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A Cohort Model of Labor Force Participation

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The aggregate labor force participation (LFP) rate measures the share of the civilian noninstitutionalized population who are either employed or unemployed (i.e., actively searching for work). From 1963 to 2000, the LFP rate was rising, reaching its peak at 67.1 percent. The LFP rate has been declining ever since, with the decline accelerating after 2007. Between December 2007 and December 2012, the LFP rate declined from 66 percent to 63.6 percent. Prior to 2012, the last year when the LFP rate was below 65 percent was 1986.

The decline in the LFP rate, which coincided with the Great Recession, raises the question: Is the LFP rate at the end of 2012 close to or below its long-run trend? The question is important to policymakers and economists. If a large portion of the workers who are currently out of the labor force represents workers who are temporarily out of the labor force, then the unemployment rate by itself might not be a good measure of the slack in the economy.

In this article, we discuss the change in the aggregate LFP rate from 2000 to 2012, with an emphasis on the changes in the age-gender composition of the population and changes in the LFP rates of different demographic groups. We then estimate a cohort-based model of the LFP rates of different age-gender groups and construct the aggregate LFP rate using the model estimates. The model is a parsimonious version of the model studied in Aaronson et al. (2006). It contains age-gender effects, birth-year cohort effects, and the estimated deviations of employment from its long-run trend as the cyclical indicator. We

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estimate the model on the 1976–2007 data and then predict the aggregate LFP rate for 2008–12.

We find that in 2008–11, the actual LFP rate closely follows the LFP rate predicted from the model that takes into account the estimated cyclical deviation of employment from its trend. In 2012, the actual LFP rate is in fact above the estimated value from the model. The actual LFP rate in 2012 is close to the estimated trend constructed from the actual age-gender composition of the population and the age-gender and cohort effects estimated from the model.

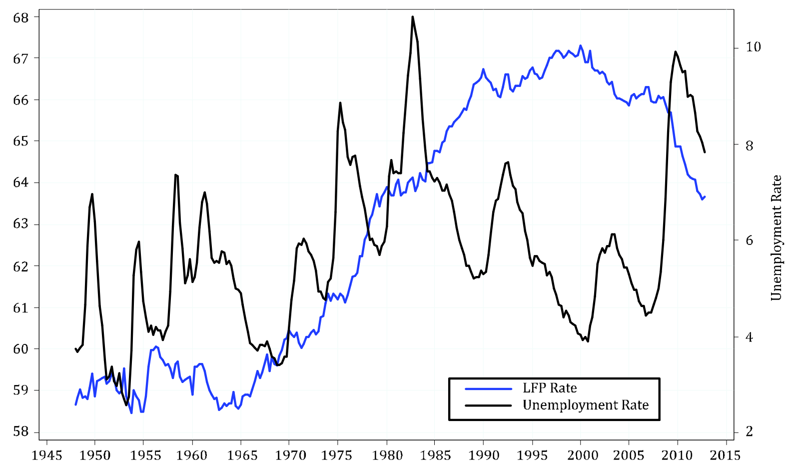
What are the factors behind the LFP rate in 2012 being above the value predicted from the model with the cyclical indicator? In the model, we use estimated deviations of employment from its long-run trend as a cyclical indicator. While it is true that the decline in employment during the Great Recession contributed to lowering labor force participation in 2008–12, it also appears that other factors during the 2007–09 recession worked to counteract this effect in 2012. Our model is silent about these factors. One can speculate that the increase in the duration of unemployment insurance benefits, or the decline in household wealth (due to the collapse of stock and housing markets), might have contributed to workers remaining in the labor force at a larger rate than predicted by the cyclical component of employment.

This article is related to an active debate in the recent academic and policy circles. The theoretical models are studied in Veracierto (2008), Krusell et al. (2012), and Shimer (2013). The empirical discussions are provided in Kudlyak, Lubik, and Tompkins (2011); Aaronson, Davis, and Hu (2012); Daly et al. (2012); Hotchkiss, Pitts, and Rios-Avila (2012); Canon, Kudlyak, and Debbaut (2013); and Schweitzer and Tasci (2013). The cohort model employed in the modeling labor force participation rate was originally proposed by Aaronson et al. (2006). Fallick and Pingle (2006) and Balleer, Gómez-Salvador, and Turunen (2009) provide extensions to the model.

The findings in the article are consistent with the findings in Aaronson et al. (2006), whose 2006 projection of the LFP rate in 2012 is 63.7 percent, the number that coincides with the actual rate in 2012. Other studies find that the LFP rate in 2012 is below its trend (Aaronson, Davis, and Hu [2012]; Bengali, Daly, and Valletta [2013]; Erceg and Levin [2013]; Hotchkiss and Rios-Avila [2013]).

The rest of the article is structured as follows. The first section reviews the behavior of the aggregate LFP rate during 2000–12 and presents counterfactual exercises using an age-gender decomposition of the aggregate LFP rate. Section 2 describes the cohort model and presents the empirical results. Section 3 concludes.

Figure 1 LFP Rate and Unemployment Rate



Notes: Quarterly averages of seasonally adjusted (SA) monthly series, January 1949–December 2012. Author's calculations using series from HAVER.

1. WHAT COMPONENTS DRIVE THE CHANGES IN THE AGGREGATE LFP RATE DURING 2000–12?

After reaching its peak of 67.3 percent in the first half of 2000, the aggregate LFP rate declined from 2000 to Q2:2004, stabilized for a few years, and then started falling again in 2008.[1] Figure 1 shows the aggregate LFP rate and the aggregate unemployment rate.

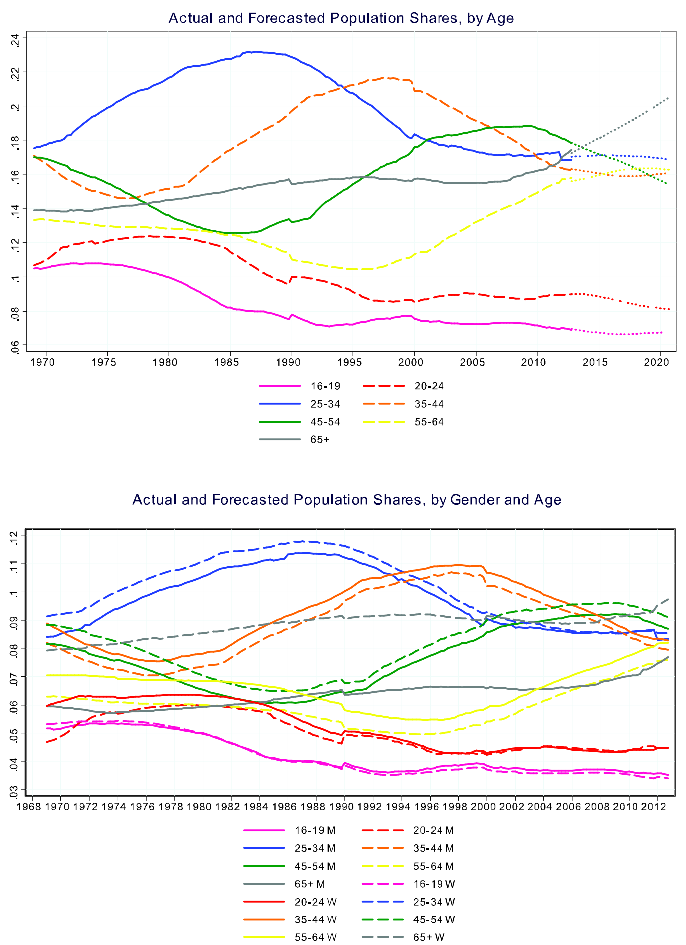
The aggregate LFP rate can be decomposed into the weighted sum of the LFP rates of different demographic groups, i.e.,

$$LFP_t = \sum_i s_t^i LFP_t^i, \tag{1}$$

where LFP_t^i is the labor force participation rate of group i, s_t^i is the population share of group i, i.e., $s_t^i \equiv \frac{Pop_t^i}{Pop_t}$, and Pop_t^i is the population of group i.

[1] The data reported in the article are from HAVER (SA), unless stated otherwise. The last data point at the time of the analysis: December 2012.

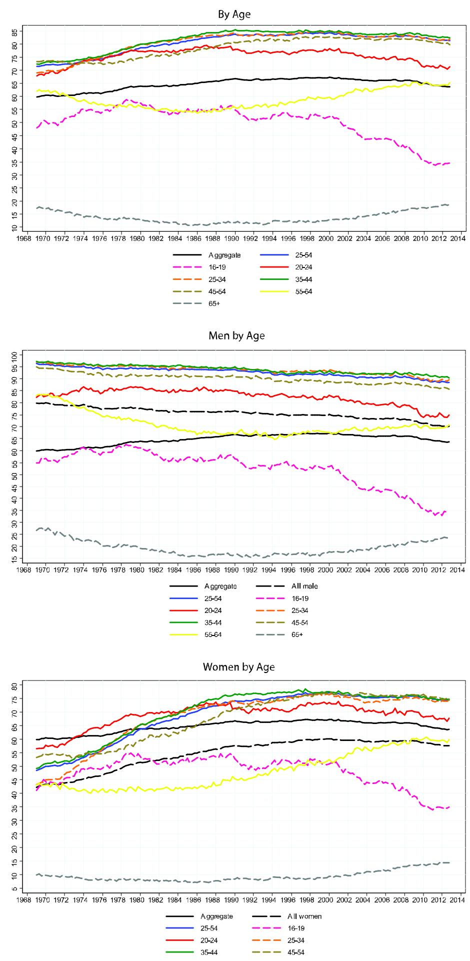
Figure 2 Actual and Forecasted Population Shares



Notes: Quarterly averages of monthly series, January 1969–December 2012. Annual series for estimates. All series from HAVER. Dotted lines denote shares based on the HAVER-estimated forecast of resident; population adjusted by the author to represent civilian noninstitutionalized population (using 2012).

To understand what forces drove the decline of the LFP rate since 2008, we first examine the change in the demographic composition of the population and the change in the LFP rates of different age-gender groups. Figure 2 shows the population shares by age-gender group.

Figure 3 LFP Rates



Notes: Quarterly averages of monthly series, January 1969–December 2012. All series from HAVER. Dotted lines denote shares based on the HAVER-estimated forecast of resident; population adjusted by the author to represent civilian noninstitutionalized population (using 2012). Author's calculations from the population and labor force series, SA.

Figure 3 shows the LFP rates of different age-gender groups. As can be seen from the figures, the developments that took place between Q4:2007 and Q4:2012 are a continuation of the developments that have been taking place since 2000, when the aggregate LFP rate reached its peak:[2]

- The composition of the population has been shifting toward older workers who typically have lower labor force attachment. This is in part due to the population of baby boomers gradually moving from the prime working age group with a high LFP rate to older age groups with lower LFP rates. Also note that the share of older women is larger than the share of older men, and women typically have lower labor force attachment than men.
- The LFP rate of 25- to 54-year-old workers, a group with the highest LFP rate, has been declining. From Q4:2007 to Q4:2012, the rate declined from 82.9 percent to 81.3 percent.
- The LFP rate of teenagers and young adults has been declining.
- The LFP rate of women has started to decline after increasing prior to 1999.
- The LFP rate of men has continued its decline, which started in the 1940s.

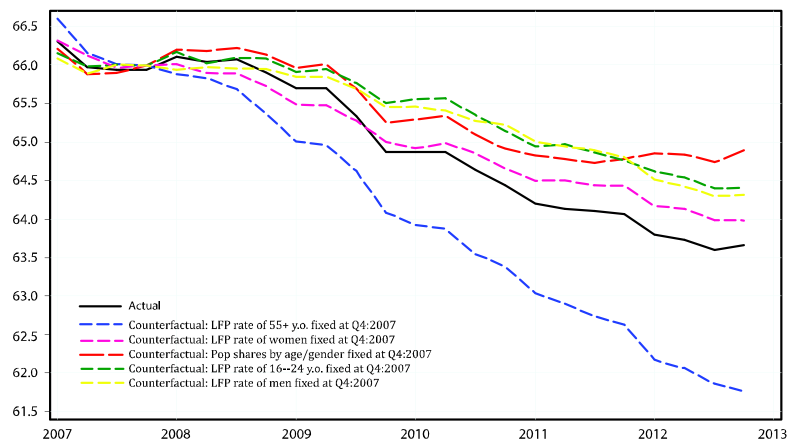
How Much Change Is Driven by the LFP Rates of Different Demographic Groups?

To understand the importance of the compositional changes and of the changes in the labor force participation rates of different demographic groups, we first present counterfactual exercises to quantify the impact of these changes on the aggregate labor force participation rate.

In the exercises, we keep the LFP rate of specific demographic groups fixed at their Q4:2007 level and allow the LFP rates of all other groups and the demographic composition of the population to follow their actual path. We consider four such counterfactual exercises: (1) fixing the LFP rate of 55+ year-old workers, (2) fixing the LFP rate of 16- to 24-year-old workers, (3) fixing the LFP rate of women, and (4) fixing the LFP rate of men. These exercises demonstrate the importance of changes in the LFP rates of different demographic groups for changes in the aggregate LFP rate. In our fifth counterfactual exercise, we fix the population shares of age-demographic groups at their Q4:2007 levels and allow the groups' LFP rates to follow their actual path. The results of these exercises are shown in Figure 4.

[2] See Toossi (2012a, 2012b) for a description of the trends and Canon, Kudlyak, and Debbaut (2013) for a summary of the Bureau of Labor Statistics projections.

Figure 4 Labor Force Participation Rate, Actual and Counterfactual



Notes: Author's calculations using data from HAVER, quarterly averages of monthly series.

As can be seen from the figure, the experiment with holding the LFP rates of 55–64 and 65+ year-old workers fixed (the dashed blue line) delivers the largest discrepancy between the actual aggregate LFP (the solid black line) and the counterfactual one. Since the LFP rate of older workers has increased, the counterfactual rate lies below the actual LFP rate, and in Q4:2012 stands at 61.7 percent.

The second largest discrepancy (in absolute value) between the actual aggregate LFP and the counterfactual one is obtained from holding the population shares fixed at their 2007 levels (the dashed red line). In this case, the counterfactual LFP rate exceeds the actual one and stands at almost 65 percent in Q4:2012. We see that between 2007 and 2012 the population composition has shifted toward a composition with lower labor force attachment.

The results also show that the counterfactual based on the fixed LFP of 16- to 24-year-old workers (the dashed green line) and the counterfactual based on the fixed LFP of men (the yellow dashed line)

line up almost perfectly and are both above the actual aggregate LFP rate.

Finally, the figure shows that the counterfactual LFP rate based on the fixed LFP by women (the dashed pink line) has declined more than the one based on the fixed LFP by men (the dashed yellow line), while both counterfactuals lie above the actual LFP rate.

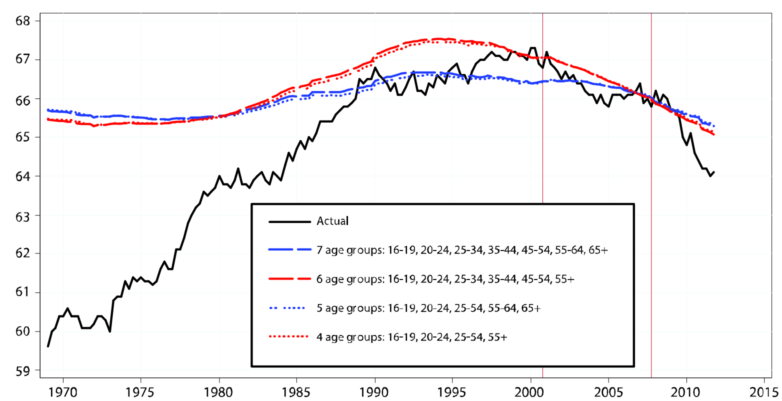
An Alternative Decomposition of LFP

As an alternative way of gauging how much of the change in the LFP rate was driven by the change in the population shares of different demographic groups, we perform the following counterfactual. We fix the LFP rates of 14 age-gender groups at their respective levels at time t_0 and construct the counterfactual LFP rate using the actual population shares of the respective groups, i.e., $LFP_t^{t_0} = \sum_i s_t^i LFP_{t_0}^i$. In the analysis, we consider the following seven age groups for each gender: 16–19, 20–24, 25–34, 35–44, 45–54, 55–64, and 65 and older. The blue lines in Figures 5 and 6 show the counterfactual LFP for t_0 equal to Q4:2007 and t_0 equal to Q4:2000, respectively.

As can be seen from Figure 6, in Q4:2012, the counterfactual LFP rate constructed from the groups' LFP rates fixed at their levels in Q4:2000 is 65.5 percent, while from 2000 to 2012 the actual LFP rate declined from 67 percent to 63.6 percent. The counterfactual LFP rate constructed from the age-gender LFP rates fixed at their levels in Q4:2007 is 65 percent, while from 2007 to 2012 the actual LFP rate declined from 66 percent to 63.6 percent (Figure 5). Thus, the results suggest that the demographic change of the population is associated with approximately 40 percent of the decline of the aggregate LFP rate between 2000 and 2012 and 37 percent of the decline between 2007 and 2012.

For such demographic counterfactuals it is important to consider as fine a group classification as possible, especially if there are substantial differences in the LFP rates of workers of different ages combined into a group. For example, the red lines in Figures 5 and 6 show the counterfactual LFP rate when we consider only six age groups for each gender (16–19, 20–24, 25–34, 35–44, 45–54, and 55 and older), i.e., combining ages 55–64 and 65+ into one group, 55+. As can be seen from the figures, in this case LFP_t^{2000} has declined more than the counterfactual rate in the seven-age-group exercise (64.4 percent). This is because the share of 55- to 64-year-old workers in the 55+ group, who have much higher labor force attachment than 65+, has increased between 2000 and 2012 (see Figure 6 for the shares).

Figure 5 The Counterfactual LFP Rate based on the Change in the Demographic Composition of the Population, Q4:2007



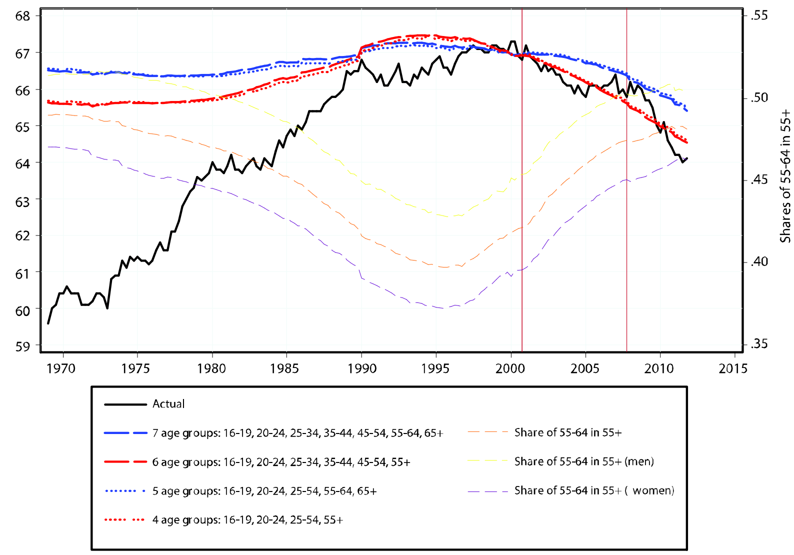
Notes: Population forecast is based on residential population forecast from HAVER, scaled by 2012 relationship between residential and civilian noninstitutionalized population by age and gender.

The observations above show that the demographic composition of the population and the changes in the LFP rates of different groups have played an important role in the change of the aggregate LFP rate. We now proceed to examine the age-gender and cohort effects in the LFP rates of different demographic groups on the aggregate LFP rate.

2. A COHORT-BASED MODEL OF LABOR FORCE PARTICIPATION

The results in Section 1 show that the time-variation in the LFP rates of different demographic groups are important for the variation in the aggregate LFP rate. In this section, we propose a model for the trend in the LFP rates of different demographic groups. We then estimate the trend in the aggregate LFP rate using the estimated trends in the

Figure 6 The Counterfactual LFP Rate based on the Change in the Demographic Composition of the Population, Q4:2000



Notes: Population forecast is based on residential population forecast from HAVER, scaled by 2012 relationship between residential and civilian noninstitutionalized population by age and gender.

LFP rates of different demographic groups and the actual demographic composition of the population.

Model

Life-Cycle and Cohort Effects in the LFP Rates of Age-Gender Groups

The LFP rates of different demographic groups reflect life-cycle and gender effects. In addition to these effects, the year-of-birth cohort effects can be an important determinant of the labor force attachment of a demographic group in a particular period. For example, as noted earlier, the baby boomers typically have higher labor force attachment.

As this cohort ages and moves through the age distribution, its stronger labor force attachment carries over to the respective age group.

We think of the demographic and the cohort effects in the LFP rates of different demographic groups as the determinants of the long-run labor force participation trend. To estimate this trend, we specify the following model:

$$\ln LFP_t^i = \alpha + \ln \alpha_i + \frac{1}{n}\sum_{b=1917}^{1996} C_{b,i,t}^f \ln \beta_b^f + \frac{1}{n}\sum_{b=1917}^{1996} C_{b,i,t}^m \ln \beta_b^m + \varepsilon_{i,t}, \quad (2)$$

where LFP_t^i is the labor force participation rate of age-gender group i, α_i is the fixed effect of age-gender group i, $C_{b,i,t}^f$ is the dummy variable that takes value 1 if age-gender group i in period t includes women born in year b, $C_{b,i,t}^m$ is the dummy variable that takes value 1 if age-gender group i in period t includes men born in year b, and n denotes the number of ages in group i. We specify separate cohort effects for men and women, i.e., $\beta_b^f(\beta_b^m)$ is the cohort-specific fixed effect of a cohort of women (men) born in year b. We assume that each cohort has equal importance in the corresponding age group conditional on the number of cohorts in the group. For the oldest group, 65+, we set $n = 20$ (setting $n = 30$ does not have a substantial effect on the results). To identify age-gender and cohort effects, we normalize $\ln \alpha_1 = 0$ and $\ln \beta_{1969}^f = 0$. The model is estimated using pooled quarterly data on the LFP rates of 14 age-gender groups.

The model in equation (2) is a simplified version of a model in Aaronson et al. (2006). Using the estimates from equation (2), we obtain the time series of $\ln LFP_t^i$ for the 14 age-gender groups, $\widehat{\ln LFP_t^i}$, and calculate $\widehat{LFP_t^i} = \exp\left(\widehat{\ln LFP_t^i} + \frac{\sigma_\varepsilon^2}{2}\right)$, where σ_ε^2 is the variance of $\widehat{\varepsilon_{i,t}}$. We then construct the estimated aggregate LFP rate as

$$\widehat{LFP_t} = \sum_i s_t^i \widehat{LFP_t^i}, \quad (3)$$

where s_t^i denotes the actual population share of group i in quarter t. Thus, the population shares capture the effect of the change in the demographic composition of the labor force, while $\widehat{LFP_t^i}$ reflects the age-gender and cohort effects of the different demographic groups. We refer to $\widehat{LFP_t}$ from model (2) as the estimated trend in the aggregate LFP rate.

Life-Cycle, Cohort, and Cyclical Effects

To further understand the behavior of the aggregate LFP rate, we also estimate a model similar to the one in equation (2) with a cyclical indicator. The cyclical indicator is the percentage deviation of employment from its trend. The idea behind the indicator is that when the labor market is weak, the labor force participation declines.[3]

The cohort model with the cyclical indicator is

$$\ln LFP_t^i = \alpha + \ln \alpha_i + \frac{1}{n} \sum_{b=1917}^{1996} C_{b,i,t}^f \ln \beta_b^f + \frac{1}{n} \sum_{b=1917}^{1996} C_{b,i,t}^m \ln \beta_b^m + \sum_{g=1}^{14} I(i=g) \left(d \ln E_t \ln \gamma_g^0 + d \ln E_{t-1} \ln \gamma_g^1 + d \ln E_{t-2} \ln \gamma_g^2 \right) + \varepsilon_{i,t}, \tag{4}$$

where $I(\cdot)$ is the indicator function, and $d \ln E_t$ is the percentage deviation of the employment series from its Hodrick-Prescott (HP)-filtered trend with a smoothing parameter $\lambda = 10^5$ applied to the quarterly data.

In the estimation, we use the contemporaneous percentage deviation from employment as well as the first and second lag of the deviation. Note that we allow the cyclical effects to vary by demographic group i. Because of the end-of-sample issues associated with HP-filtering the series, we experiment with using a counterfactual cyclical series, $\widetilde{d \ln E_t}$, obtained by calculating the deviations from the employment series simulated to grow at the 2 percent year-over-year quarterly rate after Q4:2012. While the cyclical components from the actual and simulated employment series differ after 2009, the model-based aggregate LFP rates from the two alternative series are very similar.

The model is estimated on quarterly data. After estimating equation (4), we construct the aggregate LFP rate as described in equation (3).

The error term in equation (4), $\varepsilon_{i,t}$, captures the residual between the actual LFP rate of group i in period t and the one explained by the historical relationship between age-gender, cohort, and cyclical effects and the LFP rates by group. Thus, the residual captures two main effects. First, it captures the factors that affect the LFP of group i that are not modeled explicitly in equation (4). These include some structural factors (for example, changes in taxes or disability benefits) and some cyclical factors that are not fully captured by the changes in aggregate employment (for example, changes in the duration of unemployment benefits, house prices, and stock prices). Second, the residual captures potential changes in individuals' behavior (i.e., changes in responses of the LFP rates to different structural and cyclical factors).

[3] See recent evidence in Hotchkiss, Pitts, and Rios-Avila (2012); Kudlyak and Schwartzman (2012); Elsby, Hobijn, and Şahin (2013); and Hornstein (2013).

Empirical Results

One way to obtain the predictions from the models described in equations (2) and (4) is to estimate the models using the 1976–2012 data, obtain the trend in the aggregate LFP rate (from equation [3]) and the model-predicted aggregate LFP rate from the model with a cyclical indicator, and compare the estimates with the actual LFP rate during 2008–12. Another way is to estimate the model on the 1976–2007 data and then use the estimates together with the assumptions on cohort effects and predict the aggregate LFP rate for 2008–12. The cohort model is sensitive to which approach is used.

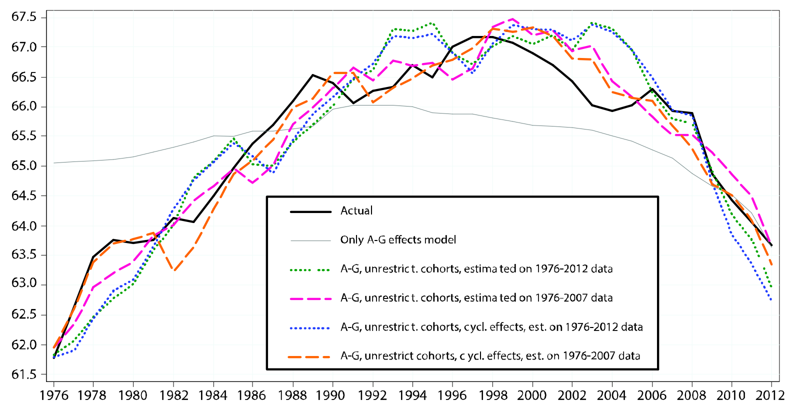
One of the concerns associated with cohort models is the end-of-the-sample effect. In particular, the young cohorts observed in the 1976–2012 sample (i.e., those born in 1985–1996) are observed only during the period of the declining aggregate LFP rate. Thus, the model identifies these cohorts' propensity to participate from the period of overall low participation, attributing low LFP to these young cohorts rather than to the model's residual. Given the severity and the length of the Great Recession, the effects of the cohorts born prior to 1985 are also, to a large extent, identified from their labor force participation rates during 2008–2012, the period of the overall low LFP. This is the case for cohorts for which, for example, at least half of the observations come from the 2008–12 period.

To avoid the end-of-sample effect on the estimates, we estimate the models in equations (2) and (4) using the data from 1976–2007. To construct the prediction of the aggregate LFP rate for 2008–12, we assign, for cohorts born after 1991, the average cohort effect of the last 20 cohorts. Figure 7 shows the following series: (1) the actual aggregate LFP rate, (2) the LFP rate constructed from the model with only age-gender effects, (3) the LFP rate constructed from the model with age-gender and cohort effects estimated on 1976–2007 data, and (4) the LFP rate constructed from the model with age-gender, cohort, and cyclical effects estimated on 1976–2007 data.[4]

As can be seen from the figure, the aggregate LFP rate estimated from the model with only age-gender and cohort effects on the 1976–2007 sample exceeds the actual aggregate LFP rate after 2008, and the two lines coincide at the end of 2012. This measure constitutes our preferred measure of the trend in the LFP rate. The aggregate LFP rate estimated from the model with age-gender, cohort, and cyclical

[4] The estimates are available from the author.

Figure 7 Actual and Model-Based Aggregate LFP Rate, Age-Gender and Cohorts Effects



Notes: To construct the LFP from the model estimated on the 1976–2007 data, we estimate unrestricted cohort effects for birth years from 1917 to 1991 and then assign the average cohort effect of the last 20 cohorts to cohorts born in 1992–96.

effects on the 1976–2007 data closely tracks the actual aggregate LFP rate during 2008–11 and is slightly below it in the last quarter of 2012.

For comparison, Figure 7 also shows the aggregate LFP rate estimated from the models using the 1976–2012 data. As can be seen from the figure, during 2008–12, the aggregate LFP rate predicted from the model estimated using the 1976–2007 data exceeds the aggregate LFP rate predicted from the model estimated using the 1976–2012 data. This is true for the predictions from the model with age-gender and cohort effects and for the predictions from the model with age-gender, cohort, and cyclical effects. It appears that the model estimated using the 1976–2012 data attributes the cyclical effects of the 2008–12 period to cohort effects. To minimize the end-of-sample effect, we also estimated the models employing a restriction on cohorts as described in Aaronson et al. (2006). In particular, we constrain the evolution of the fixed effects for consecutive pairs of the cohorts born in 1985–96 so that the difference in the average propensity to participate between one cohort and the next is the same as for a set of cohorts observed over the last full business cycle. The aggregate LFP rate based on the models with restricted and unrestricted cohorts are similar, so the figure shows only the results without restrictions.[5]

Discussion

In the model, the cohort effect stands for an average effect of all non-modeled factors (beyond life-cycle, gender, and cyclical effects) that affect the labor force participation of a cohort (i.e., the workers born in a particular year) throughout the period the cohort is observed in the sample. These factors can include both structural and cyclical variables. For example, the availability of and the rules that govern Social Security benefits and disability insurance might influence the decision to look for work versus drop out of the labor force. The wage premium from higher educational attainment might influence the decision of younger workers to go to school rather than participate in the labor force. The availability and cost of child care can influence the decision of mothers to join the labor force.

Consequently, the cohort effects constitute a black box that aggregates these influences and serve as a useful device for accounting exercises. The cohort model, however, might not be the best laboratory for long-term forecasts. In our estimation, we recognize explicitly that the effect of young cohorts is to a large degree identified from the few years during which we observe these cohorts in the data. In particular, for the youngest cohorts, a low cohort effect can be due to the true low propensity of these cohorts to participate or due to the model attributing low cyclical LFP to the cohort effect. In our exercise, we control for these effects. A forecasting exercise would inevitably involve assumptions about the cohort effects going forward. It is possible that, for example, the youngest cohorts who are not participating currently due to schooling will, in fact, increase their LFP as they grow older. The cohort model does not provide information to support or reject such scenarios.

[5] The result with restrictions is available from the author. This result motivates estimation of the benchmark model (i.e., using the 1976–2007 data) without restrictions on cohorts.

3. CONCLUSION

We find that in the aftermath of the Great Recession, the aggregate LFP rate closely tracks the one predicted by the historical relationship between the changes in employment and the labor force participation rates of different age-gender groups in a cohort-based model. In 2012, the actual LFP rate is slightly higher than the one predicted by the model. In 2009–11, the trend component of the labor force participation rate, which is based entirely on the life-cycle and cohort effects of the LFP rates of different age-gender groups and the actual age-gender composition of the population, exceeds the actual LFP rate.

The result that the LFP rate in 2012 is above the level that is predicted by the historical relationship between labor force participation and the cyclical indicator is consistent with the recent findings by Hotchkiss and Rios-Avila (2013), who provide direct evidence that some changes in behavior took place.[6] What other factors could have contributed to the estimated deviation of the actual LFP rate from its model-based prediction? We speculate that the Great Recession was characterized by unusually wild swings in some economic indicators that could have affected labor force participation. First, the unemployment benefits in some states were extended to unusually high levels. The benefits extension might have kept some workers in the labor force for up to two years to enable them to collect benefits rather than dropping out of the labor force. In particular, Farber and Valletta (2013) find that the effect of the unemployment insurance extensions on unemployment exits and duration is primarily due to a reduction in exits from the labor force.[7] Second, the collapse of the stock market led to a decline in retirement savings, which might have led older workers to stay in the labor force longer. Third, the collapse of the housing market lowered the ability of households to borrow against their home equity, which also might have caused individuals to join and/or remain in the labor force at higher rates than historically predicted by age, gender, cohort, and cyclical employment effects. Finally, to understand the behavior of labor force participation and its trend, more research is needed that would explicitly model and account for the factors that

[6] In particular, Hotchkiss and Rios-Avila (2013) use microdata from the Current Population Survey and estimate the probability of an individual participating in the labor force as a function of age, education, and other socioeconomic and demographic characteristics of the individual as well the aggregate labor market conditions. They find that the coefficients on the socioeconomic and demographic characteristics estimated from the post-2008–09 period differ from the coefficients estimated from the pre-recession period in such a way as to increase the aggregate LFP rate.

[7] See also Fujita (2010, 2011) and Rothstein (2011).

influence the labor force participation decision of different demographic groups.

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