Educational Attainment and the Evolution of Cumulative Earnings across 45 US Birth Cohorts

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March 18, 2026

Abstract

Educational attainment profoundly shapes cumulative earnings trends across US birth cohorts. Between the 1933 and 1977 cohorts, men with an advanced degree experienced rising earnings in both the early-career (ages 25 to 44) and late-career (ages 45 to 64) stages, while those with a sub-baccalaureate education—and college graduates outside the 1951–1965 cohorts—saw minimal earnings growth. Women experienced broad-based gains, with larger increases among those with a bachelor's or advanced degree. For less educated men, extended work life represented the primary growth margin in the late-career stage. While gaps between education groups widened, within-group dispersion rose across cohorts, particularly among men born between 1933 and 1957. These cohort-to-cohort changes emerged at labor market entry and persisted throughout thecareer cycle, indicating that entry conditions critically shape long-run inequality dynamics.

JEL Codes: I24, I26, J24, J31

- **Disclosure Statement:** The views expressed herein are those of the authors and do not indicate concurrence by the Federal Reserve Bank of Boston, the Federal Reserve Board of Governors, or the Federal Reserve System. Any views expressed are those of the authors and not those of the US Census Bureau. The Census Bureau has reviewed this data product to ensure appropriate access, use, and disclosure avoidance protection of the confidential source data used to produce this product. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.
- **Acknowledgments:** The authors thank Jeffrey Thompson and Osborne Jackson for constructive feedback; Bryce Hannibal and Shital Sharma for assistance with Census RDC data access and disclosure review; Lucy McMillan for excellent research assistance; and Larry Bean and Brad Arndt for editorial support.

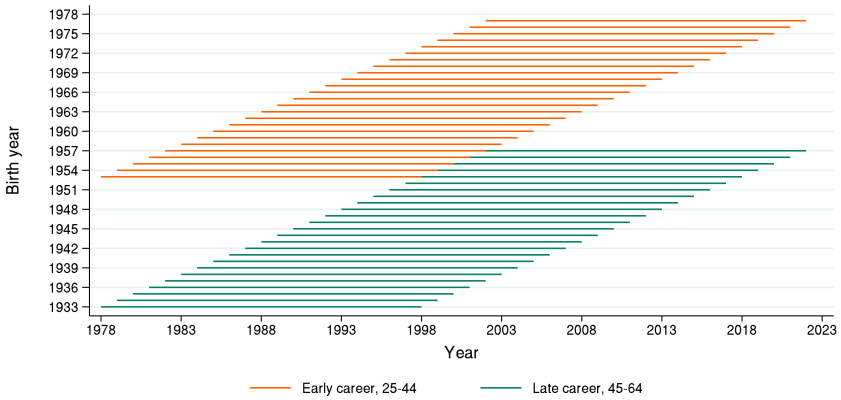
1 Introduction

This paper presents the first comprehensive empirical analysis of how long-term cumulative earnings across educational attainment have evolved over US birth cohorts. Educational attainment has long been recognized as a strong predictor of wage rates and labor market attachment—both critical determinants of workers' lifetime earnings capacity. While cross-sectional earnings snapshots provide valuable insights, long-term cumulative earnings more accurately capture lifetime earnings disparities between education groups. Historically, data constraints have limited such long-term analyses in the United States. However, the increasing availability of administrative longitudinal data has enabled us to substantially enhance our understanding of lifetime earnings distributions across demographic groups. By leveraging survey-linked administrative panel wage data, we examine three dimensions of education-earnings dynamics: 20-year cumulative earnings trends across cohorts by educational attainment, the evolution of between-group earnings gaps, and the changing dispersion of within-group earnings. Our findings document how shifting labor supply and demand forces have generated divergent cohort earnings trajectories across education levels, and they offer insights into the mechanisms underlying these patterns.

Our analysis draws upon a linked data set combining the Current Population Survey Annual Social and Economic Supplement (CPS-ASEC) with restricted-use detailed earnings records (DER) from the Social Security Administration (SSA). The DER provide individual-level panel data on wages and salaries derived from W-2 tax forms covering the period from 1978 to 2021, which we merge at the individual level with the CPS-ASEC to incorporate self-reported gender and educational attainment. Using this data set of 1.4 million workers, we examine the evolution of 20-year cumulative earnings across birth cohorts within five educational categories: less than high school (LTHS), high school graduates, some college, bachelor's degree holders, and advanced-degree holders. Our analysis distinguishes between two career stages: the early-career stage (ages 25 to 44) and the late-career stage (ages 45 to 64). We define our primary outcome measure, 20-year cumulative earnings, as the logarithm of summed annual wage income over each career stage, with all wage records inflation-adjusted using the Personal Consumption Expenditures (PCE) price index. The extensive time span of our data set allows us to measure late-career cumulative earnings for cohorts born between 1933 and 1957 and early-career cumulative earnings for cohorts born between 1953 and 1977 (see Figure 1).

Educational attainment profoundly differentiates earnings growth trajectories across successive US birth cohorts. For men, a clear hierarchical relationship emerges between educational attainment and earnings growth. Men with an advanced degree experienced the most robust earnings growth, gaining 0.40 log points in late-career earnings between the 1933 and 1957 cohorts and 0.28 log points in early-career earnings between the 1953 and 1977 cohorts. Those with a bachelor's degree also realized considerable, though more modest, growth (0.20 and 0.23 log points across the respective cohort groups). However, this growth was predominantly concentrated among those born

Figure 1: Birth Cohorts and Cumulative Earnings Outcomes



between 1951 and 1964, with relatively stagnant cumulative earnings for cohorts outside this window. For men with a sub-baccalaureate education, earnings trajectories remained largely flat across both cohort groups examined. An exception appears in early-career cumulative earnings among men with LTHS born after 1965, which experienced a modest uptick, likely reflecting this group's extended exposure to higher minimum wages implemented at the state and federal levels during the post–Great Recession era. In contrast to the lopsided growth observed among men, women at all educational attainment levels experienced robust earnings growth across successive birth cohorts. Women with a bachelor's or advanced degree demonstrated the largest growth, while those with a sub-baccalaureate education saw more modest, yet still substantial, increases. This growth was particularly pronounced among female cohorts born between 1933 and 1957, when late-career cumulative earnings rose by 0.39 to 0.50 log points for bachelor's- or advanced-degree holders and by 0.25 to 0.37 log points for those with some college education or less. Although growth moderated in more recent cohorts, it remained considerable. Between the 1953 and 1977 female birth cohorts, early-career cumulative earnings increased by 0.32 to 0.40 log points for women with at least a bachelor's degree and by 0.13 to 0.18 log points for those with some college education or less. Paralleling the pattern observed among men, women without a high school diploma born after 1965 experienced more favorable early-career growth trajectories, likely reflecting their greater exposure to higher real minimum wages.

These divergent growth trends between genders and across education levels primarily reflect group differences in the intensive margin—average earnings in years with employment. However, the extensive margin—cumulative years of employment—also experienced substantial changes for certain gender–education groups. These shifts in labor market attachment proved particularly consequential for the cumulative earnings trajectories of workers with lower educational attainment. Between the 1933 and 1957 birth cohorts, cumulative years of employment in the late-career stage rose markedly for both genders across all education levels. Women saw an increase of 0.75 to 1.07 cumulative working years, on average, while men saw comparable gains of 0.77 to 1.01 years. This significant extension of working life can be partially attributed to adjustments in Social Security's normal retirement age (NRA),

which rose incrementally from 65 to 66 for those born between 1937 and 1943 and from 66 to 66.5 for individuals born between 1954 and 1957, creating strong financial incentives for delayed retirement. The extended working years contributed 0.04 to 0.07 log points to total cumulative earnings growth across all gender–education groups. This represented 80 percent of total cumulative earnings growth for men with a high school diploma compared with 15 percent for men with an advanced degree. Among women, the pattern was similar but less pronounced, with the contribution accounting for 21 percent of earnings growth for high school graduates compared with 10 percent for those with an advanced degree. These findings highlight how increased employment years have become a critical driver of late-career earnings growth, particularly for less educated men. Cumulative employment years continued to increase for subsequent female cohorts born between 1953 and 1977 during their early-career stage, yielding an additional 0.02 to 0.06 log points in cumulative earnings growth beyond what intensive margin changes alone would have produced. By contrast, men from these same cohorts exhibited minimal changes in cumulative employment years.

These education-stratified earnings trends indicate significant changes in cumulative education premiums across the 45 cohorts studied. We consider two education premium metrics: the college premium, measuring the earnings difference between workers with a bachelor's degree and those with a high school diploma, and the advanced-degree premium, capturing the earnings difference between bachelor's- and advanced-degree holders. For men, both premiums expanded substantially by more than 0.20 log points across the cohorts studied, albeit at uneven rates. Mirroring the earnings trends of male college graduates, the college premium increased rapidly between the 1951 and 1964 male cohorts while showing relatively stagnant trends before and after this cohort span. The advanced-degree premium rose sharply between the 1933 and 1951 cohorts, followed by more moderate growth in subsequent cohorts. Women's cumulative education premiums exhibited distinctly different trends. Their cumulative college premium grew at a steady pace across all cohorts studied; however, by contrast, their cumulative advanced-degree premium maintained a largely flat trend, showing modest gains only among the more recent, 1965–1977 birth cohorts. Importantly, our comparison of cumulative and point-in-time education premiums across the life cycle reveals that growth in education premiums across successive cohorts stems primarily from newer cohorts entering the labor market with larger wage gaps between education groups. After labor market entry, the subsequent evolution of education premiums is largely determined by life-cycle effects that are remarkably stable across cohorts.

This comparison further reveals that education premiums based on cumulative earnings can differ substantially from those derived from point-in-time earnings. The magnitude of this discrepancy varies according to the age at which cross-sectional observations are made and to education-related differences in labor market attachment. To illustrate, female cohorts born between 1973 and 1977 experienced a cumulative college premium of 0.61 log points during their early-career stage, while point-in-time premiums at ages 25, 35, and 45 were 0.36, 0.55, and 0.57 log points, respectively. Since education premiums follow a concave trajectory over the life cycle, premiums measured

at younger ages (that is, 20s to early 30s) substantially underestimate the total long-term earnings gains associated with higher levels of education. Furthermore, greater educational attainment correlates with not only higher wage rates but also more consistent labor market participation. Women in the 1973–1977 birth cohort with a bachelor's degree accumulated, on average, 0.32 more years of any employment and 1.43 more years of full-time employment during their early-career stage compared with peers with only a high school diploma. Accounting for these long-term cumulative differences in labor market attachment elevates education premiums beyond levels observed at any single age across the same career stage. In addition, accounting for these extensive margin effects can influence the evolution of education premiums across birth cohorts. For example, the substantial increase in cumulative employment years among bachelor's-degree-holding women in the 1933–1957 cohorts narrowed the cumulative earnings gaps between them and advanced-degree-holding women in the same cohorts, even though these gaps show little change in cross-sectional earnings data. This highlights the non-trivial role of the employment margin in determining long-term earnings disparities across education groups.

Finally, we find that earnings dispersion within education groups increased substantially during the late-career stage among men born between 1933 and 1957, driving a sharper rise in their overall cumulative inequality compared with their female peers or younger cohorts of either gender. These divergent patterns largely reflect differences in lower-tail within-group inequality: The 1933–1957 male cohorts experienced expansion in both tails of the distribution, while men in subsequent cohorts and women across all cohorts showed compression or stagnation at the bottom that counterbalanced rising upper-tail dispersion. Notably, these cohort-level patterns align closely with documented cross-sectional inequality trends. **?** and **?** observe that growth in residual inequality slowed considerably from the late 1980s to the early 2000s—precisely when post-1957 cohorts, who exhibited slower inequality growth, entered the labor market. Moreover, as with education premiums, the pace at which within-group dispersion changes across successive cohorts is largely determined at labor market entry and remains stable over the life cycle. These findings indicate that cohort effects actively drive cross-sectional inequality trends rather than merely reflecting them: As new cohorts enter with increasingly disparate wage distributions—both within and across education groups—overall labor market inequality rises.

These findings contribute to several related strands of literature. First, we present the first comprehensive documentation of how cumulative earnings by educational attainment have evolved across birth cohorts in the United States. We build upon **?**, who analyze lifetime earnings (ages 25 to 55) for US men and women born between 1932 and 1958 using SSA earnings records. Our research extends their analysis by uncovering divergent trajectories among different education groups that underlie broader cumulative earnings trends. Our work also augments **?**, who link the 2004 Survey of Income and Program Participation (SIPP) with SSA longitudinal earnings records to investigate the relationship between education and cumulative earnings throughout career cycles. Their study provides valuable insights

into cumulative education premiums across different career stages in the United States. However, their methodological approach—pooling multiple birth cohorts to construct a complete career-cycle picture—inadvertently conflates life-cycle patterns with cohort-specific effects. Our analysis demonstrates that these two factors have distinct influences on cumulative education premiums, requiring separate examination to fully understand earnings dynamics both across the career cycle and between successive birth cohorts.

Due to data limitations, other studies on long-term cumulative earnings rely predominantly on either longitudinal survey responses from single cohorts or simulated earnings extrapolated from cross-sectional surveys. For example, **?** use the National Longitudinal Survey of Youth 1979 (NLSY79) to investigate lifetime earnings disparities between Black and White individuals born between 1957 and 1964. Likewise, **?** leverage NLSY79 data to analyze how work hours and wage components contribute distinctly to lifetime earnings inequality. **?** examine the relationship between health inequality and lifetime earnings inequality by combining longitudinal earnings data from both the NLSY79 and the Panel Study of Income Dynamics (PSID). Taking a different approach, **?** investigate lifetime earnings inequality using simulated future employment and wage trajectories based on cross-sectional observations of contemporary older workers in the Current Population Survey (CPS). Our research complements this body of literature on long-term cumulative earnings by examining both the level and distribution of cumulative earnings using administrative wage records, thereby avoiding the limitations of simulations and survey-related biases. Notably, similar administrative data sources have been used more extensively in European research on lifetime earnings. For instance, **?** compare current and lifetime income inequality using Norwegian administrative records, while **?** examine the evolution of lifetime earnings inequality using German administrative data. Focusing more directly on educational outcomes, **?** assesses the causal lifetime returns to education using Norwegian administrative data, and **?** employs Swedish administrative records to estimate lifetime earnings premiums associated with a college education.

Second, we contribute to the literature examining how educational attainment shapes earnings. Canonical studies document substantial shifts in education premiums since the mid-20th century while examining how the interplay between skill supply variations and increasing skill demand have shaped these long-term trends (**??????**). More recent research demonstrates that the college wage premium has stagnated since the early 2000s, due primarily to a deceleration in skill-biased technological change (**???**). We extend this body of work by characterizing how these factors manifest empirically in cohort earnings dynamics. Our findings reveal that increases in the education premium across successive cohorts are largely determined at labor market entry, highlighting the dominant role of early-life-cycle factors such as cohort sizes and skill specialization patterns in shaping these trends. We also document how cumulative and point-in-time education premiums relate across the life cycle. Previous research on intergenerational mobility using non-US administrative data demonstrates significant life-cycle bias when using earnings snapshots as proxies for lifetime earnings (**?????**). Consistent with these studies, we find that this relationship varies by age. Premiums

measured at younger ages substantially underestimate long-term cumulative education premiums. Moreover, consistent with **?**, our analysis reveals that accounting for differences in cumulative labor market attachment can generate substantial compounding effects that widen earnings disparities across education groups.

Third, this paper extends the inequality decomposition literature by documenting how cumulative earnings dispersion—both between and within education groups—shapes overall inequality trends. Earlier research identifies the distinct contributions of between-group and within-group inequality, as well as changes in the distribution of education and experience, to rising cross-sectional earnings inequality in the United States (**????**). Using similar methods, we show how between- and within-group components contribute to cumulative earnings inequality across successive US cohorts, with their relative importance varying over time. We also show that, like education premiums, changes in within-group inequality across cohorts are largely determined at labor market entry. These findings build on **?**, who show through theoretical modeling and calibration that most lifetime inequality originates from differences in initial conditions at age 23, and on **?**, who document that rising lifetime earnings inequality across cohorts stems primarily from greater inequality at labor market entry. Our results provide further evidence that early-career wage distributions—both within and across education groups—critically drive inequality trends across cohorts.

The rest of paper is structured as follows. Section 2 details our data sources and earnings measurement methodology. Section 3 examines the evolution of cumulative earnings by educational attainment across cohorts. Section 4 analyzes the resulting implications for cumulative education premiums. Section 5 decomposes the growth in overall cumulative earnings inequality. Section 6 concludes.

2 Data

2.1 Data Sources

Our analysis draws upon the restricted-use (DER) data from the SSA spanning from 1978 through 2021. The DER, derived from the SSA's master earnings file (MEF), contain individual-level panel data on wages and salaries, tips, self-employment income, and deferred compensation. Throughout this period, DER coverage consistently encompassed nearly all wage workers in the United States, with the exception of non-military federal employees (added in 1983 and 1984), state and local government employees (added in 1991), and police and firefighters (added in 1994) (**?**). While wage and salary income in the DER is not subject to topcoding, self-employment income was topcoded at annual FICA limits until 1994. Therefore, we focus our analysis on annual wage income, defined as the total wage and salary earnings reported on W-2 forms across all jobs held by a worker in a given year, excluding any self-employment income or deferred contributions to retirement accounts. This approach allows us to avoid complications associated with the topcoding schemes of self-employment income.

We link these wage records to the CPS-ASEC to obtain workers' self-reported demographic information, including gender and educational attainment. There are 42 CPS-ASEC years (1979 and 1981 through 2021) available for linkage. The share of CPS-ASEC observations linked to the DER varies by survey year, ranging from about 50 percent to 80 percent (**?**). While linkage rates are nonrandom—higher for more educated workers and lower for less educated workers—this selection at the education margin poses fewer concerns in our study, as all analyses are stratified by education, and we do not derive outcomes directly from the pooled sample.[1] To minimize the likelihood of educational attainment changes after the survey or unobserved selection based on longevity, we restrict our sample to individuals aged 25 to 70 surveyed by the CPS. We further link this sample to the SSA's Numident file to obtain workers' birth years and, when applicable, death years. All wage records are inflation-adjusted using the personal consumption expenditure (PCE) deflator, with 2021 as the base year.

2.2 Measurement of Cumulative Earnings

Using this sample, we analyze the evolution of 20-year cumulative earnings across birth cohorts for demographic groups defined by both gender and educational attainment. We focus on two career stages: the early-career stage (ages 25 to 44) and the late-career stage (ages 45 to 64). Our primary outcome measure, 20-year cumulative earnings, is calculated by summing real annual wage income over each career stage and then applying a logarithmic transformation:

$$\omega^i_{a,a+19} = \ln(\sum_{\tau=a}^{a+19} W^i_\tau),$$

where $a \in 25, 45$. Our data set enables measurement of late-career cumulative earnings for cohorts born between 1933 and 1957 and early-career cumulative earnings for cohorts born between 1953 and 1977. Notably, for cohorts born between 1953 and 1957, we observe cumulative earnings for both the early- and late-career stages. This overlap allows us to differentiate between earnings variations resulting from career progression and cohort differences. Throughout our study, we separately analyze earnings trends within each career stage. However, in some cases, such differentiation enhances our analytical capacity to identify meaningful earnings patterns across the full spectrum of 45 birth cohorts, despite drawing from different career stages for the older and younger cohorts.

We measure cumulative earnings in logarithmic form. This transformation offers several analytical advantages over using real dollar values. First, logarithmic transformation facilitates straightforward interpretation of wage differences across demographic groups and time periods. In this form, differences between values approximately represent percentage differences, aligning with standard practices in the literature for measuring education-related earnings premiums. Second, since cumulative earnings in our sample closely follow a log-normal distribution, the

[1] To assess potential effects of selection within other dimensions, we compare our results to those that are reweighted based on race and state of residence distributions in the CPS-ASEC for each demographic group defined by cohort, gender, and education. The results are closely comparable in terms of levels and trends.

distribution can be efficiently characterized by the mean and standard deviation of its logarithmic form. Unlike arithmetic means, logarithmic means are robust to extreme values and, in a log-normal distribution, are equivalent to the logarithm of median earnings. Therefore, these two moments—mean and standard deviation—provide concise yet comprehensive metrics for tracking how the earnings distribution of any given demographic group evolves over time, capturing changes in both central tendency and dispersion.

2.3 Sample Restriction

We apply minimum labor market attachment criteria to our sample, consistent with approaches used in the literature for studying both annual earnings and cumulative earnings. Specifically, we restrict our sample to workers who were alive throughout the career stage being examined and had annual earnings at or above the following threshold for at least half of the years (10 out of 20) in the respective career stage:

$$W_t^* = \text{Federal minimum wage}_t \times 20 \text{ hours} \times 26 \text{ weeks}.$$

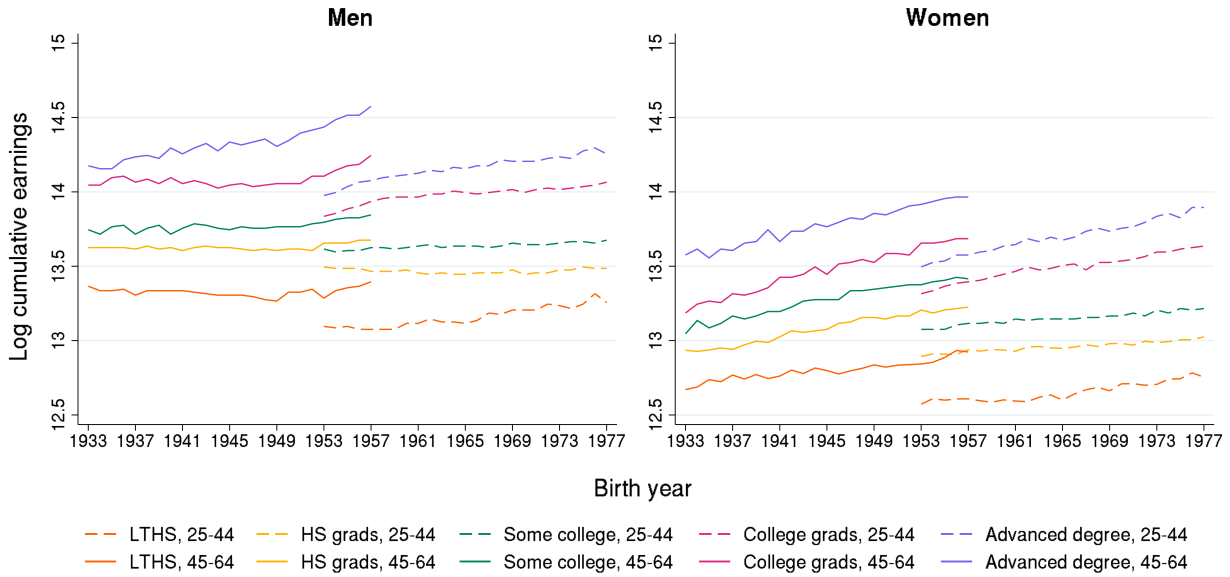
In 2021, this threshold was equal to $3,770. We intentionally set the threshold low to include all workers with meaningful long-term labor market attachment while excluding individuals chronically absent from the workforce during the relevant career stage. After we implement these restrictions, our final analytical sample comprises 1.4 million individuals distributed across genders, educational attainment levels, career stages, and birth cohorts.

3 Trends in Education and Cumulative Earnings

This section examines trends in cumulative earnings by educational attainment for US male and female 1933–1977 birth cohorts. We document distinct trajectories across education groups and genders and decompose the trends into contributions from changes in cumulative employment years and in annual wages.

3.1 Cumulative Earnings by Educational Attainment

Figure 2: Trends in Education and Cumulative Earnings in Early- and Late-career Stages



Note: Each data point represents the mean log cumulative earnings for a specific birth cohort (1933–1977) by gender, education group, and career stage (that is, early or late career).

Sources: 1978–2021 Current Population Survey (CPS) Annual Social and Economic Supplements (ASEC) and Social Security Administration (SSA) Detailed Earnings Records (DER) extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.

Figure 2 plots mean cumulative earnings across birth cohorts by educational attainment and gender. Solid lines represent late-career cumulative earnings for cohorts born between 1933 and 1957; dashed lines represent early-career earnings for cohorts born between 1953 and 1977. Colors denote educational attainment: orange (LTHS), yellow (high school diploma), green (some college or associate degree), pink (bachelor's degree), and purple (advanced degree). Note that the downward shift from solid to dashed lines reflects life-cycle earnings patterns, not cohort trends. Because earnings increase naturally over the life cycle, the drop in levels when moving from earlier cohorts (observed late career) to recent cohorts (observed early career) is an artifact of comparing different career stages rather than evidence of downward cohort trends.

Cumulative earnings rise with educational attainment for both men and women, with advanced-degree holders earning the most, followed by those with a bachelor's degree, some college, high school diploma, and LTHS. However, men and women exhibit distinct trends across education levels. For men, there is a clear educational hierarchy in the growth trajectories. Men with an advanced degree experienced consistent growth in cumulative earnings—an increase of 0.40 log points in late-career earnings between the 1933 and 1957 cohorts and 0.28 log points in early-career earnings between the 1953 and the 1977 cohorts. Though men with a bachelor's degree also exhibited substantial

growth (0.20 and 0.23 log points across the respective cohort groups), this growth was unevenly distributed. The majority of earnings increases occurred between the 1951 and 1964 birth cohorts, with relative stagnation in cohorts outside this range. As **?** establish, this uneven growth pattern likely reflects supply-driven fluctuations. The surge of college graduates among men born in the 1940s suppressed earnings for men born in these cohorts, while the subsequent deceleration in bachelor's-degree-attainment rates among post-1950 male cohorts corresponds with earnings increases for these later cohorts.[2]

For men with sub-baccalaureate educational attainment, earnings trajectories remained mostly flat across both career stages, except for those without a high school diploma, who experienced growth near the end of the study period. This growth, particularly among early-career cohorts, is partially attributable to compositional shifts toward immigrants. Between the 1933 and 1977 cohorts, the share of non-native male workers with LTHS education increased from 18 percent to 56 percent, and the share of non-native female workers with LTHS increased from 17 percent to 54 percent (Appendix Figure A2)—a population with stronger labor market attachment (**???**). However, excluding non-native workers attenuates but does not eliminate the upward trend (Appendix Figure A3). The more favorable earnings growth experienced by men with LTHS may be explained by differential exposure to minimum-wage increases. Between 2007 and 2010, the federal minimum wage increased from $5.15 to $7.25, raising the average real value of federal minimum wages in the 2010s by more than 10 percent relative to the 1990s or 2000s. Workers without a high school diploma, especially those in the early-career stage, were disproportionately affected by this policy shift. In 2009, just before the federal minimum wage reached $7.25, 4.7 percent of working men and 11.5 percent of working women aged 25 to 44 without a high school diploma were hourly workers earning less than $7.25 per hour, compared with only 2.2 percent of men and 4.6 percent of women with a high school diploma.[3] Minimum wage increases thus had direct implications for the earnings trajectories of workers with LTHS, depending on how long a cohort was exposed to the higher wage floor.

Women's cumulative earnings trajectories differ markedly from men's. While earnings growth among men was limited to those with a bachelor's or advanced degree, women at all education levels experienced consistent earnings growth across cohorts. Growth magnitude was larger for women with a bachelor's of advanced degree, though lower for those with a sub-baccalaureate education. Between the 1933 and 1957 cohorts, late-career cumulative earnings increased by 0.39 log points for women with an advanced degree, 0.50 log points for women with a bachelor's degree, 0.37 log points for women with some college, 0.29 log points for women with a high school diploma, and 0.25 log points for women with LTHS. Growth moderated in recent cohorts, narrowing gender differences, but remained substantial. Between the 1953 and 1977 cohorts, early-career cumulative earnings increased for all education levels, ranging from 0.13 log points for high school graduates to 0.40 log points for advanced-degree holders. As with men,

[2] See Appendix Figure A1 for educational attainment by birth cohort.
[3] Our calculations are based on CPS Outgoing Rotation Group data, 1982–2021.

women without a high school diploma showed stronger earnings growth in the early-career stage compared with those with a high school diploma or some college, likely reflecting longer exposure to the minimum-wage policy.

These findings complement **?**, who document that between the 1932 and 1958 cohorts, median lifetime earnings (ages 25 to 55) declined 10 percent for men while rising 22 percent for women. Our analysis explains this gender contrast: Women's substantial median-earnings growth reflects broad-based gains across education levels, while men's stagnant median earnings mirror education-stratified trajectories. For men, earnings growth was concentrated among those with a bachelor's degree or higher, while the majority of men with a sub-baccalaureate education experienced no advancement relative to earlier cohorts. However, unlike **?**, we observe no net decline in men's cumulative earnings within any education-level group. This difference likely stems from the examination of alternative age ranges and time periods. Our focus on later-career stages (ages 45 to 64 versus 25 to 55) and data extending through 2021 (versus 2013) captures earnings dynamics from delayed retirement and post-recession recovery.

3.2 The Extensive and Intensive Margins of Growth

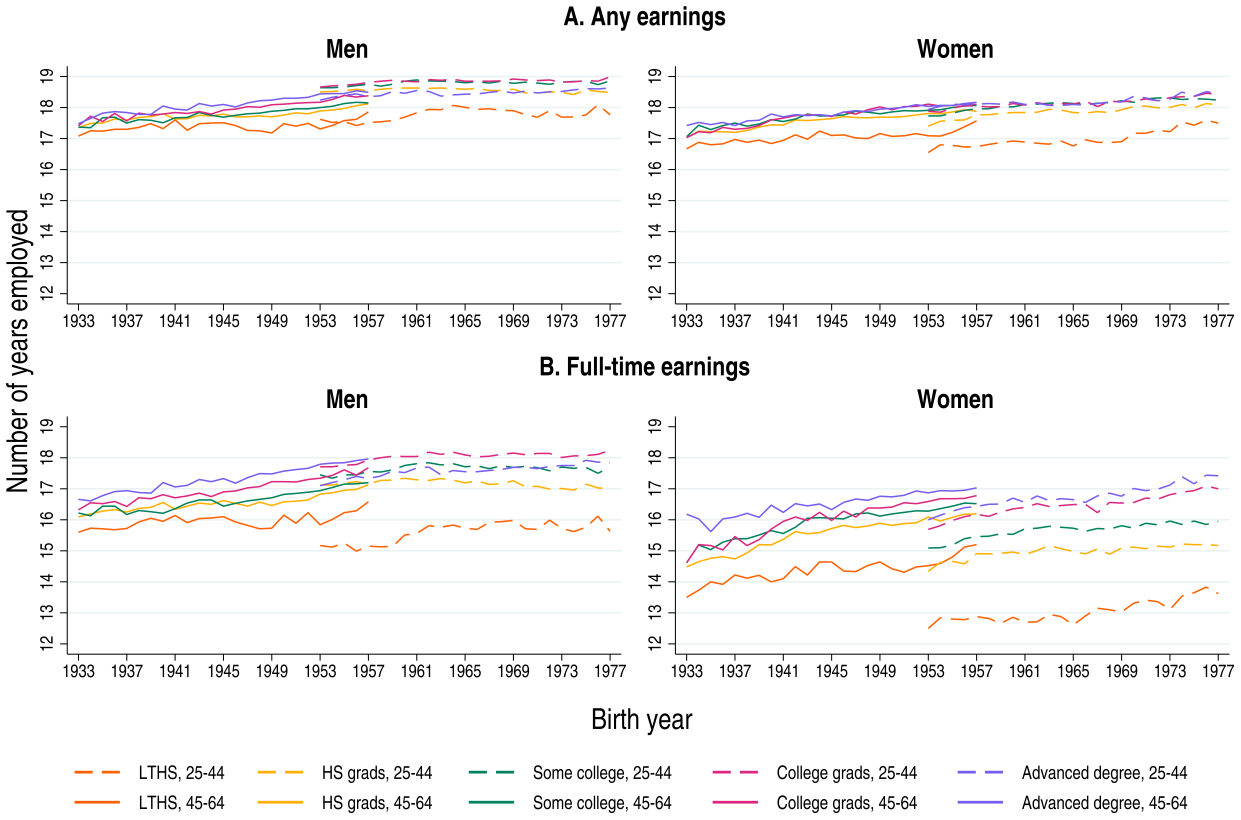
Growth in cumulative earnings across cohorts can arise from two margins: increases in years of employment (extensive margin) and higher average earnings conditional on employment (intensive margin). We assess the contributions of these margins using three measures: number of years with any earnings (Figure 3, Panel A), number of years with earnings at or above the full-time threshold—defined as the federal minimum wage multiplied by 35 hours and 39 weeks (Figure 3, Panel B)—and average log annual earnings in years with any earnings (Figure 4).

For each gender, more educated workers exhibit stronger labor market attachment than their less educated peers, except for men with an advanced degree in the early-career stage who spend fewer years employed due to additional schooling. Within each education group, women have lower cumulative labor force participation than men, though this gap narrows from the early- to late-career stages as women's participation intensity rises while men's either diminishes or grows more slowly. These differences are most salient during years with full-time equivalent earnings, indicating that employment intensity during working years, rather than merely the presence of any employment, critically differentiates variation in cumulative labor force participation.

Women's and Men's Cumulative Labor Force Participation Trends

From the 1933 cohort to the 1957 cohort, women across all education levels experienced substantial increases in labor market participation during the late-career stage. The increase in the number of years with any earnings was 0.75 to 1.07 years, while the increase in years with full-time equivalent earnings was 0.85 to 2.17 years. Labor force participation continued to increase for subsequent cohorts during the early-career stage, though at more modest rates. An exception occurred among women with LTHS in post-1965 cohorts; they experienced accelerated growth in years

Figure 3: Cumulative Employment Years by Education



Note: Each data point in Panel A and B represents the average number of years employed with any earnings and full-time earnings, respectively, for a specific birth cohort (1933–1977) by gender, education group, and career stage (that is, early or late career).
Sources: 1978–2021 CPS-ASEC and SSA DER extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.

employed. The increase likely reflects the policy effects of welfare reform and the Earned Income Tax Credit (EITC) expansion in the 1990s, which disproportionately raised labor force participation among less educated women (**???**). These employment gains were driven primarily by women in the lower half of the earnings distribution, while their counterparts in the upper half, who already maintained higher employment levels, experienced more modest growth. The overall increase in years employed therefore reflects rising labor market engagement among historically lower-earning women rather than uniform gains across the distribution.

Unlike women, who experienced broad-based growth in labor force participation across both early- and late-career cohorts, men's cumulative labor force participation diverged across career stages. For early-career men born between 1953 and 1977, changes in cumulative years of employment were relatively modest and varied by education level. Those with a bachelor's degree or higher experienced slight gains of 0.33 to 0.39 years with any earnings and 0.53 to 0.74 years with full-time equivalent earnings. By contrast, high school graduates saw corresponding declines of 0.01 and 0.13 years, respectively. Late-career men born between 1933 and 1957 demonstrated substantially larger

increases across all education levels, adding 0.77 to 1.01 years with any earnings and 0.98 to 1.36 years with full-time earnings. While these gains are less pronounced than those observed among women, they are substantial.

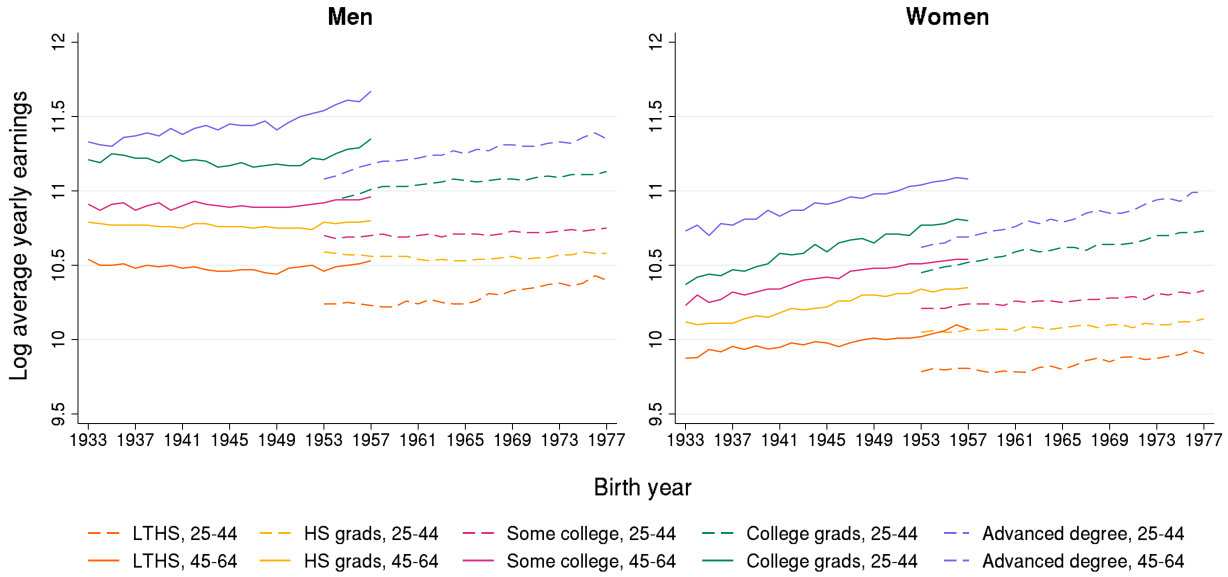
Rising employment in the late-career stage for both genders partly reflects changes to Social Security's normal retirement age (NRA). This threshold rose from age 65 to 66 in two-month intervals for cohorts born between 1937 and 1943, remained at 66 for cohorts born between 1943 and 1954, and then gradually increased again from 66 to 66.5 in two-month intervals for cohorts born between 1954 and 1957. Although these modifications occurred beyond the late-career stage examined in our analysis, they significantly impact the financial penalties that workers face when retiring early. For instance, individuals who retire at age 62 receive only 70 percent of their full Social Security benefits if their NRA is 67, compared with 75 percent if their NRA is 66, creating strong incentives for delayed retirement.

Decomposing Extensive and Intensive Margin Contributions

Increases in cumulative labor force participation contributed substantially to earnings growth in the late-career stage between the 1933 and 1957 birth cohorts. This contribution was a major source of earnings growth for workers with lower educational attainment but relatively less important for highly educated workers, who experienced substantial growth at the intensive margin, as shown in Figure 4. To quantify the contribution, we decompose log cumulative earnings into intensive and extensive margins: $\omega^i_{a,a+19} = \ln(\frac{\sum_{\tau=a}^{a+19} W^i_\tau}{\sum_{\tau=a}^{a+19} I(W^i_\tau>0)}) + \ln(\sum_{\tau=a}^{a+19} I(W^i_\tau > 0))$. The difference between total cumulative earnings growth and intensive margin growth directly measures the contribution of changes in labor force participation to earnings growth.

For men across all education levels, increased labor force participation contributed 0.04 to 0.06 log points to earnings growth. This represented more than 80 percent of total earnings growth for men with a high school diploma or less but only 15 percent for men with an advanced degree. For women, rising employment years contributed 0.04 to 0.07 log points to earnings growth, accounting for 10 percent of total growth among advanced-degree holders and more than 20 percent for those with a high school diploma or less. This trend persisted among more recent female cohorts: between the 1953 and 1977 cohorts, extensive margin changes added 0.02 to 0.06 log points to earnings growth—representing 8 percent of total growth for women with an advanced degree but exceeding 30 percent for those with a high school education or less. By contrast, changes in labor force participation had negligible effects on earnings growth trajectories for men in these more recent cohorts.

Figure 4: Average Annual Earnings Conditional on Any Employment



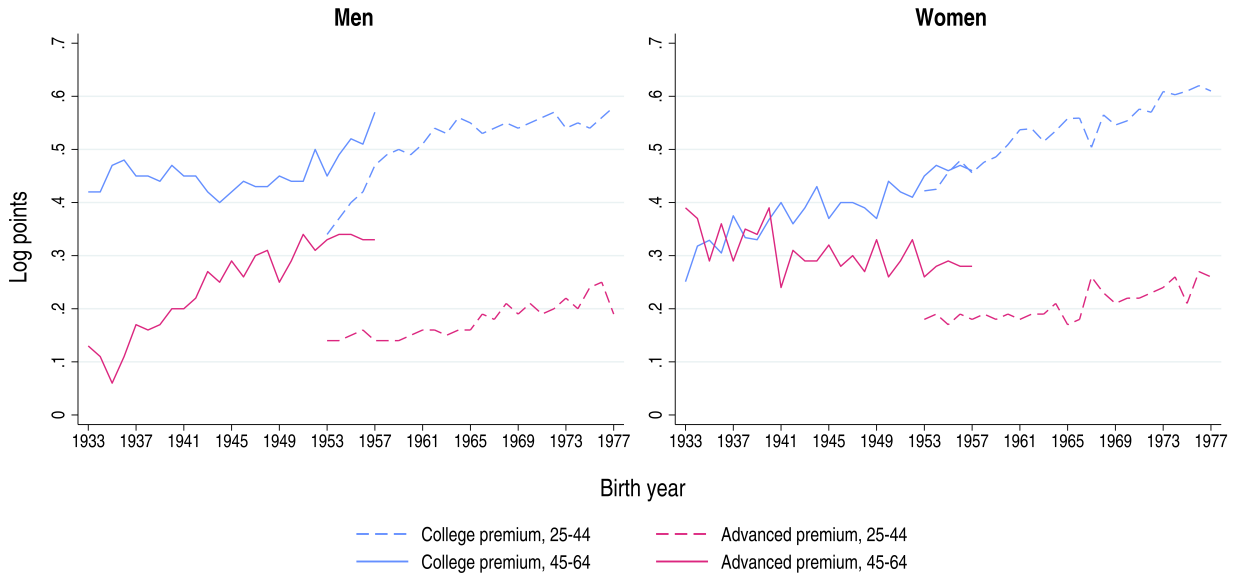
Note: Each data point represents average log annual earnings conditional on any employment for a specific birth cohort (1933–1977) by gender, education group, and career stage (that is, early or late career).
Sources: 1978–2021 CPS-ASEC and SSA DER extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.

4 Implications for Cumulative Education Premiums

Our findings related to education and cumulative earnings from Section 3 have direct implications for cumulative education premiums across the career cycle. This section examines these premiums in depth, documenting their levels and evolution across birth cohorts. We consider two types of cumulative education premiums: the college premium, defined as the difference in mean log cumulative earnings between workers with a bachelor's degree and those with a high school diploma, and the advanced degree premium, defined as the log earnings difference between advanced-degree holders and bachelor's-degree holders.

4.1 Trends in Cumulative Education Premiums

Figure 5: Cumulative Education Premiums



Note: Each data point represents cumulative education premiums measured in log points for a specific birth cohort (1933–1977) by gender and career stage (that is, early or late career).
Sources: 1978–2021 CPS-ASEC and SSA DER extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.

Figure 5 illustrates cumulative college and advanced degree premiums across birth cohorts by gender, with solid lines representing late-career premiums and dashed lines representing early-career premiums. The decline in levels when moving from earlier cohorts (measured at late career) to recent cohorts (measured at early career) reflects life-cycle dynamics in education premiums. Specifically, more educated workers typically experience steeper experience-earnings profiles than their less educated counterparts, generating education premiums that expand over the life cycle (**???????**). Importantly, examining the 1953–1957 cohorts—for whom we observe earnings at both career stages—reveals that cumulative education premiums exhibit largely parallel trajectories across both career stages. This pattern suggests that trends from either career stage effectively represent how cumulative education premiums evolve across successive cohorts, a relationship we explore further in Section 4.2. Given this consistency, our subsequent analysis pools cohorts from both career stages to examine long-term trends.

Men's cumulative college premium follows a trajectory that mirrors the earnings patterns of male college graduates—stagnating between the 1933 and 1951 birth cohorts, rebounding between the 1951 and 1965 cohorts, and then flattening thereafter. By contrast, men's cumulative advanced degree premium rose sharply between the 1933 and 1951 cohorts and sustained moderate growth between the 1951 and 1977 cohorts. Both premiums increased substantially—by more than 0.20 log points—across the 45 birth cohorts studied, underscoring the increasing cumu-

lative earnings advantages that more educated men maintain. However, growth rates diverged considerably between the two metrics. In the more recent 1965–1977 cohorts, growth occurred nearly exclusively in the advanced-degree premium, suggesting that educational advantages have shifted toward the most highly educated men. Women exhibited different trends in cumulative education premiums. Between the 1933 and 1957 cohorts, women's late-career cumulative college premium steadily grew from 0.25 to 0.46 log points, while men experienced uneven and smaller growth. For advanced-degree holders, the pattern reversed: Women's late-career cumulative advanced degree premium declined from 0.39 to 0.28 log points across these cohorts, while men's premium increased from 0.13 to 0.33 log points. This gender divergence in education-premium trends diminished among the post-1957 cohorts, with both men and women experiencing comparable growth in advanced-degree premiums. Nevertheless, women in more recent cohorts continued to see larger increases in college premiums than their male counterparts.

The gender divergence in education-premium trends stems partly from differing skill-supply dynamics between men and women. Between the 1933 and 1957 cohorts, the ratio of male advanced-degree holders to college graduates fell sharply, from 1.02 to 0.66, while women experienced a more modest reduction, from 0.57 to 0.50. This contrast aligns with the more rapid increase in men's advanced-degree premium during this period. Supply dynamics, however, explain only part of the observed gender differences. Between the 1933 and 1977 cohorts, the ratio of female college graduates to high school graduates grew substantially—from 0.16 to 0.98—outpacing men's more moderate increase from 0.30 to 0.70. Despite this larger supply growth of college-educated women relative to high school graduates, women's college premium did not diminish, as standard supply–demand models might predict. Instead, it showed stronger growth than men's college premium, suggesting that demand growth for college-educated women relative to high school graduates exceeded the corresponding demand growth for men across these cohort groups, a phenomenon that merits further investigation to understand underlying causes.

It is important to note that changes in education premiums measured in log points can exhibit different patterns compared with those measured in absolute dollar values. Table **??** compares cumulative education premiums in both log points and dollar values across cohort groups and career stages.[4] For men in the late-career stage, the cumulative college premium in dollar terms increased from $467,000 for the 1933–1937 cohort to $570,000 for the 1953–57 cohort, while for women, this premium grew from a lower base of $155,000 to $320,000. During the same cohort interval, the advanced-degree premium for men rose dramatically from $159,000 to $567,000, whereas for women, the increase was modest, from $231,000 to $277,000. Comparing the more recent cohorts (1953–1957 versus 1973–1977) at the early-career stage, the cumulative college premium for men increased from $354,000 to $531,000, while for women, it rose from $229,000 to $373,000. Similarly, during this period, the advanced degree premium increased from $169,000 to $308,000 for men and from $127,000 to $230,000 for women. In many instances,

[4] Dollar value premiums are calculated as the difference in the exponential of mean log cumulative earnings between education groups.

education premiums measured in dollar values grew much faster than the corresponding changes in log points, a contrast attributable to shifts in the underlying reference earnings levels. This divergence is particularly evident in the case of women with an advanced degree: Despite a decline in the advanced-degree premium between the 1933–1937 and 1953–1957 cohorts when measured in log points, the dollar value of this premium increased, reflecting the substantial rise in the earnings of college-educated women during this period. These comparisons highlight the substantial increase in absolute cumulative earnings gaps between education groups—a phenomenon not fully captured when premiums are expressed in log points.

Table 1: Cumulative Education Premiums in Log Points and Dollar Values

	Late-career education premium							
	Men				Women			
	College premium		Advanced degree premium		College premium		Advanced degree premium	
Birth year	Log points	$	Log points	$	Log points	$	Log points	$
1933–37	0.45	467,000	0.12	159,000	0.32	155,000	0.34	231,000
1943–47	0.42	433,000	0.27	396,000	0.40	236,000	0.30	248,000
1953–57	0.51	570,000	0.33	567,000	0.46	320,000	0.28	277,000
	Early-career education premium							
	Men				Women			
	College premium		Advanced degree premium		College premium		Advanced degree premium	
Birth year	Log points	$	Log points	$	Log points	$	Log points	$
1953–57	0.40	354,000	0.15	169,000	0.45	229,000	0.18	127,000
1963–67	0.54	500,000	0.17	219,000	0.53	299,000	0.20	162,000
1973–77	0.55	531,000	0.22	308,000	0.61	373,000	0.25	230,000

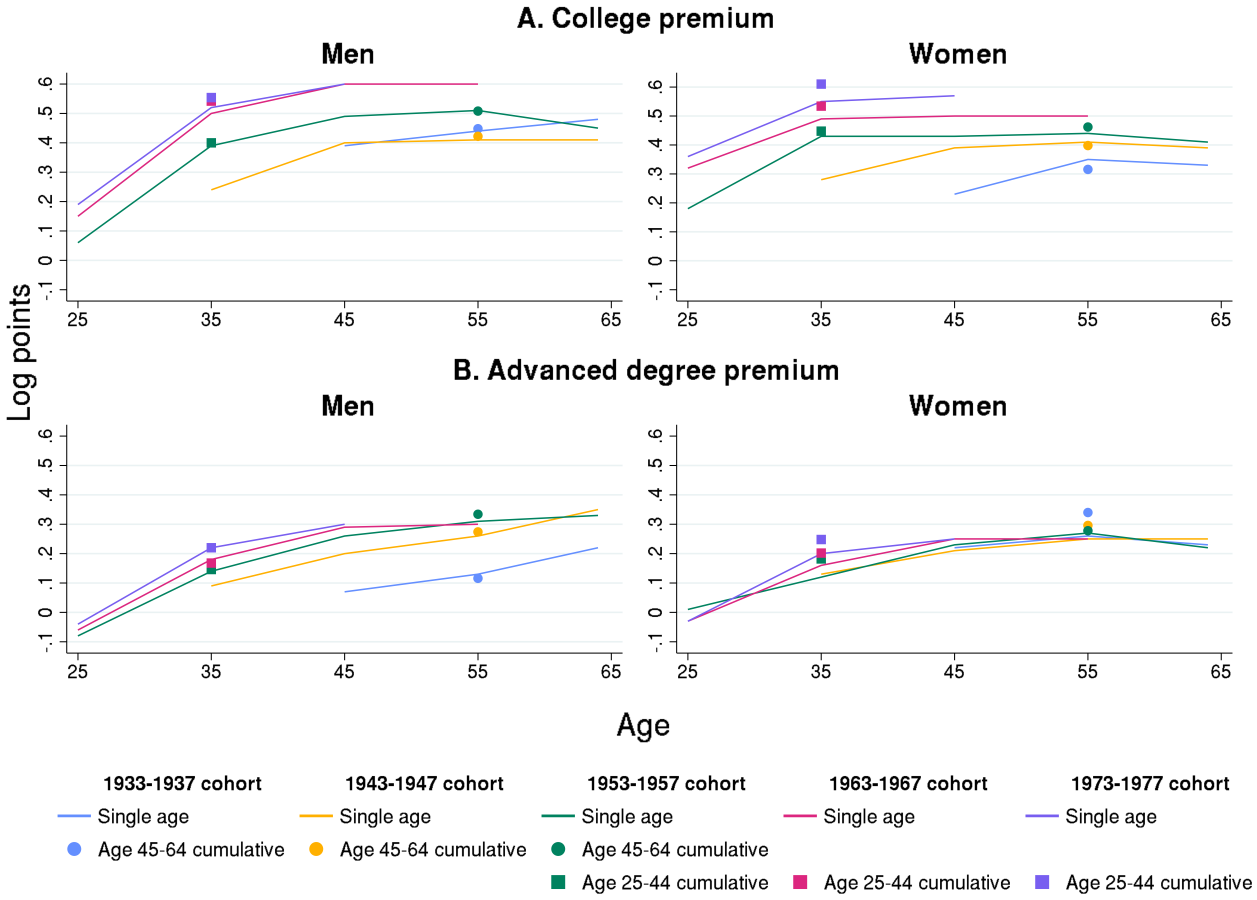
Notes: This table shows cumulative education premiums in log points and in 2021 dollar values for the 1933–37, 1943–47, 1953–57, 1963–67, and 1973–77 birth cohorts by gender and career stage (early/late).

Sources: 1978-2021 Current Population Survey (CPS) Annual Social and Economic Supplements (ASEC) and Social Security Administration (SSA) Detailed Earnings Record (DER) extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization number CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, CBDRB-FY26-051.

4.2 Comparison with Point-in-time Education Premiums

Our panel data offer a unique opportunity to compare cumulative education premiums accumulated throughout the career cycle with those observed at individual points during the cycle. While cumulative earnings differences represent a more comprehensive measure for assessing lifetime earnings premiums associated with educational attainment, researchers rarely observe them directly and instead typically rely on cross-sectional data to infer long-term earnings gaps between education groups. This comparison allows us to evaluate whether education premiums derived from cross-sectional, single-age data reliably represent the earnings differentials across parts or the entirety of the career cycle.

Figure 6: Cumulative and Point-in-time Education Premiums across the Career Cycle



Notes: This figure shows the education earnings premium for five birth cohorts (1933–1937, 1943–1947, 1953–1957, 1963–1967, and 1973–1977) by gender. Lines represent point-in-time premiums by age, circles represent late-career cumulative premiums, and squares represent early-career cumulative premiums.

Sources: 1978–2021 CPS-ASEC and SSA DER extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.

Education Premiums across the Career Cycle

Figure 6 compares cumulative college (Panel A) and advanced-degree (Panel B) premiums with their corresponding point-in-time premiums, organized by cohort groups and gender. These point-in-time premiums represent differences in mean log annual earnings between education groups, calculated using cross-sectional data from workers with earnings that meet or exceed our previously established full-time threshold (Section 3.2). Colors distinguish five cohort groups: 1933–1937, 1943–1947, 1953–1957, 1963–1967, and 1973–1977. The square markers indicate cumulative college or advanced-degree premiums during the early-career stage, while the circular markers denote the same premiums in the late-career stage.

Point-in-time education premiums typically expand over the life cycle in a concave pattern. This expansion

stems from two factors: Workers with higher educational attainment accumulate work experience at later ages, which is coupled with the diminishing return of experience (**?**), and more-skilled workers generally realize higher returns on experience (**???????**). Consistent with previous findings, our results reveal that the college premium for men more than triples between ages 25 and 45 before leveling off (Figure 6 panel A). Women's career-cycle college premium trajectories also exhibit a concave pattern but are flatter than men's, increasing by only a factor of 1.5 to 2 between ages 25 and 35 and remaining largely stagnant for the remaining working years. Unlike their male peers, college-educated women observe larger returns on additional experience relative to high-school-educated women during only the initial 10 to 15 years of their careers. After this period, earnings growth for college-educated women decelerates substantially, converging to rates similar to those of women with only a high school diploma.

Similarly, both men's and women's advanced-degree premiums follow concave trajectories over the career cycle. At age 25, workers with an advanced degree show no earnings advantage over those with a bachelor's degree, primarily because most have not yet completed their postgraduate training. By age 35, however, advanced-degree holders demonstrate a clear earnings premium over college graduates. This premium continues to expand until age 64 for men and age 55 for women. The more persistent expansion of the advanced-degree premium indicates that, relative to college graduates, advanced-degree holders experience faster earnings growth throughout the career cycle, whereas college graduates' growth advantage over high school graduates largely diminishes after age 35 for women and age 45 for men.

Education-premium trajectories over the career cycle remain consistent across birth cohort groups, as evidenced by parallel age-premium profiles, while initial premium levels rise steadily. This consistency demonstrates that increases in education premiums across birth cohorts stem primarily from widening wage gaps between education groups at labor market entry. These initial gaps persist with relative stability throughout the career cycle, with two exceptions. First, the college premium grew at an accelerated pace during the 1980s across all cohorts at their respective career stages, attributable to deteriorating earnings positions of high school graduates during this period. Second, the advanced-degree premium declined uniformly across cohort groups during the 2018–2021 period, likely reflecting upward bias in observed earnings of college graduates as a result of pandemic-induced selection effects. Barring these exceptions, the similarity in career-cycle patterns of education premiums across cohort groups suggests that factors emerging at labor market entry are the primary drivers of cross-cohort trends in education premiums.

Cumulative versus Point-in-time Education Premiums

For both men and women, cumulative college premiums generally exceed the premium measured at the median age of the corresponding career stage, sometimes by a substantial margin. For example, college-educated women born between 1973 and 1977 observed a cumulative earnings premium of 0.61 log points over their counterparts with a

high school diploma in the early-career stage, whereas the premiums at ages 25, 35, and 45 were 0.36, 0.55, and 0.57, respectively. This difference between cumulative and point-in-time premiums is driven by two factors. First, ages with higher earnings mechanically carry larger weights in determining the cumulative education premium during a career stage, making earnings observed at younger ages less reflective of long-term cumulative earnings differences between education groups. Second, cumulative education premiums are determined by differences in annual wages (intensive margin) and cumulative labor market participation (extensive margin), both of which favor college-educated workers over their peers with a high school diploma. Again using women in the 1973–1977 birth cohort as an example, women with a bachelor's degree accumulated 0.32 more years with any employment and 1.43 more years with full-time equivalent earnings during their early-career stage than high school graduates. Accounting for extensive margin differences therefore increases college premiums.

Beyond shifting premium levels, incorporating extensive margin effects modifies our understanding of how college premiums have evolved across birth cohorts. As illustrated in Figure 3, the gap in labor force participation, particularly in years with full-time equivalent earnings, between men holding a bachelor's degree and those with a high school diploma expanded from the 1953–1957 cohort to the 1973–1977 cohort during the early-career stage. When we account for the widened extensive margin difference, growth in college premiums accelerates. Between the two cohort groups, men's cumulative college premium increased 0.15 log points, exceeding the increases of 0.13, 0.13, and 0.11 log points in cross-sectional college premiums measured at ages 25, 35, and 45, respectively. These findings demonstrate that when both intensive and extensive margin differences are considered, the earnings gap between men with a bachelor's degree and those with a high school diploma expanded more than previously recognized. However, incorporating extensive margin differences does not always accelerate the growth of education premiums. In the late-career stage, the labor force participation gap between women with an advanced degree and their peers with a bachelor's degree narrowed considerably between the 1933–1937 cohort and 1953–1957 cohort. Consequently, women's cumulative advanced-degree premium declined across these cohorts, despite relatively stable cross-sectional measurements.

These comparisons illustrate that cumulative education premiums may deviate from cross-sectional education premiums in terms of both levels and trends. This deviation depends on two factors: the specific age at which cross-sectional premiums are measured and the magnitude and direction of changes in labor force participation gaps between education groups. Even without direct access to cumulative earnings data, researchers can incorporate these factors to develop a more comprehensive understanding of lifetime earnings disparities across educational-attainment levels and of how these disparities evolve over time. For instance, when evaluating earnings gains associated with additional education, examining earnings at ages 35 to 55—when workers have likely approached or reached their full earning potential—provides more accurate insights than focusing on early-career earnings before age 35. Similarly, in-

cluding participation gaps offers greater depth to discussions on earnings inequality between education groups. When these additional dimensions are considered, cross-sectional earnings data can yield findings around the relationship between educational attainment and long-term economic outcomes that are more comparable to those derived from cumulative earnings data, without requiring decades of longitudinal observation.

5 Trends in Education and Cumulative Earnings Inequality

The analysis of education premiums in Section 4 is embedded in a larger discussion on earnings inequality. An extensive literature demonstrates that rapid growth in cross-sectional earnings inequality in the United States during the last four decades stems from two distinct factors: increasing education premiums and growing residual (within-group) inequality (**????**). This section extends this framework to examine the relationship between educational attainment and cumulative earnings inequality, analyzing inequality both within and across education groups across birth cohorts.

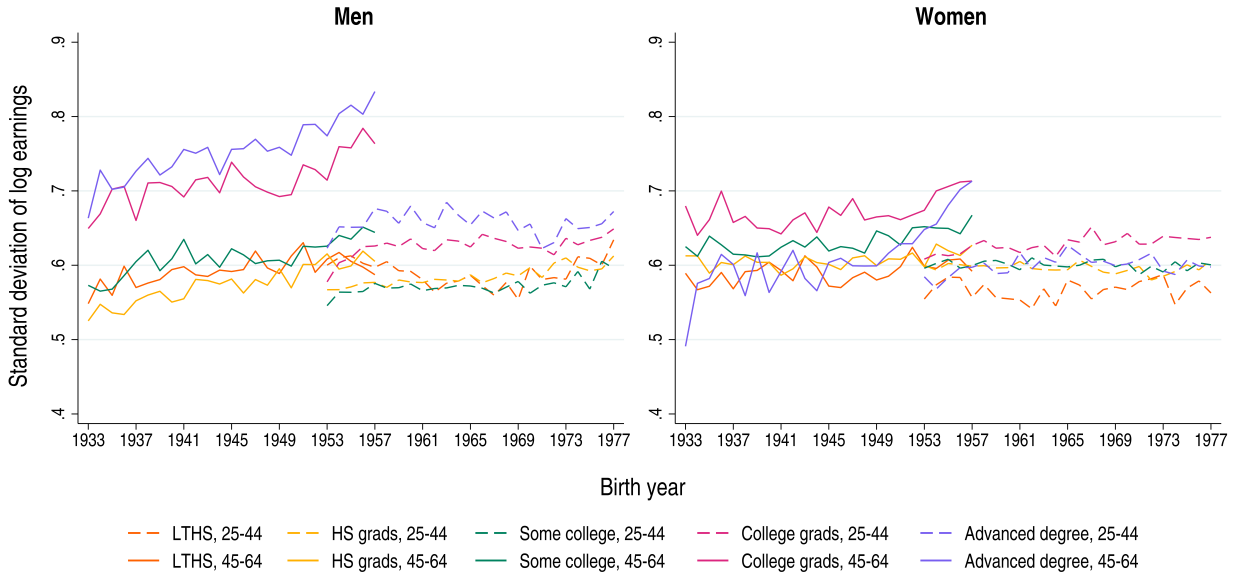
5.1 Cumulative Earnings Inequality within Education Groups

Figure 7 plots the standard deviation of log cumulative earnings across birth cohorts, stratified by educational attainment, for men and women. This metric captures the skewness of the underlying earnings distribution and serves as a commonly used measure of earnings dispersion and inequality. Solid lines represent standard deviations in the late-career stage, while dashed lines indicate the same measures during the early-career stage. Educational attainment is distinguished by the same color scheme as in earlier figures. Within a given cohort, within-group dispersion increases from the early- to late-career stages, mirroring the pattern observed in education premiums and reflecting the complementarity between skill and experience both within and across education groups.

Within-group dispersion in cumulative earnings rises monotonically with educational attainment for men, with more educated men experiencing greater earnings heterogeneity among their similarly educated peers. Across all education levels, the magnitude of dispersion grew substantially between the 1933 and 1957 male cohorts during the late-career stage, with the most pronounced increase occurring between the 1950 and 1957 birth cohorts. Standard deviations rose by 0.17 for those with an advanced degree, 0.11 for college graduates, 0.07 for those with some college education, 0.08 for high school graduates, and 0.04 for those with LTHS. The higher the educational attainment, the greater the increase in within-group earnings heterogeneity. By contrast, across the more recent 1953–1977 cohorts, growth in within-group dispersion moderated during the early-career stage, with standard deviation increases ranging from 0.03 to 0.07 across the five education categories.

Women's within-group earnings dispersion displays patterns distinct from men's in two ways. First, women's

Figure 7: Standard Deviation of Cumulative Earnings by Education and Gender



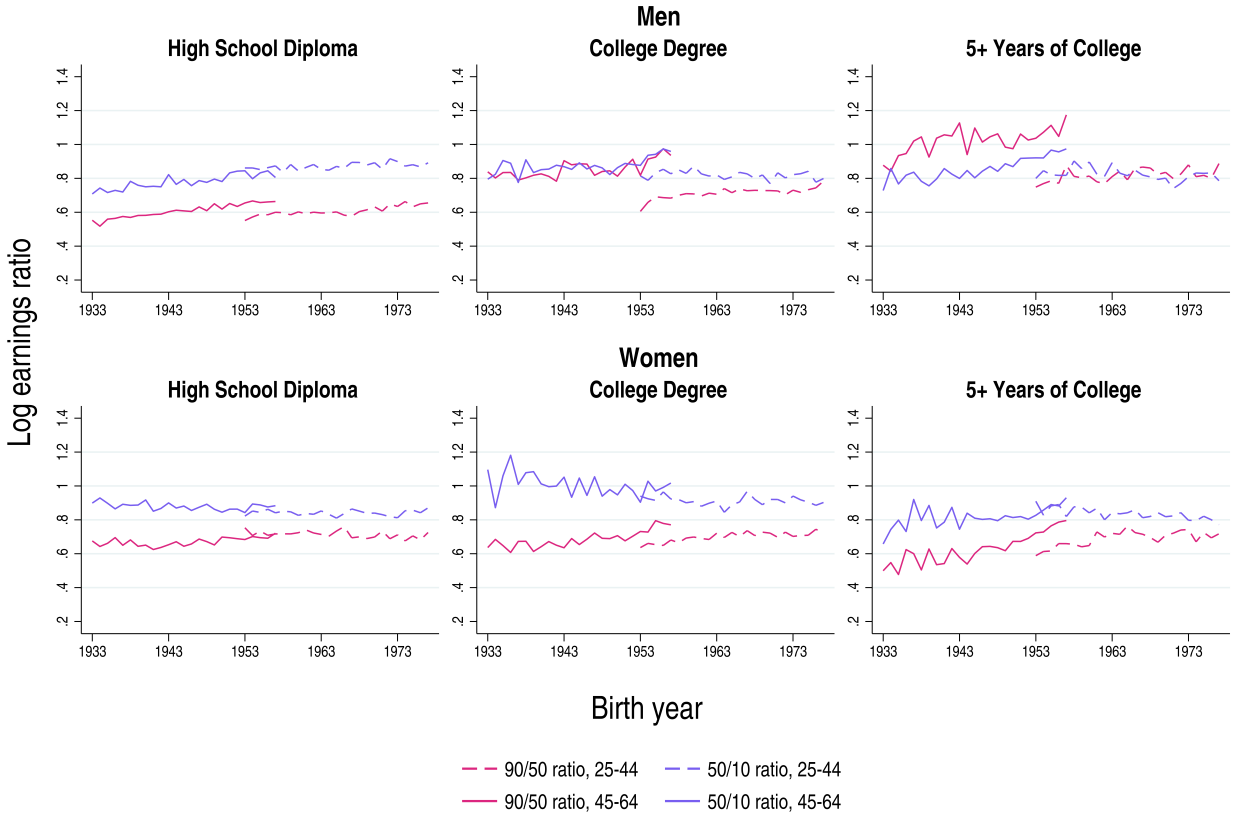
Note: Each data point represents the standard deviation of log cumulative earnings for a specific birth cohort (1933–1977) by gender, education, and career stage (that is, early or late career).

Sources: 1978–2021 CPS-ASEC and SSA DER extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.

earnings inequality does not maintain a monotonic relationship with educational attainment. Across most cohorts, women with an advanced degree demonstrated levels of within-group dispersion below their peers with a bachelor's degree and comparable to those with a high school diploma. Second, women's within-group earnings dispersion has remained relatively stable across birth cohorts, with one exception. Women with an advanced degree who were born between 1933 and 1957 experienced substantial growth in within-group dispersion during the late-career stage, with the standard deviation increasing by 0.22. By contrast, all other female demographic groups exhibited minimal changes in earnings dispersion: Standard deviation increases across education levels ranged from 0.00 to 0.04 between the 1933 and 1957 late-career cohorts and from 0.00 to 0.03 between the 1953 and 1977 early-career cohorts.

The contrasting trends between the earlier (1933–1957) and later (1957–1977) male cohorts, as well as between male and female cohorts from the 1933–1957 period, stem primarily from different trajectories in lower-tail inequality—that is, the dispersion of earnings below the median. To illustrate these differences, Figure 8 presents the log P90/P50 ratio and the log P50/P10 ratio, measures of inequality above and below the median, respectively, for each education group across birth cohorts. The substantial increase in within-group earnings inequality across the earlier-born male cohorts manifests through largely parallel movements in upper-tail and lower-tail inequality, demonstrating symmetric widening of the earnings distribution from the median. While upper-tail inequality continued to expand across the later-born male cohorts at a slower pace, increases in lower-tail inequality stagnated or reversed, contributing

Figure 8: 50/10 and 90/50 Earnings Ratios



Note: Each data point represents the log 90/50 or 50/10 cumulative earnings ratio for a specific birth cohort (1933–1977) by gender, education, and career stage (early or late career).
Sources: 1978–2021 CPS-ASEC and SSA DER extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.

to more modest earnings growth among these younger male cohorts. Similarly, the relatively stable inequality trends observed among most female education groups stem from counterbalancing movements between upper-tail and lower-tail inequality. The compression of the lower earnings distribution, characterized by declining proportions of women experiencing very low cumulative earnings, offsets expanding upper-tail inequality, resulting in flat overall inequality trends.

The divergent trajectories in upper-tail and lower-tail cumulative inequality closely mirror previous cross-sectional findings regarding the evolution of residual inequality in the United States. **?** document similar diverging patterns between upper-tail and lower-tail residual inequality since the late 1980s, which led to flatter growth in overall residual inequality during this period. The timing of this cross-sectional deceleration in residual inequality growth coincided with the entry of post-1957 cohorts into the labor market. This temporal overlap suggests two possible interpretations: Either the observed cross-sectional pattern can be partially attributed to cohort effects—that is, as cohorts with increasing within-group wage dispersion enter the labor market, observed cross-sectional residual

inequality rises—or, alternatively, this timing reflects how different cohorts experience varying exposure to cross-sectional shocks that elevate residual inequality across all ages.

Cumulative versus Point-in-time Earnings Inequality within Education Groups

To gain a more comprehensive understanding of whether these inter-cohort dynamics stem from cohort effects or differential exposure to cross-sectional shocks, we next compare within-group cumulative inequality with point-in-time inequality across the life cycle. Figure 9 illustrates this comparison by juxtaposing the standard deviation of log cumulative earnings against the standard deviations of log annual earnings measured at ages 25, 35, 45, 55, and 64 for men and women by educational-attainment level.[5] The square markers indicate cumulative earnings inequality during the early-career stage, while the circular markers represent the same measure in the late-career stage.

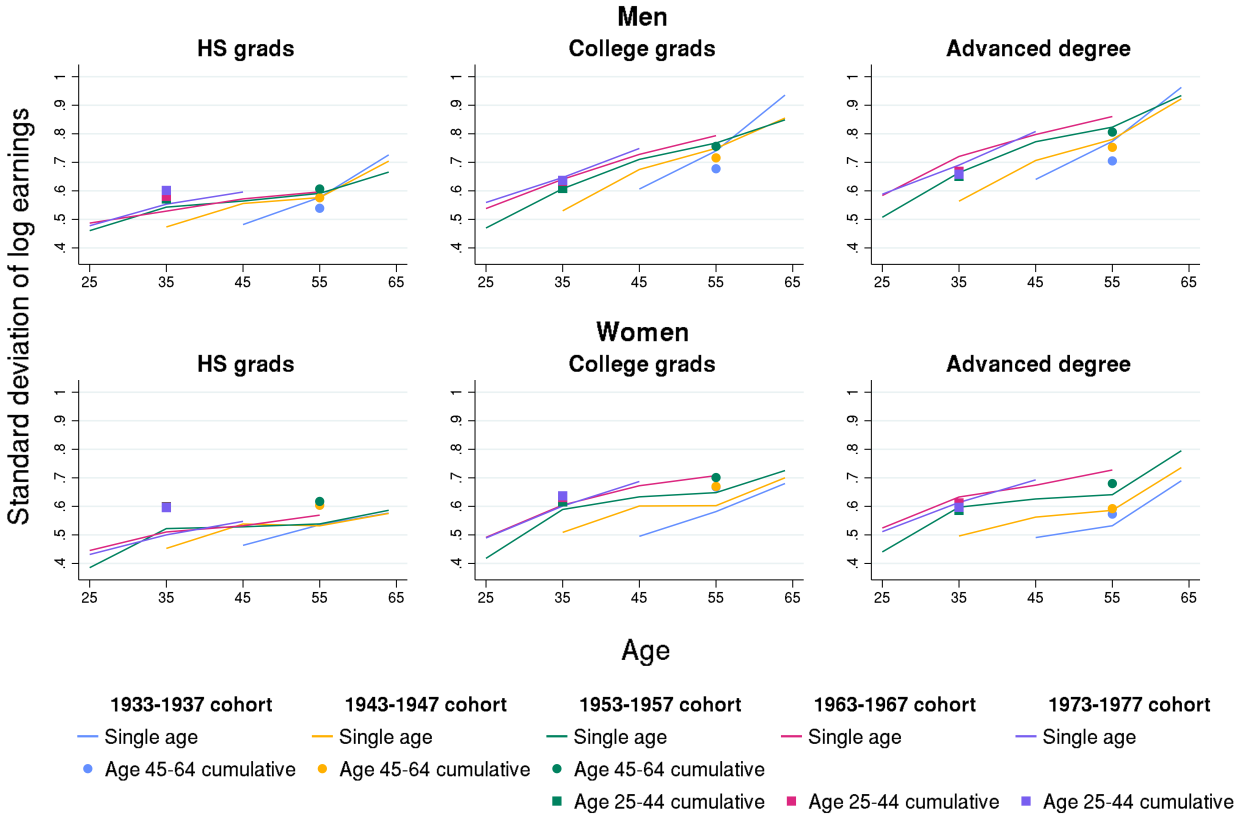
For both men and women, within-group dispersion follows an upward trajectory throughout the life cycle. This dispersion begins at its lowest level at labor market entry and increases steadily as workers progress in their careers, with an uptick near retirement age. Across successive cohort groups, within-group dispersion increased, as evidenced by the upward shift of the cohort curves. This increase occurred more rapidly among earlier-born cohorts (1933–1937 to 1953–1957) but has decelerated in subsequent cohort groups. Importantly, the largely parallel curves—mirroring patterns observed in education premiums—demonstrate that the increase in within-group dispersion for each successive cohort group emerges at labor market entry and remains fairly consistent throughout the life cycle.

An exception occurs during the 1980s, when growth in within-group dispersion accelerated across all education cohort groups in their respective career stages, particularly among high school graduates. A possible explanation is the documented decline in real minimum wage values during this period, which disproportionately affected lower-earning and less educated workers (**???**). Beyond this episode, the shapes of age-dispersion profiles within each gender–education group remain closely comparable across cohort groups, suggesting that once a cohort enters the labor market, the subsequent evolution of inequality is shaped primarily by life-cycle effects. This pattern provides further evidence that cohort effects partially drive cross-sectional inequality patterns rather than merely resulting from them. As new cohorts enter the workforce with increasingly disparate skill and wage distributions both within and across education groups, overall inequality rises.

Beyond illustrating inequality dynamics across the life cycle and between cohorts, Figure 9 reveals distinctions between within-group dispersion measures derived from cross-sectional snapshots versus those based on cumulative earnings. Among workers characterized by lower and more variable cumulative labor force participation—such as women without an advanced degree and men with sub-baccalaureate educational attainment in recent cohorts—

[5] Similarly to the comparison in Section 4.2, the cross-sectional measure is calculated using data from workers with annual earnings meeting or exceeding the full-time threshold, defined as the federal minimum wage multiplied by 35 hours and 39 weeks.

Figure 9: Cumulative versus Point-in-time Earnings Inequality within Education Groups



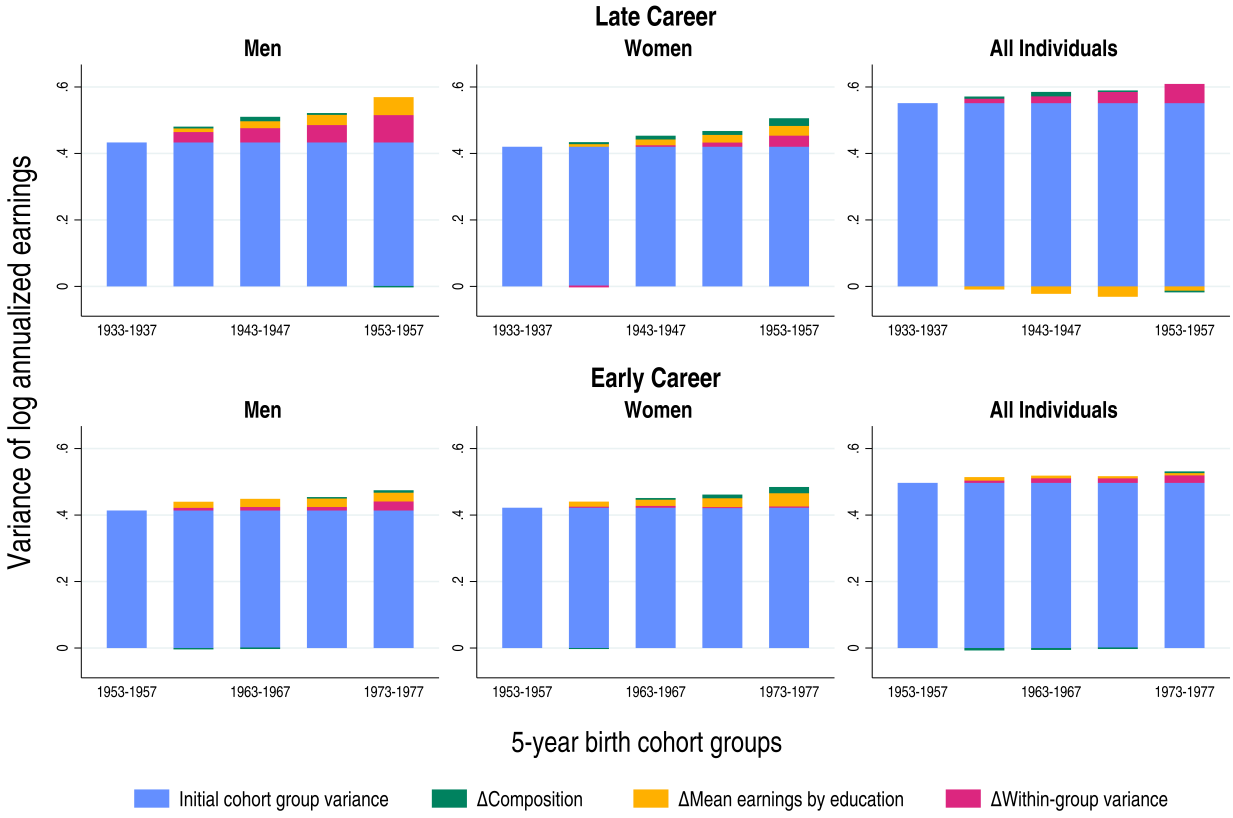
Notes: This figure shows earnings inequality, measured by the standard deviation of log earnings, for five birth cohorts (1933–1937, 1943–1947, 1953–1957, 1963–1967, and 1973–1977) by gender and education level. Lines represent point-in-time dispersion by age, circles represent dispersion of late-career cumulative earnings, and squares represent dispersion of early-career cumulative earnings.
Sources: 1978–2021 CPS-ASEC and SSA DER extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.

cumulative earnings dispersion can substantially exceed what cross-sectional earnings suggest. For example, for female high school graduates born between 1973 and 1977, early-career cumulative earnings yield a standard deviation of 0.60, markedly higher than the cross-sectional standard deviations of 0.43, 0.50, and 0.55 observed at ages 25, 35, and 45, respectively. These differences highlight that, much as differences in long-term labor market attachment deepen earnings gaps between education groups, employment gaps can generate compounding inequalities within demographic groups.

5.2 Trends in Cumulative Earnings Inequality across Education Groups

To illustrate how the evolution of education premiums and within-group dispersion contributed to broader inequality trends, we analyze changes in cumulative earnings variance across successive male and female birth cohorts using standard variance decomposition methods. This decomposition separates the total variance change into

Figure 10: Variance Decomposition



Note: This figure decomposes changes in the variance of log cumulative earnings across birth cohorts into four components: baseline variance, contributions from shifts in demographic composition, contributions from shifts in dispersion of mean group earnings, and contributions from changes in within-group earnings dispersion.

Sources: 1978–2021 CPS-ASEC and SSA DER extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.

three components: shifts in educational attainment distribution (Δcomposition), changes in mean earnings differentials between education groups (Δmean group earnings), and changes in earnings dispersion within education groups (Δwithin-group variance).[6] We conduct separate analyses for each gender and for the pooled population, though in the latter case, we define groups by gender–education combinations rather than education alone. Figure 10 presents our decomposition results. The upper panel depicts the evolution of cumulative earnings variance during the late-career stage across five cohort groups, while the lower panel presents corresponding changes during the early-career stage.

[6]The total variance of log earnings ω for a given birth cohort c can be decomposed as:

$$\text{Var}(\omega^c) = \sum_E \pi_e^c(\bar{\omega}_e^c - \bar{\omega}^c)^2 + \sum_E \pi_e^c \text{Var}(\omega_e^c),$$

where π_e^c represents the education (or education–gender) composition of the cohort and serves as the group weight. Group weights are estimated using CPS basic monthly data from 1978 to 2025. The first term measures between-group variance (dispersion of group means), and the second term measures within-group variance. Our decomposition sequentially replaces the observed values of these components for a given cohort with values from the baseline cohort (1933–1937 for late-career earnings and 1953–1957 for early-career earnings) in the following order: (1) population composition π_e^c, (2) mean group earnings $\bar{\omega}_e^c$ and $\bar{\omega}^c$, and (3) within-group variance $\text{Var}(\omega_e^c)$. The resulting differences represent the respective contributions of these three components to changes in total variance.

Bar heights represent total variance for each cohort. The blue area indicates the baseline variance associated with the initial cohort group. The remaining segments—green, yellow, and red—represent variance changes attributable to shifts in demographic composition, mean group earnings, and within-group variance, respectively.

Between the 1933–1937 and 1953–1957 cohort groups, the variance of late-career cumulative earnings increased from 0.43 to 0.57 for men, from 0.42 to 0.51 for women, and from 0.55 to 0.59 for the combined population. The total increase for men can be decomposed as follows: –0.00 (–1 percent) was attributable to shifts in educational attainment composition, 0.05 (40 percent) stemmed from increased variability in mean group earnings, and 0.08 (61 percent) resulted from rising within-group dispersion. Women's earnings displayed a different pattern, with 0.02 (27 percent) of the total increase arising from educational attainment composition changes across cohorts, 0.03 (34 percent) from greater variability in mean group earnings, and 0.03 (39 percent) from increased within-group dispersion. The more pronounced increase in men's earnings inequality compared with women's was primarily driven by larger increases in within-group dispersion and, to a lesser degree, in earnings dispersion between education groups. Conversely, changes in educational attainment composition contributed substantially to women's earnings inequality (27 percent) while having negligible effects on men's—a difference attributable largely to men's slower and non-monotonic growth in educational attainment. Earnings inequality remained relatively stable for the overall population (upper-right panel). Although rising within-group dispersion and increasing education premiums exerted upward pressure on overall inequality, the narrowing of gender-related earnings gaps produced countervailing effects, a finding similarly reported by **?**. This counterbalance is evidenced by the negative contribution from changes in mean group earnings, resulting in a more modest upward inequality trend for the total population compared with the inequality trend observed for either gender.

In contrast to the uneven growth patterns between genders observed in earlier birth cohorts, earnings inequality trends for men and women followed more parallel trajectories between the 1953–1957 and 1973–1977 cohort groups. Men's cumulative earnings variance in the early-career stage increased from 0.41 to 0.47, a considerably smaller rise than that observed between the 1933–1937 and 1953–1957 cohort groups, while women's variance grew from 0.42 to 0.48 during this period. This convergence in inequality trends between genders among later cohorts stems from the decelerated growth in between-group and within-group dispersion among men, as our earlier analysis demonstrates. Across the total population, the narrowing of gender wage gaps continues to offset widening wage differences between education groups, resulting in a modest variance increase from 0.50 to 0.53 across these cohorts. These findings underscore that cumulative earnings inequality dynamics reflect the interplay of evolving education premiums, within-group dispersion, and demographic composition changes, with the narrowing of gender pay gaps mitigating overall inequality growth across the 45 cohorts examined.

6 Conclusion

Earnings growth across 45 US birth cohorts has been sharply stratified by educational attainment. Relative to earlier cohorts, workers with a bachelor's degree or higher experienced substantially greater cumulative earnings premiums over their sub-baccalaureate counterparts. These trajectories have varied over time. Among men born between 1965 and 1977, earnings gains accrued disproportionately to advanced-degree holders, while the college premium, though sizable, showed only modest growth. Beyond widening education premiums, earnings dispersion within education groups also increased across cohorts, driven primarily by divergence between top and median earners. These two factors—widening education premiums and rising within-group heterogeneity—have driven overall cumulative earnings inequality upward across successive cohorts. Notably, cross-cohort shifts in both education premiums and within-group inequality emerge at labor market entry and remain stable throughout careers. This pattern suggests that early-career mechanisms, such as skill specialization, occupation choice, and initial sorting across industries and firms, are key drivers of long-run inequality trends. Our findings also highlight the extensive margin's role in cumulative earnings. Extended working years contributed meaningfully to late-career earnings growth for workers born between 1933 and 1957, particularly among less educated men. Women born between 1953 and 1977 continued experiencing increases in employment years that accelerated cumulative earnings growth. Beyond affecting earnings growth, differences in employment years generate compounding effects that widen disparities both between and within education groups. These findings provide new insights into how education differentiates lifetime earnings across decades of US workers and their evolving implications for understanding economic inequality in the United States.

References

Aaberge, R. and M. Mogstad (2015). Inequality in current and lifetime income. *Social Choice and Welfare 44*(2), 217–230.

Autor, D. H., L. F. Katz, and M. S. Kearney (2008). Trends in us wage inequality: Revising the revisionists. *The Review of economics and statistics 90*(2), 300–323.

Bengali, L., M. Sander, R. G. Valletta, and C. Zhao (2023). Falling college wage premiums by race and ethnicity. *FRBSF Economic Letter 22*.

Bengali, L., R. G. Valletta, and C. Zhao (2025). Explaining stagnation in the college wage premium. Technical report, IZA Discussion Papers.

Bhuller, M., M. Mogstad, and K. G. Salvanes (2017a). Life-cycle earnings, education premiums, and internal rates of return. *Journal of Labor Economics 35*(4), 993–1030.

Bhuller, M., M. Mogstad, and K. G. Salvanes (2017b). Life-cycle earnings, education premiums, and internal rates of return. *Journal of Labor Economics 35*(4), 993–1030.

Bick, A., A. Blandin, and R. Rogerson (2024). Hours worked and lifetime earnings inequality. Technical report, National Bureau of Economic Research.

Blank, R. M. (2002). Evaluating welfare reform in the united states. *Journal of Economic Literature 40*(4), 1105–1166.

Bönke, T., G. Corneo, and H. Lüthen (2015). Lifetime earnings inequality in germany. *Journal of Labor Economics 33*(1), 171–208.

Bound, J. and G. Johnson (1992). Changes in the structure of wages in the 1980s: An evaluation of alternative explanations. *American Economic Review 82*(3), 371–392.

Bowlus, A. J. and J.-M. Robin (2004). Twenty years of rising inequality in us lifetime labour income values. *The Review of Economic Studies 71*(3), 709–742.

Braga, B. (2018). Earnings dynamics: The role of education throughout a worker's career. *Labour Economics 52*, 83–97.

Brenner, J. (2010). Life-cycle variations in the association between current and lifetime earnings: Evidence for german natives and guest workers. *Labour Economics 17*(2), 392–406.

Card, D. and J. E. DiNardo (2002). Skill-biased technological change and rising wage inequality: Some problems and puzzles. *Journal of labor economics 20*(4), 733–783.

Card, D. and T. Lemieux (2001). Can falling supply explain the rising return to college for younger men? a cohort-based analysis. *The Quarterly Journal of Economics 116*(2), 705–746.

Chen, W.-H., Y. Ostrovsky, and P. Piraino (2017). Lifecycle variation, errors-in-variables bias and nonlinearities in intergenerational income transmission: new evidence from canada. *Labour Economics 44*, 1–12.

Deming, D. J. (2023). Why do wages grow faster for educated workers? Working Paper 31373, National Bureau of Economic Research.

Duncan, B. and S. J. Trejo (2012, May). The employment of low-skilled immigrant men in the united states. *American Economic Review 102*(3), 549–554.

Flood, S., M. King, R. Rodgers, S. Ruggles, J. R. Warren, and M. Westberry (2025). IPUMS CPS: Current Population Survey: Version 13.0. Dataset.

Genadek, K. R., C. Hokayem, and P. Pendergast (2021). The summary earnings record and detailed earnings record extracts. Technical report, Working Paper No. ADEP-WP-2021-05. US Census Bureau, Washington, DC.

Glover, A., J. Mustre-del Río, and E. Pollard (2023). Lifetime earnings differences across black and white individuals: Years worked matter. *Economic Review (01612387) 108*(1).

Goldin, C. and L. F. Katz (2007). Long-run changes in the u.s. wage structure: Narrowing, widening, polarizing. *Brookings Papers on Economic Activity, Economic Studies Program 38*(2007-2), 135–168.

Goldin, C. D. and L. F. Katz (2008). *The race between education and technology*. harvard university press.

Grawe, N. D. (2006). Lifecycle bias in estimates of intergenerational earnings persistence. *Labour economics 13*(5), 551–570.

Grogger, J. (2003). The effects of time limits, the EITC, and other policy changes on welfare use, work, and income among female-headed families. *Review of Economics and Statistics 85*(2), 394–408.

Guvenen, F., G. Kaplan, J. Song, and J. Weidner (2022). Lifetime earnings in the united states over six decades. *American Economic Journal: Applied Economics 14*(4), 446–479.

Haider, S. and G. Solon (2006). Life-cycle variation in the association between current and lifetime earnings. *American economic review 96*(4), 1308–1320.

Heckman, J. J., L. J. Lochner, and P. E. Todd (2008). Earnings functions and rates of return. *Journal of human capital 2*(1), 1–31.

Hoffmann, F., D. S. Lee, and T. Lemieux (2020). Growing income inequality in the united states and other advanced economies. *Journal of Economic Perspectives 34*(4), 52–78.

Hosseini, R., K. Kopecky, and K. Zhao (2026). How important is health inequality for lifetime earnings inequality? *Review of Economic Studies 93*(1), 556–599.

Huggett, M., G. Ventura, and A. Yaron (2011). Sources of lifetime inequality. *American Economic Review 101*(7), 2923–2954.

Juhn, C., K. M. Murphy, and B. Pierce (1993). Wage inequality and the rise in returns to skill. *Journal of Political Economy 101*(3), 410–442.

Katz, L. F. and K. M. Murphy (1992). Changes in relative wages, 1963-1987: Supply and demand factors. *The Quarterly Journal of Economics 107*(1), 35–78.

Lagakos, D., B. Moll, T. Porzio, N. Qian, and T. Schoellman (2018). Life cycle wage growth across countries. *Journal of Political Economy 126*(2), 797–849.

Lemieux, T. (2006a). Increasing residual wage inequality: Composition effects, noisy data, or rising demand for skill? *American economic review 96*(3), 461–498.

Lemieux, T. (2006b). The "mincer equation" thirty years after schooling, experience, and earnings. In *Jacob Mincer a pioneer of modern labor economics*, pp. 127–145.

Meyer, B. D. and D. T. Rosenbaum (2001). Welfare, the earned income tax credit, and the labor supply of single mothers. *Quarterly Journal of Economics 116*(3), 1063–1114.

Mincer, J. (1974). Age and experience profiles of earnings. *Schooling, Experience, NBER Schooling, Experience, and Earnings*, 64–82.

Murphy, K. M. and F. Welch (1992). The structure of wages. *The Quarterly Journal of Economics 107*(1), 285–326.

Nybom, M. (2017). The distribution of lifetime earnings returns to college. *Journal of Labor Economics 35*(4), 903–952.

Nybom, M. and J. Stuhler (2017). Biases in standard measures of intergenerational income dependence. *Journal of Human Resources 52*(3), 800–825.

Pinto, S. (2026, January). How does the foreign-born population affect labor force growth? Economic Brief 26-03, Federal Reserve Bank of Richmond.

Rubinstein, Y. and Y. Weiss (2006). Post schooling wage growth: Investment, search and learning. *Handbook of the Economics of Education 1*, 1–67.

Tamborini, C. R., C. Kim, and A. Sakamoto (2015). Education and lifetime earnings in the united states. *Demography 52*(4), 1383–1407.

U.S. Bureau of Labor Statistics (2025, May). Foreign-born workers: Labor force characteristics — 2024. News Release USDL-25-0847, U.S. Bureau of Labor Statistics.

Valletta, R. G. (2018). Recent flattening in the higher education wage premium: Polarization, skill downgrading, or both? In *Education, skills, and technical change: Implications for future US GDP growth*, pp. 313–342. University of Chicago Press.

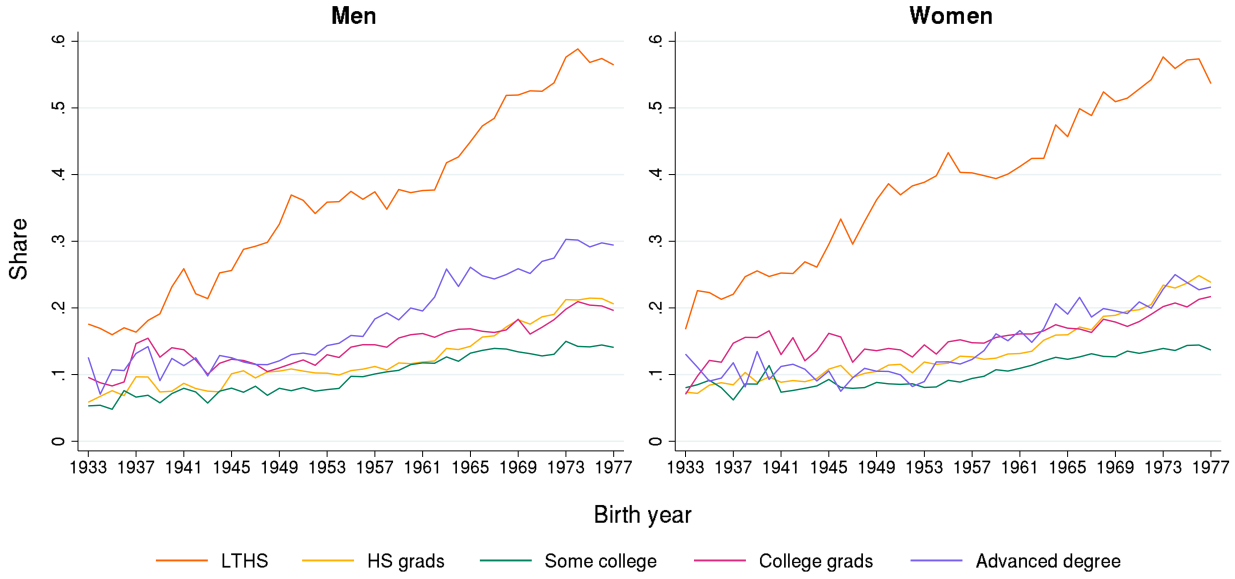
7 Appendix

Figure A1: Educational Attainment Share by Birth Cohort



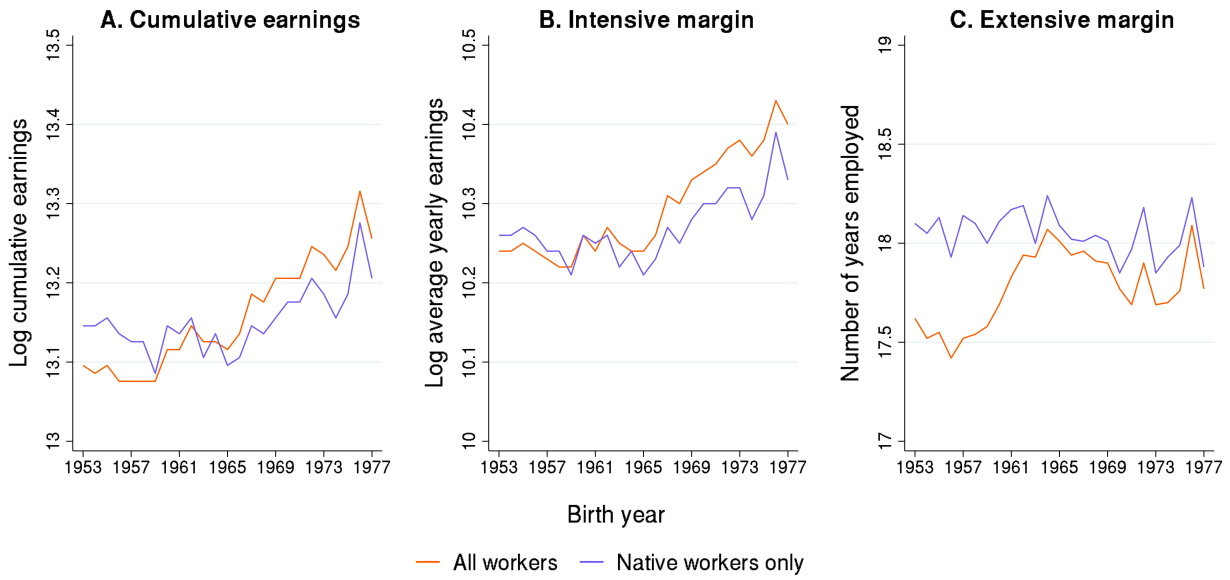
Note: This figure shows the distribution of educational attainment across birth cohorts (1933–1977) by gender.
*Sources: 1978–2021 Current Population Survey (CPS) Annual Social and Economic Supplements (ASEC) extracts from IPUMS-CPS (**?**).*

Figure A2: Non-native Population Share by Educational Attainment



*Note: Each data point represents the non-native population share across the 1933–1977 birth cohort by gender and education level. Sources: 1978–2021 CPS-ASEC extracts from IPUMS-CPS (**?**)*

Figure A3: Early-career Labor Market Outcomes: Native-born versus All Less-than-high-school Men



Notes: Each panel compares outcomes for all men versus native-born men with less than high school (LTHS) education. Panel A shows average log cumulative earnings during the early-career stage. Panel B shows average log yearly earnings conditional on any employment during the early-career stage. Panel C shows the average number of years employed during the early-career stage.

Sources: 1978–2021 CPS-ASEC and SSA DER extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.