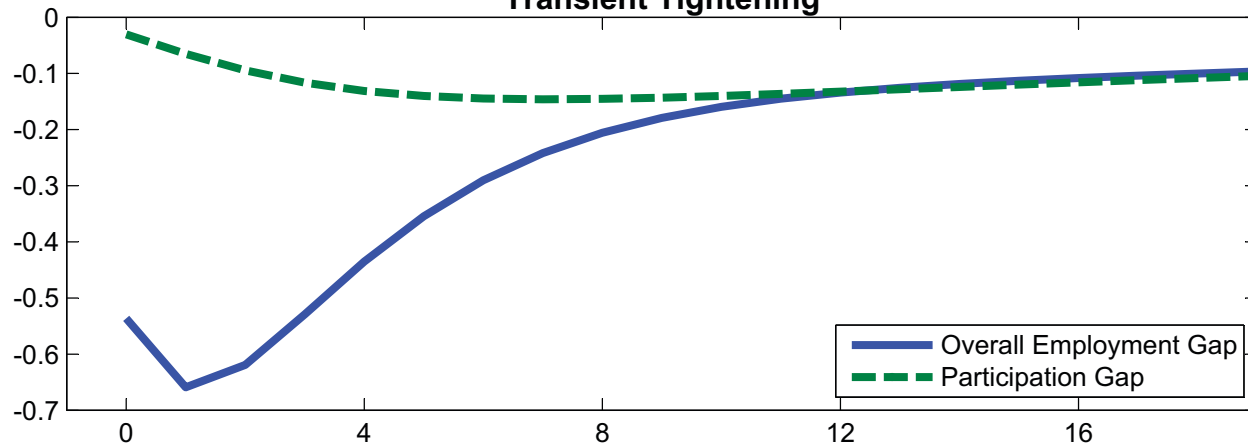
- Clark, K., Summers, L. 1982. "Labor Force Participation: Timing and Persistence." *Review of Economic Studies*, 49:825-844.
- Congressional Budget Office. 2013. "The Budget and Economic Outlook: Fiscal Years 2013-2022." February.
- Daly, M., Elias, E., Hobijn, B., Jorda, O. 2012. "Will the Jobless Rate Drop Take a Break?" Economic Letter 2012-37, Federal Reserve Bank of San Francisco.
- Daly, M., Hobijn, B., Şahin, A., Valletta, R. 2012. "A Rising Natural Rate of Unemployment: Transitory or Permanent?" *Journal of Economic Perspectives*.
- DiCecio, R., Engemann, K., Owyang, M., Wheeler, C. "Changing Trends in the Labor Force: A Survey." Federal Reserve Bank of St. Louis, *Review*, January/February, pp. 47-62.
- Eggertsson, G., Woodford, M. 2003. "The Zero Interest-Rate Bound and Optimal Monetary Policy." *Brookings Papers on Economic Activity* 1, 139-211.
- Eggertsson, G. 2008. "Great Expectations and the End of the Great Depression." *American Economic Review*, 98:4, 1476-1516.
- Elsby, M., Hobijn, B., Sahin, A. 2012. "On the Importance of the Participation Margin for Labor Market Fluctuations." Manuscript, University of Edinburgh.
- Fujita, S. 2011. "Effects of Extended Unemployment Insurance Benefits: Evidence from the Monthly CPS." Federal Reserve Bank of Philadelphia Working Paper 10-35/R.
- Goldin, C. 2006. "The Quiet Revolution That Transformed Women's Employment, Education, and Family." *American Economic Review*, 96:1-21.
- Goodfriend, M., King, R. 1997. "The New Neoclassical Synthesis and the Role of Monetary Policy." In: B. Bernanke and J. Rotemberg, eds., *The NBER Macroannual 1997*, 231-282. Cambridge, Ma.: MIT Press.
- Greenwood, J., Hercowitz, Z. 1991. "The Allocation of Capital and Time over the Business Cycle." *Journal of Political Economy* 99:6, 1188-1214.
- Gruber, J. 2000. "Disability Insurance Benefits and Labor Supply." *Journal of Political Economy* 58:1162-1183.
- Heckman, J., Killingsworth, M. 1986. "Female Labor Supply: A Survey." In: O. Ashenfelter and R. Layard, eds., *Handbook of Labor Economics* 1, 103-204. Amsterdam: Elsevier Science Publishers.
- Howard, G., Martin, R., Wilson, B.A. 2011. "Are Recoveries from Banking and Financial Crises Really So Different? International Finance Discussion Paper 1037.
- Heim, B. 2007. "The Incredible Shrinking Elasticities: Married Female Labor Supply 1978-2002." *Journal of Human Resources*, 42:881-918.

- Hotchkiss, J. 2005. "Changes in Behavioral and Characteristic Determination of Female Labor Force Participation, 1975-2005." *Economic Review*, Federal Reserve Bank of Atlanta, 1-13.
- Hotchkiss, J., Pitts, M., Rios-Avila, F. 2012. "A Closer Look at Non-Participants during and after the Great Recession." Federal Reserve Bank of Atlanta Working Paper No. 2012-10.
- Hotchkiss, J., Rios-Avila, F. 2013. "Identifying Factors behind the Decline in the Labor Force Participation Rate." Manuscript, Federal Reserve Bank of Atlanta.
- Juhn, C. 1992. "Decline of Male Labor Market Participation: The Role of Declining Market Opportunities." *Quarterly Journal of Economics*, 107:79-121.
- Kudlyak, M., Schwartzman, F. 2012. "Accounting for Unemployment in the Great Recession: Nonparticipation Matters." Federal Reserve Bank of Richmond Working Paper No. 12-04.
- Leonard, J. 1979. "The Social Security Disability Program and Labor Force Participation." National Bureau for Economic Research Working Paper 392.
- Macunovich, D. 2010. "Reversals in the Patterns of Women's Labor Supply in the United States, 1977-2009." *Monthly Labor Review* 133: 16-36.
- Mincer, J. 1966. "Labor Force Participation and Unemployment: A Review of Recent Evidence." In: R. A. Gordon and M. S. Gordon, eds., *Prosperity and Unemployment*. 73-112.
- Moffitt, R. 2012. "The Reversal of the Employment-Population Ratio in the 2000s: Facts and Explanations." *Brookings Papers on Economic Activity*, 201-250.
- Oaxaca, R. 1973. "Male-Female Wage Differentials in Urban Labor Markets." *International Economic Review* 14: 693-709.
- Orphanides, A. 2002. "Monetary Policy Rules and the Great Inflation." *American Economic Review* 92, 115-120.
- Pencavel, J. 1986. "Labor Supply of Men: A Survey." In: O. Ashenfelter and R. Layard, eds., *Handbook of Labor Economics* 1, 3-101. Amsterdam: Elsevier Science Publishers.
- Sherk, J. 2012. "Not Looking for Work: Why Labor Force Participation Has Fallen During the Recession." *Backgrounder* #2722, Heritage Foundation Center for Data Analysis.
- Shimer, Robert. 2008. "The Probability of Finding a Job." *American Economic Review*, 98:268-273.
- Smets, Frank and Raf Wouters (2007). "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach." *American Economic Review* 97(3), 586-606.

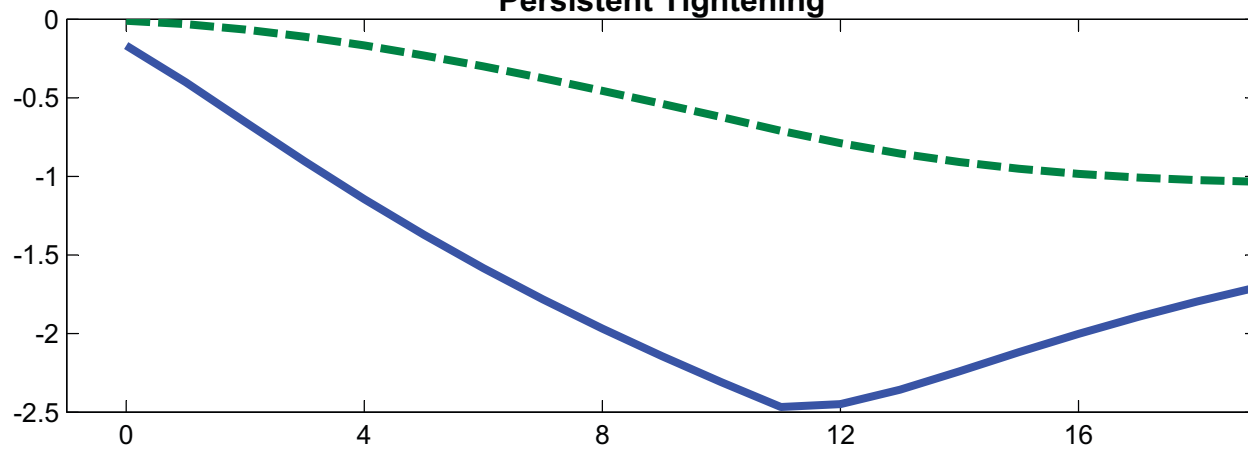


- Smith, C. 2011, "Polarization, Immigration, Education: What's behind the Dramatic Decline in Youth Employment?" Finance and Economics Discussion Series 2011-41, Board of Governors of the Federal Reserve System.
- Taylor, J., Williams, J. 2010. "Simple and Robust Rules for Monetary Policy." Federal Reserve Bank of San Francisco Working Paper 2010-10.
- Toossi, M. 2007. "Labor Force Projections to 2016: More Workers in their Golden Years." *Monthly Labor Review*, November 2007, 33-52.
- Veracierto, M. 2008. "On the Cyclical Behavior of Employment, Unemployment and Labor Force Participation." *Journal of Monetary Economics*, 55:1143-1157.
- Van Zandweghe, W. 2012. "Interpreting the Recent Decline in Labor Force Participation." *Economic Review*, Federal Reserve Bank of Kansas City, 5-34.
- Woodford, Michael (2003). *Interest and Prices*. Princeton, N.J.: Princeton University Press.

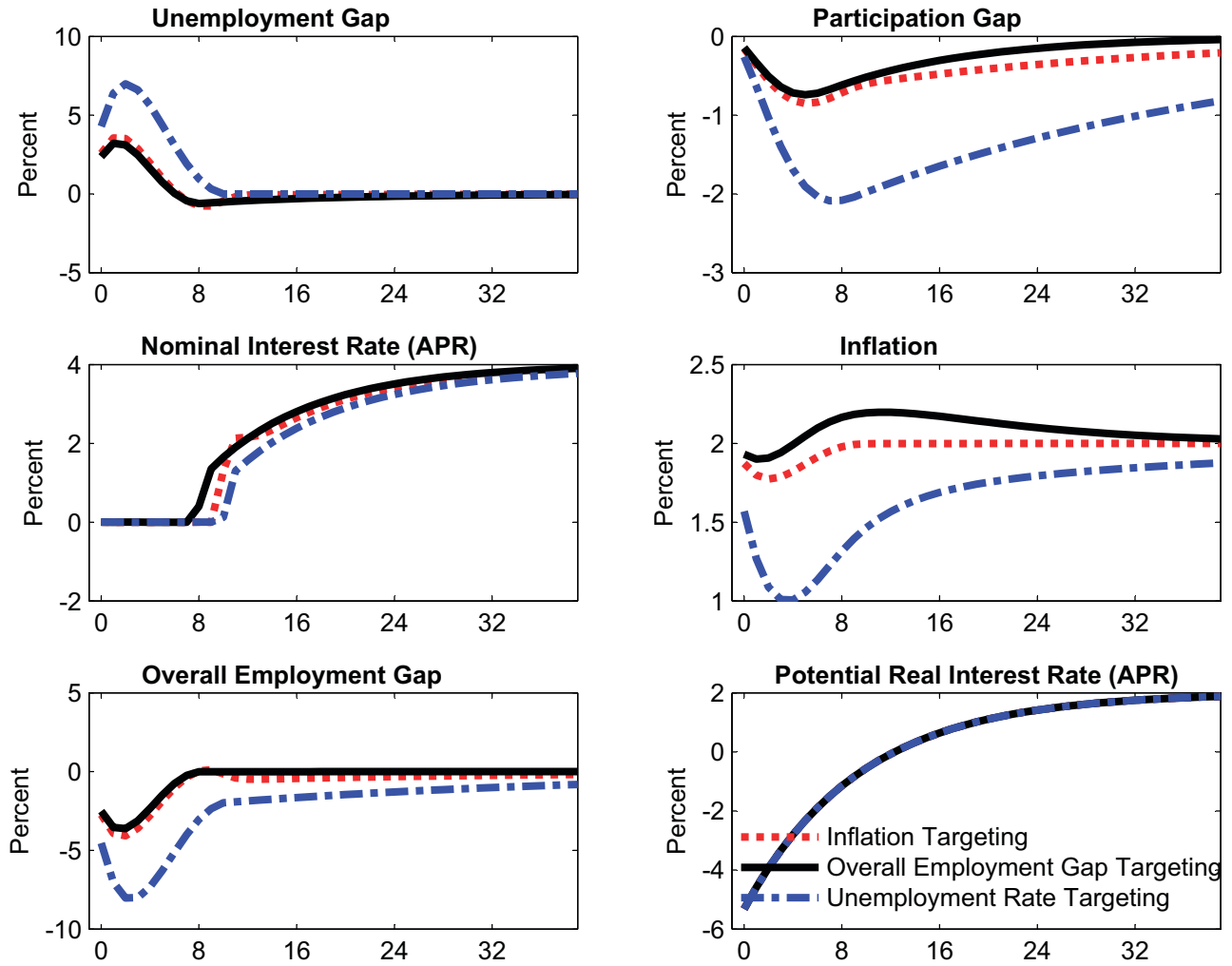
**Figure 7: Monetary Policy Tightening**  
**Transient Tightening**



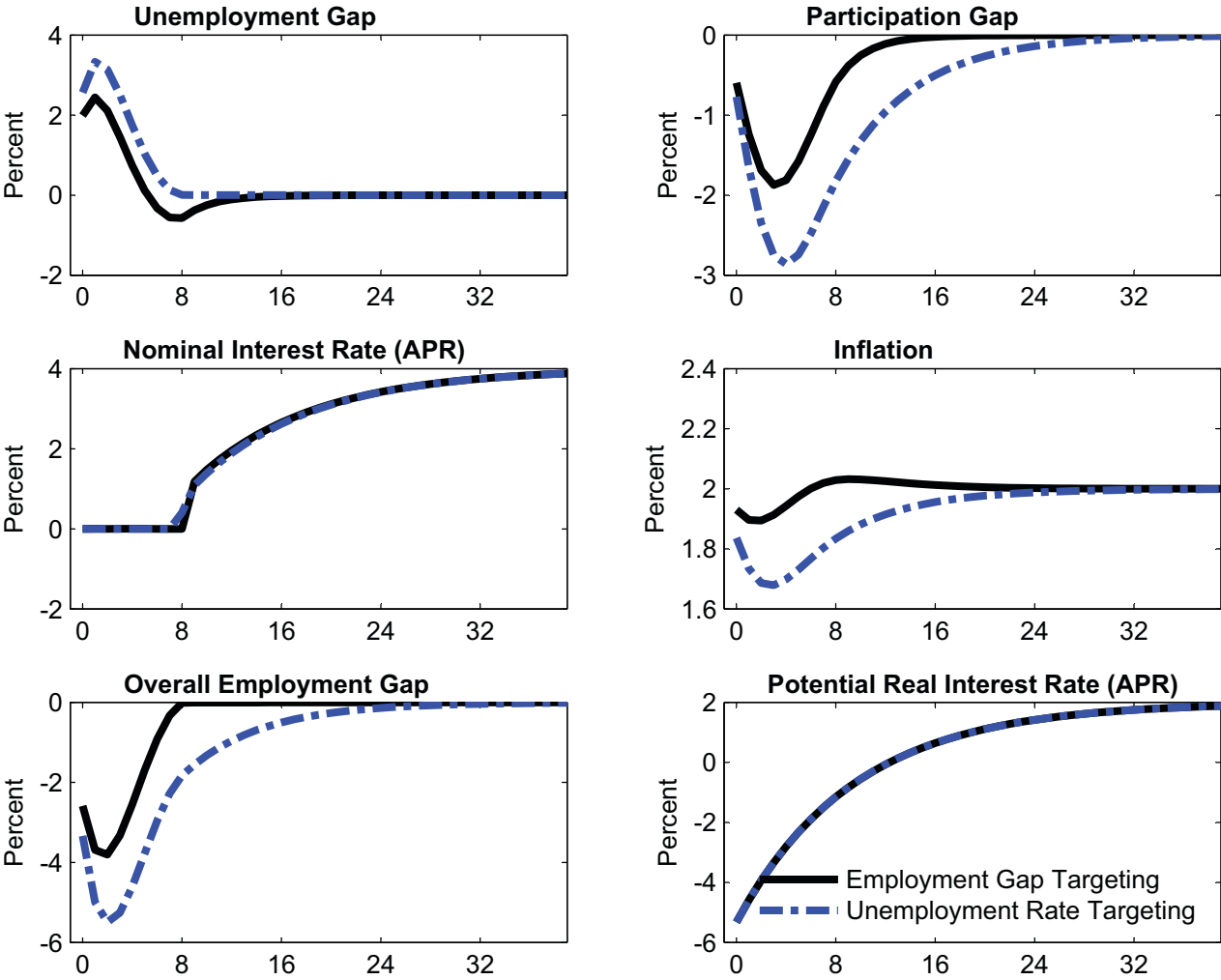
**Persistent Tightening**



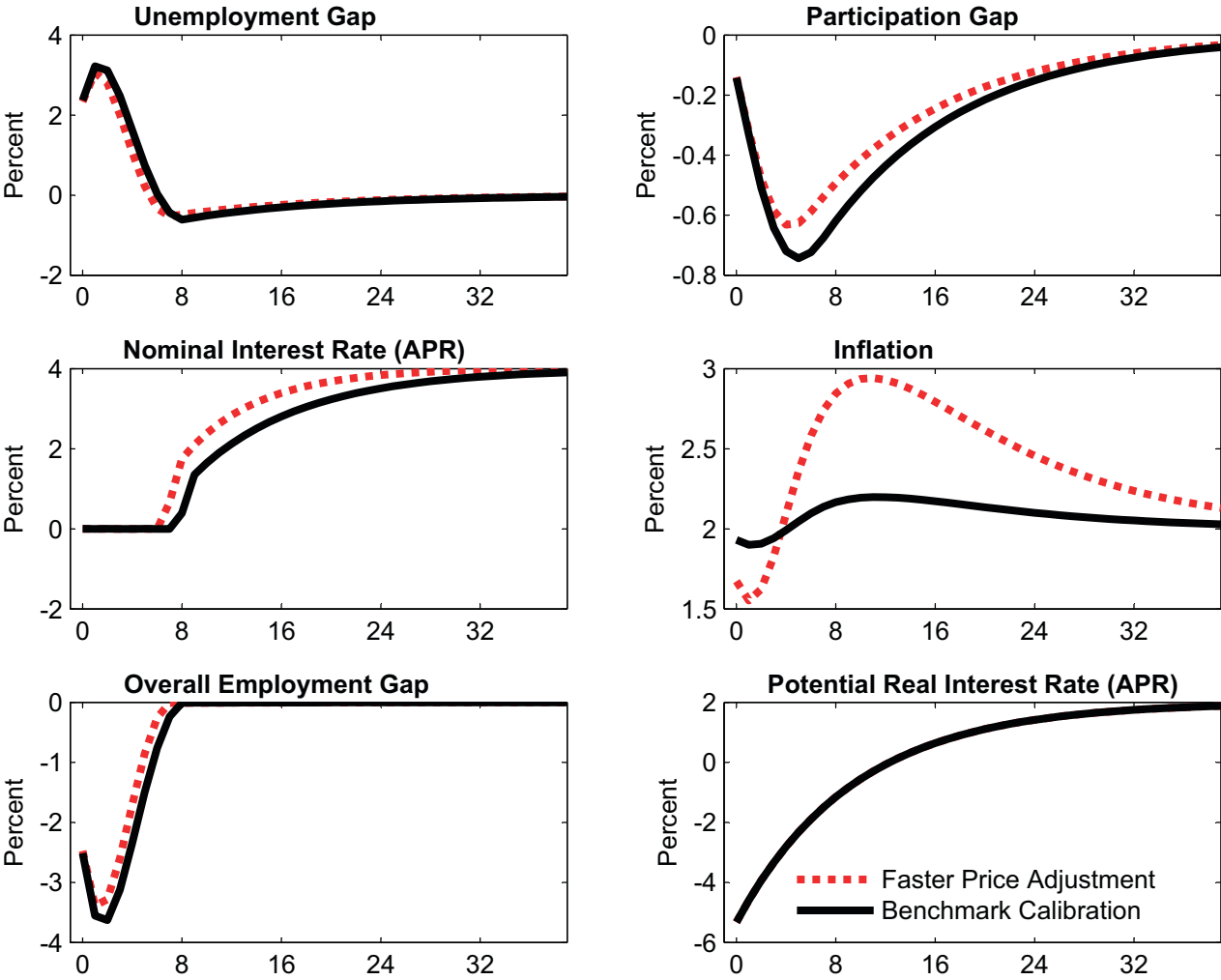
**Figure 8: Adverse Demand Shock under Different Monetary Rules**



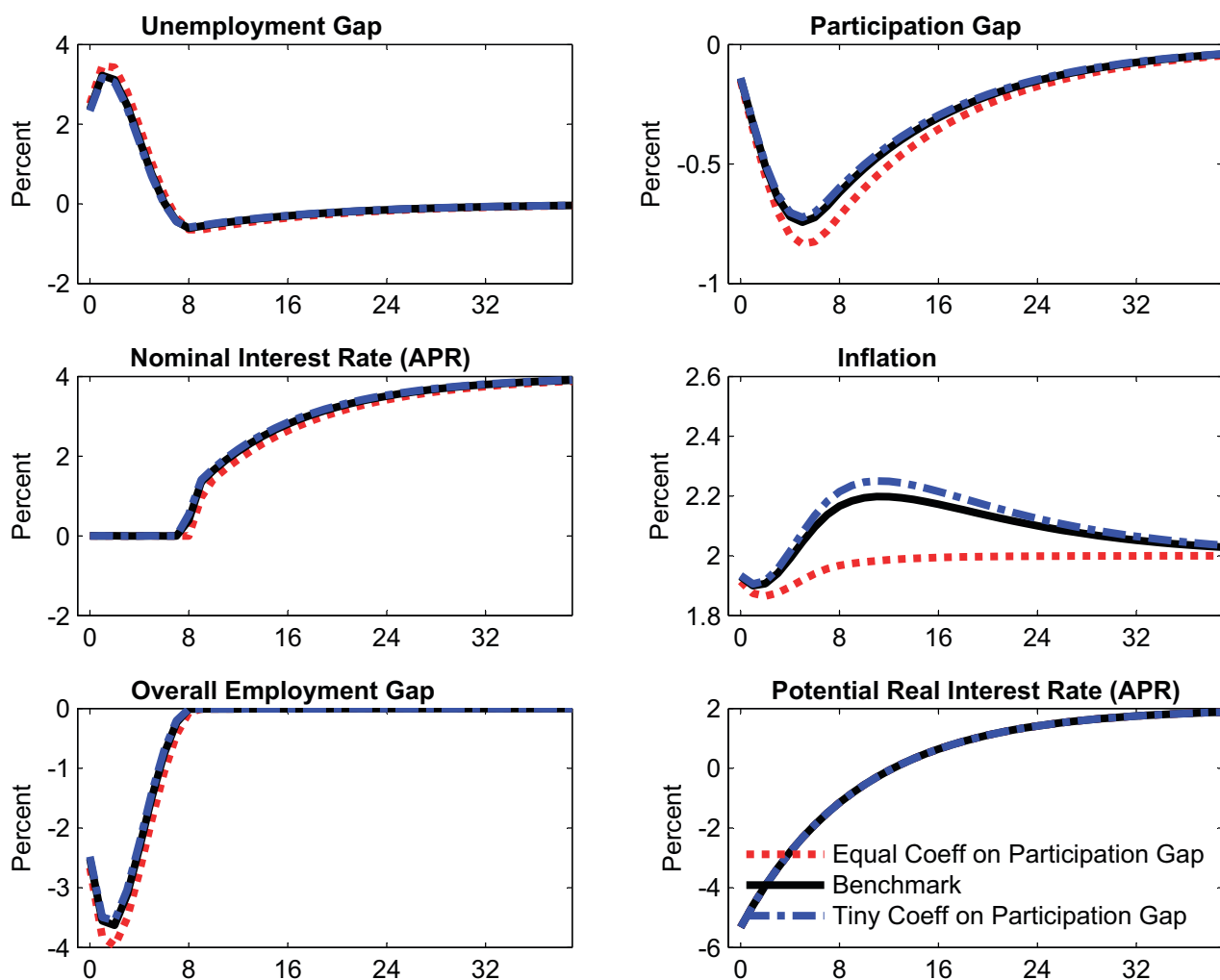
**Figure 9: Adverse Demand Shock under Different Rules: Faster Participation Response**



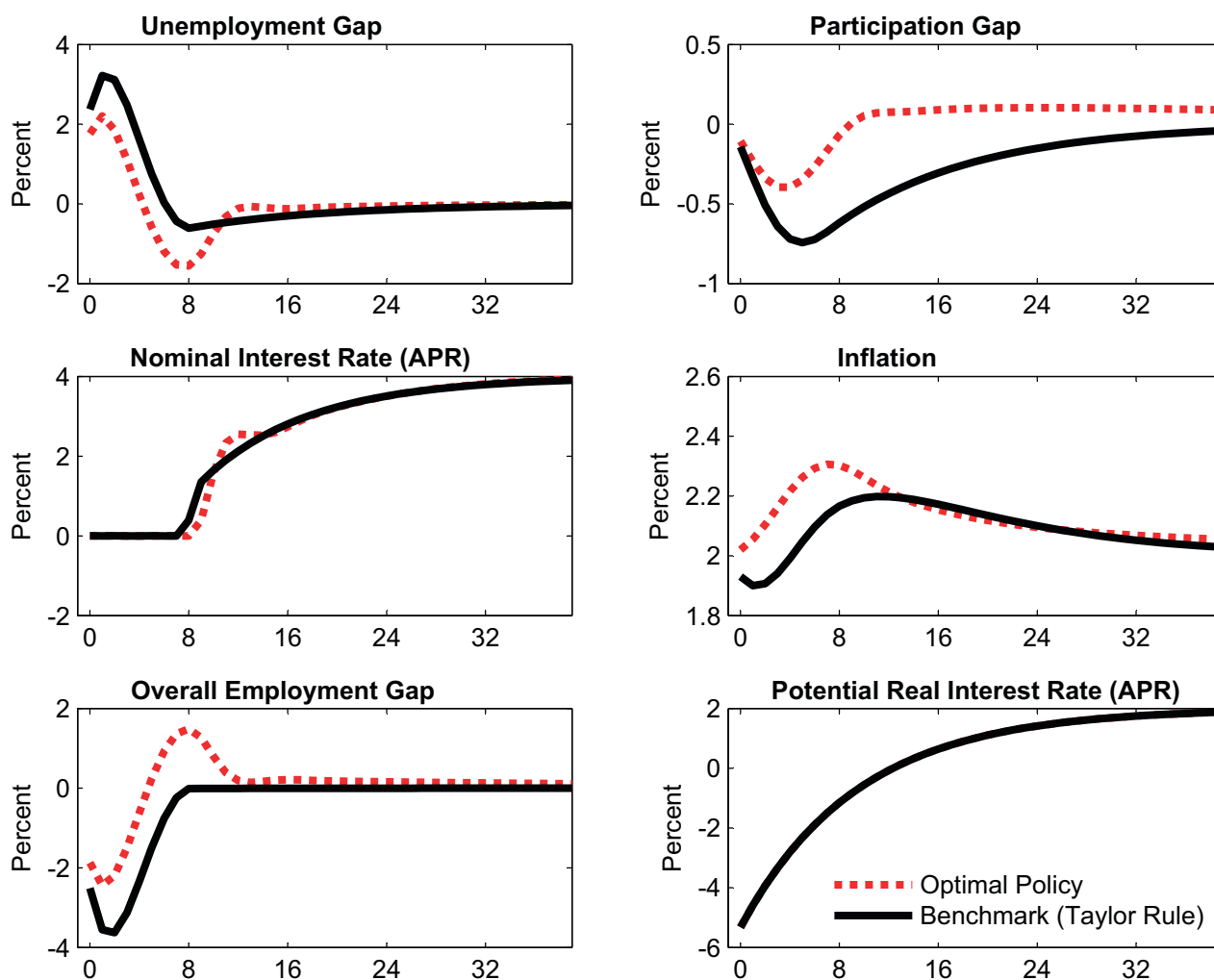
**Figure 10: Adverse Demand Shock w/Different Phillips Curve Slopes**



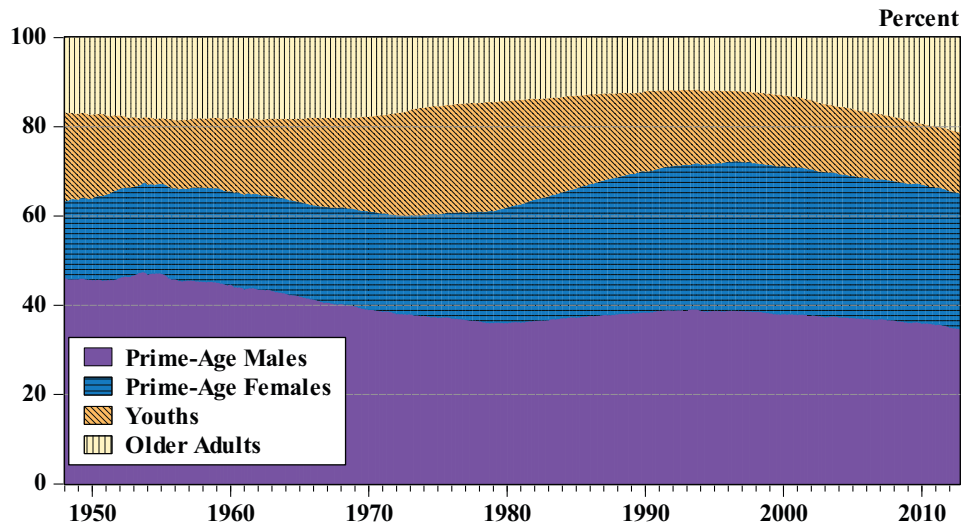
**Figure 11: Different Coefficients on Participation Gap under Employment Gap Targeting**



**Figure 12. Comparison of Employment Gap Targeting and Optimal Policy**



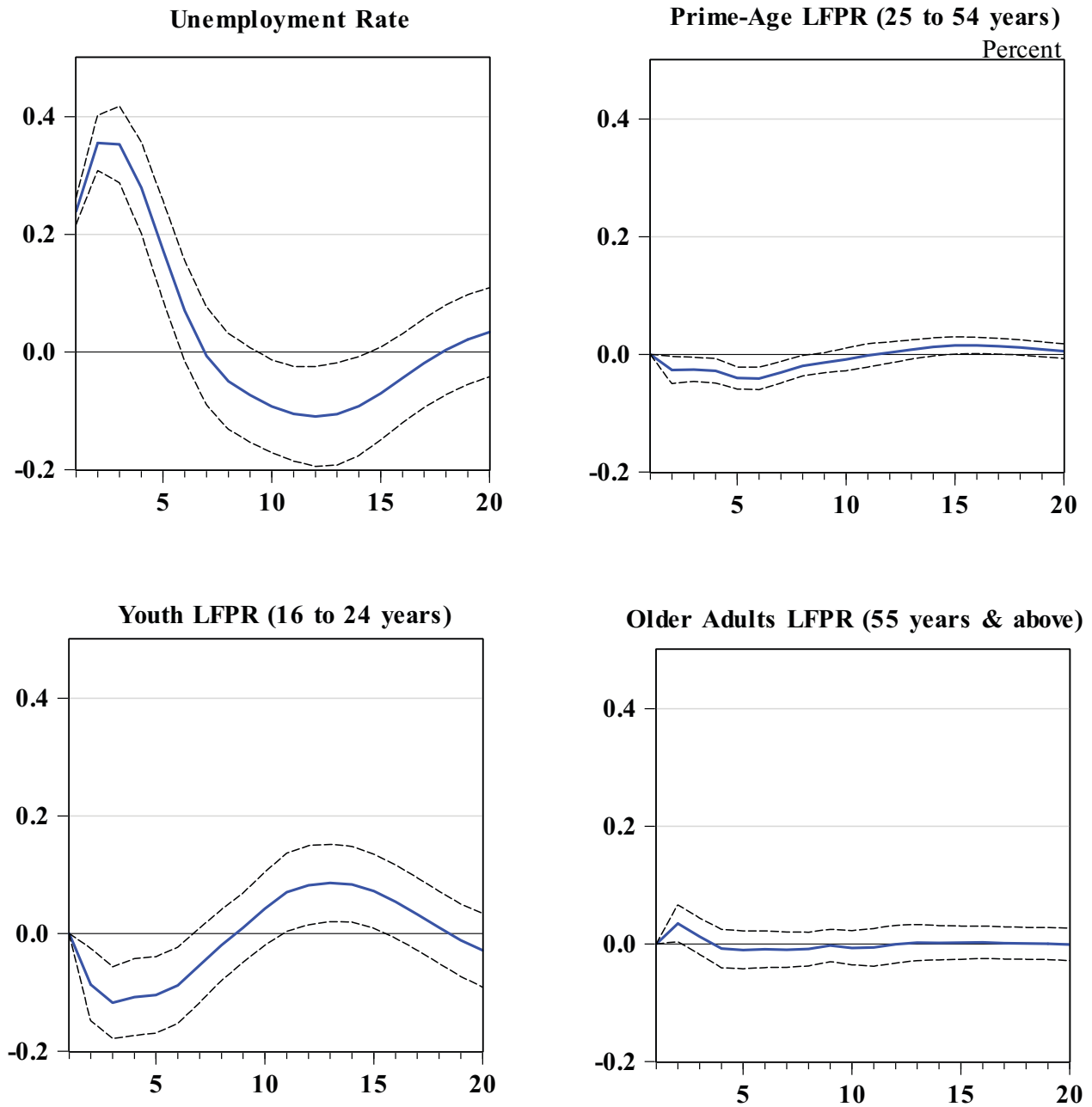
**Appendix Figure A1: The Demographic Composition of the Labor Force, 1948 to 2012**



*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. *Source:* Bureau of Labor Statistics.

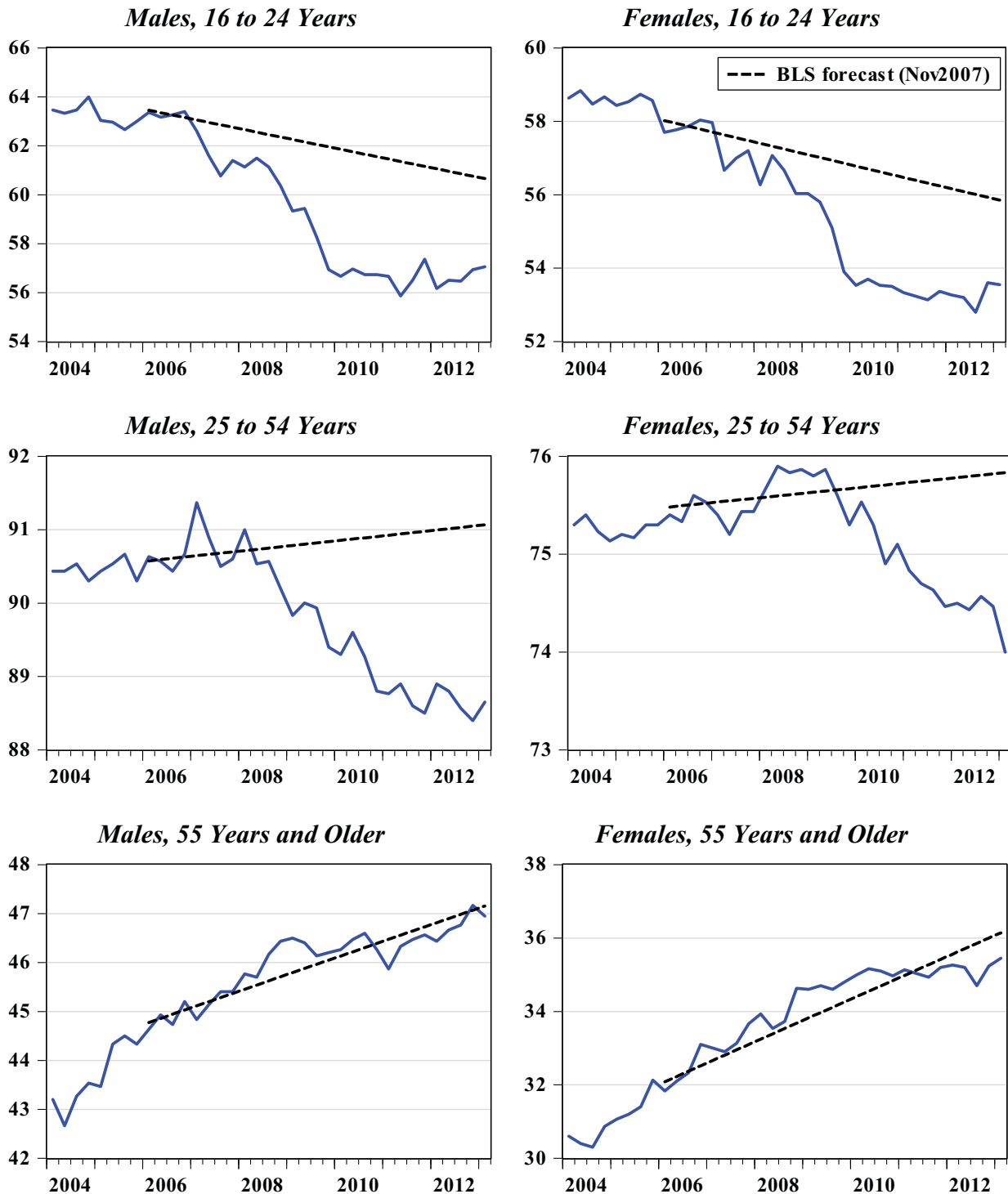


**Appendix Figure A2: The Cyclical Dynamics of the LFPR During “Normal Times”  
by Age Group**



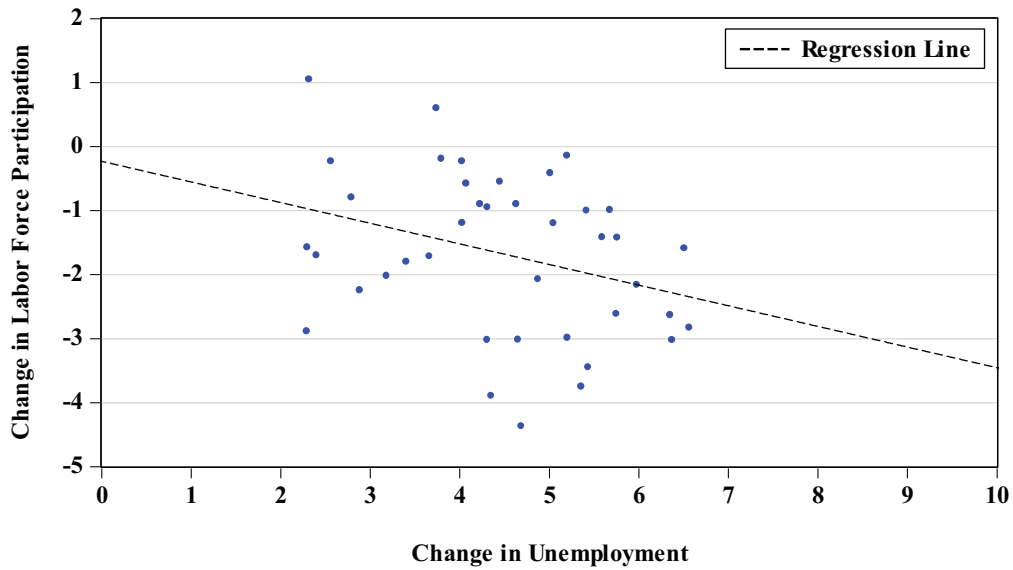
*Note:* This figure depicts the impulse responses from a VAR estimated using quarterly data on the unemployment rate and the labor force participation rates for three demographic groups (prime-age adults, youths, and older adults) over the period 1948:Q1 to 2007:Q4. In each panel, the solid line denotes 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 Rates by Gender and Age



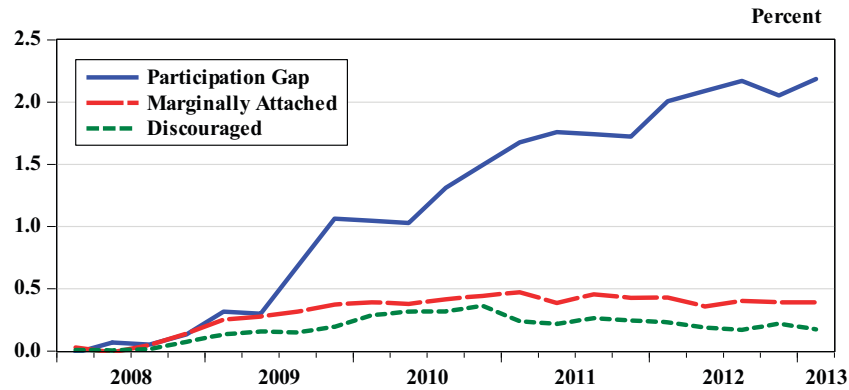
*Note:* In each panel, the solid line denotes the actual evolution of the labor force participation rate (in percent) for the specified demographic group from 2004:Q1 to 2013:Q1, and the dashed line denotes the linear trend for the decade ending in 2016 that was projected by BLS staff and published in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

**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. *Source:* Bureau of Labor Statistics.

**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