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**Graduates in a Cycle: The Effect  
of Business Cycle Trajectories on Labor  
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# Graduates in a Cycle: The Effect of Business Cycle Trajectories on Labor Market Outcomes of College Graduates

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## Abstract

I re-evaluate the long-term effects of graduating from college during a recession by focusing on entire business cycle trajectories, as opposed to unemployment at graduation. Using CPS data from 1976-2024, I suggest that the persistent gap in earnings between those graduating during high versus low unemployment chiefly corresponds to the effects of unemployment at graduation on graduates of lower GPA, SAT scores and socio-economic background who enrolled in lower-tier colleges because unemployment was high at the time of their high-school graduation. While the scarring effects of graduating during a recession are large and last for over a decade for these marginal graduates, the scarring effects are smaller than previously thought and fade within three years for student cohorts enrolling in college in a low-unemployment labor market. I also show that adverse labor market conditions beyond the year of college graduation exert a stronger influence on long-term outcomes of graduates than the unemployment rate at graduation. Following unemployment trajectories and accounting for selective enrollment highlights the policy-relevant vulnerability of marginal graduates to recessions.

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# 1 Introduction

Business cycle fluctuations play an important role in shaping individuals' labor market trajectories. New labor market entrants, particularly recent graduates, are likely to be especially vulnerable during recessions due to their limited experience and reduced job opportunities. A large body of research documents the persistent negative impact of graduating during a recession (when unemployment rates are high) on earnings of recent graduates (Schwandt and Von Wachter, 2019; Altonji et al., 2016; Oreopoulos et al., 2012; Davis and Von Wachter, 2011; Kahn, 2010). There is also research on the effect of unemployment on college entry (e.g. Betts and McFarland (1995); Sievertsen (2016)) and major choice (Blom et al., 2021)

However, existing studies typically focus on economic conditions at a single point in time (college entry, major choice, or graduation) as opposed to the broader *trajectory* of the labor market conditions that connects these points. By focusing narrowly, prior work risks overlooking the relevant economic context that drives the effect of recessions on future labor market outcomes. For example, two cohorts that graduate from college at the same unemployment rate, one just before and one just after a recession, are often treated as equivalent, even though their post-graduation labor market trajectories differ substantially.

This paper shows that understanding these trajectories is crucial for assessing the true costs of recessions and for designing policies to support young labor market entrants. I provide a new perspective on how macroeconomic conditions at college entry, college graduation, and the first few years in the labor market shape long-term career outcomes of college graduates. I argue that due to the typical unemployment trajectories the conventional focus on graduation-year conditions effectively combines two distinct mechanisms: (1) the persistent effect of adverse post-graduation labor markets, and (2) shifts in the composition of graduates due to higher college enrollment during economic downturns.

The first mechanism relates to job matching and career progression. Weak labor markets limit early-career mobility, slowing skill acquisition and wage growth. While young workers are generally mobile and able to recover from poor initial matches (Topel and Ward, 1992), recessions constrain transitions to better jobs, delaying human capital accumulation and reducing earnings (Acabbi et al., 2022). They also diminish promotion opportunities within firms (Devereux, 2002; Moscarini and Thomsson, 2007) and raise the risk and cost of layoffs

(Schmieder et al., 2023). Therefore, even for cohorts graduating under similar conditions, differences in subsequent labor market trajectories can generate very different long-term outcomes – an underexplored dimension in the literature.

The second mechanism arises from selective college enrollment during downturns. A large literature (Betts and McFarland, 1995; Dellas and Sakellaris, 2003; Clark, 2011; Barr and Turner, 2013, 2015; Sievertsen, 2016; Charles et al., 2018) shows that individuals are more likely to enroll in college during recessions. As a result, cohorts graduating at similar unemployment rates may differ in composition depending on demand conditions at entry. College enrollees during recessions may differ systematically from those who enroll in stronger labor markets in ability, motivation, or risk tolerance. At the same time, there is evidence that college graduates from less disadvantaged backgrounds have a more difficult time adjusting to the labor market (Scott-Clayton et al., 2025). Given the autocorrelation of unemployment over the business cycle, outcomes attributed to graduation-year conditions may in fact reflect this selection mechanism.

Using data from the Current Population Survey (CPS) March Supplement, covering cohorts graduating between 1976 and 2019, I construct a comprehensive picture of early-career exposure to economic shocks. By modeling labor market conditions during early career years, and accounting for selective college enrollment during recessions, this paper advances our understanding of how business cycles shape wage trajectories beyond the point of labor market entry.

To guide the analysis, I propose a conceptual framework linking labor market conditions at these three stages to eventual cohort wage trajectories, where cohorts differ in their share of high- and low-type individuals. Three predictions follow. First, high unemployment at college entry induces more low-type individuals to enroll in college, lowering the average cohort's wage at graduation. Second, graduating in a downturn has a negative effect operating through (i) cohort composition, (ii) the dependence of subsequent wages on prior-period wages, and (iii) post-graduation unemployment. This suggests that what is often interpreted as a graduation-year effect may instead reflect entry or early-career post-graduation conditions. Third, weak post-graduation labor markets exert strong negative effects on cohort wages, with the magnitude depending on cohort composition.

My empirical analysis begins by replicating the analysis of Altonji et al. (2016) while ad-

addressing the possibility of selection at college entry. I split the sample into cohorts that began college during periods of high versus low unemployment, using a detrended national unemployment rate. Cohorts that began college in weaker labor markets<sup>1</sup> may include individuals induced into college by downturns, while those starting in stronger markets are likely to have better unobservable characteristics on average. Importantly, within the latter group, variation in graduation conditions (e.g. the severe recessions of 1981-82 and 2008-09, the mild 2001 recession, and the expansion of the late 1990s) allows me to compare cohorts graduating into weak versus strong labor markets without restricting the analysis to only “bad times.” A similar logic applies to the former group: while students who enrolled during the brief 1981-82 downturn entered a favorable labor market upon graduation, those who enrolled during the Great Recession faced a slow recovery and consequently entered weaker labor markets. This variation enables meaningful comparisons across cohorts defined by both enrollment and graduation conditions.

Splitting the sample by enrollment conditions confirms the importance of selection. Among individuals who began college during low unemployment, I find no long-term effect of elevated unemployment at graduation on earnings: a 1 p.p. increase reduces initial earnings by 1.7% and wages by 0.9%, but these effects fade within three years after graduation. In contrast, for those who enrolled during recessions, the same demand shock produces large, persistent effects: a 1 p.p. increase in the graduation unemployment rate reduces earnings and wages by 2.8% and 1.4%, respectively, with effects lasting more than a decade. To compare these results with the literature, a 4-5 p.p. increase in the unemployment rate (as in a major recession) implies initial losses of roughly 12-15% for cohorts who both enrolled and graduated in bad times, compared to those who enrolled during recessions but graduated when the labor market was recovering. These effects are larger than the average estimates in [Altonji et al. \(2016\)](#), who find 8-10% initial earnings losses. The cohorts who enrolled in good times but graduated in bad times experience 6-8% of initial losses compared to the cohorts who enrolled and graduated in good times which is smaller than the effect documented in the literature.

Next, I extend the analysis by incorporating post-graduation conditions. I first construct an accumulated unemployment rate, defined as the sum of unemployment rates in the graduation year and the two subsequent years, to capture overall exposure to weak labor markets

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<sup>1</sup>I define the labor market as weak if the detrended unemployment rate exceeds 0.1%, the sample average.

in the beginning of the career. I also compute the average unemployment rate in the first two years after graduation and include it alongside the graduation rate to isolate post-graduation effects. These refinements capture variation in the speed of recovery (or decline) that earlier models (Kahn, 2010; Altonji et al., 2016; Schwandt and Von Wachter, 2019) do not study.

Post-graduation economic conditions have a significant negative effect on labor market outcomes. The point estimates suggest that the accumulated unemployment rate has a larger impact on individuals who enrolled during recessions: a 6 percentage point increase in the accumulated rate reduces earnings by 6.6% for this group three years after graduation, compared to 3% for those who enrolled under favorable economic conditions. However, the difference in effects between the two groups are not statistically significant. Moreover, when post-graduation unemployment is included separately from the unemployment rate at graduation, the graduation-year rate becomes insignificant with the estimated effects remaining statistically indistinguishable across groups.

Finally, I estimate a Heckman selection model and find that the selection equation of college entry is significant. After controlling for the probability of being in the college-graduates sample, the estimated effects become similar in magnitude to those observed among cohorts who enrolled during good times, with similar persistence: the effect on earnings disappears after four years in the labor market, and the effect on wage rates disappears after five years.

These findings are consistent with the lower average quality of cohorts that entered college during recessions, as reflected in lower freshman GPAs, lower SAT scores among college-bound seniors, increased enrollment in lower-tier institutions, and a higher share of graduates from lower socioeconomic backgrounds, proxied by mothers' education. This pattern aligns with the greater sensitivity of college graduates from lower socioeconomic backgrounds to labor market conditions at the time of graduation (Scott-Clayton et al., 2025). Consistent with this interpretation, I find that the effect of adverse graduation-year conditions is significantly larger for graduates with low-educated mothers than for their more advantaged counterparts. Importantly, cohorts with a higher share of such "marginal" individuals do not typically enter the labor market at the worst point of the cycle (when the unemployment rate is at its peak) and their post-graduation conditions are, on average, better than those of individuals who enrolled during economic expansions, reinforcing their higher sensitivity to the labor market demand shocks.

This study builds on the extensive literature studying the long-term consequences of entering the labor market during economic downturns. Prior research has consistently found that cohorts graduating during recessions suffer persistent earnings losses, often taking 10–15 years to recover (Kahn (2010); Davis and Von Wachter (2011); Oreopoulos et al. (2012); Altonji et al. (2016); Schwandt and Von Wachter (2019)). The literature hypothesizes that the primary mechanism behind these effects is recession graduates being forced into lower-paying jobs, leading to weaker career progression and limited access to high-quality employers. My study contributes to this literature by showing that labor market conditions in the years following graduation significantly affect long-term earnings outcomes and that a cumulative measure of labor market conditions—such as the accumulated unemployment rate—provides a more informative predictor of long-term outcomes than the graduation-year unemployment rate alone.

This study also contributes to the broader literature on the importance of early-career conditions. Prior research has shown that early-career experiences have a long-lasting impact on earnings trajectories and that individuals who experience initial setbacks often struggle to recover (Gibbons and Waldman (2006); Wachter and Bender (2006); Arellano-Bover (2022, 2024)). Building on these studies, I consider the conditions of early labor market experiences from a macroeconomic trajectory perspective and contribute to this strand of research by demonstrating which effects adverse economic conditions have at the different points of the start of a career on long-term career outcomes.

Beyond labor market entry, my results speak to the persistence of macroeconomic shocks in shaping careers. Previous studies show that recessions have long-lasting effects on employment and wages even after recovery (Beaudry and DiNardo, 1991; Hagedorn and Manovskii, 2013; Fernald et al., 2017; Yagan, 2019; Huckfeldt, 2022; Schmieder et al., 2023; Rothstein, 2023). I show that for recession graduates, the speed and strength of recovery determine whether initial disadvantages persist or dissipate. This suggests that the long-term impact of recessions cannot be understood by looking only at whether individuals graduate during a downturn; the trajectory of the labor market before and after graduation is equally critical.

This paper aims to explore the effect of the whole trajectory of the business cycle rather than of one unemployment point at a time. I find that adverse post-graduation economic conditions significantly negatively affect earnings and wages. By accounting for selection into college, I show that the negative effect of graduating during a recession is concentrated among cohorts

that enrolled during periods of elevated unemployment. In contrast, those who began college under favorable conditions experience smaller, more transitory losses, suggesting meaningful differences in composition.

The paper is structured as follows. Section 2 introduces the theoretical framework. Section 3 describes the data. Section 4 outlines the empirical models. Section 5 provides the main results on how graduation unemployment rates and post-graduation conditions affect labor market outcomes by selection groups and Section 6 presents descriptive evidence on college selection. Section 7 concludes.

## 2 Conceptual Framework

I begin by presenting a stylized framework that links unemployment rates at different stages of a college graduate’s trajectory to long-run labor market outcomes. The purpose of the framework is not to fully model all choices and outcomes but to provide a simple structure that highlights the mechanisms through which cyclical conditions at enrollment, graduation, and the early career stages interact to shape cohort earnings. The framework guides the empirical analysis by clarifying what the main margins of interest are and how they can be interpreted.

### 2.1 Description

Consider a model with four periods, indexed by  $t = 0, 1, 2, 3$ , and two types of potential college students. High-type individuals ( $\theta = H$ ) have higher expected future wages, while low-type individuals ( $\theta = L$ ) have lower expected wages. Their population shares are  $\pi_H$  and  $\pi_L$ , with  $\pi_H + \pi_L = 1$  and  $\pi_\theta > 0$ . The timeline is depicted in Figure 1.

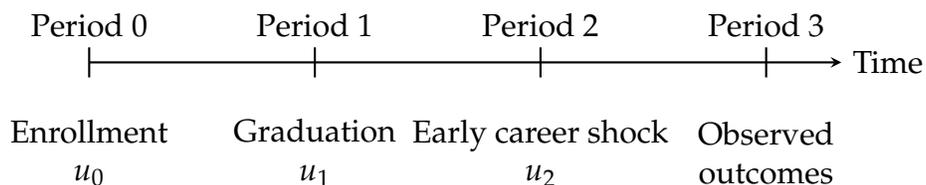


Figure 1: Timeline of model: enrollment, graduation, early career, and long-run outcomes.

#### **Period 0 (Enrollment decision):**

At  $t = 0$ , individuals decide whether to enroll in college. High-types always enroll. Low-types weigh enrollment against the outside option of entering the labor market immediately, which is less attractive when the contemporaneous unemployment rate  $u_0$  is high. Hence,

$$Pr(\text{College}) = \begin{cases} 1 & \text{if } \theta = H, \\ p(u_0) & \text{if } \theta = L, \quad p(u_0) \in [0, 1), \quad p'(u_0) > 0. \end{cases}$$

The share of low-type entrants among college students is:

$$s_L(u_0) = 1 - s_H(u_0) = \frac{\pi_L \times p(u_0)}{\pi_L \times p(u_0) + \pi_H}.$$

Since  $s'_L(u_0) > 0$ , recessions at enrollment increase the proportion of low-types in the college cohort.

### Period 1 (Graduation):

All enrolled students graduate and enter the labor market. For simplicity, I assume no dropout and no pursuit of postgraduate studies. Dropout behavior could respond to later improvements in labor markets, but recessions tend to be persistent, making this assumption reasonable.<sup>2</sup>

Wages depend negatively on the contemporaneous unemployment rate  $u_1$ , with stronger sensitivity for low-types:

$$\begin{aligned} w_1 &= f_1(u_1, \theta), \\ \frac{\partial f_1}{\partial u_1} &< 0 \quad \forall \theta, \\ \frac{\partial f_1(u_1, \theta_H)}{\partial u_1} &\geq \frac{\partial f_1(u_1, \theta_L)}{\partial u_1}, \\ w_{t,L} &< w_{t,H} \quad \forall u_t. \end{aligned}$$

Intuitively, both types suffer when graduation market conditions worsen, but low types incur larger scarring (as shown by [Scott-Clayton et al. \(2025\)](#)). The stronger sensitivity of low-type individuals to adverse labor market conditions can be understood through differences in network size and quality: low-types may have weaker access to professional and social

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<sup>2</sup>The main predictions are robust to relaxing the assumption.

connections that facilitate job finding, whereas high-types are more likely to be embedded in networks that buffer against recessionary shocks.<sup>3</sup>

**Period 2 (Early career shock):**

A new labor market shock occurs, reflected in unemployment rate  $u_2$ . This period corresponds to roughly 1–3 years after graduation. Wages depend non-negatively on initial wages (persistence/scarring) and negatively on  $u_2$ :

$$\begin{aligned} w_2 &= f_2(w_1, u_2) = f_2(f_1(u_1, \theta), u_2), \\ \frac{\partial f_2(w_1, u_2)}{\partial u_2} &< 0, \\ \frac{\partial f_2(w_1, u_2)}{\partial w_1} &\geq 0. \end{aligned}$$

The assumption  $\partial f_2/\partial w_1 \geq 0$  reflects persistence: early wages matter for later wages due to potentially limited job mobility and persistence of entry wages.

**Period 3 (Long-run outcomes):**

Expected cohort wages are a weighted average of type-specific outcomes:

$$E[w_3] = s_L(u_0)f_2(f_1(u_1, \theta_L), u_2) + s_H(u_0)f_2(f_1(u_1, \theta_H), u_2). \quad (1)$$

Finally, unemployment is persistent across adjacent periods in the sense that

$$\begin{aligned} \frac{\partial u_1}{\partial u_0} &\geq 0 \\ \frac{\partial u_2}{\partial u_1} &\geq 0 \\ \frac{\partial u_2}{\partial u_0} &= 0 \end{aligned} \quad (2)$$

The persistence between  $u_1$  and  $u_2$  reflects the well-documented autocorrelation of unemployment over short horizons. By contrast, the correlation between  $u_0$  and  $u_1$  is empirically weak, as these periods are separated by roughly four years of college, during which labor markets can undergo significant adjustments. I therefore assume  $\partial u_1/\partial u_0 \geq 0$  but likely close to zero. Finally,  $u_2$  and  $u_0$  are separated by about six years, making their correlation empirically

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<sup>3</sup>The importance of networks and social contacts for new labor market entrants, particularly during recessions, is documented by [Hensvik et al. \(2023\)](#).

negligible; hence  $\partial u_2 / \partial u_0 = 0$ . Importantly, the process is one-directional: past labor market conditions affect future ones, but not vice versa.

## 2.2 Predictions

I start with the most recent shock, the early-career unemployment rate,  $u_2$ . Since  $\frac{\partial f_2}{\partial u_2} < 0$  for both types, higher  $u_2$  lowers long-run wages:

$$\frac{dE[w_3]}{du_2} = s_L(u_0) \frac{\partial f_2(f_1(u_1, \theta_L), u_2)}{\partial u_2} + s_H(u_0) \frac{\partial f_2(f_1(u_1, \theta_H), u_2)}{\partial u_2} < 0 \quad (3)$$

This formula captures the *direct* effect of adverse early-career conditions: each graduate suffers a wage reduction, and the cohort loss is the weighted average of those damages. Two amplification channels are implicit. First, each derivative is evaluated at  $w_1$ , so if graduation unemployment already depressed initial wages, an additional rise in  $u_2$  falls on a lower baseline, producing larger losses. Second, if  $\frac{\partial f_2}{\partial u_2}$  itself depends on  $w_1$ , then cohorts scarred at graduation are disproportionately more vulnerable to early-career shocks.

Next, I consider the effect of unemployment rate at the time of graduation.

$$\begin{aligned} \frac{dE[w_3]}{du_1} &= s_L(u_0) \left( \frac{\partial f_2(f_1(u_1, \theta_L), u_2)}{\partial (f_1(u_1, \theta_L))} \frac{\partial f_1(u_1, \theta_L)}{\partial u_1} + \frac{\partial f_2(f_1(u_1, \theta_L), u_2)}{\partial u_2} \frac{\partial u_2}{\partial u_1} \right) \\ &+ s_H(u_0) \left( \frac{\partial f_2(f_1(u_1, \theta_H), u_2)}{\partial (f_1(u_1, \theta_H))} \frac{\partial f_1(u_1, \theta_H)}{\partial u_1} + \frac{\partial f_2(f_1(u_1, \theta_H), u_2)}{\partial u_2} \frac{\partial u_2}{\partial u_1} \right) \\ &= \sum_{i=L,H} s_i(u_0) \left( \underbrace{\frac{\partial f_2(f_1(u_1, \theta_i), u_2)}{\partial (f_1(u_1, \theta_i))}}_{\text{Propagation}} \underbrace{\frac{\partial f_1(u_1, \theta_i)}{\partial u_1}}_{\text{Sensitivity}} + \underbrace{\frac{\partial f_2(f_1(u_1, \theta_i), u_2)}{\partial u_2}}_{\text{Sensitivity}} \underbrace{\frac{\partial u_2}{\partial u_1}}_{\text{Persistence}} \right) < 0 \end{aligned} \quad (4)$$

There are four main elasticities inside the brackets:  $\frac{\partial f_1(u_1, \theta_i)}{\partial u_1} < 0$  - sensitivity to condition at graduation;  $\frac{\partial f_2(f_1(u_1, \theta_i), u_2)}{\partial (f_1(u_1, \theta_i))} \geq 0$  - propagation of initial wages into later outcomes (“scarring”);  $\frac{\partial f_2(f_1(u_1, \theta_i), u_2)}{\partial u_2} < 0$  - sensitivity to early-career conditions, and  $\frac{\partial u_2}{\partial u_1}$  - persistence of unemployment rate between the periods (specifically, correlation between  $u_1$  and  $u_2$ ).

This expression contains two main channels. The first component of this expression (Propagation  $\times$  Sensitivity) is the canonical graduation scarring channel: higher  $u_1$  lowers the entry wage  $w_1 = f_1(u_1, \theta)$  and because the propagation channel is non-negative, this reduction translates into lower later pay. However, if wages in period 2 are not affected by wages in

period 1 (i.e.,  $\frac{\partial f_2(f_1(u_1, \theta))}{\partial (f_1(u_1, \theta))} = 0$ ), e.g. due to mass layoffs in period 2, this channel would turn to 0.

The second component (Sensitivity  $\times$  Persistence) is a persistence channel: if a worsening of labor market conditions at graduation makes the early-career market worse, then a part of the cost of higher  $u_1$  operates *indirectly* through a higher  $u_2$ , which further depresses  $w_2$ . This component is particularly important when wages in period 2 are only weakly responsive to period 1 wages. In such cases the persistence channel largely determines the total effect of graduation unemployment, and can dominate the longer-term scarring.

Because  $\frac{\partial f_1(u_1, L)}{\partial u_1}$  is larger in magnitude than  $\frac{\partial f_1(u_1, H)}{\partial u_1}$ , low-types are more strongly affected. Cohorts with higher  $s_L$  therefore suffer disproportionately from graduation recessions.

The distinction between two components matters for interpretation. If one estimates graduation effects without controlling for post-graduation labor-market conditions (i.e. omitting any measure of  $u_2$ ), the estimated coefficient on  $u_1$  reflects the *total* effect (direct scarring plus the component transmitted via  $u_2$ ). By contrast, including an explicit measure of early-career unemployment (for example the average unemployment rate *after* graduation) allows a decomposition in which the coefficient on  $u_1$  principally identifies the direct scarring channel, and the coefficient on average unemployment rate *after* graduation captures the marginal damage of  $u_2$ .

Finally, based on  $s'_L(u_0) > 0$ ,  $w_{t,L} < w_{t,H} \quad \forall u_t$  and the autocorrelation pattern of the unemployment rate, the model implies the following prediction about the effect of  $u_0$  on long-term wages:

$$\begin{aligned}
\frac{dE[w_3]}{du_0} &= \frac{\partial s_L(u_0)}{\partial u_0} \times w_{2,\theta_L} + s_L(u_0) \frac{\partial f_2(f_1(u_1, \theta_L), u_2)}{\partial f_1(u_1, \theta_L)} \frac{\partial f_1(u_1, \theta_L)}{\partial u_1} \frac{\partial u_1}{\partial u_0} \\
&+ \frac{\partial s_H(u_0)}{\partial u_0} \times w_{2,\theta_H} + s_H(u_0) \frac{\partial f_2(f_1(u_1, \theta_H), u_2)}{\partial f_1(u_1, \theta_H)} \frac{\partial f_1(u_1, \theta_H)}{\partial u_1} \frac{\partial u_1}{\partial u_0} \\
&= \sum_{i=L,H} \underbrace{\frac{\partial s_i(u_0)}{\partial u_0} \times w_{2,\theta_i} + s_i(u_0)}_{\text{Selection}} \underbrace{\frac{\partial f_2(f_1(u_1, \theta_i), u_2)}{\partial f_1(u_1, \theta_i)}}_{\text{Propagation}} \underbrace{\frac{\partial f_1(u_1, \theta_i)}{\partial u_1}}_{\text{Sensitivity}} \underbrace{\frac{\partial u_1}{\partial u_0}}_{\text{Persistence}} < 0
\end{aligned} \tag{5}$$

The first term is the pure composition effect: because  $s'_L(u_0) > 0$  and because  $f_2(f_1(u_1, \theta_L), u_2) < f_2(f_1(u_1, \theta_H), u_2)$ , higher enrollment unemployment mechanically raises the share of lower-payoff entrants and thereby reduces the cohort mean. The second term

captures the indirect scarring channel that operates if enrollment-period worsening spills into graduation ( $\frac{\partial u_1}{\partial u_0} > 0$ ): through this term higher  $u_0$  predicts higher  $u_1$ . Then, the subsequent reduction of entry wages and any induced worsening of the early-career market reduce each type-specific continuation payoff.

The autocorrelation between  $u_1$  and  $u_0$  is empirically close to zero (correlation coefficient is 0.15), which makes the whole second term become insignificant. Overall, this implies that the main impact of the unemployment rate at college enrollment on the cohort's wage is due to the selection mechanism. This has an important implication in terms of my empirical strategy: I therefore split the sample by  $u_0$  and estimate the graduation and early-career regressions separately for high- $u_0$  and low- $u_0$  cohorts, in order to isolate whether compositional changes affect the magnitude of scarring. In addition, to purge the estimates of composition effects, I implement a Heckman correction, treating  $u_0$  as an exclusion variable due to low autocorrelation between  $u_1$  and  $u_0$ .

To sum up, the derivatives highlight how labor market conditions at different stages shape long-run outcomes through distinct channels. Early-career unemployment ( $u_2$ ) directly reduces wages, with larger effects when graduation wages are low. Graduation unemployment ( $u_1$ ) reduces long-run wages through both potential scarring and persistence, with stronger effects for low-types. Enrollment unemployment ( $u_0$ ) primarily affects outcomes through cohort composition, with limited persistence into graduation. These distinctions provide a clear mapping between theory and empirics: graduation and early-career unemployment act as wage shifters, while enrollment unemployment operates mainly as a selection mechanism.

### 3 Data

This section describes the individual-level and macroeconomic data used in the analysis and the construction of key cyclical exposure measures. The empirical analysis combines person-level observations from the Current Population Survey (CPS) with the state-level unemployment series from the Bureau of Labor Statistics (BLS).

### 3.1 Individual level

I use the Current Population Survey (CPS) March Supplement, which provides information on employment, earnings, and demographic characteristics, making it well-suited for analyzing the long-term effects of graduating during different phases of a business cycle. Because the CPS does not report graduation year directly, I follow the common approach in the literature and proxy the graduation year by the year in which a respondent with a bachelor's degree turns 22, the modal U.S. graduation age for four-year programs (Altonji et al., 2016). Similarly, the CPS does not record the state of graduation; I therefore assume that individuals graduated in the state in which they resided at the time of the interview.<sup>4</sup>

The sample is restricted to men with a bachelor's degree (or four years of college) and with 1–10 years of potential experience, where potential experience is measured as the difference between the survey year and the inferred graduation year (age – 22). I include only men in the sample because women exhibit different selection mechanisms, which I show in my companion paper. I include cohorts with inferred graduation years from 1976 through 2018 and exclude later cohorts due to sparse coverage. Consistent with common practice, I further restrict the earnings sample to observations with annual earnings above \$1,500 (in 2019 dollars). Nominal values are converted to real 2019 dollars using the CPI (BLS).

The main outcomes are: log annual earnings, log hourly wage, employment status, full-time employment (working at least 35 hours per week), log annual hours worked, and an occupation-based measure of job quality (occupation attainment). Table 1 reports summary statistics for the key variables. On average, men in the sample earn \$63,536 annually (2019 dollars). The log annual income averages 10.817 and the log hourly wage averages 3.216. Employment conditional on being in the labor force is very high (96.6%). To increase variation in the employment margin I therefore measure employment relative to the population (i.e., treating individuals out of the labor force as non-employed). Under this definition 90% of men are employed, which provides more informative cross-cohort variation for the analyses. The indicator for full-time work is defined conditional on being in the labor force and working at least 35 hours per week. It exhibits similar cross-sectional variation to the employment-population measure. Occupational attainment is constructed as the estimated return to the

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<sup>4</sup>It is a common assumption in the literature. However, Schwandt and Von Wachter (2019) while estimating the effect of unemployment rate at graduation for *all* labor market entrants account for the possibility of moving to another state and do not find any difference in the results with and without this correction.

Table 1: Summary Statistics

	Mean	St Dev	Min	Max
Annual Income (2019 \$)	63,536	55,098	1500	1,289,685
Log Annual Income	10.817	0.740	7.313	14.070
Log Hourly Wage	3.216	0.606	-0.672	10.210
Labor Force Participation	0.934	0.249	0	1
Share of Employed in Labor Force	0.965	0.183	0	1
Share of Employed in Population	0.901	0.298	0	1
Share of Full-time in Labor Force	0.902	0.298	0	1
Log Hours	7.734	0.796	1.386	10.858
Occupation Attainment	-0.103	0.315	-1.111	0.677
Potential experience	5.508	2.807	1	10
Observations	81,658			

Note: The primary sample consists of individuals with a Bachelor's degree or four years of college education, aged 23–32, with 1–10 years of potential experience and valid annual earnings observations (greater than \$1500 in 2019 dollars). Nominal earnings are converted to real 2019 dollars using the Consumer Price Index (CPI) from the Bureau of Labor Statistics (BLS). The reported number of observations corresponds to the Earnings Sample size. The wage is defined as annual earnings divided by number of hours worked in the previous year. Occupation Attainment is defined as the return to occupation an individual reports estimated on the sample of older workers (age 35–65). Potential experience is defined as years since graduation (age-22).

occupation an individual reports, where the occupation-specific returns are estimated on a separate sample of older workers (age 35–64) and assigned to each respondent. After applying all sample restrictions, the final earnings dataset contains 81,658 observations.

### 3.2 Labor Market Conditions

To measure economic conditions, I use unemployment rate data from the Bureau of Labor Statistics (BLS) at both the national and state levels. Figure 2 displays monthly national unemployment rates and unemployment rates for college graduates, calculated using the Monthly CPS. The figure shows that unemployment among college graduates follows the same trend as the overall unemployment rate, though with lower volatility. Gray-shaded areas mark recession periods as defined by the National Bureau of Economic Research (NBER).<sup>5</sup>

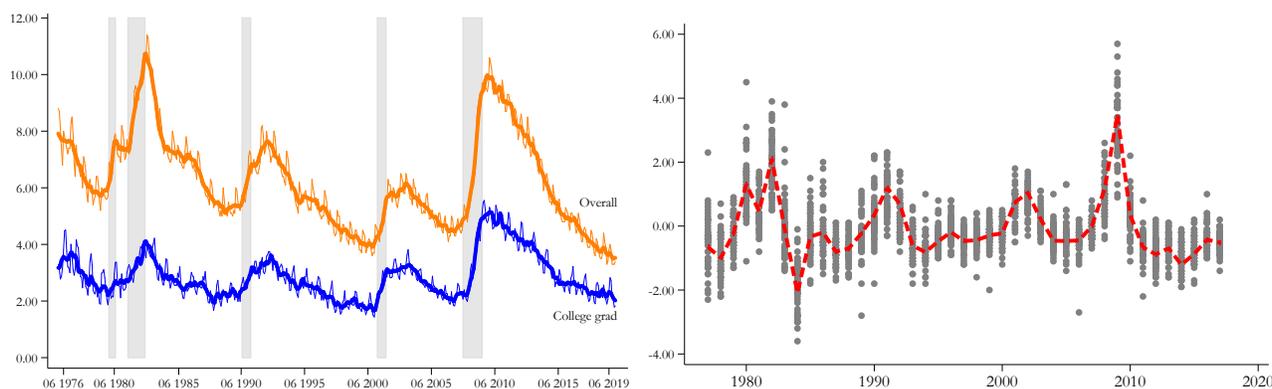


Figure 2: Monthly Unemployment Rates (Left) and Change in the State Unemployment Rate. Source: BLS, CPS

Note: The figure presents monthly unemployment rates for the overall population (sourced from the BLS) and for college graduates (calculated using the Monthly CPS). Thin lines depict the raw data, while thick lines represent seasonally adjusted values (following BLS methodology) smoothed using a three-month moving average. Gray-shaded areas indicate NBER recessions.

Since the BLS reports unemployment data monthly, I construct (calendar) annual rates by averaging monthly observations, following standard practice in the literature. To capture labor-market exposure during the early career, I construct two main measures.

The first measure is the *accumulated* unemployment rate, which sums unemployment conditions at graduation and in the two subsequent years:

$$U_{s,c}^{ACC} = U_{s,c} + U_{s,c+1} + U_{s,c+2}, \quad (6)$$

where  $U_{s,c}$  is the state-level unemployment rate in the graduation year  $c$ ,  $U_{s,c+1}$  is the rate one year after graduation, and  $U_{s,c+2}$  is the rate two years after graduation. By summing three

<sup>5</sup><https://www.nber.org/research/data/us-business-cycle-expansions-and-contractions>

consecutive annual rates this measure captures both the magnitude and the duration of early-career weakness, and therefore distinguishes cohorts who enter just before a downturn from those who enter just after it even when their single-year graduation rates are similar.

This measure is not identical to the model’s total derivative with respect to the graduation-year unemployment rate  $U_{s,c}$  (see Equation 4). However,  $U_{s,c}^{ACC}$  can approximate the total effect of a marginal change in  $U_{s,c}$  (i.e., direct scarring plus the part transmitted via later unemployment) under two conditions: (i) later-year unemployment is well predicted by the graduation-year rate (stable persistence), and (ii) wage sensitivity to unemployment is broadly similar across the three years included in  $U_{s,c}^{ACC}$ .

Figure 3 (left panel) plots fluctuations in the national accumulated unemployment rate. As expected, the accumulated rate rises during recessions, typically beginning its increase before the onset of a downturn and peaking shortly after its official end. Compared with the overall unemployment rate, the accumulated series displays more symmetric cycles: the duration of increases is roughly equal to the time it takes to return to pre-recession levels. This symmetry implies that, on average, individuals graduating after a recession do not face persistently higher accumulated unemployment than those who graduate just before a downturn.

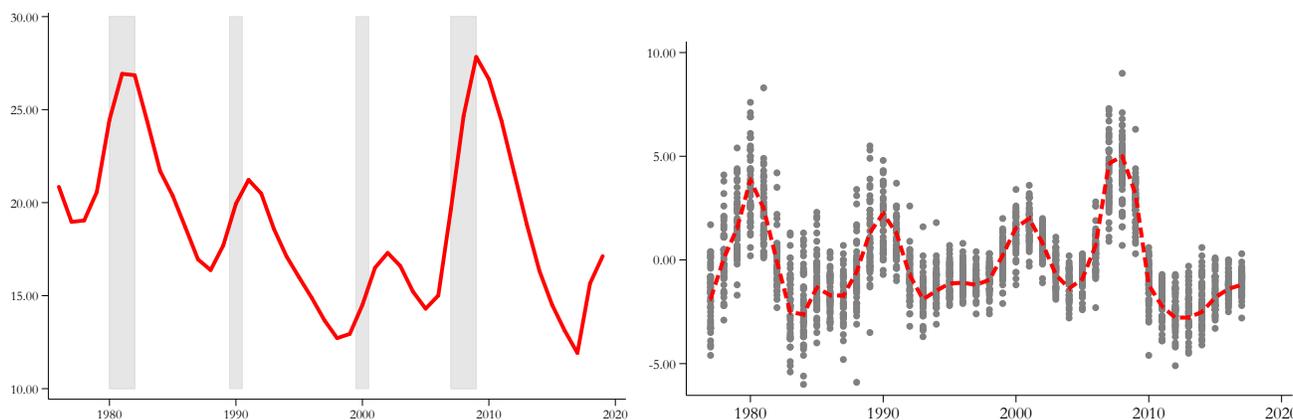


Figure 3: National Accumulated Unemployment Rate (left) and Change in the State Accumulated Rates (Right). Source: BLS

Note: The left panel presents the national accumulated unemployment rate, defined in Equation 6. Each point corresponds to the sum of unemployment rates faced by the graduation cohort over its first two years in the labor market. Gray-shaded areas indicate NBER recessions. The right panel shows the year-to-year change in state accumulated unemployment rates. The red line shows the change in the national accumulated unemployment rate.

By construction, the accumulated unemployment rate exhibits substantially greater variation than a single-year rate: at the national level it ranges roughly from 12% to 27%. State-level

unemployment rate (Figure 3 (right panel)) displays even larger cross-state and cross-cohort dispersion: the maximum cohort-to-cohort change exceeds eight percentage points, while the minimum change is below minus five percentage points. The figure also gives a sense of the magnitudes of the exposure that the empirical estimates correspond to.

Despite its usefulness, the accumulated rate has limitations. First, it implicitly gives equal weight to unemployment conditions at graduation and in the two subsequent years, which may not reflect actual wage-scarring dynamics. Second, it conflates initial conditions at graduation with post-graduation (year 1 and 2 after graduation) conditions, making it difficult to disentangle their separate effects. To address these issues, I construct an alternative measure: the average unemployment rate in the first two years after graduation, excluding graduation itself:

$$\bar{U}_{s,c+1,c+2} = \frac{U_{s,c+1} + U_{s,c+2}}{2}, \quad (7)$$

where  $U_{s,c+1}$  is the state-level unemployment rate in the year following graduation year and  $U_{s,c+2}$  is the state-level unemployment rate in two years after graduation.

Figure 4 shows that the two series are strongly countercyclical: cohorts that enroll during recessions (i.e., when unemployment is high at enrollment) typically face lower unemployment rates after graduation. For instance, the cohort that entered college in 1982, when unemployment was nearly 10%, graduated in 1986 and faced an average post-graduation unemployment rate of around 5.5% in 1987–1988. Conversely, cohorts that began college under favorable labor market conditions often encountered weaker early-career markets. This countercyclicity matters for identification because it implies that pre-enrollment selection and post-graduation exposure move in opposite directions on average; it also motivates analyzing cohorts separately by enrollment conditions. I will use this measure as an approximation of  $u_2$  from the conceptual framework.

In sum, these two measures provide complementary ways of capturing cyclical conditions faced by new graduates. The accumulated unemployment rate reflects total exposure in the first years of a career, while the post-graduation average isolates conditions after labor market entry, disentangling them from initial conditions at graduation and helps identify the persistence channel.

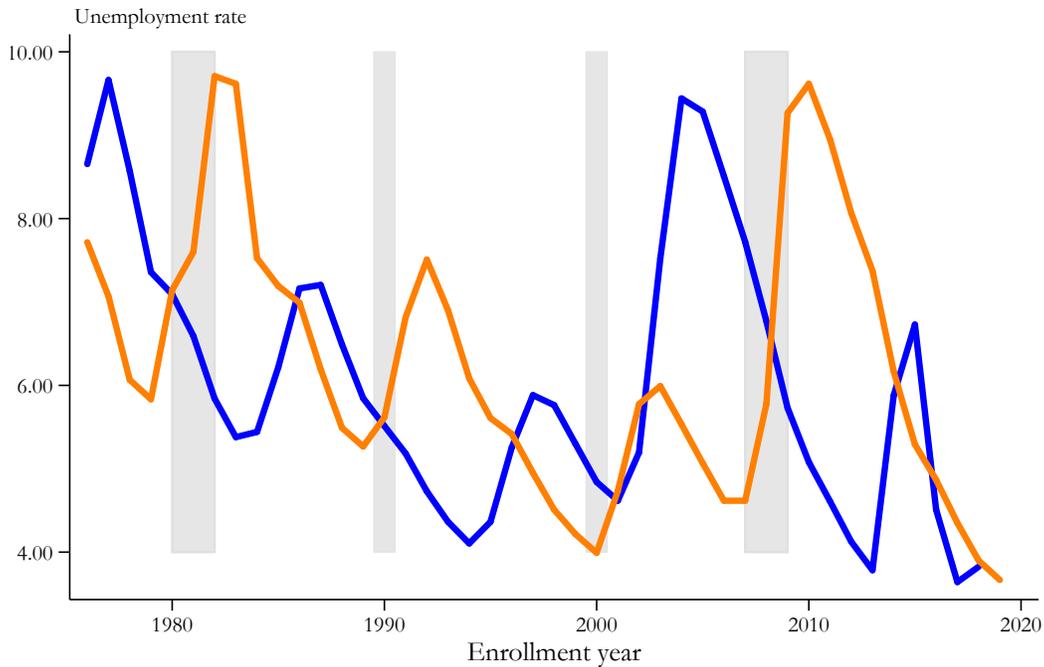


Figure 4: Unemployment rates faced by each cohort at the time of college enrollment (orange) and after graduation (blue). Source: BLS

Note: The panel compares the national unemployment rate at college enrollment (orange line) with the early-career unemployment rate (blue line) of the corresponding cohort, calculated as the average of unemployment rates in years 1 and 2 after graduation (counting graduation year as year 0), as defined in Equation 7. Gray-shaded areas indicate NBER recessions.

## 4 Methodology

This section outlines the empirical strategy used to identify the causal effect of graduating into adverse labor market conditions on subsequent outcomes. I begin by addressing potential selection into college enrollment driven by pre-enrollment labor market conditions and then estimate how unemployment at and after graduation shapes long-term earnings trajectories.

### 4.1 Selection at Enrollment

Economic conditions at the time of college entry can influence enrollment decisions, creating potential selective composition of (unobservable) graduate quality across cohorts. Evidence indicates that individuals are more likely to enroll in college during economic downturns (Del- las and Sakellaris, 2003), implying that recessions may induce marginal students who would otherwise enter the labor market directly to enroll instead. If not accounted for, such selection

could affect estimates of graduation-year effects, as cohorts entering college in recessions may differ systematically in unobserved characteristics from those entering in good times.

Figure 5 illustrates three stylized business cycle scenarios based on the unemployment rate at age 18 (typical college enrollment age):

1. Starting and graduating during low unemployment.
2. Starting with low unemployment and graduating during high unemployment.
3. Starting with high unemployment and graduating into slow recovery.
4. Starting with high unemployment and graduating into fast recovery.

If selection at college entry matters, estimated effects of graduation-year conditions could be biased upward (in magnitude) due to the inclusion of students who would not have enrolled under favorable labor market conditions.

To address this, I adopt two complementary strategies. First, I divide the sample based on labor market conditions at age 18. Cohorts entering during “good” (demand) times are defined as those with a detrended national unemployment rate below 0.1% (the sample average), while others enter during “bad” periods. For each subsample, I estimate the graduation-year effect separately using the model from [Altonji et al. \(2016\)](#):

$$y_{icst} = \beta_1 X_{icst} + \beta_2 U_{sc} + \beta_3 U_{sc} PE_{it} + \beta_4 U_{sc} PE_{it}^2 + \theta_s + \epsilon_{icst}, \quad (8)$$

where  $y_{icst}$  represents the labor market outcome of interest,  $U_{sc}$  is the unemployment rate at graduation,  $PE_{it}$  is potential experience (the difference between the observation year and the graduation year),  $\theta_s$  is a state fixed effect, and  $X_{icst}$  is a vector of control variables (including race dummies, a cubic time trend, and a quadratic form of potential experience). Standard errors are clustered at the state-cohort level.

Second, I account for selective entry into the graduate sample using a standard Heckman selection framework. The outcome equation (estimated only for observed graduates,  $s_i = 1$ )

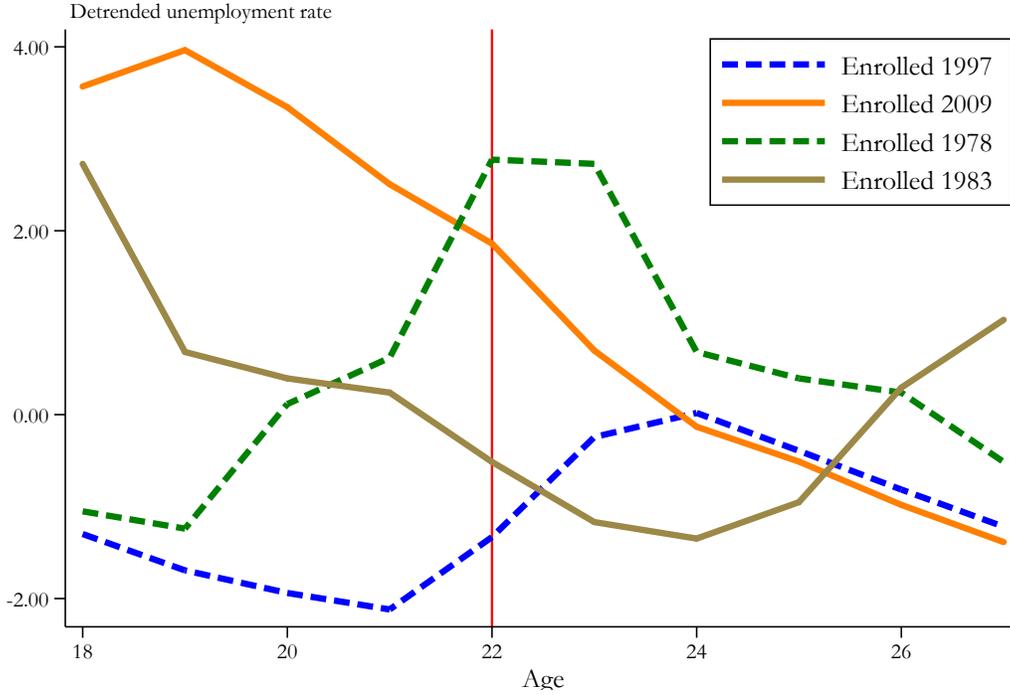


Figure 5: Detrended Unemployment Rates based on the labor market conditions at age 18. Source: BLS

Note: The figure presents detrended national unemployment rates experienced by three cohorts graduated in 1982, 2001, 1987 and 2013 starting from the moment of age 18 (college enrollment) till age 27 (5 years after graduation). The red line denotes age 22 - college graduation year. Selected cohorts represent one of three big groups: enrolled with low unemployment rate - graduated with low unemployment rate (blue line), enrolled with low unemployment rate - graduated with high unemployment rate (green line), enrolled with high unemployment rate (orange line).

follows the general form of the specifications discussed above (Equation 8)<sup>6</sup>. In compact form:

$$y_i = X_i' \beta + \epsilon_i, \quad \text{observed only if } s_i = 1 \quad (9)$$

$$s_i^* = U_{s,c18} \gamma + \sigma Z_i + v_i, \quad s_i = 1 \text{ if } s_i^* > 0, \quad (10)$$

where  $s_i = 1$  indicates being in the sample of college graduates,  $U_{s,c18}$  is the cohort  $c$ 's state-level unemployment rate at the time of college enrollment (age 18), and  $Z_i$  includes state fixed effects and a cubic time trend. This structure allows for systematic differences in the composition of graduates across cohorts induced by economic conditions at enrollment. The outcome equation then estimates the effects of graduation-year unemployment on labor market outcomes, conditional on selection. Identification relies on the exclusion restriction that the

<sup>6</sup>In the next section, I alternatively use Equations 12 and 13.

unemployment rate at enrollment affects outcomes only through the selection channel — an assumption supported by the low persistence of unemployment beyond three years, as discussed in the conceptual framework.

Being self-selected in the sample means being in the college graduates' sample. From a theoretical standpoint, weak pre-enrollment labor markets are expected to induce enrollment among marginal students who would otherwise enter employment. These individuals are likely to have lower unobserved earnings potential compared to those who would enroll regardless of economic conditions. Consequently, I expect negative selection on unobservables, implying a negative correlation ( $\rho < 0$ ) between the outcome error ( $\epsilon_i$ ) and the selection error ( $v_i$ ). In the Heckman framework, this corresponds to a negative coefficient on the inverse Mills ratio ( $\lambda = \rho\sigma$ ). A significantly negative  $\lambda$  would thus confirm that part of the observed effect of graduation-year unemployment reflects compositional changes in who attends college during recessions rather than solely differences in post-graduation conditions.

While both the parametric correction (Heckman model) and the nonparametric split-sample approach attempt to account for potential bias in the estimates, I place greater weight on the split-sample results, which rely on fewer functional form assumptions. The Heckman correction, which assumes joint normality of the error terms and a linear selection mechanism, is used primarily as a robustness check. Its results confirm that the heterogeneity observed in outcomes is consistent with selection into the population of college graduates at the time of enrollment.

## 4.2 Post-Graduation Trajectory

The second part of the analysis focuses on the effects of early-career labor market conditions. Using both the divided sample and the Heckman-corrected specifications, I first employ the accumulated unemployment rate as defined in Equation 6 and estimate both the average effect and effect by potential experience:

$$y_{isct} = \beta U_{s,c}^{ACC} + \gamma X_{isct} + \theta_s + \epsilon_{isct}, \quad (11)$$

and

$$y_{isct} = \beta_1 U_{s,c}^{ACC} + \beta_2 U_{s,c}^{ACC} PE_{it} + \beta_3 U_{s,c}^{ACC} PE_{it}^2 + \gamma X_{isct} + \theta_s + \epsilon_{isct}, \quad (12)$$

where  $U_{s,c}^{ACC}$  is the sum of state-level unemployment rates at graduation and during the two subsequent years, and  $X_{isct}$  includes potential experience (in quadratic form), race indicators, and a cubic time trend.

The unemployment measure captures cumulative exposure to adverse labor market conditions in the early career and distinguishes cohorts entering just before or after a recession. In terms of the theoretical framework,  $U_{s,c}^{ACC}$  is not identical to the total derivative of wages with respect to graduation-year unemployment in the conceptual model. However, it approximates the combined effect of graduation and early-career shocks under the assumption of relatively stable persistence and similar wage sensitivity across years. The coefficient  $\beta$  thus reflects the impact of adverse early-career economic conditions. A statistically significant negative  $\beta$  would indicate persistent negative effects on labor market outcomes, even after controlling for conditions at graduation.

To separate the effects of graduation versus post-graduation conditions, I estimate an alternative model including both graduation-year and post-graduation unemployment, where post-graduation unemployment is defined as in Equation 7:

$$y_{ict} = \alpha + \beta_1 U_{s,c} + \beta_2 \bar{U}_{s,c+1,c+2} + \gamma X_{ict} + \theta_s + \epsilon_{ict}. \quad (13)$$

In this setup,  $\bar{U}_{s,c+1,c+2}$  denotes the mean unemployment rate during the first two years after graduation. This specification allows for a separation of the direct effect of graduation-year conditions from subsequent early-career labor market experience, while mitigating multicollinearity concerns (correlation between  $U_{s,c}$  and  $\bar{U}_{s,c+1,c+2}$  is 0.77).

Connecting this specification to the theoretical model, including both  $U_{s,c}$  and  $\bar{U}_{s,c+1,c+2}$  allows me to empirically approximate the decomposition of the total derivative of wages with respect to graduation unemployment derived earlier. The coefficient on  $U_{s,c}$  captures the direct scarring effect – the immediate earnings penalty associated with entering the labor market during a recession (e.g., lower job quality, mismatch, or depressed entry wages). In contrast,  $\beta_2$  on  $\bar{U}_{s,c+1,c+2}$  reflects the persistence channel, through which continued macroeconomic weakness after graduation amplifies and prolongs the initial shock. In theoretical terms, this corresponds to the second summand in the total derivative  $dw_3/du_1$ , where early-career unemployment transmits part of the initial graduation-year effect through subsequent labor-market conditions. Incorporating both terms therefore allows this empirical specification to approx-

imate the full, long-run effect of graduating into a recession while separately identifying its immediate and propagated components.

Together, these specifications form the empirical backbone of the analysis. The first part corrects for potential selection into higher education driven by pre-enrollment labor market conditions using both sample division and a Heckman selection model, while the second part decomposes the total effect of adverse graduation conditions into direct and persistence-driven channels.

## 5 Results

I begin by presenting results from the graduation-year specification (the model in [Altonji et al. 2016](#)) while holding enrollment conditions fixed. I then introduce post-graduation labor-market conditions and, finally, show Heckman sample-selection corrections.

### 5.1 Effect of Graduation Unemployment Rate

To address selection at enrollment, I first fix enrollment conditions and estimate the effect of the unemployment rate at graduation separately for cohorts that began college in “bad” (high) versus “good” (low) enrollment unemployment environments. Specifically, I split cohorts according to the detrended national unemployment rate at age 18,  $U_{c18}$ , using a cutoff at 0.1% (sample average): (1) above cutoff - cohorts who started college under high unemployment conditions and (2) below cutoff cohorts who started under low unemployment. For each subsample, I estimate the graduation-year specification from Equation (8).

Figure 6 plots the estimated marginal effect of a one percentage-point increase in the graduation unemployment rate as a function of potential experience, using the combination  $\hat{\beta}_2 + \hat{\beta}_3PE + \hat{\beta}_4PE^2$ . Table 2 reports summary values for the key level of potential experience.

The results show that the negative effect of graduation-year unemployment on long-run earnings and wages is primarily driven by cohorts that enrolled under high enrollment unemployment. For men in this group, a one percentage-point increase in the state unemployment rate at graduation is associated with an average earnings loss of about 1.8% and a wage loss of about 1.6% at the average level of potential experience.<sup>7</sup> The largest losses expectedly occur at

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<sup>7</sup>Average level of potential experience is set to 4.5 years following [Altonji et al. \(2016\)](#).

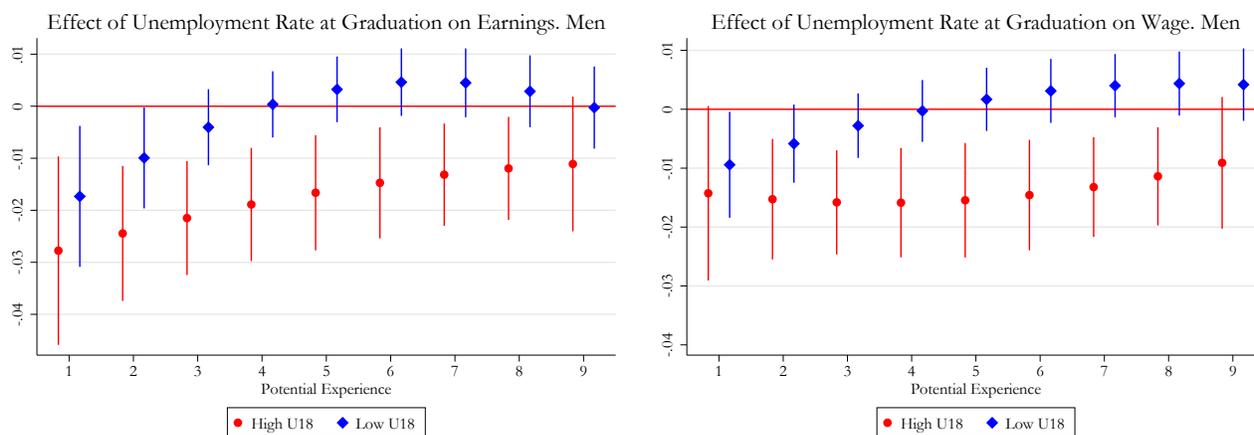


Figure 6: The effect of a 1 p.p increase in the state unemployment rate for cohorts enrolled in college during high vs. low unemployment rates.

Note: The figure presents the effect of a 1 percentage-point increase in the unemployment rate at the time of graduation on Earnings (left) and Wages (right). High  $U_{c18}$  defines cohorts for which the detrended national unemployment rate at 18 (college enrollment) was higher than 0.1%. Low  $U_{c18}$  defines cohorts for which the detrended national unemployment rate at 18 (college enrollment) was lower than 0.1%. The coefficients are derived using the formula  $\hat{\beta}_2 + \hat{\beta}_3 \times potexp + \hat{\beta}_4 \times potexp^2$  from Equation 8. Standard errors are clustered by state and graduation year.

the beginning of the career - year 1 of the potential experience, where earnings fall by roughly 3.0% and wages by about 1.4%, and these losses remain economically meaningful a decade after graduation.

Graduates who began college under low pre-enrollment unemployment also experience initial earnings and wage losses (about 1.7% and 0.9% in year 1 after graduation, respectively), but these effects attenuate rapidly and are largely gone by year three. Both subsamples show short-term reductions in the probability of full-time employment. A temporary reduction in hours worked is observed mainly for the low- $U_{c18}$  group and disappears after two years. Occupation-based earnings (columns 6/12) provide suggestive evidence that job-quality shifts contribute to the earnings penalties for the high- $U_{c18}$  cohorts, although the estimates are too noisy.

In Appendix Table 3, I present estimates based on the sample of college graduates with low-educated mothers (defined as those whose mothers who have a high school education or less). The results indicate substantially larger initial earnings losses - about 5.5%, for individuals who started college during recession. This finding suggests that graduates from lower socioeconomic backgrounds are more sensitive to adverse labor market conditions at the time

Table 2: Fixing Enrollment Conditions. Effect of Unemployment Rate at Graduation

	High $U_{c18}$						Low $U_{c18}$					
	In Earnings (1)	In Wage (2)	Pr(Emp Pop) (3)	Pr(Full time) (4)	In Hours (5)	Occupation Earnings (6)	In Earnings (7)	In Wage (8)	Pr(Emp Pop) (9)	Pr(Full time) (10)	In Hours (11)	Occupation Earnings (12)
Average effect 1-10 PE	-0.018*** (0.006)	-0.016*** (0.005)	-0.001 (0.002)	0.0004 (0.002)	-0.006 (0.005)	0.001 (0.002)	0.002 (0.003)	0.001 (0.003)	0.0001 (0.002)	-0.001 (0.001)	-0.001 (0.004)	0.002 (0.001)
Potential Exp = 1	-0.028*** (0.009)	-0.014* (0.008)	0.003 (0.004)	-0.006* (0.004)	-0.003 (0.009)	-0.003 (0.004)	-0.017** (0.007)	-0.009** (0.005)	-0.006** (0.003)	-0.008*** (0.003)	-0.013** (0.006)	-0.0004 (0.002)
Potential Exp = 3	-0.021*** (0.006)	-0.016*** (0.005)	0.001 (0.002)	-0.001 (0.002)	-0.007 (0.006)	-0.0005 (0.002)	-0.004 (0.004)	-0.003 (0.003)	-0.002 (0.002)	-0.003** (0.001)	-0.002 (0.004)	0.001 (0.001)
Potential Exp = 7	-0.013*** (0.005)	-0.015*** (0.004)	-0.005*** (0.002)	-0.001 (0.002)	-0.0003 (0.005)	0.001 (0.002)	0.004 (0.003)	0.004 (0.003)	0.001 (0.001)	-0.0003 (0.001)	-0.001 (0.003)	0.002 (0.001)

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses. The sample consists of college graduates with potential experience from 1 to 10 years who turned 22 between 1976 and 2018. High  $U_{c18}$  defines cohorts for which the detrended national unemployment rate at 18 (college enrollment) was higher than 0.1%, and low  $U_{c18}$  defines cohorts for which it was lower than 0.1%. The graduation unemployment rate is the state unemployment rate at age 22. Controls include race dummies, a cubic time trend, and state fixed effects. Standard errors are clustered by state and graduation year. The estimates are derived using the formula  $\hat{\beta}_2 + \hat{\beta}_3 \times potexp + \hat{\beta}_4 \times potexp^2$  from Equation 8. The underlying regression results are in Appendix Table 1.

of graduation. By contrast, no significant effects (and basically zero) are observed for cohorts who enrolled during relatively favorable economic periods.

These patterns are consistent with a composition mechanism: recessions at enrollment expand the college-going margin to include more marginal, lower-unobserved-type individuals; cohorts that enroll under high enrollment unemployment therefore contain a higher share of individuals potentially more vulnerable to scarring from adverse graduation conditions. The larger and more persistent losses for the high- $U_{c18}$  group suggest that selection into college during bad times can amplify the cohort-level costs of graduating into a weak labor market.

Overall, these findings imply that selection at enrollment matters: the cohorts most affected by graduation-year recessions are those that enrolled when enrollment was high because of poor labor markets at college enrollment.

## 5.2 Effect of Post-Graduation Conditions

I now analyze how labor market conditions after graduation affect early-career outcomes, holding enrollment conditions fixed. Specifically, I estimate Equation 12 using the accumulated unemployment rate ( $U_{sc}^{ACC}$ ) as the main explanatory variable, separately for cohorts entering college under high versus low unemployment ( $U_{c18}$ ). Table 3 presents these estimates.

The coefficients on the accumulated unemployment rate are negative for earnings, though generally modest in magnitude. For individuals in the high- $U_{c18}$  group, a 1 percentage point increase in  $U_{sc}^{ACC}$  reduces earnings by about 0.4%, whereas the effect for low- $U_{c18}$  cohorts is slightly smaller (0.3%). This indicates that cumulative exposure to weak labor markets after

Table 3: Fixing Enrollment Conditions. Average Effect of the Accumulated Unemployment Rate

	High $U_{c18}$						Low $U_{c18}$					
	In Earnings	In Wage	Pr(Empl Pop)	Pr(Full Time)	In Hours	Occupation Earnings	In Earnings	In Wage	Pr(Empl Pop)	Pr(Full Time)	In Hours	Occupation Earnings
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$U_{c18}^{ACC}$	-0.004* (0.002)	-0.002 (0.002)	-0.001* (0.001)	-0.0005 (0.002)	0.0003 (0.001)	0.001 (0.001)	-0.003** (0.001)	-0.002** (0.001)	-0.001 (0.0005)	-0.001 (0.001)	-0.002 (0.001)	0.00003 (0.001)
Obs	22921	21939	25399	24007	22670	23997	35746	35746	39815	37716	37110	37668
Clusters	816	816	816	816	816	816	1071	1071	1071	1071	1071	1071
State FE	X	X	X	X	X	X	X	X	X	X	X	X

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses. The table presents estimates of Equation 11, which uses the accumulated unemployment rate as the main explanatory variable (see Equation 6). The sample includes college graduates with 3–10 years of potential experience who turned 22 between 1976 and 2017. Cohorts are classified as high  $U_{c18}$  if the detrended national unemployment rate at age 18 exceeds 0.1%, and low  $U_{c18}$  otherwise. All specifications include fixed effects for state, cubic time trend, potential experience in quadratic form and control for race. Standard errors are clustered by state-graduation-year.

graduation has measurable effects, particularly for cohorts who started college during high unemployment.

Table 4: Fixing Enrollment Conditions. Effect of the Accumulated Unemployment Rate by Potential Experience

	High $U_{c18}$						Low $U_{c18}$					
	In Earnings	In Wage	Pr(Empl Pop)	Pr(Full Time)	In Hours	Occupation Earnings	In Earnings	In Wage	Pr(Empl Pop)	Pr(Full Time)	In Hours	Occupation Earnings
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Potential Exp = 3	-0.011*** (0.003)	-0.007** (0.003)	-0.001 (0.001)	-0.002* (0.001)	-0.006 (0.004)	-0.002 (0.001)	-0.005** (0.002)	-0.003* (0.002)	0.001 (0.001)	-0.002 (0.001)	-0.002 (0.002)	0.001 (0.001)
Potential Exp = 5	-0.004* (0.002)	-0.002 (0.002)	-0.001 (0.001)	-0.0002 (0.001)	-0.003 (0.002)	-0.001 (0.001)	0.001 (0.001)	-0.002 (0.001)	-0.0001 (0.001)	-0.001 (0.001)	-0.002 (0.002)	0.0003 (0.001)
Potential Exp = 7	-0.001 (0.002)	0.0002 (0.002)	-0.001 (0.001)	0.001 (0.001)	0.001 (0.002)	0.002 (0.001)	-0.002 (0.002)	-0.001 (0.001)	0.0004 (0.001)	-0.0002 (0.001)	-0.002 (0.002)	-0.0001 (0.001)

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses. The table presents estimates of Equation 12, which uses the accumulated unemployment rate as the main explanatory variable (see Equation 6). The sample includes college graduates with 3–10 years of potential experience who turned 22 between 1976 and 2017. Cohorts are classified as high  $U_{c18}$  if the detrended national unemployment rate at age 18 exceeds 0.1%, and low  $U_{c18}$  otherwise. All specifications include fixed effects for state, cubic time trend and control for race. Standard errors are clustered by state-graduation-year.

For wages, the effects are similar in size between the two groups, although they are noisier for the group of recession-enrollees. The effects on the probability of being employed (Pr(Empl|Population)) are small but negative for the high- $U_{c18}$  group, indicating that prolonged exposure to poor labor markets modestly reduces the likelihood of employment, consistent with scarring mechanisms. In contrast, for the low- $U_{c18}$  group, this effect is negligible. Similarly, hours worked are only slightly affected and primarily for the low- $U_{c18}$  group, suggesting that employment adjustments, such as reducing hours, function as a short-term coping mechanism in less distressed cohorts.

Introducing heterogeneity by potential experience reveals that, as expected, the estimated effects are strongest in the immediate years following the measurement of post-graduation labor-market conditions. Specifically, the adverse impact peaks around three years after grad-

uation for both earnings and wages, regardless of the timing of college enrollment. However, the magnitude of the effect among individuals who enrolled during recessionary periods is approximately twice as large as that observed for those who entered college in more favorable economic conditions. The remaining outcomes appear largely unaffected by the accumulated unemployment rate, suggesting that the scarring effect primarily operates through earnings and wage channels rather than through broader labor-market participation or occupational mobility.

To distinguish the effect of immediate versus subsequent labor market conditions, Table 5 reports estimates using separate measures for the unemployment rate at graduation ( $U_{s,c}$ ) and the mean unemployment rate in the two years following graduation ( $\bar{U}_{s,c+1,c+2}$ , Equation 7).

Table 5: Fixing Enrollment Conditions. Effect of Separate Unemployment Rates

	High $U_{c18}$						Low $U_{c18}$					
	ln Earnings (1)	ln Wage (2)	Pr(Empl   Pop) (3)	Pr(Full Time) (4)	ln Hours (5)	Occupation Earnings (6)	ln Earnings (7)	ln Wage (8)	Pr(Empl   Pop) (9)	Pr(Full Time) (10)	ln Hours (11)	Occupation Earnings (12)
$U_{s,c}$	0.012 (0.007)	0.010* (0.006)	-0.004* (0.002)	0.00002 (0.003)	-0.001 (0.007)	0.009*** (0.003)	0.001 (0.004)	0.002 (0.003)	0.001 (0.002)	0.001 (0.002)	-0.003 (0.004)	0.004*** (0.002)
$\bar{U}_{s,c+1,c+2}$	-0.022*** (0.008)	-0.015*** (0.006)	0.0001 (0.003)	-0.001 (0.003)	0.002 (0.008)	-0.006* (0.003)	-0.010** (0.004)	-0.008** (0.003)	-0.002 (0.002)	-0.003** (0.001)	-0.003 (0.004)	-0.004** (0.002)
F test (p-value)	0.02**	0.08*	0.08*	0.76	0.98	0.03**	0.03**	0.04*	0.34	0.08*	0.25	0.02**
Obs	22921	23329	25399	24007	23704	23997	35746	35746	39815	37716	37110	37668
Clusters	816	816	816	816	816	816	1071	1071	1071	1071	1071	1071
State FE	X	X	X	X	X	X	X	X	X	X	X	X
Year FE	X	X	X	X	X	X	X	X	X	X	X	X
Pot Exp FE	X	X	X	X	X	X	X	X	X	X	X	X

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses. The sample includes college graduates with 3-10 years of potential experience who turned 22 between 1976 and 2017. High  $U_{c18}$  defines cohorts for which the detrended national unemployment rate at 18 (college enrollment) was higher than 0.1%, and low  $U_{c18}$  defines cohorts for which it was lower than 0.1%. The model uses two main explanatory variables: the unemployment rate at 22 (graduation) and the mean unemployment rate in the two years following graduation (Equation 7). The unemployment rate is defined as the rate in the year the individual turned 22 in the state of current residence. Fixed effects for state, year, and potential experience are included. All specifications control for race, and standard errors are clustered by state-graduation-year.

The point estimates suggest that post-graduation unemployment matters more for vulnerable cohorts. For individuals in the high- $U_{c18}$  group who faced elevated unemployment when they began college a one percentage point increase in the average post-graduation unemployment rate is associated with a roughly 2.2% decline in earnings. By contrast, the same effect is only about 1% for the low- $U_{c18}$  group. A similar pattern emerges for wages and occupational earnings, indicating that labor market conditions immediately after graduation weigh disproportionately on cohorts already exposed to adverse economic conditions at college entry. However, the standard errors of these coefficients are too large to conclude that the point estimates are significantly different.

The estimated coefficients on the unemployment rate at the time of graduation are mostly

insignificant (with the exception of the probability of employment, for which the post-graduation unemployment rate is insignificant) and even positive for wages and occupational attainment. This positive effect might reflect the ability of individuals to anticipate unfavorable labor market conditions and adjust their choices accordingly. However, in the case of wages, the negative effect of post-graduation unemployment outweighs this potential positive effect, suggesting the negative overall effect of early-career exposure to adverse labor market conditions.

Taken together, post-graduation labor market conditions exert a strong influence on early-career outcomes and appear to matter even more than the unemployment rate at graduation. The magnitude of these effects depends on the labor market environment individuals faced at college entry. Ignoring post-graduation conditions risks misinterpreting the true scarring effects of graduating into a weak labor market and may lead to misleading conclusions about the timing and persistence of earnings losses associated with recessions.

### 5.3 Heckman Selection Model

Initially, I divided the sample into two parts based on the national unemployment rate at enrollment. This simple approach allowed us to identify cohorts with potentially more favorable unobservables and estimate the effects of graduating during a recession for them. A more formal approach is to use a Heckman selection model, where the selection equation is based on unemployment at enrollment. This model requires an exclusion restriction: unemployment at enrollment should affect labor market outcomes only through selection into college.<sup>8</sup> This approach explicitly models the process of college completion under the assumption of joint normality in the error structure. While this specification is more restrictive, it provides a useful robustness check.

In this framework, unemployment at enrollment captures variation in the probability of enrolling in college induced by pre-enrollment labor market conditions: during recessions, individuals who might otherwise have entered the workforce are more likely to enroll. Consequently, the model accounts for systematic differences in the composition of college graduates depending on whether cohorts began their studies in periods of high or low unemployment. By explicitly modeling selection, the estimated effects of graduation-year unemployment re-

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<sup>8</sup>As discussed in the conceptual framework, this condition is satisfied due to the weak correlation between pre-enrollment unemployment and post-graduation labor market conditions.

flect scarring rather than changes in the underlying composition of graduates. Table 6 reports

Table 6: Heckman Selection Model. Effect of Unemployment Rate at Graduation

	ln Earnings	ln Wage	Pr(Empl   Pop)	Pr(Full time)	ln Hours	Occupation Earnings
	(1)	(2)	(3)	(4)	(5)	(6)
Average effect 1-10 PE	−0.003 (0.002)	−0.005** (0.002)	0.001 (0.001)	−0.001 (0.001)	−0.003 (0.003)	0.001 (0.001)
Potential Exp = 1	−0.018*** (0.005)	−0.012*** (0.004)	−0.004*** (0.001)	−0.005*** (0.001)	−0.010** (0.005)	−0.002 (0.001)
Potential Exp = 3	−0.008*** (0.003)	−0.007*** (0.002)	−0.001 (0.001)	−0.002** (0.001)	−0.005* (0.003)	0.0001 (0.001)
Potential Exp = 7	−0.0002 (0.002)	−0.003 (0.002)	0.002 (0.001)	0.001* (0.001)	−0.001 (0.002)	0.002** (0.001)
Heckman $\lambda$	−0.990*** (0.009)	−0.553*** (0.019)	−0.453*** (0.096)	−0.330*** (0.104)	−0.011 (0.008)	−0.545*** (0.003)

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses. The table presents the results of the Heckman selection model estimation. The overall sample consists of high school graduates, vocational school graduates, and college graduates. Being selected in the sample means having a college degree. I include individuals with potential experience from 1 to 10 years who turned 18 between 1977 and 2014. The graduation unemployment rate is the state unemployment rate at age 22. The controls include race dummy, cubic time trend, and state fixed effects. Standard errors are clustered by state and graduation year. The results of the underlying regressions as defined in Equation 8 are presented in Appendix Table 4. The estimates are derived through the formula  $\hat{\beta}_2 + \hat{\beta}_3 \times potexp + \hat{\beta}_4 \times potexp^2$ .

estimates from the Heckman selection model. The estimated effects of graduation-year unemployment on earnings closely resemble those obtained for the subsample of individuals who enrolled during favorable labor market conditions: initial earnings losses are nearly identical, and the effects dissipate after approximately four years - slightly longer than for good-time enrollees but shorter than for recession enrollees. These results indicate that, once selection into higher education is explicitly accounted for, the scarring effect of graduating in a recession is substantially shorter than suggested by prior studies. The estimated inverse Mills ratio is statistically significant and negative, implying that individuals who enter college during recessions possess systematically less-favorable unobserved characteristics relative to those enrolling during expansions. This finding underscores the relevance of correcting for selection in analyses of cyclical graduation effects.

Table 7 presents estimates of the accumulated unemployment rate, both on average and by potential experience, accounting for selection using the Heckman framework. The results

are consistent with the main predictions. The selection-corrected effect is smaller than that estimated for the recession-enrollee subsample, yet somewhat larger and more persistent than the corresponding estimate for individuals who enrolled during favorable labor market conditions. The effect becomes statistically insignificant approximately five years after graduation. In contrast to the split-sample results, the Heckman estimates reveal statistically significant effects on hours worked and the probability of full-time employment. Across all specifications, the estimated  $\lambda$  remains negative and significant, confirming the presence of negative selection into college during recessions.

Overall, the Heckman selection results confirm that accounting for selection into college meaningfully alters the estimated effects of early-career labor market conditions. The inclusion of the selection correction reduces the persistence of recession-related earnings losses, aligning outcomes more closely with those observed among cohorts who enrolled under favorable conditions.

Table 7: Heckman Selection Model. Average Effect of the Accumulated Unemployment Rate

	ln Earnings (1)	ln Wage (2)	Pr(Emp Pop) (3)	Pr(Full Time) (4)	ln Hours (5)	Occupation Earnings (6)
	Average Effect					
$U_{s,c}^{ACC}$	-0.003*** (0.001)	-0.002*** (0.001)	0.0004 (0.0003)	-0.0002 (0.002)	-0.002** (0.001)	0.0002 (0.0003)
Heckman $\lambda$	-0.977*** (0.011)	-0.620*** (0.015)	-0.444*** (0.102)	-0.395*** (0.109)	-0.010 (0.008)	-0.559*** (0.003)
	Effect by Potential Experience					
Potential Exp = 3	-0.008*** (0.002)	-0.006*** (0.001)	-0.0001 (0.0005)	-0.001** (0.0003)	-0.004** (0.002)	0.0003 (0.001)
Potential Exp = 5	-0.002** (0.001)	-0.003*** (0.001)	0.0005 (0.0003)	0.0005 (0.0003)	-0.002* (0.001)	0.0005 (0.0004)
Potential Exp = 7	-0.0003 (0.001)	-0.001 (0.001)	0.001* (0.0003)	0.0003 (0.0003)	-0.001 (0.001)	0.0003 (0.0004)
Heckman $\lambda$	-0.977*** (0.011)	-0.620*** (0.015)	-0.242*** (0.105)	-0.413*** (0.113)	-0.012* (0.007)	-0.559*** (0.003)
Obs	217,211	217,218	238,179	220,337	219,428	220,270
Clusters	1,887	1,887			1,887	1,887
State FE	X	X	X	X	X	X

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

The table presents the results of the Heckman selection model estimation. The outcome equation is defined in Equations 11 and 12, which use the accumulated unemployment rate as the main explanatory variable (see Equation 6). The overall sample consists of high school graduates, vocational school graduates, and college graduates. Being selected in the sample means having a college degree. I include individuals with potential experience from 3 to 10 years who turned 18 between 1977 and 2014. The graduation unemployment rate is the state unemployment rate at age 22. The controls include race dummy, cubic time trend, and state fixed effects. Standard errors are clustered by state and graduation year.

## 6 Cohort Characteristics

To provide direct support for the notion that there are qualitative differences across graduation cohorts that may influence subsequent labor market outcomes, I examine three main indicators of student characteristics at college entry: the distribution of high school GPA of enrolled students, SAT scores, and the socioeconomic background of enrolled students proxied by mother's education.

## 6.1 High School GPA

Data on the GPA distribution of first-year college students are drawn from The American Freshman: 50-Year Trends report by the Higher Education Research Institute (HERI) (Eagan et al., 2016), which covers over 1,000 U.S. universities. I classify GPA into three categories: A- and higher, B+/B-, and C+ and lower. Figure 7 displays the evolution of these distributions from 1976 to 2015.

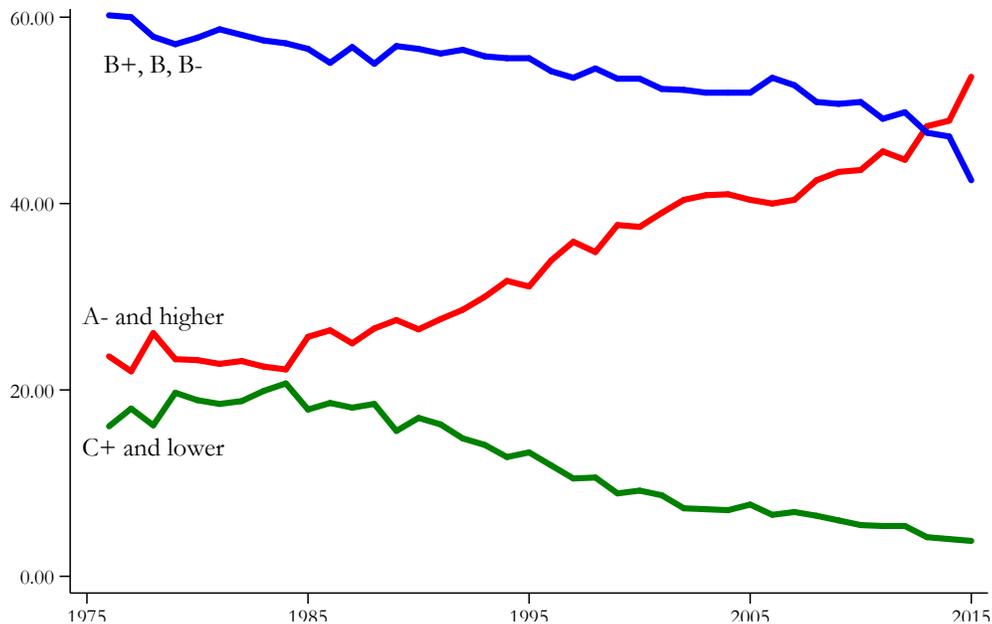


Figure 7: Distribution of high school GPA groups 1976-2015.

Note: The figure presents the share of the U.S. Freshmen in 1976-2015 within each High School GPA group for men. The GPAs are combined into three groups: A- and higher; C+ and lower, and the rest in between. Source: The American Freshman: 50-Year Trends report by Higher Education Research Institute (HERI) (Eagan et al., 2016)

There is a clear upward trend in the proportion of students in the highest GPA group over time. This shift primarily reflects a decline in the share of students with the lowest GPA.

To assess how enrollment-period labor market conditions affect this distribution, I estimate the relationship between the unemployment rate at the time of college enrollment and the share of students in each GPA category. Figure 8 illustrates a clear countercyclical pattern: the share of students with the highest GPA declines in periods of high unemployment, while the share of students with the lowest GPA rises.

Regression results in Table 8 confirm this relationship. Higher unemployment at enrollment significantly decreases the share of top-GPA students and increases the share of low-GPA

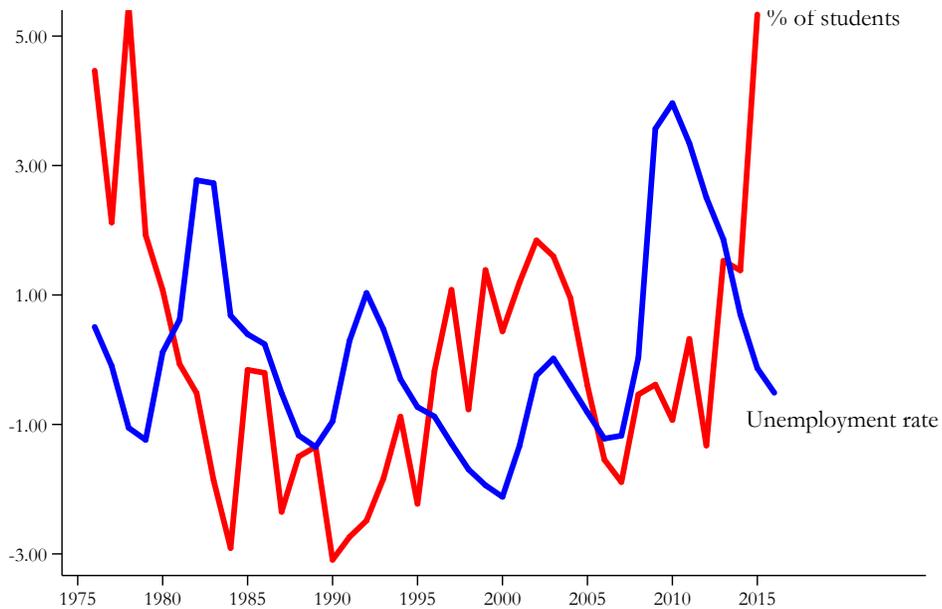


Figure 8: Detrended share of enrolled students with the highest high school GPA and detrended national unemployment rate 1976-2015.

Note: The red line presents the detrended share of college enrolled students with the highest high school GPA (A- and higher) for men. The blue line represents the detrended national unemployment rate. Source: The American Freshman: 50-Year Trends report by Higher Education Research Institute (HERI) (Eagan et al., 2016), BLS.

students, consistent with the theoretical model’s prediction that recessions draw in relatively lower-ability individuals.

Specifically, the effect on the highest GPA group is a 0.627 percentage point decline compared to a 0.431 percentage point increase in the lowest GPA group.

Table 8: Enrollment Conditions. Cohort Characteristics. National level.

	GPA			Average SAT	
	A+/A-	B+/B-	C+/D	Math	Verbal
	(1)	(2)	(3)	(4)	(5)
$U_t$	-0.627*** (0.147)	0.192 (0.160)	0.431*** (0.150)	-0.375 (0.386)	-0.408 (0.253)
Obs	40	40	40	40	40

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

Columns (1)–(3) report regression results based on time series data for the share of students with the corresponding GPA from 1976 to 2015, sourced from "The American Freshman: 50-Year Trends". Columns (4) - (5) present regression results using national mean SAT scores for Math and Reading over the same period, obtained from NCES Table 226.20. The unemployment rate is defined as the national unemployment rate in the year of school enrollment. All regressions include quadratic time trend.

## 6.2 SAT Scores

SAT data come from two sources: (i) the NCES national averages for Math and Verbal scores (1976–2015), and (ii) institutional-level data from IPEDS (2001–2015<sup>9</sup>), which report the 25th and 75th percentiles of admitted students' SAT scores. Although the IPEDS data is relatively short and doesn't report data by gender, it allows for meaningful analysis due to the inclusion of the state in which each university is located. This enables the incorporation of state-level variation in the unemployment rate at the time of enrollment. Summary statistics for both data sources are presented in Table 9.

For the NCES national series, regression results in Table 8 show that higher unemployment at enrollment is associated with lower average national SAT scores. The effects are not statistically significant as they are noisy. Using the richer IPEDS data with state-level variation (Table 10), I find consistent evidence: both the 25th and 75th percentiles of Math and Verbal SAT scores decline with an increase in unemployment rate at enrollment.

Moreover, the analysis reveals an increase in enrollment at lower-tier universities, con-

<sup>9</sup>I stop at 2015 because the SAT was redesigned in 2016, rendering the scores incomparable with earlier years.

Table 9: Summary Statistics

	Mean	St Dev	Min	Max
Average SAT Verbal	506.375	4.9	495	515
Average SAT Math	526.4	7	515	538
Math 25 percentile	483.6	73.4	100	799
Math 75 percentile	593.4	69.6	100	800
Verbal 25 percentile	478	68.9	100	799
Verbal 75 percentile	588.3	68.5	100	800

Note: Average SAT scores correspond to national averages for men, collected by the NCES from 1976 to 2015. Percentile data correspond to institutional self-reported 25th and 75th percentile scores and are sourced from IPEDS. The IPEDS dataset includes all U.S. degree-granting universities with four-year undergraduate programs, covering the 2001–2015 period.

Table 10: Enrollment Conditions. Cohort Characteristics. College level.

	In Enrolled: Tier 1-2	In Enrolled: Excl Tier 1-2	Math 75 perc	Math 25 perc	Verb 75 perc	Verb 25 perc
	(1)	(2)	(3)	(4)	(5)	(6)
$U_{st}$	-0.001 (0.001)	0.005*** (0.001)	-0.289** (0.114)	-0.196* (0.106)	-0.346*** (0.115)	-0.369*** (0.342)
Obs	1718	19712	16769	16770	16653	16651
School FE	X	X	X	X	X	X

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

The table presents the results of the estimation of universities' reported percentiles of SAT score for Math and Verbal on unemployment rate. The data is sourced from IPEDS and covers 2001-2015 period. The unemployment rate is defined as the state level unemployment rate in the year of school enrollment. All regressions include a quadratic time trend.

sistent with the pattern that individuals are more likely to pursue higher education during recessions, albeit at less selective institutions.

Because the composition of college cohorts is shaped at entry, cohort characteristics may

also correlate with economic conditions prevailing at graduation. In particular, if lower unemployment at the time of college entry attracts higher-ability students (e.g., cohorts with higher SAT scores), this selection should manifest in later graduation-period conditions with the opposite sign. To examine this relationship I regress the national average SAT scores of incoming cohorts on the unemployment rate at enrollment ( $U_0$ ) and the unemployment rate four years later, at graduation ( $U_1$ ). The results, reported in Table 11, confirm that cohorts entering college during periods of lower unemployment exhibit higher average SAT scores. As expected, the estimated coefficient on  $U_0$  is negative, while the coefficient on  $U_1$  is positive, although smaller in magnitude, reflecting the fact that unemployment rates do not complete a full cycle (i.e. return to the same level) between enrollment and graduation.

Table 11: Cohort Characteristics: Enrollment and Graduation. National level.

	All cohorts					
	Math			Verbal		
	(1)	(2)	(3)	(4)	(5)	(6)
	Male	Female	Total	Male	Female	Total
$U_t$	-0.523 (0.345)	-0.782** (0.320)	-0.673** (0.314)	-0.399* (0.202)	-0.891*** (0.280)	-0.581** (0.247)
$U_{t+4}$	0.754** (0.328)	0.577* (0.326)	0.643* (0.317)	0.607* (0.342)	0.543** (0.258)	0.501* (0.271)
Obs	40	40	40	40	40	40

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

The Table presents regression results using national mean SAT scores for Math and Reading over the 1976-2015 period, obtained from NCEs Table 226.20.  $U_t$  is defined as the national unemployment rate in the year of school enrollment,  $U_{t+4}$  is the national unemployment rate at graduation i.e. four years after the enrollment. All regressions include a quadratic time trend.

To address the selection problem, I distinguish between cohorts that were negatively selected and those that were not, based on the unemployment rate at the time of college enrollment. Since I rely on national-level data, I cannot conduct a regression analysis.<sup>10</sup> Instead, I compute correlation coefficients: first for the pooled sample of cohorts, and then separately within each enrollment group (high versus low unemployment at enrollment, using the same

<sup>10</sup>Rich IPEDS data do not cover a sufficient number of cohorts within each enrollment group. Therefore, I use national-level data that allows me to include all 40 cohorts and to divide the sample by the unemployment rate at enrollment. In this case, regression analysis is infeasible because each enrollment group contains fewer than 30 observations.

0.1% threshold in the detrended national unemployment rate). If selection at graduation arises from selection at enrollment, controlling for enrollment-period conditions should eliminate the graduation selection. I report only the correlations for the total SAT score.

Table 12: Cohort Characteristics: Enrollment and Graduation. National level. Correlation Coefficients.

	All cohorts		High $U_t$		Low $U_t$	
	Total					
	Math	Verbal	Math	Verbal	Math	Verbal
	(1)	(2)	(3)	(4)	(5)	(6)
$U_t$	-0.318** (0.046)	-0.282* (0.078)	0.035 (0.894)	-0.0004 (0.999)	0.027 (0.904)	0.001 (0.996)
$U_{t+4}$	0.362** (0.022)	0.302* (0.058)	0.275 (0.286)	0.310 (0.150)	0.320 (0.137)	0.128 (0.626)
Obs	40	40	17	17	23	23

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

The Table presents correlation coefficients between national mean SAT scores for Math and Reading over the 1976-2015 period, obtained from NCES Table 226.20, and unemployment rates at enrollment and graduation.  $U_t$  is defined as the national unemployment rate in the year of school enrollment,  $U_{t+4}$  is the national unemployment rate at graduation i.e. four years after the enrollment. All regressions include a quadratic time trend.

The results for the pooled sample are consistent with the regression findings in Table 11: there is a positive and statistically significant correlation between the unemployment rate at graduation and cohort quality. Dividing the sample into two groups appears to mitigate the selection problem, as the correlation coefficients become smaller and insignificant. Although these estimates are based on small samples that are insufficient to detect moderate effects, the remaining correlation is likely to be minor.

### 6.3 Socioeconomic Background

The final piece of evidence on selection concerns the socioeconomic composition of entering cohorts. While students who enroll during recessions may face greater financial or psychological stress that could affect their performance, differences in family background provide a more concrete indication of selection into higher education.

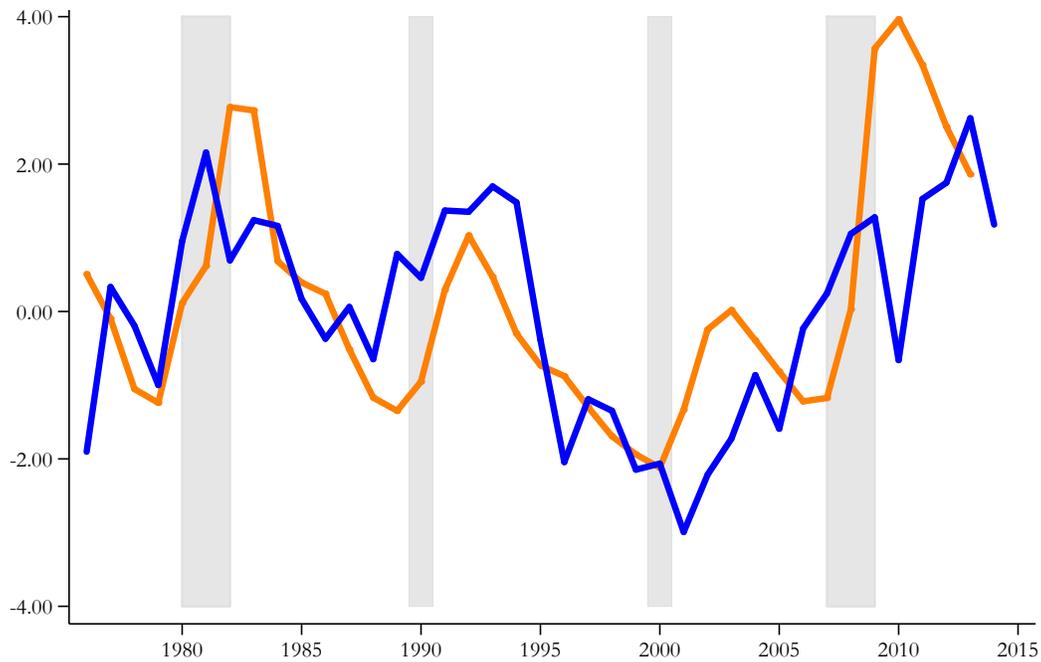


Figure 9: Detrended share of college graduates with low-educated mothers (blue) and detrended national unemployment rate (orange).

Note: The figure presents the detrended share of college graduates with low-educated mothers and detrended national unemployment rate. The share of college graduates with low educated mothers was calculated as the number of graduates who report mother’s education as high school or less to the number of graduates who reported mother’s education. Source: ACS, BLS

Using data from the American Community Survey (ACS) for 2001–2024, I focus on individuals who report having obtained a bachelor’s degree between 1980 and 2018 (corresponding to college enrollment between 1976 and 2014). For each enrollment cohort, I compute the share of college graduates whose mothers have low educational attainment (high school or less). Although information on parental education is available for only about 10 percent of respondents, the large ACS sample allows for relatively precise cohort-level estimates.

Figure 9 plots the detrended share<sup>11</sup> of graduates with low-educated mothers together with the detrended national unemployment rate at the time of enrollment. The relationship is strongly countercyclical: the share of graduates from less educated families rises when the unemployment rate at enrollment is higher.

Summary statistics for the raw and detrended shares are reported in Table 13. The range of variation across cohorts is substantial: the difference between the minimum and maximum

<sup>11</sup>I use the detrended share as since the female college graduation is increasing over time, the share of low-educated mothers is decreasing. The raw shares are presented in Appendix 1.

detrended share is 5.6 percentage points for men, which is slightly larger than the cyclical fluctuation in the unemployment rate itself.

Table 13: Summary of Percent of Graduates from Low Socioeconomic Background

	Men			
	Mean	St Dev	Min	Max
Raw Share of Graduates	58.045	11.903	39.532	77.034
Detrended Share of Graduates	0	1.427	-2.992	2.623

Note: Raw and detrended share of college graduates with low-educated mothers. College graduates are defined as having low-educated mothers if they report the mother’s education as high school or less. The share is calculated based on individuals who report mother’s education. The detrended rate is calculated as residuals from the regression of the raw share on the linear time trend.

Overall, the evidence establishes a consistent link between labor market conditions at the time of college entry and both the academic and socioeconomic composition of cohorts. Periods of high unemployment attract students from less advantaged backgrounds and with weaker academic preparation, and shift enrollment toward less selective institutions. These patterns reinforce the interpretation that the long-run earnings differences across graduation cohorts partly reflect composition effects: recessions alter not only the timing of labor market entry but also the type of individuals who enter higher education in the first place. Accounting for this endogenous variation in cohort quality is thus essential for identifying the true causal effect of graduating in a recession.

## 7 Conclusion

This paper examines how the trajectory of macroeconomic conditions surrounding college entry, graduation, and the early career period shapes the long-term earnings outcomes of college graduates. By extending the traditional focus on the unemployment rate at graduation to encompass both pre- and post-graduation labor market conditions, the study provides a more comprehensive understanding of how business cycle fluctuations translate into persis-

tent wage differences across cohorts. The results highlight that the timing of exposure to adverse economic conditions plays a crucial role in determining long-run labor market outcomes.

The analysis reveals three central findings. First, selection into college during recessions substantially alters cohort composition. When unemployment is high at college entry, individuals with lower academic preparedness or weaker attachment to the labor market are more likely to enroll, consistent with countercyclical enrollment behavior documented in prior studies. As a result, cohorts that begin college in recessions differ systematically from those that enroll in expansions, and these compositional differences partly explain observed long-term earnings gaps across graduation cohorts.

Second, the conventional “graduation effect” identified in earlier studies appears to combine three distinct influences: selection into higher education, labor market conditions at graduation, and post-graduation labor market dynamics. Earnings losses are substantially larger and more persistent among individuals who both enrolled and graduated during weak labor markets, whereas cohorts who began college during expansions experience smaller and short-lived effects. This finding underscores that scarring from early labor market entry is not uniform across cohorts but depends critically on the sequence of macroeconomic shocks encountered throughout the early career.

Third, conditions faced after, rather than at graduation per se emerge as key determinants of long-term outcomes. The accumulated unemployment rate over the first three years of labor market experience predicts subsequent earnings more strongly than the single-year graduation rate. When both graduation and post-graduation unemployment rates are included, the latter consistently show greater importance for long-term career outcomes. This suggests that what matters most for early-career trajectories is not merely the shock of entering a recessionary job market, but the persistence and depth of weak conditions that follow. Accordingly, the focus should shift from “graduating in a recession” to “starting a career in a persistently weak recovery.”

From a policy perspective, the results highlight the importance of targeting support toward graduates most at risk of long-term scarring. Governments and institutions can mitigate the enduring effects of recessions by providing wage subsidies, targeted placement assistance, or retraining programs that focus on cohorts graduating into persistently weak labor markets. Equally, in recognizing that selection during recessions brings in more vulnerable students,

higher education policy could prioritize academic and financial support for these individuals early in their college careers. Doing so would not only reduce dropout risks but also strengthen the resilience of future cohorts entering challenging labor markets.

In conclusion, the long-term costs of recessions extend beyond the immediate employment losses at graduation. They are embedded in the broader economic context in which individuals make education and early-career decisions. Understanding these trajectories provides not only a more accurate measure of the true burden of economic downturns but also a roadmap for designing policies that help the most vulnerable graduates recover faster and more fully from the shocks of the business cycle.

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# Appendix

Table A.1: Fixing Enrollment Conditions. Effect of Unemployment Rate at Graduation

	High $U_{c18}$						Low $U_{c18}$					
	ln Earnings	ln Wage	Pr(Empl)	Pr(Full time)	ln Hours	Occupation Earnings	ln Earnings	ln Wage	Pr(Empl)	Pr(Full time)	ln Hours	Occupation Earnings
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$U_{sc}$	-0.031** (0.013)	-0.013 (0.011)	0.004 (0.005)	-0.010* (0.005)	-0.0002 (0.012)	-0.005 (0.006)	-0.026*** (0.010)	-0.014** (0.006)	-0.009* (0.004)	-0.011*** (0.004)	-0.019** (0.008)	-0.002 (0.003)
$U_{sc} \times Potexp$	0.004 (0.005)	-0.002 (0.005)	-0.001 (0.002)	0.004** (0.002)	-0.004 (0.004)	0.002 (0.002)	0.010*** (0.003)	0.004* (0.002)	0.003** (0.001)	0.003** (0.001)	0.006** (0.003)	0.001 (0.001)
$U_{sc} \times Potexp^2$	-0.0002 (0.0005)	0.0002 (0.0005)	-0.0001 (0.0002)	-0.0004** (0.0002)	0.001 (0.0004)	-0.0001 (0.0002)	-0.001*** (0.0003)	-0.0003 (0.0002)	-0.0003** (0.0001)	-0.0002** (0.0001)	-0.001* (0.0003)	-0.0001 (0.0001)
Obs	29136	29136	32824	30626	30092	30586	43013	43013	48580	45484	44599	46138
Clusters	867	867	867	867	867	867	1071	1071	1071	1071	1071	1071

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

The sample consists of college graduates with 1–10 years of potential experience who turned 22 years old between 1976 and 2019. The table presents the estimation results of Equation 8. High  $U_{c18}$  defines the cohorts for which the detrended national unemployment rate at 18 (college enrollment) was higher than 0.1%. Low  $U_{c18}$  defines the cohorts for which the detrended national unemployment rate at 18 (college enrollment) was lower than 0.1%. The state-level unemployment rate is defined as the unemployment rate in the year the individual turned 22 in the state of their current residence. The table indicates the fixed effects included in each specification. All specifications control for race and include a cubic time trend. Standard errors are clustered by state-graduation year.

Table A.2: Fixing Enrollment Conditions. Effect of Accumulated Unemployment Rate

	High $U_{c18}$						Low $U_{c18}$					
	In Earnings	In Wage	Pr(Empl)	Pr(Full time)	In Hours	Occupation Earnings	In Earnings	In Wage	Pr(Empl)	Pr(Full time)	In Hours	Occupation Earnings
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$U_{sc}^{ACC}$	-0.029*** (0.011)	-0.019* (0.010)	-0.004 (0.005)	-0.010** (0.005)	-0.010 (0.013)	-0.008 (0.005)	-0.013* (0.008)	-0.007 (0.006)	-0.004 (0.003)	-0.005 (0.004)	-0.004 (0.007)	0.001 (0.003)
$U_{sc}^{ACC} \times Potexp$	0.007** (0.004)	0.005 (0.003)	0.001 (0.002)	0.003** (0.002)	0.001 (0.004)	0.003 (0.002)	0.003 (0.002)	0.002 (0.002)	0.001 (0.001)	0.001 (0.001)	0.001 (0.002)	-0.0001 (0.001)
$U_{sc}^{ACC} \times Potexp^2$	-0.0005* (0.0003)	-0.0003 (0.0003)	-0.0001 (0.0001)	-0.0003** (0.0001)	-0.00003 (0.0003)	-0.0002 (0.0001)	-0.0002 (0.0002)	-0.0001 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0002)	-0.000 (0.0001)
Obs	22,921	22,921	25,399	24,007	23,704	23,997	35,746	35,746	39,815	37,716	37,110	37,668
Clusters	816	816	816	816	816	816	1071	1071	1071	1071	1071	1071

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

The sample includes college graduates with 3–10 years of potential experience who turned 22 between 1976 and 2017. High  $U_{c18}$  defines cohorts for which the detrended national unemployment rate at 18 (college enrollment) was higher than 0.1%, and low  $U_{c18}$  defines cohorts for which it was lower than 0.1%. The model uses two main explanatory variables: the unemployment rate at 22 (graduation) and the mean unemployment rate in the two years following graduation (Equation 7). The unemployment rate is defined as the rate in the year the individual turned 22 in the state of current residence. Fixed effects for state and cubic time trend are included. All specifications control for race, and standard errors are clustered by state-graduation-year.

Table A.3: Fixing Enrollment Conditions. Effect of Unemployment Rate at Graduation for individuals from low SES.

	High $U_{c18}$						Low $U_{c18}$					
	In Earnings	In Wage	Pr(Emp  Pop)	Pr(Full time)	In Hours	Occupation Earnings	In Earnings	In Wage	Pr(Emp  Pop)	Pr(Full time)	In Hours	Occupation Earnings
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Average effect 1-10 PE	-0.017 (0.016)	0.003 (0.013)	-0.008 (0.009)	-0.003 (0.010)	-0.009 (0.024)	0.009 (0.008)	0.006 (0.018)	0.011 (0.012)	-0.003 (0.010)	-0.012 (0.010)	0.010 (0.014)	0.004 (0.005)
Potential Exp = 1	-0.055** (0.024)	-0.029 (0.011)	0.0003 (0.012)	-0.029** (0.013)	0.028 (0.032)	-0.012 (0.013)	0.027 (0.025)	0.027* (0.016)	-0.006 (0.009)	-0.001 (0.009)	-0.005 (0.027)	0.004 (0.008)
Potential Exp = 3	-0.032** (0.014)	-0.007 (0.011)	-0.004 (0.007)	-0.012 (0.007)	-0.000 (0.024)	0.003 (0.009)	0.013 (0.017)	0.016 (0.010)	-0.003 (0.010)	-0.009 (0.009)	0.002 (0.017)	0.003 (0.004)
Potential Exp = 7	0.004 (0.017)	0.006 (0.015)	-0.017* (0.009)	0.004 (0.010)	0.001 (0.021)	0.009 (0.009)	0.004 (0.016)	0.008 (0.011)	-0.009 (0.010)	-0.013 (0.008)	0.029** (0.014)	0.010* (0.005)
Obs	1,595	1,595	1,930	1,732	1,655	1,722	2,083	2,083	2,531	2,280	2,164	2,264

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

The sample consists of college graduates with potential experience from 1 to 10 years who turned 22 between 1976 and 2018 and reported their mother's education as high school or less. High  $U_{c18}$  defines cohorts for which the detrended national unemployment rate at 18 (college enrollment) was higher than 0.1%, and low  $U_{c18}$  defines cohorts for which it was lower than 0.1%. The graduation unemployment rate is the state unemployment rate at age 22. Controls include race dummies and a cubic time trend. I exclude state fixed effects because of the low degree of freedom but I cluster standard errors by state. The estimates are derived using the formula  $\hat{\beta}_2 + \hat{\beta}_3 \times potexp + \hat{\beta}_4 \times potexp^2$  from Equation 8.

Table A.4: Heckman Selection Model. Effect of Unemployment Rate at Graduation.

	ln Earnings (1)	ln Wage (2)	Pr(Emp Pop) (3)	Pr(Full time) (4)	ln Hours (5)	Occupation Earnings (6)
$U_{sc}$	-0.025*** (0.006)	-0.015*** (0.005)	-0.006*** (0.002)	-0.008*** (0.002)	-0.013* (0.007)	-0.004* (0.002)
$U_{sc} \times Potexp$	0.008*** (0.002)	0.003 (0.002)	0.002*** (0.001)	0.004*** (0.001)	0.003*** (0.003)	0.002** (0.001)
$U_{sc} \times Potexp^2$	-0.001*** (0.0002)	-0.0002 (0.0002)	-0.0002*** (0.0001)	-0.0002*** (0.0001)	-0.0002 (0.0002)	-0.0001* (0.0001)
Selection Equation						
$U_{s,c18}$	0.003 (0.002)	0.003 (0.002)	0.003* (0.002)	0.003* (0.002)	0.004 (0.003)	0.002 (0.001)
Correlation $\rho$	-0.912*** (0.003)	-0.738*** (0.035)	-0.945***	-0.821***	-0.014 (0.010)	-0.980*** (0.001)
Heckman $\lambda$	-0.990 (0.009)	-0.553 (0.019)	-0.452 (0.096)	-0.330 (0.104)	-0.011 (0.008)	-0.545 (0.003)
First Stage						
$U_{s,c18}$	0.004* (0.002)	0.004* (0.002)	0.003* (0.002)	0.003* (0.002)	0.004* (0.002)	0.003 (0.002)
Obs	235,361	235,361	259,785	239,460	238,008	239,323
Clusters	1,989	1,989			1,989	1,989
State FE	X	X	X	X	X	X

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

The table presents the results of Heckman selection model estimation. The overall sample consists of high school graduates, vocational school graduates, and college graduates. Being selected in the sample means having a college degree. I include individuals with potential experience from 1 to 10 years who turned 18 between 1977 and 2014. The graduation unemployment rate is the state unemployment rate at age 22. The controls include race dummy, cubic time trend, and state fixed effects. Standard errors are clustered by state and graduation year.

Table A.5: Probability of College Enrollment and College Graduation

	Pr(Ever Enrolled)			Pr(Grad)					
	(1)	(2)	(3)	High $U_{18}$			Low $U_{18}$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$U_{s,c-4}$	0.002** (0.001)	0.002* (0.001)	0.002* (0.001)						
$\bar{U}_{s,c-3..c-1}$				0.010*** (0.002)	0.010*** (0.002)	0.010*** (0.002)	-0.001 (0.003)	-0.001 (0.003)	-0.001 (0.003)
Obs	331,343	331,343	331,343	78,646	78,646	78,646	120,535	120,535	120,535
Clusters	1,989	1,989	1,989	867	867	867	1,112	1,112	1,112
State FE	X	X	X	X	X	X	X	X	X
Cohort FE	X	X	X	X	X	X	X	X	X
Year FE	X			X			X		
Time trend		X			X			X	
Age FE			X			X			X

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

Columns (1)-(3) are estimated based on the sample of individuals who completed high school and more. Ever Enrolled is defined as 1 if an individual reports more than 1 year of college and 0 otherwise. Columns (4)-(9) report estimates based on the sample of people who were ever enrolled, i.e. reported at least 1 year of college. Graduated is defined as 1 if the individual reports a completed bachelor's degree (or at least 4 years of college) and 0 otherwise. High  $U_{c18}$  defines the cohorts for which the detrended national unemployment rate at 18 (college enrollment) was higher than 0.1%. Low  $U_{c18}$  defines the cohorts for which the detrended national unemployment rate at 18 (college enrollment) was lower than 0.1%. The state-level unemployment rate is defined as the unemployment rate in the year the individual turned 22 in the state of their current residence. The table indicates the fixed effects included in each specification. All specifications control for race. Standard errors are clustered by state-graduation year.

Table A.6: Probability of Post-graduate Degree

	Pr(Post-Grad)			Pr(Post-Grad)					
				High $U_{18}$			Low $U_{18}$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$U_{s,c}$	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)	0.006** (0.003)	0.006** (0.003)	0.006** (0.003)	0.00002 (0.003)	-0.0001 (0.003)	-0.0003 (0.002)
Obs	94,853	94,853	94,853	37,166	37,166	37,166	57,687	57,687	57,687
Clusters	1,989	1,989	1,989	867	867	867	1,112	1,112	1,112
State FE	X	X	X	X	X	X	X	X	X
Cohort FE	X	X	X	X	X	X	X	X	X
Year FE	X			X			X		
Time trend		X			X			X	
Age FE			X			X			X

Note: \* - significant at 10%; \*\* - significant at 5%; \*\*\* - significant at 1%. Standard errors are in parentheses.

The sample consists of individuals who reported at least a Bachelor's degree. Post-graduate degree is defined as 1 if an individual reports any degree beyond bachelor's and 0 otherwise. I consider only individuals older than 24 (the earliest possible year to obtain a master degree). High  $U_{c18}$  defines the cohorts for which the detrended national unemployment rate at 18 (college enrollment) was higher than 0.1%. Low  $U_{c18}$  defines the cohorts for which the detrended national unemployment rate at 18 (college enrollment) was lower than 0.1%. The state-level unemployment rate is defined as the unemployment rate in the year the individual turned 22 in the state of their current residence. The table indicates the fixed effects included in each specification. All specifications control for race. Standard errors are clustered by state-graduation year.

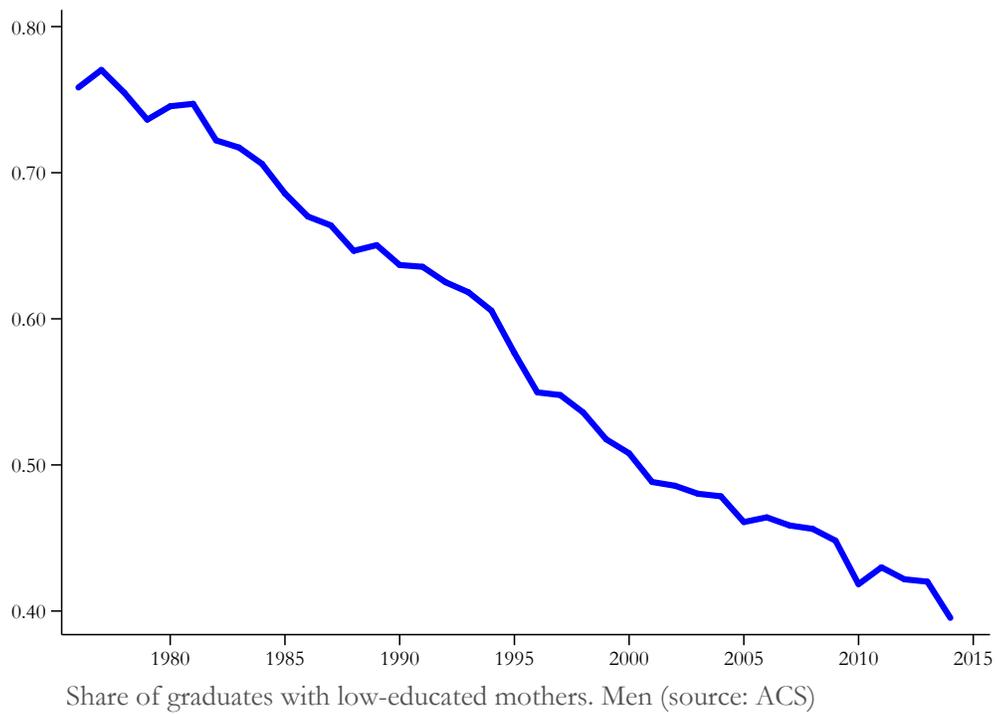


Figure A.1: Raw share of college graduates with low-educated mothers.

Note: The figure presents the raw share of male college graduates with low-educated mothers. The share was calculated as the number of graduates who report mother's education as high school or less to the number of graduates who reported mother's education. Source: ACS.

## Abstrakt

Přehodnocuji dlouhodobé dopady absolvování vysoké školy během recese tím, že se zaměřuji na celé trajektorie hospodářského cyklu, namísto míry nezaměstnanosti v roce absolvování. Na základě dat CPS z let 1976–2024 ukazují, že přetrvávající rozdíl v příjmech mezi těmi, kteří absolvovali v období vysoké oproti nízké nezaměstnanosti, především odpovídá dopadům nezaměstnanosti v době ukončení studia na absolventy s nižším GPA, nižšími výsledky SAT a z méně příznivého socioekonomického prostředí, kteří se zapsali na méně prestižní vysoké školy, protože nezaměstnanost byla vysoká v době jejich ukončení střední školy. Zatímco „jizvové“ efekty absolvování během recese jsou u těchto hraničních absolventů značné a přetrvávají více než deset let, u studentských kohort, které nastoupily na vysokou školu v podmínkách nízké nezaměstnanosti, jsou tyto efekty menší, než se dříve předpokládalo, a mizí během tří let. Rovněž ukazují, že nepříznivé podmínky na trhu práce po roce absolvování vysoké školy mají silnější vliv na dlouhodobé výsledky absolventů než samotná míra nezaměstnanosti v roce absolvování. Sledování trajektorií nezaměstnanosti a zohlednění selektivního zápisu do studiu zdůrazňuje z hlediska veřejné politiky významnou zranitelnost hraničních absolventů vůči recesím.

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