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ELASTICITIES OF DEMAND FOR EDUCATED LABOR AND ELASTICITIES OF SUPPLY OF EDUCATED LABOR

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ABSTRACT

This paper reviews a variety of estimates of the demand and supply elasticities of educated labor. It finds that elasticities of substitution between more and less educated labor range from 1.0 to 2.0 and that elasticities of the supply of students to colleges are also on the order of 1.0 to 2.0 while elasticities of supply to specific professions are on the order of 2.0 to 3.0. With elasticities of this magnitude, wages and employment depend on both supply and demand factors, with shifts of either schedule influencing both market outcome variables.

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SUPPLY ELASTICITIES FOR EDUCATED LABOR

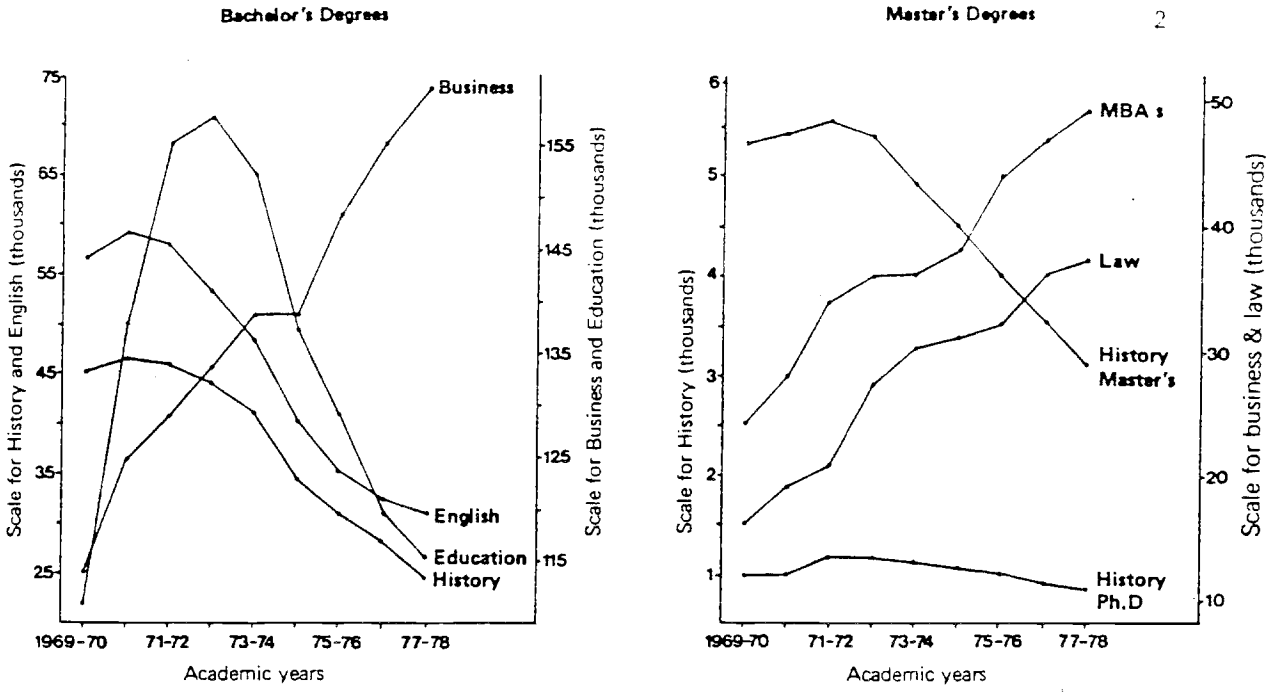
The number of persons choosing to enroll for higher education overall and in various specialties has varied greatly over the years. In the 1960s, enrollment in colleges and universities grew throughout the world, leveling off and in some cases declining relative to the relevant age group. Among fields, some expanded at some periods of time while contracting at others. As Figure 1 shows for the U.S. the supply of new educated labor to various disciplines has shown remarkable change over time.

To what extent do these changes represent the response of persons making education and career decisions to economic incentives?

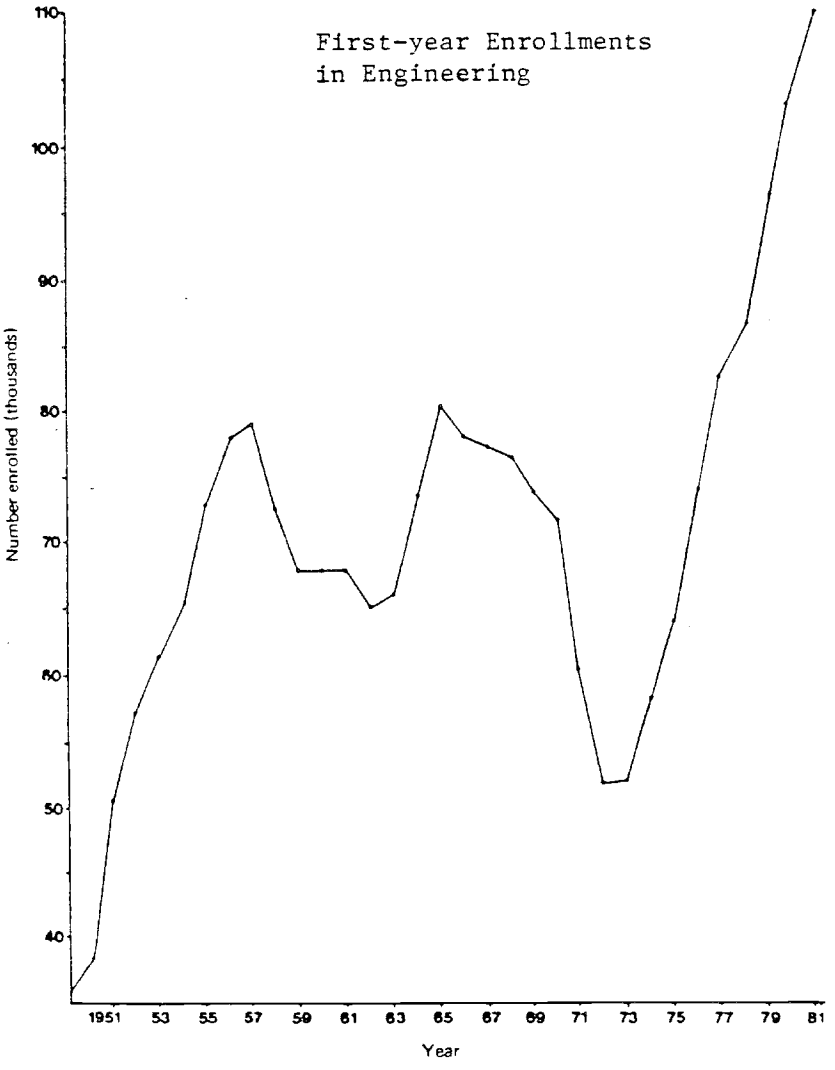
The key concept used to answer this question is the elasticity of the supply of educated labor, measured as the percentage change in the number of persons choosing various forms of education per percentage change in the relevant economic incentive. The magnitudes of the elasticities depend on the relative number of persons who are "on the margin" among various alternatives -- that is to say, the number who, at existing pecuniary and nonpecuniary rewards to various careers, are potentially movable across fields. Since older workers have often made sizeable investments in their careers in the past, the responsive "margin" consists largely of the young, who are in the process of making career choices.

Whether or not supply elasticities of educated labor are large or small has long been an issue of concern. In the aftermath of Sputnik (1956), many doubted whether individual career decisions were sufficiently flexible to permit free market economies to produce as

FIGURE 1 : Changes Over Time in the Supplies of Educated Labor



Source: National center for Educational Statistics



Source: American Association of Engineering Societies

large a supply of scientists and engineers as planned economies. The human capital "revolution" in economic thinking about labor supply also directed attention to the magnitude of the supply elasticities. One key assumption of the human capital model is that individuals make investments in education in response to market incentives, which should be revealed in significant elasticities of the supply of educated labor.

Efforts to estimate elasticities of supply of educated labor have taken several forms. Some studies have analysed the impact of the salaries of college workers relative to high school workers on the proportion of the young enrolled in college; some have focused on the effect of tuition and scholarship charges on enrollments; while others have studied the relation between salaries in specific disciplines and the relative number of young persons choosing to study in those areas. Several of the studies have used time series data to estimate supply elasticities, identifying supply behavior from demand behavior by the fact that, because education takes a number of years, the decision to study in a field depends on salaries and related market conditions prior to the individual's graduation into the job market. Other studies have compared the relative number of persons obtaining different levels or types of education across geographic areas to salaries in these areas. Another body of literature has concentrated on the decision of individuals to enroll in higher education and/or the type of education or institution they choose.

The various studies have yielded generally consistent results

regarding the magnitude of the elasticities of supply of educated labor. They show that the decisions of young persons to enroll in college and to choose various fields of study are quite responsive to economic incentives, producing substantial elasticities of supply. They indicate, further, that elasticities of supply to specific fields tend to be higher, in general, than elasticities of supply to higher education as a whole. Surveys of students regarding the importance of salary and career considerations in their educational decisions buttress these conclusions: a large number take explicit consideration of monetary factors in decision-making.

Table 1 summarizes some estimates of the responsiveness of the overall supply of young persons to higher education. Panel A treats studies that have focused on the elasticity of supply to salary or wage incentives while Panel B treats studies that estimate responsiveness to tuition charges.

Despite differences in the nature of the studies, the estimates in Panel A fall into a range of around one to two. The studies for the U.K. are comparable to those for the U.S. The Mattila study, which is the only one to estimate responses to calculated rates of return rather than starting or average salaries, yields figures analogous to studies using these measures of incentives. All told, the various studies reveal considerable responsiveness, which goes a long way to accounting for observed swings in the proportion of young persons enrolled in college in postwar years.

Studies of responses to changes in tuition rates, summarized by

TABLE 1: Estimates of the Supply of Persons to Higher Education

A. Studies of Responses to Salaries

Study	Sample	Elasticity Response to Salaries
Tinbergen (1974)	countries	0.54 to 2.64
Freeman (1975)	time series, USA	1.3 to 1.7
Freeman and Hansen (1982)	time series, USA	1.82
Willis & Rosen (1979)	Individuals in NBER-Thorndike sample, U.S.A.	about 2.00
Pissarides (1979)	time series, UK	1.12 to 1.31
Dolphin (1981)	time series, UK	0.7
Mattila (1982)	time series, USA	.86 to 1.39

B. Studies of Responses to Tuition

Study	Sample	Response of Enrollment Rate per $100 Change in Tuition
Corazzini, Dugan, Grabowski (1963)	National cross section	0.62
Hopkins (1963)	State cross section	0.75
Barnes (1970)	Individual students	1.53
Radner and Miller (1966)	Individual students	0.05
Kohn, Manski, Mundel (1966)	Individual students	0.92
Hoenack (1965)	High school districts	0.71
Hoenack and Weiler (1972)	Individual students	1.46
Spies (1971)	Individual students	0.05
Campbell and Siegel (1919-64)	Time series	0.20
Bishop (1963)	Individual students	0.90

Source: All studies listed in bibliography. Panel B from McPherson, "The Demand for Higher Education," in Public Policy and Private Higher Education, D. Breneman and C. Finn (eds), p.181, Table 3-9.

McPherson, tell a similar story. All of the reviewed studies found that tuition affected enrollment, with a magnitude that roughly indicates that a $100 change in tuition would alter the proportion enrolled by perhaps .8 or so percentage points. Translated into an elasticity of response, the tuition-elasticity of enrollment is about 0.3 (McPherson, p. 181). Since tuition is only a fraction of the salaries received by students, this low number makes intuitive sense and is, indeed, consistent with a supply elasticity of the magnitude found in Panel A.

Finally, U.S. survey evidence provides additional support for the notion that students are highly responsive to economic rewards in decisions to enroll in college. Nearly 80 percent of freshment surveyed by the American Council of Education in 1977 agreed, for example that a major reason for going to college was that it would enable them to get a better job. One-third cited "ability to make money" as a very important reason for going to college. While some may doubt the meaningfulness of these responses, they are consistent with the statistical studies cited in Table 1.

As for elasticities of supply to specific fields of study, a substantial literature has examined time series fluctuations in enrollment and degrees, of the type shown in Figure 1. Supply elasticities have been estimated for a wide variety of professional specialties. Physics (Freeman, 1976), Economics (L. Hansen, 1980), Engineering (Freeman, 1976, Sirbu et al, 1978), Law (Freeman, 1976, Freebairn and Withers, 1979, Pashigan, 1977), in the U.S.; teachers in

the U.K. (Zabalza, 1979), among other areas. The principal result of this work is that supply elasticities to various professions are quite sizeable and, in conjunction with observed wage changes, explain a large proportion of the changes in degrees and enrollments of the type shown in Figure 1.

An important prerequisite for labor supply to be responsive to economic incentives is that decision-makers be knowledgeable about market conditions. Surveys of several thousand college students have shown them to be aware of the ranking of fields by salary, of differences in lifetime income profiles, and of recent changes in salaries, providing further support for the high estimated supply elasticities (Freeman 1971).

Many studies distinguish between short-run and long-run elasticities of response. The short-run response is defined as the percentage change in one year's supply due to a change in economic incentives; the long run response represents the percentage change in supply a number of years in the future assuming the new wage pattern persists. As a rough generalization, short-run supply elasticities are typically below 1.00, while long-run elasticities are in the range of 3.0 to 4.0. The long-run responses tend to exceed those estimated for college enrollments overall, presumably because any given field can attract persons from other college fields as well as from persons on the margin between attending college and working.

There is some evidence that the supply of educated labor to specialties such as engineering fluctuates according to "cobweb-type"

dynamics in which a large supply in one period depresses wages and market opportunities, which in turn reduces enrollment and future supply, thereby raising wages and improving conditions, and so on. The impact of this market dynamics on supply in engineering can be seen in the swings in enrollment in Figure 1. Estimates of the supply and demand elasticities in the market do, however, indicate that these fluctuations are stable and dampened (Freeman, 1976, Freeman and Hansen, 1982), which means that it takes considerable shocks to set off supply responses that greatly overshoot the appropriate levels in the market.

Overall, it appears that supply elasticities for educated labor are quite substantial among new entrants to the job market. Because of the relative stability of the supply of older specialists, relatively few of whom go back to school to change their fields of specialization, however, elasticities of total supply are much smaller.

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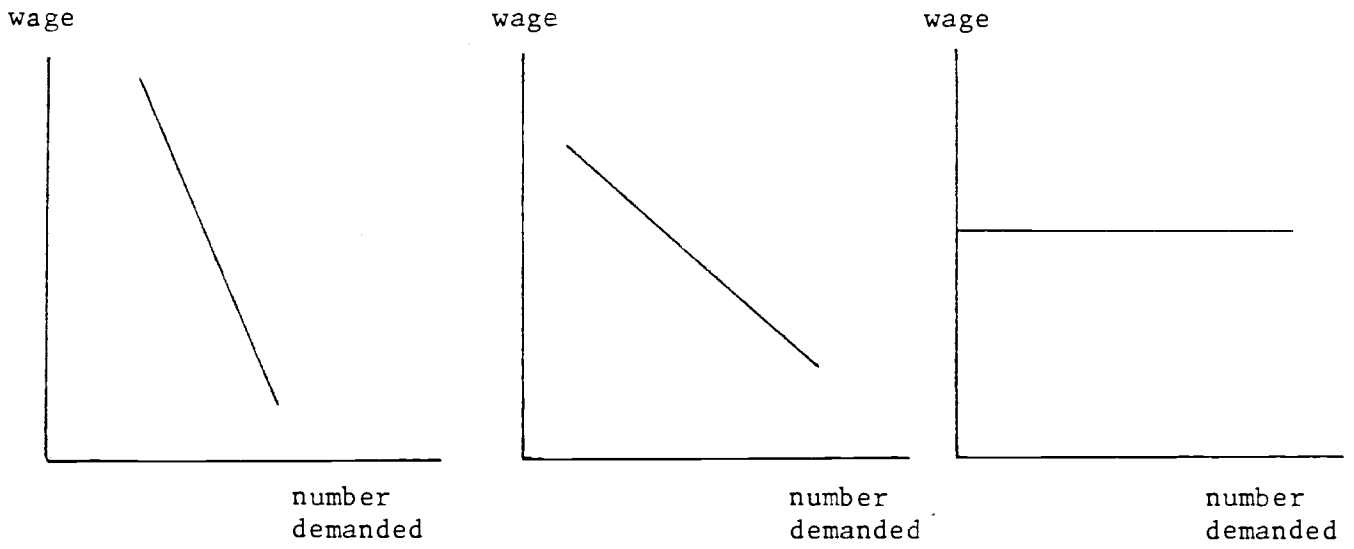
The elasticity of demand for educated labor measures the percentage change in the number of workers with specified levels of education demanded by employers per percentage change in the wage of these workers, other wages and input prices assumed fixed. It is a central concept in the analysis of the market for labor skills, as it represents the responsiveness of employers to price incentives to employ workers of varying levels of education. When the elasticity of demand is relatively small (as in case A of figure 1) enormous changes in wages are needed to induce employers to alter the number of workers hired. In this case, one can practically ignore responses to wage changes and analyze demand for labor as if it did not depend on wages. When the elasticity of demand is moderate, by contrast, the concept is a critical element in understanding the effect of economic changes on demand for labor and wages (case B in figure 1). When the elasticity of demand is near infinite, it is probably not useful to think of educated labor as a distinct input in production at all, as it is likely that other inputs are perfectly substitutable for it (case C in figure 1).

FIGURE 1: ELASTICITY OF DEMAND FOR EDUCATED LABOR



A: Near zero elasticity of demand: changes in wages induces only slight changes in number demanded

B: Moderate elasticity of demand: changes in wages induce moderate changes in number demanded

C: Near infinite elasticity of demand: changes in wages cause enormous changes in number demanded

The magnitude of the elasticity of demand for educated labor depends critically on the extent to which educated labor is substitutable for other inputs in production. The ease of substitutablilty is generally measured by the elasticity of substitution, defined as the percentage change in the number of educated workers relative to the amount of other inputs (say, less educated workers) per percentage change in the wages of educated workers relative to the price of other inputs (say, the wages of less educated labor). Formally, if E_1 measures the number of educated workers and E_0 the number of other inputs and if w_1 and w_0 are the respective factor prices, the elasticity of substitution σ is

$$(1)\ \sigma = E_1(\%\Delta E_1/E_0)/(\%\Delta w_1/w_0)$$

where $\%\Delta$ measures percentage changes. In analyses which treat employer demand responses at a given level of output, the elasticity of demand is just a function of elasticities of substitution. When the level of output varies in response to changes in prices, the elasticity of demand for educated labor, like other inputs, depends on the elasticity of demand for the final product as well.

The elasticity of substitution between more and less educated workers (or other inputs) has been at the center of analyses of demand for educated labor for two reasons. First, because the validity of widely used 'fixed coefficient' methods for forecasting educational demands or "needs" and the potential economic worth of educational planning to meet such demands or "needs" hinges critically on the size of the elasticity. Standard "fixed coefficient" forecast methods assume

zero elasticities of substitution in order to focus on the impact of changes in the composition of industries on the demand for educated labor. The greater are actual elasticities, the less valuable are such forecasts. Similarly, planning education to meet future labor market demands is useful only if elasticities of substitution are small; if the elasticities are large, employers can readily substitute less educated for more educated labor, so that even accurate planning will be of little economic value. Second, the elasticity of substitution between more and less educated labor is important in analyzing the impact of changes in relative supplies of workers on the distribution of earnings. When the elasticity is high, large increases in the supply of graduates relative to nongraduates will have little effect on their relative wages. When the elasticity of substitution is small, large increases in the relative supply of graduates will cause sizeable changes in relative wages and thus will alter the distribution of earnings.

Given these issues, it is not surprising that economists have undertaken empirical studies designed to measure the elasticity of substitution between more and less educated or skilled workers. Because the number of workers with varying levels of education is predetermined in any given year by supply decisions made years earlier due to the length of training, most analyses actually examine the inverse of the elasticity of substitution, the elasticity of complementarity, which measures the percentage change in relative wages due to percentage changes in relative supplies. While it is

reasonable to assume that supplies are fixed in analyses that treat time series data, this assumption is less defensible in comparisons across geographic regions at a point in time: within a country, the supply of educated workers to an area can migrate in response to wage incentives and thus cannot be regarded as "exogenous" to wage determination; across countries, differences in supply may reflect responses to differences in the rewards to education that persist over time, weakening the assumption that supplies can be taken as independent of the wages. Accordingly, some studies have also used 'simultaneous equations' techniques to estimate the relevant elasticities of substitution. In these studies demand and supply of educated labor are estimated conjointly in a system.

What is the result of these studies? What is currently known about the elasticity of substitution between more and less educated labor?

Table 1 summarizes the findings of the most important empirical studies.

Initial work on elasticities of substitution focused on cross-sectional data, with most attention given to cross country comparisons. While the early evidence on U.S. states supported relatively moderate elasticities (Johnson, Welch) the work of several analysts led many to believe that the elasticity was rather high, sufficiently so to yield practically horizontal demand curves. Bowles' book on Planning Educational Systems for Economic Growth produced, in particular, an elasticity between workers with some college education

TABLE 1: Estimates of the Elasticity of Substitution Between Highly Educated and Less Educated Workers

Study	Sample	Elasticity of Substitution
Bowles (1969)	countries	202
Johnson (1970)	states, U.S.A.	1.3
Welch (1970) (Agriculture Sector)	states, U.S.A.	1.4
Dougherty (1972)	states, U.S.A.	8.2
Psacharopoulos & Hinchliffe (1972) (countries)	developed less developed	1000 2.1-2.5
Tinbergen (1974)	countries states	0.6-1.2 0.4-2.1
Freeman (1975)	years, U.S.A.	1.0-2.6
Layard and Fallon (1975)	countries	0.6-3.5
Grant (1979)	SMSAs	1.2

Note: Definitions of highly educated to less educated vary somewhat between samples. All except Layard and Fallon treat college relative to some other group. Layard and Fallon relate groups with 8 or more years to less than 8.

Sources: Bowles, S., Planning Educational Systems for Economic Growth, Harvard University Press, 1969.
Johnson, G. "The Demand for Labor by Educational Category," Southern Economic Journal, (October 1970) 190-204.
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and those with 8 to 11 years of school of 202, and smaller but still sizeable elasticities (6 to 12) between other educational groups. With a sample of 28 states from the United States, Dougherty obtained a more moderate but still high estimate of over 8. Psacharopoulos and Hinchliffe divided the international sample by degree of development, obtaining an essentially infinite elasticity (implying perfect substitutability at the relevant wage ratios) in the developed countries but a more modest value in the less developed countries. As the relative earnings of graduates remained constant or increased in the 1950s and 1960s, despite increased supplies of graduates from colleges and universities, these estimates were generally accepted as being in accord with reality. Some viewed them as casting serious doubt on the concept of educational bottlenecks as a barrier to economic growth and on the value of the fixed coefficient model of labor demand, then being used by the Organization for Economic Cooperation and Development, among others, to analyse the graduate and skilled worker labor markets for the purpose of educational planning.

In the 1970s, concurrent with the observed decline in the relative earnings of college graduates throughout the developed world, analysts began to re-examine these results. New estimates based on better data and models provided a very different picture of the elasticity of substitution between educated and less-educated labor. Nobel-laureate Jan Tinbergen amplified the country and state analyses to take account of the likely simultaneous determination of relative wages and relative supplies in cross-sections and obtained quite

different results from Bowles and Dougherty using their data sets. His elasticities ranged from 0.50 to 2.00, which were consistent with the earlier cross U.S. state work of Welch and Johnson. Freeman used time series data for the United States to estimate the effect of the growth in the number of college graduates relative to high school graduates on their relative earnings and obtained estimated elasticities of a similar magnitude, ranging from 1.0 to 2.6. Layard and Fallon examined a large cross-section of countries, with the comparable results shown in the table. Grant developed estimates in a complete translogarithmic systems equation which included capital in the analysis and obtained a value of 1.2. All told, the current evidence suggests a value of the elasticity of substitution between more and less educated labor in the range of 1.0 to 2.0. This magnitude is consistent with changes in the supply of graduates altering their relative earnings and does not invalidate the potential economic worth of educational planning based on fixed coefficient models.

A large number of additional studies on substitution among groups of workers have used occupational disaggregation. While these results show a wider range than those given for educational groups in Table 1, the estimates are consistent with elasticities of substitution between highly educated and less educated workers of 1 - 2. In the Hamermesh and Grant review of 20 estimates of elasticities of substitution between production (blue collar) and nonproduction (white collar) workers, the mean estimate was 2.3, with half the studies yielding estimates below 1.0 and half above that value.

The relationship between capital and more educated or skilled labor and the relationship between capital and less educated or skilled labor has also been studied as important elements in the demand for labor of varying educational qualities. The key hypotheses in this work had been that capital is less substitutable (more complementary) for educated than for less educated labor (Griliches). If this is the case increases in capital raise the demand for educated labor relative to less educated labor and changes in the price of capital cause employers to alter employment of the less educated more than employment of the more educated. The extant evidence appears to support this hypethesis. Of the twelve studies in the Hamermesh-Grant review article, eight show capital to be more easily substituted for blue collar labor than for white-collar labor, and half indicate that white-collar labor is actually complementary with capital, so that changes in the price of capital raise demand for white collar labor rather than reduce it. The only study to examine labor by education also shows lower substitutability between the more educated and capital than between the less educated and capital (Grant).

With moderate elasticities of substitution between educated and less educated labor and with relatively small (or even oppositely signed) elasticities of substitution between more educated labor and capital, current evidence suggests that the elasticity of demand for educated labor is of a moderate magnitude. In terms of Figure 1, the evidence suggests that case B represents actual labor markets. Hence, analyses of the impact of economic changes or policies on employment or

wages of educated labor cannot ignore the employment response to changes in wages.

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