# The Lost Generation? Scarring after the Great Recession

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Abstract:

Young people graduating after 2007 encountered very weak labor demand, perhaps inflicting long-term damage on their labor market prospects. I explore the labor market outcomes of young college graduates following the recession for evidence on the magnitude and permanence of "scarring" effects. Employment rates of post-recession graduates remain depressed, even as those from earlier cohorts have recovered. I decompose this into transitory time effects, medium-term scarring, and permanent cohort effects. The last accounts for half or more of the decline. The implied long-run cumulative effect of the recession on graduates' employment will be more than twice as large as the immediate effect. There is less evidence of persistent effects on wages among those employed.

# I. Introduction

The Great Recession was unusually severe and, in the labor market, long lasting. The unemployment rate rose from 4.4 percent in May 2007 to 10.0 percent in October 2009, and over a decade after the onset of the crisis the prime-age employment-to-population ratio remains a full percentage point below its 2007 peak.

The extended downturn was particularly hard on young people. Where most older workers can weather a weak labor market by remaining in their existing jobs – cumulative layoffs in 2008 and 2009, relative to the prior two years, represented only about 6% of total employment – students leaving school must find new jobs to work. Job openings were at least 20% below their pre-recession peak for nearly five years, and the hiring rate remained significantly depressed until late 2014. The share of individuals aged 20-25 who were neither working nor in school rose by nearly half, from 13.1% in 2007 to a high of 19.0% in 2013.

Prolonged unemployment may have long-run consequences for individuals' employability and productivity. Yagan (forthcoming) documents that experienced workers who were exposed to more severe local shocks during the Great Recession had lower employment rates even after their local labor markets had recovered. Hysteresis effects may be even larger for young workers, for whom graduating in a recession may mean reduced access to valuable on-the-job experience and training. Evidence from past business cycles indicates that individuals who enter the labor market during downturns are "scarred" for many years thereafter, with lower employment and wages than similar individuals from cohorts that entered at better times (Kahn 2010; Oreopolous, von Wachter, and Heisz 2012; Schwandt and von Wachter, forthcoming). DeLong and Summers (2012) point to this type of hysteresis as a major cost of economic volatility, and argue that in its presence countercyclical fiscal stimulus can be self-financing.

I use data on the labor market outcomes of young people during and after the 2007-9 Great Recession to obtain a preliminary measure of the medium- and long-run scarring effects of the deep, extended downturn on young people's labor market outcomes. Following the past literature on scarring, I focus on college graduates, whose human capital is least likely to have become technologically obsolete during the downturn.

I find that the employment, annual earnings, and hourly wages of those who entered the labor market during and after the recession were lower than for previous cohorts. The wage effects are the smallest of the three, and were largely transitory. But the employment and earnings effects lasted beyond the end of the recession for those cohorts that entered the market during the labor market trough. College graduates who entered the labor market in 2010 and 2011 have employment rates that are a full four percentage points lower than the age- and time-adjusted employment rates of pre-recession cohorts, and annual earnings that are ## lower. Graduates who entered after the recession also have depressed employment rates, though earnings conditional on employment have recovered. In a simple age-time-cohort decomposition, I find that pure time effects account for only about half of the decline in

employment for cohorts entering the labor market in 2009-2011, and none of the decline for subsequent cohorts. The remainder is attributed to cohort effects, as these cohorts continue to do poorly even in more recent data when older cohorts have recovered.

I next investigate whether existing models of scarring can account for the ongoing weak employment and earnings outcomes. An important feature of the specifications that have typically been estimated is that scarring effects, while long lasting, are not permanent. The effects of the initial employment rate are typically estimated to dissipate by the individual's $10^{th}$ year in the labor market (Borgschulte and Martorell 2018; Kahn 2010; Oreopoulos et al. 2012). Thus, insofar as these models correctly characterize the scarring effect of the Great Recession, they imply that much of the damage to the post-recession cohorts has already been borne, and that the Recession will not cast a large shadow going forward. But the estimates of the scarring parameters derive from earlier downturns, so need to be extrapolated well out of the support of the prior data to predict the effects of the Great Recession.

I reproduce scarring estimates in Current Population Survey data, using similar specifications to those used by previous authors but focusing on annual employment rather than on earnings. Post-Great-Recession scarring is closely in line with extrapolations based on estimates from pre-2007 data. Whether I use the full sample or just the pre-recession subsample, I find substantial medium-term scarring that fades out over several years. The magnitude, however, implies that scarring can account for only about half of the depressed employment of the post-recession cohorts, relative to other cohorts in the post-recession labor market. The remaining half of the employment effect is attributed to cohort changes. By the logic of the specification, these are persistent, unlikely to recover as the Recession fades into the past.

I close with a calculation of the contribution of these long-lasting effects to the total cumulative impact of the Great Recession. This is necessarily speculative, requiring extrapolation of the cohort-level shock through the decades remaining in the affected cohorts' potential careers. I estimate that the Great Recession will reduce the employment rates of college graduates over the 2007-2060 period (by the end of which the last of the recession entrants will have retired) by a total of nearly 17 percentage point-years. A bit less than half of this loss was incurred during the 2008-2014 period when the unemployment rate was elevated, while the remainder reflects medium- and long-term effects of the recession. The medium-term effects, due to scarring, will gradually fade over the next few years, while the long-run effects will persist as long as the recession cohorts remain in the labor market. Effects that will manifest in 2027 and beyond account for fully one-third of the total.

This evidence supports the view that hysteresis is an important component of the welfare cost of business cycles. Just the long-run impacts on new entrants represent a sizeable overhang of the downturn that will reduce prosperity for decades to come. DeLong and Summers (2012) argue that this kind of shadow constitutes a quantitatively important component of the true cost of recessions, and if post-recession hangovers are large enough counter-cyclical fiscal policies can be self-financing. My estimates of the scarring effects of the recession on new labor

market entrants capture only a small component of potential hysteresis, but are on their own large enough to imply a meaningful fiscal offset for countercyclical policies.

## II. The Great Recession in the labor market

The unemployment rate rose by 6.5 percentage points between mid-2007 and late-2009, more than during any earlier post-war business cycle (Appendix Figure 1). Unemployment declined roughly linearly after mid-2010. It has been below 6% since the third quarter of 2014 and below its pre-recession level since mid-2017.

The prime-age (25-54) employment rate fell by over five percentage points by late 2009. Employment was much slower to recover than unemployment, however. At this writing the employment rate is 79.7%, just one point above the lowest level seen after the early-2000s recession and still a half percentage point below the 2007 peak.

Job openings, which tend to be higher in tight labor markets, have been above their pre-recession peak since early 2015. In part for this reason, the Federal Reserve began tightening monetary policy in that year. However, the evidence for labor market tightness is not unambiguous. As noted, employment has not fully recovered. Other indicators, including the labor force participation rate and the quit rate (Appendix Figure 2), also suggest that there may have been remaining slack for longer, perhaps even up to the present.

Young people fared particularly poorly during the downturn. Figure 1, Panel A shows the employment rate separately for those aged 25-30 and those aged 31-54. While the two series generally rise and fall together, the cyclical amplitude is much larger for young workers, whose employment fell ## during the Great Recession. Figure 1, Panel B distinguishes college graduates and non-graduates within the 25-30-year-old group. Employment rates are higher and less cyclical for college graduates. However, their employment rate declined substantially during the recession, and was very slow to recover thereafter. By the end of 2014, the non-graduates had made up ##% of the ground lost during the recession, while graduates had made up only ##%.

There is substantial evidence that wages do not respond flexibly to fluctuations in labor demand (Bewley 1999). Nevertheless, one can also see the impact of the downturn in average wages. Appendix Figure 3 shows average real hourly wages for the same groups broken out in Figure 1. All four mean wage series fell after the downturn, with a larger decline for younger workers and similar declines for young college graduates and non-graduates. Older workers' wages have more than recovered in recent years, but young workers' wages, both graduates and non-graduates', remain well below their 2000 peak and comparable to or below their 2007 local maximum.

## III. Literature review

My study relates to three literatures.

The most closely related work examines the persistent effects of labor market conditions at the time of college graduation (e.g., Kahn 2010; Oreopoulos et al. 2012; Schawndt and von Wachter, forthcoming; Borgschulte and Martorell 2018; Oyer 2006, 2008). This research generally finds sizable persistent effects on wages that fade out over the first decade following graduation. One interpretation of this persistence is that new graduates are delayed in beginning to climb up the job ladder during recessions; another is that the labor market weakness at career start translates into a weak bargaining position for many years thereafter (Beaudry and DiNardo 1991).

Second, a number of studies examine the effects of job displacement on subsequent earnings (Jacobson, LaLonde, and Sullivan 1993; von Wachter and Bender 2006; Schmieder, von Wachter, and Heining 2018). Again, these studies typically find persistent effects that fade out only over a long period. This is again consistent with job ladder models, as displaced workers must begin again at the bottom of the ladder. Davis and von Wachter (2012) find that the displacement effect is larger in recessions.

Third, some papers examine hysteresis directly. Clark and Summers (1982) examine short- and long-run effects of labor demand on labor market participation, and conclude that transitory shocks have small effects but that previous experience has persistent effects on subsequent labor supply. “Workers drawn into the labour force by cyclical upturns tend to remain even after the boom has ended. The converse is true for shocks which reduce employment,” (Clark and Summers 1982, 842). Yagan (forthcoming) examines hysteresis effects of the same Great Recession shock that is my focus. He finds that workers who lived in areas that experienced larger Great Recession shocks have worse outcomes 6-8 years later, not attenuated by mobility to healthier labor markets. My analysis extends Yagan’s by examining young workers – his estimates are based on workers already over 30 in 2007 – and relating the persistent impacts of the Great Recession to those of pre-2007 fluctuations.

## IV. Data

My analysis focuses on the employment rate of young workers, measured in the monthly Current Population Survey (CPS). I also analyze log real annual earnings, measured in the Annual Social and Economic Supplement (the March CPS), and log real hourly wages, from the Outgoing Rotation Group (ORG). Data processing and definitions are discussed in the Appendix.

My primary sample consists of individuals born between 1948 and 1995 and observed at ages 22 to 40 in the years 1979 through 2017. I estimate many models on those who had fully entered the labor market before the 2007 recession; for these, I limit the sample to those born by 1978.

For each outcome and sample, I aggregate to the education-state-year-cohort cell mean.[1] Education groups are those with bachelor's degrees and above and those with less than a BA. I merge onto these cells the contemporaneous state unemployment rate and the unemployment rate at labor market entry (defined below).[2]

There are three important limitations to the CPS data for my purposes. First, I observe only the respondent's current state of residence, not the state where he/she lived at labor market entry. Schwandt and von Wachter (forthcoming) explore the bias in similar specifications from failing to measure location as of graduation, and conclude that it is "unlikely to be very large." The coefficients of interest in my study are primarily identified from time-series variation in the national unemployment rate, not from cross-sectional variation, so accurately measuring state-to-state migration is relatively unimportant.[3]

Second, I do not observe the date that a respondent entered the labor market. Following the scarring literature (e.g., Kahn 2010), I assume that for college graduates the unemployment rate at age 22 is the relevant initial condition – although many enter the labor market after that, these decisions depend in part on economic conditions (Schwandt and von Wachter, forthcoming). Thus, even for late entrants the age-22 unemployment rate influences the age at which graduates are able to reach the first rung of the employment ladder. For non-graduates, I use the unemployment rate at age 18, by similar logic.

Third, I observe education as of the CPS survey, not the respondent's eventual completed education. Ideally, I would assign each individual to his/her eventual education category, but when I observe someone at age 23 I do not know whether he/she will earn a degree at 26. Thus, my education-specific mean outcomes are based on populations that are selected differently at young than at older ages.

Appendix Figure 4 shows the share of the CPS sample with a bachelor's degree by birth cohort (in two-year bins) and year. The figure shows that the degree attainment rate rises dramatically with age within cohorts – a rate computed for 22-year-olds is only half or one-third of what will be seen for the same cohort at age 30. For cohorts born in the 1960s, the great majority of degrees were earned by age 24. Time-to-degree lengthened notably with about the 1968 birth cohort, which turned 22 in 1990 (Bound, Lovenheim, and Turner 2012), but still the great majority of degrees are awarded by 26. The age distribution of degree awards does not seem to have changed dramatically since the mid-1990s, and does not seem to vary with business cycles. Eventual attainment has grown substantially since the 1968 birth cohort, particularly for cohorts graduating during and after the recession, but the increase is already apparent by age 24 and there is little increase in degrees awarded after that age. Together,

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[1] Birth cohorts are approximated by subtracting the age as of the CPS interview from the year of the survey, so are off by one for respondents who have not yet had their birthdays.

[2] State unemployment rates are available only from ##; for cohorts that entered the labor market before this date, I use the national rate.

[3] I explore sensitivity to mobility in the Appendix.

these facts make it plausible that age effects will absorb most of the bias in the cohort mean outcomes averaged across various ages.

I take two approaches to dealing with remaining bias from changing composition of the college graduate subgroup over cohorts and years. First, I include in my regression specifications an inverse Mills ratio computed from the cohort-by-age attainment rate (or, for non-graduates, from the complement of this). Because my specifications all include cohort and age effects, the coefficient on this control is identified solely from changes in the attainment rate over age that differ across cohorts. In a simple bivariate normal selection model, this will absorb any bias from changing selection (Gronau 1974, Card and Rothstein 2007). Second, I have reestimated my primary specifications excluding observations from ages under 24. Results are largely unchanged.

# V. Methods and results

## A. Age-time-cohort decomposition

My basic analytical method is an age-time-cohort decomposition. Let $Y_{satc}$ represent the employment rate of college graduates in state s at age a in time t from birth cohort c (indexed by the year that the group entered the labor market, or c=t-a+22). I estimate models of the form:

$$Y_{satc} = \alpha + \beta_t + \gamma_a + \delta_c + \zeta_s + \rho\lambda(p_{satc}) + \epsilon_{satc}. \quad (1)$$

Here, $\beta_t$ are a set of fixed effects for years, $\gamma_a$ are age effects, and $\delta_c$ are birth cohort fixed effects (indexed by the year that the cohort turns 22). $\zeta_s$ represent state effects, while $\lambda(\cdot)$ is the inverse Mills function applied to the cell-level attainment rate, $p_{satc}$.

A normalization is required for the cohort, time, and age effects, as the three linear trends are not separately identified. I normalize the cohort effects for the 1991 and 2000 entry cohorts (born in 1969 and 1978, respectively) to be the same.

The primary coefficients of interest in (1) are the time effects $\beta_t$ and the cohort effects $\delta_c$. In particular, I am interested in the degree to which poor employment rates of young graduates following the 2007-9 Great Recession can be attributed to transitory demand shocks ($\beta_t$) versus permanent differences between the cohorts who turned 22 just before, during, or just after the Great Recession, and other cohorts facing the same demand conditions ($\delta_c$). To avoid confounding the age effects $\gamma_a$ with the experience of post-recession cohorts, in my preferred specifications I estimate (1) using data only on cohorts entering the market in 2000 and earlier, then hold the $\beta_t$ and $\gamma_a$ vectors fixed and extrapolate the $\delta_c$s for more recent birth cohorts. I obtain nearly identical results, however, when I simply estimate (1) on the entire sample.

The solid line in Figure 2 shows the cohort effects from the basic specification, applied to college graduates and extrapolated from the pre-recession sample. Appendix Figures 6 and 7 show the age and time effects, respectively, while Appendix Figure 8 shows that cohort effects

are nearly identical when the full sample is used to estimate (1). In Figure 2, cohort effects are largely stable, declining slightly but smoothly, for the entry cohorts between 1975 and 2004. The overall slope is not identified, so the smooth decline could equally well be an increase. Regardless, there is a sharp downward turn for cohorts entering after about 2005; the *change* in slope is identified. The cumulative decline from the 2004 to the 2015 cohorts, relative to the slope between 1993 and 2004, is nearly five percentage points, with most of this decline occurring between 2006 and 2010. This echoes smaller declines in cohort effects seen in earlier recessions, but is much more dramatic.

Interestingly, while the decline in cohort effects seems to have flattened out around 2013, there is no indication that the post-2013 cohorts have recovered any of the lost ground. Despite entering a labor market that was much stronger than that faced by the cohorts entering in 2009-12, they continue to fare quite poorly relative to past cohorts observed at similar ages. By contrast, the pure time effects (Appendix Figure 7) had fully recovered their 2007 levels by 2014. In other words, the model indicates that the slow recovery of college graduates' employment (shown as the orange line in Appendix Figure 7) in 2011-6 is not evenly distributed, as might be expected if weak labor demand were the culprit, but is specific to younger cohorts. Somewhat older cohorts who were already established in the labor market by 2007 had fully recovered by 2013.

## B. Excess sensitivity and scarring

In the context of the model specified by equation (1), the decline in cohort effects seen in Figure 2 indicates that post-recession cohorts will have lower employment rates in every year of their careers than pre-recession cohorts, after adjusting for any differences in time effects. In other words, the recession has a large, permanent scarring effect, totaling four to five percentage points, on the post-recession cohorts' annual employment rates.

However, equation (1) is does not allow for two alternative explanations that would point to rosier futures. First, young people's employment is more cyclically sensitive than that of older people. Because the post-recession cohorts are observed only at young ages, and primarily at times when the unemployment rate is high, their estimated cohort effects may be depressed by the omission of age-unemployment interactions from (1).

To address this, I create a sequence of age indicators $g_j(a)$, j=1,…5, where $g_1(a)$ is an indicator for ages 22-23, $g_2(a)$ for 24-25, $g_3(a)$ for 26-27, $g_4(a)$ for 28-29, and $g_5(a)$ for 30-31. I then control for interactions between these indicators and the contemporaneous unemployment rate, $UR_{st}$:

$$\begin{aligned} Y_{satc} \quad = \quad & \alpha + \beta_t + \gamma_a + \delta_c + \zeta_s + \rho\lambda(p_{satc}) \\ & + \textstyle\sum_{j=1}^{5} g_j(a) * UR_{st} * \theta_j + (UR_{st} - UR_t)\kappa + \epsilon_{satc}. \end{aligned} \tag{2}$$

I also include a main effect for the deviation of the state unemployment rate from the national rate, $(UR_{st} - UR_t)$, to capture effects of economic conditions on those aged 32 and over.[4]

The estimated $\theta_j$s are plotted, with confidence intervals, in Figure 3A. They show the expected excess sensitivity: Employment of the youngest college graduates falls by about 0.4 percentage point for every 1.0 percentage point increase in the unemployment rate, but the effect declines roughly linearly with age.

A natural concern is that my approach of estimating (2) only on cohorts who entered the labor market before the recession means that I am extrapolating the effects of early-career unemployment from cycles with much lower unemployment rates. The dots in Figure 3A show the estimates when I use the full sample. These indicate somewhat more excess sensitivity of young graduates, but are generally similar. Evidently the extrapolation works fairly well.

The short dashed line in Figure 2 shows the estimated cohort effects from specification (2). The adjustment makes only a modest difference, with slightly better cohort effects for the 2001 to 2011 entry cohorts. There is no effect at all on the most recent cohorts – not surprising, since the unemployment rate has not been elevated during most of their time in the market.

Overall, this specification does not indicate that the apparent downturn in cohort effects in the base specification was an artifact of failing to allow for excess sensitivity of younger workers to economic conditions. The adjusted cohort effect series shows essentially the same decline between the pre- and post-recession cohorts as in the base specification.

A second explanation for the apparent decline in cohort effects is that the recession cohorts may have been scarred by their initial experiences, but that scarring effect will fade away quickly as they gain experience. This would be consistent with many of the estimates in the scarring literature, which show effects that fade out over the first ten years of workers' careers. Because the post-recession cohorts are observed only at young ages, the estimated cohort effects from specification (1) will reflect the early-career impacts of elevated unemployment in 2007-2015, and may overstate the permanent damage to the post-recession cohorts.

Again, I address this by including terms in the decomposition that allow for gradual fade-out of the effects of entry conditions. The specification is identical to (2), but replaces the contemporaneous unemployment rate $UR_{st}$ with the unemployment rate at labor market entry (i.e., at age 22), $UR_{sc}$:

$$\begin{aligned} Y_{satc} \quad = \quad & \alpha + \beta_t + \gamma_a + \delta_c + \zeta_s + \rho\lambda(p_{satc}) \\ & + \textstyle\sum_{j=1}^{5} g_j(a) * UR_{sc} * \varphi_j + (UR_{sc} - UR_c)\kappa + \epsilon_{satc}. \end{aligned} \tag{2}$$

[4] The $\theta_j$ coefficients are interpreted as the effect of the state unemployment rate on those from age group j, relative to its effect on those over 32. Although the unemployment rate main effect is specified as the deviation of the state from the national rate, the time effects $\beta_t$ capture any effect of the national unemployment rate on those aged 32 and older.

The $\varphi_j$ terms represent age-cohort-state interactions.[5] Thus, this model has two ways that economic conditions in the first year of the career can have persistent effects: They can have medium-term consequences through the $\varphi_j$ coefficients, and they can have permanent consequences via the cohort coefficients $\delta_c$.

Figure 3B shows the estimated $\varphi_j$ coefficients. We see strong effects of initial conditions on early career employment, fading out over about five years.[6] Again, these are slightly larger but basically similar when I include the post-recession cohorts in the sample as when I extrapolate from earlier cohorts, indicating that nonlinearity in the unemployment rate effect is not a major source of bias.

The cohort effects from this specification, plotted as long dashed lines in Figure 2, show a notably smaller decline – though still a quantitatively important one – in the period surrounding the Great Recession than in the two prior specifications. This indicates that the earlier failure to account for potential fade-out of the effects of the entry unemployment rate may have led me to overstate the sensitivity of permanent cohort effects with respect to entry conditions. In the adjusted series, there is still a sharp change in the series around the 2005 cohort, but the subsequent decline is more gradual and linear. The decline from 2006-2010 is only ##% as large as in the baseline specification.

### C. Cyclicality of estimated cohort effects

Inspection of Figure 2 shows that cohort effects tend to decline for cohorts that enter the labor market during recessions, whether or not I adjust for excess sensitivity or medium-term scarring. To quantify this, in Table 1, Columns 1-3, I show time series regressions of the three sets of cohort effects on the national unemployment rate when the cohort was 22, controlling for a quadratic time trend (which absorbs the normalization of the cohort effects) and allowing for an autoregressive error term. The sample for these regressions is the time series of estimated cohort effects for the entry cohorts of ## through ## (born in ## through ##). In the initial decomposition, the estimated unemployment rate coefficient is -0.29, indicating that each 1 percentage point increase in the unemployment rate at the time of labor market entry permanently lowers the employment rate of college graduates in a cohort by almost one-third

[5] As before, I omit an interaction with the indicator for those aged 32 and above, and I include a main effect for the unemployment rate at cohort entry, deviated from the national rate in that year. This ensures that any permanent effect of the national unemployment rate at entry is captured by the $\delta_c$ cohort effects.

[6] There is no indication that unemployment at labor market entry is associated with employment probabilities for those in their late 20s, relative to those for older workers. It is possible that the later-age scarring coefficients are attenuated due to mobility, as I measure $UR_{sc}$ based on the state of current residence, which may not be where the individual lived at age 22. This would imply that the $\varphi_j$ coefficients primarily reflect the influence of the national unemployment rate at entry. von Wachter and Heisz (forthcoming) find little indication that cross-state mobility it biases scarring coefficients like $\varphi_j$.

percentage point. This declines to -0.19 when the specification allows for excess sensitivity and to -0.13 when it allows for fadeout of early-career scarring effects. Column 4 presents results that allow for both excess sensitivity and early-career scarring (not shown in Figure 2). These are similar to those in column 3. About half of the apparent permanent effect of recessions on new graduates' employment from (1) operates through the semi-permanent channel of the $\varphi_j$ coefficients, not through permanent effects on $\delta_c$. Nevertheless, the permanent component remains quantitatively important.

### D. Earnings and wages

The analysis thus far has examined employment rates as the outcome. I have also conducted parallel analyses for log annual earnings, among those with positive employment during the year, and for log hourly wages, among those with positive employment in the reference week. Cohort effects (shown in Appendix Figures 9 and 11) are not as dramatically related to entry conditions for either of these outcomes, in large part because they recovered very quickly for the post-Great Recession cohorts even though unemployment remained high. I find little evidence of excess sensitivity or scarring effects on younger workers' hourly wages (Appendix Figure 10), but somewhat more evidence for annual earnings (Appendix Figure 12). When I relate cohort effects in wages and earnings to the unemployment rate at entry, in the lower rows of Table 1, I find that the covariance is minimal when log wages are the outcome, but larger when it is log annual earnings. Both coefficients become more positive when I augment the basic decomposition (1) with age-unemployment (excess sensitivity) or age-initial unemployment (semi-permanent scarring) interactions. Cohort effects on earnings remain procyclical even when medium-term scarring is allowed (though this is not statistically significant). By contrast, cohort effects on log wages are if anything positively related to the unemployment rate (again insignificant). There is no indication of meaningful scarring effects on wages, and only weak evidence that recessions have permanent effects on entrants' log earnings (conditional on work) more than a few years after labor market entry.

### E. Non-college workers

The right-hand columns of Table 1 show results for non-college workers, relating cohort effects on employment, wages, and earnings to the unemployment rate when they were 18 years old. Cohort employment is much less cyclically sensitive for non-college workers, though inspection of the data (Appendix Figure #) indicates that this may be because the downward secular trend is so pronounced for these workers in the last two decades that it is difficult to disentangle business cycle effects. There is similarly little evidence that either hourly wages or annual earnings, each conditional on employment, are sensitive to starting conditions for non-college workers. Indeed, coefficients on the entering unemployment rate are positive and statistically significant for both wages and earnings once excess sensitivity and semi-permanent scarring are accounted for. Thus, the results indicate that cohorts that enter the market during recessions have lower wages and earnings for the first several years of their careers than do those entering at low-unemployment times (consistent with Schwandt and von Wachter,

forthcoming), but that in the long run their wages and earnings are all higher. This result has not been highlighted in earlier scarring studies, and calls for further investigation.

## F. Measuring the shadow cast by the Great Recession

The results in Table 1 indicate that recessions have hangover effects on college graduates' employment rates. I use the employment results to measure the relative magnitude of medium- and long-run effects of the Great Recession, comparing them to the short-run effects. I use for this the specification that includes temporary early-career effects of initial economic conditions, equation (3).

To explicate the magnitude of the estimated effects, I simulate the employment rates of college graduates under two scenarios. In both scenarios, I abstract from demographic considerations by assuming that all birth cohorts have the same number of college graduates, all graduates finish college by 22, and all retire at 65 (with no mortality before that). In my first scenario, capturing the effects of the Great Recession, I use the actual estimated year effects $\beta_t$ and cohort effects $\delta_c$. To forecast the future, I assume that the year effects revert to their 2005-2007 average in 2015-2060, while the cohort effects revert to their average for the 2005-7 entry cohorts for all cohorts entering after 2014. My second scenario is a counterfactual, representing a world in which the Great Recession did not happen. In this scenario, I use the empirical estimates only through 2007. Thereafter, I assume that year effects were constant from 2008 onward, at their 2005-2007 average, and that cohort effects were constant from the 2008 cohort onward, at their 2005-7 average.

The first panel of Figure 4 shows average employment rates of college graduates, age 22-65, under the two scenarios. Both are the same through 2007, declining in the 2001 recession and then recovering. In scenario 1 (labeled "observed"), employment plummets in the Great Recession, then recovers about half of the loss. Beginning in 2015, it begins slowly trending downward. This reflects my assumption that future cohorts will resemble the ones that entered in 2005-2007. These cohorts have lower employment rates than earlier cohorts, so as the pre-2005 cohorts gradually retire the labor force average trends downward.

The second series in Figure 4, panel A shows the counterfactual scenario 2. Here, there is no Great Recession. We see the same gradual decline from 2015 onward as in scenario 1, but from a higher level. The two series move in parallel from 2015 through the mid-2050s, when the cohorts that entered following the Great Recession will retire, and then finally converge. Integrating the difference between them, we find that the recession reduced the employment of college graduates by a cumulative 16.6 percentage point-years, of which only 8.0 percentage points occurred during the downturn years, 2.7 percentage points will occur between 2015 and 2025, and 5.9 percentage points will after 2025. The two latter portions represent the shadow of the recession, and are in combination larger than the immediate effect.

There are three components to the recession effect indicated in panel A, reflecting the three time-varying terms in equation (3). These are shown separately in panels B, C, and D of Figure 4. Panel B shows the pure year effects $\beta_t$. These are the short-term direct effects of the recession,

which are common to all participants in the labor market at the same time but do not persist after it ends. By construction, these are stable after 2014. The integrated gap between the two series here is 6.4: The recession caused the employment rate of college graduates to fall by 6.4 percentage point-years between 2008 and 2014.

Panel C shows the medium-term scarring effects, represented by the coefficients $\phi_j$ in (3). These are specified to last beyond the initial shock for those cohorts that were exposed to it at labor market entry, but to fade out within ten years. To translate these into effects on the overall labor market at a point in time, I average $\sum_j g_j(a) * UR_{sc} * \varphi_j$ over all cohorts in the labor market in that year. These averages are graphed in Figure 4, Panel C. Because the scarring effects fade out quickly, the gap between the two scenarios, never large to begin with, nearly disappears by 2020. Cumulatively, scarring effects reduce employment by 1.9 percentage point-years, a bit less than one-third as large in total as the short-term effect. Over half of this occurred during the extended downturn itself, so the hangover after the shock is assumed to have ended cumulates to only 0.9 percentage point-years.

Panel D shows the long-run effects, captured by the cohort coefficients $\delta_c$. These are averaged over all cohorts in the labor market at any point in time. They decline steadily in both scenarios over the entire period, due to the composition effect mentioned above. But there is a gap between the two scenarios over the duration of the careers of the 2008-2014 entry cohorts. The gap is small at any point in time, but it integrates to a total of 8.3: The permanent effects of the recession on those who entered the labor market during it have a cumulative effect over a 40+ year period that is almost one-third larger than the short-term effect.[7]

DeLong and Summers (2012) define a hysteresis parameter $\eta$, representing the permanent decline in future output per unit cyclical reduction in current output. Summarizing the results from Figure 4, I estimate that the immediate effect of the Great Recession was to reduce employment of college graduates by 6.4 percentage point-years, and that this led to medium-term temporary scarring effects cumulating to 1.9 percentage point-years and long-term declines in cohort effects cumulating to 8.3 percentage point-years. Assuming that these are spread evenly across 5 and 43 years, respectively, and using a real discount rate of 2.5%, these are equivalent in present value terms to a constant, permanent reduction in employment of 0.17 percentage points, or to $\eta$ =0.17/6.4=0.027. With a higher discount rate of 5% or 10%, $\eta$ rises to 0.039 or 0.052, respectively. These are at the low end of DeLong and Summers' (2012) posited range of $\eta \in (0, 0.2)$, though still large enough to be quantitatively important in their analysis. Moreover, these capture only a single, limited source of hysteresis: My specification does not capture any persistent effects of a recession on any workers who were already in the labor market when the recession began, nor any increased scarring when high unemployment

[7] Because the downturn lasted for so long, a portion of the permanent scarring effect (0.5 percentage point-years) occurred before the downturn had ended, as the damage inflicted on cohorts that entered at the beginning manifested in lower employment for those cohorts later. This is counted as part of the immediate damage in the overall decomposition above.

at a cohort's entry persists for the first several years in the market. Moreover, I do not examine potential non-labor-side channels for hysteresis.

## VI. Conclusion

Cyclical downturns can have long-run effects on economic outcomes due to scarring and hysteresis effects. This could perhaps explain why the 2018 U.S. economy is simultaneously characterized by historically low unemployment and an unimpressive employment-population ratio, particularly for young college graduates. If true, it has important consequences for assessing the economic cost of cyclical volatility.

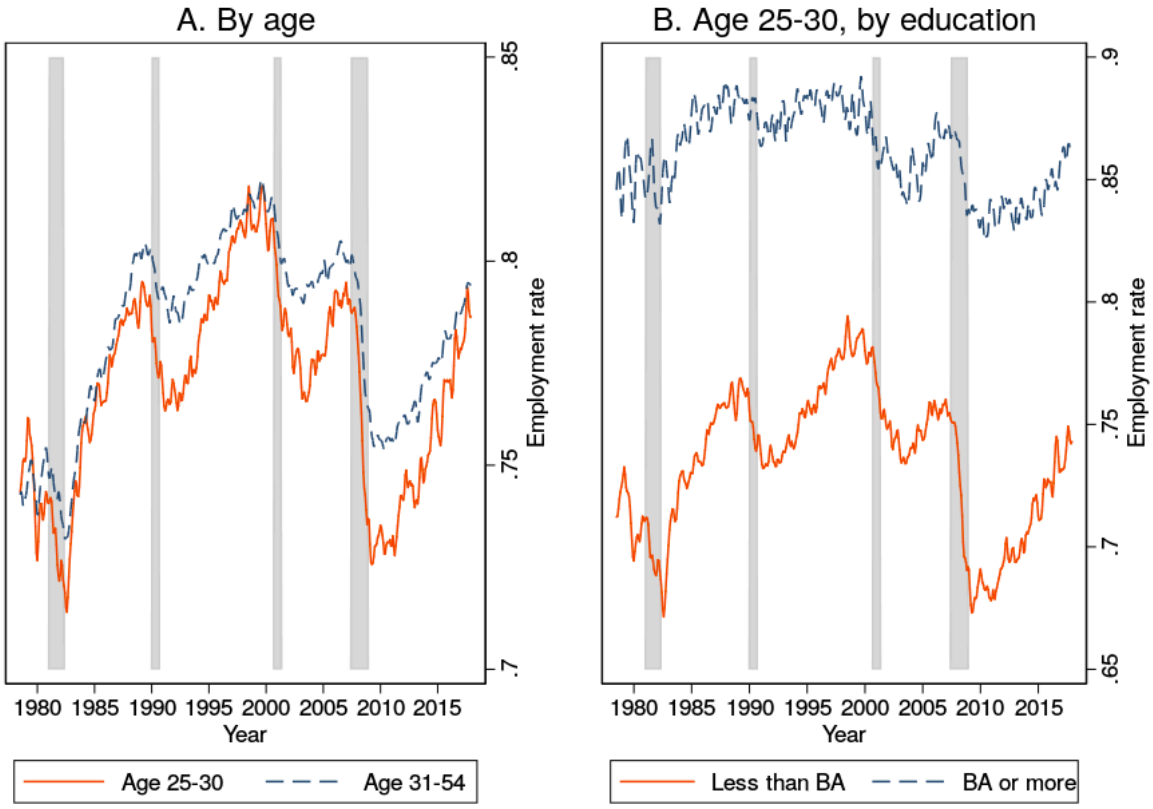
My analysis of college graduates' employment rates indicates that they are modestly sensitive to the economic conditions that prevailed at the time that the graduates entered the labor market. Cohorts that graduate during recessions have lower employment rates even after the recession is past.

Past research has indicated that this hangover effect is largely temporary, generally evaporating within the first ten years after graduation. However, the experience of the cohorts that graduated college during and after the Great Recession has not been consistent with that past pattern: Their employment rates have recovered from the initial insult much more slowly than would be predicted, given the now extended period of low unemployment that we have experienced since 2015. Although there will be no way to know for sure until these cohorts complete their careers, the evidence to date points to apparently permanent negative effects. These permanent negative effects are concentrated on the employment margin, with some effect as well on log annual earnings, and among college graduates.

In a simulation exercise, I demonstrate the magnitude of these long-run effects. I find that the employment losses for new graduates during the Recession are meaningfully smaller than the cumulative employment losses that those graduates will experience during the subsequent decades due to scars incurred. If this prediction comes to pass, it will imply that hysteresis is an important component of the welfare evaluation of cyclical variation in economic conditions, and will support stronger counter-cyclical policies aimed at reducing scarring by minimizing the initial shock.

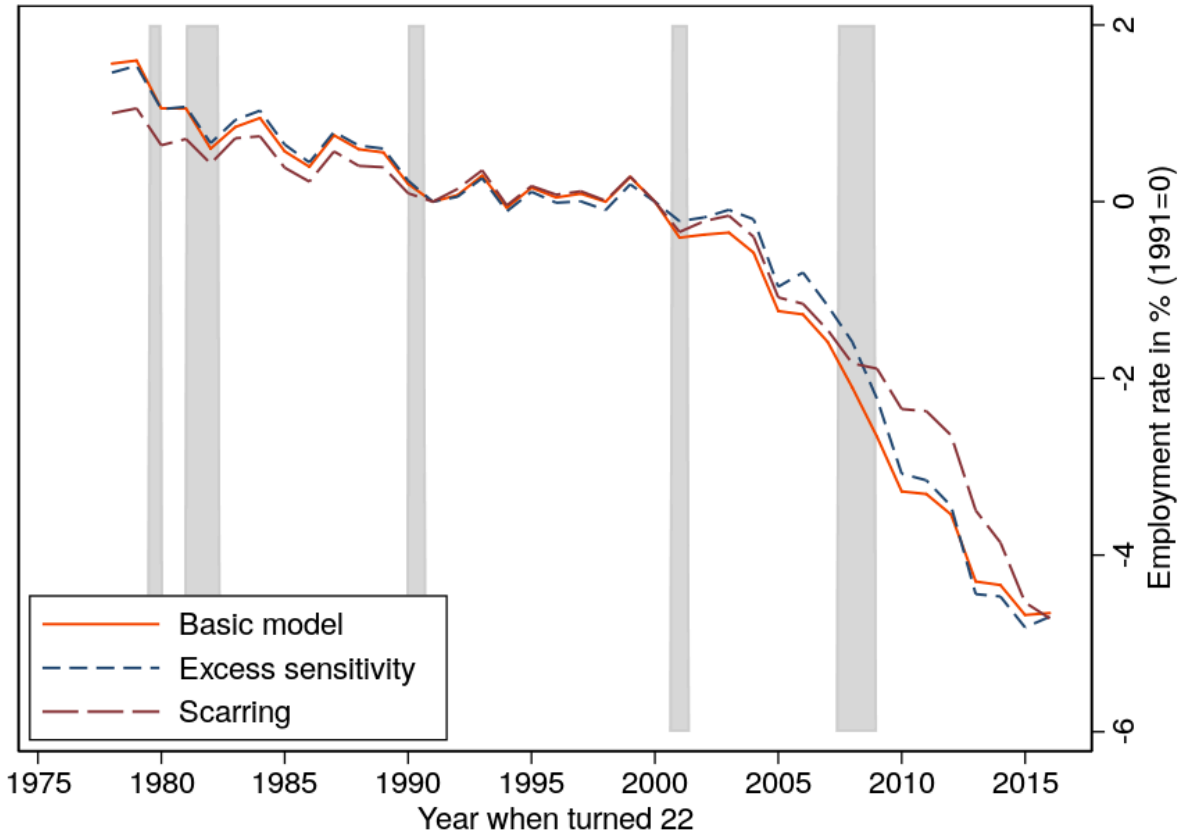
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Figure 1. Employment rates, by age and education, 1979-2018



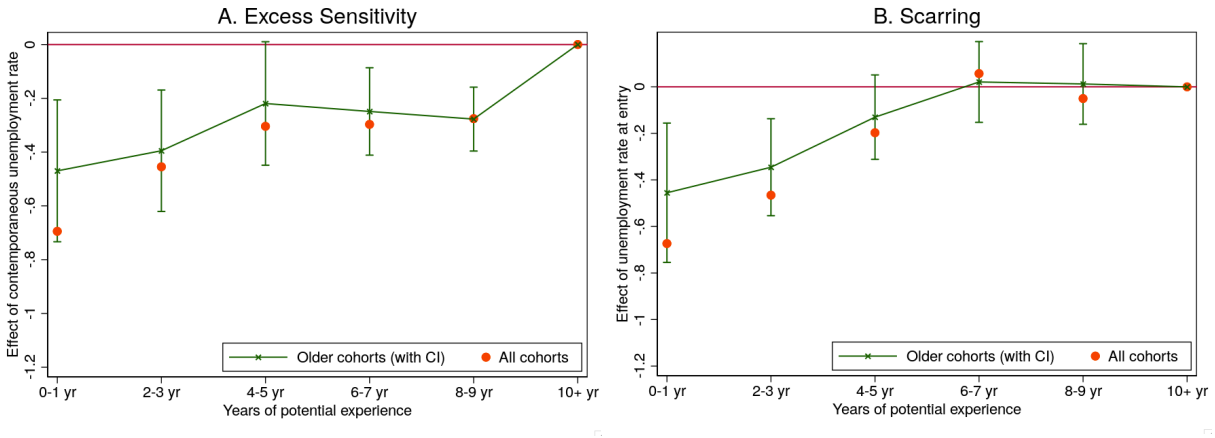

Notes: Prior week employment rates, computed from monthly Current Population Survey data, are seasonally adjusted and smoothed using a 3-month triangle smoother.

Figure 2. Cohort effects on employment rates of college graduates aged 22-40



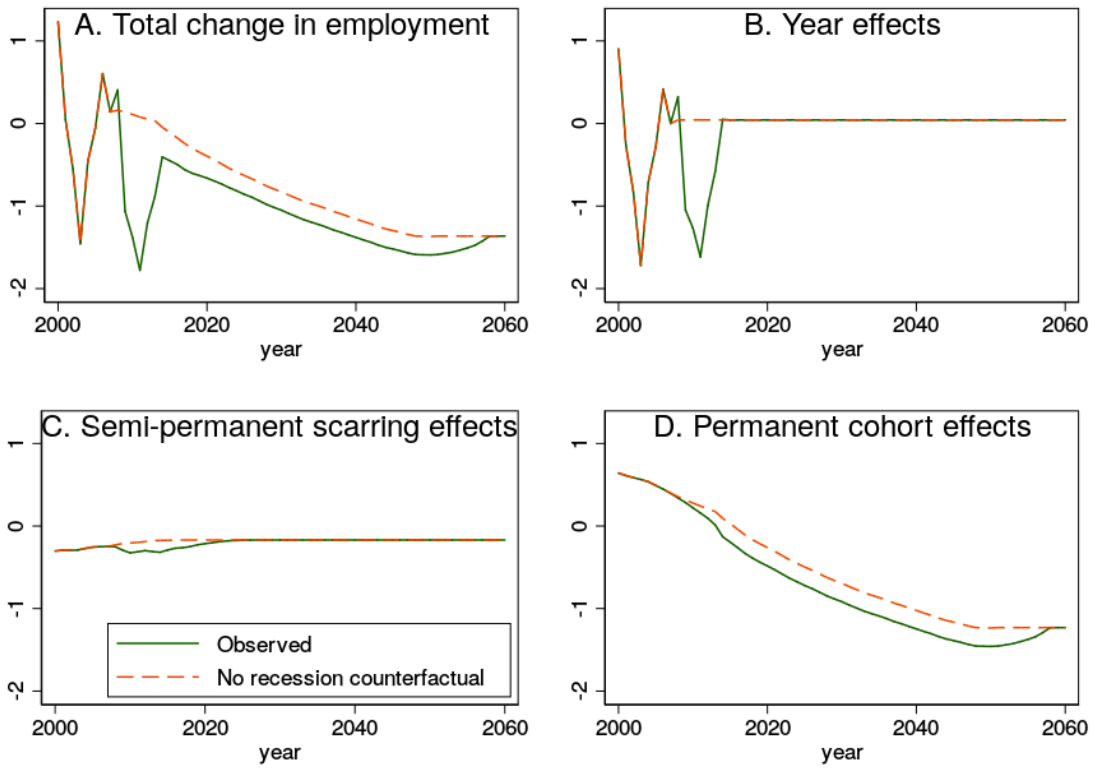

Notes: Prior-week employment rates are estimated from the monthly Current Population Survey and aggregated to the education-cohort-age-year-state cell. Sample consists of college graduates age 22-40 observed in ## to ##. Cohorts are indexed by the year they turned 22. Specifications correspond to equations (1), (2), and (3), respectively, and include age, year, and state fixed effects, plus an inverse Mills ratio in the cohort-by-year college attainment rate. Cohort effects are normalized to zero for the 1991 and 2000 entry cohorts.

Figure 3. Excess sensitivity and scarring coefficients from augmented age-time-cohort decompositions of college graduate employment rates




Notes: See notes to Figure 2. Panel A shows coefficients and confidence intervals for $\theta_j$ coefficients, reflecting current unemployment rate-age interactions, from equation (2); panel B shows $\varphi_j$ coefficients, reflecting entry unemployment rate-age interactions, from equation (3). Connected series and confidence interval correspond to estimates using 1974-2000 entry cohorts, while dots correspond to estimates using all entry cohorts through 2017.

Figure 4. Decomposition of the long-run effect of the Great Recession on the employment rate of college graduates




Notes: See text for details. Estimates are based on the specification plotted in Figures 2 ("scarring" series), 3B, and Appendix Figures 6 and 7

Table 1. Time series regressions of cohort effects on the national unemployment rate in the year the cohort entered the labor market

| Table 1. Time series regressions of cohort effects on national unemployment rate at entry | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | College graduates | | | | Non-college | | | |
| Employment | | | | | | | | |
| UR at entry | -0.29 | -0.19 | -0.13 | -0.12 | -0.06 | 0.08 | 0.10 | 0.16 |
| | (0.04) | (0.06) | (0.05) | (0.06) | (0.05) | (0.08) | (0.06) | (0.09) |
| Cohort effect model controls for | | | | | | | | |
| Excess sensitivity | | Y | | Y | | Y | | Y |
| Semi-permanent scarring | | | Y | Y | | | Y | Y |
| Log real hourly wages | | | | | | | | |
| UR at entry (*100) | -0.03 | 0.05 | 0.21 | 0.25 | -0.07 | 0.13 | 0.36 | 0.42 |
| | (0.20) | (0.20) | (0.20) | (0.20) | (0.17) | (0.13) | (0.14) | (0.12) |
| Log real annual earnings | | | | | | | | |
| UR at entry (*100) | -0.96 | -0.63 | -0.66 | -0.60 | -0.33 | 0.28 | 0.39 | 0.62 |
| | (0.43) | (0.39) | (0.40) | (0.39) | (0.26) | (0.20) | (0.20) | (0.18) |

Notes: Each entry corresponds to a separate regression of estimated cohort effects on the unemployment rate in the year the cohort entered the labor market, with a quadratic calendar year control and Newey-West standard errors allowing for autocorrelations at lags up to three years. Cohort effects in columns 1-3 are estimated using equations (1), (2), and (3), respectively. In column 4, the specification combines (2) and (3), with controls for both $UR_{st}$-age and $UR_{sc}$-age interactions. The same specifications are repeated in columns 5-8, using cohort effects on non-college-graduates' outcomes and the unemployment rate when the cohort was 18 as the entry condition. Lower rows show estimates for cohort effects on log hourly wages among those employed, from the CPS Outgoing Rotation Groups, and on log annual earnings among those with positive annual employment, from the March CPS.