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Inequality in Annual Earnings, Volatility of Earnings, and Inequality in Lifetime Earnings in the United States, 1986-2018

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Abstract

We estimate the contribution of changes in lifetime inequality, volatility, and life-cycle variation in earnings to the recent rise in the inequality of annual earnings. Using PSID data, we first regress annual earnings on a function of age, education, race, and cohort group to estimate annual predicted earnings and anticipated average lifetime earnings for males born between 1927 and 1987. We then apply these estimates to decompose the sources of annual earnings inequality among males aged 31-59 in each year from 1986 to 2018. Until the turn of the millennium, lifetime inequality and volatility each accounted for about 45% of annual inequality, all three fluctuating moderately without trend. Subsequently, annual inequality and volatility increased while lifetime inequality has remained stable, highlighting the role of volatility in driving the recent rise in annual inequality, which we find was amplified by an increase in the regressive incidence of transitory shocks.

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1. Introduction

Inequality in annual earnings in the United States has risen in recent decades, and many studies have sought to determine to what extent this rise reflects greater volatility in earnings, which can be smoothed over time, or an increase in the inequality of persistent lifetime earnings driven by technical change, globalization, the decline of unionization, and other structural factors. These studies have mostly focused on estimating earnings volatility from short, overlapping panels, and tracking it over time. They generally find a decade of rising volatility beginning in the early 1970s followed by a longer plateau coinciding with the "Great Moderation", and then a second rise, possibly cyclical, beginning slowly with the dot-com recession at the turn of the millennium and peaking in the wake of the Great Recession (Moffitt, 2020).[1] These studies indicate that increased volatility was an important factor driving the increase in annual inequality. However, they cannot determine whether inequality in lifetime earnings has also increased in this period, nor can they fully account for the impact of changes in the joint distribution of age and schooling on inequality in annual earnings.[2]

A number of studies have directly estimated inequality in lifetime earnings, which they measure from long panels of individual earnings histories drawn from longitudinal administrative datasets. Early efforts include Bjorklund's (1993) analysis of Swedish tax data on the 1924-36 birth cohorts, which found lifetime earnings inequality to be 35 to 40 percent

[1] How much of the second rise is cyclical remains to be seen.

[2] Many of these studies adjust earnings for age but none account for the variation of age-earnings profiles with education.

lower than inequality in annual earnings; and Aaberge and Mogstad's (2015) analysis of inequality in lifetime earnings for the 1942-1944 Norwegian birth cohorts, observed over forty years, which found that inequality in current earnings was greater than inequality in lifetime earnings at young ages, and smaller at older ages. Neither study followed variation in lifetime inequality over time. Nearer our focus here, Guvenen, Kaplan, Song and Weidner (2017) use United States Social Security data from 1957-2013 to measure inequality in lifetime earnings within single-year birth-cohorts of commerce and industry workers born between 1932 and 1958; when they consider men and women separately, they find rising lifetime earnings inequality for both. While these studies offer valuable historical perspectives on lifetime inequality, their extensive data requirements imply that they can only be applied to cohorts near or past the end of their working lives and for whom there are sufficiently long data series. This effectively precludes their application to more recent cohorts, and to tracking lifetime earnings inequality among active participants in the labor force by calendar years—a measure that can be compared to standard calendar-year measures of inequality in annual earnings.[3]

We offer a less direct approach, which estimates anticipated average lifetime earnings from shorter earnings histories, and can be applied to more recent cohorts, thus enabling a comparison of annual and lifetime earnings inequality among (the same) active labor force participants in a calendar year. Using data from the Panel Study of Income Dynamics (PSID), we measure annual earnings as wages and salaries; and following Solon and Shin (2011), Moffitt

[3] Measuring lifetime earnings inequality among individuals aged 31-59 in a single year from complete earnings histories requires at least 29 earlier years of longitudinal earnings data for the oldest cohort and 29 subsequent years for the youngest cohort, a span of 59 years in all. A different approach to assessing persistent inequality estimates inequality in consumption (e.g., Hall and Mishkin, 1982; Blundell and Preston, 1998; Fisher, Johnson and Smeeding, 2015).

and Zhang (2020) and others, trim the top and bottom one percent of positive earnings in each year. We then regress earnings on a cubic function of age and its interaction with education, race, and cohort-group, and on individual random effects, and obtain predicted annual earnings over the life cycle for male heads of households born between 1927 and 1987, from which we estimate their anticipated average lifetime earnings.[4] We show that our estimates of anticipated average lifetime earnings are accurate for earlier cohorts for whom fuller earnings histories are available. Further evidence that our findings are robust to the addition of future data is provided by retrospective analysis of inequality in average anticipated lifetime earnings in 1986-2008 using only data to 2008, which yields findings that closely approximate our full data estimates for these years.

This preliminary stage allows us to decompose the variance of log annual earnings in each year, annually from 1986 to 1996 and biannually to 2018, among males aged 31-59 with positive untrimmed earnings in each year, into six components: the variance of log anticipated average lifetime earnings, the variance of the log difference between actual and predicted annual earnings (our measure of volatility), the variance of the log difference between predicted annual earnings and average lifetime earnings (our measure of dispersion in life-cycle variation in earnings), and the covariances between each three pairs of these variables. We focus on the variance of log earnings as a measure of inequality because it allows this decomposition; we show that other widely used measures behave similarly. We focus on ages 31-59, rather than

[4] This first stage follows Justman and Krush (2013) and Justman and Stiassnie (2021). Coronado, Fullerton and Glass (2000) estimated a similar earnings equation from PSID data to construct synthetic earnings profiles; and Blomquist (1981) and Bowlus and Robin (2004) simulated lifetime profiles from shorter panels drawn respectively from Swedish tax records and the US Current Population Survey.

25-59, as this allows us to extend our analysis to 2018, and, as we show, does not substantively affect our results. Using a linked dollar threshold to trim low earnings values, instead of the one percent trim, dampens measured inequality and volatility in the Great Recession but also does not substantively affect our results, as we show.

We find that annual inequality fluctuates without trend from 1986 to the turn of the millennium, increases moderately during the dot-com recession, and then more sharply after 2008, following the Great Recession. Inequality in anticipated average lifetime earnings hardly varies at all throughout the period studied. Consequently, the variance of log lifetime earnings accounts for 45% of the variance of log annual earnings, on average, before 2008, but only 35% after 2008. The variance of life-cycle variation in earnings, measured as the variance of the log difference between predicted annual and lifetime earnings, was much smaller, and varied without trend in a very narrow range.

This points to the role of volatility, measured as the variance of the log difference between actual and predicted earnings, in driving changes in annual inequality, and indeed we find a correlation of 0.98 between the two series, with both increasing moderately during the dot-com recession, and more sharply following the Great Recession. This pattern supports the findings of previous research, which estimated volatility from short overlapping panels (often measured as the variance of the two-year log difference or arc-difference in earnings) regarding the importance of increased volatility in driving the recent rise in annual earnings inequality. Our findings go beyond previous research in demonstrating the stability of inequality in lifetime earnings over the last three decades, and in quantifying the changing relation between annual earnings inequality, lifetime earnings inequality and volatility over time. In addition, we show that an increase in the regressive incidence of transitory shocks since the turn of the millennium amplified the effect of volatility on inequality.

To allow a comparison of our estimates of lifetime earnings inequality to estimates from other data sources, we also estimate lifetime inequality within forty-one rolling ten-year cohort groups born between 1938 and 1987. Lifetime earnings inequality in these groups is similar in its average level to our year-by-year measures but exhibits a different dynamic pattern, first rising substantially and then falling back to its original level. We compare these findings to Guvenen et al.'s (2017) analysis of inequality in lifetime earnings within single-year cohorts born between 1938 and 1958, averaging out their single-cohort means and medians within each of the twelve overlapping ten-year cohort groups born in this period. We find a correlation of 0.90 between our mean-to-median ratios and theirs, with their values 18% higher on average. We also show that our PSID-based measures of lifetime inequality are nearly identical to measures we derive from the larger sample—but shorter coverage—of the 1979 National Labor Survey of Youth (NLSY79) for the 1957-64 cohort-group.

The structure of the paper is as follows. Section 2 estimates predicted annual earnings and anticipated average lifetime earnings. Section 3 decomposes the log variance of annual earnings, relating it to the log variance of lifetime earnings, transitory shocks, and life-cycle variation, and their covariances, over time. Section 4 applies short-panel measures of volatility to our data and compares them to our measure of residual volatility. Section 5 estimates inequality in lifetime earnings within birth-cohort groups and compares it to other estimates. Section 6 demonstrates the dynamic consistency of our findings, and Section 7 concludes.

2 Estimating predicted annual earnings over the life cycle and anticipated average lifetime earnings

We begin by estimating the following Mincer-type equation, regressing annual earnings on a function of age, education, race, and cohort-group, with individual random effects:

$$(1)\quad Y_{it} = \Sigma_{c=1}^{2}\{\alpha_{0c}cogr_{ic} + \Sigma_{k=1}^{3}\alpha_{1kc}age_{it}^{k}cogr_{ic} + \Sigma_{h=1}^{6}\Sigma_{k=1}^{3}\alpha_{2hkc}educ_{ih}age_{it}^{k}cogr_{ic} + \Sigma_{l=1}^{3}\Sigma_{k=1}^{3}\alpha_{3lkc}race_{il}age_{it}^{k}cogr_{ic}\} + \varepsilon_{it}$$

Here Y_{it} is individual $i's$ earnings in year t; age_{it}^{k} is i's age in year t, to the power k; $\{educ_{ih}\}$, $\{race_{il}\}$ and $\{cogr_{ic}\}$ are categorical variables indicating $i's$ years of schooling, race and birth-cohort group; ε_{it} is an i.i.d. error term; and the α terms are regression coefficients.[5] This yields an age-earnings profile for each combination of schooling, race, and birth-cohort group; and with individual random effects we obtain predicted earnings for each individual in each year, $\hat{Y}_{it}$. Predicted earnings at age 40, $\hat{Y}_{i4}$, is our proxy for average lifetime earnings. We denote: $y_{it} = \log{(Y_{it})}, \hat{y}_{it} = \log\left(\hat{Y}_{it}\right)$, and $\hat{Y}_{i} = \log{(\hat{Y}_{i40})}$.

Our data source is the PSID, using earnings data from 1969 to the most recent 2018 wave, with data collected annually until 1996 and bi-annually thereafter.[6] We follow previous research in restricting our analysis to male heads of households from the representative national sample drawn from the Survey Research Center (SRC), and do not include the over-sample of low-income families (SEO) or Latino families. Our earnings variable is “wages and salaries”. We adjust all earnings data to 2018 prices using the personal consumption expenditures (PCE) index; and trim the top and bottom one percent of positive earnings observations in each year,

[5] Education categories are 8 or less years of schooling, 9-10, 11-12, 13-15, 16, 17 or more; race categories are white, Afro-American, Latino, other; birth-cohorts are 1925-55, 1956-89. We adopt the simplifying assumption of an i.i.d. error term because of the sparseness of our panel, and the implicit difficulty in identifying error structures from our data.

[6] We omit two earlier years of data to maintain a consistent definition of earnings. Dynan, Elmendorf and Sichel (2011) note that methodological changes in the collection of PSID data in the early 1990s may have affected its consistency before and after these changes. This should not affect our main findings, which focus on later years.

following Solon and Shin, 2011, and subsequent studies. Using a linked dollar threshold to trim low earnings values dampens measured inequality and volatility in economic downturns, especially in the Great Recession, as Moffitt and Zhang (2020) note, but does not substantively affect our results, as we show. Trimming at the top is necessary because the PSID changed its top-coding values over time, and again our findings are not sensitive to the method used.

Our first-stage sample comprises 3,371 male heads of households born from 1925 to 1989 (we use only the 1927-87 cohorts in the second stage), with reported race and years of schooling, and with at least three untrimmed earnings observations between the ages 25 and 59. Altogether, we have 45,939 annual earnings observations, 13.6 per person. The average age at which earnings are observed is 39; average years of schooling rises from 13.9 in 1986 to 14.6 in 2018; about 90% percent of the sample are white and 8% are African American.

Equation (1) with individual random effects accounts for 0.679 of the overall variance in our earnings observations. The two panels of Appendix Figure A1 show two age-earnings profiles derived from this estimation for each of the two cohort groups (coefficient estimates are available on request.) They highlight the effect of education on the shape of the age-earnings profile and the change in the shape of the curves over time (the levels of the curves are determined by averaging individual random effects). For both cohort groups, peak earnings of college graduates, at age 50, are about twice the level of their earnings at age 30, while individuals with 11-12 years of schooling experience much less life-cycle variation.

To gauge how well our lifetime earnings proxy, $\hat{Y}_{i40}$, approximates actual lifetime earnings averages, we compare it, in Figure 1, to actual average observed earnings for a subset of our sample with better data coverage: 958 males born between 1937 and 1957, and thus observed throughout their prime earning years, each with at least ten annual untrimmed earnings observations, an average of 23 per person. It shows a close correspondence between our estimates of anticipated average lifetime earnings and actual lifetime averages. In Section 6 below we show that estimates using data to 2008 are robust to the addition of later data.

FIGURE 1 HERE

3 A decomposition of year-by-year inequality in annual earnings

Our primary measure of inequality in annual earnings in a given year is the variance of log annual earnings, $V(y_{it})$, among male heads of households aged 31-59 with positive earnings in that year, after trimming the top and bottom one percent. We track this measure between 1986 and 2018—annually to 1996 and biannually thereafter—with an average of 1,046 positive earnings observations per year. (Appendix Table A1 shows summary statistics year by year, for this second-stage sample.) We measure lifetime earnings inequality as the variance of log anticipated average lifetime earnings, $V(\hat{Y}_i)$; the dispersion of lifetime variation in earnings, as the variance of the log difference between predicted annual and anticipated average lifetime earnings, $V(\hat{y}_{it} - \hat{Y}_i)$; and volatility, as the variance of the log difference between actual and predicted annual earnings, $V(y_{it} - \hat{y}_{it})$. Writing $y_{it} = \hat{Y}_i + (\hat{y}_{it} - \hat{Y}_i) + (y_{it} - \hat{y}_{it})$, equation (2) decomposes inequality in annual earnings as follows:

$$(2) \qquad V(y_{it}) = V(\hat{Y}_i) + V(\hat{y}_{it} - \hat{Y}_i) + V(y_{it} - \hat{y}_{it}) +$$

$$2Cov(\hat{y}_{it} - \hat{Y}_i, \hat{Y}_i) + 2Cov(y_{it} - \hat{y}_{it}, \hat{Y}_i) + 2Cov(y_{it} - \hat{y}_{it}, \hat{y}_{it} - \hat{Y}_i)$$

These seven terms are shown graphically in Figure 2 for 1986-2018 (and numerically in Appendix Table A2). The topmost dotted graph is the variance of log annual earnings, the left-hand term in equation (2), and the six lower graphs represent the six right-hand terms—the solid lines are the three variances and the dashed lines are the three covariances.

Inequality in annual earnings, $V(y_{it})$, fluctuates cyclically without trend for the first two decades, and then increases sharply after the Great Recession, to a peak level of 0.83 in 2012, before declining to levels that remain above its average value of 0.52. Three alternative measures, the Gini coefficient in earnings and the Theil indices for $\alpha = 0$ and $\alpha = 1$, are shown in Appendix Figure A2 with numerical values in Table A3. All follow a similar pattern. The correlation of $V(y_{it})$ is 0.95 with the Theil index for $\alpha = 0$, and 0.80 with the Gini coefficient and with the Theil index for $\alpha = 1$. Figure A2 also shows Moffitt and Zhang's (2020, Appendix Table 1) PSID-based measure of the variance of log earnings, which is nearly identical to ours. Our measure of volatility $V(y_{it} - \hat{y}_{it})$ moves in tandem with annual earnings inequality, $V(y_{it})$, with a correlation of 0.98 between the two time-series, indicating the dominant role of volatility in driving the recent increase in the variance of log annual earnings. The ratio of our measure of residual volatility to annual earnings inequality is a steady 0.45.

FIGURE 2 HERE

Figure 2 points to a second driving factor, also strongly correlated with annual inequality, which further contributed to its recent rise: the rise in $Cov(y_{it} - \hat{y}_{it}, \hat{Y}_i)$, the covariance of transitory shocks with the log of anticipated average lifetime earnings, a measure of the regressive distributional incidence of volatility (Bourguignon, 2010; Fields, 2010). Relating the magnitude of these changes to the decomposition in equation (2), we find that between its trough in 1998 and our final year of 2018, $V(y_{it})$ increased by 0.190, and $V(y_{it} - \hat{y}_{it}) + 2Cov(y_{it} - \hat{y}_{it}, \hat{Y}_i)$ increased by 0.196, while other factors showed little variation; in particular, $V(\hat{Y}_i)$ increased by only 0.006.

Replacing our 1% threshold for trimming earnings with a dollar threshold equal to thirteen weeks of full-time work at half the minimum wage (used by Guvenen, Ozkan and Song, 2014) slightly dampens the recent increase in annual earnings inequality and volatility, as it excludes a larger fraction of observations during economic downturns (Moffitt and Zhang, 2020), but leaves our substantive results unchanged, as Figure 3 shows, reproducing the decomposition shown in Figure 2 for earnings trimmed by this dollar threshold. The correlation of annual earnings inequality, $V(y_{it})$, with volatility, $V(y_{it} - \hat{y}_{it})$, and with the regressive incidence of transitory shocks, $Cov(y_{it} - \hat{y}_{it}, \hat{Y}_i)$, remains very high, 0.94 and 0.93 respectively. Lifetime inequality, $V(\hat{Y}_i)$, and the variance of lifetime variation in earnings, $V(\hat{y}_{it} - \hat{Y}_i)$, are unaffected by the change in threshold.

FIGURE 3 HERE

Expanding the age range to ages 25-59 has virtually no effect on our measures of annual and lifetime inequality, and only slightly reduces the level of residual volatility, $V(y_{it} - \hat{y}_{it})$, while retaining its shape, as we show in Appendix Figure A4.

4 Measures of volatility from short overlapping panels

We compare our long-panel measure of residual volatility, $V(y_{it} - \hat{y}_{it})$, to two widely-used short-panel measures: the variance of the two-year log difference of earnings, $V(y_{it} - y_{i,t-2})$; and the variance of the two-year arc-difference of earnings, $2(Y_{it} - Y_{i,t-2})/(Y_{it} + Y_{i,t-2})$. Moffitt and Zhang (2018) refer to these as measures of "gross volatility".[7] The three measures

[7] Residualizing the differences by first regressing them on a polynomial in age yields nearly identical results. "Window averaging", which separates "within" and "between" earnings variances in larger windows of five years or more, and structured error-components models, offer intermediate decompositions that distinguish between transitory and persistent shocks (Gottschalk and Moffitt, 1994, 2009, among others).

are presented in Figure 4 along with the variance of log annual earnings, biannually from 1986 to 2018 (with numerical values in Appendix Table A5). The four measures behave similarly. The correlations of the arc difference and log difference measures with our measure of residual volatility are 0.88 and 0.92, with our measure falling mostly between these two short-panel measures. Their correlations with the variance of log annual earnings are 0.89 and 0.94, only slightly lower than the correlation between the variance of log annual earnings and our measure of residual volatility, 0.98.

FIGURE 4 HERE

The pattern described by our long-panel measure is consistent with previous short-panel analyses of mobility including analyses of PSID data by Shin and Solon (2011), Moffitt and Gottschalk (2012), and Moffitt and Zhang (2018, 2020); Carr and Wiemer's (2018) comparative analysis of mobility measures drawn from the PSID and from survey-linked administrative earnings data; and Moffitt's (2020) summary of a comparative analysis of mobility measures drawn from four data sources.[8]

Expanding the age range to 25-59 has almost no effect on the two-year arc difference and log difference of earnings, as Appendix Figure A5 shows for the years 1986-2012, with correlations of 0.97 for each of the two measures between the 31-59 and 25-59 age ranges. Again, using a dollar threshold equal to thirteen weeks of full-time work at half the minimum wage to trim the bottom of the earnings distribution, instead of our one percent trim, dampens the measured increase in both volatility measures after the Great Recession, as the dollar threshold excludes an increasing fraction of low earnings when economic conditions worsen.

[8] For further references, see Burkhouser and Couch (2009), Gottschalk and Moffitt (2009), Kopczuk, Saez and Song (2010), Jännti and Jenkins (2013), and Moffitt and Zhang (2020).

However, as Appendix Figure A6 shows, the relation between our residual measure of volatility and the two short-panel measures considered in Figure 4, is not greatly changed: our measure falls between the two short-panel until 2008 and rises slightly above them afterward, with slightly reduced correlations of 0.70 and 0.74.

5 Inequality in lifetime earnings within cohort-groups

Guvenen et al. (2017) measure inequality in lifetime earnings within annual birth cohorts, born between 1938 and 1958, and track its movement over time.[9] To apply our measures of lifetime earnings inequality for this alternative reference group, we track inequality in lifetime earnings within forty-one rolling ten-year cohort-groups, the oldest born in 1938-47 and the youngest in 1978-87, plotting the variance of log(anticipated average lifetime earnings), the Gini coefficient, and the Theil coefficients for $\alpha = 0$ and $\alpha = 1$. This is shown in Figure 5 (See Appendix Tables A6 and A7 for descriptive statistics, and numerical values for Figure 5.)

FIGURE 5 HERE

The four measures behave very similarly, with pairwise correlations of 0.94 and higher. The average values are similar to the average yearly values for lifetime earnings, but the cohort-group measures vary in a much wider range than the yearly measures—the coefficient of variation of the time series of each of the cohort group measure is roughly twice as large as its year-by-year counterpart—and all four cohort-group measures follow similar concave patterns, first rising by almost 50 percent, from the earliest cohort-group to their peak values in 1953-

[9] Our sample is too small to measure inequality within single-year birth cohorts. In related work, Haider (2001) compares inequality in 10-year earnings averages between the 1925-39 and 1938-52 cohort-groups, from PSID data to 1991, and finds that it increased.

62, and then falling back gradually to just over their initial values for the youngest, 1978-87 cohort group. Calendar-year and cohort-group measures of inequality in anticipated average lifetime earnings thus provide very different answers to the question, has lifetime earnings inequality increased in recent years?

Our cohort-group estimates of lifetime earnings inequality overlap Guvenen et al.'s (2017) estimates for the 1938-58 birth-cohorts, comprising our first twelve ten-year cohort-groups, from 1938-47 to 1949-58. The estimates are not directly comparable, as Guvenen et al. (2017) estimate inequality from Social Security data within very large single-year cohorts of commerce and industry workers, but both show clearly rising trends of similar magnitude.[10] In addition, we average their single-cohort means within each of these ten-year cohort-groups, divide it by the median of their ten single-cohort medians, and compare this ratio to our corresponding mean to median ratio, shown in Figure 6. Their values are slightly higher, by 18% on average, with a correlation of 0.90 between the two time-series, both showing a similar moderately rising trend.

FIGURE 6 HERE

We also compare our cohort-group measures of inequality in lifetime earnings to corresponding measures derived for a larger sample of the 1957-64 cohort-group drawn from the 1979 National Labor Survey of Youth (NLSY79). Applying the current approach to the NLSY79 data, we first estimated equation (1) to obtain age-earnings profiles similar to our

[10] Their Figure 11(a) shows an increase of about 20% in the standard deviation of log lifetime earnings for males, from the 1938 to the 1958 birth cohorts (represented there as entering the workforce at age 25 between 1963 and 1983), where the standard deviation of our log lifetime earnings proxy increased by 17% from the 1938-47 to the 1949-58 cohort group.

PSID-based profiles (Appendix Figure A7), and then used predicted earnings at age 40 as our measure of anticipated average lifetime earnings. Table 1 presents four measures of inequality in lifetime earnings derived from the two data sources. The four pairs are very similar, as are the trends and levels of inequality in annual earnings shown in Appendix Figure A8.

TABLE 1 HERE

6 Dynamic consistency: robustness to the addition of new data

The usefulness of our two-stage method rests on its ability to accurately anticipate average lifetime earnings for younger birth cohorts from short earnings histories, and thus provide a meaningful measure of lifetime inequality in earnings for more recent years. In this section, we demonstrate the dynamic consistency of our anticipated measure by reproducing our results retrospectively, using ten years (five waves) less of data, to 2008, to estimate year by year inequality in lifetime earnings to the year 2008 for males aged 31-59 in each year (and thus born until 1977); and comparing these estimates to our full-data estimates, in three respects.

Figure 7 compares our first-stage anticipated lifetime earnings proxy, retrospectively estimated using only data to 2008, to our full data estimates for 1,713 males born in 1938-77. There are a few outliers but the overall correlation is very high, 0.99.

FIGURE 7 HERE

Next, Figure 8 compares year-by-year estimates of two measures of inequality in lifetime earnings for 1986-2008 derived from data to 2008, to our full-data estimates: the log variance of anticipated average lifetime earnings and their Gini coefficient. The restricted-data estimates are only slightly lower than the full-data estimates, by 4 percent and 2 percent, respectively, and similarly vary in a narrow range. Differences increase over time, but at their greatest, in 2008, restricted-data estimates are only 9 percent, and 4 percent lower than the full data estimates. Correlations are 0.78 for the log variances and 0.92 for the Gini coefficients.

FIGURE 8 HERE

Finally, Table 2 compares three measures of inequality in lifetime earnings based only on data to 2008 to the corresponding full data estimates within three birth-cohort groups: 1938-57, 1938-67, and 1938-77. The two sets of estimates of the variance of log anticipated average lifetime earnings, and of the Gini coefficient and the mean to median ratio, are nearly identical. The close correspondence between the limited-data eastimates and the full-data estimates in all three dimensions indicates that our current estimates of anticipated average lifetime earnings should be similarly robust to the addition of future waves of data.

TABLE 2 HERE

7 Conclusion

Recent increases in inequality in annual earnings raise the question, to what extent do they reflect an increase in persistent inequality in lifetime earnings or only a rise in earnings volatility, which can be smoothed over time? Previous efforts to address this issue estimated earnings volatility from overlapping short data panels, and found that volatility has indeed increased markedly, in tandem with the rise in annual inequality. However, these studies could not determine whether persistent inequality in lifetime earnings has also increased at the same time. Directly calculating permanent earnings by averaging actual lifetime earnings from long administrative data sets can only be applied to estimating historical inequality among cohorts near or past the end of their working lives, and therefore cannot be applied, in practice, to estimating year-by-year inequality in lifetime earnings in recent years, in a manner that can be related to corresponding measures of inequality in annual earnings.

To overcome this limitation, we use richer but less extensive PSID survey data to estimate anticipated average lifetime earnings for cohorts with incomplete earnings histories, specifically for male heads of households born between 1927 and 1987. To this end, we first regress trimmed annual earnings on a function of age, education, race and cohort-group and individual random effects to estimate predicted annual earnings over the life cycle and derive from this an estimate of anticipated average lifetime earnings. We then use these estimates to decompose the yearly variance of log earnings among male heads of households aged 31-59 and with positive untrimmed earnings in the year, from 1986 to 2018, as the sum of six terms: the variance of log anticipated average lifetime earnings, the variance of the log difference between actual and predicted annual earnings (our measure of volatility), the variance of the log difference between predicted annual earnings and average lifetime earnings (measuring the contribution of life-cycle variation in earnings), and their three covariances.

We find that initially, annual inequality fluctuated moderately without trend until the turn of the millennium and then began a slow rise that accelerated after the Great Recession, while inequality in lifetime earnings varied very little over the entire period. Consequently, the log variance of lifetime earnings, which accounted for 45% of the variance of log annual earnings before 2008, accounted for only 35% on average from 2008 on. At the same time, our measure of residual earnings volatility, the variance of the log difference between actual and predicted earnings, moved in close correlation with annual earnings inequality throughout the period studied, and accounted for a steady 45% of the variance of log annual earnings throughout the period. This accords well with previous short-panel measures volatility, the variance of the two-year log difference and of the two-year arc-difference in earnings, reinforcing the conclusions of these studies regarding the importance of increased earnings volatility in driving the recent rise in annual earnings inequality.

Our findings go beyond previous research in quantifying the changing relation between annual earnings inequality, lifetime earnings inequality and volatility over time; in demonstrating the stability of inequality in lifetime earnings over the last three decades, including the recent period of rising inequality in annual earnings; and in showing that the effect of volatility on annual earnings inequality was amplified by an increase in the regressive incidence of transitory shocks. Attributing the rise in annual inequality almost entirely to the effect of transitory shocks highlights the importance of smoothing consumption over time in the face of growing volatility. [11] In addition, we reproduce our findings to the year 2008 without the last ten years of data and obtain similar results to our full-data estimates, indicating that our findings to 2018 should hold up well as future waves of data are collected.

Finally, we note that the stability of inequality in anticipated average lifetime earnings over the last three decades applies to inequality among male heads of household actively participating in the workforce in each year. Cohort-based measures of inequality in anticipated average lifetime earnings present a different picture. Inequality in lifetime earnings within ten-year cohort-groups born between 1938 and 1987 followed a concave pattern, first increasing markedly for two decades, and then declining by a similar degree. The answer to the question, what has happened to inequality in lifetime earnings over the last two decades, depends on whether one measures lifetime inequality among active labor-force participants in a calendar year or within birth cohorts: the former has remained stable while the latter has declined.

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[11] Financial innovation has enhanced households' ability to smooth consumption (Dynan et al., 2006) even as it may have contributed to greater volatility.

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Tables

Table 1. Estimates of inequality in average antiicipated lifetime earnings in the 1957-64 cohort-group calculated from NLSY79 data, compared to our PSID estimates

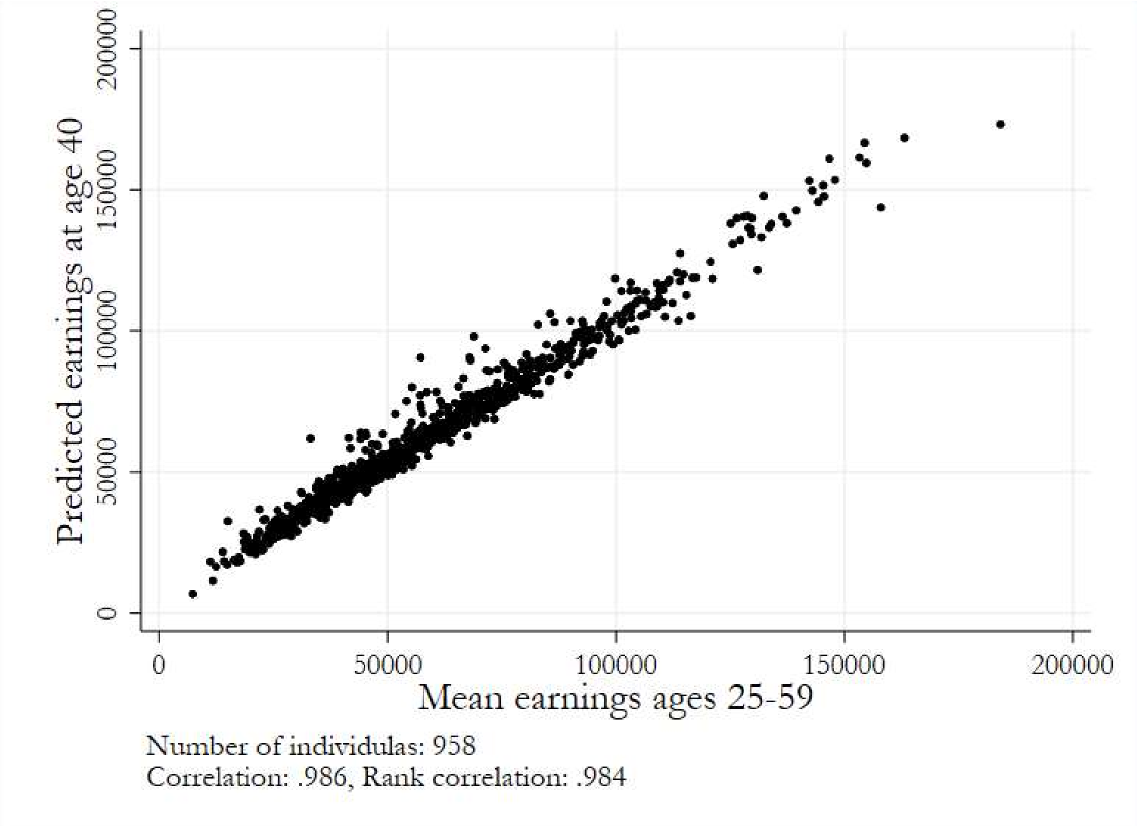
	N	*Variance of log earnings*	*Gini coefficient*	*Mean to median ratio*	*Coefficient of variation*
NLSY79	4,951	0.23	0.26	1.08	0.045
PSID	466	0.25	0.28	1.14	0.046

Table 2. Inequality in anticipated average lifetime earnings within the 1938-57, 1938-67 and 1938-77 cohort-groups using only data to 2008, and using all data to 2018

Data waves	*N*	*Variance of log (anticipated average lifetime earnings)*	*Gini coefficient*	*Mean to median ratio*
		1938-57 birth cohorts		
1969-2008	1,153	0.19	0.23	1.08
1969-2018	1,153	0.19	0.23	1.08
		1938-67 birth cohorts		
1969-2008	1,679	0.19	0.24	1.09
1969-2018	1,691	0.19	0.24	1.09
		1938-77 birth cohorts		
1969-2008	1,713	0.19	0.24	1.08
1969-2018	2,225	0.20	0.25	1.09

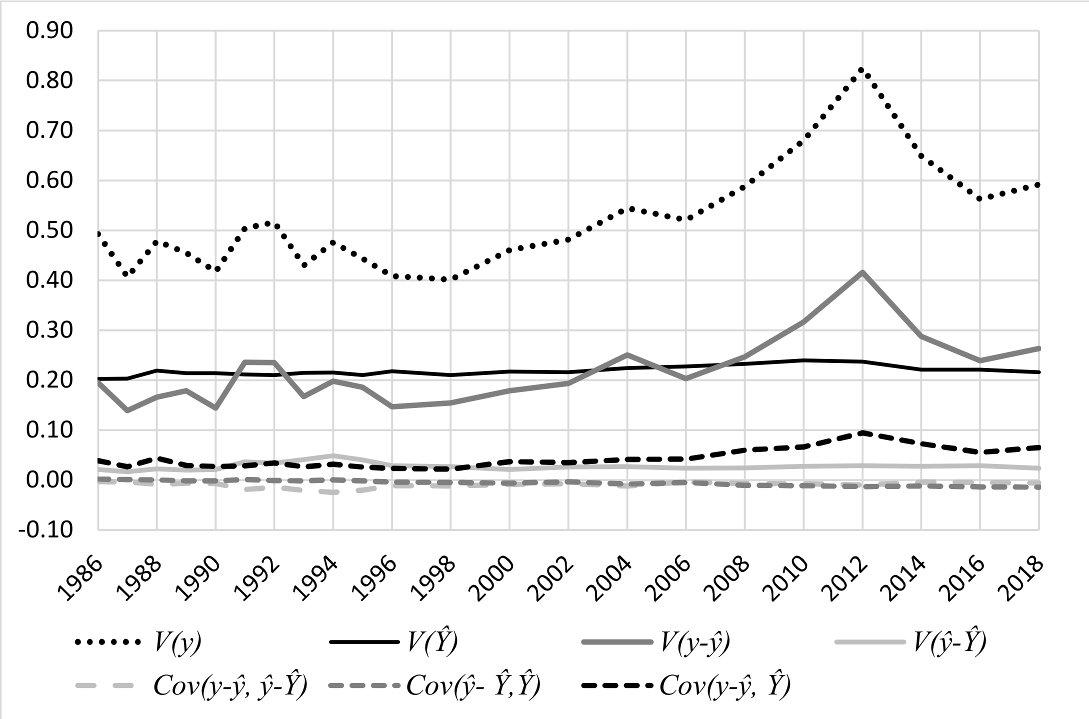
Figures

Figure 1. Predicted earnings at age 40 against average actual earnings, for a subsample of males born in 1937-57 with 10 or more untrimmed earnings observations



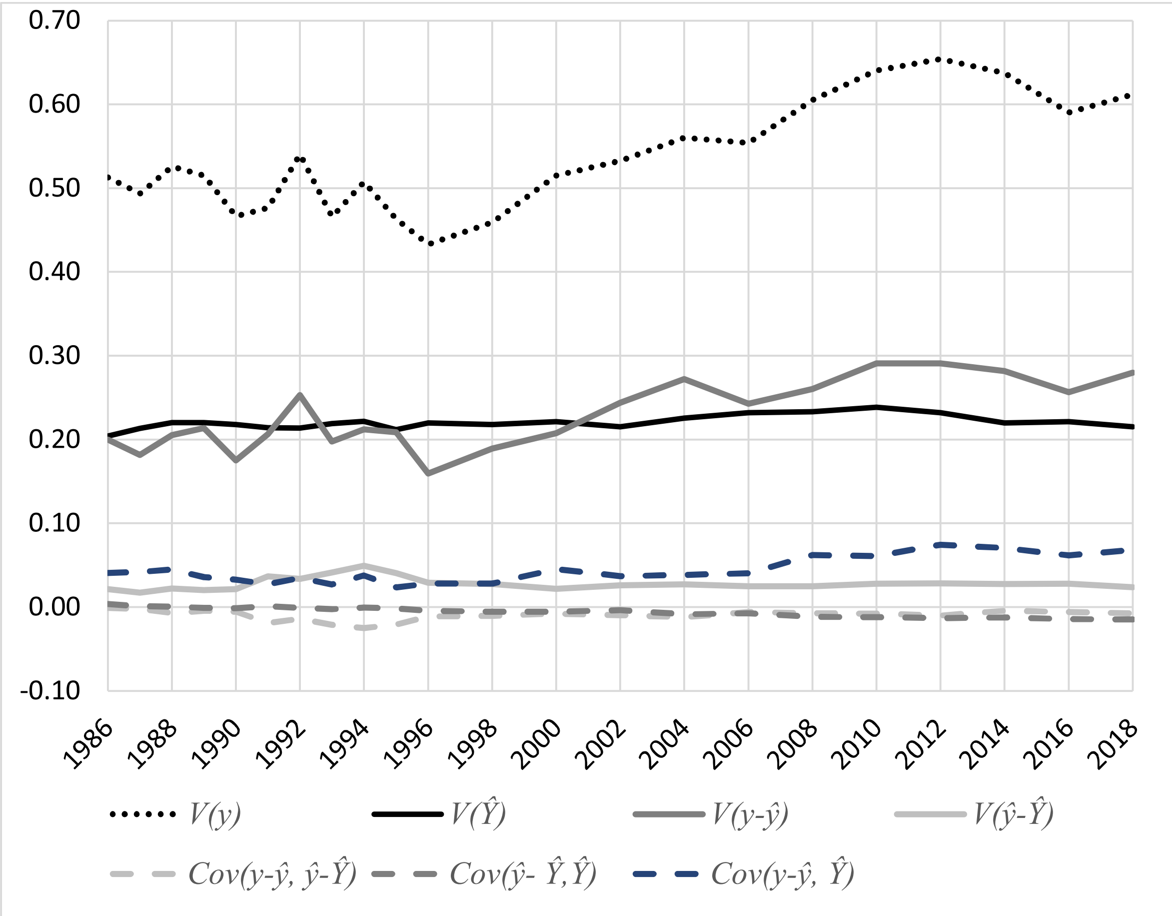
Note: Predicted earnings at age 40, our proxy for anticipated average lifetime earnings, from a regression of annual earnings on a cubic polynomial in age and its interaction with education, race and cohort group indicators, and on individual random effects.

Figure 2. Yearly variances and covariances of log annual earnings, log lifetime earnings, life-cycle variation, and residual volatility, 1986-2012, 1% trim



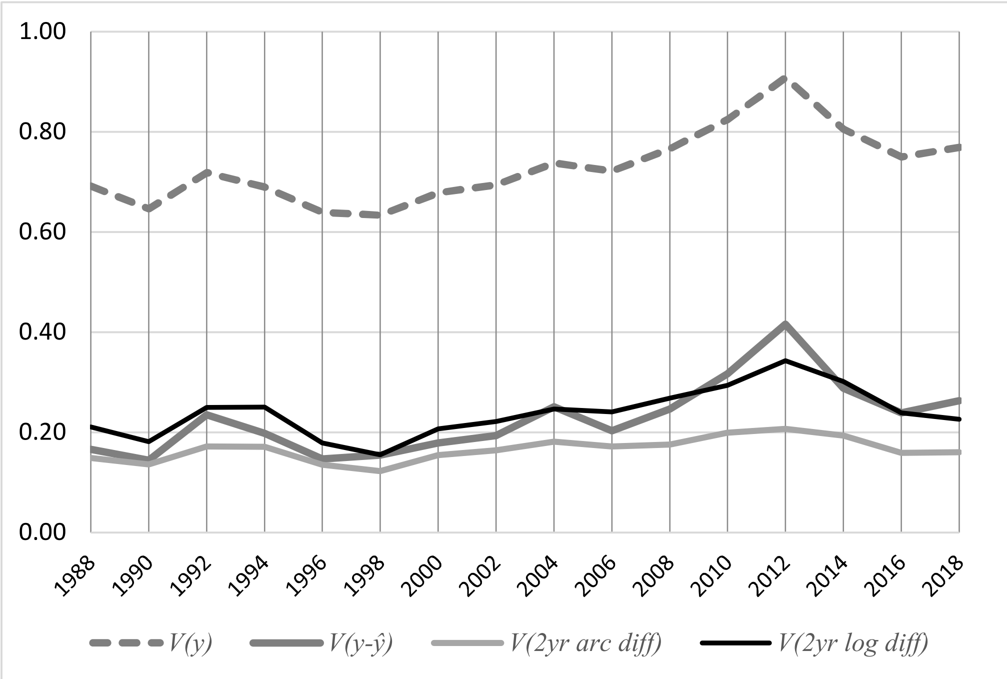
Note: Male heads of households with at least three untrimmed earnings observations after trimming the top and bottom 1% in each year; aged 31-59 and with positive untrimmed earnings in the year; annually to 1996 and biannually thereafter. The variable y *denotes log annual earnings and* $\hat{y}$ *and* $\hat{Y}$ *denote first-stage estimates of, respectively, predicted log annual earnings and log anticipated average lifetime earnings.*

Figure 3. Yearly variances and covariances of log annual earnings, log lifetime earnings, life-cycle variation, and residual volatility, 1986-2012, dollar threshold



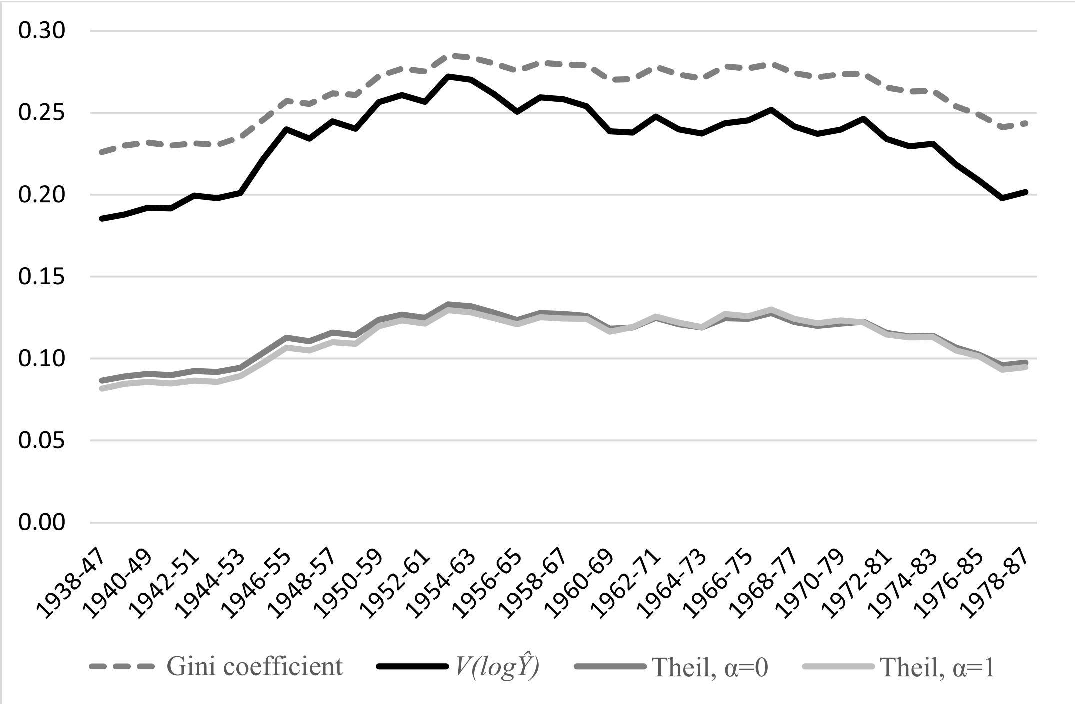
Note: Male heads of households with at least three untrimmed earnings observations after trimming the top 1% of earnings and earnings below a threshold equal to thirteen weeks of full-time work at half the minimum wage in each year, aged 31-59 and with positive untrimmed earnings in the year; annually to 1996 and biannually thereafter. The variable y denotes log annual earnings and y ˆand Y ˆdenote first-stage estimates of, respectively, predicted log annual earnings and log anticipated average lifetime earnings.

Figure 4. Short-panel measures of volatility, our residual measure of volatility, $V(y - \hat{y})$, and annual earnings inequality, $V(y)$



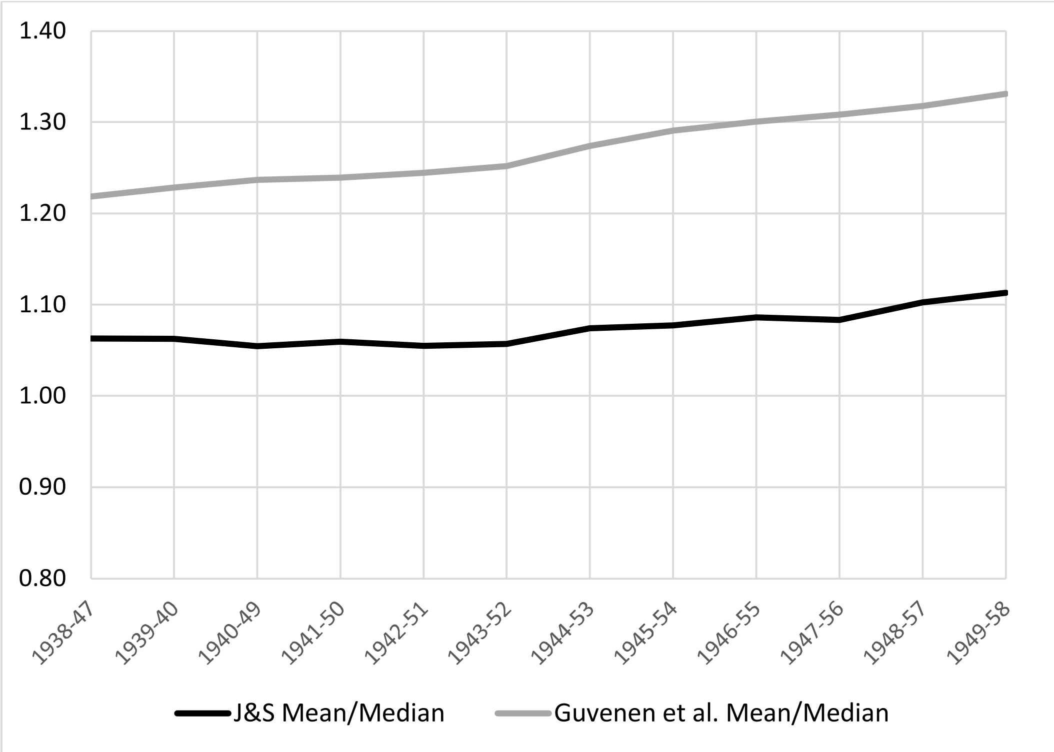
Note: Male heads of households aged 31-59 with positive earnings after trimming the top and bottom 1%. The two-year arc-difference of earnings is $2(Y_{it} - Y_{i,t-2})/(Y_{it} + Y_{i,t-2})$.

Figure 5. Four measures of inequality of anticipated average lifetime earnings within 10-year cohort groups, 1938-87



Note: Anticipated average lifetime earnings estimated as predicted earnings at age 40, from a regression of annual earnings on a cubic polynomial in age and its interaction with education, race and cohort group indicators, and on individual random effects.

Figure 6. Mean to median ratios of lifetime earnings in ten-year cohort groups, 1938-47 to 1949-58, current estimates compared to Guvenen et al. (2017, Table A1)



Note: The Guvenen et al. cohort-group mean to median ratios are constructed from their annual values by taking the within-group averages of their yearly means and the median of their yearly medians. We identify cohorts by birth years where Guvenen et al. (2017) identify them by the year they turn 25.

Figure 7. Estimated anticipated lifetime earnings for males born in 1938-77 using only data up to 2008, plotted against our full data estimates (2018 PCE prices)

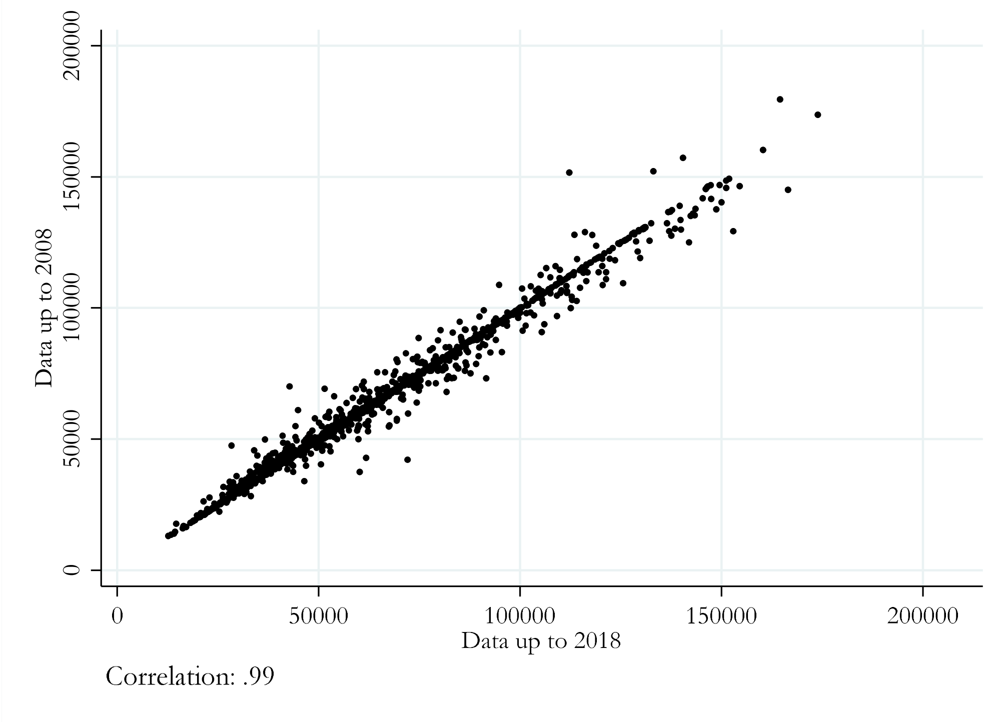
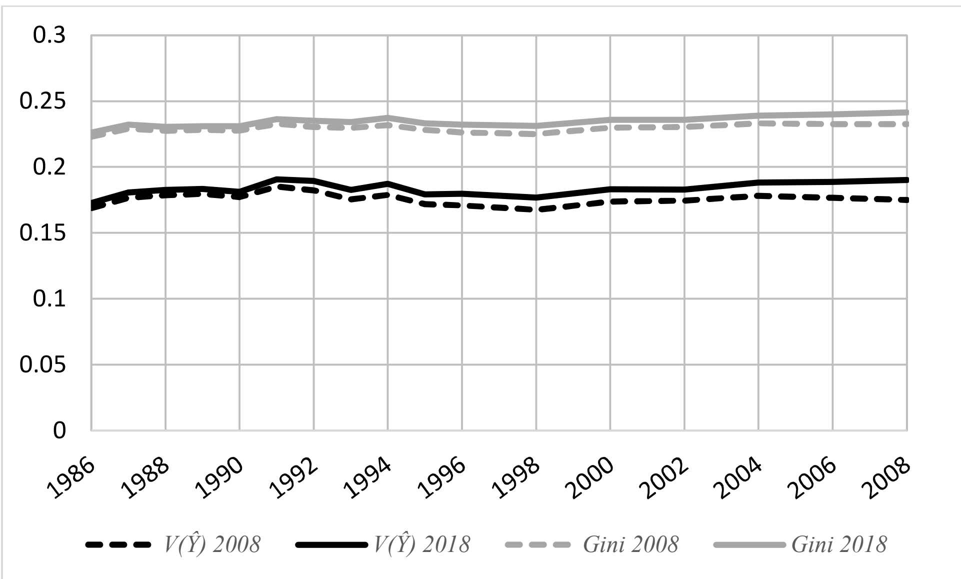


Figure 8. Two measures of year-by-year inequality in lifetime earnings, 1986-2008, using only data to 2008 and using all data to 2018



Appendix Tables and Figures

Table A1. *Year-by-year summary statistics, working sample, males aged 31-59 with positive untrimmed earnings in the year; 2018 PCE prices,*

Year	*N*	*Age group*			*Years of schooling*			*White*	*Mean earnings*	*Median earnings*
		31-34	35-54	55-59	0-12	13-15	16+			
1986	967	22%	65%	13%	40%	24%	36%	93%	60,617	56,821
1987	969	21%	67%	12%	39%	25%	36%	93%	62,097	57,443
1988	976	21%	69%	11%	39%	25%	36%	93%	61,714	55,841
1989	980	20%	70%	10%	38%	25%	37%	92%	60,745	53,693
1990	979	18%	73%	9%	36%	25%	39%	92%	61,818	54,671
1991	1,008	19%	72%	9%	37%	25%	38%	91%	59,881	52,902
1992	1,011	18%	74%	9%	37%	25%	38%	92%	62,602	56,359
1993	1,067	18%	73%	9%	36%	25%	39%	93%	63,364	54,988
1994	1,080	19%	73%	8%	36%	25%	38%	92%	63,162	53,867
1995	1,070	16%	76%	8%	36%	24%	40%	92%	63,824	54,259
1996	1,064	16%	76%	8%	34%	25%	41%	93%	65,465	56,078
1998	1,060	13%	77%	10%	34%	24%	42%	93%	70,549	60,440
2000	1,093	14%	75%	12%	34%	25%	42%	92%	73,210	60,874
2002	1,091	15%	72%	13%	33%	26%	41%	92%	71,044	57,610
2004	1,168	17%	69%	14%	30%	27%	42%	91%	73,119	59,581
2006	1,126	17%	68%	15%	30%	29%	41%	91%	76,376	60,690
2008	1,145	18%	66%	15%	31%	28%	41%	91%	72,088	58,613
2010	1,081	20%	64%	16%	30%	28%	42%	91%	70,246	58,810
2012	1,084	21%	64%	15%	29%	28%	43%	91%	70,925	58,449
2014	1,025	21%	65%	14%	29%	28%	43%	90%	71,702	57,893
2016	1,016	19%	67%	14%	28%	28%	44%	90%	74,530	62,373
2018	979	18%	69%	13%	25%	29%	45%	90%	76,463	63,000

Table A2. *The variance of log annual earnings and its decomposition, 1986-2018*

Year	*N*	*V(y)*	*V(Ŷ)*	*V(y-ŷ)*	*V(ŷ-Ŷ)*	*Cov(y-ŷ, ŷ-Ŷ)*	*Cov(ŷ- Ŷ,Ŷ)*	*Cov(y-ŷ, Ŷ)*
1986	967	0.49	0.20	0.19	0.02	0.00	0.00	0.04
1987	969	0.41	0.20	0.14	0.02	0.00	0.00	0.03
1988	976	0.48	0.22	0.17	0.02	-0.01	0.00	0.04
1989	980	0.45	0.21	0.18	0.02	-0.01	0.00	0.03
1990	979	0.42	0.21	0.14	0.02	-0.01	0.00	0.03
1991	1,008	0.50	0.21	0.24	0.04	-0.02	0.00	0.03
1992	1,011	0.52	0.21	0.23	0.03	-0.01	0.00	0.03
1993	1,067	0.43	0.21	0.17	0.04	-0.02	0.00	0.03
1994	1,080	0.48	0.22	0.20	0.05	-0.02	0.00	0.03
1995	1,070	0.44	0.21	0.19	0.04	-0.02	0.00	0.03
1996	1,064	0.41	0.22	0.15	0.03	-0.01	0.00	0.02
1998	1,060	0.40	0.21	0.15	0.03	-0.01	-0.01	0.02
2000	1,093	0.46	0.22	0.18	0.02	-0.01	-0.01	0.04
2002	1,091	0.48	0.22	0.19	0.03	-0.01	0.00	0.03
2004	1,168	0.54	0.22	0.25	0.03	-0.01	-0.01	0.04
2006	1,126	0.52	0.23	0.20	0.02	0.00	0.00	0.04
2008	1,145	0.59	0.23	0.25	0.02	-0.01	-0.01	0.06
2010	1,081	0.68	0.24	0.32	0.03	-0.01	-0.01	0.07
2012	1,084	0.83	0.24	0.42	0.03	-0.01	-0.01	0.09
2014	1,025	0.65	0.22	0.29	0.03	0.00	-0.01	0.07
2016	1,016	0.56	0.22	0.24	0.03	0.00	-0.01	0.06
2018	979	0.59	0.22	0.26	0.02	-0.01	-0.01	0.07

Males aged 31-59 with positive untrimmed earnings in the year; top and bottom 1% trimmed each year; 2018 PCE prices. V(y) is the variance of log annual earnings; V(Ŷ) is the variance of log anticipated average lifetime earnings; V(y-ŷ) is the variance of the log residual, the log difference between actual and predicted annual earnings. The decomposition, given by equation (2) is:

$$V(\,y_{it}) = V(\hat{Y}_i) + V(\hat{y}_{it} - \hat{Y}_i) + V(y_{it} - \hat{y}_{it}) +$$
$$2Cov(y_{it} - \hat{y}_{it}, \hat{Y}_i) + 2Cov(y_{it} - \hat{y}_{it}, \hat{y}_{it} - \hat{Y}_i) + 2Cov(\hat{y}_{it} - \hat{Y}_i, \hat{Y}_i)$$

Table A3: *Measures of inequality in annual earnings, 1986-2018*

Year	*N*	*V(y)*	*Gini coefficient*	*Theil index* α*=0*	*Theil index* α*=1*
1986	967	0.493	0.308	0.194	0.157
1987	969	0.407	0.301	0.172	0.148
1988	976	0.479	0.315	0.196	0.164
1989	980	0.455	0.313	0.190	0.162
1990	979	0.418	0.317	0.185	0.167
1991	1,008	0.504	0.318	0.201	0.168
1992	1,011	0.516	0.318	0.205	0.168
1993	1,067	0.430	0.318	0.187	0.168
1994	1,080	0.476	0.328	0.203	0.180
1995	1,070	0.443	0.322	0.192	0.172
1996	1,064	0.408	0.322	0.184	0.169
1998	1,060	0.402	0.323	0.185	0.171
2000	1,093	0.461	0.345	0.212	0.199
2002	1,091	0.482	0.351	0.220	0.204
2004	1,168	0.545	0.367	0.245	0.226
2006	1,126	0.521	0.376	0.248	0.241
2008	1,145	0.588	0.367	0.253	0.226
2010	1,081	0.680	0.370	0.274	0.232
2012	1,084	0.825	0.381	0.306	0.246
2014	1,025	0.649	0.369	0.266	0.229
2016	1,016	0.562	0.360	0.242	0.216
2018	979	0.592	0.363	0.252	0.223

Males aged 31-59 with positive untrimmed earnings in the year; top and bottom 1% trimmed each year; 2018 PCE prices. V(y) is the variance of log annual earnings.

Table A4: *Year-by-year inequality in anticipated average lifetime earnings, 1986-2018*

Year	*N*	*$V(\hat{Y})$*	*Gini coefficient*	*Theil index α=0*	*Theil index α=1*
1986	967	0.20	0.24	0.09	0.09
1987	969	0.20	0.24	0.09	0.09
1988	976	0.22	0.24	0.10	0.09
1989	980	0.21	0.24	0.10	0.09
1990	979	0.21	0.25	0.10	0.10
1991	1,008	0.21	0.25	0.10	0.10
1992	1,011	0.21	0.24	0.10	0.10
1993	1,067	0.21	0.25	0.10	0.10
1994	1,080	0.22	0.25	0.10	0.10
1995	1,070	0.21	0.25	0.10	0.10
1996	1,064	0.22	0.25	0.10	0.10
1998	1,060	0.21	0.25	0.10	0.10
2000	1,093	0.22	0.26	0.11	0.10
2002	1,091	0.22	0.26	0.11	0.11
2004	1,168	0.22	0.26	0.11	0.11
2006	1,126	0.23	0.27	0.11	0.11
2008	1,145	0.23	0.27	0.12	0.11
2010	1,081	0.24	0.27	0.12	0.12
2012	1,084	0.24	0.26	0.12	0.11
2014	1,025	0.22	0.26	0.11	0.11
2016	1,016	0.22	0.26	0.11	0.10
2018	979	0.22	0.25	0.10	0.10

Males aged 31-59 with positive untrimmed earnings in the year; 2018 PCE prices. Anticipated average lifetime earnings are predicted earnings at age 40 derived from a first stage regression.

Table A5. *Our long panel measure of volatility in annual earnings, and two overlapping 2-year short-panel measures, males aged 31-59 and with untrimmed earnings in the year, top and bottom 1% trimmed, 1986-2018, biannually*

Year	$V(y_{it})$	$V(y_{it} - \hat{y}_{it})$	$V(y_{it} - y_{i,t-2})$	$V\left(\frac{Y_{it} - Y_{i,t-2}}{(Y_{it} + Y_{i,t-2})/2}\right)$
1986	0.69	0.17	0.21	0.15
1988	0.65	0.14	0.18	0.14
1990	0.72	0.23	0.25	0.17
1992	0.69	0.20	0.25	0.17
1994	0.64	0.15	0.18	0.14
1996	0.63	0.15	0.16	0.12
1998	0.68	0.18	0.21	0.15
2000	0.69	0.19	0.22	0.16
2002	0.74	0.25	0.25	0.18
2004	0.72	0.20	0.24	0.17
2006	0.77	0.25	0.27	0.18
2008	0.82	0.32	0.29	0.20
2010	0.91	0.42	0.34	0.21
2012	0.81	0.29	0.30	0.19
2014	0.75	0.24	0.24	0.16
2016	0.77	0.26	0.23	0.16
2018	0.69	0.17	0.21	0.15

Table A6. *Descriptive statistics for ten-year cohort groups, 1938-87; the four disjoint cohort-groups are shaded*

Birth cohort	*N*	*Observations*	*Average annual earnings*	*Average lifetime earnings*	*Years of schooling*
1938-47	494	4,025	67,650	60,341	13.8
1939-40	523	4,569	68,803	60,824	14.0
1940-49	546	4,918	68,460	60,998	14.1
1941-50	567	5,325	69,505	62,026	14.1
1942-51	588	5,691	68,592	61,571	14.2
1943-52	606	6,046	68,343	61,604	14.2
1944-53	634	6,649	68,051	61,711	14.2
1945-54	650	7,131	67,422	61,206	14.2
1946-55	671	7,597	67,881	61,600	14.2
1947-56	676	7,754	66,891	61,487	14.1
1948-57	661	7,787	66,515	61,249	14.0
1949-58	645	7,677	66,128	61,525	13.9
1950-59	654	7,848	66,728	62,231	13.9
1951-60	665	8,047	66,489	62,400	13.9
1952-61	649	7,896	67,546	63,937	13.9
1953-62	645	7,693	68,062	65,070	13.9
1954-63	633	7,268	67,352	65,078	13.9
1955-64	606	6,794	68,080	66,545	14.0
1956-65	578	6,170	67,688	67,124	13.9
1957-66	548	5,698	68,185	67,556	14.0
1958-67	538	5,294	69,093	69,127	14.0
1959-68	521	4,904	68,294	68,872	14.0
1960-69	513	4,595	68,119	69,553	14.0
1961-70	496	4,072	69,275	71,242	14.1
1962-71	498	3,841	68,180	70,892	14.1
1963-72	494	3,622	67,691	71,333	14.1
1964-73	490	3,418	69,422	72,530	14.2
1965-74	501	3,300	70,177	73,275	14.1
1966-75	505	3,212	69,221	73,040	14.2
1967-76	525	3,203	70,472	75,120	14.2
1968-77	537	3,113	70,507	75,256	14.2
1969-78	560	3,102	70,584	76,151	14.3
1970-79	576	3,004	70,547	76,630	14.4
1971-80	575	2,839	69,452	76,286	14.4
1972-81	593	2,734	69,707	77,360	14.5
1973-82	584	2,503	69,452	77,258	14.5
1974-83	599	2,352	68,664	77,666	14.5
1975-84	602	2,173	67,603	78,089	14.5
1976-85	597	1,980	68,268	78,714	14.6
1977-86	591	1,762	67,239	78,106	14.6
1978-87	576	1,503	66,407	78,439	14.7

Table A7. *Inequality in lifetime earnings within rolling ten-year cohort groups, 1938-87; the four disjoint cohort-groups are shaded*

Birth cohorts	*N*	*Var* ($log\hat{Y}$)	*Theil,* $\alpha = 0$	*Theil,* $\alpha = 1$	*Gini coefficient*	*Mean to median ratio*
1938-47	494	0.186	0.09	0.08	0.23	1.06
1939-40	523	0.188	0.09	0.08	0.23	1.06
1940-49	546	0.192	0.09	0.09	0.23	1.05
1941-50	567	0.192	0.09	0.08	0.23	1.06
1942-51	588	0.199	0.09	0.09	0.23	1.05
1943-52	606	0.198	0.09	0.09	0.23	1.06
1944-53	634	0.201	0.09	0.09	0.24	1.07
1945-54	650	0.222	0.10	0.10	0.25	1.08
1946-55	671	0.240	0.11	0.11	0.26	1.09
1947-56	676	0.234	0.11	0.10	0.26	1.08
1948-57	661	0.245	0.12	0.11	0.26	1.10
1949-58	645	0.240	0.11	0.11	0.26	1.11
1950-59	654	0.256	0.12	0.12	0.27	1.14
1951-60	665	0.261	0.13	0.12	0.28	1.15
1952-61	649	0.257	0.12	0.12	0.28	1.13
1953-62	645	0.272	0.13	0.13	0.29	1.16
1954-63	633	0.270	0.13	0.13	0.28	1.14
1955-64	606	0.261	0.13	0.12	0.28	1.13
1956-65	578	0.251	0.12	0.12	0.28	1.13
1957-66	548	0.259	0.13	0.13	0.28	1.13
1958-67	538	0.258	0.13	0.12	0.28	1.15
1959-68	521	0.254	0.13	0.12	0.28	1.14
1960-69	513	0.239	0.12	0.12	0.27	1.12
1961-70	496	0.238	0.12	0.12	0.27	1.14
1962-71	498	0.248	0.12	0.13	0.28	1.14
1963-72	494	0.240	0.12	0.12	0.27	1.14
1964-73	490	0.237	0.12	0.12	0.27	1.14
1965-74	501	0.244	0.12	0.13	0.28	1.15
1966-75	505	0.245	0.12	0.13	0.28	1.15
1967-76	525	0.252	0.13	0.13	0.28	1.16
1968-77	537	0.242	0.12	0.12	0.27	1.15
1969-78	560	0.237	0.12	0.12	0.27	1.14
1970-79	576	0.240	0.12	0.12	0.27	1.14
1971-80	575	0.246	0.12	0.12	0.27	1.14
1972-81	593	0.234	0.12	0.11	0.27	1.14
1973-82	584	0.229	0.11	0.11	0.26	1.14
1974-83	599	0.231	0.11	0.11	0.26	1.13
1975-84	602	0.218	0.11	0.10	0.25	1.12
1976-85	597	0.209	0.10	0.10	0.25	1.11
1977-86	591	0.198	0.10	0.09	0.24	1.09
1978-87	576	0.201	0.10	0.09	0.24	1.09

Figure A1. *PSID age-earnings profiles, by years of schooling, white males born in 1925-56 and 1957-87; derived from a regression of earnings on a cubic polynomial in age and its interaction with education and race (equation 1), and individual random effects. Heights of the graphs are averages of the random effects for white males, by schooling and cohort.*

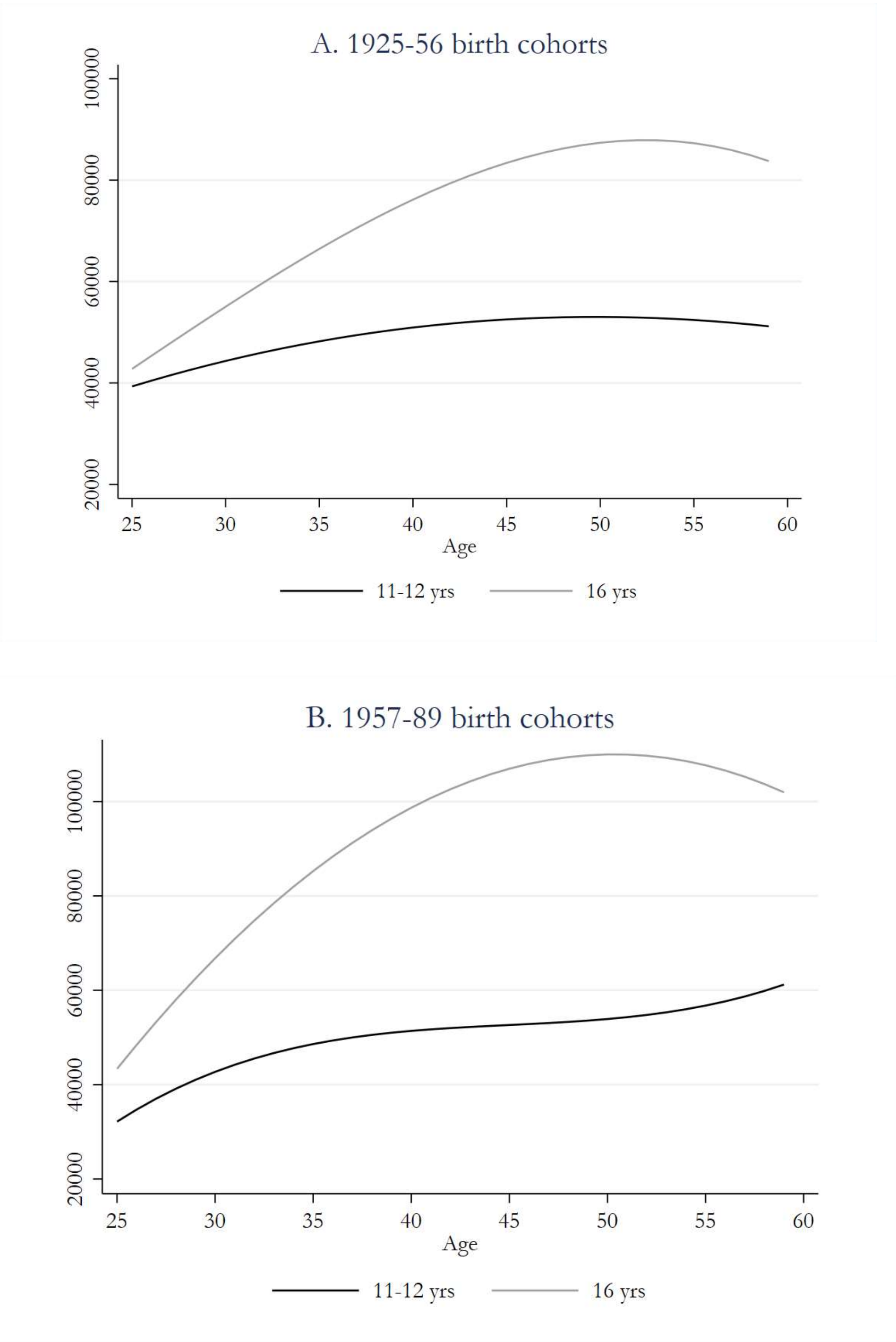


Figure A2. *Measures of inequality in annual earnings*

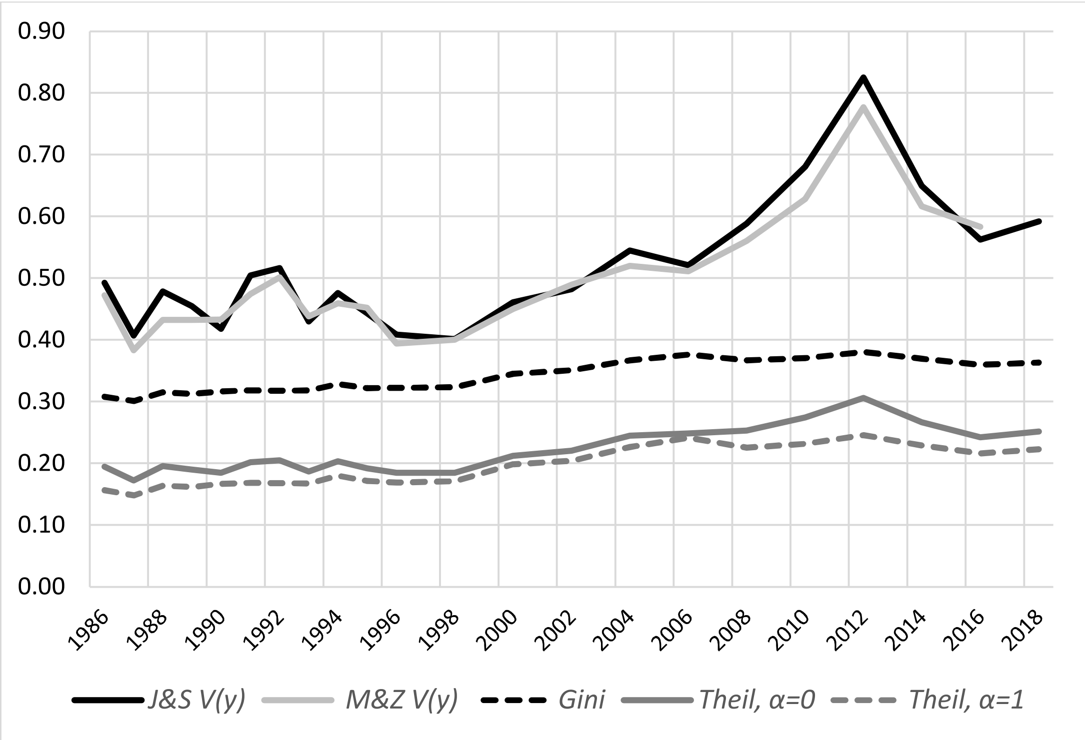


Figure A3. *Measures of inequality in lifetime earnings, 1986-2012*

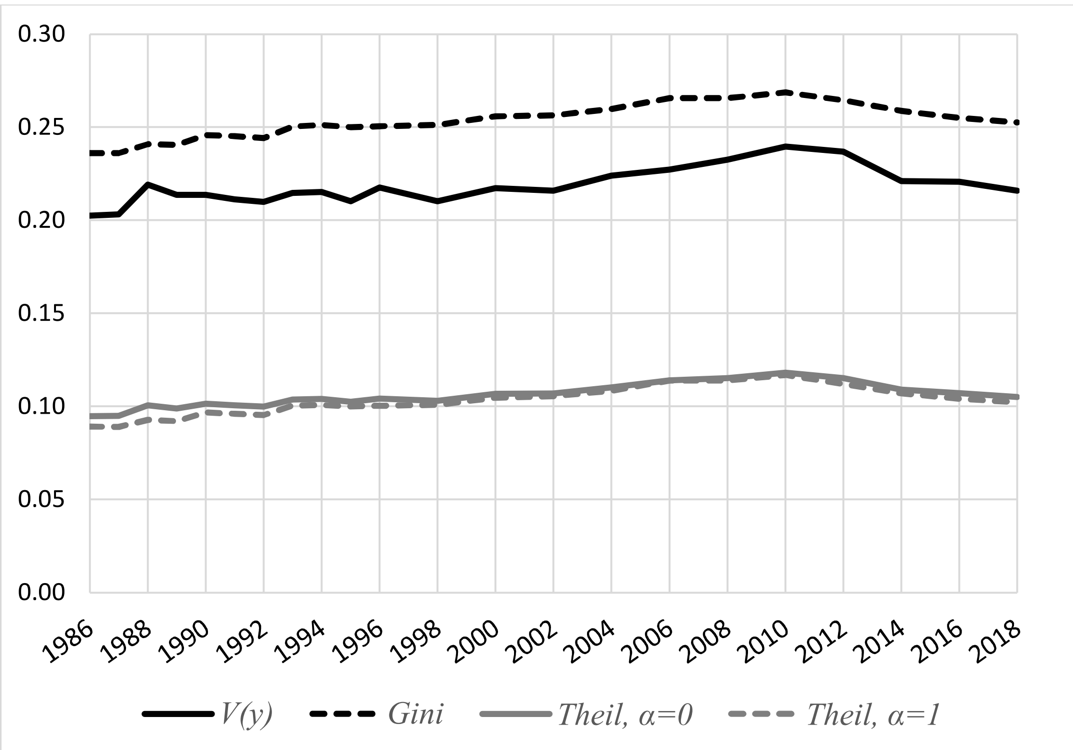
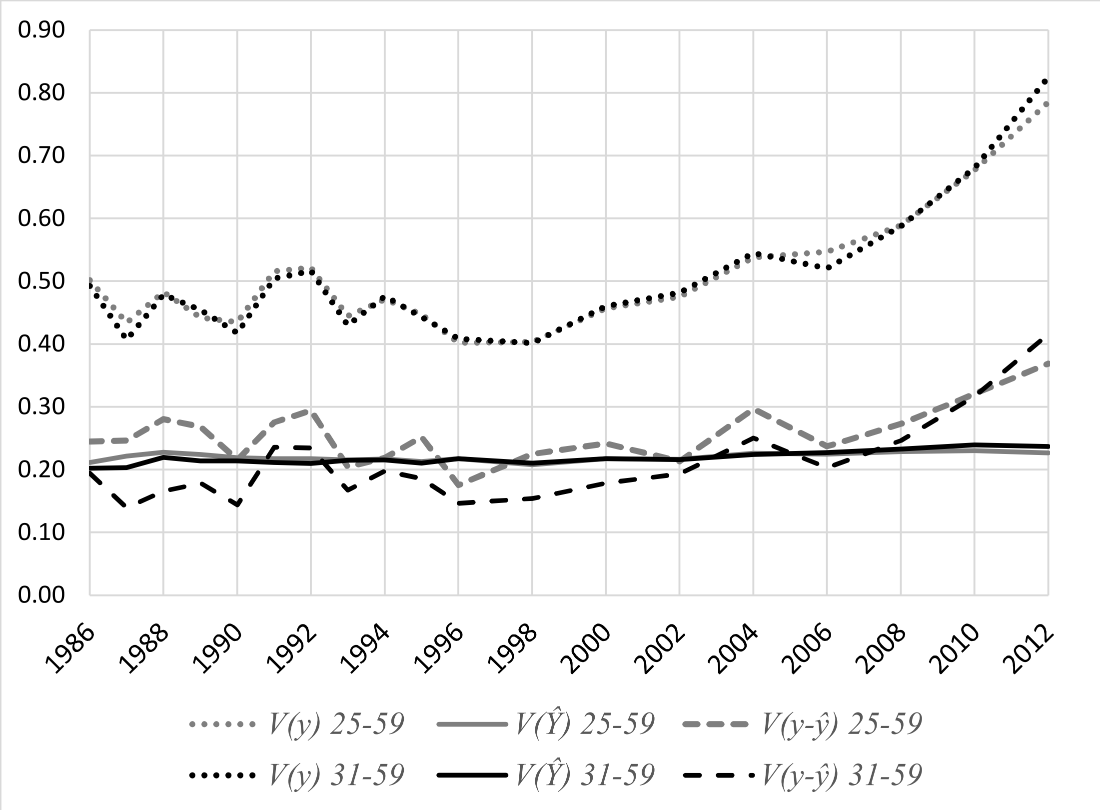


Figure A4. *Inequality in annual and lifetime earnings and residual volatility, males aged 31-59 and 25-59, with untrimmed earnings, 1986-2012, 1% trim*



Note: V(y) is annual inequality, V(Ŷ) is lifetime inequality and V(y-ŷ) is residual volatility.

Figure A5. *The two-year arc difference and log difference of earnings, for the 31-59 and 25-59 age ranges, 1986-2012*

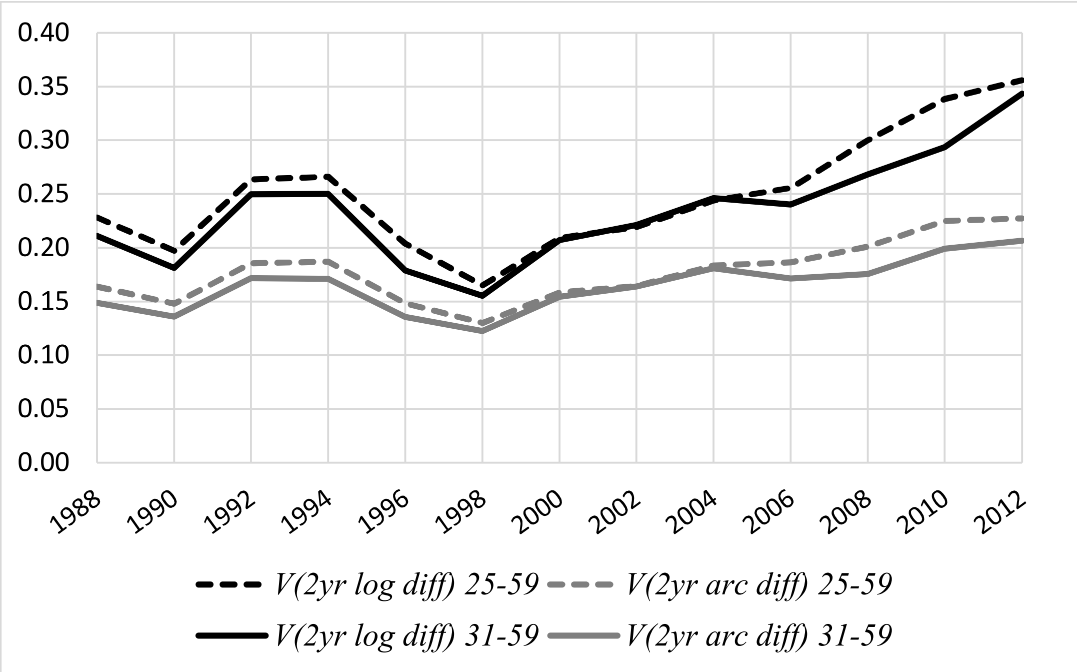
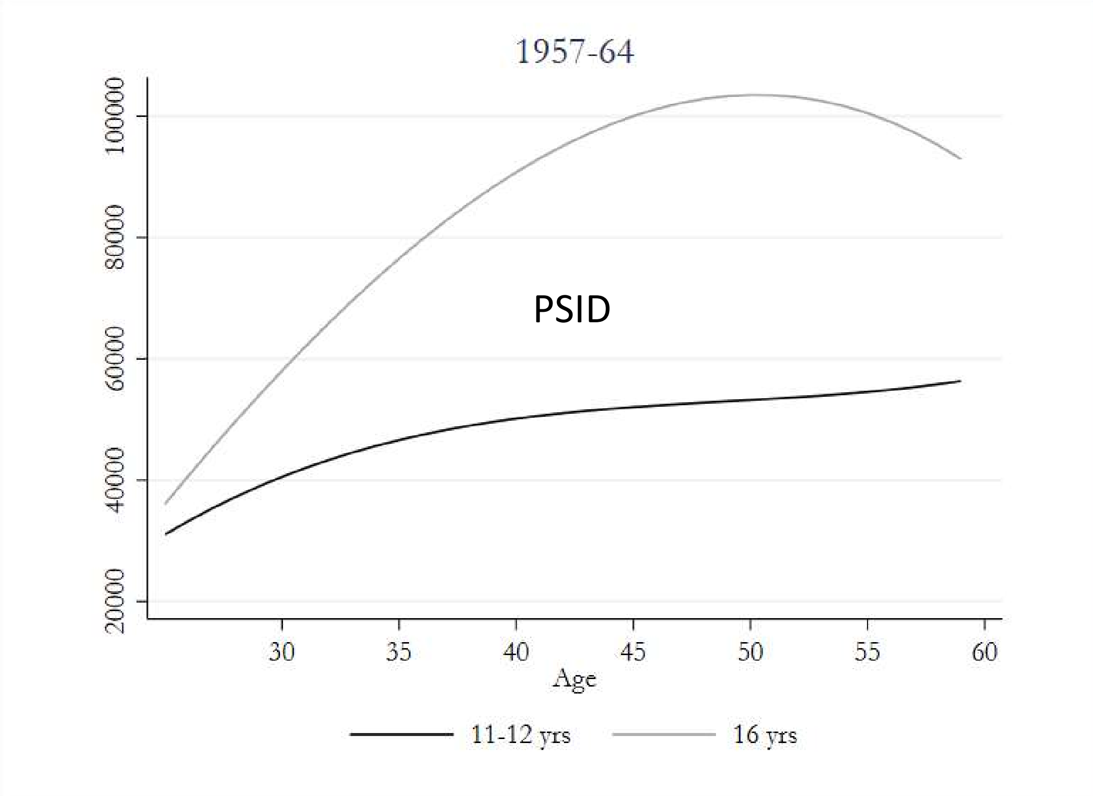


Figure A6. *Short-panel measures of volatility, and our residual measure,* $V(y - \hat{y})$, *males aged 31-59 top 1% trimmed with earnings in the year above a dollar threshold equal to 13 weeks of full-time work at half the minimum wage*

Figure A7. *PSID and NLSY age-earnings profiles, by years of schooling, white males born in 1957-64; derived from a regression of earnings on a cubic polynomial in age and its interaction with education and race (equation 1) and individual random effects. Heights of the graphs are averages of the random effects for white males, by schooling, in each data set.*



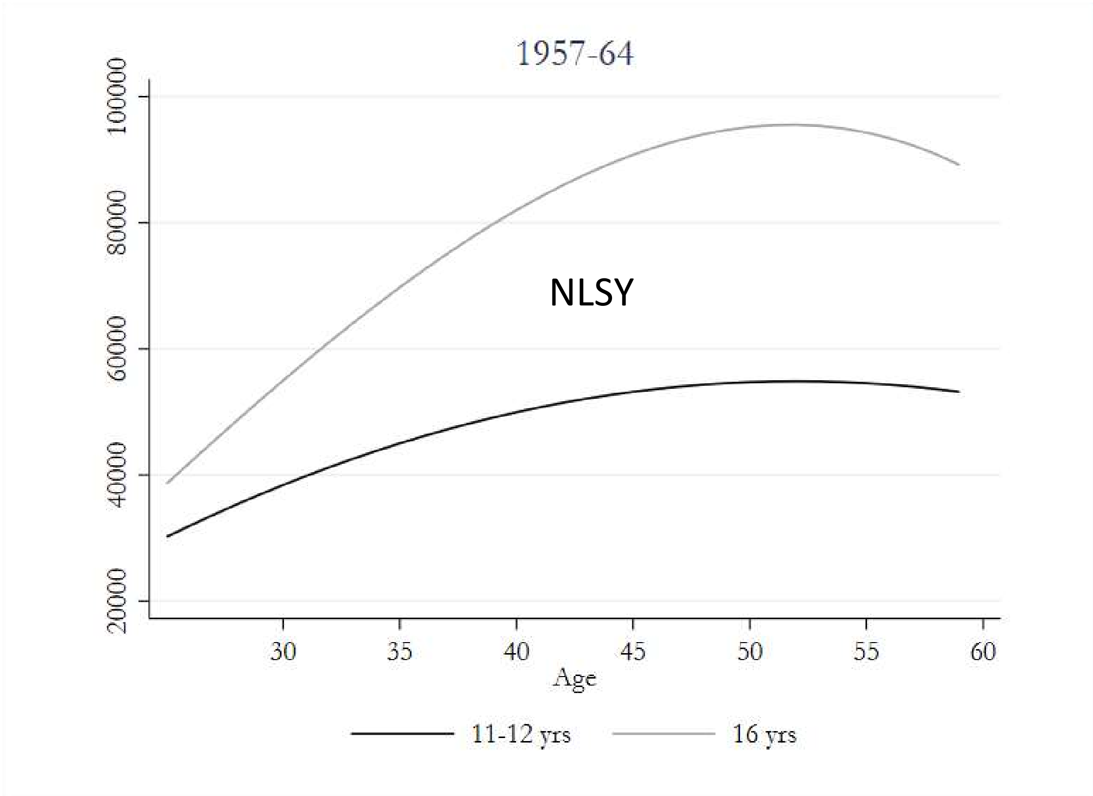
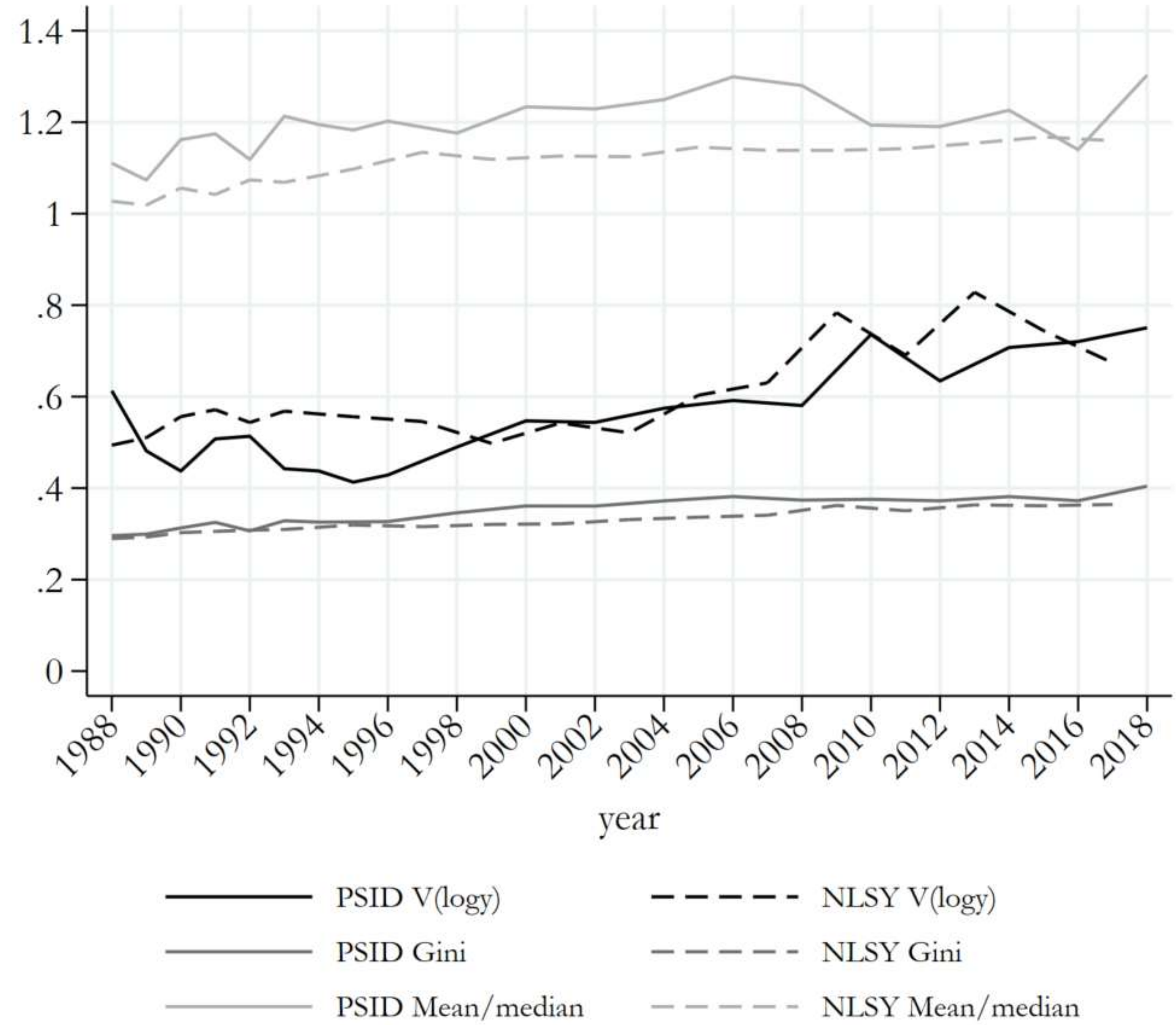


Figure A8. *PSID and NLSY inequality in annual earnings, males born in 1957-64, aged 31-59 and with untrimmed earnings (2018 prices) in each year*



Note: We use the 1978-2017 waves the of the NLSY79, collected annually to 1993 and biannually thereafter.