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

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Abstract

Using longitudinal Social Security records for 1.4 million workers born 1933–1977, we provide the first comprehensive analysis of how lifetime earnings by education evolved across US birth cohorts. Among men, cross-cohort earnings gains accrued almost exclusively to those with bachelor's or advanced degrees; high-school graduates exhibited minimal improvement except through prolonged late-career labor force attachment rather than higher wages. Women experienced substantial cross-cohort gains across all education levels. Greater dispersion in women's cumulative employment years amplifies lifetime inequality—both between and within education groups—relative to cross-sectional measures, though employment convergence across successive cohorts attenuated inequality growth compared to men. Inequality differences between cohorts emerge at labor market entry and remain persistent throughout the life cycle, demonstrating that early-career mechanisms critically shape long-term inequality dynamics.

JEL Codes: I24, I26, J11, J31

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1 Introduction

This paper presents the first comprehensive empirical analysis of how lifetime earnings by educational attainment have evolved across US birth cohorts. Educational attainment has long been recognized as a strong predictor of wage rates and labor market attachment—both critical determinants of lifetime earnings capacity. While cross-sectional earnings snapshots provide valuable insights, long-term cumulative earnings more accurately capture lifetime earnings disparities between education groups. We measure lifetime earnings through cumulative totals over two 20-year career stages: early career (ages 25–44) and late career (ages 45–64). Historically, data constraints have limited such long-term analyses in the United States. The increasing availability of administrative longitudinal data, however, now permits significantly enhanced understanding of lifetime earnings distributions across demographic groups. Leveraging survey-linked administrative panel wage data, we examine how cumulative earnings have shifted across birth cohorts by educational attainment and how earnings dispersion has evolved both within and across education groups.

Our analysis draws upon linked data combining the Current Population Survey Annual Social and Economic Supplement (CPS-ASEC) with restricted-use Detailed Earnings Records (DER) from the Social Security Administration. The DER provide individual-level panel data on wages and salaries derived from W-2 tax forms covering 1978 to 2021, which we merge at the individual level with the CPS-ASEC to incorporate self-reported gender and educational attainment. Using this sample 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, high school graduates, some college, bachelor's degree, and advanced degree. Our primary outcome measure is log cumulative earnings, defined as the logarithm of summed annual wage income over each career stage, with all wage records inflation-adjusted using the Personal Consumption Expenditures price index. The extensive time span of our data allows us to measure late-career cumulative earnings for cohorts born 1933–1957 and early-career cumulative earnings for cohorts born 1953–1977 (see Figure 1).

Our findings show that women at all educational attainment levels experienced robust earnings growth across successive birth cohorts, driven by changes in both average earnings conditional on employment (intensive margin) and cumulative years of employment (extensive margin). Women with a bachelor's or advanced degree demonstrated the largest growth, while those with a sub-baccalaureate education saw

smaller, yet still sizable, increases. This growth was particularly pronounced among female cohorts born between 1933 and 1957, among whom 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 substantial. 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. Cumulative years of employment rose significantly across cohorts: between the 1933 and 1957 cohorts, late-career employment years increased by 0.75 to 1.07 years, and between the 1953 and 1977 cohorts, early-career employment years increased by 0.51 to 0.95 years. These extensive margin changes accounted for 8 to 30 percent of total cumulative earnings growth, with larger contributions among women with lower educational attainment.

In contrast, earnings growth for men was strongly stratified by educational attainment. Men with an advanced degree experienced the most robust 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 growth—between 0.20 and 0.23 log points across the respective cohort groups. However, this growth was concentrated among those born between 1951 and 1964, with relatively stagnant earnings for cohorts outside this window. For men with a sub-baccalaureate education, earnings trajectories remained largely flat across both cohort groups examined. Cumulative years of employment in the late-career stage rose markedly between the 1933 and 1957 cohorts, increasing by 0.77 to 1.01 years across all education levels, likely driven by changes to Social Security's normal retirement age. These extensive margin increases contributed 0.04 to 0.06 log points to total cumulative earnings growth. Extended employment proved far more important for less-educated men: it represented 80 percent of total earnings growth for those with a high school diploma but only 15 percent for those with an advanced degree.

These earnings trends translated into evolving 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 considerably at uneven rates by more than 0.20 log points across the cohorts studied. Women's cumulative education premiums exhibited different trends. Their cumulative college pre-

mium grew steadily across all cohorts studied; however, their cumulative advanced-degree premium maintained a largely flat trend, showing modest gains only among the more recent 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 have been stable across cohorts.

Beyond documenting premium trends, our analysis reveals that education premiums based on cumulative earnings can differ significantly 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, consider female cohorts born in 1973–1977, who observed a cumulative college premium of 0.61 log points during their early-career stage, exceeding the point-in-time premiums of 0.36, 0.55, and 0.57 log points at ages 25, 35, and 45, 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 higher wage rates and more consistent labor market participation. Women in the 1973–1977 birth cohort with a bachelor's degree accumulated, on average, 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.

The contribution of employment differences to cumulative premiums varies systematically by gender. Labor market attachment is significantly more stratified by education for women than for men, particularly in the early-career stage, making employment years a key differentiator of women's cumulative earnings. While prior research finds women exhibit larger college premiums than men at ages 25 to 34, our findings show the gender difference in college premiums depends on the age at which premiums are measured and whether cumulative or cross-sectional earnings are used. In cross-sectional data, women observe larger college premiums at younger ages, but this reverses after age 35 when men's premiums continue expanding while women's flatten. With cumulative earnings, the pattern changes: women's early-career cumulative college premiums exceed their point-in-time counterparts and surpass men's, reflecting the large

gap in labor market attachment between college-educated and high-school-educated women. Incorporating extensive margin differences thus provides a more comprehensive understanding of gender differences in education premiums.

Finally, we find that earnings dispersion within education groups increased considerably among men born between 1933 and 1957, contrasting with the relatively modest growth observed among their female peers or younger cohorts of either gender. This gender difference among earlier cohorts partly reflects rapid growth and convergence in women's labor force participation, which attenuated the impact of rising annual wage inequality on cumulative dispersion. The slowdown in inequality growth among more recent cohorts aligns closely with documented cross-sectional inequality trends. Autor et al. (2008) and Lemieux (2006a) observe that growth in within-group 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. This alignment is not coincidental. As with education premiums, cross-cohort variation in within-group dispersion is largely determined at labor market entry, after which cohorts experience comparable life-cycle dynamics. These findings indicate that early-career mechanisms outweigh aggregate shocks in shaping inequality trends, with cohort effects actively driving—rather than merely reflecting—cross-sectional patterns. 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 Guvenen et al. (2022), 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 Tamborini et al. (2015), 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—combines 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 US studies on long-term cumulative earnings rely predominantly on longitudinal survey panel data from single cohorts or simulated earnings from cross-sectional surveys. Recent NLSY79 studies examine racial disparities (Glover et al., 2023), hours versus wage contributions (Bick et al., 2024), and health-earnings relationships (Hosseini et al., 2026), while Bowlus and Robin (2004) simulate lifetime earnings using cross-sectional CPS data. Our research complements this literature by examining cumulative earnings using administrative wage records, avoiding limitations of simulations and survey biases. Similar administrative data have been used more extensively in European research. Nordic and German studies examine current versus lifetime inequality (Aaberge and Mogstad, 2015; Bönke et al., 2015), causal returns to education (Bhuller et al., 2017), and college earnings premiums (Nybom, 2017).

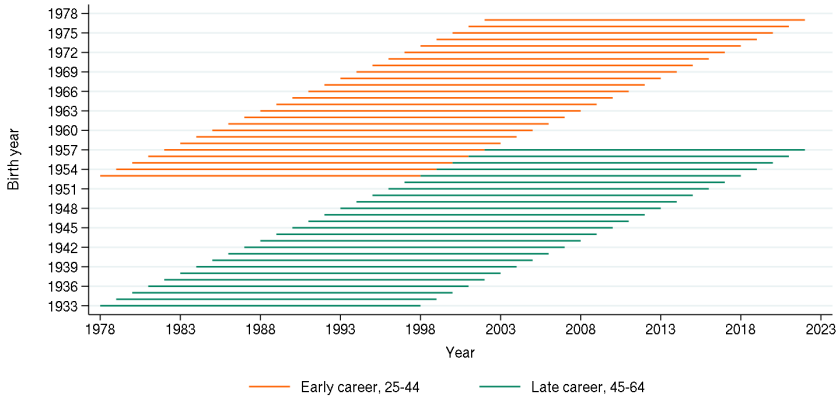
Second, we contribute to the literature examining how educational attainment shapes earnings. Canonical studies document sizable shifts in education premiums since the mid-20th century while examining how the interplay between skill supply variations and increasing skill demand have shaped these long-term trends (Murphy and Welch, 1992; Katz and Murphy, 1992; Bound and Johnson, 1992; Card and Lemieux, 2001; Goldin and Katz, 2008, 2007). 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 (Bengali et al., 2025, 2023; Valletta, 2018). 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 (Haider and Solon, 2006; Grawe, 2006; Brenner, 2010; Chen et al., 2017; Nybom and Stuhler, 2017). 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 Bick et al. (2024), 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 (Juhn et al., 1993; Lemieux, 2006a; Autor et al., 2008; Hoffmann et al., 2020). 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 Huggett et al. (2011), who show through theoretical modeling and calibration that most lifetime inequality originates from differences in initial conditions at age 23, and on Guvenen et al. (2022), 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 critically drive inequality trends.

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.

Figure 1: Birth Cohorts and Cumulative Earnings Outcomes



2 Data

2.1 Data Sources

Our analysis draws upon the restricted-use Detailed Earnings Records (DER) from the Social Security Administration spanning 1978 through 2021. The DER, derived from the SSA's master earnings file, 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) (Genadek et al., 2021). While wage and salary income in the DER is not subject to topcoding, self-employment income was topcoded at annual FICA limits until 1994. We therefore focus on annual wage income, defined as total wage and salary earnings reported on W-2 forms across all jobs held by a worker in a given year, excluding self-employment income and deferred contributions to retirement accounts. This approach avoids complications associated with topcoding 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. Forty-two CPS-ASEC years (1979 and 1981 through 2021) are available for linkage. The share of CPS-ASEC observations linked to the DER varies by survey year, ranging from approximately 50 to 80 percent (Genadek et al., 2021). While linkage rates are nonrandom—higher for more educated workers—this selection at the education margin poses fewer concerns in our study, as all analyses are stratified by education.[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 at the time of the CPS survey. 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 Expenditures (PCE) price index, with 2021 as the base year.

[1] To assess potential selection effects within other dimensions, we compare our results to those reweighted by 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 levels and trends.

2.2 Measurement of Lifetime Earnings

We measure lifetime earnings through 20-year cumulative totals for two career stages: the early-career stage (ages 25 to 44) and the late-career stage (ages 45 to 64). Our primary outcome is log cumulative earnings, defined as:

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

where $a \in \{25, 45\}$ and W^i_τ denotes real annual wage income for individual i in year τ. The logarithmic specification facilitates interpretation of earnings differences as percentage changes, aligns with standard practice for measuring education premiums, and efficiently characterizes the log-normal earnings distribution through mean and standard deviation.

Our data enable measurement of late-career cumulative earnings for cohorts born 1933–1957 and early-career cumulative earnings for cohorts born 1953–1977. Cohorts born 1953–1957 are observed in both career stages, allowing us to distinguish life-cycle effects from cohort differences. We analyze each career stage separately to preserve this distinction, referencing the overlapping cohorts where relevant to contextualize patterns across all 45 cohorts.

2.3 Sample Restriction

We impose minimum labor market attachment criteria following standard practice in the earnings literature. We restrict our sample to workers who were alive throughout the career stage and had annual earnings at or above the following threshold for at least 10 of the 20 years:

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

This threshold equaled \$3,770 in 2021. We set the threshold low to include all workers with meaningful long-term labor market attachment while excluding those chronically absent from the workforce. 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 wage income.

3.1 Cumulative Earnings by Educational Attainment

Figure 2 plots mean cumulative earnings across birth cohorts by educational attainment and gender, with solid lines representing late-career earnings (1933-1957 cohorts) and dashed lines representing early-career earnings (1953-1977 cohorts). The downward shift between line types reflects life-cycle patterns rather than 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 Card and DiNardo (2002) 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—a population with stronger labor market attachment (U.S. Bureau

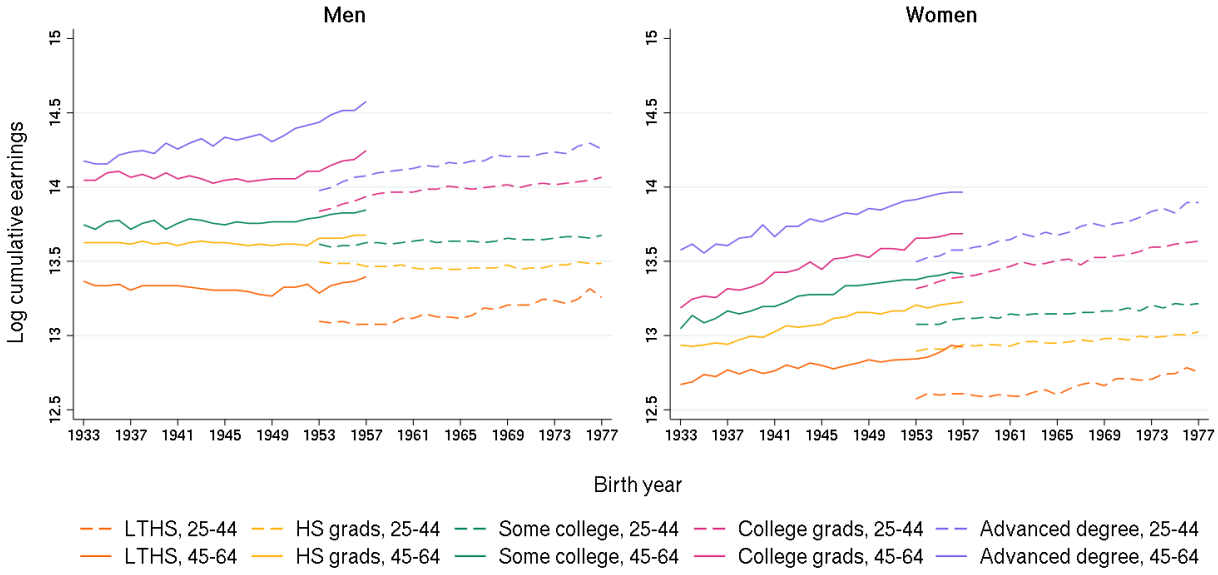
[2]See Appendix Figure A1 for educational attainment by birth cohort.

of Labor Statistics, 2025; Duncan and Trejo, 2012; Pinto, 2026).[3] However, excluding non-native workers attenuates but does not eliminate the upward trend (Appendix Figure A3). An additional explanation for this growth is differential exposure to minimum-wage increases in the late 2000s, which disproportionately affected early-career LTHS workers depending on how long a cohort was exposed to the higher wage floor.[4]

[3]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)

[4]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. Based on CPS Outgoing Rotation Group data, 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 and subject to the policy change, compared with only 2.2 percent of men and 4.6 percent of women with a high school diploma.

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.

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, 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 Guvenen et al. (2022), 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 Guvenen et al. (2022), 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.

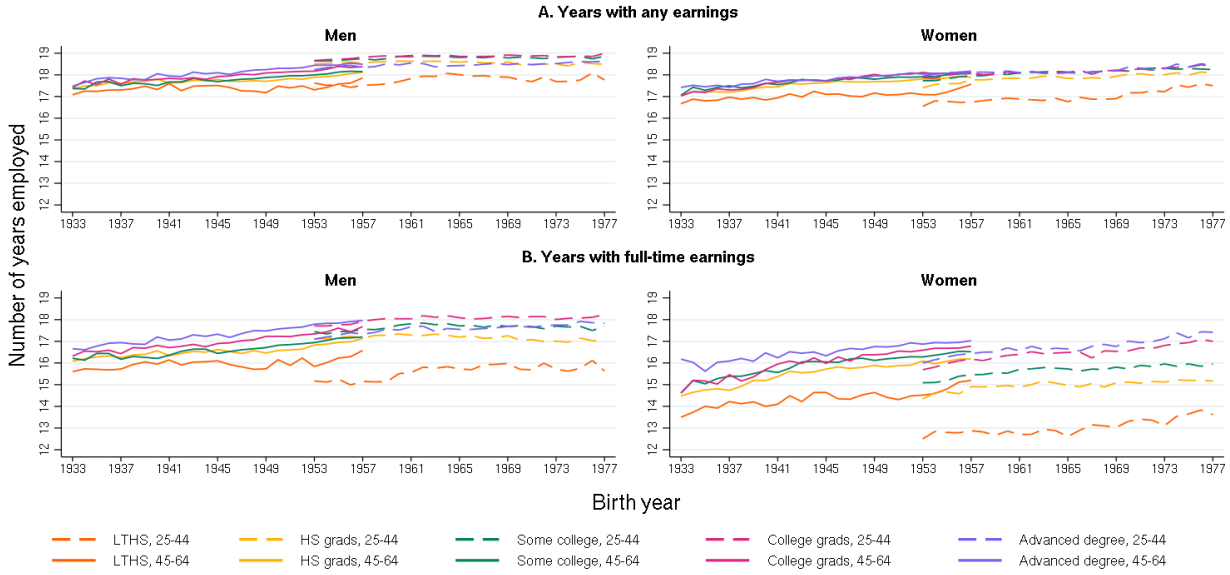
To understand the sources of these earnings trends, we decompose cumulative earnings growth into two components: changes in years of employment (extensive margin) and changes in average annual earnings conditional on employment (intensive margin).

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 patterns are most pronounced when measured by years with full-time equivalent earnings rather than any employment, indicating that employment intensity during working years is the critical dimension of variation. Notably, labor market attachment is substantially more stratified by education for women than for men, particularly in the early-career stage, making cumulative employment a key margin differentiating lifetime earnings among women. The employment gap between college and high school graduates also widened across successive cohorts for both genders, reflecting the growing role of labor market attachment in explaining earnings disparities by educational attainment.

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.

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, who experienced accelerated growth in years employed, likely reflecting welfare reform and EITC expansion in the 1990s, which disproportionately raised labor force participation among less educated women (Meyer and Rosenbaum, 2001; Blank, 2002; Grogger, 2003).

Unlike women, who experienced broad-based growth in labor force participation across both early- and late-career cohorts, likely driven by cultural norm changes, 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. 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. Rising employment in the late-career stage for men is changes to Social Security's normal retirement age (NRA). This threshold rose from age 65 to 66.5 for cohorts born between 1937 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, creating strong incentives for delayed retirement.[5]

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

[5]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.

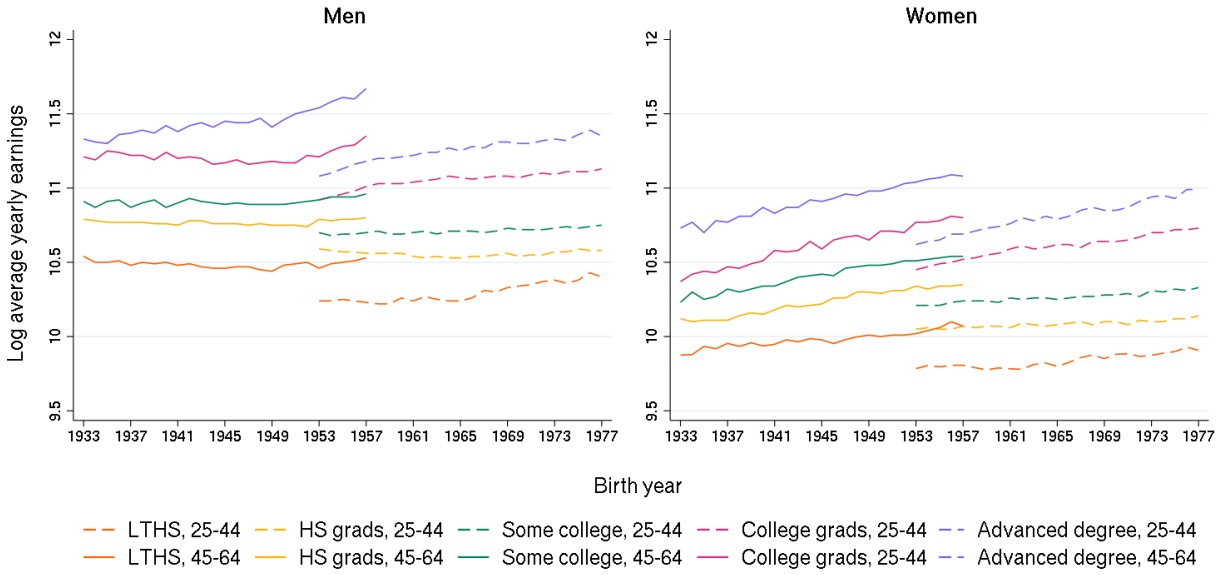
the contribution, we decompose log cumulative earnings into intensive and extensive margins:

$$\omega^i_{a,a+19} = \ln(\frac{\sum_{\tau=a}^{a+19} W^i_\tau}{\sum_{\tau=a}^{a+19} I(W^i_\tau > 0)}) + \ln(\sum_{\tau=a}^{a+19} I(W^i_\tau > 0)).$$

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 during the late-career stage. 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.

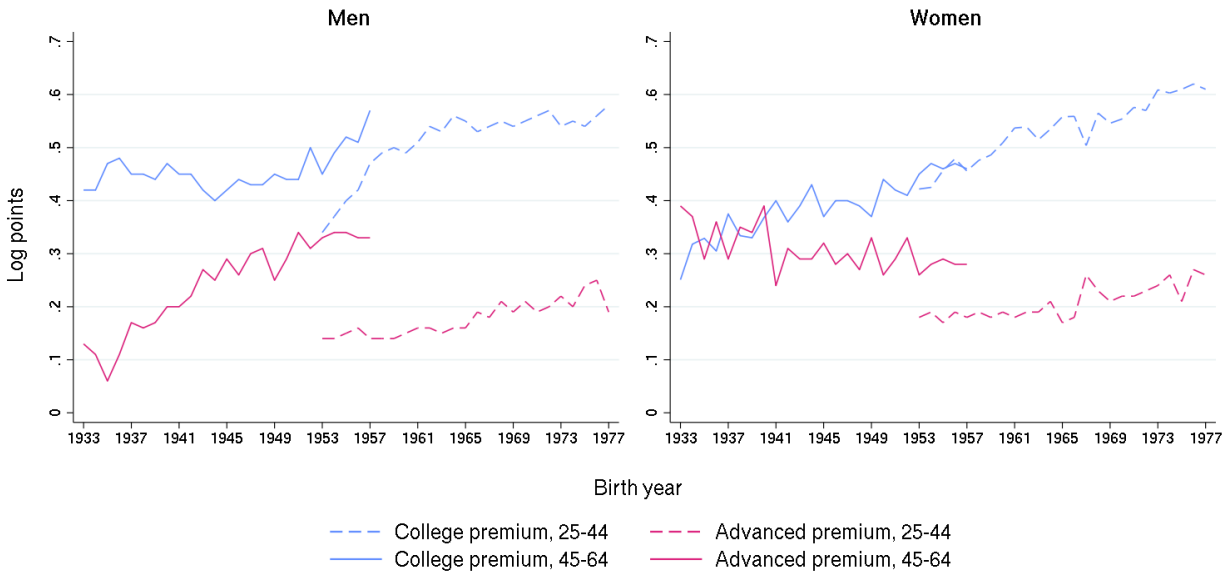
4 Implications for Cumulative Education Premiums

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 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 (Lemieux, 2006b; Rubinstein and Weiss, 2006; Heckman et al., 2008; **?**; Lagakos et al., 2018; Braga, 2018; Deming, 2023). 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.

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.

Men's cumulative college premium mirrors the earnings patterns of male college graduates: stagnating between the 1933 and 1951 cohorts, rebounding through 1965, then flattening. In contrast, men's advanced-degree premium rose sharply and consistently across all cohorts. For recent cohorts born after 1965, earnings growth concentrated almost entirely among men with advanced degrees, signaling a shift toward returns at the very top of the educational distribution. Women's education premiums followed a different path. Between the 1933 and 1957 cohorts, women's college premium grew steadily from 0.25 to 0.46 log points, while men's showed uneven and smaller gains. The advanced-degree premium, however, moved in opposite directions by gender: rising from 0.13 to 0.33 log points for men but falling from 0.39 to 0.28 log points for women. This divergence suggests that advanced degrees increasingly stratified men's earnings in these earlier cohorts but not women's. Among post-1957 cohorts, this gender gap narrowed, with both men and women experiencing similar growth in advanced-degree premiums.

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.

4.2 Comparison with Point-in-time Education Premiums

Having documented trends in cumulative education premiums, we now examine how these cumulative measures compare with education premiums 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 typi-

cally 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.

Education Premiums across the Career Cycle

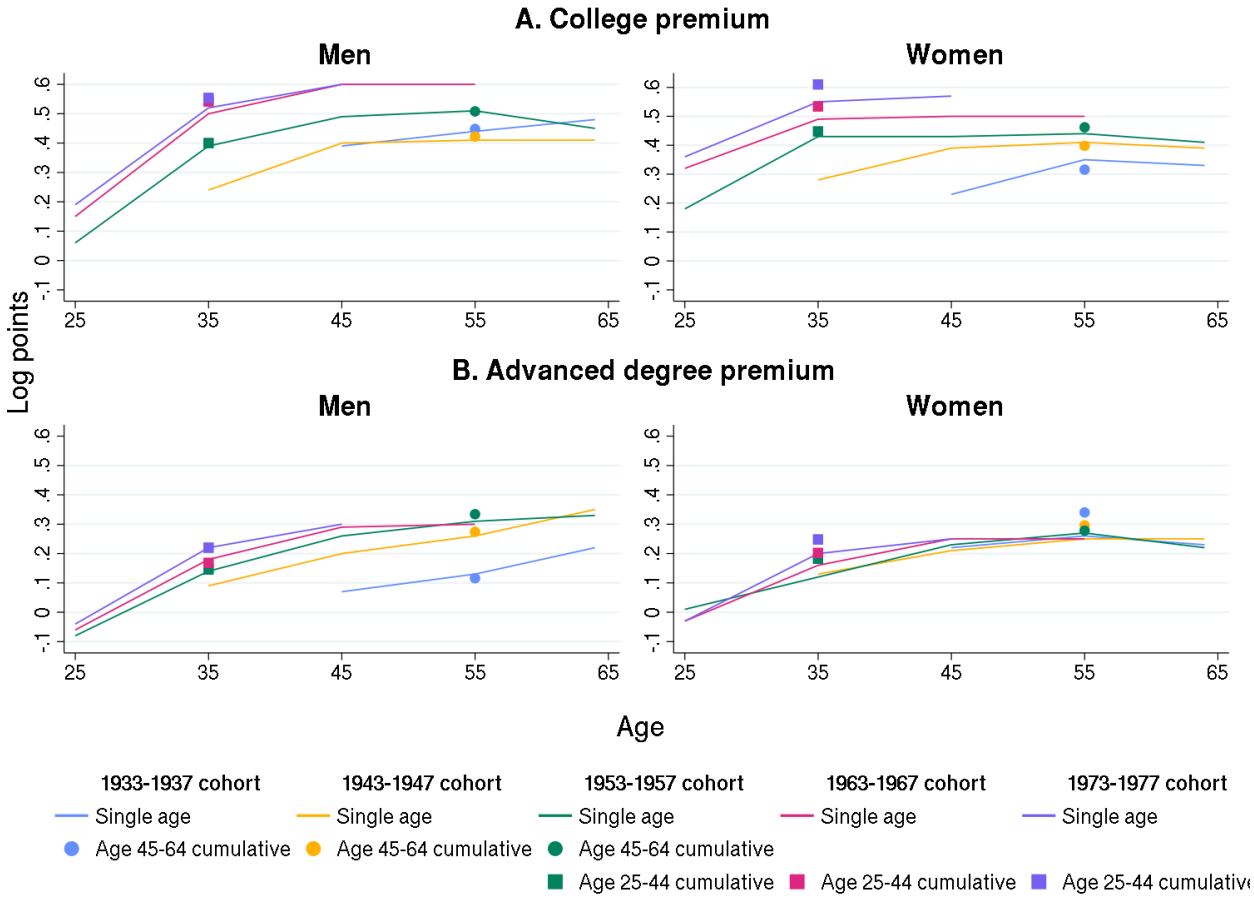
Figure 6 compares cumulative college (Panel A) and advanced-degree (Panel B) premiums with their corresponding point-in-time premiums, organized by cohort groups and gender. These point-in-time premiums represent differences in mean log annual earnings between education groups, calculated using cross-sectional 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.

As discussed earlier, point-in-time education premiums typically expand over the life cycle in a concave pattern. 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.

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.

Cumulative versus Point-in-time Education Premiums

For both men and women, cumulative college premiums generally exceed point-in-time premiums at the median age of the corresponding career stage, with particularly large gaps for early-career women. For example, women born between 1973 and 1977 observed a cumulative college premium of 0.61 log points in the early-career stage, compared with 0.36, 0.55, and 0.57 at ages 25, 35, and 45, respectively. Two factors drive this difference. First, ages with higher earnings carry larger weights in cumulative premiums, making younger-age earnings (before age 35) less reflective of long-term differences. Second, cumulative premiums capture differences in both annual wages (intensive margin) and labor market participation (extensive margin), both of which favor college-educated workers. Since labor market participation is substantially more stratified by education for women than for men, the extensive margin contributes disproportionately to women's cumulative college premiums. Women in the 1973–1977 cohort with a bachelor's degree accumulated 0.32 more years with any employment and 1.43 more years with full-time equivalent earnings than high school graduates, accounting for the substantial gap between cumulative and point-in-time 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 also offer new insights into gender differences in education premiums. While

prior research finds women exhibit larger college premiums than men at ages 25 to 34 (Dougherty, 2005; DiPrete and Buchmann, 2006; Ashworth and Ransom, 2019), our findings reveal a more nuanced picture that depends on the age at which premiums are measured and whether cumulative or cross-sectional earnings are used. In cross-sectional data, women observe larger college premiums at younger ages, but this reverses after age 35 when men's premiums continue expanding while women's flatten. The pattern shifts again with cumulative earnings, particularly in the early-career stage when education-related employment gaps are larger for women. Women's cumulative college premiums in the early-career stage substantially exceed their point-in-time counterparts and surpass men's, reflecting the large gap in labor market attachment between women with a bachelor's degree and high school diploma. Similarly, accounting for the extensive margin raises women's cumulative advanced-degree premium above men's in the early-career stage. These findings demonstrate that incorporating extensive margin differences provides a more comprehensive understanding of gender differences in education premiums.

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 (Juhn et al., 1993; Lemieux, 2006a; Autor et al., 2008; Hoffmann et al., 2020). 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.

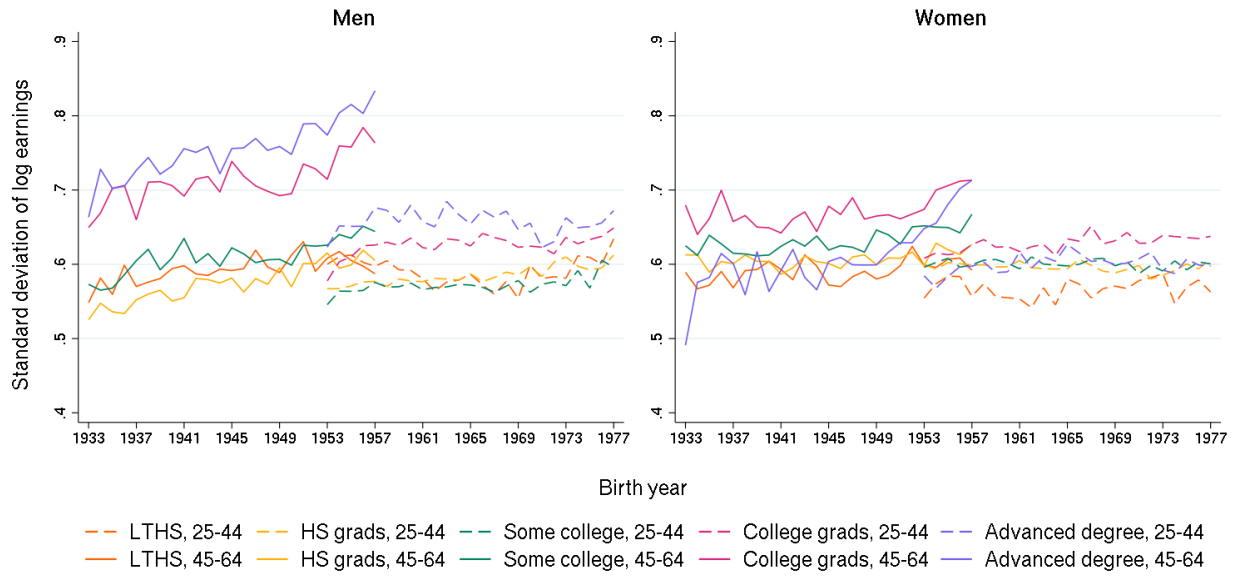
5.1 Cumulative Earnings Inequality within Education Groups

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 increased by 0.04 to 0.17 across education levels, with larger increases among more educated workers. By contrast, across the more recent 1953–1977 cohorts, growth in within-group dispersion was moderate during the early-career stage, with standard deviation increases ranging from 0.03 to 0.07 across the five education categories.

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).

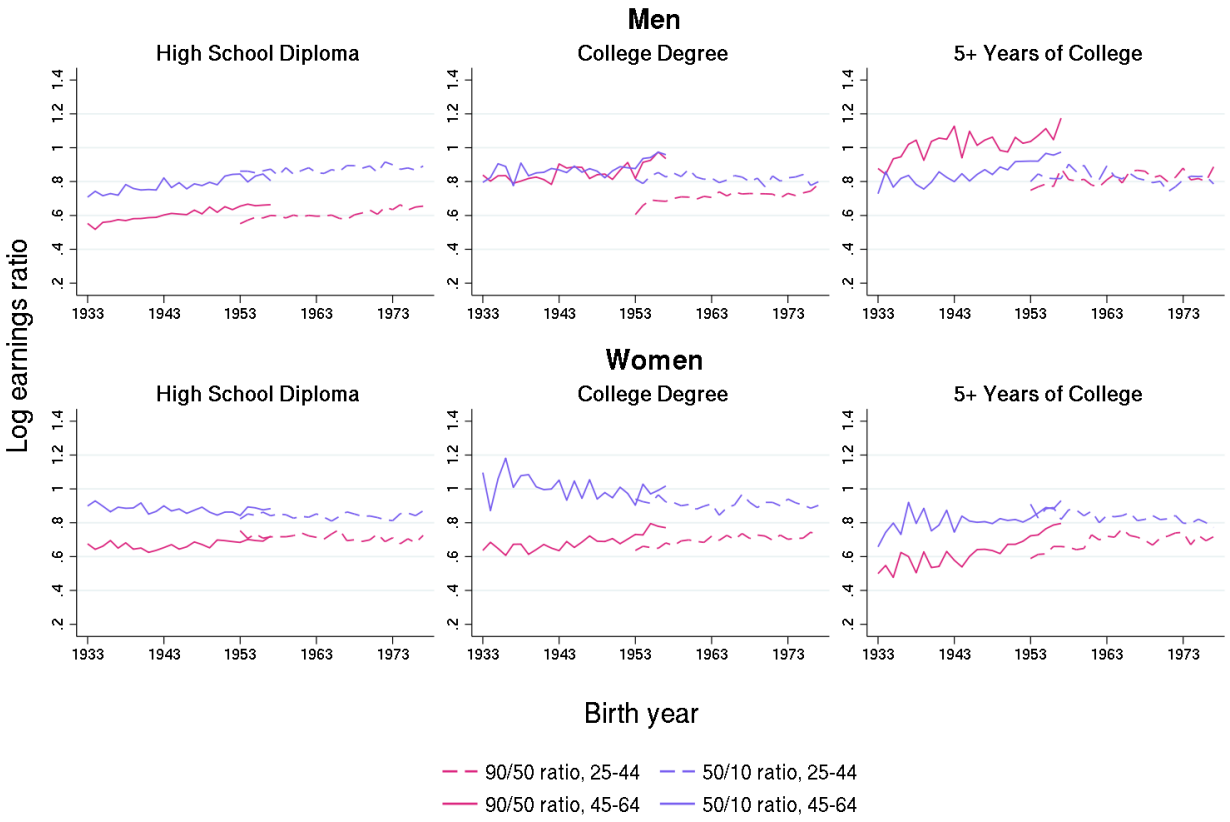
Sources: 1978–2021 CPS-ASEC and SSA DER extracts. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2108. All results were approved for release by the US Census Bureau, authorization numbers CBDRB-FY25-0203, CBDRB-FY25-0204, CBDRB-FY25-0467, and CBDRB-FY26-051.

Women's within-group earnings dispersion shows patterns distinct from men's in two ways. First, women's 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 sizable growth in within-group dispersion during the late-career stage, with the standard deviation increasing by 0.22. All other female education 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 earlier (1933-1957) and later (1957-1977) male cohorts, as well as between male and female cohorts from 1933-1957, stem primarily from different trajectories in lower-tail inequality. Figure 8 presents the log P90/P50 and log P50/P10 ratios, measuring inequality above and below the median, respectively.

For earlier-born male cohorts, substantial increases in earnings inequality manifested through largely parallel movements in upper- and lower-tail inequality, demonstrating symmetric widening from the median. Among later-born male cohorts, upper-tail inequality continued expanding at a slower pace while lower-tail inequality stagnated or reversed, contributing to more modest growth. Similarly, relatively stable inequality trends among most female education groups stem from counterbalancing movements: compression of the lower distribution, as fewer women experienced very low cumulative earnings, offsets expanding upper-tail inequality.

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.

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. Autor et al. (2008) 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 or, alternatively, this timing reflects how different cohorts experience varying exposure to cross-sectional shocks.

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.[6] 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 was larger among earlier-born cohorts (1933–1937 to 1953–1957) but has decelerated in subsequent cohort groups. Importantly, the largely parallel life-cycle 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 steady throughout the life cycle.

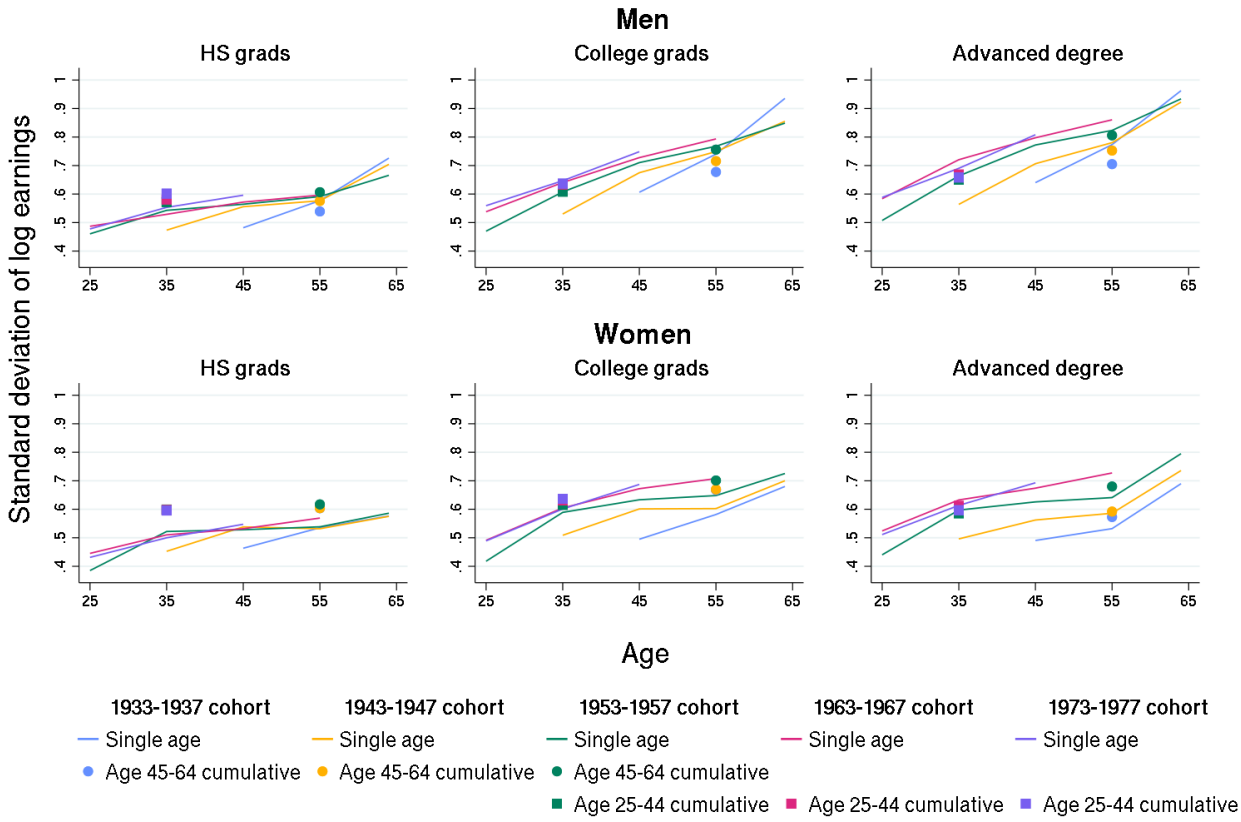
An exception occurs during the 1980s, when growth in within-group dispersion accelerated across all education cohort groups in their respective career stages, particularly among high school graduates. A possible explanation is the documented decline in real minimum wage values during this period, which

[6]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.

disproportionately affected lower-earning and less educated workers (Lemieux, 2006a; Autor et al., 2008; Card and DiNardo, 2002). Beyond this episode, the shapes of age-dispersion profiles within each gender–education group are 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 dominance of cohort effects explains the pattern in Figure 7: even when using earnings records from the same cross-sectional years, the evolution of inequality appears markedly different across earlier cohorts (1933–1957) and later cohorts (1953–1977). In other words, cohort effects drive, at least in part, cross-sectional inequality patterns rather than merely reflecting them.

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—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.

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.

Accounting for the employment margin also shapes how within-group dispersion evolved differently for men and women across earlier cohorts. For men, the evolution of point-in-time within-group dispersion measured at age 45—an age observable for all cohorts—closely tracks the evolution of within-group dispersion based on cumulative earnings. For women in earlier cohorts, however, the rise in within-group dispersion based on cumulative earnings is noticeably slower than point-in-time measures suggest. This divergence reflects the equalizing effect of rapid growth and convergence in women's cumulative labor force participation across these cohorts, which attenuates the contribution of rising annual wage inequality to cumulative dispersion within education groups.

Having examined inequality within education groups, we now analyze overall cumulative earnings inequality across the entire population and decompose it into contributions from educational composition, between-group earnings gaps, and within-group dispersion.

5.2 Trends in Overall Cumulative Earnings Inequality

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 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).[7] 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. Bar heights represent

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

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

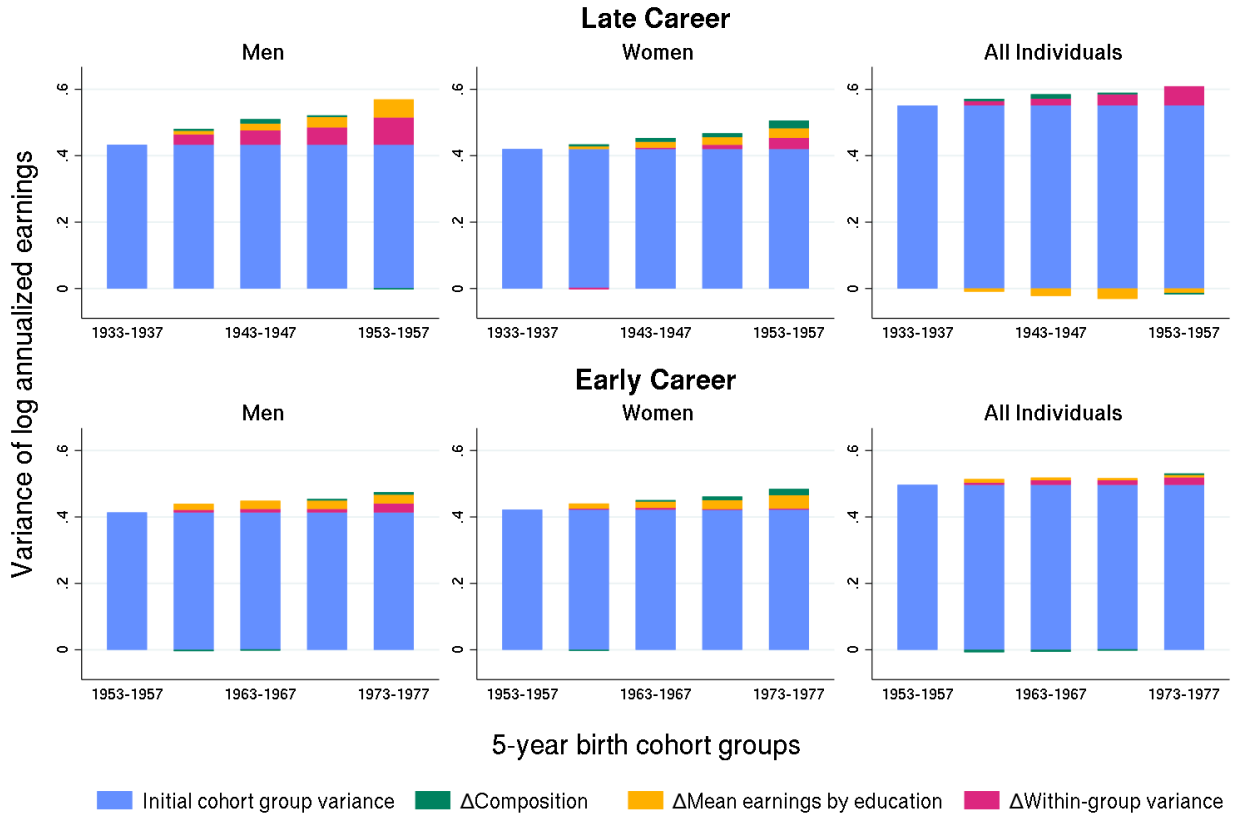
where π_e^c represents the education (or education–gender) composition of the cohort and serves as the group weight. Group weights are estimated using CPS basic monthly data from 1978 to 2025. The first term measures between-group variance (dispersion of group means), and the second term measures within-group 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.

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. For men, rising within-group dispersion accounted for 61 percent of this increase, with increased variability in mean group earnings contributing 40 percent and composition shifts negligible. Women's pattern differed: educational attainment composition changes contributed 27 percent, mean group earnings 34 percent, and within-group dispersion 39 percent. The larger increase in men's inequality relative to women's primarily reflects greater within-group dispersion growth. For the overall population, earnings inequality remained relatively stable. Although within-group dispersion and education premiums exerted upward pressure, the narrowing of gender-related earnings gaps produced countervailing effects (Guvenen et al., 2022), resulting in a more modest upward trend.

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.

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.

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 varied by gender and over time. Women at all education levels experienced consistent earnings growth, while men's growth was concentrated among those with a bachelor's degree or higher. Among men born between 1965 and 1977, earnings gains accrued disproportionately to advanced-degree holders. 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 dispersion—have driven overall cumulative earnings inequality upward across successive cohorts. Importantly, cross-cohort shifts in both education premiums and within-group inequality emerge at labor market entry and remain stable throughout careers, suggesting 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.

The extensive margin plays a critical role in cumulative earnings, with distinct contributions to men's and women's earnings growth. For women, increases in employment years accelerated cumulative earnings growth across all education levels and successive cohorts. For men, extended working years contributed meaningfully to late-career earnings growth among workers born between 1933 and 1957, particularly for those without a college degree. Beyond affecting earnings growth, the extensive margin shapes education premiums differently by gender: labor market attachment is substantially more stratified by education for women than for men, particularly in the early-career stage, making cumulative employment a key factor differentiating women's lifetime earnings. This greater stratification generates larger gaps between cumulative and point-in-time education premiums for women relative to men. As a result, women's early-career cumulative college premiums exceed men's, a pattern distinct from cross-sectional measures where gender differences vary by age—women observe larger premiums than men at younger ages but smaller premiums at later career stages.

These findings provide new insights into how education differentiates lifetime earnings across decades of US workers. Incorporating differences in employment years reveals how employment patterns

amplify or offset earnings gaps both between and within education groups and provides a more comprehensive understanding of gender differences in education premiums. Our analysis demonstrates that cumulative earnings measures, which capture both wage rates and labor market attachment, offer a fuller picture of lifetime economic inequality than point-in-time snapshots alone.

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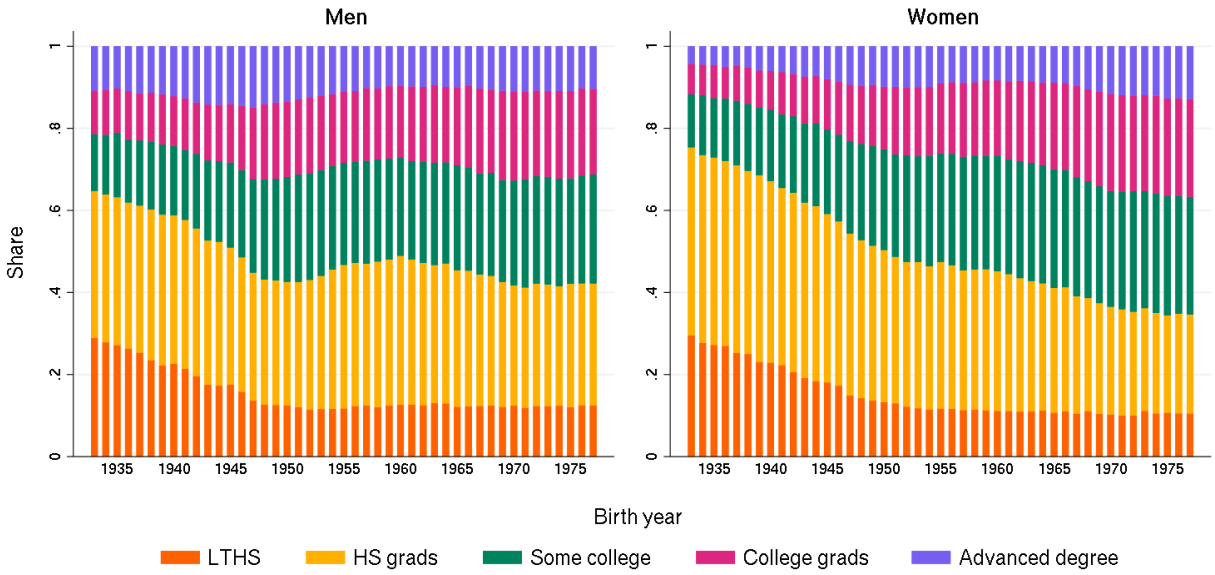
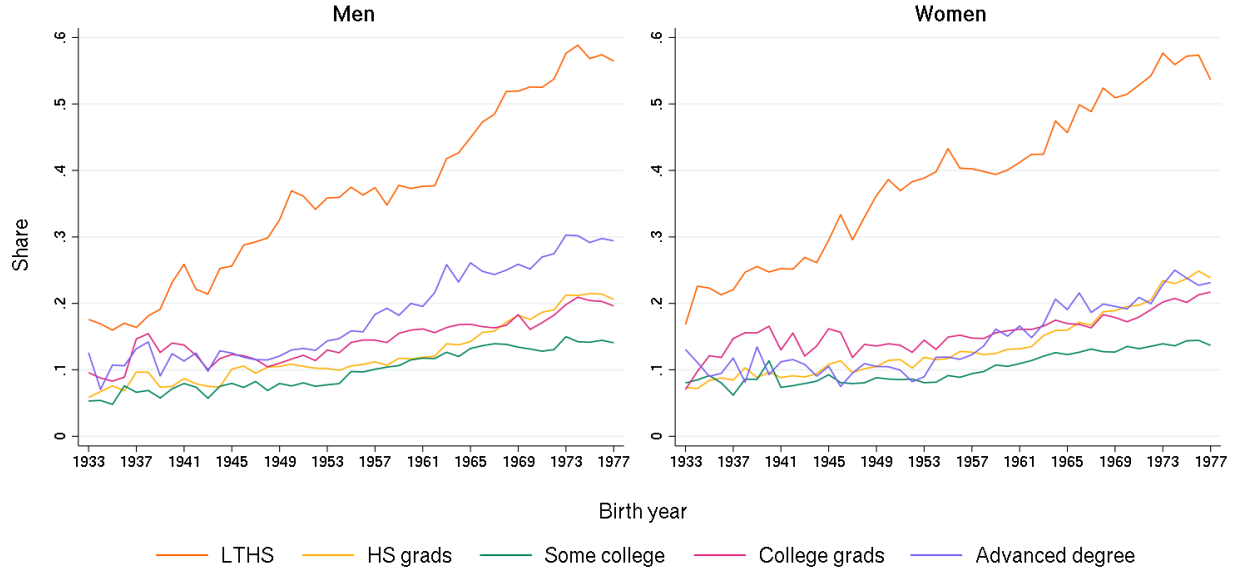
7 Appendix

Figure A1: Educational Attainment Share by Birth Cohort



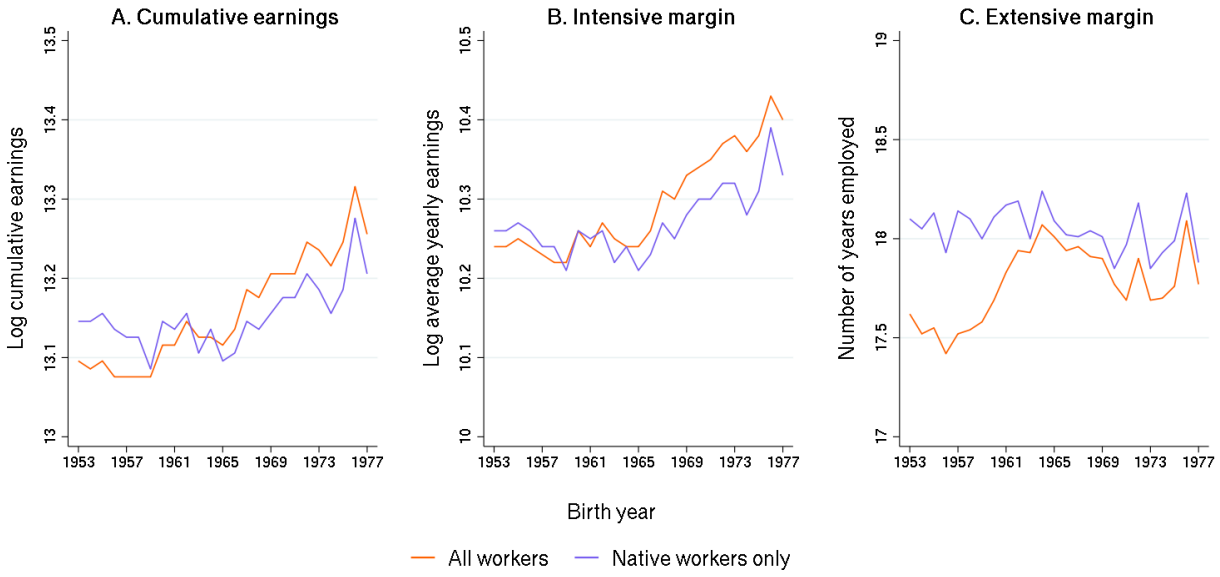
Note: This figure shows the distribution of educational attainment across birth cohorts (1933–1977) by gender.
Sources: 1978–2021 Current Population Survey (CPS) Annual Social and Economic Supplements (ASEC) extracts from IPUMS-CPS (Flood et al., 2025).

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 (Flood et al., 2025)

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.