Gender Differences in Completed Schooling: An Analysis of Recent Trends *

Kerwin Kofi Charles  
University of Michigan  
e-mail:kcharles@umich.edu  
phone:734.764.8075  

Ming-Ching Luoh  
National Taiwan University  
e-mail:luohm@ccms.ntu.edu.tw  

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1 Introduction

Education has long been among the most intensely studied subjects by economists - a focus which is not surprising given the important role that schooling plays as a determinant of labor force and other important life outcomes. This research effort has taught us much about many aspects of education, but some important questions about the phenomenon have received remarkably little attention. Among these is the important question of how the supply of schooling among adult Americans has changed over the post World War II era. And, whereas casual inspection of the student body at any of the nation’s major universities suggests that major changes may be afoot, virtually no formal analysis of changes in education between men and women over the past thirty years has been done. Nor has there been an effort to systematically identify the reasons for changes in education patterns over time.

In the first part of the work presented below, we describe how levels of education have changed among prime-aged American adults over the past 30 years. We find that completed schooling for adult men and women over age 25 has risen consistently over the past thirty years. And, in every year in since 1962, men over age 25 have completed more years of schooling on average than women. But, these aggregate trends mask several startling facts. First, whereas completed schooling by age 25 for men born in 1940 is about 1 year more than that of women in the same birth year cohort, the gender gap in years of schooling disappears by the 1955 birth year cohort. For subsequent cohorts, adult women have more education that comparably aged men, on average.

Obviously, this convergence has occurred because, relative to women, men have been increasingly less likely over time to attain higher levels of schooling. But perhaps our most surprising finding is that one reason for the gender convergence in completed

\[1\] For example, much is known now about the causal effect of schooling on wages, and the effect of education quality on earnings
schooling is that years of schooling have fallen for men born in cohorts after 1950. This trend is dramatically at odds with another trend which has received substantial attention in the labor economics literature\(^2\) - the rise in the return to education over the past thirty years for both men and women. Presumably, recent generations of adult men and women have either known or suspected that those with more schooling do better in the labor market, on average, at the time that they made their schooling decisions. Increased schooling among women is consistent with this knowledge, but what accounts for the stagnation in completed schooling among men?

In the second part of the paper, we present a model of the demand for schooling by potential students. As in models of education choice such as that by Willis and Rosen and Freeman (**), expectations in our model are shown to play a prominent role in determining individual demand for schooling. But, whereas applications of the standard model of schooling choice focus on the expectations that people form about the average wage premium to be derived from acquiring schooling,\(^3\), we argue that, people should also be interested in forming expectations about the variance of the wage premium around these means. Intuitively, our argument is that looking at the average wage premium says something about what the average college attendant can expect to receive from advanced schooling; to learn what the marginal attendant can expect to receive, the anticipated variance of earnings within education categories has to be accounted for as well. And it is the expected return of this marginal person which should explain trends in completed schooling across.

After summarizing changes across cohorts in the variables which our model suggests ought to affect schooling outcomes, we present results of a set of simple regressions of schooling choice across the different generations of workers we study. We find that the simple model explains education patterns quite well.

\(^2\)Katz and Autor (1999) summarize these changes

\(^3\)footnote here should mention freeman’s paper in the handbook, the paper in econ ed review; and the studies about occupations
In the final part of our paper, we assess whether there has been a more direct connection between the education outcomes for men and women in recent decades. Specifically, we ask whether increased recent advanced school attendance by women might have caused flat or falling advanced schooling outcomes for men. Our theoretical argument hinges on the existence of constraints in the supply of college places. Given these constraints, we argue that increases in the fraction of women who wish to obtain a college education can lead to reductions in the total proportion of men who attend college.  

If all colleges have difficulty expanding the number of spaces that they offer, then the possibility of crowd-out of women by men follows (theoretically) trivially. But, it is almost surely the case that there are at least some colleges which could easily expand to enroll any number of college students who wished to attend them. How can there be crowd-out from college places if there exist such colleges exist? In our model, selective colleges - those which cannot expand easily - have a larger positive effect on student wages than do other institutions. Because of this assumption, increases in the demand for college enrollment by women in such a model can lead not only to a reduction in the number of men attending the selective college, but also to a reduction in the number of men attending college at all.

A prediction of the model is that crowd-out of this type should apply with particular force to men whose are of average ability. Men of the lowest ability are not at risk of being admitted to the selective schools. They are only eligible for admission to the schools which can easily expand so it is irrelevant whether more women want to come to these schools or not. Men of the highest ability are too good to be crowded

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4Constraints in the supply of college spaces can also cause reductions in the proportion of people who attend college when the size of the birth cohort rises for exogenous reasons. Oddly, though some papers, for example Conneley **, and **, have examined the relationship between cohort size and schooling decisions, none emphasizes this most basic effect. Authors have instead focused on the fact that members of idiosyncratically large cohorts anticipate that their wage premium from advanced schooling will be depressed when many members of the cohort enter the workforce. Fewer members of such cohorts decide to get advanced training as a result.
out of selective institutions when more women wish to attend such schools. Medium
ability men are less attractive to admissions officers at selective schools when more
women wish to attend such institutions. And because they are of higher ability than
low quality men, some of these medium ability men would rather attend no school at
all than to go to a non-selective school.

Using data from the High School and Beyond (HSB), the National Longitudinal
Study of Youth and the NELS 88, we test this proposition for generations of men
and women graduating from high school between 1972 and 1988. The notion that
the college attendance rates for men of medium ability should be falling relative to
the attendance rates of eighteen year olds of higher and lower ability over time is
inconsistent with an overall reduction for college attendance on the part of men. As
such, we view such evidence as strongly supportive of our crowd-out hypothesis.

In the next section, we describe changes in completed schooling in the post World
War II era.

2 Post-War Completed Schooling

2.1 Average Education Over Time

To assess changes in education among adults over time, we use information from the
37 (March) Current Population Surveys conducted between 1962 and 1998. As is well
known, each of these surveys is a random sample of the American working-age popu-
lation, and consists of approximately 50,000 observations. In each survey, information
is elicited from every respondent about their age and the level of schooling they have
completed. Our aim is to study the education of prime-aged workers. As such, we
seek to measure education at a point in the life cycle when formal schooling could be
expected to have ended. We also must be on guard against measures which might
overstate the level of schooling that people ultimately complete, such as enrollment
rates in college just after high school which has been used in a few other studies.\textsuperscript{5}

In the U.S. most people graduate from high school at about age 18. Many of those who attend college - which, if attended continuously, lasts for about 4 or 5 years - do so immediately upon or soon after high-school graduation. This means that if the traditional path to higher education is followed, people who will ever graduate from college will have done so by age 23. Of course, many people do not follow this traditional route; people may either stretch out the number of years over which they attend college, or may choose to begin their college education deep into their mature years. Overall, though, it is probably fair to say that the initial college attendance is an activity principally pursued by the young. Recognizing this, while at the same time allowing for non-traditional routes to college attendance, we look at completed schooling by age 25 in most specifications.\textsuperscript{6}

Figure 1 depicts mean years of completed schooling for the population aged 25-65 and 30-65 between the years 1968 and 1998. The figure reveals several interesting things. First, for both men and women, average education among prime-aged adults is high and has been high for some time. Today, average education among prime-aged men and women is substantially above 12 years - the level of education synonymous with only a high-school education - and has been so ever since at least the late 1970’s. Second, for both men and women, mean years of schooling have increased steadily since the late 1960’s among the prime-aged population. For adult women, the year-to-year increase over the past 30 years has occurred at essentially a constant rate. For men, the increase has much more uneven, with an acceleration in the year-to-year rate in the mid-70’s and a slowdown a decade later. Third, throughout the past 30 years, average education among adult men has exceeded that of women in each of the past 30 years. But the figure also shows that within-year gender differential in average schooling

\textsuperscript{5}mention kane and people he mentions in his biblio here
\textsuperscript{6}We also use completed schooling by age 30, and the results are virtually identical in instances where they are comparable.
among adults was quite wide throughout the 1980’s and has narrowed considerably since.

Figure 2 repeats the exercise depicted in Figure 1, but narrows the age range to the adult population aged 30-65. The pattern is quite similar to that shown for ages 25-65. Completed schooling levels are larger (predictably) than the younger sample, but only marginally so. From these figures, it appears that little additional schooling occurs in the late 20’s.

Figure 3 investigates the distribution of education among prime-aged adults over various categories of completed schooling. In the graphs, the people designated as having “any college” are those whose highest level of completed schooling is anything greater than 12 years that completed schooling. “College graduates” are those whose highest level of schooling is exactly a college graduate degree. In the figures, the trends for people with only a high-school education or lower may be deduced from gap between the any-college graph and the x-axis, and the trend for people who have some college education but who have not graduated from the difference between the “college graduate” and “any college” college graphs. The figure shows that the average increase in education among prime-aged adults over the past 30 years has not been solely driven by greater rates of high school completion. The fraction of the adult population with only a high school education has steadily fallen since the 1960’s, and college attendance rates have consistently risen as well. The same basic patterns apply to both men and women.

Given the widespread belief in the positive consequences of greater levels of education, both insofar as the overall effect on society and on the people receiving the higher education, these results are quite reassuring. Not only has education in the United States in the past 30 years exceeded levels in most other societies during the same interval, but there has also been a tendency towards ever higher average levels of completed schooling in the population. But this sense of confidence about the ed-
ucation of American adults may be inappropriate, for these upward trends may mask interesting changes across the generations.

Consider the estimate of the mean level of education in any year for a particular sex. In any year $t$, the mean level of education among adults (men or women) is the weighted average of the mean levels of education across the different birth year cohorts $c$ of all the birth year cohorts present in year $t$, where the weights equal the ratio of $N_c$, the size of the birth year cohort, to $N_t$, the size of the adult population in year $t$. That is,

$$\hat{E}_t = \sum \frac{N_c}{N_t} \hat{E}_t^c \tag{1}$$

where $\hat{E}_t$ is the mean education in year $t$, and $\hat{E}_t^c$ is mean education of a particular birth year cohort, $c$. Changes over time in the education of the adult population can come from either changes in the relative sizes of cohorts in the adult work force as well as from changes in the education choices of successive cohorts. For example, if there is no increase in education across two successive birth year cohorts, but if education among the cohort leaving the adult population (age 65) at a point in time is less than that of the cohort entering the adult population (age 25), we would see average education rise across successive years. Analysis of the components of (1), particularly cohort specific education rates, might reveal better information about trends in education that the movement of the summary measure depicted in Figure 1. We turn to this analysis next.

\subsection{2.2 Education Across The Generations}

People aged 25 in any year might be thought of as entering the adult labor force in that year, while persons aged 65 can be viewed as leaving the labor force in that year. Figure 4 shows the relative education at 25 of the cohorts born after 1936 relative to the schooling of people who were age 65 when the younger cohort entered the adult workforce. Whereas cohorts born in 1936 or later have been consistently better educated than the cohorts who were leaving the labor force when the younger
cohort entered, the advantage has been falling consistently over time for both men and women. This figure partially explains the steady upward trend in average completed schooling in the adult population from year to year, but does not answer questions about gender-specific completed schooling across successive generations.

Figures 5 depicts mean years of completed schooling as of ages 25 for men and women, by birth year cohort for the cohorts born between 1936 and 1972. The figure shows that education for women has been rising consistently across successive cohorts. For men, years of schooling rose for with each successive cohort until about 1948 and then declined absolutely for with each birth year cohort until about 1963, when it leveled off. The combined effect of these changes is that the across cohorts, the gender gap in completed schooling has not only narrowed, but has actually reversed for birth year cohorts after 1960. That education attainment for American men achieved a maximum with the 1948-49 birth year cohort surely runs counter to conventional wisdom, as does the fact that the completed schooling for U.S. women was equal to that of men as far back as the 1956 birth year cohort and has consistently exceeded that of men in each cohort since.

The highest level of education that someone achieves by a given age can fall into five different categories: high school dropout; high graduate; less than 4 years of college; a college graduate; and at least some post-graduate work. How has assignment to these different categories across cohorts account for the trends depicted above? Figures 6 through 8 explore this issue.

Figure 6a shows the fraction of men and women in each birth year cohort who by age 25 have received no college training of any type. This chart might be viewed as summarizing representation in the lowest education categories. Up to the 1950 birth year cohort, a smaller fraction of men were to be found in this lowest education grouping than was true for women, and the fraction of both men and women fell consistently across cohorts. Beginning with the 1950 birth year cohort, there was an upwards turn
in the trend for men which lasted until the 1970 birth cohort. Between the 1948 and 1960 cohorts, the otherwise generally downward trend was constant. As a result, by the cohort born in the mid-1950's, men were more likely than women to have not ever attended college at all by the age 25.

Figure 6b disaggregates the trend in 6a more closely. The figure shows that the increase in the share of men who have never attended college since the 1950 cohort comes mainly from the sharp trend increase - both absolutely and relative to women - in the proportion of men for whom high school graduation was the highest level of schooling completed between the 1949 and 1960 birth year cohorts. In more recent cohorts, the series for high school graduation as the highest level of schooling has moved similarly for men and women. The fraction of men and women who did not graduate high school by age 25 fell consistently, and evenly, for men and women born before 1951. In recent cohorts, the fraction of people in the education category has been constant at slightly over 10 percent for women, while there is evidence of an modest upwards growth for women.

Figures 6 show that a major source of the gender convergence in completed schooling and in the trend reversal in years of completed schooling for men is a result of what is happening at the bottom of the education distribution. A greater fraction of men in each cohort born since the 1940's have stopped their education at the high school level.

Figures 7 analyze what has been happening at the middle levels of education: people who have attended college at least for a while, but who have received no postgraduate training. The differences across cohorts and across the sexes are quite stark. In ever succeeding birth year cohort, a greater fraction of women have college but no post graduate training. For men, there was a trend increase up to the 1949 birth year cohort, at which point it abruptly stopped. The proportion of men who have college but no post graduate training was flat or falling for about 14 birth year cohorts. An
increase has occurred among recent cohorts, but it is has been insufficient to reverse the fact that greater fractions of women in every birth year cohort since 1950 have some college but no post-graduate training. When the trends are broken up into their constituent pieces in Figure 7b, the same basic pattern emerges. Whether we measure the “college but no post-graduate” category by graduation from a 4 year college, or some smaller level of college completion, a greater share of women could be assigned to these categories in every birth year cohort. For men, the increases in both series until the 1950 birth year cohort have been followed by long interval during which the share of men in this “middle” education category has been flat or falling.

Figure 8 is the final figure we present showing completed schooling by cohort. This figure depicts the proportion of men and women in every birth year cohort whose completed schooling by age 25 places them in the highest education category: those who have received at least one year of post-graduate education. Two things are noteworthy in this figure. First, from the two series, it is obvious that the gender gap at this level of education has fallen quite steadily through time. Indeed, whereas it was once as large as 8 percentage points for the 1946 birth year cohort, it vanishes for the most recent birth year cohorts. This convergence at the highest level of schooling is thus another major explanation for the gender convergence in completed years of schooling over time. The second interesting result is that whereas the gender gap has fallen steadily since 1950, the proportions of men and women whose schooling places them in this highest education category has fallen absolutely for both men and women across cohorts.

The falling share of women who belong to this highest education category is particularly striking given the general trend in greater education among women. One possible explanation for this pattern at the highest level of schooling is the falling importance of teaching careers in the lives of women. For men and women in every cohort, we compute the fraction of years spent in the teaching profession among all years spent
working after age 25. These numbers are plotted in Figure 9a. Among all years spent working by women of every education category, there was a precipitous drop in the importance of teaching between the 1948 and 1958 birth year cohorts. The importance of teaching for men has remained essentially unchanged since the 1936 birth year cohort. Figure 9b shows that the historical importance of teaching to women with high levels of completed schooling, and the astounding drop-off in the importance of this career between the 1948 and 1958 birth year cohort. Among women from the 1940 birth year cohort who had more than a college education by age 25, 14% of the years that these women spent working, on average, would be spent as teachers. Given the large number of occupations in the economy this is a very large number. By the 1960 birth year cohort, the fraction of their working years spent as teachers had fallen by 700 percent!

The two figures suggest that whereas teaching was one of the few occupations open to women from earlier birth year cohorts, that condition changed radically for women from more recent cohorts. Educated women moved in larger numbers into those new careers - most of which did not require the very high levels of education that traditional teaching careers demanded.

The various figures in this section show that there has been a dramatic increase in the relative education of women to men across birth year cohorts. This convergence has occurred at every level of schooling: low, middle and high. The trends within a specific gender are of independent interest. Why was there the downturn in college attendance for men? What forces were acting on men and women differently? Are these trends consistent with changes in the returns to schooling over the past forty years? Can a traditional story of the demand for human capital explain the changes? And, is there any direct relationship between the two sets of series? We turn to these questions in the following sections.
3 The Demand for Advanced Schooling

As before, let a person’s birth year cohort be denoted $c$. Suppose that life beyond age 18 can be separated into two intervals. We call the ages 18-25 be the “advanced schooling years” in an individual’s life cycle. The index $S^c$ in what follows will refer to the calendar years that cohort $c$ spends in the advanced schooling years. $M^c$ will represent the calendar years that span the interval during which persons born in year $c$ are between 26 and 64.

During the years $S^c$ members of cohort $c$ decide whether to get advanced training, which is we can think of as education beyond high school. Suppose that advanced training lasts for a period of $g$ years. If the direct costs are $D_t$ in any period $t$, then people in cohort $c$ who decide to get higher education pay

$$g \bar{D}_c$$

in direct education costs, where $\bar{D}_c$ is the average annual direct cost of obtaining training in the years $S^c$. We suppose as well that there are certain psychic costs of obtaining advanced schooling, and we denote these

$$c(\epsilon_i).$$

The parameter $\epsilon_i$ is a measure of an individual’s ability. We suppose that ability is distributed Standard Normal for both men and women in every cohort. It is useful to think of this “ability” as something like the intellectual difficulty that an individual faces in doing advanced academic work. Alternatively, it might measure something like the ease with which people grasp any new concept. We assume that the psychic costs of advanced training are a decreasing function of ability. That is,

$$c'(\epsilon) < 0.$$  

Also, let

$$c(-\infty) = \infty; \quad c(\infty) = 0.$$
Earnings during the mature years are a function of the education received earlier in life. Suppose that an individual worker from birth cohort $c$ who decides to get no advanced training receives average log wages of $a_{sc}^c$ and $a_{mc}^c$, during his advanced schooling years and mature working years, respectively. And, suppose that he would receive average log wages during his work life of $B_{sc}^c$ if he got advanced training. Then, we can immediately write down that the person will get an advanced education if and only if,

$$c(\epsilon_i) \leq E_{Sc}^i \left\{ (B_{yc}^{ic} - a_{yc}^{ic}) \mid I_c \right\} - g\left( \bar{\pi}_{jc} + \bar{D}_c \right).$$

On the left hand side of (6) are the costs psychic costs of schooling. The second term on the right hand side of the expression is the cohort-specific opportunity cost of getting advanced education. By assumption, this does not vary across the individuals in a population. It consists, in part, of wages forgone because of time that would be spent in school, and the direct costs of schooling. The expression $B_{yc}^{ic} - a_{yc}^{ic}$ in the first term on the right hand side is the actual individual return that the decision-maker will receive by getting an advanced education. This actual return accrues in the future from the perspective of the time the schooling decision is made. Moreover, it can be expected to vary across the different people in a population. Because of this inherent and fundamental uncertainty, the actual returns people receive will not drive their investment decisions; instead, their expectations of these returns will matter. $E_{Sc}^i$ is an conditional expectations operation, and refers to expectations that an individual forms during his schooling years. (No expectations are taken over the direct costs of schooling for we presume that when people decide to get training all of these costs are known.) Expectations about the future are formed conditional on the any information available to members of cohort $c$, $I_c$, which might assist them in making inferences about the wages they are likely to receive in the future from different education choices.

To summarize the uncertainty which characterizes future earnings, we suppose that if all persons in cohort $c$ got no advanced training, average log earnings would be dis-
tributed Normal with means $\mu_c^c$ and variance $\sigma^2_{\alpha_c}$. Similarly, if all workers in a cohort got advanced training, average log earnings during the work life would be distributed Normal with mean $\mu^B_c$ and variance $\sigma^2_{\alpha^B_c}$. Note that because they are in school, people who get educated earn nothing during the schooling years. We argue that, at a minimum, the information set of decision-makers in cohort $c$ will include information about the likely means of the two relevant distributions of log wages. After all, at the time they make their schooling decisions, people observe the earnings of people who are working adults during these years, and know, on average what adults with different levels of schooling are earnings during the years $S^c$. If these averages change slowly over time, then a good approximation of the average future wages that one might receive in the future with different levels of education should be average of the wages that people with different levels of education are receiving right now. Thus, if $\bar{Y}_{\text{ce}}$ is the mean earnings that adults with education type $e$ receive during the calendar years $S^c$:

$$E_{S^c}^i \{ \mu_{B_e} | I_c \} = \bar{Y}_{cB} + u_1 \text{ and } E_{S^c}^i \{ \mu_{a_e} | I_c \} = \bar{Y}_{ca} + u_2.$$  \hspace{1cm} (7)

The errors $u_1$ and $u_2$ derive from several possible sources. Of these, one of pre-eminent importance is the fact that circumstances change over time, so that what prevailed in the past will not prevail in the future exactly, even if things change slowly. Another is that the observed wage distribution is the result of choices made by people in previous generations, derives from choices made by people in the past. This means that selection bias and errors of judgment are likely to cause a difference between observed wages of one generation and actual wages of one which follows it. We suppress these considerations and suppose that these errors are mean-zero.

If this is all that the information set consists of, people can be expected to form the conditional expectation

$$E_{S^c}^i \{ (P_{Y_e}^c - a_{Y_e}^c) \mid \cdot \} = \bar{Y}_{cB} - \bar{Y}_{ca}.$$ \hspace{1cm} (8)
That is, people's decisions under this most basic formulation of the information set are driven by differences over time in the anticipated wage premium. Many models of the demand for education have not written down formal models of the choice, but a structure of this form is implicit in the approach taken by authors. For example, Kane (***) looks at changes in college attendance rates for blacks and whites over time, and relates these changes to the variation is a version of the premium presented in (8). Similarly, ** and ** (**check rons text for the cite***) examine the college enrollment rates of successive generations of recent high school graduates over time. A key explanatory variable in their paper is the wage premium received by older workers at the time the high school students are making their decision. Finally, Averett and Burton (1996) apply the same well-established methodology to relate the college attendance patterns for men and women to the changes in a form of the average college premium given by (8).

Intuitively, it does not seem quite right that the only relevant moments which a decision-maker would wish to estimate about the future distribution of the log high school and the log college wage are the means of those two distributions. A moment’s reflection is enough to establish if all the other parameters laid out in the model stayed the same, the anticipated variances of the two future log wage distributions ought to matter in determining college attendance as well. After all, a statistic such the average log wage premium in (7) reflects merely what the average person can expect to receive by going to college rather than stopping his education at high school; is says virtually nothing about what the marginal person can expect to receive. And it is the return that this marginal person anticipates that should explain advanced training choices over time. We argue that estimates of this marginal return should, under certain basic assumptions, depend crucially on the variances of the various distributions.

The inadequate explanatory power of the estimated average log wage return to college is illustrated by Figures 10a and 10b. Notice that for both men and women, the
average log wage return as calculated by (8) has been rising steadily and dramatically across successive cohorts. At the same time, college attendance rates have been flat for women and flat or falling for men. Unless the influence of other factors are the source of the trends depicted in the earlier sections, then using there are clearly problems with relying on the average log wage premium as the driving labor market consideration. In fact, figures 11a and 11b show that the alternative wage has been moving in such as fashion as to make greater college attendance unquestionably more attractive. And, whereas tuition costs have risen pretty consistently over time, these presumably apply with equal force to men and women. Why would the marginal effect of greater tuition costs be towards greater college attendance for one sex, but falling (or flat) rates for another?

In our analysis, we assume that the information set, \( I_c \) consists of more than information about the likely average of the log wage distributions. First, we suppose that

\[
E_{S^c} \{ \sigma_{cB}^2 \mid I_c \} = \overline{\sigma}_{cB} + u_3 \quad \text{and} \quad E_{S^c} \{ \sigma_{ca}^2 \mid I_c \} = \overline{\sigma}_{ca} + u_4. \tag{9}
\]

where \( \overline{\sigma}_{cB} \) and \( \overline{\sigma}_{ca} \) are the variances of log wages during the years \( S^c \) of mature workers with and without advanced education, respectively. That is, people have information which should enable them to imperfectly predict the variance of the log wages distributions that different education choices will cause them to sample from in the future. The terms \( u_3 \) and \( u_4 \) reflect selection bias, truncation and other possible errors, and as was true for the errors which apply to the expectations about the means, we ignore these errors in all that follows. Our second assumption is that every individual knows his ability \( \epsilon_i \) exactly. Thus, the information set that an individual in a given cohort has at the time that he makes his advanced schooling decision is

\[
I_c = [\overline{Y}_{cB}; \overline{Y}_{ca}; \overline{\sigma}_{cB}; \overline{\sigma}_{ca}; \epsilon_i]. \tag{10}
\]

Since the three random variables \( B_i, a_i, \) and \( \epsilon_i \) distributed jointly Normal, we know
that the random variable $(B_i - a_i|\epsilon_i)$ is distributed Normal with mean

$$
\mu_{B_i} - \mu_{a_i} + \epsilon_i \left( \rho_B \sigma_{cB} - \rho_a \sigma_{ca} \right) = F(\epsilon).
$$

The parameters $\rho_B$ and $\rho_a$ are the correlation coefficients between ability and educated and uneducated log wages, respectively. Since in every education group, more able people may be expected to be more productive in the labor market, we assume that $\rho_B > 0$ and $\rho_a > 0$. We assume as well that

$$
\rho_B \sigma_{cB} - \rho_a \sigma_{ca} B > 0.
$$

This assumption says that the actual productive benefit derived from advanced schooling is an increasing function of ability: training is assumed complementary with talent in other words.

Considering what people have in their information sets at the time that they make their advanced schooling decisions, it is easy to see from (11) and (12) that the best estimate of their likely individual return from getting advanced training is

$$
E^*_{s^*} [B_i - a_i|L_i] = \overline{Y}_{cB} - \overline{Y}_{ca} + \epsilon_i g \left( \overline{V}_{cB}, \overline{V}_{ca} \right) = F(\epsilon)
$$

where

$$
g(\ldots) > 0; \quad \frac{\delta g}{\delta \overline{V}_{cB}} > 0; \quad \frac{\delta g}{\delta \overline{V}_{ca}} < 0.
$$

The marginal college attendant in a cohort is that individual who is exactly indifferent between getting advanced education and not doing so. Since people can be sorted according to their ability, we define this marginal person in terms of his ability. Ignoring the effect of the direct and opportunity costs of schooling, the (ability of the) marginal college attendant will be given implicitly as the solution to

$$
F(\epsilon^*_c) - c(\epsilon^*_c) \equiv 0
$$

17
Let $P_c = \overline{Y_{cB}} - \overline{Y_{ca}}$. Since

$$\frac{\delta F}{\delta e^*_c} = g(V_{cB}, V_{ca}) - c'(e^*_c) > 0$$  \hspace{1cm} (16)

by the straightforward invocation of the implicit function rule, it follows that

$$\frac{\delta e^*_c}{\delta P_c} < 0. \hspace{1cm} (17)$$

Also,

$$\frac{\delta e^*_c}{\delta V_{cB}} \begin{cases} < 0 & \text{if } e^*_c > 0 \\ > 0 & \text{if } e^*_c < 0 \end{cases} \hspace{1cm} (18)$$

and

$$\frac{\delta e^*_c}{\delta V_{ca}} \begin{cases} < 0 & \text{if } e^*_c < 0 \\ > 0 & \text{if } e^*_c > 0 \end{cases} \hspace{1cm} (19)$$

Recall that $\epsilon$ is assumed to be distributed Standard Normal. So $\epsilon = 0$ represents the person whose ability places him exactly at the mean.

Since $e^*_c$ is the ability of the marginal college attendant in a cohort, and since the gain from attending college is strictly increasing in ability, we know that the proportion of people getting advanced training in a cohort, $S_c$, is given by

$$S_c = 1 - \Phi(e^*_c). \hspace{1cm} (20)$$

where $\Phi$ is the cumulative density of the Standard Normal distribution. Changes in $e^*_c$ caused by a change in any arbitrary parameter $x$ have a marginal effect on $S_c$ of

$$-\frac{\delta e^*_c}{\delta x} \phi(e^*_c), \hspace{1cm} (21)$$

where $\phi$ is the marginal density of the Standard Normal distribution. It follows straightforwardly that

$$\frac{\delta S_c}{\delta P_c} > 0.$$
\[
\frac{\delta S_c}{\delta V_{eB}} > 0 \text{ if and only if } \epsilon_c^* < 0
\]

\[
\frac{\delta S_c}{\delta V_{ca}} > 0 \text{ if and only if } \epsilon_c^* < 0
\] (22)

Graph 1 summarizes our model. The line $AA'$ plots the returns which the different people in a birth year cohort could anticipate receiving when they make their decisions whether to invest in higher education. People of average ability - those for whom $\epsilon_i = 0$ - expect to receive the average log wage premium. But this is not the return that everyone expects to receive. People of above average ability expect more than this average return; those of below-average ability expect to receive less than the average return $P_c$. The two downwards-sloping curves reflect the psychic costs of attending school which vary with ability. People who attend college are those for whom costs are less than their expected returns. The marginal college attendant is determined by the intersection of the cost and anticipated return schedules. With cost function $C_1$ and the anticipated return schedule $AA'$, this marginal person is $E_2$, and share of the cohort who get advanced training is indicated by the horizontal arrow.

An increase in the average log wage return may be depicted by a shift of the expected return schedule from $AA'$ to $BB'$. Our model suggests that the slopes of these two lines are the same. Notice that irrespective of where the cost schedule cut the original original anticipated return schedule, an increase in the average log wage premium will cause the proportion of people obtaining advanced education to increase.

If there is a ceteris paribus increase in the anticipated variance of wages of college educated labor, then the anticipated return schedule rotates from $AA'$ to $CC'$. An anticipated mean-preserving increase in the variance of the log wages of college educated workers does not change the return that someone who is of exactly average ability expects to receive from advanced education. But every above-average person should see expect greater returns from schooling than the did before, with the most able people expecting the greatest increase in their gains. People who are below average should
now expect to receive smaller returns from getting trained. These two effects explain the rotation of the anticipated return schedule.

A rotation of this type has an effect on the proportion of people which depends on the fraction of the population who were originally obtaining higher education. Suppose that only above-average ability people were already getting higher educations, so that the original equilibrium was at a position such as \( F \). Then, since an increase in anticipated variance of future college wages raises the wages of all above-average ability people, some high ability people who did not previously wish to get an advanced education will now find it worth their while. Thus, the proportion of people attending college should rise, as the change in the equilibrium from \( F \) to \( FF \) indicates.

If, on the other hand, the original equilibrium were at a point such as \( E \), so that even some low ability people selected to get higher education, then an anticipated increase in the variance of college wages would lead to a reduction in the share of a birth year cohort getting advanced education. The returns for high ability people rises with a rotation in the anticipated return schedule, but all high ability people were getting advanced education already so there is no increase in schooling among them. At the same time, some below-average people who previously got an advanced education will forego that option now, so the share of the population getting higher education should fall, and a change in the equilibrium from \( E \) to \( EEE \) shows.

The effect of an increase in the anticipated variance in the log wages of people without advanced training should be the mirror image of those discussed above, so we only present the intuition for one case. Mean-preserving increases in the variance of the wages for uneducated workers means that anticipated returns to advanced schooling should fall for high ability people and rise for high ability people. This type of change is illustrated by a shift in the anticipated return function from \( CC' \) to \( AA' \). If some low ability people initially got advanced schooling, then there should be an increase in the share of the population getting college education. If only high ability people initially
got college education, then the share of the population getting advanced schooling should fall in the new equilibrium.

In the next section, we explore how well our simple model explains cross cohort education outcomes for men and women.

3.1 Changes in the Wage Distribution and Cross-Cohort Education Patterns

3.2 Capacity Constraints in College Services

The attendance rates of either men and women can be analyzed using the framework laid out in the previous subsection. Changes over time in the sex-specific advanced schooling rate can be related to the changes in the two moments of the sex-specific distributions of earnings. Also, differences between the sexes in attendance rates in any particular cohort may partially be explained by differences across the sexes in the sizes of the various parameters in the model.

But the relationship between the advanced schooling rates of men and women may be linked in a much more direct way. Specifically, changes in the advanced schooling rate for one group can cause members of the other group to be crowded out of school opportunities. Changes in the size of birth year cohorts over time can have this effect as well. For crowding to occur, there must be a supply constraint of some type. In this section, we discuss how schooling attendance rates can be affected by the presence of these constraints.

Suppose in what follows that there are two types of schools, $k = 1$ and $k = 2$. College $k = 1$ is selective. We will mean two things by this expression. First, this college only has the capacity to serve a fixed number of students $N_1$ at any time, and suffers no ill consequences for operating at less than full capacity. In general, it will be difficult for any college to expand capacity; new professors must be hired, new courses or majors offered and even new buildings built in order to serve more students. Being
selective means these expansions are more difficult for a prestigious institution, if it is to maintain its high standards. Second, being selective means that college \( k = 2 \) cares very deeply about the average quality of its students. Specifically, we might suppose that college \( k = 2 \) has a utility function which is strictly increasing in the average quality of its students above some level \( \tau \) and is infinitely negative if average ability ever falls below this level. The non-selective institution \( k = 2 \) does not care about the average quality of the student it accepts, and can easily expand its capacity to accommodate all students who apply. Suppose that the problem for the two schools is to set acceptance standards for the students in every cohort. Because of discrimination concerns, neither school can set a standard which is gender specific.

Assume that the minimum ability among the men and women who attend the selective and non-selective school if accepted are respectively, \( \alpha_{mc}^1 \) and \( \alpha_{fc}^1 \), and \( \alpha_{mc}^2 \) and \( \alpha_{fc}^2 \). Let the \( S_c \) be the number of men and the number of women in cohort \( c \); total cohort size is therefore \( 2S_c \).

Given its utility function, the selective college enrolls the best \( N_1 \) students from every birth year cohort who apply. With no loss of generality, suppose that \( N_1 = 1 \). It can be shown very easily that if the selective school rejects some students in every cohort (or, equivalently that there are more students who wish to attend the selective school every cohort than can be accepted), then the min \( [\alpha_{mc}^1, \alpha_{fc}^1] \leq \frac{1}{2S_c} \). It is easy to show that the acceptance standard chosen by the selective college, \( \alpha^*_c \) has the following form:

\[
\alpha^* = \begin{cases} 
\frac{1}{2S_c} & \text{if } \max[\alpha_{mc}^1, \alpha_{fc}^1] \leq \frac{1}{2S_c} \\
\frac{1-a_{mc}^1}{S_c} & \text{if } \alpha_{mc}^1 > \alpha_{fc}^1 \\
\frac{1-a_{fc}^1}{S_c} & \text{if } \alpha_{fc}^1 > \alpha_{mc}^1 
\end{cases}
\] (23)

Given the selective college’s objective function, its first best outcome is the case where it sets its admission standard at \( \frac{1}{2S_c} \); enrolls a study body in each birth year
cohort which is one-half female and one half male; and where the ability of the marginal male and student it accepts both equal \(\frac{1}{2}\); and where, *coincidentally*, half of the selective school’s in every cohort are men and the other hand women. This first best outcome has nothing to do with the selective school’s preferences for gender distribution in the student body. The point is, that given that the distribution of ability is assumed the same across the sexes, if large enough numbers of both men and women want to attend the selective school, the highest average quality is achieved when the marginal male and female entrant are of the same ability.

But this best case scenario occurs in only a very special case. Suppose that very few women - only those of the very highest levels of ability - want to attend the selective college. Then, the selective college will admit all of these women. But doing so will fill less than one-half of its available places. In order to fill capacity, the selective college set a low acceptance standard. This low standard will not affect the number of women who attend: the binding constraint for female students is the low number of women who *want to attend* the selective school. But, the low standard will affect number of male students because so many of them wish to attend. In a sense, these low ability men are able to enter the selective school only because they have no competition. Suppose that the number of women wish to attend school rises. They will be of lower ability than the women who wished to attend previously, but they will be, at the margin, *more qualified* than the low ability men who previous gained admittance. Thus, there can be variation over time in the fraction of students in the selective school who are men which derives completely from the college attendance desires of women. Indeed, the college attendance preferences of men could even rise over successive cohorts and their numbers among the student body still fall, so long as the attendance preferences for women rises by more.

The effect of changes in other parameters may be similarly calculated. Suppose birth cohort size gets bigger. What effect would this have on the gender representation
among accepted students at the selective school? The larger the birth year cohort, then the more people there are of the very highest ability. But the selective college wants to maximize average ability among the students it accepts. This means that it should become more selective about the people it accepts. Retaining the assumption from above that more men than women want to attend school, then the larger cohort size and the consequent increase in admission standards should, ceteris paribus, cause female representation among college students to rise.

In the non-selective school, the enrollment of male and female students in any cohort is determined completely by whether or not these people wish to attend this type of school. By assumption, these schools have no admissions standards.

In equilibrium, there will be three sets of people - those who attend the selective college, those who attend the non-selective college, and those who attend neither. Recall the assumptions that the return to college education is complementary with ability, and that the selective school brings a higher rate of return for a given level of ability. People have three courses of action, and they presumably make pairwise rankings of their different options. Clearly, some people will find the option of attending no college the most preferred option. It is also clear that attending the non-selective school cannot be any individual’s most preferred option since these schools always yield lower payoffs than their selective counterparts. Finally, and most interestingly, there are some people who would rank going to the selective school highest, going to a non-selective school last, and not going to college at all a second best outcome.

To see this, suppose that people earned wages equal to their ability, $\alpha$ if they did not go to school at all; and earned $B_1 \alpha$ and $B_2 \alpha$, where $B_1 > B_2$, by attending the selective and non-selective schools, respectively. Ignore the opportunity costs of lost wages, and assume that all college students pay direct costs of schooling $D$. Since $B_1 > B_2$ no-one prefers the non-selective school to the selective one. People of ability less than $\frac{D}{B_1 - 1}$ rate not going to school at all is their best option. People with abilities
above $\frac{D}{B_1-1}$ rank the selective school as their best choice. And finally, people of ability greater than $\frac{D}{B_2-1}$ rank going to the non-selective school as better than not going to school at all. These points taken together mean that people of ability between $\frac{D}{B_1-1}$ and $\frac{D}{B_2-1}$ rate the selective school as their best option, but rate not going to school at all their second best choice.

An interesting consequence of these pairwise rankings is that when the fraction of women wishing to attend the selective college has been historically low, an increase in that fraction can cause not only a reduction in the share of men who end up attending the selective college, but can even cause the share of men attending any college to fall as well. With historically low female college attendance, we have already argued that the admissions standards will be low at college $k = 1$. This means that some men of ability between $\frac{D}{B_1-1}$ and $\frac{D}{B_2-1}$ will be admitted to the selective school. Now suppose that there is a slight increase in the share of women wishing to attend the selective school. We argued above that the selective school will raise its admission standard slightly. This increase in the admission standard will have no effect on the college decisions of men who previously went to the non-selective school: they could not get into selective schools when standards are low, and standard are now higher. But men whose abilities are slightly above $\frac{D}{B_1-1}$ will now be rejected from selective school. And, as we have already shown that men in this category prefer not going to college at all to going to a non-selective one, the proportion of men attending any college as a result of greater female enrollment should fall.

The simple crowd-out effect in the model exists even though there is a segment of the college industry which can quite easily expand to accommodate the increase in the number of students. Are a number of college which can But will all of these men simply shift over to the non-selective institutions? The natural result because they do not meet the $\frac{\alpha^1_{min} + \alpha^2_{min}}{2}$ between equal to This means that men whose abilities span the interval between some $e$ an increase in the share of women who wish to attend
the selective college might not only cause result. This inequality. Men with abilities in the range \(\alpha_{me}^{1}, \frac{\alpha_{me}^{1}+\alpha_{me}^{2}}{2}\) attend the non-selective school. All men with abilities above \(\frac{\alpha_{me}^{1}+\alpha_{me}^{2}}{2}\) go to the selective school. Now suppose that there is a slight increase in the number of women wishing to attend the selective school. We argued above that the selective school will raise its admission standard slightly. This increase in the admission standard will have no effect on the college decisions of men who previously went to the non-selective school: they could not get into selective schools when standards are low, and standard are now higher. But men whose abilities are slightly above \(\frac{\alpha_{me}^{1}+\alpha_{me}^{2}}{2}\) will now be rejected from selective schools. But will all of these men simply shift over to the non-selective institutions? the natural result because they do not meet the \(\frac{\alpha_{me}^{1}+\alpha_{me}^{2}}{2}\) between equal to This means that men whose abilities span the interval between some e an increase in the share of women who wish to attend the selective college might not only cause result. This inequality student will Under the assumptions in the previous subsection,

If the fraction of people of a given gender who wish to attend the selective school is small, then even when it accepts all of these people, the selective school operates at less than full capacity. To make up capacity, the school will have to set a low acceptance standard. by accepting all of these people, the selective school operates at less than full capacity. To the student body will obviously women and one half men has one half of can set objective function, The selective best admission standard for the

Since \(\frac{\partial \delta}{\partial \alpha^{*}} > 0\), if follows from (13) that the most preferred standard, \(\alpha^{*}\), is strictly increasing in the size of the birth year cohort. Also, the greater the capacity of the selective school, the lower its optimal standard. Even though the selective college has no tastes about the gender composition of its student body, the minimum ability of both the men and women it enrolls in any cohort are both equal to \(\alpha^{*}\) only in very special cases. The people who attend the selective school in any year obviously are those who want to go to that school, but they are also those who are accepted by the
institution.

Suppose, for example, that the
are those whom the selective colleges would accept if they applied, want and those
who would like to go, the number of people observed to be in college in any year will
depend on the parameters , , and . colleges But because colleges are constrained in
their acceptance of students not merely by who they would want to come to their
schools; but also by which people who want to attend college, the number of men and
women from every birth cohort who enter the selective college will not, in general, be
equal to the first best indicated in (1).

Because the college wants to fill capacity, it must always depart from a gender
blind admission standard, except for the special case where the ability of the lowest
ability man who would attend if accepted is exactly equal to the ability of the least
able woman who would attend if accepted, or

In ability in its entering class, given the distribution of ability in the population
students given by Since the distribution among men and women is exactly the same
in any birth cohort, and distribution of ability in the population is Uniform, the first
best outcome for the selective college is to have the ability of the last man and woman
be exactly the same and be equal to

accepts any student who desires to attend, because it can easily expand capacity.
Obviously, this college does not care about average quality.

In the first portion of our empirical work below, we assess the degree to which our
model can explain trends in schooling across cohorts for men and women. The model
presented above presumes that the college market is can be easily expanded to serve
all students in any cohort who wish to attend. We relax this assumption later.

people are making is the individual's rate of return to advanced training in
the year during the young adult years. This return is distributed Normal with mean
\( \mu_{Bt} - \mu_{at} \) and variance \( \sigma^2_{Bt} + \sigma^2_{at} \) under the assumption that college and high school
earnings are independent.

Title College Attendance and the College Wage Premium: Differences by Gender
Author(s)/Editor(s) Averett,-Susan-L. Burton,-Mark-L. Author Affiliation Lafayette College; Lafayette College Source Economics-of-Education-Review; 15(1), February 1996, pages 37-49. Abstract This paper examines gender differences in the decision of whether or not to attend college. We use a human capital model of the decision to attend college, positing that this decision is a function of family background characteristics and the expected future earnings differential between college and high school graduates (the college wage premium). Using data from the NLSY, we demonstrate that for men, the higher the college wage premium, the more likely they are to attend college. However, for women, higher college wage premia have an insignificant effect on the decision to attend college and this effect is robust to a variety of specifications. In addition, we find some support for the comparative advantage hypothesis suggesting that individuals self-select themselves into that level of education which best utilizes their talents.
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