Post Schooling Wage Growth: Investment, Search and Learning - TA Session

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Post Schooling investment and wage growth

- In the first class we talked about "static" inequality, where we compared cross-sectional distributions of workers
- An important factor that shapes these distributions is the workers' composition and wage schedule
- Considering the wage schedule also raises additional questions on lifetime earnings inequality

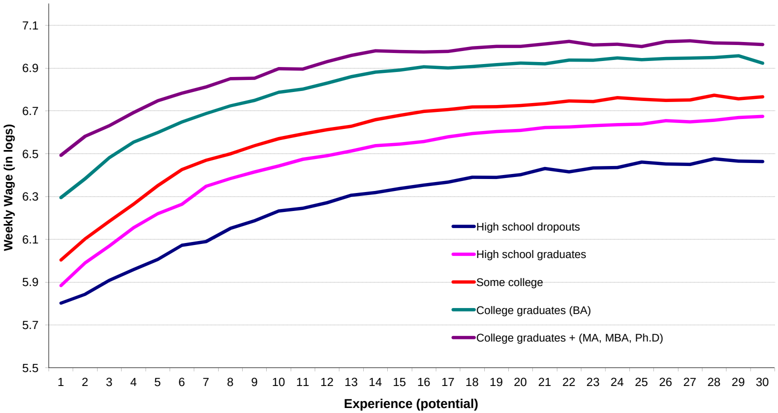

Figure 1: Mean Weekly Wages (in Logs) by Education and Experience, White Males, Full-Time Full-Year Workers, CPS, March Supplement, 1964-2002

- The sharp growth in wages is associated with a sharp increase in labor supply and regularity of employment, as indicated by the life-cycle profiles of the proportion of workers who work full time, full year (among those who worked some time during the year) and average weekly hours (for those with positive hours).
- Workers with higher levels of schooling work more and reach a steady level much earlier than do less educated workers (see Figures 2a and 2b).
- Thus, hours and wages move together over the life cycle, and earnings grow faster than wages.

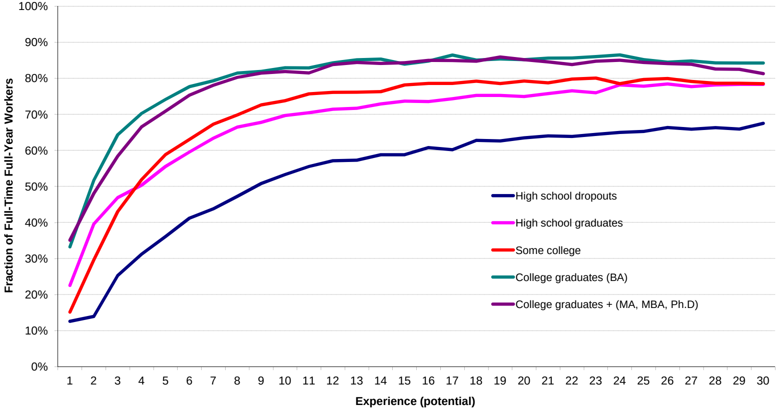

Figure 2: Fraction of Full-Time Full-Year Workers and Average Weekly Hours of Employed Workers by Education and Experience among Employed, White Males, CPS, March Supplement, 1964-2002
Figure 2a: Fraction of Full-Time Full-Year Workers

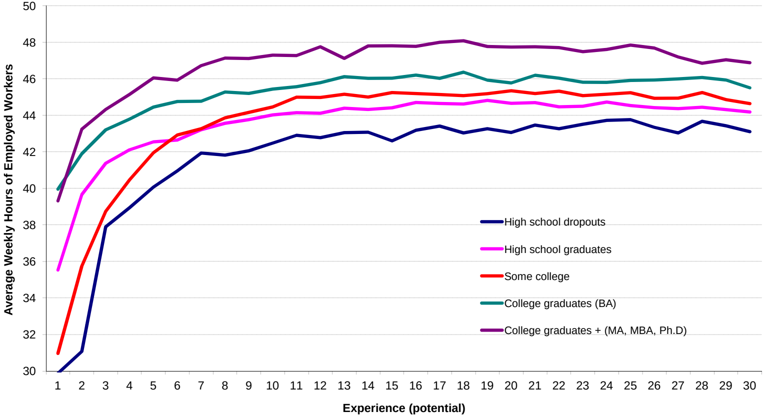

Figure 2: Fraction of Full-Time Full-Year Workers and Average Weekly Hours of Employed Workers by Education and Experience among Employed, White Males, CPS, March Supplement, 1964-2002
Figure 2b: Average Weekly Hours of Employed Workers

Cohorts and Cross-Sections

- the economy is not stationary.
- The wage structure has undergone major changes beginning in the late 1970's, when workers with high level of schooling started to gain relative to those with low levels of schooling, mainly as a result of the decline in the wages of low-skill workers [see Katz and Autor (1999)].
- Such changes in returns to skill imply different wage profiles for different cohorts, where workers born in the same year are followed over time, and for cross sections, where workers with different experience (and time of entry into the labor force) are observed at a given year.

- Figures 3a and 3b show the wage-experience profiles for the cohort of high school graduates born in 1951-1955 and the cohort of college graduates born in 1946-1950, respectively.
- These two groups entered the labor market at roughly the same time, 1971-1975.
- Added to the graphs is the evolution of the cross section wage-experience profiles from 1971 to 2000 in five year intervals, where each such cross section profile shows the mean wages of workers with the indicated schooling and experience in a given time interval.
- These figures make it very clear that cohort-based wage profiles are affected by changes in market conditions that shift the cross section profiles over time.
- These shifts differ by level of schooling.

- High school graduates of *all* experience levels earned lower wages during the period 1970-2000, which is the reason why the mean wage profile of the cohort of high school graduates born between 1951 to 1955 exhibits almost no wage growth after ten years in the labor market (see Figure 3a).
- In contrast, workers with a college degree or more maintained their earning capacity over time.
- Consequently, as seen in Figure 3b, the cross section and cohort wage profiles of college graduates are quite similar and rise throughout most of the worker's career.

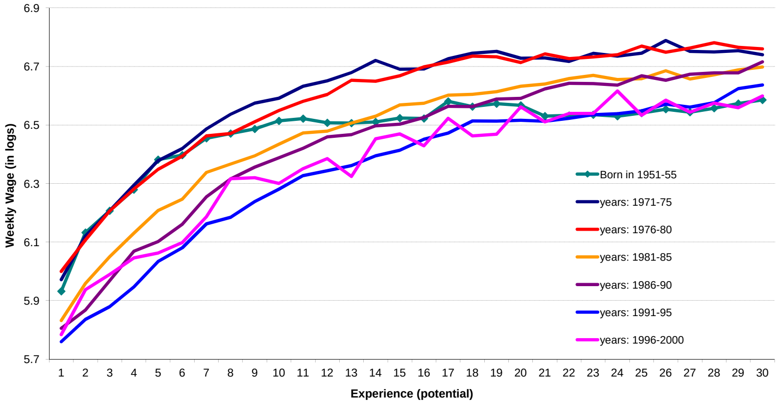

Figure 3: Cohort and Cross-Section Wage Profiles for High School Graduates and College Graduates, White Males, CPS March Supplement, 1964-2002
Figure 3a: High School Gradautes

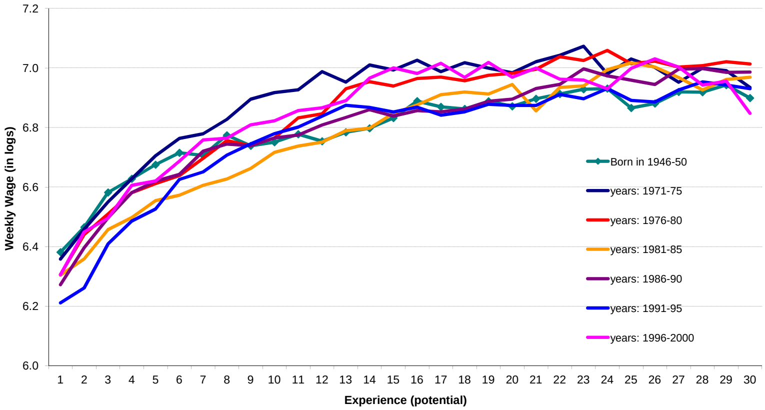

Figure 3: Cohort and Cross-Section Wage Profiles for High School Graduates and College Graduates, White Males, CPS March Supplement, 1964-2002
Figure 3b: College Gradautes

Individual Growth Rates

- Table 1 summarizes the main results on wage growth.
- For each individual, we calculate annual wage growth and then present the averages and standard deviations of these rates, by experience and schooling.
- For comparison, we also present the predicted average growth rates that would be implied for the same individuals by using Mincer's quadratic specification for wage levels.
- We report these figures for the CPS short panel as well as the PSID and the NLSY samples.

Table 1:
The Average Annual Wage Growth by Education, Experience, Specification and Data Source

Expirience	**Data Source**	**Education categories**									
		Less than HSG		HSG (12)		Some College		College Graduates		MA, Ph.D.	
		Level	Dif	Level	Dif	Level	Dif	Level	Dif	Level	Dif
0-10											
	CPS-ORG	0.024	0.039	0.032	0.056	0.033	0.063	0.036	0.063	0.029	0.077
		(0.003)	(0.029)	(0.001)	(0.010)	(0.001)	(0.010)	(0.002)	(0.011)	(0.003)	(0.017)
	PSID	0.028	0.043	0.030	0.057	0.038	0.065	0.039	0.076	0.032	0.110
		(0.003)	(0.007)	(0.002)	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.006)	(0.021)
	NLSY	0.024	0.065	0.034	0.071	0.046	0.081	0.052	0.082	0.055	0.096
		(0.006)	(0.010)	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.009)	(0.012)
11-15											
	CPS-ORG	0.016	0.007	0.022	0.033	0.022	0.055	0.022	0.045	0.018	0.053
		(0.002)	(0.034)	(0.001)	(0.011)	(0.001)	(0.012)	(0.001)	(0.012)	(0.001)	(0.020)
	PSID	0.019	0.030	0.020	0.021	0.026	0.021	0.027	0.029	0.022	0.013
		(0.002)	(0.007)	(0.001)	(0.004)	(0.002)	(0.005)	(0.002)	(0.005)	(0.004)	(0.016)
	NLSY	0.013	0.024	0.023	0.019	0.026	0.024	0.035	0.067	0.039	0.123
		(0.002)	(0.008)	(0.001)	(0.004)	(0.002)	(0.007)	(0.004)	(0.009)	(0.009)	(0.018)

Table 1:
The Average Annual Wage Growth by Education, Experience, Specification and Data Source

Expirience	**Data Source**	**Education categories**									
		Less than HSG		HSG (12)		Some College		College Graduates		MA, Ph.D.	
		Level	Dif	Level	Dif	Level	Dif	Level	Dif	Level	Dif
16-25											
	CPS-ORG	0.010	0.052	0.013	0.022	0.012	0.026	0.009	0.026	0.009	0.015
		(0.001)	(0.021)	(0.000)	(0.007)	(0.000)	(0.008)	(0.001)	(0.009)	(0.001)	(0.012)
	PSID	0.011	0.010	0.012	0.010	0.015	0.014	0.017	0.026	0.014	0.019
		(0.001)	(0.004)	(0.001)	(0.003)	(0.001)	(0.004)	(0.001)	(0.004)	(0.003)	(0.009)
	NLSY	0.003	0.035	0.014	0.038	0.009	0.065	0.021	0.111	0.025	0.044
		(0.004)	(0.009)	(0.003)	(0.005)	(0.005)	(0.013)	(0.009)	(0.015)	(0.022)	(0.035)
25 +											
	CPS-ORG	-0.002	0.025	-0.004	0.011	-0.005	0.002	-0.014	-0.002	-0.009	0.012
		(0.003)	(0.017)	(0.001)	(0.007)	(0.001)	(0.008)	(0.002)	(0.011)	(0.003)	(0.013)
	PSID	-0.003	0.004	-0.005	0.006	-0.005	0.010	-0.003	0.000	-0.001	0.011
		(0.001)	(0.003)	(0.002)	(0.003)	(0.003)	(0.005)	(0.004)	(0.005)	(0.005)	(0.006)
	NLSY	-0.015	0.034	-0.003	0.034						
		(0.012)	(0.042)	(0.007)	(0.041)						

Notes:

The numbers in the "dif" columns are cell means and standard deviations.
The numbers in the "level" columns are growth rates as implied by the estimated coefficients of the experience and experience squared terms in Mincer's wage equation.
Standard errors are in parentheses

- The average worker's career is characterized by three very different phases.
- The first, decade-long phase is characterized by a sharp growth of wages.
- The second, five-year long phase is characterized by moderate wage growth; the late phase of a career has zero or negative growth.
- The growth rates are substantially higher for workers with higher levels of schooling.

- The variability in the rates of wage growth follows a U-shape pattern with respect to schooling.
- That is, the standard deviations are lower for workers with high school degree than for workers with more schooling or less, suggesting that, in this regard, the middle levels of schooling are less risky.
- However, there is no systematic pattern for the standard deviations of wage growth by level of experience.

Models of Wage Growth

- These observations raises the following questions
  - What causes the large wage growth at the initial phase of a career?
  - Why does wage growth decline?
  - What are the interrelationships between wage growth, job change and labor supply?
  - What causes the large variance in individual wage growth and who are the gainers and losers?

Models of Wage Growth

Models of Wage Growth

- All the models we consider here focuses on on workers ability to influence on their current and future wage, by choosing schooling, occupations and employer/industry.
- It's important to remember that there are other factors that can influence workers wages (change in prices, technology, level of competition and institutional framework, discrimination)

Models of Wage Growth - Investment

- Workers have a finite life, T, and time is discrete.
- Let Y_t denote the earning capacity of the worker with the *current* employer, $t, t = 1, 2., ... T$.
- We assume that
$$Y_t = R_t K_t, \tag{1}$$
where K_t is the worker's human capital and R_t is the rental rate.
- In a competitive world, without friction, all firms pay the **same** rental rate.

Models of Wage Growth - Investment

- Workers can accumulate human capital by investment on the job.
- Let I_t, be the proportion of earnings capacity that is forgone when the worker learns on the job.
- Hence, current earnings are

$$y_t = R_t K_t (1 - I_t). \tag{2}$$

- Following the Ben-Porath (1967) model, suppose that human capital evolves according to

$$K_{t+1} = K_t + g(I_t K_t), \tag{3}$$

where $g(.)$ is increasing and concave with $g(0) = 0$.

Models of Wage Growth - Investment

- To determine a worker's investment, we form the Bellman equation

$$V_t(K_t) = \underset{I_t}{Max}[R_t K_t(1 - I_t) + \beta V_{t+1}(K_t + g(I_t K_t))], \quad (4)$$

  where β represents the discount factor and $\beta < 1$.
- Current value consist of current payment and the **option** value to augment human capital, through learning-on-the-job

Models of Wage Growth - Investment

- The first-order condition for I_t in an interior solution is

$$\frac{R_t}{g'(I_t K_t)} = \beta V'_{t+1}(K_{t+1}). \tag{5}$$

- The left-hand side of describes the marginal costs of investment in terms of forgone current earnings, while the right- hand side is the marginal value of additional future earnings.

Models of Wage Growth - Investment

- Using the envelope theorem, and using (5) we obtain the rule of motion for the marginal value of human capital

$$V_t'(K_t) = R_t + \beta V_{t+1}'(K_{t+1}). \quad (6)$$

- In the last period, T, investment is zero because there are no future periods left in which to reap the benefits, $V_{T+1}(K_{T+1}) = 0$ for *all* K_{T+1},

$$V_T'(K_T) = R_T. \quad (7)$$

- We assume stationary conditions; hence, R_t is a constant that can be normalized to 1.
- Then, using (7) and solving (6) recursively, the value of an additional unit of human capital at time t is

$$V_t'(K_t) = \frac{1-\beta^{T+1-t}}{1-\beta}, \quad (8)$$

which is *independent* of K_t.

Models of Wage Growth - Investment

- It follows that the value of being employed at a given current wage *declines* with time, that is, $V_t'(K_t) \geq V_{t+1}'(K_{t+1})$ for all periods $t = 1, 2, ., ., T$.
- The shorter the remaining work horizon, the less valuable is the current stock of human capital and the lower the incentive to augment that stock (see (5)).
- The lack of dependence on history, implicit in the Ben-Porath (1967) specification, is sufficient but not necessary for the result of declining investment, which holds under more general conditions (see Weiss, 1986).

Models of Wage Growth - Investment

- Allowing R_t to change over time, implies that

$$V_t'(K_t) = \sum_{\tau=t}^{T} \beta^{\tau-t} R_\tau. \tag{8'}$$

- Comparing these expressions, it is seen that if R_t rises with time, then the investment in human capital is higher at each period.
- The reason is that investment occurs when a worker receives a relatively lower price for his human capital, so that the forgone earnings are relatively low.
- If the rental rate rises with time at a decreasing rate, this relative price effect weakens with time and investment declines.

Models of Wage Growth - Investment

The observable implications of this model are clear:

- For a constant R, investment declines as the worker ages and approaches the end of his working life.
- Earnings rise along an optimal investment path. This is caused by two effects that reinforce each other; positive investment increases earning capacity and declining investment induces a rise in its utilization rate.
- If R varies with time, workers that expect exogenous growth in their earning capacity invest at a higher rate and their wage rises at a higher pace. Investment declines if the rate of growth in the rental rate decreases.

Models of Wage Growth - Investment in School

- Investment in school and on the job can be viewed as two alternative modes of accumulation of human capital that complement and substitute each other.
- Complementarity arises because human capital is self-productive, so that human capital accumulated in school is useful for learning on the job.
- Substitution arises because life is finite and if more time is spent in school, there is less time left for investment on the job.
- School investment and Post-School investment are, to some extant, jointly determined. This leads us to expect interactions, whereby individuals completing different levels of schooling will invest differentially on the job and therefore display different patterns of wage growth.

Models of Wage Growth - Investment in School

- Investment on the job is usually done **jointly** with work, while schooling is done separately.
- As a consequence, one foregoes less earning when training on the job than in school.
- However, in school, one typically specializes in the acquisition of knowledge and human capital is consequently accumulated at a faster rate.
- One can capture these differences by assuming different production (and cost) functions for the two alternative investment channels.

Models of Wage Growth - Investment in School

- Let p_t be a labor force participation indicator.
- Individuals can either go to school or work
- Individuals in school accumulates human capital

$$K_{t+1} = K_t(1+\gamma)$$

where γ is a fixed parameter such that $\gamma K_t > g(l_t K_t)$

- We also assume that $(1+\gamma) > \frac{1}{\beta}$, which means that the rate of return from investment in human capital γ exceeds the interest rate.
- Assume stationary conditions and normalize $R_t = 1$.
- We can now rewrite the Bellman equation in the form

$$V_t(K_t) = \underset{p_t, l_t}{Max}[p_t K_t(1-l_t) + \beta V_{t+1}(K_t + p_t g(l_t K_t) + (1-p_t)\gamma K_t)]. \tag{9}$$

Models of Wage Growth - Investment in School

- School is the preferred choice in period t if

$$\beta V_{t+1}(K_t(1+\gamma)) > K_t(1-I_t^*) + \beta V_{t+1}(K_t + g(I_t^* K_t)), \quad (10)$$

  where the optimal level of training on the job, I_t^*, is determined from (5).

- The law of motion for the marginal value of human capital is modified to

$$V_t'(K_t) = p_t + \beta V_{t+1}'(K_{t+1})(1 + (1-p_t)\gamma). \quad (11)$$

Models of Wage Growth - Investment in School

This extension has several implications:

- Using (11), (10), (5) and (8) we see that the value of $V_t(K_t)$ is decreasing with t, with on the job-training. This implies that Specialization in schooling occurs, if at all, in the first phase of life. It is followed by a period of investment on the job. In the last phase of the life cycle, there is no investment at all.
- During the schooling period, there are no earnings, yet human capital is accumulated at the maximal rate $(1+\gamma)$. During the period of investment on the job, earnings are positive and growing. In the last phase (if it exists), earnings are constant.
- A worker leaves school at the first period in which (11) is reversed. At this point it must be the case that $l_t^* < 1$, which means that at the time of leaving school, earnings must **jump** to a positive level. This relies on the assumption that accumulation in school is faster but requires a larger sacrifice of current earnings.

Models of Wage Growth - Investment in School

- A person with a larger initial stock of human capital, K_0, will stay in school for a shorter period and spend more time investing on the job. He will have higher earnings and the same earnings growth throughout life.
- A person with a larger scholastic learning ability, γ, will stay in school for a longer period and spend less time investing on the job. He will also have higher earnings and the same earning growth throughout life.

Models of Wage Growth - Investment in School

- These results (although depends on the particular form of the production function), illustrate that unobserved characteristics of economic agents can create a negative correlation between the amounts of time spent investing in school and on the job, while there need be no correlation between completed schooling and post schooling wage growth.
- Uncertainty and unexpected shocks can also affect the correlation between schooling and investment. For instance, the introduction of computers may raise the incentive to invest on the job among educated workers to a larger extent than among uneducated workers because the investment's payoff may be lower for the second group.

Models of Wage Growth - Search

- In a world with limited information and frictions, firms may pay a different R because workers cannot immediately find the highest paying firm and must spend time and money to locate employers.
- If a worker meets a new employer, he obtains a random draw $\tilde{R}$ from the given distribution of potential wage offers $F(R)$. The worker decides whether to accept or reject this offer.
- To simplify, we assume here that workers are relatively passive in their search for jobs.
- They receive offers at some fixed exogenous rate λ, but do not initiate offers through active job search.

Models of Wage Growth - Search

- We assume homogeneous workers and firms
- Firms post wage R, and their profit is $K - RK$
- Firms that post a high R draw more workers and can coexist with a firm that posts a low R and draws few workers.
- In equilibrium, all firms must have the same profits
- Here we consider only the behavior of workers for a given wage distribution, $F(R)$, and do not attempt to close the model by deriving either the equilibrium wage offer distribution or the equilibrium trade-off between current and future earnings.

Models of Wage Growth - Search

- Consider a worker who receives a rental rate R_t for his human capital from his current employer in period t so that $Y_t = KR_t$.
- Now imagine that during period t, the worker is matched with a new employer offering another rental rate, R. Because the worker can follow the same search strategy wherever he is employed, it is clear that the offer will be accepted if $R > R_t$ and rejected if $R < R_t$.
- If the worker rejects the offer and stays with the current employer, his earning capacity remains the same and $Y_{t+1} = Y_t$.
- If the worker accepts the outside offer and moves to the new employer, his new wage, $Y_{t+1} = RK$, must exceed Y_t
- The probability that the worker will switch jobs is $\lambda(1 - F(R_t))$ and is *decreasing* in R_t.

Models of Wage Growth - Search

The observable implications of this model are:

- A job has an **option value** to the worker. In particular, he can maintain his current wage and move away when he gets a better offer. Consequently, earnings rise whenever the worker switches jobs and remain constant otherwise.
- The higher the worker's current wage, the more valuable is the current job; hence, the offers that the workers accepts must exceed a higher reservation value. Therefore, the quit rate and the expected wage growth decline as the worker accumulates work experience and climbs up the occupational ladder.
- A straight-forward extension is to add involuntary separations. Such separations are usually associated with wage reduction and are more likely to occur at the end of the worker's career, which may explain the reduction in average wages towards the end of the life cycle.

Models of Wage Growth - Comparison of investment and search

- The investment and search models have similar empirical implications for **average** growth in earnings, i.e., positive and declining wage growth.
- In the investment model, the reason for wage growth is that the worker chooses to spend some of his time learning.However, investment declines as a result of the shortened remaining work period, which causes wage growth to taper off.
- In the search model, wage growth is an outcome of the option that workers have to accept or reject job offers. Acceptance depends on the level of earnings that the worker attained by time t so that history matters. Two workers at the same age would look different due to different "success rate" in finding better jobs

Models of Wage Growth - Comparison of investment and search

- The two approaches to wage growth can be distinguished by their different patterns in the **variance** of wages and the correlation between wages at different points of the life cycle.
- In the investment model, the variance take the U-Shape. Low wage is compensated for by a future high wage, so that workers who invest more intensely will *overtake* those with a lower investment rate.
- The minimal variance occurs in the middle range of experience, where individual earning profiles cross.

Models of Wage Growth - Comparison of investment and search

- Under search, the cause for variability is not differential investment but different success record in locating suitable job matches and the variability in accepted wage offers.
- In the homogeneous workers become increasingly heterogeneous due to their longer exposure to random job offers.
- However, selection modifies the impact of such shocks on wages, because wages do not go down when the worker keeps the job and those who have high wages are less likely to get a better offer.
- Thus, the variance first increases and then declines as workers are gradually climbing up the income distribution.
- If workers are initially heterogeneous, the variance may also first increase and then decline as workers are gradually sorted into their "right" place.

Models of Wage Growth - Search + Investment

- We now consider the possible interaction between search and investment behavior.
- To simplify, we continue to assume that workers can reject or accept offers as they arrive at an exogenous rate λ but cannot initiate offers by investing in search.
- However, the option of passive search changes the incentives to invest in human capital

Models of Wage Growth - Search + Investment

- The Bellman equation becomes

$$\begin{aligned} V_t(R_t, K_t) = & \\ & \underset{I_t}{Max}\{R_t K_t(1 - I_t) \\ & + \beta[\lambda E\{\max[V_{t+1}(R_t, K_{t+1}), V_{t+1}(R, K_{t+1})] \\ & + (1-\lambda)V_{t+1}(R_t, K_{t+1})]\}. \end{aligned} \tag{12}$$

- Because a worker with a given K can follow the same search and investment strategy on any job, it is clear that he will switch jobs if $R > R_t$.

Models of Wage Growth - Search + Investment

- Given this reservation value strategy, we can write

$$E\{\max\left[V_{t+1}(R_t, K_{t+1}), V_{t+1}(\tilde{R}_{t+1}, K_{t+1})\right]\} =$$

$$F(R_t)V_{t+1}(R_t, K_{t+1}) + \int_{R_t}^{\infty} V_{t+1}(R, K_{t+1})f(R)dR, \quad (13)$$

where $f(R)$ is the density of wage offers.

- The first-order condition for I_t is now

$$\frac{R_t}{g'(I_t K_t)} = \beta V_{k,t+1}\left(R_t, K_{t+1}\right)$$

$$+ \lambda\beta \int_{R_t}^{\infty} \left(V_{k,t+1}\left(R, K_{t+1}\right) - V_{k,t+1}(R_t, K_{t+1})\right)f(R)dR, \quad (14)$$

where $V_{k,t}$ denotes the partial derivative of $V_t(.,.)$ with respect to K_t.

Models of Wage Growth - Search + Investment

- The interaction between investment and search decisions is captured by the second term in equation (14) which shows that the incentives to invest now include the *capital gains* that the worker obtains if he changes employers.
- The higher K_t, the more one gains from a favorable draw of R; therefore, the incentive to accumulate human capital is stronger.

Models of Wage Growth - Search + Investment

This extended model has the following features:

- As long as the worker stays with the same firm, investment in human capital declines because of the shortened work period.
- On any such interval, the worker invests more than he would without search and a fixed R. This result reflects the upward drift in the R which is inherent in the search model and qualitatively similar to the result in the regular investment model when R rises exogenously.
- Investment drops when the worker switches to a new job with a higher R, because the option of switching to a new job becomes less valuable.

Human capital and skills

- Human capital K is an aggregate that summarizes individual skills in terms of production capacity.
- Different skills are rewarded differentially in different occupations.
- We assume that this aggregate may be represented as

$$\ln K_j = \sum_s \theta_{sj} S_s, \tag{15}$$

  where S_s is the quantity of skill s possessed by the individual and θ_{sj} is a non-negative parameter that represent the contribution of skill s to occupation j.
- Firms reward individual skills indirectly by renting human capital at the market-determined rental rate, R.

- Thus, the parameter θ_{sj} is the proportional increase in earning capacity associated with a unit increase in skill x_s if the individual works in occupation j.
- Having assumed that θ_{sj} is independent of the quantity of skill s possessed by the individual, these coefficients may be viewed as the implicit "prices" (or "rates of return") of skill s in occupation j.

- Because we are interested here in the timing of occupational changes, it will be convenient to set the problem in continuous time.
- We denote by T the duration of the worker's lifetime and by t a point in time in the interval $[0, T]$.
- We define $h_j(t)$ as the portion of available time spent working in occupation j at time t, so that $0 \leq h_j(t) \leq 1$ and $\sum_j h_j(t) = 1$.
- The worker will typically work at one particular occupation in each point in time but is free to switch occupations at any time.
- The worker's earning capacity is

$$Y(t) = R \sum_j h_j(t) K_j(t). \tag{16}$$

- Skills are initially endowed and can then be augmented by acquiring experience.
- We consider here a "learning by doing" technology whereby work at a rate $h_j(t)$ in a particular occupation j augments skill s by $\gamma_{sj} h_j(t)$.
- Thus, the change in skill s at time t is

$$\dot{S}_s = \sum_j \gamma_{sj} h_j(t). \tag{17}$$

- Note the joint production feature of this technology.
- Working in any one occupation j can influence many skills that are useful in other occupations.
- Yet, such experience may be more relevant to some particular skills.
- In this way, we obtain that work experience is transferable but not necessarily general.

- In the static version of this model (the Roy model), individual skills are constant ($\gamma_{sj} = 0$ for all s and j) and the main issue is the mapping between skills and earnings that results from the different occupational choices of workers with different skills.
- The basic principle that applies there is that each individual will spend *all* his work time in the occupation in which his bundle of skills commands the highest reward [see Willis (1986) and Heckman and Honore, 1990].
- Unexpected changes in the prices of skills, θ_{sj}, can cause the worker to switch occupations; however,under static conditions there is no occupational mobility.
- In the dynamic set up that we outline here, skills vary with time, and this variation is influenced by the worker's career choices.
- In such a context, *planned* occupational switches can arise, even in the absence of shocks, if experience is sufficiently transferable across occupations.

- To simplify the exposition, we consider the case of two occupations and two skills and examine the conditions for a single switch.
- Given our simplifying assumptions, the earnings capacity of a worker in different occupations, K_j grows at constant rates that depend on the occupation in which the worker specializes.
- Suppose that the worker switches from occupation 1 to occupation 2 at time x and then stays there for the rest of his life.
- Then, in the early phase, prior to time x, $h_1(t) = 1$ and

$$\begin{aligned} \frac{\dot{K}_1}{K_1} &= \theta_{11}\gamma_{11} + \theta_{21}\gamma_{21} \equiv g_{1,1}, \\ \frac{\dot{K}_2}{K_2} &= \theta_{12}\gamma_{11} + \theta_{22}\gamma_{21} \equiv g_{2,1}. \end{aligned} \tag{18}$$

- In the later phase, after x, $h_2(t) = 1$ and

$$\frac{\dot{K}_1}{K_1} = \theta_{11}\gamma_{12} + \theta_{21}\gamma_{22} \equiv g_{1,2}, \quad (19)$$

$$\frac{\dot{K}_2}{K_2} = \theta_{12}\gamma_{12} + \theta_{22}\gamma_{22} \equiv g_{2,2}.$$

- The expected lifetime earnings of the worker is

$$V(x) = R\{K_1(0)\int_0^x e^{-rt+g_{1,1}t}dt + K_2(0)\int_x^T e^{-rt+g_{2,1}x+g_{2,2}(t-x)}dt\}. \quad (20)$$

- For a switch at time x to be optimal, it is necessary that $V'(x) = 0$ and for $V''(x) < 0$.

- It can be shown that if work experience in each occupation raises the worker's earnings in that same occupation by more than in the alternative occupation (that is, $g_{1,1} > g_{2,1}$ and $g_{2,2} > g_{2,1}$) then $V'(x) = 0$ implies that $V''(x) > 0$, so that the worker will *never* switch occupations.
- Instead, the worker will specialize in one occupation throughout his working life and concentrate all his investments in that occupation (see Weiss, 1971).
- However, some occupations require a preparation period in other occupations, that serve as stepping stones (see Jovanovic and Nyarko, 1997).
- For instance, it is not uncommon that successful managers start as engineers or physicians rather than junior managers.

Specifically, suppose that

$$\gamma_{11} > \gamma_{12}, \quad \gamma_{21} > \gamma_{22}, \quad \theta_{11} < \theta_{12}, \quad \theta_{21} < \theta_{22}. \tag{21}$$

- Then it is easy to verify that, depending on initial conditions, the worker may start in occupation 1 and then switch to occupation 2 because skill 1 is more important in occupation 2, i.e., $\theta_{12} > \theta_{11}$, but occupation 1 is the better place to acquire skill 1, i.e., $\gamma_{11} > \gamma_{12}$.
- It does not pay to specialize in occupation 1 because the worker will not exploit his acquired skills that are more useful in occupation 2.
- Nor is it usually optimal to specialize in occupation 2, because then the worker will not acquire sufficient skills.
- However, a worker with a large endowment of skill 1 or skill 2 may specialize in occupation 2 immediately.

- This model illustrates quite clearly the main features of occupations that serve as stepping stones.
- Basically, these occupations enable the worker to acquire skills that can be used later in other occupations in a cheaper or more effective way.
- Although these jobs pay less for *all* workers with *given* skills, some workers may still enter them as an investment in training.

Unobserved productivity and learning

- A particular worker's productivity may be unknown to the worker and potential employers.
- Over time, the worker's performance is observed; one may use this information to make inferences about the worker's "true" skills.
- This learning process can create negative and positive shocks to the worker's perceived productivity, similar to those discussed above.
- However, the learning model has further implications concerning mobility.
- That is, workers can experiment in an occupation where learning about ability is possible and then, as their abilities are gradually revealed, sort themselves into different occupations, based on their realized performance.

Unobserved productivity and learning

- Let there be two occupations, one low skill, one high skill,
- Two types of workers with low, l, and high ability h.
- All workers perform equally well in the low-skill occupation and produce one unit of output per period, irrespective of ability.
- Workers differ in their ability to perform the required jobs in the high-skill occupation; we denote the expected output, per period of time, as q_l and q_h for the low and high ability workers, respectively.
- However, neither the workers nor their employers know whether a particular worker is of high or low ability.
- The common prior probability that a specific worker is of low ability is denoted by π_0.

Unobserved productivity and learning

- We model the realized output as a simple Bernoulli trials so that q_i is the fixed probability that type i, $i = l, h,$ will produce one unit of output in period t and $1 - q_i$ is the probability that type i will produce nothing in period t.
- Let $n(t)$ be the (random) number of successes that a worker has accumulated up to period t.

Unobserved productivity and learning

- Based on the observed "successes", workers and employers form a posterior on the ability of the worker.
- Specifically, the posterior probability is

$$\pi(t, r) \equiv \Pr\{q = q_l / n(t) = r\} = \frac{\pi_0 q_l^r (1 - q_l)^{t-r}}{\pi_0 q_l^r (1 - q_l)^{t-r} + (1 - \pi_0) q_h^r (1 - q_h)^{t-r}}, \tag{27}$$

and the updated expected output per period is

$$q(t, r) = q_l \pi(t, r) + q_h [1 - \pi(t, r)]. \tag{28}$$

Unobserved productivity and learning

- From (27) it follows that $\pi(t, r)$ rises in t for a given r and declines with r for a given t.
- That is, if a worker did not perform well, a low $n(t)$ up to a given time t, the posterior probability that he is of low ability increases. *In contrast*, if the worker has a favorable record, the posterior probability that he is of high ability increases.
- The perceived (expected) output of the worker is correspondingly modified downwards or upwards.
- With sufficient time, the process reveals the true identity of the worker.

Unobserved productivity and learning

- Consider first the case in which workers are risk-neutral and assume that workers are paid their current perceived output at each point of time.
- Because all workers are ex-ante identical, they will all start at the risky high skill occupation, while attempting to learn their true ability. (low variance)
- As the public information about each worker accumulates, workers are separated in terms of wages and employment.
- Those with inferior performance will receive lower wages and some of them will choose to leave.
- Those with superior records will receive higher wages and will choose to stay.

(Some) Suggestive Evidence on Models

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

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

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.

Mincer's earnings function

- 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.
- This result, that mostly hold under more restrictive specficiation and identification technique, agrees with the model of school investment.

The Variance Covariance Structure of Earnings

- Another important finding in Mincer, 1974, 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.

The Variance Covariance Structure of Earnings

- 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.

The Variance Covariance Structure of Earnings

- 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.

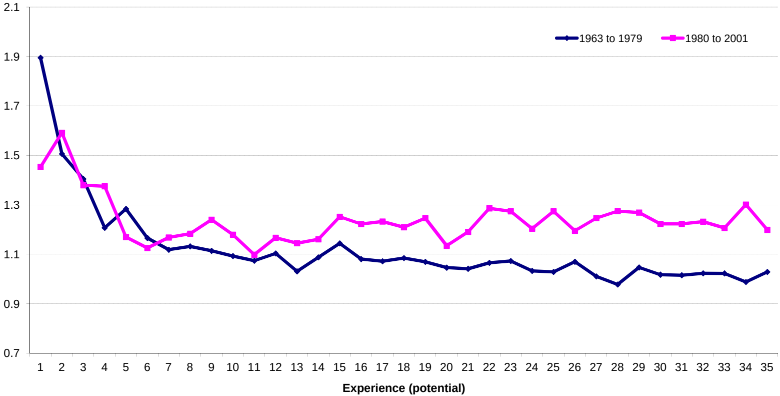

Figure 6: The Gap between White Male Workers Belonging to the 90'th and 10'th Perecntiles of the Residual Log Wage Distribution for the Periods 1963-1979 and 1980-2001, by Education and Experience, March CPS Supplements, 1964 to 2002
Figure 6a: High School Dropouts

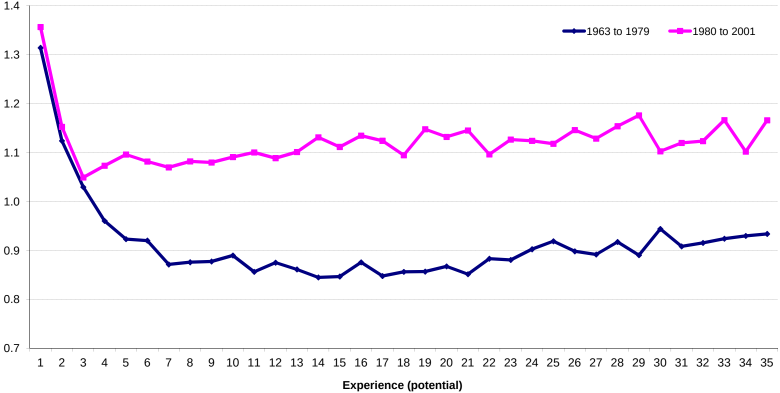

Figure 6: The Gap between White Male Workers Belonging to the 90'th and 10'th Perecntiles of the Residual Log Wage Distribution for the Periods 1963-1979 and 1980-2001, by Education and Experience, March CPS Supplements, 1964 to 2002
Figure 6b: High School Graduates

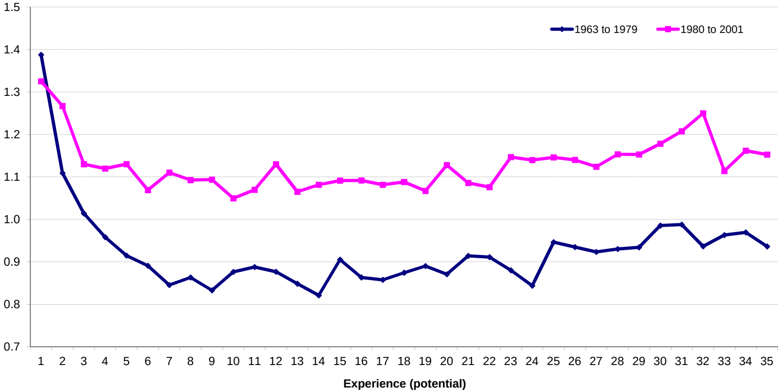

Figure 6: The Gap between White Male Workers Belonging to the 90'th and 10'th Perecntiles of the Residual Log Wage Distribution for the Periods 1963-1979 and 1980-2001, by Education and Experience, March CPS Supplements, 1964 to 2002
Figure 6c: Some College

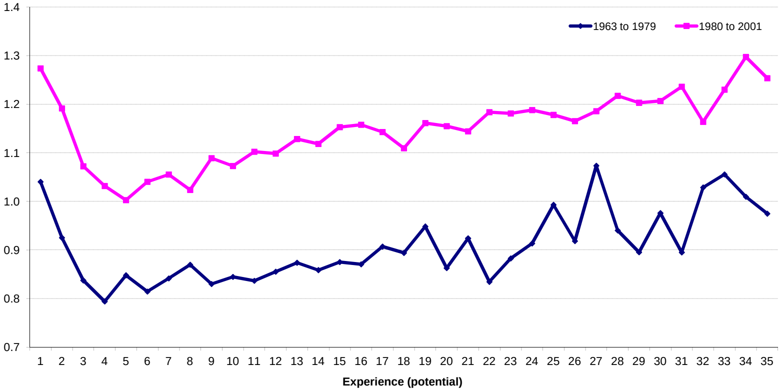

Figure 6: The Gap between White Male Workers Belonging to the 90'th and 10'th Perecntiles of the Residual Log Wage Distribution for the Periods 1963-1979 and 1980-2001, by Education and Experience, March CPS Supplements, 1964 to 2002
Figure 6d: College Graduates

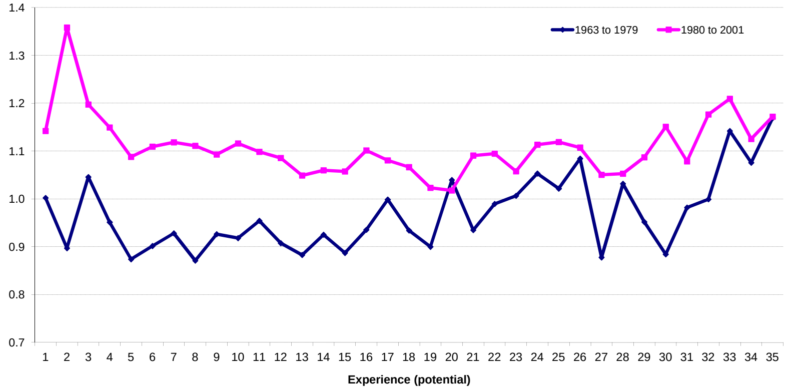

Figure 6: The Gap between White Male Workers Belonging to the 90'th and 10'th Perecntiles of the Residual Log Wage Distribution for the Periods 1963-1979 and 1980-2001, by Education and Experience, March CPS Supplements, 1964 to 2002
Figure 6e: Advanced Degrees

The Variance Covariance Structure of Earnings

- 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.

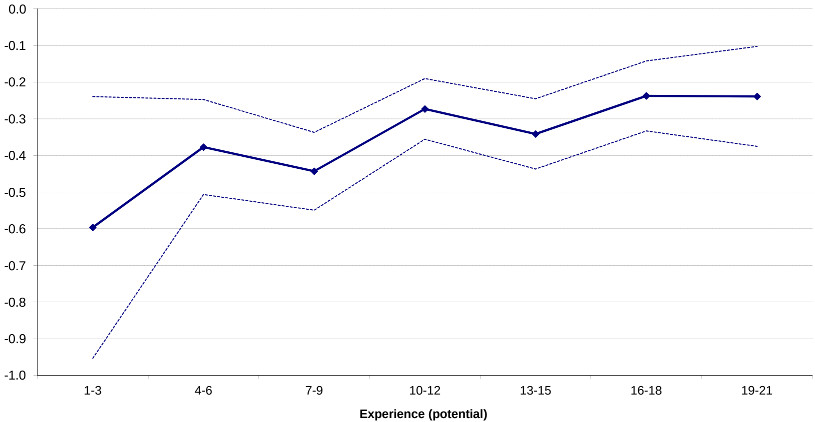

Figure 8: Regression Coefficients and Confidence Intervals of Annual Wage Growth Rates on Log Wage Levels in Prior Period (3 year averages), by Experience and Schooling, NLSY, 1979-2000
Figure 8a: High School Dropouts

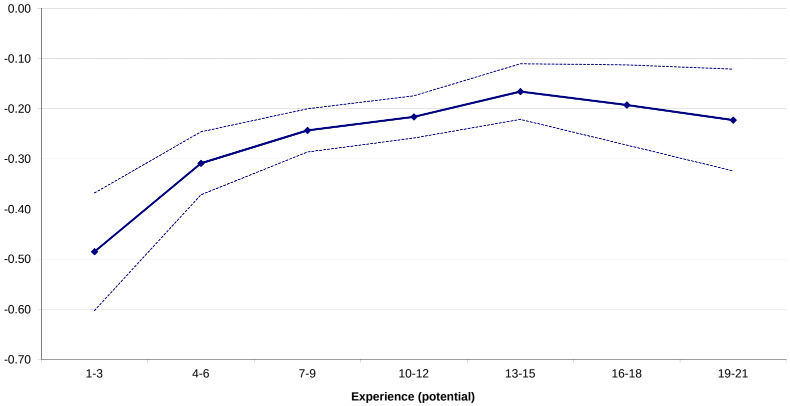

Figure 8: Regression Coefficients and Confidence Intervals of Annual Wage Growth Rates on Log Wage Levels in Prior Period (3 year averages), by Experience and Schooling, NLSY, 1979-2000
Figure 8b: High School Graduates

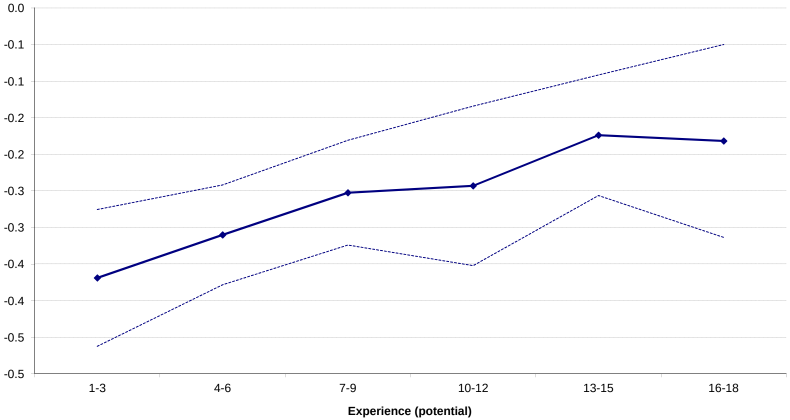

Figure 8: Regression Coefficients and Confidence Intervals of Annual Wage Growth Rates on Log Wage Levels in Prior Period (3 year averages), by Experience and Schooling, NLSY, 1979-2000
Figure 8c: Some College

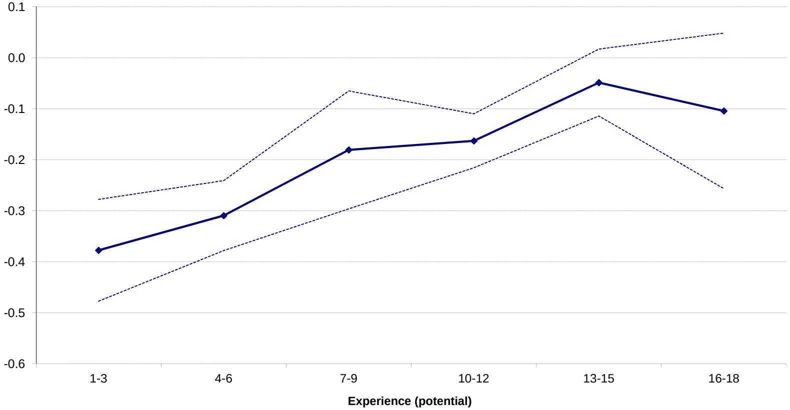

Figure 8: Regression Coefficients and Confidence Intervals of Annual Wage Growth Rates on Log Wage Levels in Prior Period (3 year averages), by Experience and Schooling, NLSY, 1979-2000
Figure 8d: College Graduates

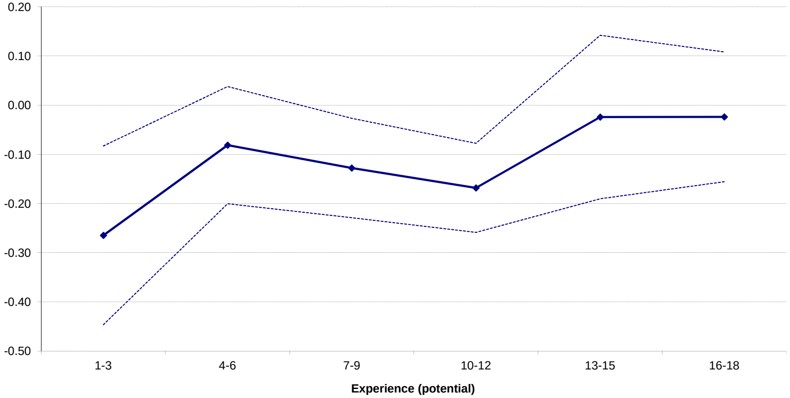

Figure 8: Regression Coefficients and Confidence Intervals of Annual Wage Growth Rates on Log Wage Levels in Prior Period (3 year averages), by Experience and Schooling, NLSY, 1979-2000
Figure 8e: Advanced Degree

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

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

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.
- 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

- 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

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	(0.148)	(0.000)				
10-12	0.024	0.030	0.049	**0.077**		
	(0.534)	(0.266)	(0.067)			
13-15	-0.038	0.037	0.031	-0.230	**0.059**	
	(0.364)	(0.213)	(0.291)	(0.000)		
16-18	-0.058	0.073	0.038	-0.054	-0.243	**0.037**
	(0.227)	(0.032)	(0.250)	(0.067)	(0.000)	

Learning

- 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.

Learning

- 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.

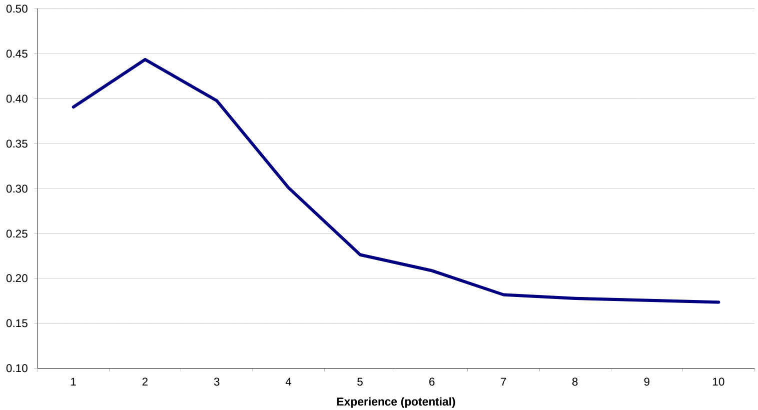

Figure 12: Hazard Function of Separation from Current Employer (in annual terms), NLSY, 1979-2000

- 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.

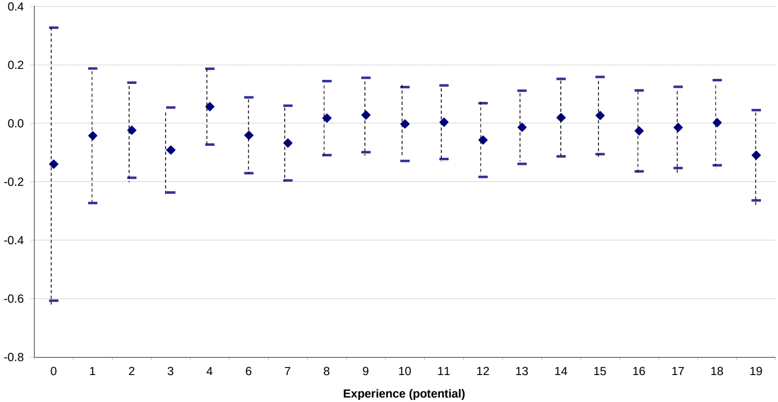

Figure 13: The Effect of AFQT on Log Hourly Wage, by Experience and Education, Point Estimates and Confidence Intervals (Relative to the AFQT Effect at 5 Years of Experience), White Males Working at least 1000 Annual Hours, NLSY, 1979-2000
Figure 13a: High School Dropouts

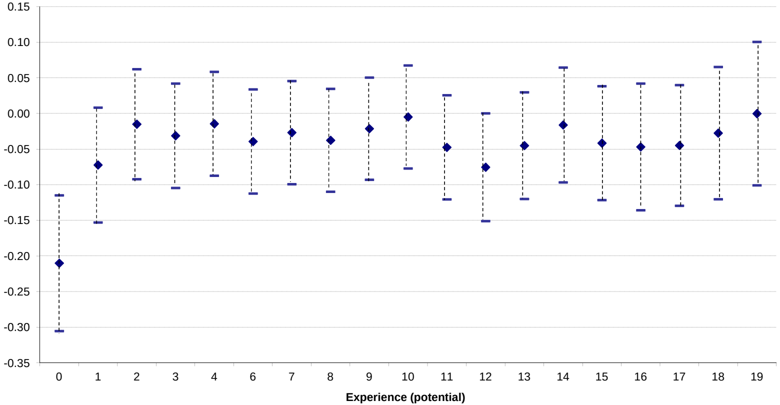

Figure 13: The Effect of AFQT on Log Hourly Wage, by Experience and Education, Point Estimates and Confidence Intervals (Relative to the AFQT Effect at 5 Years of Experience), White Males Working at least 1000 Annual Hours, NLSY, 1979-2000
Figure 13b: High School Graduates

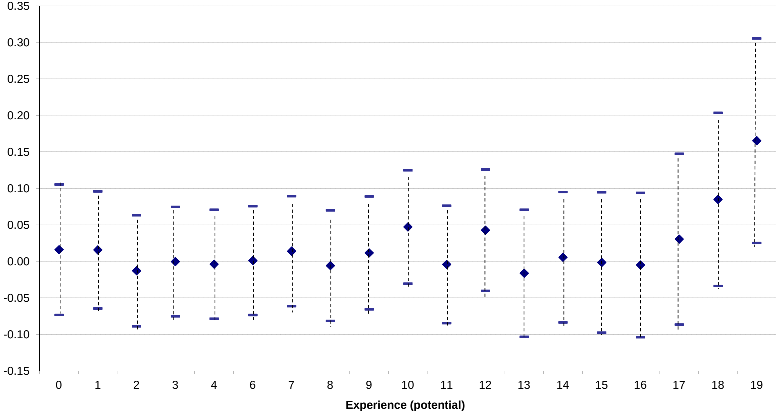

Figure 13: The Effect of AFQT on Log Hourly Wage, by Experience and Education, Point Estimates and Confidence Intervals (Relative to the AFQT Effect at 5 Years of Experience), White Males Working at least 1000 Annual Hours, NLSY, 1979-2000
Figure 13c: Some College

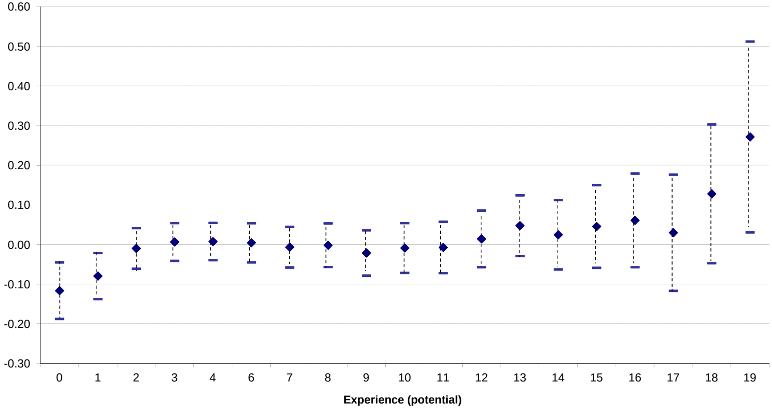

Figure 13: The Effect of AFQT on Log Hourly Wage, by Experience and Education, Point Estimates and Confidence Intervals (Relative to the AFQT Effect at 5 Years of Experience), White Males Working at least 1000 Annual Hours, NLSY, 1979-2000
Figure 13d: College Gradautes and Advanced Degrees

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.

- 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.