Post Schooling Wage Growth: Evidence on Models Part III

Yona Rubinstein and Yoram Weiss

Econ 350, Spring 2022

Basic Findings and their Interpretation

- In this section we provide a second look at the data, while stressing findings that have some bearing on the alternative models of wage growth.

Mincer's earnings function

- Jacob Mincer discovered an important empirical regularity in the wage (earnings) structure.
- Average earnings of workers (in a given schooling-experience group) are tied to schooling and work experience in a relatively precise manner as summarized by the now familiar Mincer equation

$$\ln Y_{it} = \alpha + \beta s_i + \gamma(t - s_i) - \delta(t - s_i)^2 + ... \qquad (31)$$

where Y_{it} are annual earnings (or weekly or hourly wage) of person i in year t, s_i are the years of schooling completed by person i and $(t - s_i)$ are the accumulated years of (potential) work experience of person i by year t.

- In his 1974 book, Mincer estimated this specification for a sample of about 30.000 employed males taken from the US 1960 census; he reported a coefficient of .107 for schooling and .081 and $-.0012$ for the two experience coefficients.
- Including weeks worked as an explanatory variable, the effects of experience declined to .068 and $-.0009$, implying that wages grow less than earnings.
- The same equation has since been estimated in many countries for different periods and sectors, with similar results.

- Mincer's important insight was that this stability is no accident but rather a reflection of powerful and persisting economic forces.

- In an early (1958, pp. 284-5) paper, he wrote that: "The starting point of an economic analysis of personal income distribution must be an exploration of the implications of the theory of rational choice. An implication of rational choice is the formation of income differences that are required to compensate for various advantages and disadvantages attached to the receipts of incomes....This principle, so eloquently stated by Adam Smith has become a common place in economics. What follows is an attempt to cast one important aspect of this compensation principle into an operational model that provides insights into some features of the aggregative income distribution and into a number of decompositions of it which recent empirical research has made possible. The aspect chosen concerns differences in training among members of the labor force."

- To apply the compensation principle to the data, Mincer considered long-lived individuals who operate in a stationary economy with access to a capital market and maximize the present value of their lifetime incomes.
- Suppose that the different occupations (jobs) pay wages that depend on the worker's schooling and experience and can be described by some earnings (wage) function of the form $Y_j(s, t-s)$.
- Given that workers can choose schooling and then occupations (jobs) that require different levels of training, what form should these functions have in equilibrium?

- One basic condition is that the present value of different lifetime earnings streams must be equal.
- Otherwise, all workers will be attracted to the highest paying j, s option, and no one will choose any other option.
- This condition alone puts strong restrictions on the equilibrium wage structure and, in particular, it implies that the marginal contribution of schooling is the *same* for all occupations, irrespective of the time shape of the experience profile, which is a form of separability.
- A simple functional form that satisfies these requirements for a large T is $Y_j(s, t-s) = e^{rs} y_j(t-s)$, where $\int_0^\infty e^{-r\tau} y_j(\tau) d\tau$ is a constant that is independent of j.

- Taking logs, one gets that

$$\log Y_j(s, t-s) = y_0 + rs + \log y^e(t-s) + \varepsilon_{tj}, \qquad (32)$$

where $y^e(t-s_j)$ is the mean effect of experience and ε_{tj} $= \log y_j^e(t-s) - \log y^e(t-s)$ are deviations caused by differences in on the job training across occupations.

This simple model highlights several general points:

- The effect of schooling on the log of wages is determined by the prevailing interest rate, reflecting the delay in receiving income that is implied by investment in schooling. Under this interpretation, it is important that schooling be measured in years. Moreover, if workers care only about income and leisure has little value, earnings rather than hourly (or weekly) wages should be the dependent variable.
- The average log earnings profiles of workers with different schooling are parallel, reflecting the separability of investment decisions in school and on the job.

- Individual earnings profiles intersect because they must provide the same present value of lifetime earnings. To the extent that a common effect for experience is used to describe earnings, the errors must be correlated over the life cycle so that early negative residuals imply positive late residuals and the variance of these residuals must be a U- shaped as a function of experience.
- These features are independent of demand conditions and should hold as long as individuals are homogenous and schooling and occupations can be freely chosen, without barriers to entry. Significantly, these features may hold in different countries or periods, with different technologies and different demands for educated workers. In this respect, the model is classical. Prices are determined by an infinitely elastic supply and demand determines only the number of workers of each type.

- Mincer then used Becker's 1967 Woytinsky lecture [reprinted in Becker (1975)] and Ben-Porath's (1967) results on optimal investment in human capital to put restrictions on the average contribution of experience to earnings, $y^e(t-s)$.

- He notes that: "learning from experience is an investment in the same sense as the more obvious forms of on-the-job training, such as, say, apprenticeship programs. Put in simple terms, an individual takes a job with an initially lower pay than he could otherwise get because he knows that he will benefit from the experience gained in the job taken" (1993, vol.1, p. 102). He then notes that: "Generally speaking, the fact that age-earnings profiles slope upward over part of the life cycle is a consequence of the tendency to invest in human capital at young ages... Investments are spread over time because the marginal costs of producing them is upward sloping in each period. They decline over time because marginal benefit decline and because the marginal cost curve shifts upward" (1993, v. 1, p. 44).

- The decline in benefits reflects the fact that one can only exploit human capital by "renting" it out, but not by selling it.
- The increase in costs reflects the fact that investment in human capital requires the person's own time which is diverted from work.

- Let $k(t) = \frac{Y(t)}{K(t)}$ denote the portion of earning capacity that is utilized in the form of actual earnings; then, by definition, $Y(t) = K(t)(1 - I(t))$.
- Assume that $\frac{\dot{K}(t)}{K(t)} = rI(t)$ and that the investment ratio $I(t)$ equals 1 during schooling and then declines linearly with experience during the work period, i.e., $I(t) = a - b(t - s)$ for $t \geq s$.
- One thus obtains

$$\ln Y(s, t-s) \cong \ln K(0) + rs + r \int_0^{t-s} (a - bx)dx - (a - b(t-s)), \quad (33)$$

which has the same functional form as the earnings function specified in (31).

- It his 1974 book, Mincer used these considerations to provide a direct economic interpretation for the coefficients of his estimated "human capital earnings function".
- The estimated coefficient on schooling in equation (30) reflects "the rate of return for schooling" and the coefficients on experience reflect the shape of the average person's investment profile.
- The reduction in investment is thereby tied to the observed slope and concavity of log earnings-experience profiles.

- As pointed out by Rosen (1977), under the model's strict assumptions, in particular the assumption that all earnings profiles yield the same present value, the life cycle pattern of earnings is undetermined.
- Thus, to use the human capital model, one must specify a particular trade-off between current and future earnings, usually called the "production function" of human capital.
- Thus, let $\dot{K} = g(I)$, where $I = IK$ and $g(I)$ is rising and concave.
- The assumptions that $g(I)$ rises and Y declines in I maintain the idea of compensation because one must sacrifice current earnings in order to increase earning capacity (and future earnings).

- The added assumption of concavity can be justified by the fact that a person must use his own resources to augment his earning capacity.
- But this would force identical individuals to choose the same investment path on the job.
- Differences in individual earnings profiles cannot, then, be simply attributed to differences in investments; individual attributes such as ability or access to the capital market, which affect individual "propensity to invest", must be introduced.
- In this case, it is no longer true that, in equilibrium, all income profiles are equivalent and that the observed wage ratios are independent of demand.

- Mincer has often relied on Becker's (1975) analysis (first presented in his 1967 Woytinsky lectures) of the roles of ability and access to the capital market as factors affecting individual differences in investment.
- He is quite explicit in stating that: "Once ability and opportunity are introduced as determinants of investment, earning differentials can no longer be considered as wholly compensatory. Rents or "profits" from investment in human capital arise.." (1993, vol. 1, p. 59).
- These rents depend on the individual's attributes and on how much he chooses to invest.
- Mincer thus often refers to the estimated returns for schooling and experience as average returns.

- Nevertheless, the role of individual heterogeneity initiated a major debate about the economic interpretation of the coefficients in the Mincer earnings functions.
- Given that these rates are based on comparison of different individuals who choose different levels of schooling, the casual effect of schooling is not identified, because it may simply reflect the impact of omitted (unobserved) ability and the positive correlation between ability and schooling (Griliches, 1977).
- This debate was further stimulated by theoretical criticisms, based on asymmetric information and signaling, showing that schooling may have a positive effect even if it has no impact on a worker's output.
- More generally, to the extent that schooling is mainly a sorting device, social rates of return may be far lower than the private returns captured in the cross section.

- Huge research effort, based on twin data, natural experiments, and using variety of instrumental variables methods has tried to identify the causal effect of schooling.
- These studies generally follow Becker's scheme and assume that the individual level of schooling is determined by equating the marginal lifetime benefits of schooling with the marginal costs of financing it.
- The object of interest in these studies is the expected increase in average annual log earnings if a random sample (in a particular population) were to acquire an additional unit of education.

- The same interpretation of the rate of return holds in Mincer's compensating differences model, applied on the individual level.
- A person who is arbitrarily moved to a schooling program that requires one additional year of study will have proportionally higher future annual earnings (and output) given by the common interest rate, although there is no gain in lifetime earnings (or output).
- The crucial difference is that Mincer provides a market level analysis in which the contribution of schooling to earning is determined rather than taken as given.
- It is quite amazing that, after all this work, it was found that the impact of ability on the estimated rates of return is apparently not large and that Mincer's estimates of the average rates of return to schooling survived unscathed (see Card, 1999, 2001).

- It must be recognized, however, that individual differences in ability can change the equilibrium structure in a fundamental way.
- The supply of workers of different skills is now positively sloped and the slope depends on the distribution of ability in the population.
- In this case, the rate of return to schooling depends on demand conditions.
- In addition, workers with different abilities invest differentially and have different lifetime earnings.
- Only "marginal" workers receive compensation for their investment, while other workers obtain ability rents.
- Further complications arise if ability is not unidimensional, and different workers fit different jobs (as in Willis and Rosen, 1979), or if ability is not observed by employers (as in Altonji and Pierret, 2001).

- Similar problems arise with respect to the estimated impact of work experience on wage growth: Can we interpret the estimated coefficients of experience in Mincer's equation as the causal impact of investment on the job, or are they severely contaminated by differences in the attributes of the individuals choosing different levels of investment on the job?
- Moreover, how is trade off between current and future incomes determined in equilibrium?
- These issues are more difficult to resolve in the case of post schooling investments because the observed outcome is a whole wage profile rather than a single wage level and because, in contrast to schooling, investment on the job is not observed.
- Nevertheless, using panel data, one may examine properties of individual life cycle profiles to tease out some qualitative answers.

The Variance Covariance Structure of Earnings

- One of Mincer's (1974) important findings is that the variance of the residuals from his estimated wage function forms a U-shaped function of potential work experience.
- This finding is quite surprising given that alternative models of life cycle earnings, such as learning or search, predict a monotonically increasing variance or a variance that is first increasing and then decreasing.
- Mincer has interpreted this result as a consequence of compensating wage differences.
- That is, individual variation in the "propensity to invest" generates substantial differences at the early and the late stages of the life cycle, when workers who choose to invest first pay for their training and later receive the benefits.

- Mincer (1974) provides evidence supporting his U-shape prediction.
- Again, Mincer's early findings appear surprisingly robust.
- Heckman, Lochner and Todd (2001) confirmed Mincer's findings using later data and Polachek (2003) brought evidence for such patterns across countries.
- Figures 6a to 6e show the gap in log wages between the 90th and 10th percentiles within the education and experience categories, using the CPS repeated cross-sectional data for the periods 1964-1979 and 1980-2001.
- Like Mincer (1974) and Heckman, Lochner and Todd (2001), we find that the interpersonal wage dispersion exhibits a U-shape pattern, which is less pronounced at higher levels of schooling.

- As in Plachek (2003), we find that in recent years, the "break-even point" at which the variance is at its minimum (i.e., the experience level at which the earnings of investors and non-investors coincide) appears quite early in a career, approximately 3 to 5 years after entry into the labor market.
- The higher variability in the second period, 1980-2001, reflects the general increase in wage inequality due to changing skill prices.
- Nevertheless, the U-shape pattern persists in both periods.

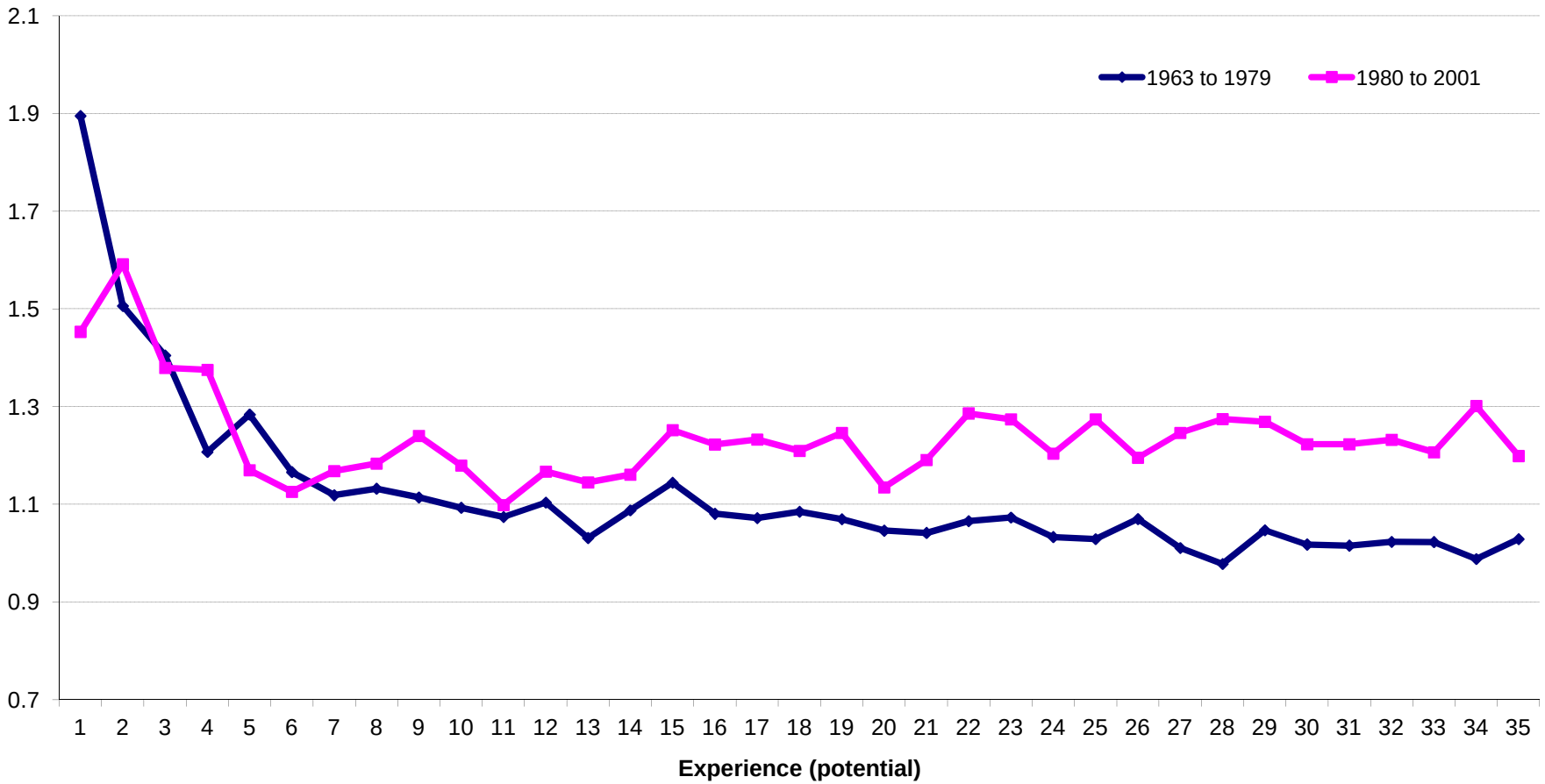

Figure 6: The Gap between White Male Workers Belonging to the 90'th and 10'th Perecntiles of the Residual Log Wage Distribution for the Periods 1963-1979 and 1980-2001, by Education and Experience, March CPS Supplements, 1964 to 2002
Figure 6a: High School Dropouts

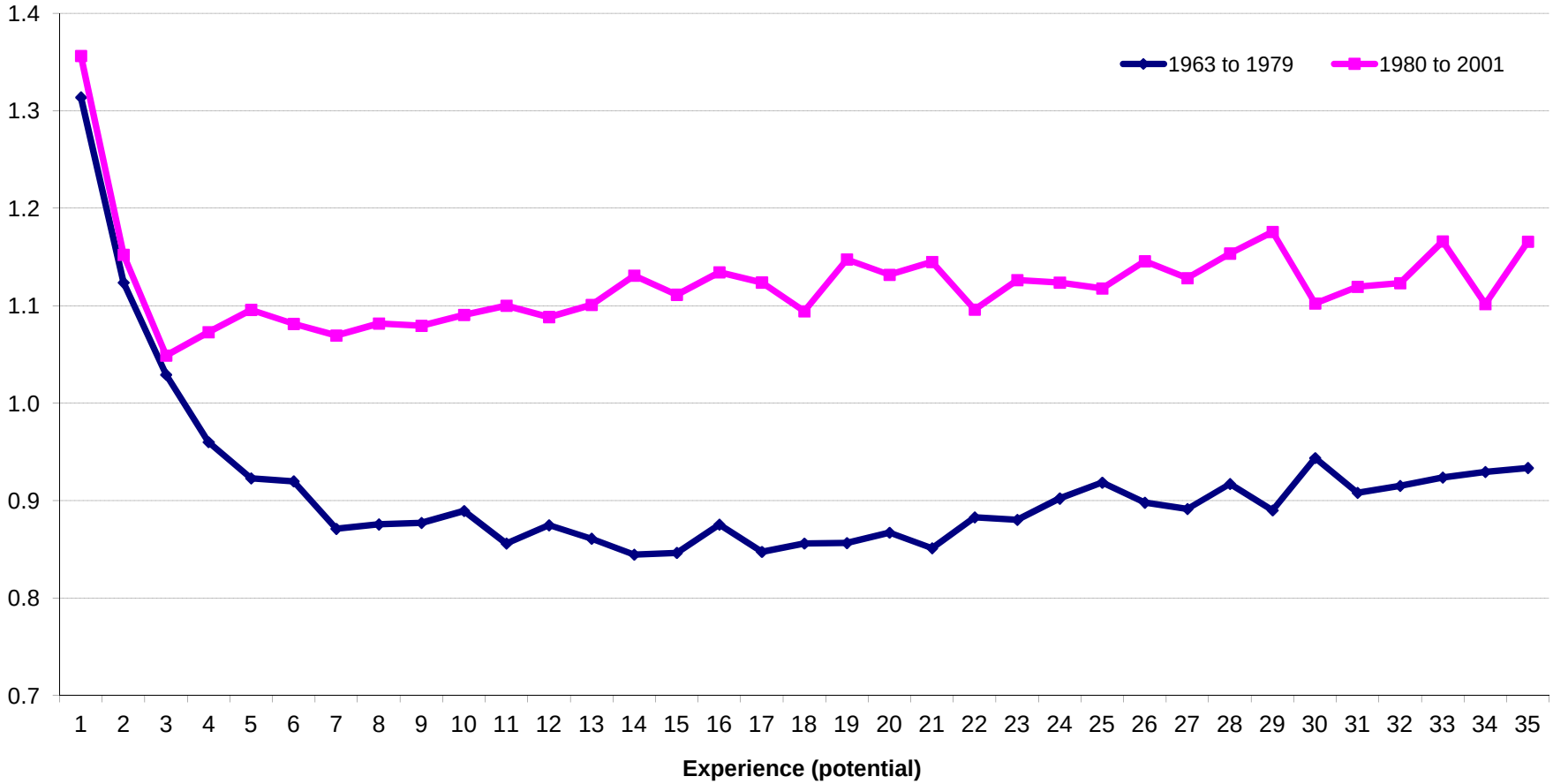

Figure 6: The Gap between White Male Workers Belonging to the 90'th and 10'th Perecntiles of the Residual Log Wage Distribution for the Periods 1963-1979 and 1980-2001, by Education and Experience, March CPS Supplements, 1964 to 2002
Figure 6b: High School Graduates

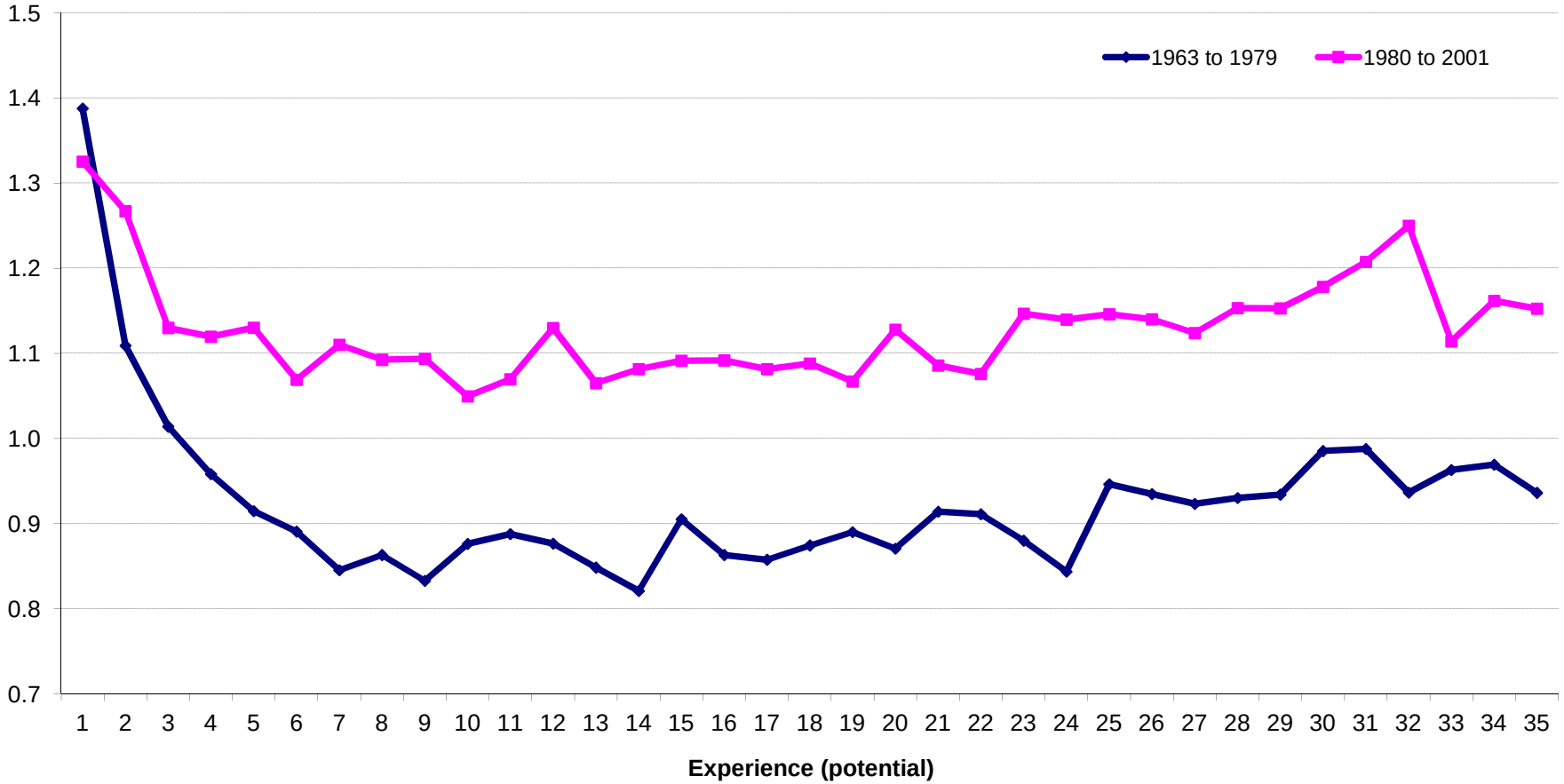

Figure 6: The Gap between White Male Workers Belonging to the 90'th and 10'th Perecntiles of the Residual Log Wage Distribution for the Periods 1963-1979 and 1980-2001, by Education and Experience, March CPS Supplements, 1964 to 2002
Figure 6c: Some College

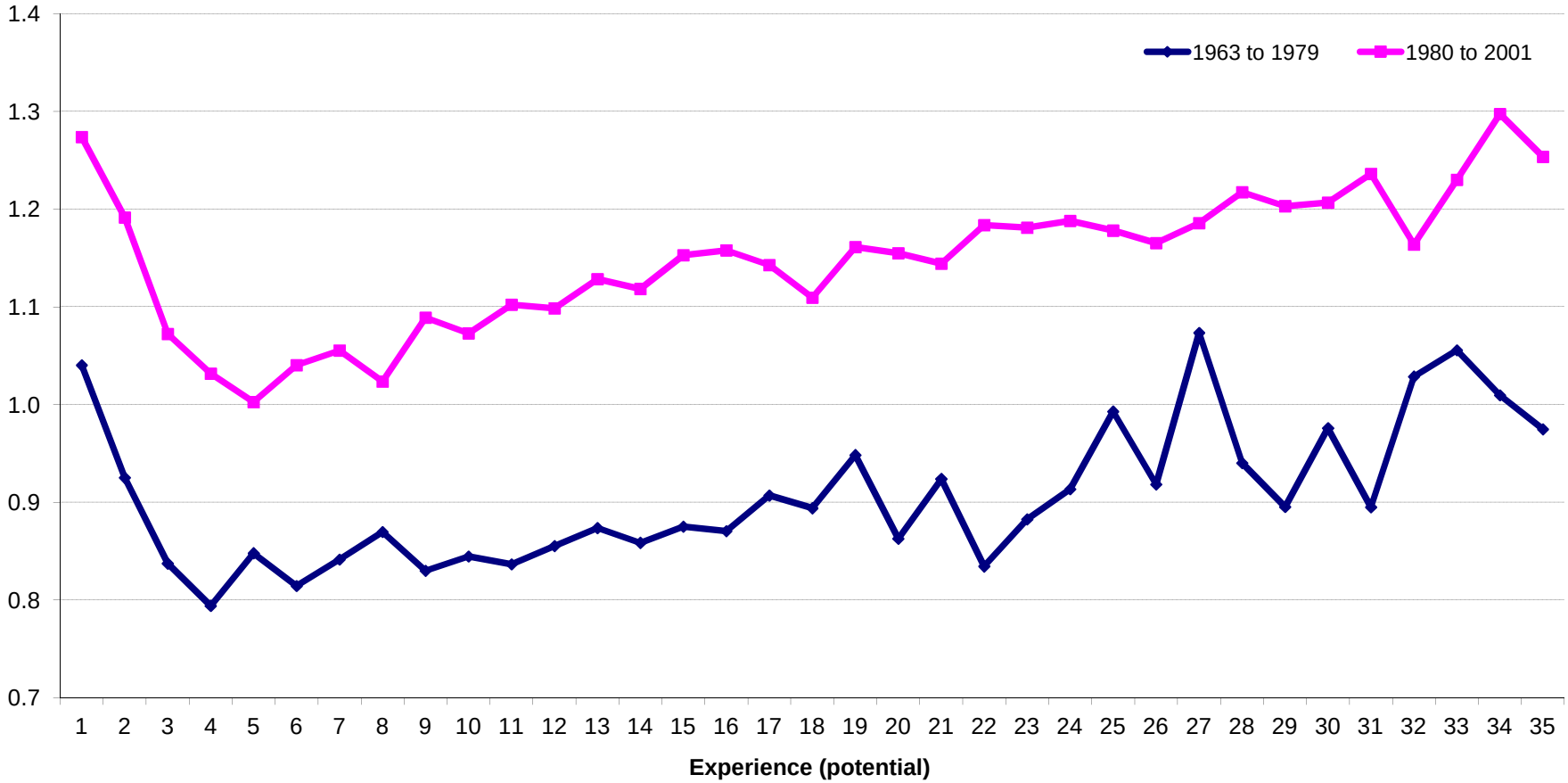

Figure 6: The Gap between White Male Workers Belonging to the 90'th and 10'th Perecntiles of the Residual Log Wage Distribution for the Periods 1963-1979 and 1980-2001, by Education and Experience, March CPS Supplements, 1964 to 2002
Figure 6d: College Graduates

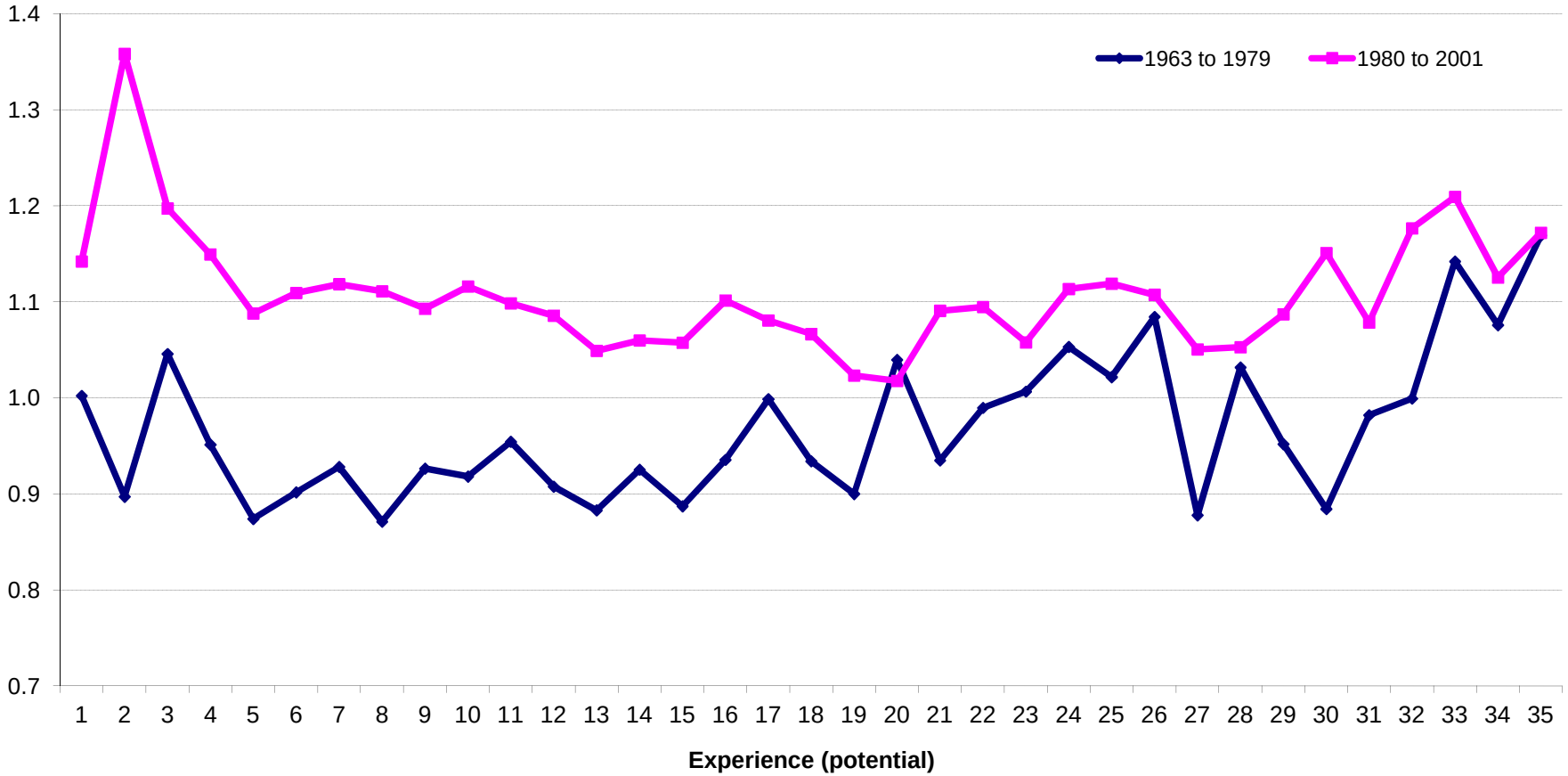

Figure 6: The Gap between White Male Workers Belonging to the 90'th and 10'th Perecntiles of the Residual Log Wage Distribution for the Periods 1963-1979 and 1980-2001, by Education and Experience, March CPS Supplements, 1964 to 2002
Figure 6e: Advanced Degrees

- The PSID and NLSY panels are too small to provide reliable estimates of the experience (time) patterns of the variance within education cells.
- We therefore follow Mincer (1974) and examine the variance of the residuals from a log wage regression equation that is linear in school years and quadratic in experience.
- For both panels, we obtain that the variance rises with labor market experience.
- It is only when we add individual fixed effects and consider the deviations for each person around the individual mean (over all the years that person was observed working) as well as the average wage profile of the sample that the U-shape pattern for the residual variance emerges (see Figures 7a and 7b).

- Moreover, the minimum variance in both panels occurs at about ten years of experience, which is very close to Mincer's theoretical prediction.
- This suggests the presence of heterogeneity, meaning that individuals who invest more also have higher potential wages in the absence of investment.
- To address this possibility, one must go beyond the comparisons of different individuals, observed at different points of their career, and examine the properties of individual life cycle profiles by using panel data.

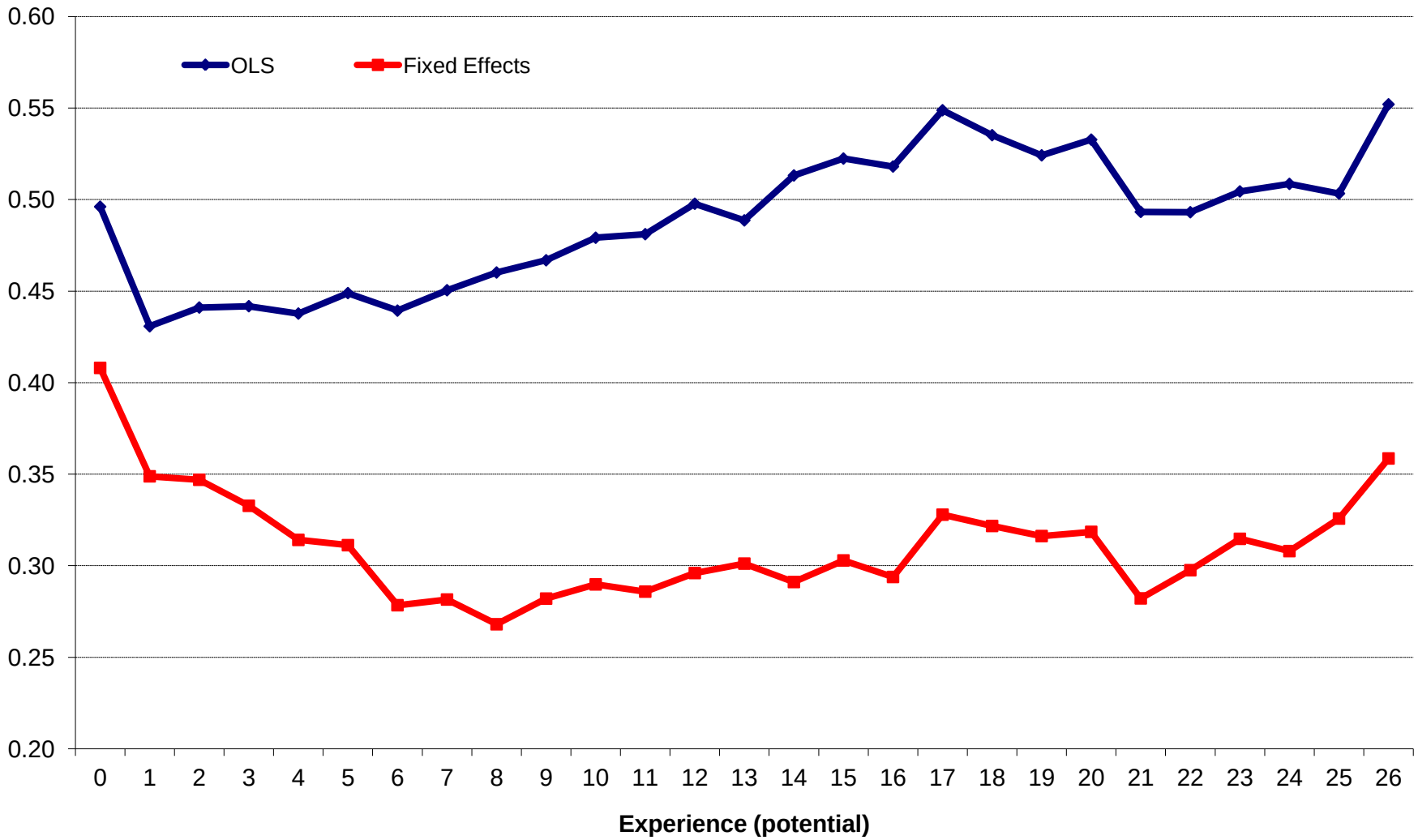

Figure 7: Standard Deviation of Residuals in Mincer's Wage Equation by Experience, With and Without Fixed Effects. PSID, 1968-1997 and NLSY 1979-2000,
Figure 7a: PSID, 1968-1997

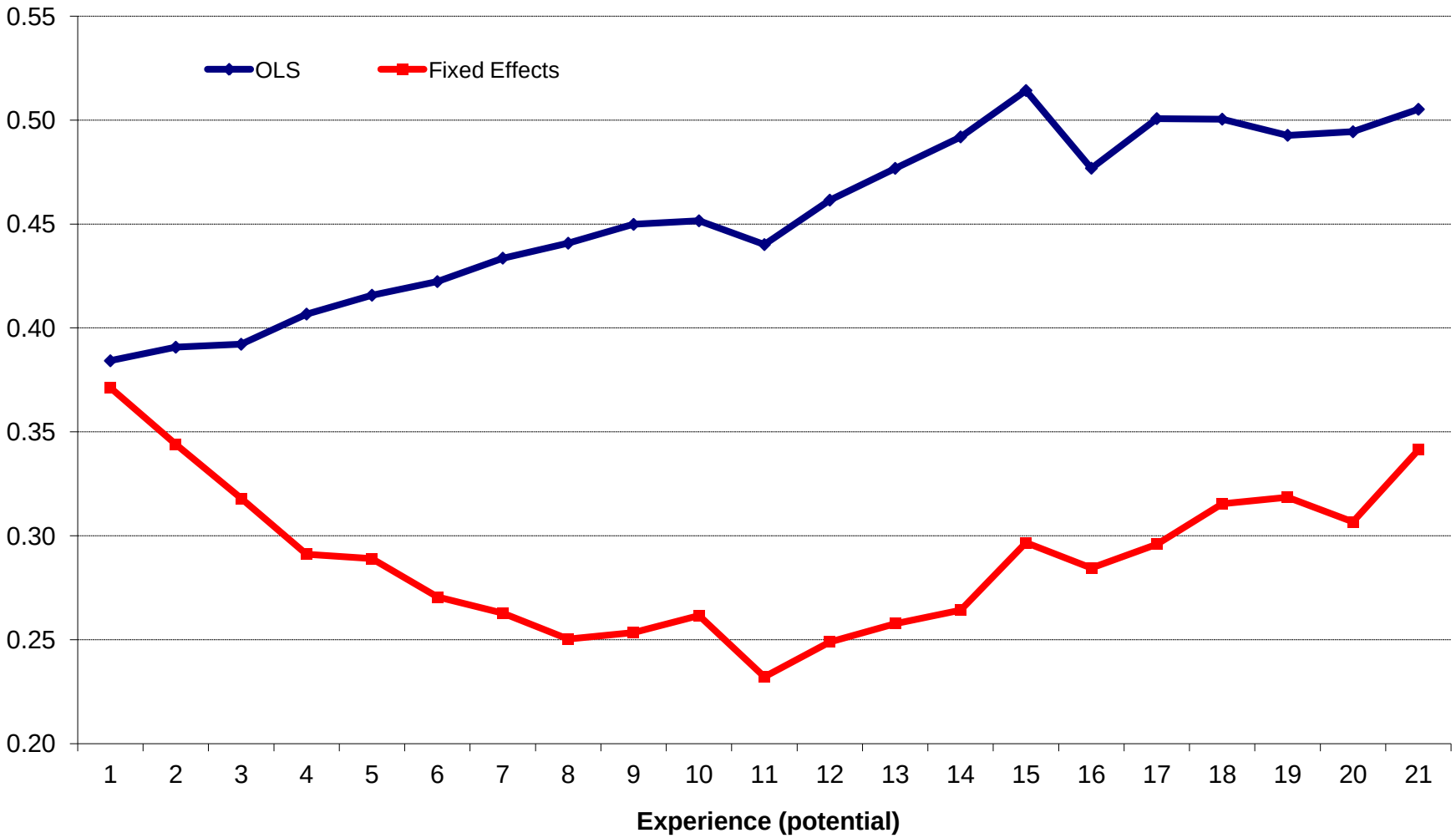

Figure 7: Standard Deviation of Residuals in Mincer's Wage Equation by Experience, With and Without Fixed Effects. PSID, 1968-1997 and NLSY 1979-2000,
Figure 7b: NLSY, 1979-2000

- In figures 8a -8e, we take a first glance at the correlations between wage growth and wage level.
- The figures show the estimated coefficients and confidence intervals from a regression of wage growth on prior wage level by experience and education.
- To reduce the role of measurement errors, we look at three-year averages of these variables.
- We see that within each experience group, there is a *negative* correlation between the current wage level and subsequent wage growth.
- This pattern is consistent with search behavior, because high-wage individuals are less likely to obtain superior offers.
- The investment model would suggest that the correlation is initially negative because low wages imply high investment, but later becomes positive as the high investment results in overtaking.

- In contrast, we observe negative correlations in all years.
- Yet, the fact that the correlations weaken as we move to higher experience groups suggests a presence of investment considerations.

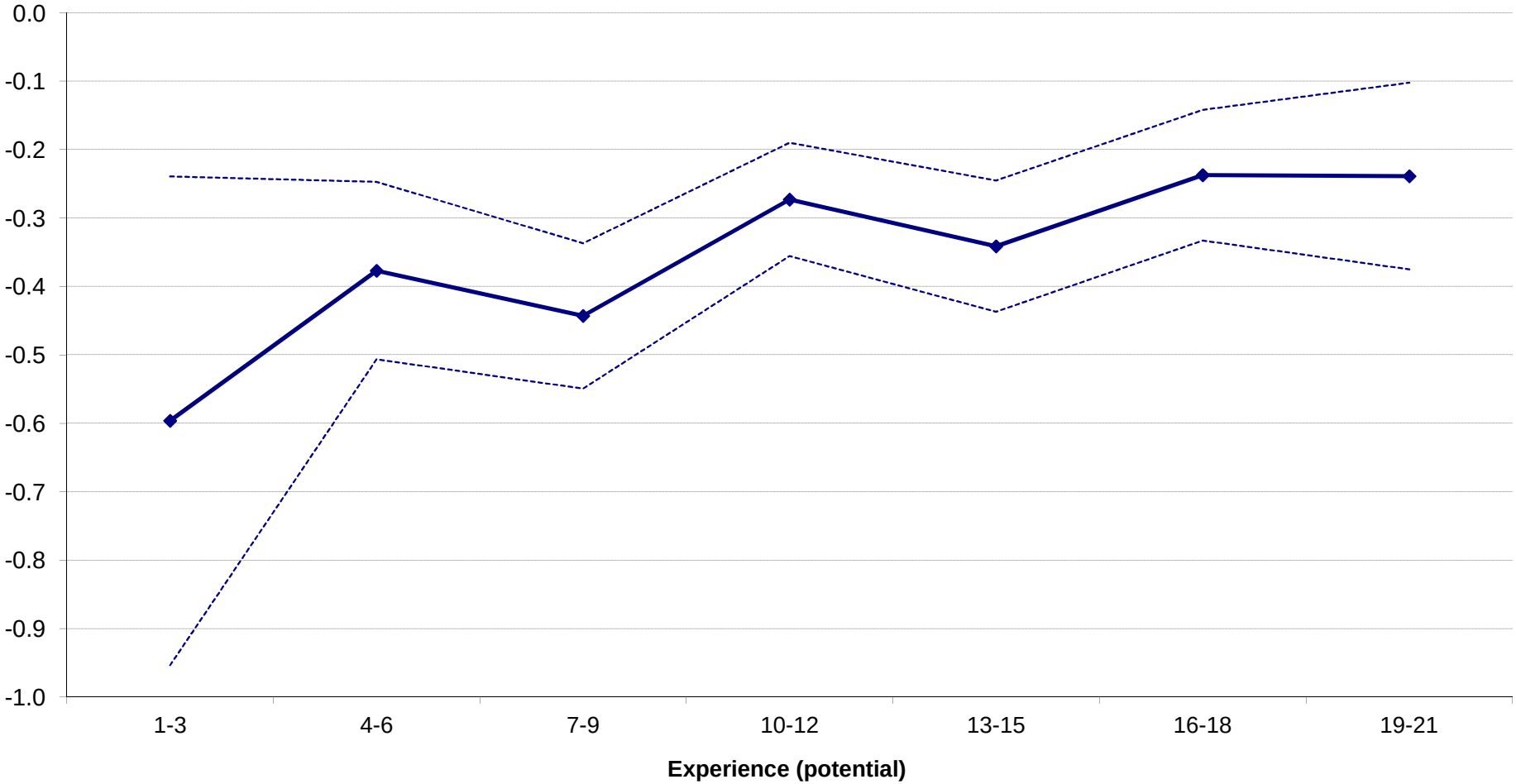

Figure 8: Regression Coefficients and Confidence Intervals of Annual Wage Growth Rates on Log Wage Levels in Prior Period (3 year averages), by Experience and Schooling, NLSY, 1979-2000
Figure 8a: High School Dropouts

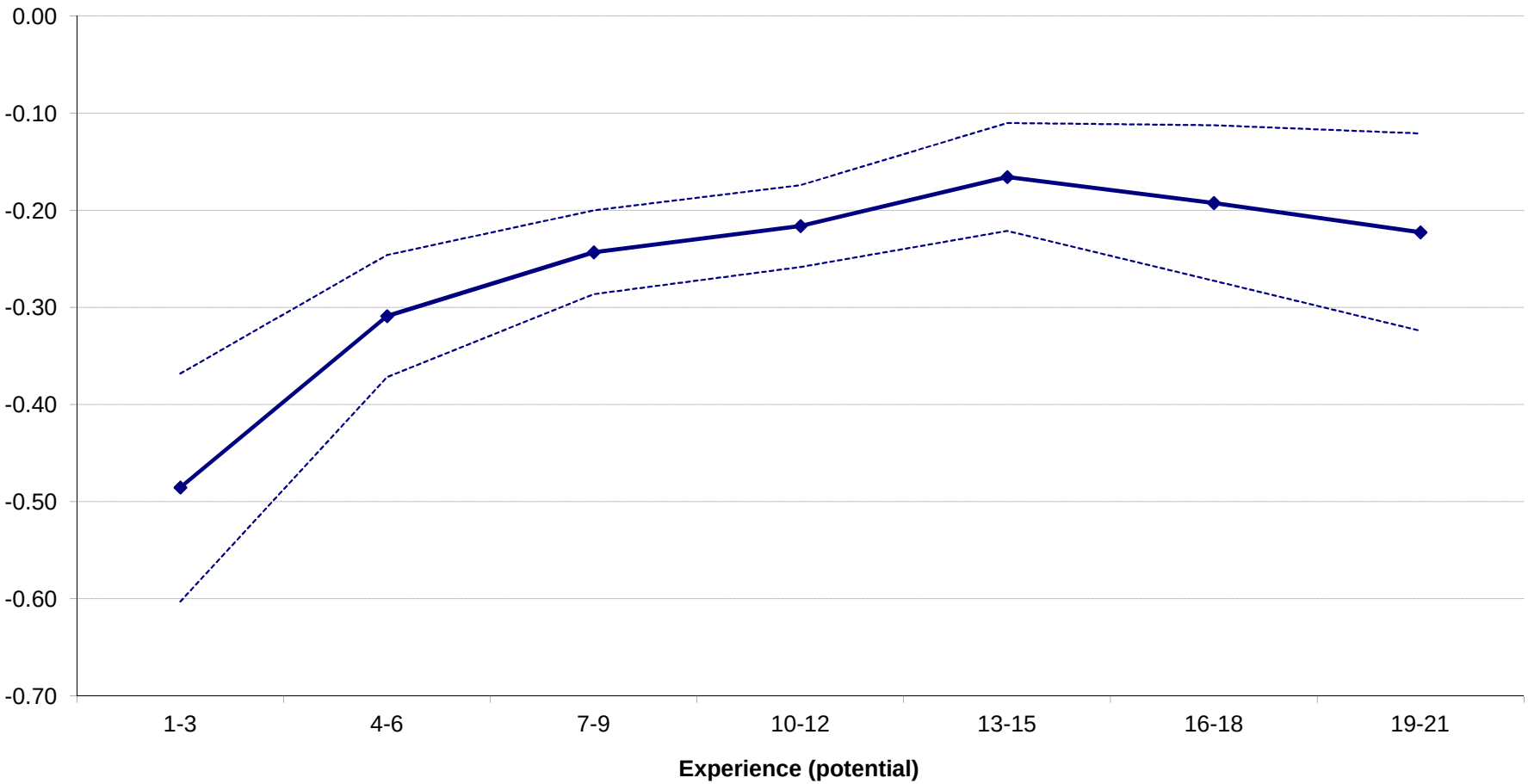

Figure 8: Regression Coefficients and Confidence Intervals of Annual Wage Growth Rates on Log Wage Levels in Prior Period (3 year averages), by Experience and Schooling, NLSY, 1979-2000
Figure 8b: High School Graduates

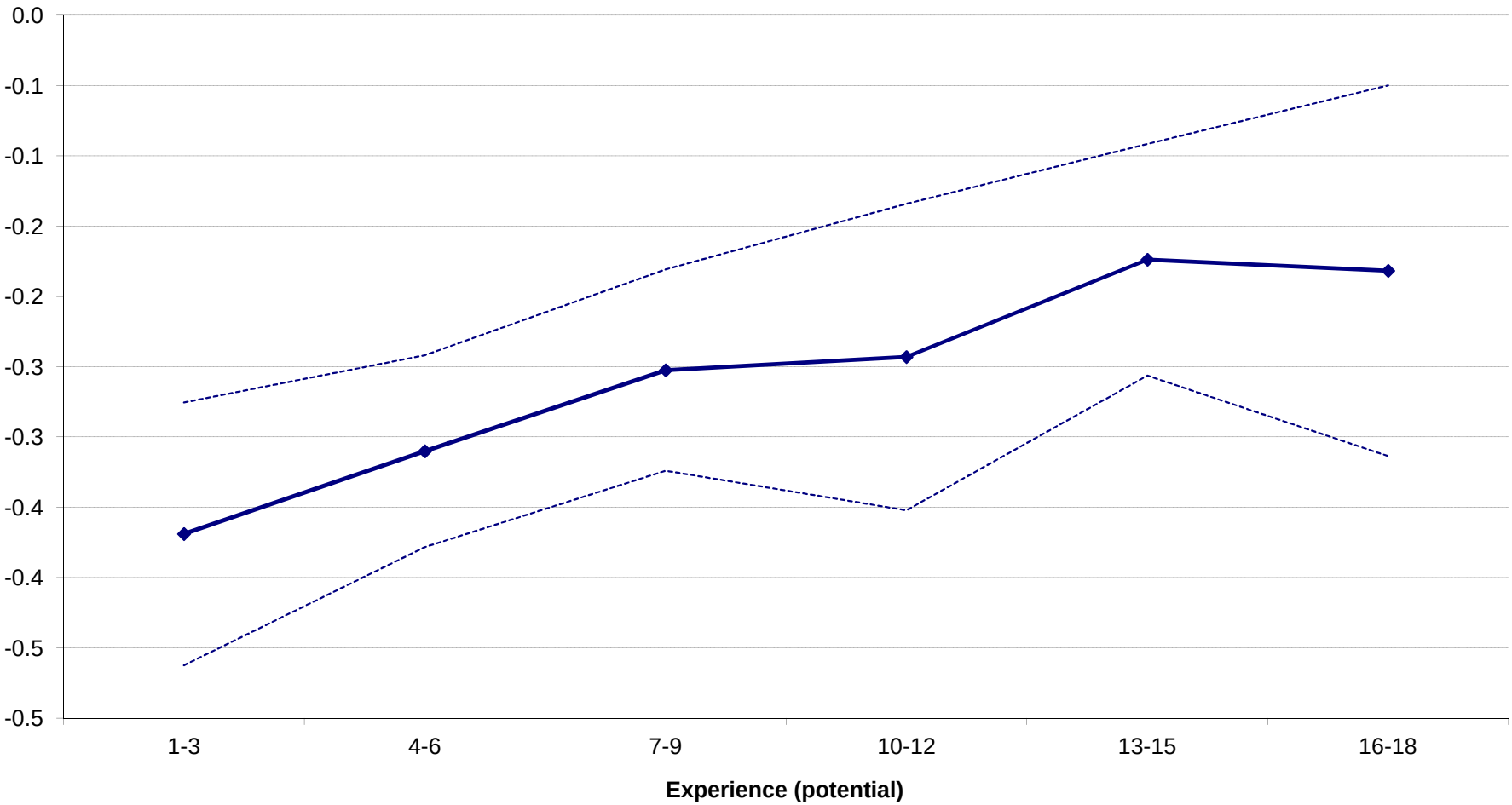

Figure 8: Regression Coefficients and Confidence Intervals of Annual Wage Growth Rates on Log Wage Levels in Prior Period (3 year averages), by Experience and Schooling, NLSY, 1979-2000
Figure 8c: Some College

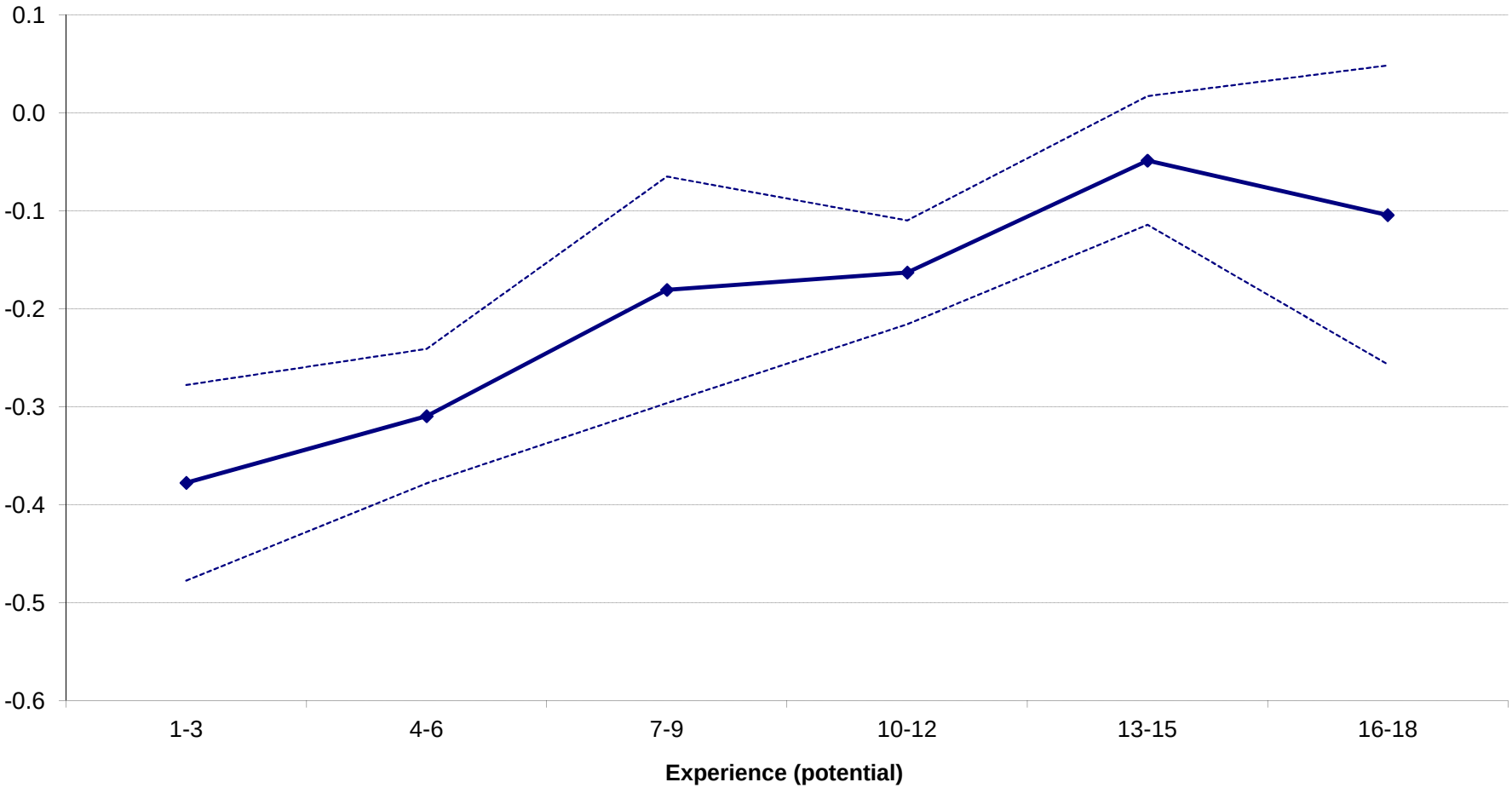

Figure 8: Regression Coefficients and Confidence Intervals of Annual Wage Growth Rates on Log Wage Levels in Prior Period (3 year averages), by Experience and Schooling, NLSY, 1979-2000
Figure 8d: College Graduates

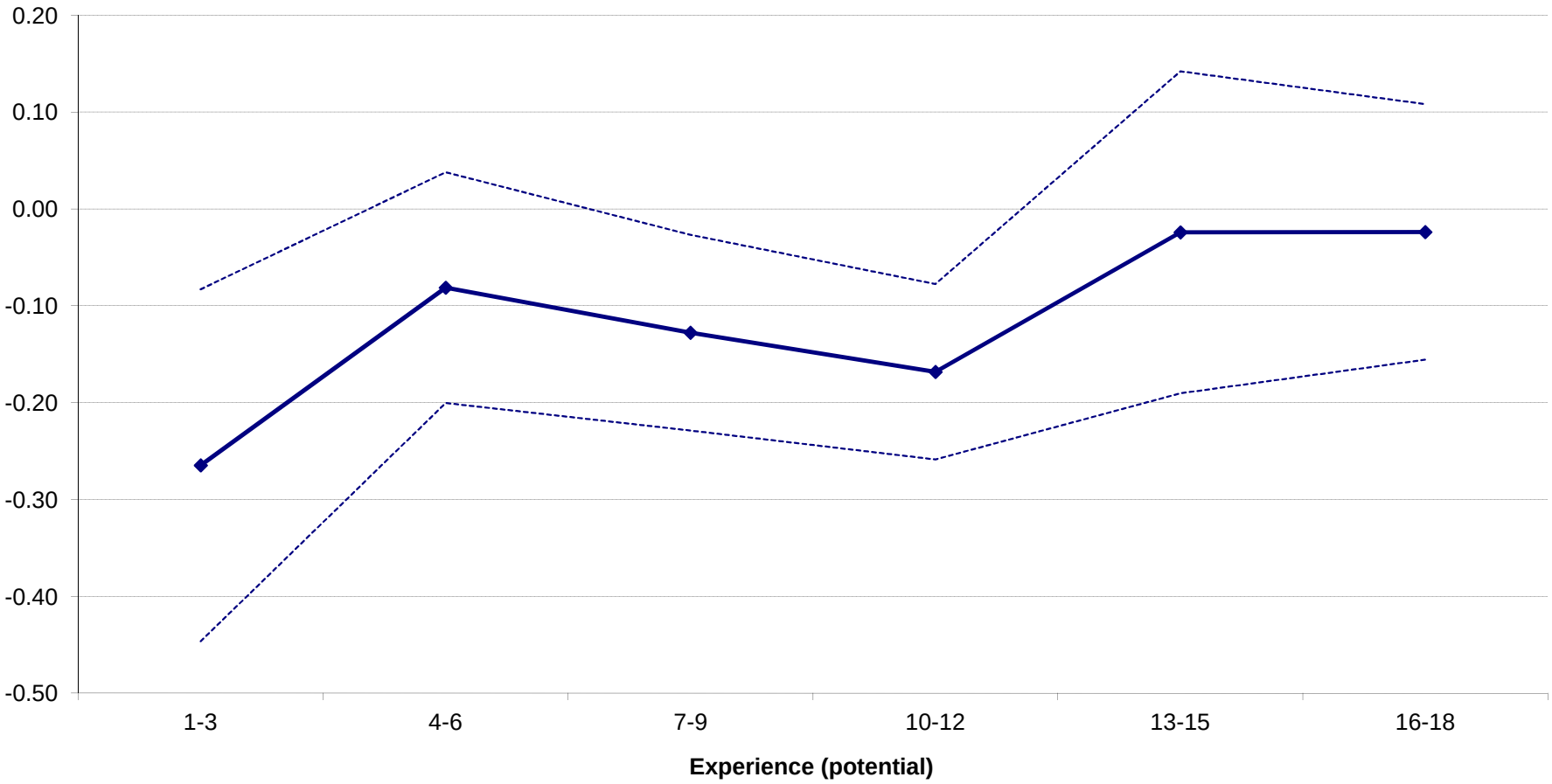

Figure 8: Regression Coefficients and Confidence Intervals of Annual Wage Growth Rates on Log Wage Levels in Prior Period (3 year averages), by Experience and Schooling, NLSY, 1979-2000
Figure 8e: Advanced Degree

- To further examine the role of investment, we take a closer look at the covariance between earning levels at different points of time.
- The correlation matrices in Table 3 display the correlations between wages (and residuals obtained from the estimated Mincer wage equation, with and without individual fixed effects) at different stages of the life cycle.
- We use a balanced panel from the NLSY, where we again take three year averages.
- The correlation between incomes level at different stages of the life cycle decays with the time distance, but is always positive. This result holds true also when we take residuals, eliminating the effects of schooling and experience.

- It is only when we eliminate the fixed effect of each person and consider the residual variation around the individual means (over all time periods) and the group average wage growth that we find negative correlations between early and late residuals.
- Moreover, these correlations become more negative as the time distance increases, providing clear evidence for compensation, whereby an early wage that is below the individual mean is associated with a late wage that is above the individual mean.

Table 3:
Correlations of Log Wages and Residuals at Different Stages of the Life Cycle (three-year averages), Full-Time Workers, NLSY, 1979-2000

(i): Log Wage Levels

Experience	1-3	4-6	7-9	10-12	13-15	16-18	19-21
1-3	0.195						
4-6	0.606 (0.000)	0.173					
7-9	0.476 (0.000)	0.738 (0.000)	0.193				
10-12	0.424 (0.000)	0.646 (0.000)	0.817 (0.000)	0.211			
13-15	0.374 (0.000)	0.588 (0.000)	0.701 (0.000)	0.789 (0.000)	0.238		
16-18	0.314 (0.000)	0.533 (0.000)	0.643 (0.000)	0.691 (0.000)	0.789 (0.000)	0.271	
19-21	0.321 (0.000)	0.531 (0.000)	0.629 (0.000)	0.673 (0.000)	0.740 (0.000)	0.783 (0.000)	0.300

(ii): Residuals of Mincer's Wage Function

Experience	1-3	4-6	7-9	10-12	13-15	16-18	19-21
1-3	0.181						
4-6	0.563 (0.000)	0.151					
7-9	0.415 (0.000)	0.698 (0.000)	0.166				
10-12	0.358 (0.000)	0.592 (0.000)	0.788 (0.000)	0.183			
13-15	0.297 (0.000)	0.522 (0.000)	0.653 (0.000)	0.755 (0.000)	0.206		
16-18	0.230 (0.000)	0.459 (0.000)	0.586 (0.000)	0.644 (0.000)	0.757 (0.000)	0.236	
19-21	0.232 (0.000)	0.453 (0.000)	0.567 (0.000)	0.619 (0.000)	0.699 (0.000)	0.750 (0.000)	0.259

(iii): Residuals of Mincer's Wage Function with Fixed Effects

Experience	1-3	4-6	7-9	10-12	13-15	16-18	19-21
1-3	0.141						
4-6	0.317 (0.000)	0.066					
7-9	-0.094 (0.027)	0.157 (0.000)	0.047				
10-12	-0.280 (0.000)	-0.209 (0.000)	0.218 (0.000)	0.047			
13-15	-0.429 (0.000)	-0.419 (0.000)	-0.267 (0.000)	0.072 (0.089)	0.056		
16-18	-0.481 (0.000)	-0.465 (0.000)	-0.351 (0.000)	-0.198 (0.000)	0.203 (0.000)	0.080	
19-21	-0.448 (0.000)	-0.437 (0.000)	-0.351 (0.000)	-0.220 (0.000)	0.059 (0.165)	0.291 (0.000)	0.095

Notes:
Significance level in parentheses

- Thus, to identify compensation one must eliminate heterogeneity among individuals.
- Obviously, if individuals differ permanently in their earning capacity a positive correlation will exist between early and late wages within each cohort because individuals who are above the mean are likely to remain above the mean, irrespective of investment.
- However, there may be more complex forms of heterogeneity that interact with experience.
- In particular, there may be "systematic heterogeneity", whereby individuals with higher initial earning capacity also tend to invest more.
- As explained in Mincer (1974, ch.2) such heterogeneity tends to raise the within-cohort variance in earnings with the passage of time and may offset the effects of compensation.

- Figure 9a displays estimated coefficients from regressions of individual fixed level effects on individual fixed growth effects, where the level effects are evaluated at two different points in the life cycle.
- When the level effect is the usual individual fixed effect, i.e., the mean wage residual during an individual career, the relationships between level and growth are significantly positive in all schooling groups but stronger among the highly educated.
- In such a case, we can interpret the level as a proxy for the individual's initial earning *capacity* and can conclude that individuals with higher "ability to learn" also have higher "ability to earn".

- However, if one evaluates the fixed effect as the intercept of the individual residual profile at the beginning of the worker's career, the relation becomes negative.
- In this case, the level effect also reflects investment, and the negative correlation reflects the fact that individuals with a higher propensity to invest forego a larger proportion of their initial earning capacity.

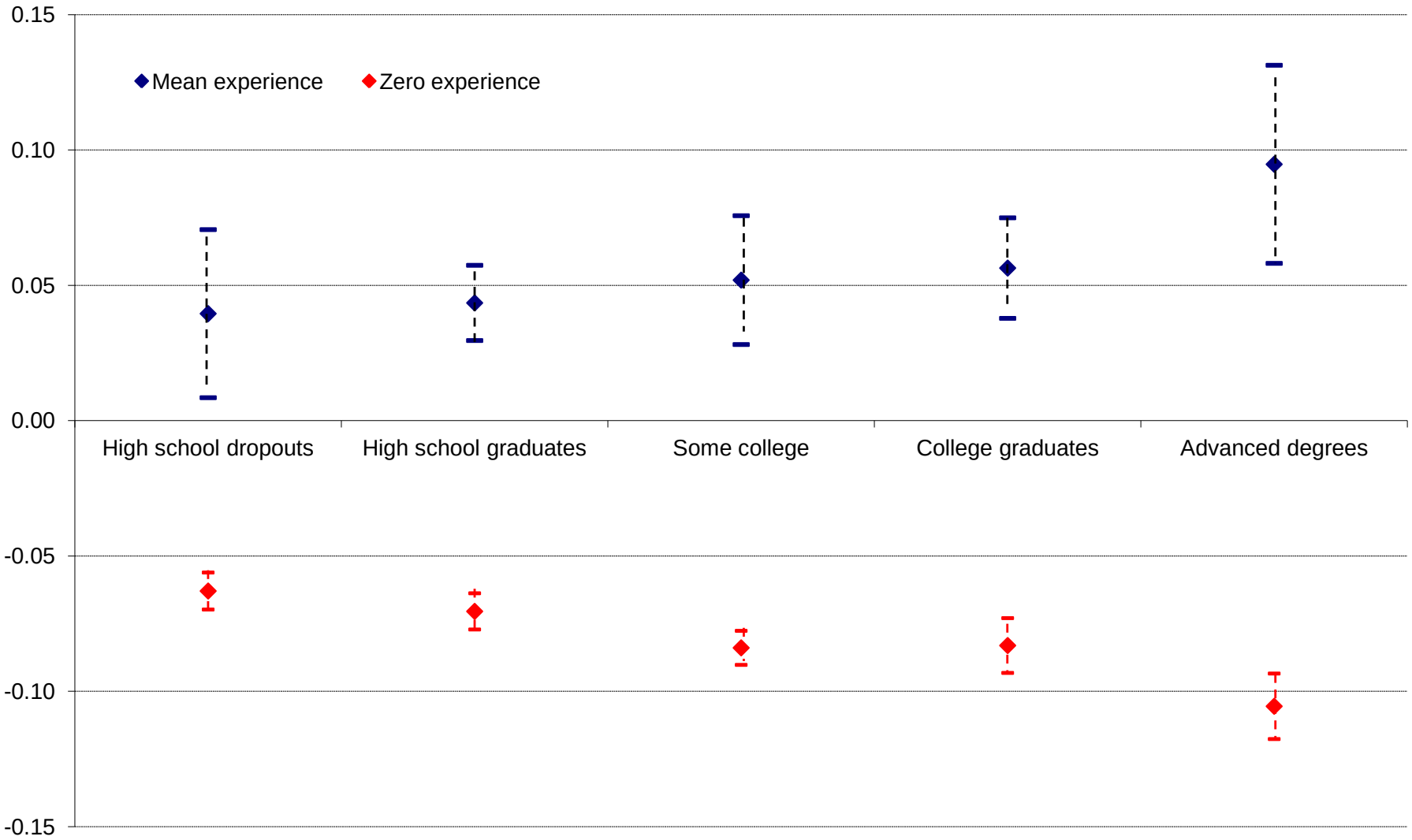

Figure 9a: Regression Coefficients of Individual Growth Rates on Individual Level Effectss, Evaluated at Zero Experience and the Individual's Mean Experience by Education

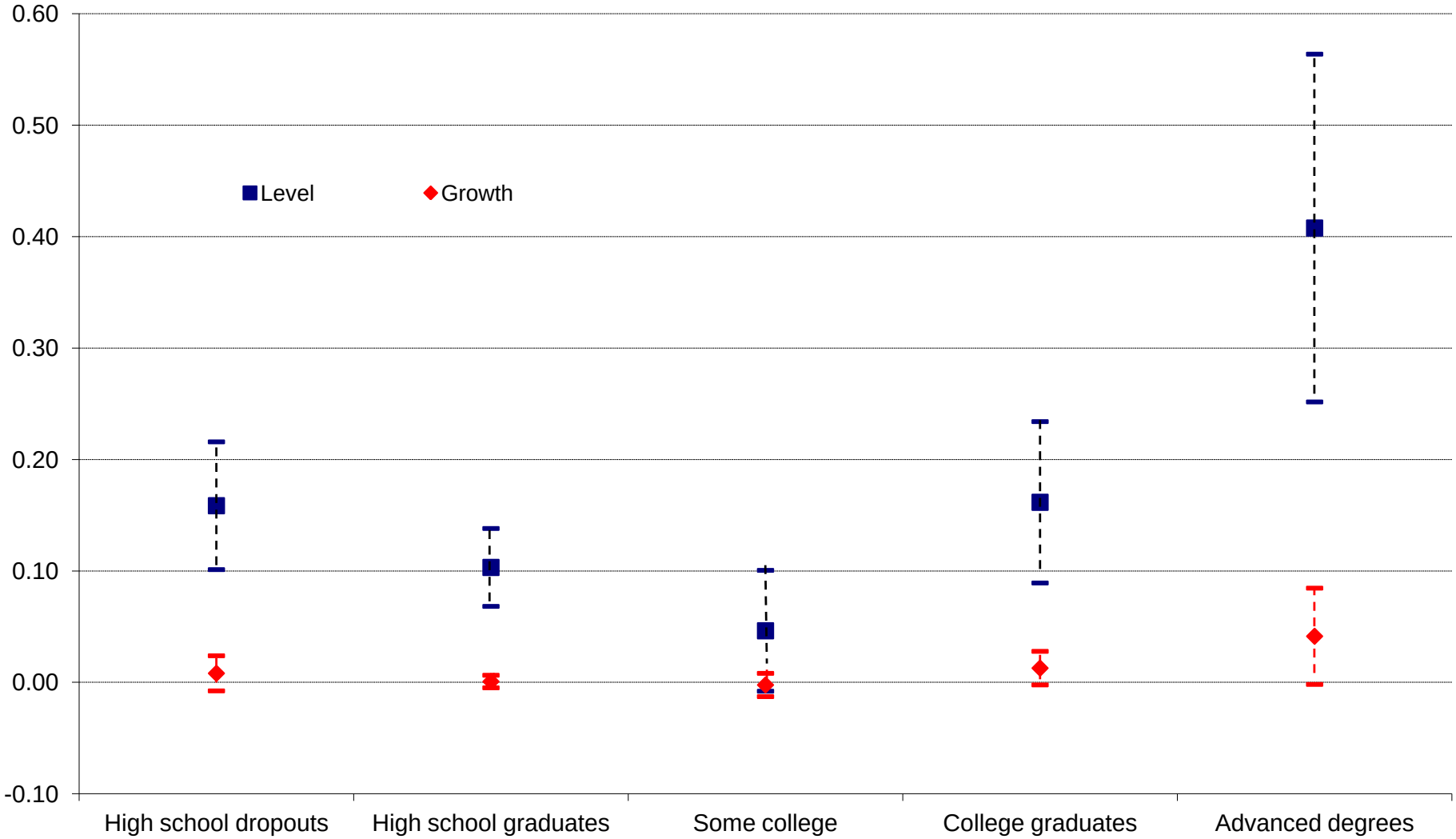

Figure 9b: Regression Coefficients of Individual Growth Effects and Level Effects (Evaluated at the Mean) on AFQT Scores by Education

- In Figure 9b we present the regression coefficients of the individual slope and level (evaluated at the mean) on AFQT, which is an observable measure of individual ability.
- We see that *both* the level and growth effects are positively correlated with AFQT, which supports our interpretation of the previous results whereby individuals with higher "ability to learn" also have higher "ability to earn".
- However, we do not find strong evidence that the differences in investment magnify the differences in initial human capital endowments, expressed as present value of lifetime wages.
- This is indicated by the fact that the *initial* residual levels associated with higher wage growth are sufficiently negative to render the total impact on the present value of lifetime earnings to be rather small.

- Although the investment interpretation is consistent with important features of the data on wage *levels*, it cannot explain some important feature of wage *changes.*
- In particular, it was noted by MaCurdy (1982) and Abowd and Card (1989) that, after accounting for the common wage growth, the growth rates of individual wages are not correlated for periods that are more than few years apart.
- This finding, confirmed by subsequent studies (Lillard and Reville (1999); Meghir and Pistaferri (2001); Alvarez et al (2001), is also shown in Table 4a. Moreover, the correlations between short subsequent periods (one or two years) are negative.

- This correlation pattern is consistent with search where shocks are random, with those experiencing positive shocks less likely to exhibit high wage growth in subsequent periods.
- However, for sufficiently long periods (6 years) that are distant from each other one obtains a positive and significant correlation (see Table 4b) that is consistent with fixed individual growth rates, indicating that those who have above-average wage growth early in life also have above-average wage growth late in life.
- Generally, investment is indicated by a positive correlation between early and late earnings, whereas search and learning imply short-term persistence with positive drift and negative correlation in wage growth.

- As in Abowd and Card (1989) and Baker (1997), we also find that the variance in wage growth exhibits a U shape pattern, similar to wage levels.
- The increase in variance at older ages is inconsistent with the investment model which predicts that differences in investment decline over time (see Lillard and Reville, 1999).
- This feature suggests that individual wage shocks dominate at old ages.

Table 4:
Variances and Correlations of the Residulas of the First Differences of Log Hourly Wages of Full-Time Workers at Different Stages of the Life Cycle.
NLSY, 1979-2002

a: Three-year averages

Experience (potential)	**1-3**	**4-6**	**7-9**	**10-12**	**13-15**	**16-18**
1-3	**0.092**					
4-6	-0.236 (0.000)	**0.077**				
7-9	-0.054 (0.148)	-0.228 (0.000)	**0.077**			
10-12	0.024 (0.534)	0.030 (0.266)	0.049 (0.067)	**0.077**		
13-15	-0.038 (0.364)	0.037 (0.213)	0.031 (0.291)	-0.230 (0.000)	**0.059**	
16-18	-0.058 (0.227)	0.073 (0.032)	0.038 (0.250)	-0.054 (0.067)	-0.243 (0.000)	**0.037**

b: Four-year averages (excluding overlapping periods)

Experience (potential)

	1 to 4	6 to 9	11 to 14	16 to 19
1 to 4	**0.085**			
6 to 9	-0.076 (0.011)	**0.077**		
11 to 14	0.025 (0.439)	0.073 (0.004)	**0.059**	
16 to 19	0.067 (0.055)	0.016 (0.572)	-0.226 (0.000)	**0.036**

Notes:
We calculate individuals' mean residuals for each cell from within cell regressions of the change in log hourly wages on experience and national unemployment rates. Significance level in parentheses

Labor mobility and wage growth

- Search theory not only competes with the theory of human capital, it also complements that theory.
- The challenge is to understand the interactions between these two processes.
- Mincer and Jovanovic (1981) provide the first attempt to integrate these processes.

- They describe the potential impact of search as follows "Perhaps the best way to summarize the life cycle relation between wages and mobility is to recognize that initial (first decade ?) job search has two major purposes: to gain experience, wages, and skills by moving across firms; and to find sooner or later a suitable job in which one can settle and grow for along time. The life cycle decline in mobility is, in part, evidence of successful initial mobility, an interpretation which is corroborated by corresponding life cycle growth in wages" (Mincer and Jovanovic, 1981, p. 42).

- To identify the actual impacts of search and investment, they consider two different aspects of work experience, tenure in a given firm, T, and general work experience, X.
- They then examine two jointly determined outcomes; the wage, $w(T, X)$, and the separation rate, $s(T, x)$.
- The latent variables in this system are investments in general and firm-specific training and search.
- They use the NLS panel data and run regressions of wages and separations on tenure in the current job and potential work experience.
- To partially correct for the endogeneity of tenure, they add the number of past moves across firms as an indicator of individual "propensity to move".

Their main results are:

- Tenure has a separate positive and declining effect on wages, which is as important as the effect of total work experience. Tenure effects are much more important for young workers.
- Experience and tenure have negative impacts on separation, but the negative effect of tenure is much larger.
- Past moves have positive effects on separation, suggesting heterogeneity, but have only weak negative effects on wages.
- Controlling for both experience and tenure, education has a negative effect on mobility.
- The positive impact of schooling on wages is unaffected by the inclusion of mobility variables such as tenure and past moves, but the experience effects among young men are reduced substantially. This suggests that search mainly affects the size and interpretation of the experience effect but has little bearing on returns from schooling.

- Subsequent work in this area tried to address the potential biases that arise when estimating the tenure effect and the impact of occupational moves.
- Potential biases arise from a variety of selection issues (i.e., in what ways are stayers different from movers) and in part from the assumed imperfect information and specific investments that create relational rents and give scope to bargaining and other noncompetitive behavior.
- A rather broad range of estimates for the size of the tenure effects have been obtained, ranging from approximately 7 to 35 percent per ten years of seniority [see Topel (1991), Altonji and Williams (1998, 2004), Dustmann and Meghir (2005)].

- Data on wage loss following plan closure also indicate that the loss of wages is higher for workers with more tenure, yielding a tenure effect of about 14 percent [see Farber (1999)].
- A positive tenure effect is often attributed to firm-specific human capital that is shared if the worker stays with the firm and lost if he changes employers, although it is not entirely clear why and how wage growth should respond to the accumulation of such specific capital.

- A simple indication of the complexity of the relationship between wage growth and mobility is that, on the average, wage growth is associated with mobility, yet when we look at individual data, movers exhibit lower wage growth than stayers (see Figure 10).
- There are several possible explanations for this discrepancy: (1) If moving is a personal attribute, then firms are less likely to invest in prospective movers. (2) If jobs differ by the quality of match, successful and more productive matches are less likely to come apart. (3) If the firm is subject to exogenous shocks, the better workers are selected to stay with the firm. (4) If the continuation of the match is jointly profitable, the sharing of the gains will depend on outside options.

- Therefore, the *threat* of mobility rather than realized mobility can cause wage growth; much of the benefit of this threat is captured by the stayers.
- This threat is reflected by the *average* trends in mobility within a cohort.

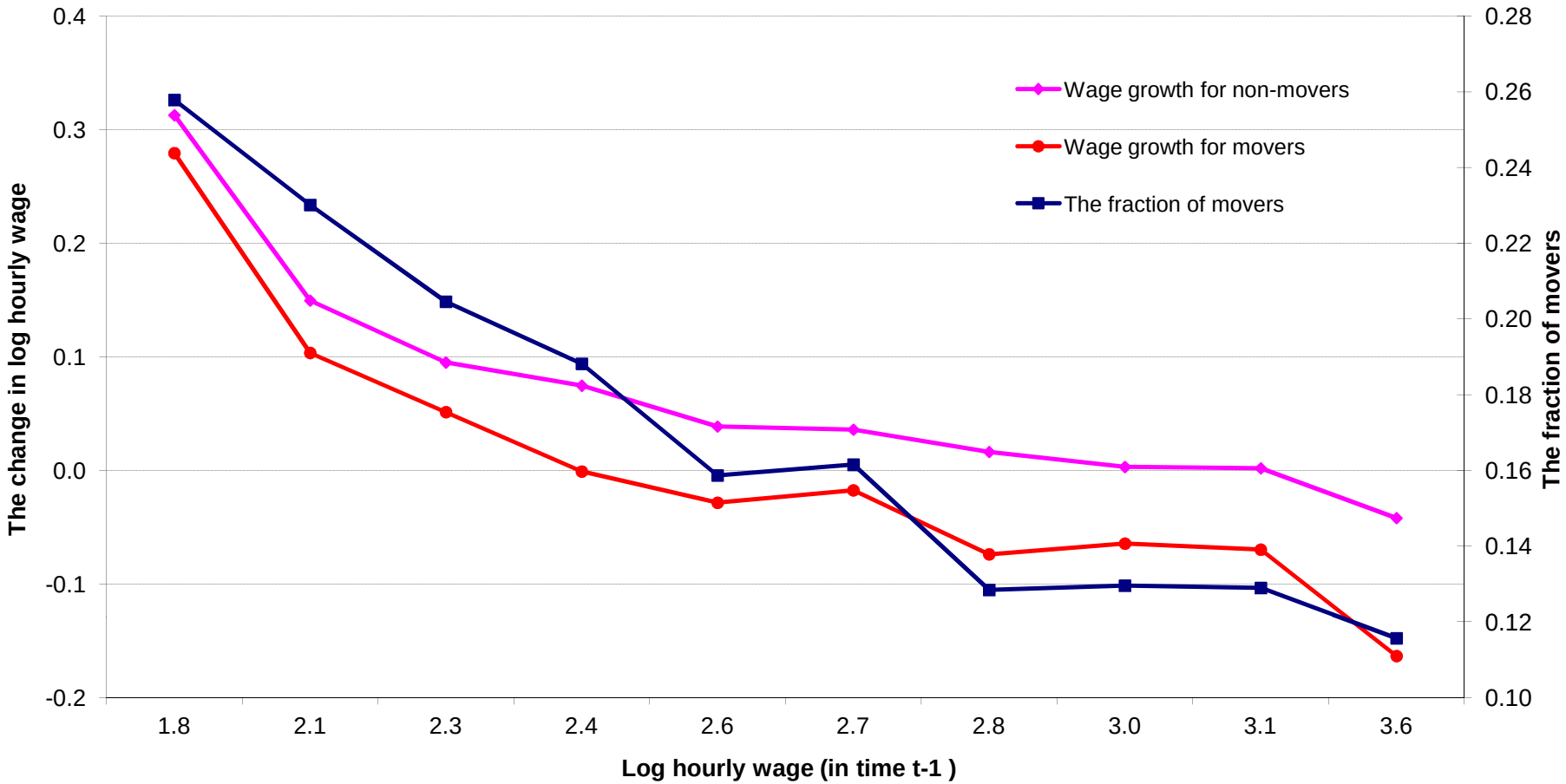

Figure 10: Fraction of Movers and Annual Growth Rates in Hourly Wages of Movers and Stayers by Hourly Wage in the Previous Year, NLSY, 1979-2000

Topel and Ward (1992), who examined the mobility and wage growth of young workers, find that

- Wage growth within firms is quite high (7 percent on average) and declines with both tenure and experience.
- Jobs that are going to last longer currently offer higher wage growth.
- Wage growth across jobs is substantial (20 percent on the average) and declines with tenure (at previous job) and experience.
- Higher wage growth upon transition is obtained when one moves to a job with longer prospective tenure.
- The exit rate from a given job declines with experience and the wage level. However, conditional on the wage, the effect of experience on the job exit rate is positive.

- Together these findings provide strong support for the importance of search at early stages of the worker's career.

- Changes in occupation and industry are also channels for wage growth.
- If one ranks occupations or industries by their average wage level at the "prime" ages, 36-45, then we can identify the direction of moves on this scale.
- We find that the occupational and industry changes of less-educated workers involve transitions to higher paying occupations, while highly educated workers move across similar occupations and industries in terms of their mean wage.
- In this respect, there is substitution between learning in school and on the job (see Figures 11a and 11b).

- In contrast, highly educated workers obtain higher wage growth when they change employers, suggesting that education and search are complements.
- These results are consistent with the findings of Sicherman (1991) and Neal (1995, 1999) that educated workers are less likely to make a career change and that they also experiment with fewer employers prior to making such a change.
- A partial explanation is that educated workers learn about their ability in school, which facilitates their career choice. However, educated workers may take more time to find an employer that matches their skills.
- In fact, workers that report that their education exceeds the requirements of the job they hold are, on average, more educated and less experienced.

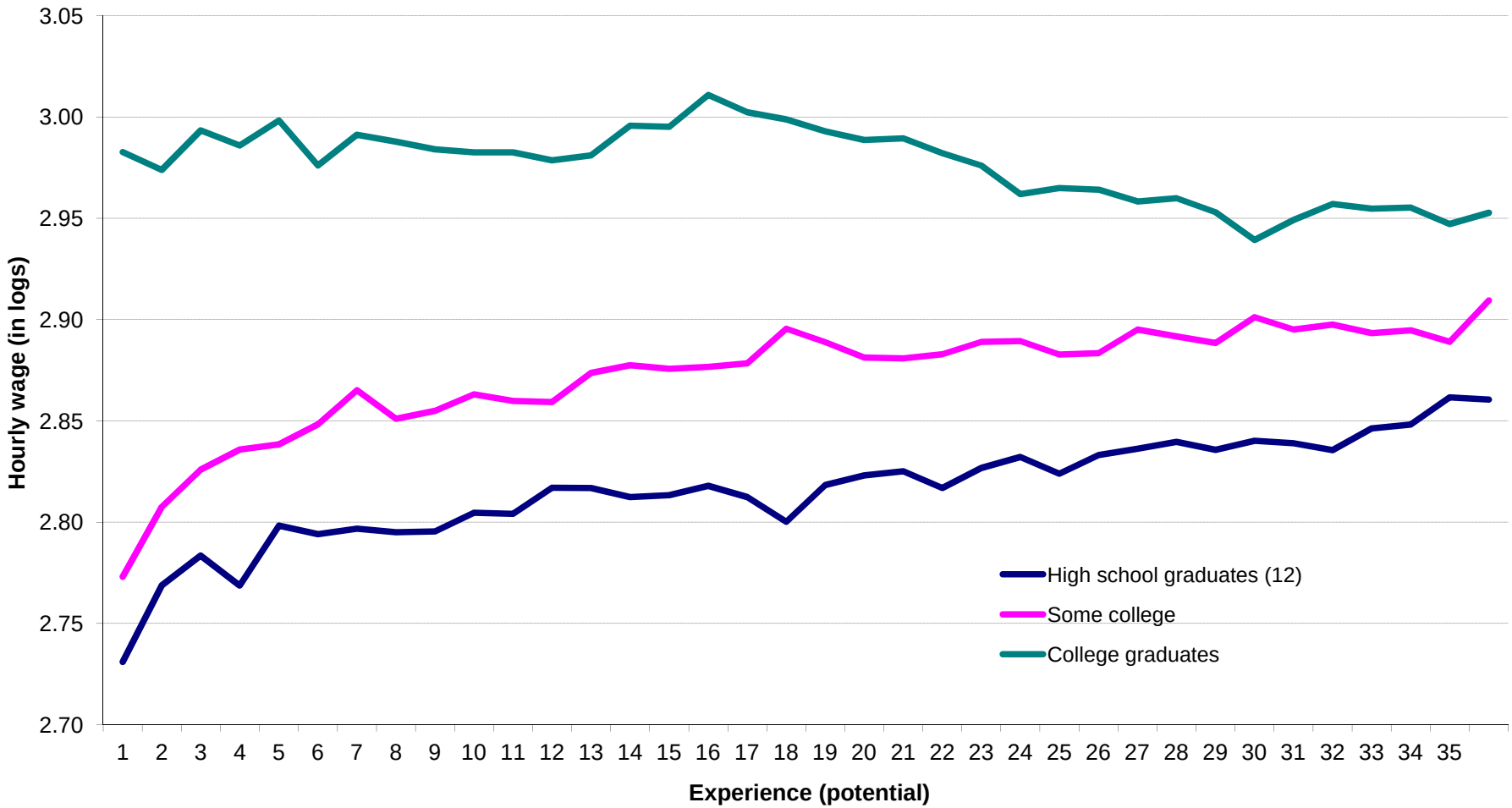

Figure 11: Mean Hourly Wages (in Logs) of Prime Aged Workers (36-45) in the Currently Held Industry and Occupation, by Education and Experience, CPS-ORG, 1998-2002
Figure 11a: Occupation

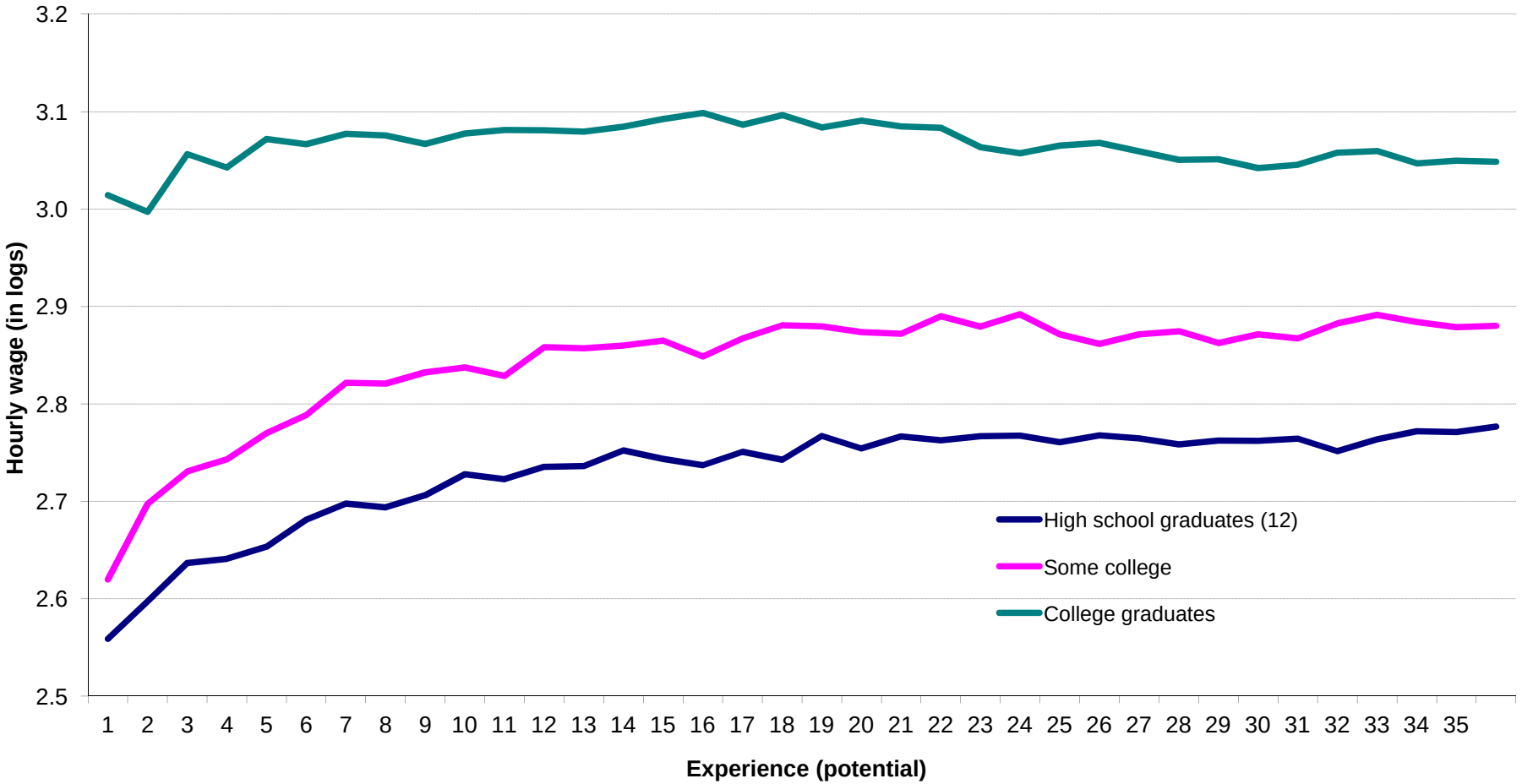

Figure 11: Mean Hourly Wages (in Logs) of Prime Aged Workers (36-45) in the Currently Held Industry and Occupation, by Education and Experience, CPS-ORG, 1998-2002
Figure 11b: Industry

- One must bear in mind that wage gains or losses that one observes upon job change are partial and possibly misleading indicators of the total value of such moves because workers may anticipate consequences that occur later in their career.
- Studies of mobility patterns over the business cycle show that movers who obtained wage gains during booms often leave their new jobs and suffer a wage loss during recession (see Keane, Moffitt and Runkle, 1988; Barlevy, 2001).
- There is, however, no evidence that young movers accept jobs in low-wage industries in exchange for future prospects in those industries (see Bils and McLaughlin, 2001).

Learning

- When employers and workers are uncertain about each other's attributes, it takes time to reduce this uncertainty through experimentation.
- Such learning can occur within a firm or in the market at large.

- As noted by Jovanovic (1979b), learning at the firm level can be inferred from the shape of the hazard function of leaving the firm.
- That is, if workers and firms learn about the quality of the match after they have spent an initial period together, then the weak matches terminate and the good ones survive.
- As time passes, learning has been accomplished and the proportion of good matches rises, so that the hazard function is first rises and then declines.
- This is a rather sharp test because a sorting model based on the survival of the fittest usually implies a declining hazard.

- The hazard function in Figure 12 displays such a pattern, showing that the probability of separation conditional on length of employment peaks at about 15 months.
- A similar finding is reported by Booth et al. (1999).
- In contrast, the data on young men used by Topel and Ward (1992) show a decline in the hazard by tenure (and experience) right from the beginning of the employment relationship.
- This, of course, does not exclude experimentation but shows that sorting is more important.

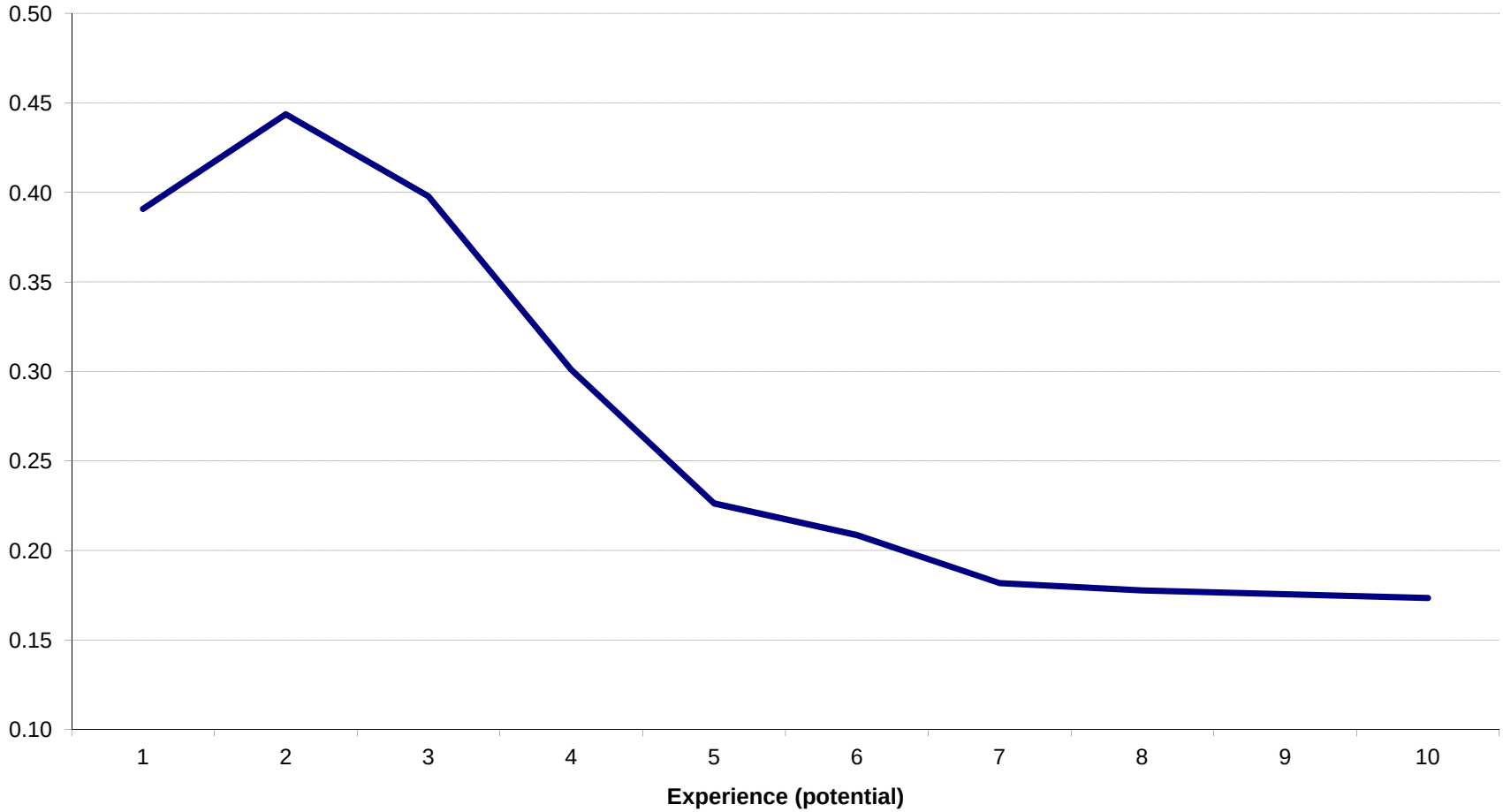

Figure 12: Hazard Function of Separation from Current Employer (in annual terms), NLSY, 1979-2000

- As noted by Farber and Gibbons (1996) and Atonji and Pierret (2001), public learning can be inferred from the impact on wages of individual attributes that are not directly observed by employers.
- As time passes and employers observe the worker's performance, they learn about the worker's true productivity and the impact on wages of variables that are observed by the researcher but not by the firm (such as AFQT) increases, while the impact on wages of early signals of ability (such as schooling) declines.

- In Figures 13a to 13d, we show the marginal impact of AFQT on earning by experience within education groups.
- The graphs show an increase in the impact of AFQT at early years of experience, especially for high school graduates, suggesting that learning about ability is more relevant for this group.
- A further indicator of interest is race or ethnicity, which employers may use as a predictor of ability.
- In Table 5 we show that the increase in the impact of AFQT and the decline in the effect of schooling over the life cycle are substantially higher for blacks and Hispanics.
- This suggests initial racial statistical discrimination which gradually dissipates, as employers learn about individual ability.

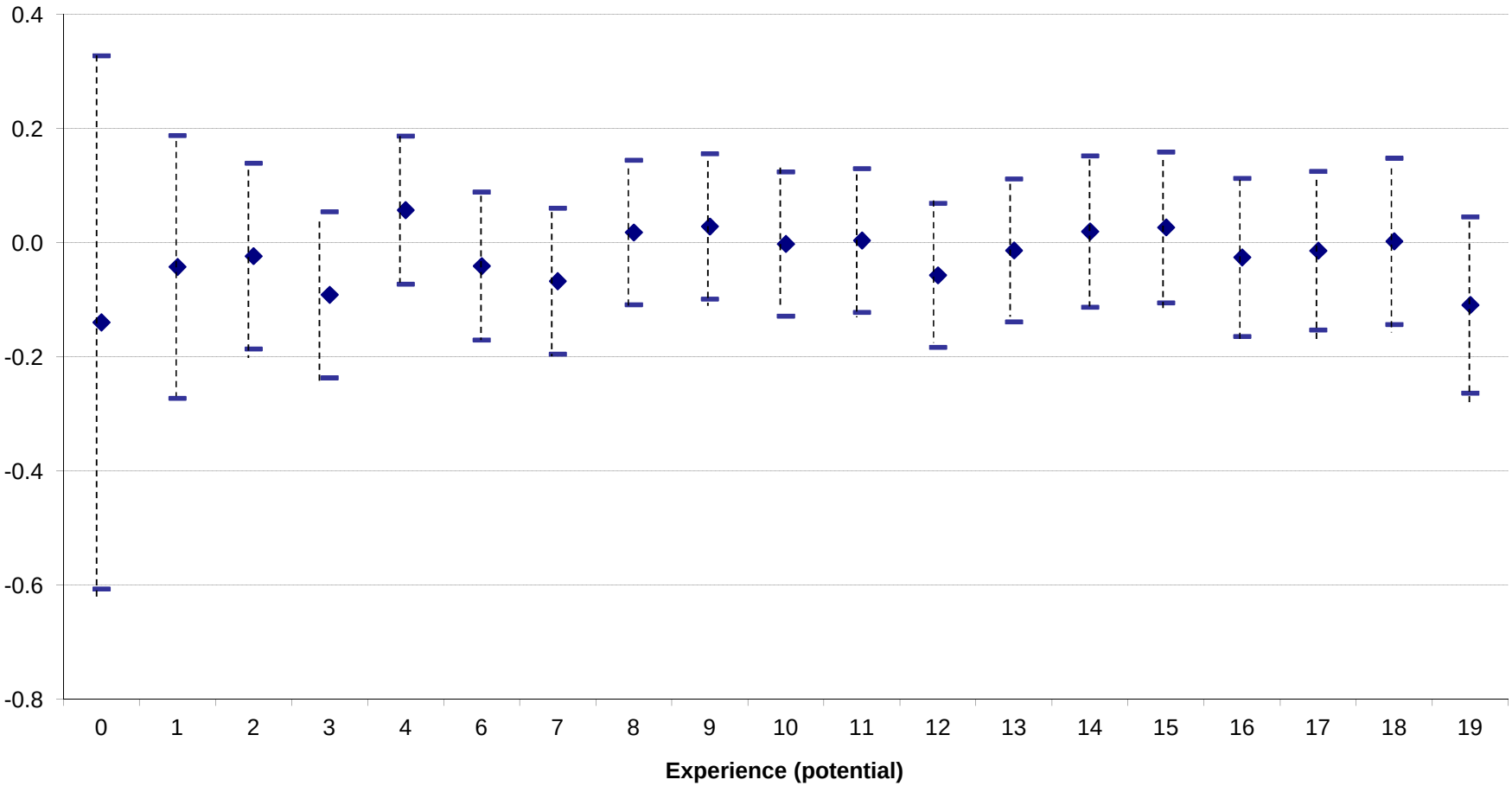

Figure 13: The Effect of AFQT on Log Hourly Wage, by Experience and Education, Point Estimates and Confidence Intervals (Relative to the AFQT Effect at 5 Years of Experience), White Males Working at least 1000 Annual Hours, NLSY, 1979-2000
Figure 13a: High School Dropouts

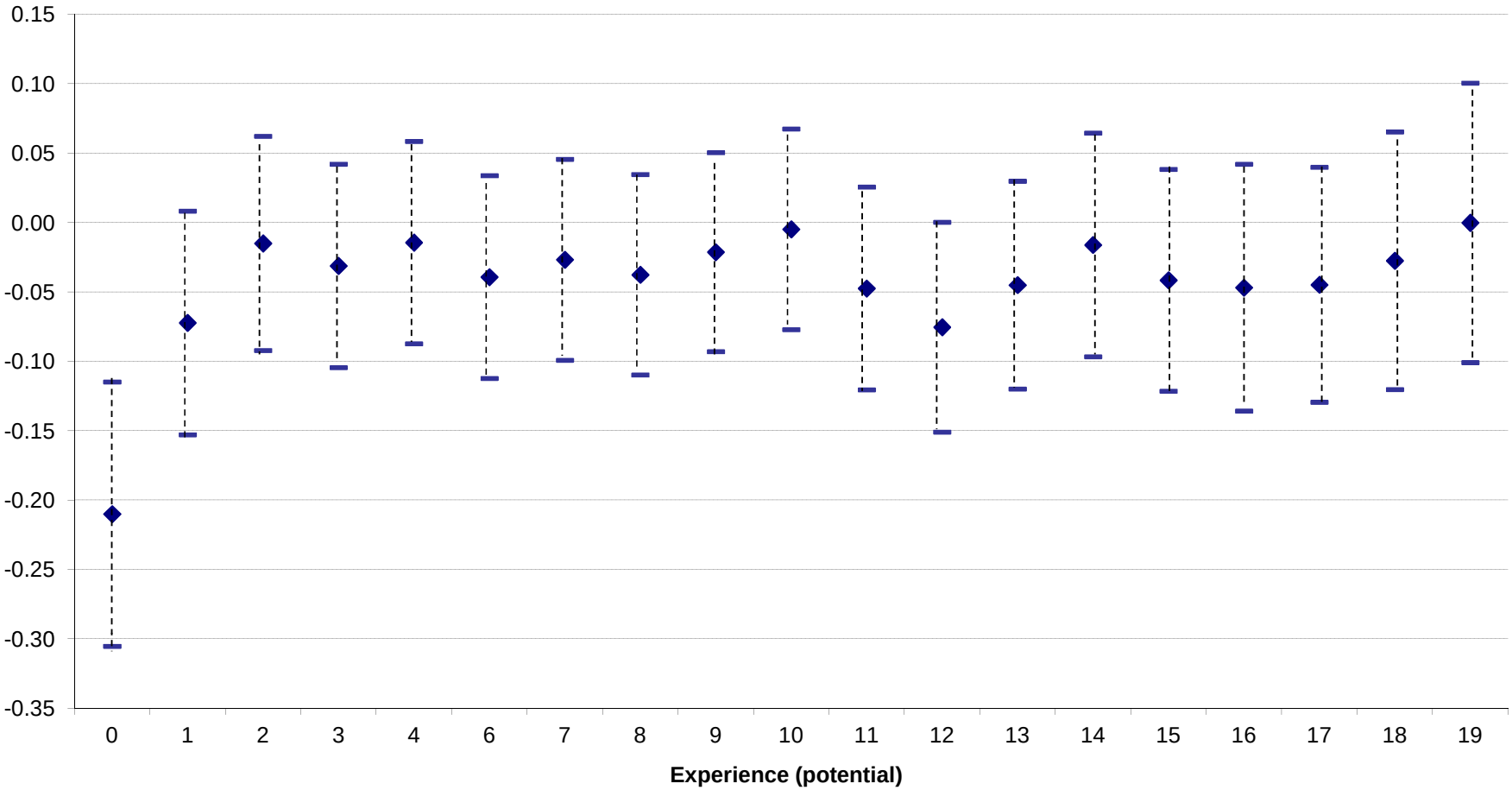

Figure 13: The Effect of AFQT on Log Hourly Wage, by Experience and Education, Point Estimates and Confidence Intervals (Relative to the AFQT Effect at 5 Years of Experience), White Males Working at least 1000 Annual Hours, NLSY, 1979-2000
Figure 13b: High School Graduates

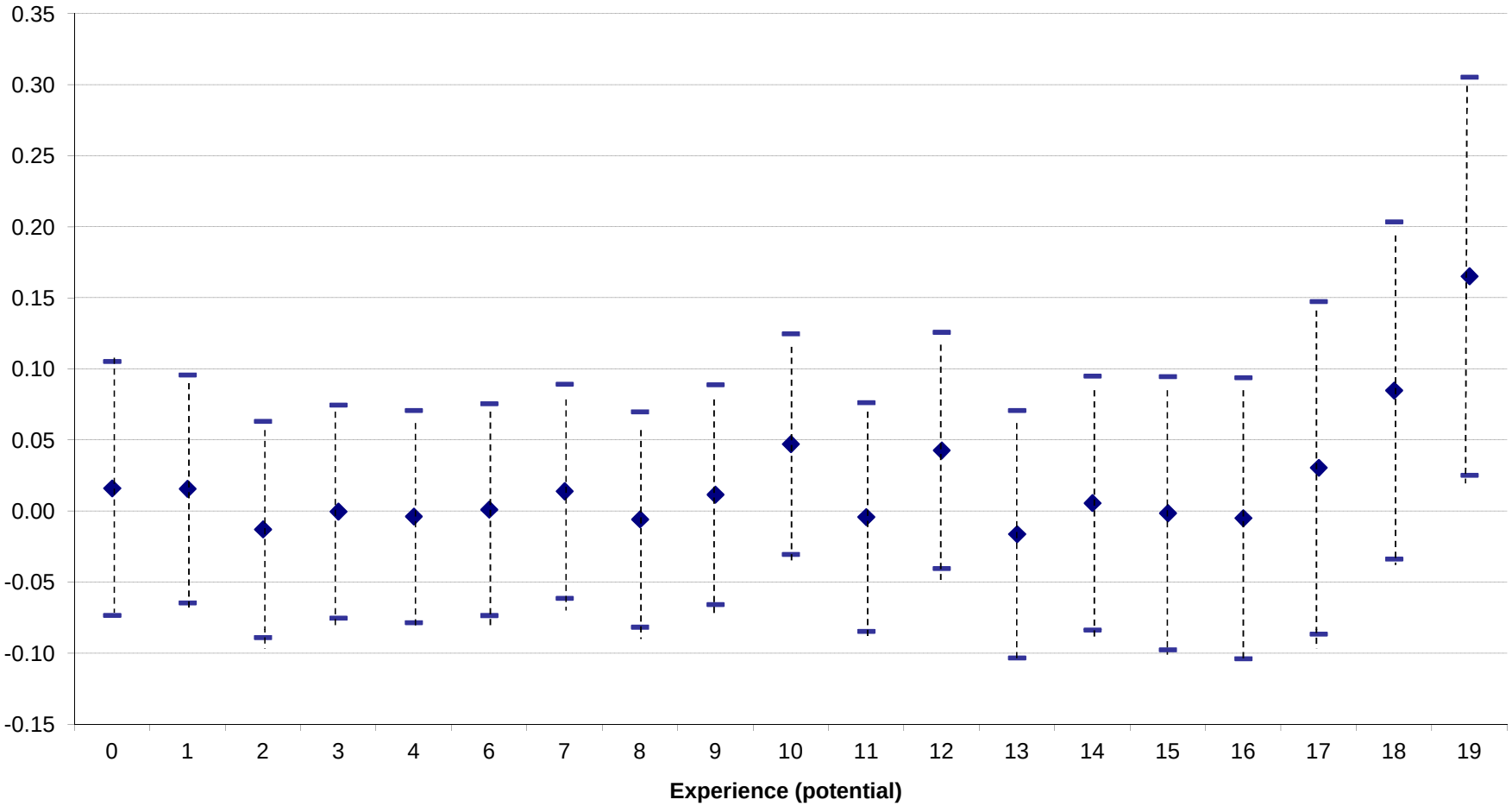

Figure 13: The Effect of AFQT on Log Hourly Wage, by Experience and Education, Point Estimates and Confidence Intervals (Relative to the AFQT Effect at 5 Years of Experience), White Males Working at least 1000 Annual Hours, NLSY, 1979-2000
Figure 13c: Some College

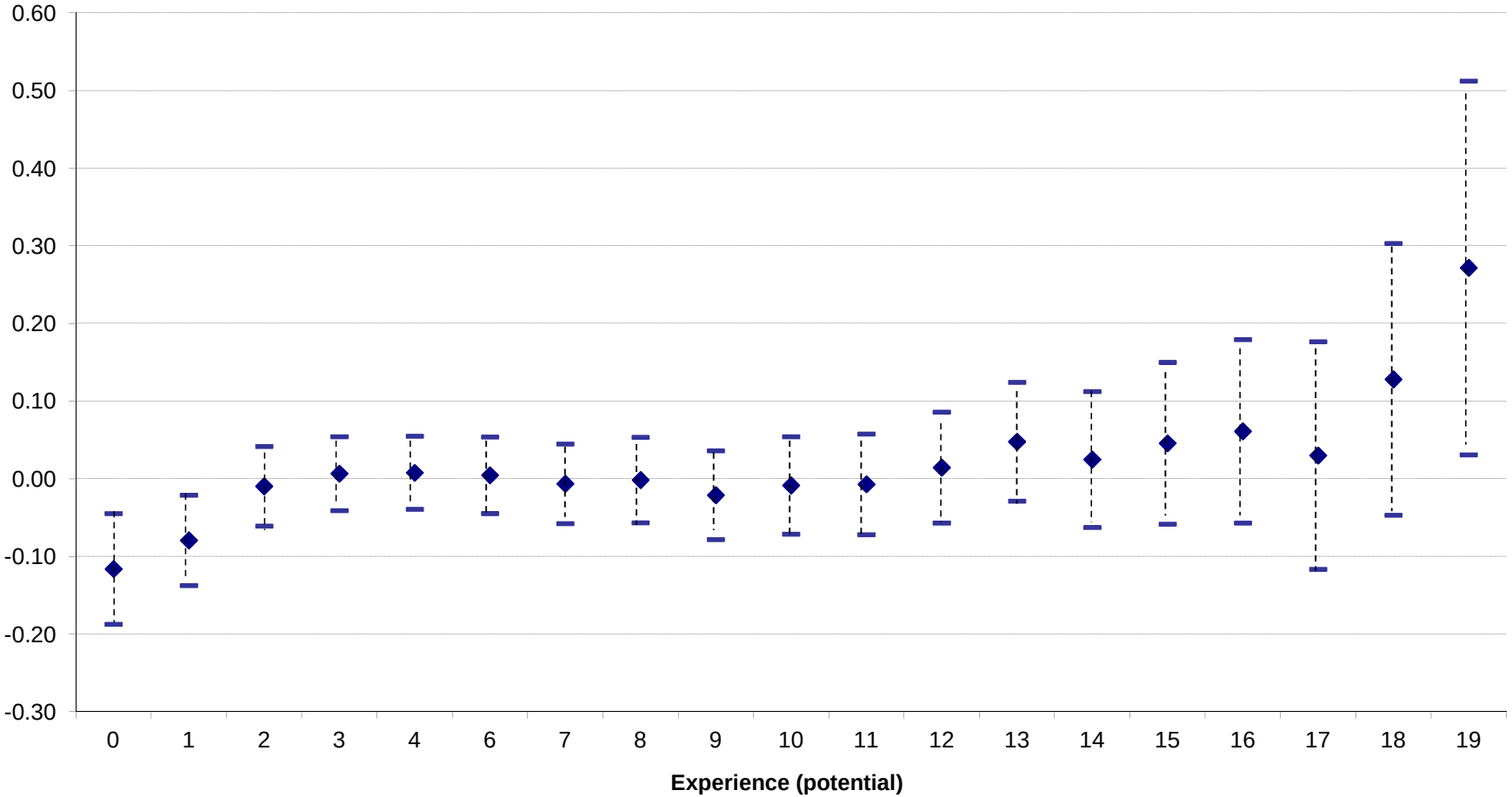

Figure 13: The Effect of AFQT on Log Hourly Wage, by Experience and Education, Point Estimates and Confidence Intervals (Relative to the AFQT Effect at 5 Years of Experience), White Males Working at least 1000 Annual Hours, NLSY, 1979-2000
Figure 13d: College Gradautes and Advanced Degrees

Table 5:
Mincer's Wage Equation with AFQT by Race and Ethnicity
Males, NLSY, 1979-2000

Variables	OLS			Fixed Effects		
	All	Whites	Blacks and Hispanics	All	Whites	Blacks and Hispanics
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Black	**-0.093** (0.020)	--	**-0.103** (0.028)	--	--	--
Hispanic	**0.005** (0.023)	--	--	--	--	--
AFQT	**0.043** (0.014)	**0.083** (0.019)	**0.043** (0.024)	--	--	--
School Years Completed	**0.096** (0.008)	**0.082** (0.010)	**0.109** (0.012)	--	--	--
Experience	**0.106** (0.011)	**0.089** (0.014)	**0.122** (0.017)	**0.098** (0.006)	**0.078** (0.007)	**0.119** (0.010)
Experience square^	**-0.024** (0.002)	**-0.023** (0.003)	**-0.025** (0.003)	**-0.027** (0.001)	**-0.027** (0.002)	**-0.027** (0.002)

Table 5:
Mincer's Wage Equation with AFQT by Race and Ethnicity
Males, NLSY, 1979-2000

Variables	OLS			Fixed Effects		
	All	Whites	Blacks and Hispanics	All	Whites	Blacks and Hispanics
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Interactions						
Schooling * Experience^	**-0.015**	**0.001**	**-0.033**	**-0.001**	**0.015**	**-0.019**
	(0.006)	(0.008)	(0.009)	(0.003)	(0.004)	(0.005)
AFQT * Expereince^	**0.058**	**0.018**	**0.061**	**0.053**	**0.009**	**0.074**
	(0.011)	(0.016)	(0.020)	(0.006)	(0.008)	(0.010)
Observations	24801	15430	9371	24801	15430	9371
R-squared	0.319	0.318	0.272	0.265	0.306	0.201

Notes:
^ Coefficients and standard errors multiplied by 10.
Robust standard errors in parentheses

- Generally speaking, it is relatively difficult to tease the impact of learning from the data based on the impact of AFQT scores on wage growth.
- Apart from problems of separating learning from investment, where AFQT as an indicator of ability can affect both level and growth of wages, there are some deeper problems related to the connections between indicators of ability, such as AFQT, and wages.
- Willis and Rosen (1979), Heckman and Rubinstein (2001) and Heckman, Hsee and Rubinstein (2003) have shown that a two factor model that recognizes the role of comparative advantage is more suitable for explaining schooling choices and wage outcomes.

- Figures 9a and 9b show the strong positive interaction between schooling and AFQT, which suggests that ability is more important among workers who are more educated and thus placed at more "responsible" jobs.
- Alternatively, the interaction indicates that high-ability individuals who do not acquire high levels of schooling may be lacking valuable noncognitive traits.
- Similar issues arise in the context of the impact of AFQT on wage growth.
- It is quite possible that, conditional on a low level of schooling, high AFQT indicates that the worker is lacking in some other important dimension, such as motivation; as time passes this is confirmed by performance.
- This substitution may explain the low impact of AFQT among workers with some college and the initially negative interaction between AFQT and experience for this group.

- Learning can also influence the variance of wages within a cohort of workers, as workers are gradually sorted out.
- It is generally difficult to separate this force for increasing variability from other considerations, such as investment, discussed above.
- In special cases, however, such a separation is possible.
- An interesting example is when workers move to a new labor market and can be followed based on their time spent in the new country.
- Eckstein and Weiss (2004) provide such an analysis for the wave of immigration from the former USSR to Israel during 1990-2000.

- The issue in this case was that employers were uncertain about the quality of schooling received in the former USSR, a factor that affects all immigrants, as well as the quality of particular immigrants.
- The results show that initially, all immigrants are treated alike and receive the same wage, irrespective of the experience and schooling brought from abroad.
- As time passes and the market learns about the immigrant's quality, the returns for imported skills rise and immigrants are gradually sorted by their observed attributes.
- At the same time, the residual variance reflecting unobserved attributes rises, too.
- The outcome is that both the mean and variance of immigrant wages rise with time spent in the new country.

- One issue of interest in learning models is whether individuals move from high risk to low risk occupations or vice versa.
- It has been shown by Johnson (1978) and Miller (1984) that if workers are unsure about their ability to perform a job, or about the quality of the worker-job match, young workers will willingly try out jobs where success is rare, which the more- experienced have already quit after finding out that they are unsuitable.
- However, Jovanovic and Nyarko (1997) have shown that if what one learns from experience is how to perform the job- rather than about one's own ability or the job's quality- then the direction of mobility is reversed.
- Thus, the young first try the safe jobs, as long as experience is sufficiently transferable, because it is better to learn in jobs where mistakes are less costly.

- In Figures 14a and 14b, we show the standard deviations for the occupations and industries in which individuals are employed at different stages of their life cycle.
- We see that these measures of risk are stable under occupational moves but *decline* as the worker changes industries.
- The results suggest experimentation with match quality across industries.

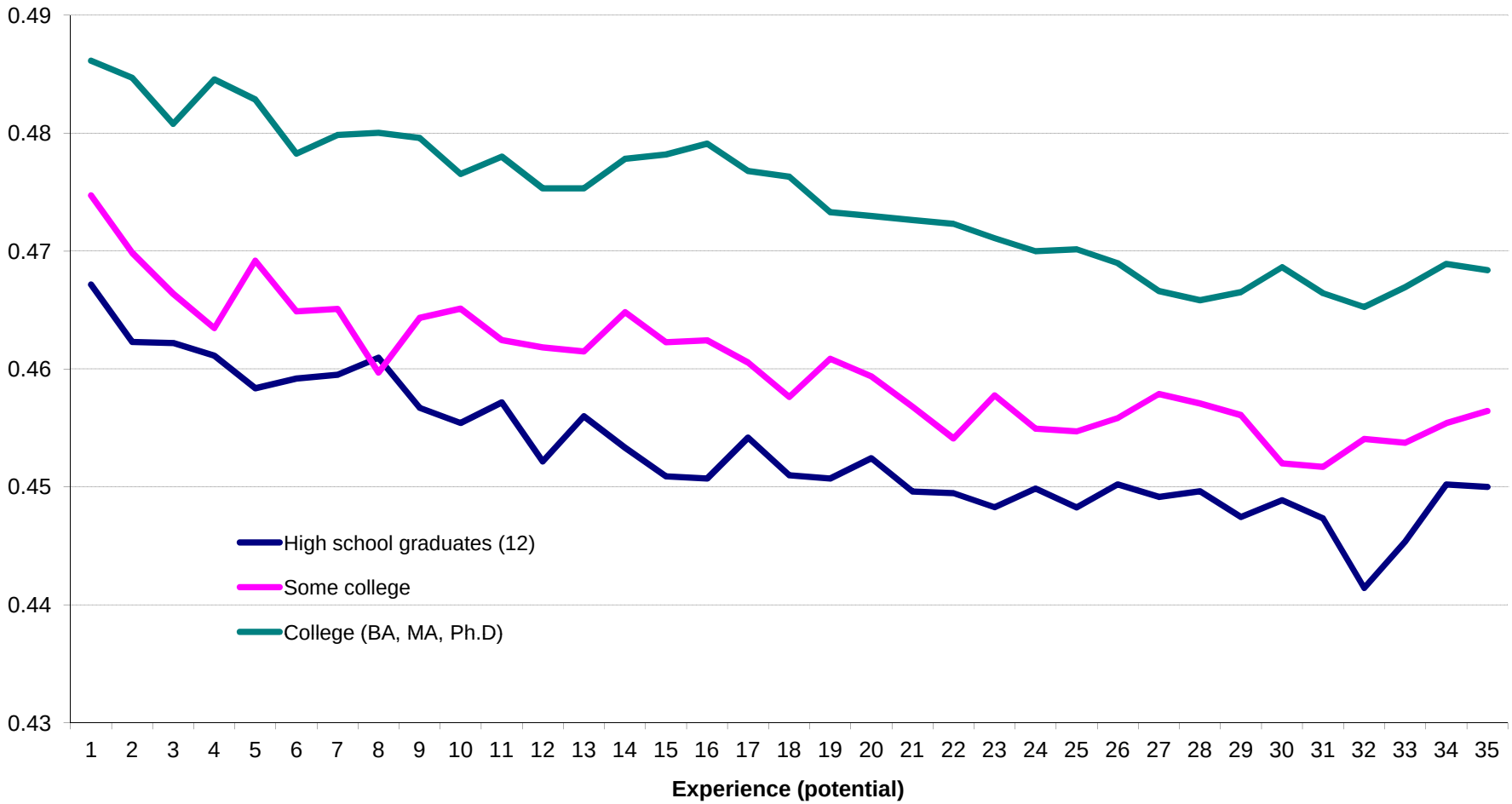

Figure 14: Standard Deviations of the Log Hourly Wages of Prime Aged Workers (36-45) at the Industry and at the Occupation in which the Worker is Currently Employed, by Education and Experience, CPS-ORG, 1998-2002
Figure 14a: Industry

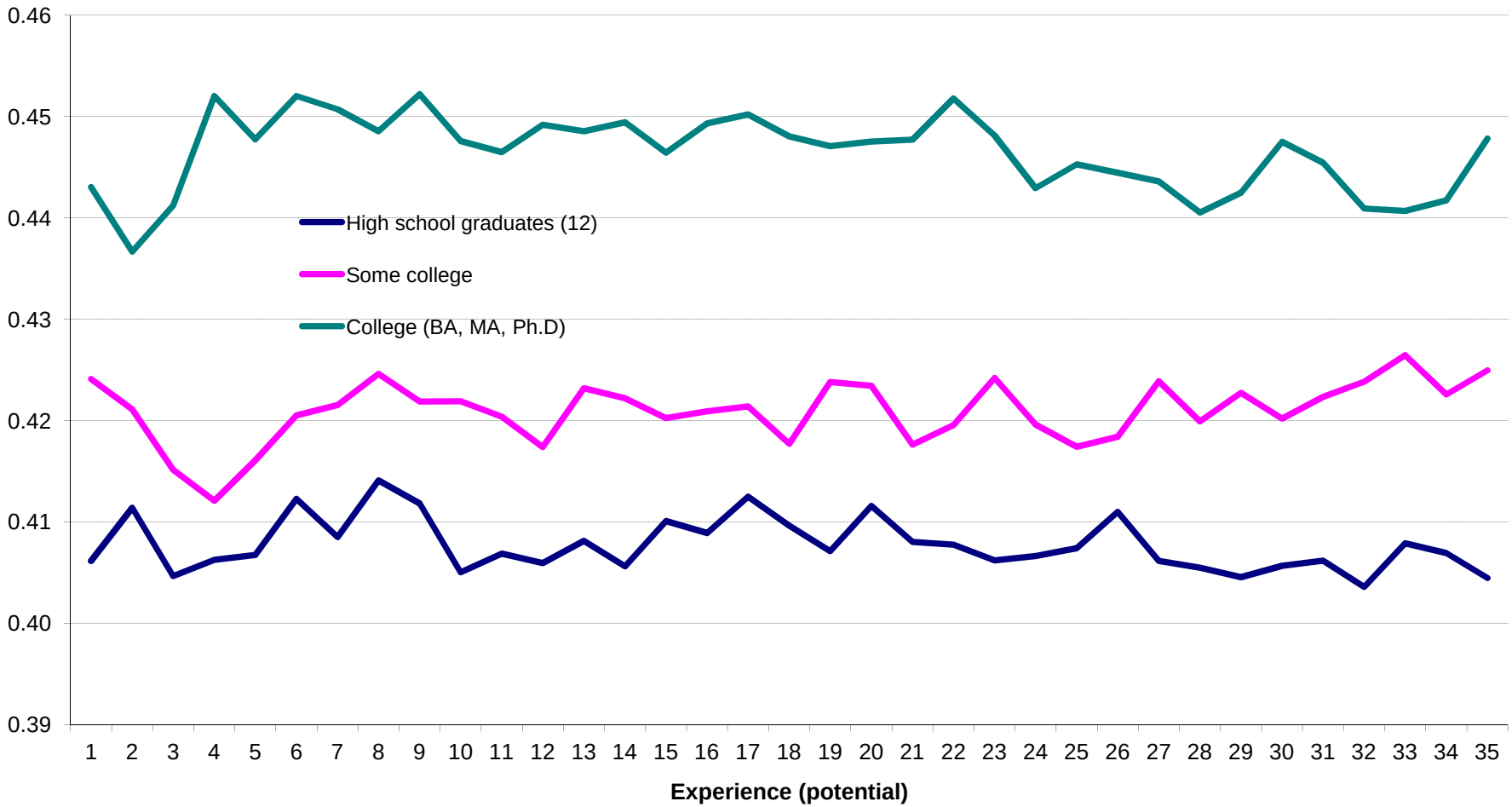

Figure 14: Standard Deviations of the Log Hourly Wages of Prime Aged Workers (36-45) at the Industry and at the Occupation in which the Worker is Currently Employed, by Education and Experience, CPS-ORG, 1998-2002
Figure 14b: Occupation

Data Appendix: **Data and Sample-Inclusion Criteria**

The CPS individual-level repeated cross-section data set

- These data come from a series of 39 consecutive March *Current Population Surveys* (hereafter: March CPS) for the years 1964 to 2002.
- These data provide information on employment and wages in the preceding calendar year.
- Thus, the annual data - taken from the CPS demographic supplement - cover the period of 1963 to 2001.
- The individual-level repeated cross-section data set is restricted to men aged 18 to 65 with zero (0) to forty (40) years of potential experience, where potential experience is defined as age-6-school years completed.

- The main advantage of the March CPS is that micro data samples are available from the mid-1960s onward.
- On the minus side, the March CPS has no "point-in-time" measure of the wage rate. Wage rates, in many of studies using the March CPS data, are often constructed by dividing total annual earnings in the previous year by an estimate of weeks or hours of work.
- The task is made more difficult by the absence of information on usual hours of work per week prior to 1976.
- For these reasons we further restrict this sample to include – Full-Time-Full-Year workers (hereafter: FTFY) - full-time workers (35+ hours per week) who reported working at least 51 weeks of the previous year.

- The wage measure in the March CPS data set that we use throughout this paper is the average weekly wage computed as total annual earnings divided by total weeks worked.
- Top coding has been changed over the years.
- Until the 1995 survey, the imputed wages/earnings of top-coded workers were set to equal the cutoff point.
- Since 1996, the imputed wages for the top-coded group are based on the conditional mean earnings of these workers conditional on characteristics such as race, gender and region of residence.
- In order to deal with the top-coding issue, we employ a unified rule for all years.
- We calculate for each worker his rank/position on the wage distribution for the year observed and exclude those belonging to either the lower 2 percent or the top 2 percent each year.

- Observations are divided by completed schooling, when interviewed, into five categories: (i) high school dropouts – less than twelve grades, (ii) high school graduates (iii) some college completed, (iv) college graduates with 16 years of schooling (BA) and (v) college graduates with advanced/professional education (MBA, PhD)

The CPS monthly longitudinally matched data

- The vast majority of empirical analyses of the Current Population Surveys use either a single cross-section data point or a series of consecutive CPS surveys, treating the latter as a series of repeated cross-sections.
- The CPS data have, in fact, a longitudinal component.
- In this paper we take advantage of the CPS basic monthly files - a probability sample of housing units in the US - to construct a panel data set.

- The CPS divides housing units into 8 representative sub-samples called "rotation groups".
- Each unit is interviewed for 4 consecutive months, followed by a break lasting two quarters, and again for another four monthly interviews.
- Overall, each unit is interviewed for 8 times over 16 months.
- The CPS monthly files we employ - from the years 1998 to 2002 - include a set of identifier variables that enables us to follow the same housing unit over 16 months.
- If there is no change in the composition of individuals residing in a particular unit, we have a panel of individuals.
- Yet, since people do switch locations, it might be the case that the same id number was shared by 2 (or more) individuals over time.

- Therefore, we follow the Madrian and Lefgren (1999) procedure, whereby individuals are identified in our panel data not only by their id number but also by matching a set of time-invariant characteristics.
- This procedure makes us quite confident that we do not combine different persons into one artificial observation.

- Data on schooling, employment, occupation and industry, are available for all interviews.
- However weekly wage data is collected only during the fourth and the eighth interview - among what is known as the "outgoing rotation groups" hereafter (ORG).
- We construct two samples.
- The main sample includes only workers participating in all interviews.
- This sample is used for the analysis of transitions between industries and occupations.
- Our second sample is taken from the ORG sample restricted to full-time workers, not enrolled in school and with two wage data points.
- We exclude observations with a reported hourly wage lower than \$4 or higher than \$2000 (adjusted for 2000 CPI).
- This sample is used to study wage growth of individuals.

The Panel Study of Income Dynamics

- The Panel Study of Income Dynamics (PSID) is a longitudinal, nationwide survey of a representative sample of individuals and the families in which they reside. The PSID began in 1968 with approximately 4,800 white and black households and approximately 18,000 individuals.
- The sample had expanded as original members formed additional families over the years.
- We restrict our sample to US born white males aged 21 to 65 during the work year, with non missing demographics.

- When we discuss wage data, we exclude workers with a reported hourly wage lower than $4 or higher than $2000 (adjusted for 2000 CPI) and individuals who worked less than 35 weeks or less than 1000 annual hours.
- When using wage differences, we restrict the sample according to these cretiria in both consecutive years.
- Observations are divided by completed schooling into five categories - similar to our definitions using the CPS data.

National Longitudinal Survey of Youth (NLSY)

- The micro data we use are from the 1979-2000 waves of the National Longitudinal Survey of Youth (NLSY).
- The NLSY includes a randomly chosen sample of US youths and a supplemental sample that includes Black, Hispanic, and non-Black, non-Hispanic economically disadvantaged young people.
- Interviewees have been surveyed annually since the initial wave of the survey in 1979, when sample members all ranged between age 14 and 21 in 1979.
- The military sub-sample and the non-black, non-Hispanic disadvantaged samples are excluded.

- We further exclude observations with missing data regarding own or parents' education, Armed Forces Qualification Test score (hereafter AFQT), or labor market outcomes.
- In order to guarantee that AFQT test scores were not influenced by school attendance, AFQT scores are gender-age-school–adjusted (standardized within birth year cohort to mean 0, variance 1).
- When studying labor market outcomes we exclude individuals enrolled in schooling in the given year.
- We group respondents into five education categories: high school dropouts, high school graduates (including GED graduates), some college (SC), college graduates and individuals with advanced degrees.

- When we discuss wage data, we further exclude workers with a reported hourly wage lower than \$4 or higher than \$2000 (adjusted for 2000 CPI) and individuals who worked less than 35 weeks or less than 1000 annual hours.
- When using wage differences, we restrict the sample according to these criteria in both consecutive years.