

The Microeconomics of College Choice, Careers, and Wages:

Measuring the Impact of Higher Education

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## Abstract

Understanding the economic payoff to human capital investments is very important from the standpoint both of individuals and of society. Correctly estimating these impacts necessitates having a well-developed idea of the microeconomic determinants of human behavior. Without this, empirical analyses of such topics as career choice, college choice, or wage determination will be flawed. We begin with a discussion of why these choice models are important - using examples of similar attempts that do not capture sufficient information - and illustrate their usefulness in a variety of contexts. We also describe the results of our attempts to examine college choice using microeconomic models.

Microeconomic analyses of educational investment and career choice examine how the influence of personal and family background characteristics, actual and expected market conditions, and economic incentives interact to shape individuals' choices about the sequence of decisions that result in an educational and occupational outcome. Sophisticated analyses of college and career choice at the microeconomic level emphasize the heterogeneity in various respects (academic aptitude, family resources, and so on) of the populations studied and the interactions among these varied characteristics and various opportunities and incentives in producing observed choices.

The underlying conception of behavior in the kinds of microeconomic models we have in mind is longitudinal and sequential. That is, college and career destinations are seen as the result of an individual moving along a path over time. Choices made along the way are influenced by the person's characteristics, which themselves are partly a function of past choices and also partly a function of expectations about future opportunities and alternatives. The facts that these choices are extended over time and that choices at a given time are responsive to the results of past choices and to expectations about the future have crucial implications for empirical modeling strategies in this area.

First, empirical estimation of such models virtually requires the availability of longitudinal data on individuals – that is, observations of the choices made by individuals at various stages in the evolution of their educational and career paths. Second, the complex temporal interdependence of choices made at different times introduces serious complexities in the empirical analysis of such data. Two particular implications should be underscored. First, it is clear in sequential modeling that the alternatives available at time  $t_1$  are dependent on

choices made at an earlier time  $t_0$  -- for example, the decision to go to Julliard for college certainly conditions one's later choice of major. But with this kind of interdependence it becomes very easy to believe that attendance at Julliard has a causal impact on one's likelihood of majoring in piano when in fact it may be that a disposition to major in piano produced both the decision to go to Julliard and the decision to major in piano. In principle, if one could accurately measure the disposition to major in music at, say, age sixteen, one could control for this factor in estimating the impact of Julliard attendance on choice of major. (Equivalently, one could achieve such control by having good measures of all the factors that determine the disposition at age sixteen.) Unfortunately, one is likely to lack complete measures. In that case, the omitted variables that influence both the tendency to go to Julliard and the tendency to major in piano are likely to lead to overestimating the "Julliard" effect on choice of major.

The second, and related, problem is the influence of expected future opportunities on choices at a particular time. Here the essential difficulty is posed by the fact that individuals' characteristics will influence their expectations – a highly talented mathematics student, for example, will expect greater returns from pursuit of a mathematics career than would someone with limited mathematical aptitude. If the researcher possessed a good independent measure of the individual's expectations and of the individual's relevant characteristics, this dependency could be explicitly modeled and would not be problematic. In the absence of such measures, there are great difficulties in sorting out the effects on career choice that operate through influencing earnings expectations from effects that operate in other ways.

The proper analysis of sequential choice in longitudinal data sets remains a difficult

analytical and empirical issue. Fortunately, however, the last twenty years have brought real improvements in our capacity to perform such analyses. Several large longitudinal data sets on individuals, with good information on personal and family characteristics, educational histories and employment histories have been developed with federal support. Over the same period, improved statistical techniques to cope with the temporal interdependence of choices have been developed.

Below, we examine as a case study a career with special significance for a nation's economic future, science and engineering, before turning to a broader discussion of career choice. We then report more briefly on some original empirical results regarding college choice and future wages that result from the type of estimation methods suggested here.

#### Career Choice: The Case of Science and Engineering

Only the foolhardy defend economic models on grounds of their realism. Yet the simplifications inherent in many models of the labor market for scientists and engineers seem particularly unsettling. Many of these models, including some rather influential ones, are almost purely mechanical: with fixed proportions of students grinding through high school, some other fixed proportion grinding through college, some percentage of them going into scientific or engineering careers, some fraction of others going to graduate school and so on. The proven ability of these models to be quite spectacularly and consistently wrong has not been enough to discourage their production.

More sophisticated models recognize the interaction of supply and demand in determining labor market outcomes. Demand increases raise wages and, with a lag, yield an increase in quantity supplied. While it has proved difficult to come up with stable and believable parameters

for such models, they highlight an important adjustment mechanism that is bound to play a role and is almost sure to be important.

Yet even these models overlook or oversimplify aspects of the operation of markets for educated labor that intuitively seem quite important. While the presence of lags in the adjustment process in aggregate supply-demand models recognizes that some rather complicated behavior is taking place, which involves learning and the adjustment of plans, the details of that process are very much behind the scenes.

By contrast, microeconomic models of career choice put these matters of planning, choosing, learning and adjusting at center stage. It is illuminating, we think, to view the process of career choice explicitly as a sequential process, marked by uncertainty at every step. In contrast to aggregate supply- demand models, which tend to suppress recognition of differences in the characteristics of labor market participants, and thus of differential response to changes in external conditions, microeconomic models of career choice highlight the differences in background, aptitude and circumstances and permit the testing of hypotheses about whether these differences matter.

To motivate the following discussion, consider two stories about how the market for some group of scientists -- say microbiologists -- responds to variation in the wages and opportunities in that field. Suppose wages and job opportunities for microbiologists experience a rather abrupt drop, but one which is widely believed to be likely to persist for some years. Imagine that we can successfully categorize potential microbiologists according to ability. The question we want to ask is: how will the relative supply of students to the field of microbiology vary according to the ability of the students?

Scenario I is that the most promising students in microbiology have a real passion for the subject and feel something of a calling to it. In more prosaic terms, we might say that their relative advantages as microbiologists, compared to their prospects in other fields, are quite high. In this scenario, most of the top quality students stick with microbiology while the poorer wages and job prospects scare the less promising students away. Most of the decline in entry of microbiologists to the profession occurs at the low end in terms of quality, with the result that the average quality of microbiologists actually rises as total numbers fall.

Scenario II reverses this. Top microbiology students have excellent alternatives and can with relative ease and little sacrifice migrate from microbiology to other fields of study, such as law or banking. Less capable students, although subject to the same pressures, face less good alternatives and are, on the margin, less likely to leave the field. As a result, the average quality of entering microbiologists falls with declining demand. The economic and social significance of a decline in the number of entering microbiologists is likely to be quite different depending on which of these scenarios would prevail.

The issue raised by these two stories illustrates one class of questions that is naturally studied under the rubric of the microeconomics of career choice. In general, models of science and engineering labor markets, particularly those that aim at forecasting or policy analysis, completely neglect the kinds of considerations suggested by these stories. Here we raise the following question: can insights and evidence from the microeconomic analysis of career choice be used effectively to improve the usefulness of forecasts and policy analyses of markets for educated labor in science and engineering?

Recent controversies have focused considerable attention on the adequacy of current

models of science and engineering labor markets. In the late 1980s, the National Science Foundation (NSF) produced forecasts of substantial "shortfalls" of scientists and engineers at both bachelors and advanced levels through the 1990s and beyond. Although the producers of these analyses introduced various qualifications into their analyses, policy advocates both inside and outside NSF relied on these forecasts in arguing for programs that would increase the number of scientists and engineers in coming years.

In the last several years, a variety of circumstances have resulted in substantial declines in the demand for scientists and engineers, leading many observers to conclude that the nation faces a surplus instead of a shortfall of qualified science and engineering personnel. Congressional hearings have focused on the inadequacies of the NSF modeling efforts, and substantial efforts have been undertaken to produce more adequate models.

Some of the limitations of existing models lie on the demand side. The controversial NSF models, for example, measure demand for new scientists and engineers simply as the number of newly produced scientists and engineers in a benchmark period which is judged to be one of rough supply-demand balance. Whether or not the number of science and engineering personnel produced in that year could be taken as a good measure of demand in that year, it is certainly quite arbitrary to suppose that the same level of production would be suitable in other years. An adequate model of demand would need to take into account the influence of underlying economic factors, such as changes in the industrial mix and changes in technology, on demand for scientists and engineers.

More directly pertinent to issues of career choice are limitations on the treatment of supply in existing models. The NSF model derives a supply of new college graduates by applying a

coefficient to the size of the college-age population. This coefficient is determined judgmentally on the basis of recent experience; the model does not make the coefficient sensitive to variation in the supply-demand balance. The yield of scientists and engineers from the college graduate pool is similarly determined by a judgmental coefficient, which again is not sensitive to supply-demand consideration. Wages are not included in the model.

Many other models of science and engineering labor markets share major characteristics with the NSF model, although some are more elaborate in various ways. Thus, some models disaggregate fields within science and engineering more finely; some recognize more stages in the educational "pipeline" – introducing a separate step from college entry to college completion, for example.

Perhaps the most significant departure from the NSF type of model is found in those models that explicitly incorporate feedback between supply and demand. Richard Freeman has contributed a number of studies for various markets for educated labor which explicitly model lagged wage adjustments and lagged responses of supply and demand to changes in wages as part of the adjustment process. Other analysts have produced models in which an adjustment of supply to demand is assumed to occur, but without explicitly incorporating wages or other mediating variables into the analysis.

It is a controversial question whether these simple aggregate models, whether or not they incorporate lagged adjustment processes, can capture enough of reality to shed light on likely future developments in science and engineering labor markets. There cannot, however, be much doubt that these analyses fall woefully short of allowing analysts to assess the effects of various policy issues that are brought forward in response to diagnoses of shortages or surpluses in these

labor markets.

Consider, for example, the influential analyses of the market for scientists and engineers published by Richard Atkinson (1990, 1988) almost a decade ago. Atkinson cited the NSF forecasts of shortfalls in scientists and engineers in making a case for increased support for the education of people in those fields. Yet both the nature of the problem as he diagnosed it and the policies he advocated in response to the shortfall assumed knowledge of behavioral relationships that are not included in typical aggregate models of these labor markets. He argued, for example, on the basis of evidence which is not integrated into these aggregate models, that the majority of the interested and qualified students who are "lost" to science and engineering between their freshman and senior years of college switch to other areas because they find other fields more promising and believe they would have better job prospects elsewhere. He emphasized the importance for policy purposes of interesting women and minorities in scientific and engineering careers, while the aggregate models shed little light on how determinants of the decision to enter science or engineering differ among race and gender groups.

Atkinson's policy proposals also presupposed facts about behavioral responses that are not explored in typical supply- demand models. He proposed in particular that increases in fellowship opportunities, especially when targeted at women and minorities, would elicit a strong supply response.

A second set of issues which figures prominently in policy discussions but is largely absent from modeling efforts is the matter of quality of scientists and engineers. It is commonly alleged, with at least some empirical support, that the quality of students in undergraduate engineering programs fluctuates sharply with fluctuations in the state of the engineering labor

market. When the market is strong, both the numbers and quality of engineering students rise, with the rise in quality being due partly to the interest of more able students in engineering and partly to engineering departments in universities rationing access to their programs by quality. Although the relation between "quality" as measured by conventional academic standards and "quality" as measured by workplace performance is by no means clear, it seems plausible to many observers that fluctuations in the academic quality of persons entering the science and engineering professions matter significantly to productivity. In the limited context of research science, for example, Levin and Stephan (1991) have argued that absence of growth in the publication productivity of recent cohorts of scientists, despite the fact that they have a larger knowledge base to work with, may reveal a decline in the quality of the research personnel. They speculate that such a decline might be related to the relatively weak labor market for academic scientists and engineers in recent times.

The quality issue assumes added importance in policy discussions for two reasons. First, it seems quite plausible that at the margin adjustments in the employment of scientists and engineers occur through quality. It is less likely that jobs will go unfilled than that they will be filled by less qualified personnel -- a fact that has been shown strikingly in the case of high school teachers of science and mathematics. Second, programs to recruit students to science and engineering are often very quality oriented, as is the case with fellowship programs of the kind Atkinson advocates. The issue is generally not only one of attracting enough students or workers, but of attracting the right students and workers -- and this is an issue which aggregate models of supply and demand barely address at all.

Can Microeconomic Analysis of Career Choice Help?

We suggest four categories of questions where aggregate models of supply and demand quickly run into severe difficulties:

(1) How large is the response of individuals to changes in the incentives for pursuing particular career paths? Incentives may include scholarships and fellowships, expected earnings, expected risks of unemployment and the like. The impact of incentives may vary at different points in the career path. Once a student has chosen to attend a technical institute like Cal Tech for college, for example, he or she may be unlikely to become discouraged about pursuing a science/engineering career. Yet the decision for a student with particular characteristics to attend such an institution in the first place may well be more strongly influenced by incentives.

(2) How do responses to incentives vary among students with differing characteristics? Are students with strong mathematical aptitudes more or less sensitive to fluctuation in science/engineering wage rates than those with weaker aptitudes?

(3) How do various social and economic background characteristics influence persons' interests in science and engineering?

(4) What is the interaction between these background characteristics and incentives to pursue careers in science and engineering? For example, are students from low-income families more likely to be influenced by fellowship opportunities in their choice of majors and careers? An affirmative action would provide a reason for aiming to target fellowship money on such students.

It should be clear enough that aggregate supply and demand models are very limited in their ability to respond to these questions. Some worthwhile evidence about responses to wages and labor market conditions can be obtained from time-series models that incorporate response

lags. Such studies are bound to be handicapped, however, by the limited number of observations available in the time-series, and the confounding effects of other economic and social changes that are correlated with the labor market variables of interest.

To push further with aggregate time-series models, by trying to detect effects of changes in fellowship or financial aid policies or by examining differential responsiveness to wage changes among different population groups, is almost certainly too ambitious. Convincing analyses of differential behavior of different population groups is similarly very difficult to achieve in the time-series context.

Do we have reason to believe that micro data sets and the kind of longitudinal analysis described earlier can do better? Plainly the best way to answer this question affirmatively is to do the analyses and demonstrate their effectiveness. Still, there may be some purpose to trying to describe the reasons why conceptually this approach seems to hold promise.

The first point to emphasize is that it is very plausible to believe that behavioral responses vary importantly both at different stages of the life cycle and across groups with different characteristics. This variation is important in its own right, we have suggested, for policy purposes, but it also suggests advantages to the use of micro data sets. Time-series analyses will inevitably require aggregating over people with quite different characteristics and collapsing different segments of the sequential career path. Such aggregation is certain to add to the imprecision of estimated behavioral effects and can easily lead to biases.

A sequential approach, by contrast, makes it possible to design the model so as to permit the extent of behavioral response to, say, expected wages, to vary along the career path -- affecting the decision to go to college, the choice of major, the decision to complete, and so on

in potentially different ways.

Similarly an analysis based on micro data can make explicit the possibility that men and women or people of different ethnic, social or economic backgrounds may respond differently to differences in the incentives they face. The opportunity to study interactions between people's characteristics and their response to variations in expected wages adds an important dimension to what can be learned from aggregate studies.

In the following two sections, we report briefly on studies we have undertaken that apply the kind of sequential microeconomic analysis here to questions about college choice and about the impact of college attendance on wages.

#### Microeconomic Analysis of College Choice

There is a large literature concerning college attendance decisions. These decisions are naturally thought to be influenced strongly by family background. But previous studies of the impact of family background on college attendance generally suffer from the selectivity problem we have described previously: if they include high school achievement as a determinant of college choice, they treat it as predetermined in a statistical sense rather than determined in part by observed and unobserved components of family background as part of a longer- run educational strategy. But family background may affect college decisions indirectly through effects on high school achievement as well as having direct effects. Previous estimates, by treating high school achievement as predetermined, may be biased and are not informative about the importance of direct versus indirect effects of family background.

In Behrman, Kletzer, McPherson and Schapiro (1995), we show statistically that high school achievement is determined jointly with college investment decisions: that is, student's

decisions about working to achieve in high school are influenced by their college ambitions. We find evidence that high school achievement depends on many of the same background variables that influence college educational investments and that failure to account for this interdependence leads one mistakenly to attribute part of the effect of high school achievement to family background variables that influence achievement levels. Thus, treatment of high school achievement as an endogenous component of a longer- run educational strategy rather than as predetermined has substantial effects on the estimated magnitudes of some responses of interest and permits the identification of direct versus indirect effects of family background.

Another improvement on the existing literature is that we focus on qualitative differences among colleges rather than merely on the quantitative nature of college choice (enrollment in two-year versus four-year schools, for example). School quality variations are large among four-year colleges and universities and appear to affect post-schooling outcomes. Studies that focus exclusively on the quantitative aspect of college choices miss the important qualitative dimension of those choices on which family background may also have direct and indirect influences.

We estimate the effects of family background on both the qualitative choice whether to enroll in two-year versus four-year school and, for those who enroll in four-year colleges and universities, on the qualitative choice among those schools. The inclusion of this qualitative dimension of choice affects our understanding of the nature and magnitude of family background effects on college in some important respects. For example, family income has but limited direct impact on whether students enroll in post-secondary colleges and universities, but has strong direct effects on the quality of educational institution selected for those who attend private

four-year colleges.

This discussion is far from being the final word on the determination of college choice. Instead, it is intended to indicate that the type of methodology described above can be usefully applied in analyzing how students select among colleges and universities.

#### Microeconomic Analysis of Wage Determination

The greatest effort economists have made in studying the impact of college attendance on the economy has undoubtedly been in terms of estimating the returns to human capital. Again, the methods described here can shed new light on a much-discussed topic.

There has been a rising interest in understanding better the impact of college choices on wages, an interest motivated by concerns about increasing wage inequalities, about increasing costs of elite private colleges, and about the perceived increasing roles of highly educated individuals in maintaining international competitiveness. As in the case of college choice, previous studies have been subject to several limitations. For one, they have not considered possible differential impacts for different demographic groups identified by race and gender. And, once again, with few exceptions, they have not considered the choice dimensions with regard to time in college and college quality.

Behrman, Constantine, Kletzer, McPherson, and Schapiro (1996) addresses both of these limitations. Estimates are obtained of the impact of time in college and of college quality choices on wages for four demographic groups based on an explicit dynamic framework. These estimates suggest that treating time in college and college quality as choices within a dynamic framework affects fairly substantially the estimated effects. Based on these results, most previous studies may have overestimated the impact of both college quality and time in college because of the

failure to deal with such choices and, in a lesser but still substantial number of cases, because of the failure to control for the quality dimensions of pre-college education.

The estimates also suggest that there are important demographic differences in the wage benefits of college. The estimated wage benefits from higher college quality and more time in college tend to be highest for nonwhite males and next for nonwhite females, then white females and least for white males. For some members of all groups there appear to be some incentives for increasing college quality (by paying somewhat higher tuition or whatever), more so for those who are longer in college because of interactions between college quality and time in college. But these incentives differ strongly across groups, being much higher for nonwhite males and much lower for white males, with the females in between. For nonwhites there also appear to be incentives (again stronger for males than females) to increase time in college. For whites, in contrast, the estimated net gains do not appear to create such incentives (at least at a reasonable real discount rate of 4%) - a result that contrasts with common interpretations of estimated earnings equations.

The results for nonwhites raise important questions regarding why there is unrealized potential for reaping net benefits from more time in college or attending higher quality colleges. A number of possible answers to this question - poor information about the impact of college, imperfect capital markets for financing college, poor information about college quality differentials, discriminatory admissions - may have important policy implications on both equity and efficiency grounds.

### Conclusion

Understanding the economic payoff to human capital investments is very important both

from the standpoint of individuals and of society. But it is our view that to estimate these impacts correctly necessitates having a well-developed idea of the microeconomic determinants of human behavior. Without this, empirical analyses of such topics as career choice, college choice, or wage determination will be flawed. Our intention here has been to lay out our reasoning as to why these choice models are important and to illustrate their usefulness in a variety of contexts.

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