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The Economic Return to School Quality: A Partial Survey

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The Economic Return to School Quality: A Partial Survey

ABSTRACT

We present a survey of the literature on the economic returns to school quality. A dozen studies conducted over the past 20 years show remarkably consistent estimates of the effect of school quality on students' subsequent earnings. A 10 percent increase in school spending is associated with 1 to 2 percent higher annual earnings for students later in life. We argue that the similarity of the findings across data sources and research methods suggests that school quality has a true causal effect on student earnings. Increases in school resources are also associated with significantly higher educational attainment, although the range of estimates of the effect is relatively wide.

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For the past three decades, education policy in the United States has been guided by the conclusions of the Coleman Report (1966) and subsequent research on test scores and schooling resources. This literature is widely interpreted as showing that increased levels of spending on educational inputs such as lower class size or higher teacher salaries have no significant effect on student achievement. For example, Hanushek's (1986) influential survey of this literature concluded that "there appears to be no strong or systematic relationship between school expenditures and student performance" (p. 1162).

In recent years, the conclusion that schooling inputs don't matter for student achievement has come under renewed investigation for two main reasons. First, there have been advances in the statistical technique of meta-analysis -- a method for quantitatively summarizing a set of studies that address a similar question.[1] In contrast to Hanushek's (1986, 1991) informal summaries, modern meta-analyses have concluded that schooling resources do exert a systematic and positive effect on test scores. Indeed, Hedges (1993) performs a meta-analysis of the same set of studies examined by Hanushek and concludes that "the data are more consistent with a pattern that includes at least some positive relation between dollars spent on education and output, than with a pattern of no effects or negative effects."[2]

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[1]See Glass, McGaw, and Smith (1981) and Hedges and Olkin (1985) for general introductions to the techniques of meta-analysis. A meta-analysis is (loosely) a statistical analysis of the estimates from a series of related papers. Meta-analysis methods can be used to adjust the estimates from different studies to a common basis, making it easier to identify common factors in a diverse body of research.

[2]Meta-analyses by Glass and Smith (1978), McGiverin, Gilman and Tillitski (1989), and Hedges and Stock (1983) also conclude that children assigned to smaller classes have higher academic achievement.

Second, and irrespective of the relationship between school resources and test scores, a series of studies have found that increased school spending is significantly associated with improvements in the socioeconomic outcomes of students, including their schooling attainment and their subsequent earnings. Indeed, these studies show remarkably consistent findings, and suggest that a ten percent increase in schooling outlays per student is associated with something like a 1.5 percent increase in earnings for each year of a student's working life.

To economic analysts, earnings are a natural focus of study because they reflect the market valuation of skills acquired in school. If better schools impart more or better knowledge, this should be reflected in the higher earnings of students. Furthermore, for many students, the potential earnings gains associated with additional schooling are a primary motivation for attending school. Thus, earnings-based measures of school performance are directly relevant for the students themselves. Many economists also question whether standardized test scores are a reliable indicator of school performance. For example, there is evidence that teachers can coach students to perform well on standardized tests, without any lasting effect on their knowledge.[3] Moreover, a number of studies have found only a weak association between standardized test scores and socioeconomic achievement, once years of schooling are held constant.

This paper surveys the economics literature on school quality and earnings. Throughout the paper, we measure school quality by means of indexes of the quantity of resources in the school, for example, by expenditures per student or the pupil-teacher ratio. In Section II we describe the logic and methodology behind the economic approach to the

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[3]For example, see Johnson (1984).

study of school quality, education and earnings. In Section III we present a summary of the literature. Section IV concludes the paper by discussing comparative strengths and weaknesses of the economic approach to school quality and student achievement.

II. Economic Methodology

A. Economic Measures of School Performance

Economists have a strong preference for studying tangible and objectively measured outcomes like income, rather than subjective outcomes like consumer confidence or job satisfaction. In the field of education this has meant that economists typically focus their attention on market-related measures of school performance -- mainly the subsequent earnings of students.[4] In the prototypical economic model of schooling (Becker, 1967) education is viewed as an investment: current resources are spent (or forgone) while the student is in school in anticipation of higher earnings later in life. This framework lends itself naturally to consideration of the costs and benefits of alternative education policies. A reduction in the pupil-teacher ratio, for example, has immediate and readily measured costs. The benefits (if any) are only realized over the lifetimes of the students as they use their improved knowledge to achieve higher pay.

The preference for objective and market-oriented outcome measures has led many economists to eschew other measures of school performance, such as standardized test

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[4]Haveman and Wolfe (1984) catalog a variety of outcomes, unrelated to markets, that may be influenced by education (e.g. criminal participation).

scores.[5] This approach contrasts sharply with other researchers in the education field, who tend to have more faith in standardized testing. Part of economists' skepticism regarding standardized testing arises because the tests are arbitrarily scaled, and can possibly be manipulated by teachers and test writers. More important, there is no guarantee that standardized tests measure "skills" that are of economic value. A particular outcome measure is only an effective gauge of the economic value of schooling insofar as it is correlated with some aspect of earnings. Standardized test scores typically have a weak relationship with economic outcomes like earnings, once other factors (such as the individual's educational attainment) are held constant.[6]

Finally, many economists have little expertise in conducting or interpreting standardized tests.[7] It is thus not surprising that the large body of research that uses test scores to assess the efficacy of school inputs has been conducted primarily by educational researchers, sociologists, and psychologists; not by economists.

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[5]See Johnson and Stafford (1973) for example.

[6]For example, the addition of test score information to the earnings models reported by Griliches and Mason (1972, Table 3) improves the explanatory power of their models by less than one-half of a percentage point. Research on the GED test suggests that simply passing the test has no significant effect on labor market outcomes (Heckman and Cameron, 1993). These findings underscore the importance of directly examining labor market outcomes.

[7]Notable exceptions are researchers in the field of economics education, e.g. Walstad and Becker (1994), Becker, Greene and Rosen (1990).

B. The Relation Between Earnings and Schooling

Although education has many objectives, a major goal of the school system is to raise the productivity and incomes of students. Indeed, an important reason why many students attend school is to improve their labor market prospects. In view of these goals, and economists' relative expertise in using market-related outcome measures, labor economists have focused on models of the relationship between years of education and students' subsequent earnings, and the effect of school inputs on this relationship. A benefit of using earnings as a yardstick of school quality is that it passes a "market test." Economists feel comfortable with the premise that a product or skill is only worth what someone else is willing to pay for it. Earnings, clearly, are a direct measure of the value that the labor market places on individual skills. Of course, there are many other factors that affect individuals' earnings, including geographic location, work amenities, and pure luck. But a worker's wage rate is considered a reliable, if incomplete, indicator of the value of his or her skills.

The economics literature has focused on two main questions concerning education and earnings. First, do individuals with a higher level of education earn more than individuals with a lower level of education? Second, what characteristics of schools affect the relationship between schooling and earnings?

The evidence that earnings tend to be higher for individuals who have higher levels of schooling is undeniable.[8] Figure 1 illustrates the strong statistical relationship between

[8]Of course, some individuals with a high level of education may have low earnings. The literature focuses on central tendencies, as measured by average wages at each level of education.

hourly wages and years of schooling that is evident in the labor market. The figure simply plots the average of the logarithm of the hourly wage rate of workers at each level of education, using a national sample of data for 1993.[9] It is clear that log wages rise almost linearly with years of education. Furthermore, if we were to fit a line through the points in Figure 1 it would be quite steep. Indeed, the data in Figure 1 suggest that each additional year of education raises workers' wages by 9.5 percent. The coefficient relating the percentage increase in earnings for an additional year of schooling is referred to as the "rate of return to education." Historically, this rate of return has fluctuated between 5 and 7 percent, although in the 1980s, the return rose significantly (see Levy and Murnane 1992).

How should we interpret the strong, positive association between earnings and education? Does it mean that we can increase the average wages of people who would normally drop out of high school by forcing them to stay is school longer? Or is it merely a reflection of some omitted factor that is jointly correlated with education and earnings? For example, the parents of children with more education may have better labor-market connections, and these connections may help their children to obtain higher-paying jobs. In this case, we would observe a correlation between wages and schooling, but it would incorrect to conclude that higher schooling causes higher wages.

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[9]It is common in economic studies of wages to study the distribution of the natural logarithm (log) of wages. There are two reasons for this. First, simple plots show that the log of wages is approximately normally distributed (i.e., a graph of the frequency distribution of log wages looks like the familiar "bell-shaped" curve). Second, many standard economic theories predict a linear relationship between the log of wages and years of education (see Mincer 1974 and Willis 1986). Heckman and Polachek (1974) find that earnings and schooling have an approximately log-linear relationship.

A vast literature in economics has investigated the relationship between earnings and years of schooling with the aim of understanding whether schooling has a causal effect on wages, or only an indirect association. The early wave of these studies tried to control explicitly for individuals' characteristics, such as parental education and IQ (see Griliches, 1977). Essentially, these studies used statistical techniques to create plots like Figure 1 for workers who possess similar observed characteristics -- including such characteristics as family background and measured ability. In another set of studies, economists have used data on identical twins, to see whether a twin with higher education earns more than his or her sibling (see Behrman et al. 1980 and Ashenfelter and Krueger 1994). Yet another strand of this literature has taken a different tack, and tried to estimate the gains in schooling and earnings for individuals who obtained higher levels of education for reasons having nothing to do with their innate ability or background. Examples of this approach include Angrist and Krueger (1992), who examine the effect of state-wide compulsory schooling laws, and Card (1993), who examines the effect of growing in close proximity to a four-year college.

Our interpretation of all three strands of literature is that additional years of schooling do lead to higher earnings, and that this relationship results primarily from the extra schooling itself rather than from extraneous factors.[10] While some economists believe that part of the measured payoff to extra schooling arises from factors other than schooling itself, few doubt that additional schooling leads to at least some increase in the average students' subsequent income.

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[10]In a classic article, Griliches (1977) reaches much the same conclusion. See Card (1994) for a survey of the most recent literature that investigates the causal effect of schooling.

C. School Quality and Earnings

How does the quality of schooling affect the relationship between years of schooling and earnings? The most plausible theoretical explanation for a link between school quality and earnings is that -- other things being equal -- students acquire more skills if they attend higher quality schools (i.e., schools with more generous resources). This hypothesis suggests two alternative approaches to modelling the effect of school quality. In the first approach, researchers have assumed that an increase in schooling resources affects the subsequent earnings of all students who attended a particular school (or school system) by an equal amount, regardless of how much schooling they acquired. Specifically, these studies use multivariate regression analysis to relate an individual's earnings at a point in time to their years of schooling and measures of the resources available at the schools they attended. Schooling resources are typically measured by expenditure per student or the number of pupils per teacher in the student's state, school district or school. These studies hold constant several other factors that may be correlated with earnings and the quality of schooling, such as parental education, IQ, and race.

This approach is illustrated in Figure 2 with two levels of school resources: high and low. Notice that average wages at each level of schooling are affected equally by an increase in resources. The figure illustrates a situation in which average earnings are higher for those who attended higher quality schools, although the statistical models that are estimated in the literature allow for the possibility that higher schooling resources increase, decrease, or have no effect on average earnings, depending on the actual patterns in the data.

The assumption that the earnings differential for those who attend higher quality schools is the same for all levels of education implies that the two lines in Figure 2 are parallel. This assumption has the unappealing implication that even students who drop out with low levels of schooling receive the same earnings gains from higher expenditures as those who completed high school. As a practical matter, however, a vast majority of U.S. students complete high school, so this problem is of less significance than might be suspected.

An alternative approach to modelling the effect of school quality on earnings allows school quality to have a larger impact upon individuals who stay in school longer (Behrman and Birdsall 1983 and Card and Krueger 1992a, 1992b). Graphically, this approach corresponds to Figure 3. Here, the divergence of the two lines for higher levels of schooling means that the earnings premium for attending higher quality schools is greater for individuals who stayed in school longer. In order to implement this approach, researchers relate an individual's earnings to their years of schooling, with a slope coefficient (i.e., a rate of return to schooling) that depends on school resources. As with the first approach, other factors that may be correlated with earnings are held constant in the analysis.

If school quality is measured at the state level, this second approach can be implemented in two steps. First, a separate slope coefficient representing the rate of return to schooling is estimated for individuals educated in each state. Second, these slope coefficients are related to measures of the quality of education in the state at the time the individuals attended school.

There are two important methodological issues that arise in interpreting the measured relation between school quality and earnings. The first is the issue of causality. Schooling

resources vary widely across school districts, and parents may choose to live in certain school districts because of the quality of the schools or the level of property taxes used to finance these schools. It is possible that certain family characteristics (such as higher income) lead some families to choose more expensive schools, and also lead their children to earn higher wages. In this case, the measured positive effect of school quality on wages and school quality may be overstated. Researchers attempt to deal with this problem by including controls for family background and other characteristics of the school districts. Some researchers also try to identify differences in school quality that are "exogenously determined" -- such as differences between school quality for black and white students from states that operated segregated schooling systems (Card and Krueger 1992b).

A second methodological issue concerns the unit of observation under study. Some studies of earnings and school quality use microdata on individuals' wages combined with microdata on school resources pertaining to the individuals' school or school district (e.g., Ribich and Murphy 1975, and Link and Ratledge 1975). Because school level expenditure and staffing data are often noisy (e.g., they vary a lot from year to year for no apparent reason), and because some families may choose their location on the basis of school resources, there are reasons why it may be desirable to aggregate over a larger area (such as a state) to derive average school quality measures. Thus, in other studies, microdata on individual wages are combined with state-level data on the average quality of schooling in a particular state (e.g., Rizzuto and Wachtel, 1980). Finally, some studies have related the average wages of workers from a state to the average school quality in the state when the workers attended school (e.g. Nechyba 1990).

The advantages and disadvantages of using aggregated versus disaggregated data on earnings and school quality are often misunderstood. Microdata have the advantage of providing greater variation in the explanatory variables. For example, there is a much wider range in expenditures per student across schools within a given state than in the average expenditures per school across states. On the other hand, an important disadvantage of microdata is that the variation is not exogenously determined. Higher-income families may choose to live in a particular suburb in order to send their children to higher-quality schools. Since parental income may exert an independent influence on children's earnings, this is a potentially confounding effect. Another and more extreme example arises if school resources are determined by policies that target increased spending on schools with disadvantaged or low-achieving students. In this case, school resources and student achievement will be negatively correlated, concealing any positive effect of higher resources on student achievement. At the state level, the endogenous determination of school quality is far less of a problem. Fewer families move across state lines to change the quality of schools than move between school districts within a state. The average quality of schools in an entire state gives a balanced picture of the resources available to the average student in the state -- not just the children from high-income families, or those with learning disabilities.

Measurement errors also tend to be a greater problem for studies based on micro-level school quality data. For example, a particular school may appear to have high expenditures in one year because it has high capital expenditures that year, or because its data are misreported. When school-level data are aggregated to the state level, however, mistakes or short-term spending variations tend to average out, leaving a more representative picture of

true school quality. As a result, measurement errors are likely to be less important in aggregate data studies than in micro data studies.[11]

D. School Quality and Educational Attainment

A second way in which higher quality schooling may influence earnings is by encouraging students to stay in school longer. From the students' perspective, schooling may be more pleasant and rewarding in schools with greater resources.[12] Thus higher quality schooling may induce students to attain a higher average level of education.

Any increase in educational attainment due to school quality could also be expected to increase individual earnings. The total effect of school quality can be seen most clearly with the aid of Figure 3. An increase in school quality will have two effects. First, at any given level of education, it will push the average worker up from the line for low quality schools to the line for high quality schools. Second, it will push workers to the right along the X-axis of Figure 3 (toward higher education), which will also increase earnings because earnings tend to rise with years of education. Note that if improved school resources only serve to increase individuals' educational attainment, workers' earnings will still increase as a result of improved school quality because earnings tend to rise with years of education.

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[11]See Malinvaud 1980, pp. 416-419 for a general analysis of the benefits of averaging in the presence of measurement errors.

[12]Higher-expenditure school districts may establish enrichment programs or special interest programs (sports, music, drama) that keep students interested in school.

III. Review of Evidence

A. School Resources and Earnings

Table 1 summarizes published studies of the impact of school resources on students' subsequent labor market income in the U.S.[13] We derived the set of studies in the table by searching the Journal of Economic Literature, and by examining citations in known papers and past issues of selected education journals. For each study we report the main estimates in the paper, with separate estimates by race if reported. We were able to find 13 separate studies that are based on eight different data sets on earnings. Table 1 reports a total of 25 estimates from these studies.

To place the estimates on comparable footing, we have converted the estimated coefficients in each paper into an "elasticity", representing the percentage gain in earnings for a 1 percent increase in expenditures per pupil. Elasticities are widely used to convey both the sign and magnitude of the effect of an independent variable on a dependent variable. For example, an elasticity of 0.10 indicates that a 10 percent increase in expenditures raises an average student's annual earnings by 1 percentage point. Estimates from studies that use the pupil-teacher ratio or the average teacher salary as a school quality measure were converted to estimates of the effect of expenditures per pupil by assuming that teacher salaries represent 60 percent of total expenditures per pupil.

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[13]The table is limited to studies of U.S. data. See Behrman and Birdsall (1983) for a seminal article on the effect of school quality on students' subsequent income in Brazil. Note that if an author published more that one article using the same data set to estimate a similar empirical specification, we report results from only one of the articles in Table 1.

In sharp contrast to the literature on test scores, most of the studies summarized in Table 1 suggest that more school resources are associated with higher subsequent income. The arithmetic average of the 25 estimated elasticities is 0.16, and the median value is 0.14. All the estimates are positive, and almost all are statistically significant. Furthermore, although the studies use a variety of data sets and statistical models, the estimated elasticities of earnings with respect to school resources fall in a narrow range.[14] Two-thirds of the estimated elasticities lie between 0.09 and 0.20. The studies in Table 1 employ a variety of different statistical methods, samples and controls.[15] Most of the studies control for the worker's education level, so these estimates should be interpreted as the increase in income associated with higher school quality for a given level of education. Many of the studies also control for differences in family background by including father's education, family income, or whether the individual grew up on a farm. In addition, to control for interpersonal differences in innate ability, some of the studies include an IQ measure or the Armed Forces Qualifying Test score.

Despite these controls, there is always a chance that the observed correlations between earnings and school quality reflect omitted factors, rather than the true effect of school resources. In our view, the most important omitted variables are likely to be measures of family background characteristics (e.g., family income) that are positively correlated with

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[14]One explanation for the low estimates by Tremblay (1986) is that she controls for the workers' occupation and industry. Since higher quality education may raise individuals earnings by enabling them to enter a higher paying occupation or industry, we would not consider this an appropriate variable to hold constant.

[15]The studies focus primarily on male workers, because female workers historically had a much lower labor force participation rate.

both school expenditures and students' earnings. The omission of such factors will tend to lead to a spurious over-estimate of the effect of school quality on earnings.

Comparing the estimated elasticities of school spending across studies there is no indication that studies that control for parental background tend to recover lower elasticities. In addition to this fact, another finding in the literature suggests that school resources per se influence students' subsequent earnings. In particular, Card and Krueger (1992a) examine changes in school quality across the states over time. This work essentially compares workers from different birth cohorts who were educated in the same state at different times. For example, over the course of the 20th century school resources in Alabama increased considerably relative to California. Card and Krueger relate the changes in the quality of schooling over time to the differences in the payoff per year of education for men in those cohorts. The results suggest that an increase in school quality within a given state over time leads to a rise in the earnings of people from that state.

Another consideration that arises in interpreting studies of earnings and school quality is that some of the same factors that lead to more generous school resources in a state or area may also lead to better labor market conditions for students after they leave school. For example, if the economy in a certain region is strong, the school authorities may have more revenues to spend on schools. If economic conditions are persistent over time, and if students tend to work in the same area where they attended school, then students' performance in the labor market may be spuriously related to the level of school resources.

In Card and Krueger (1992a and 1992b) we attempted to overcome this possible bias by studying groups of workers who were educated in one state, and moved to another state to

work. In our 1992b paper, for example, we compared students who were educated in the South and moved to one of nine metropolitan areas outside the South. An intuitive explanation of this line of research is straightforward: consider only high school graduates who work in Chicago. Some of these workers were educated in states with high pupil-teacher ratios, and others were educated in states with low pupil-teacher ratios. Our comparison is based on workers with different school quality backgrounds in the same labor market, providing a stronger test of the "pure" quality effect. Our findings using this type of comparison are very similar to the other findings in the literature.

Finally, and perhaps most persuasively, several studies listed in Table 1 have examined the impact of differences in school resources for workers who were educated in the South, where relative school resources for blacks and whites differed dramatically across the states and over time. For example, North Carolina and South Carolina provide a natural contrast that is investigated in Card and Krueger (1992b). In the early part of this century, school resources for blacks in South Carolina were far below those for blacks in North Carolina, while whites in South Carolina had slightly greater school resources than whites in North Carolina.[16] The relative incomes of blacks and whites from the two states mirror these differences in school resources, even when we limit the sample to individuals who were born in North or South Carolina and are observed working in the North. A more extensive

[16]For example, in the early 1920s the black schools in South Carolina had over 60 students per teacher, while black schools in North Carolina had 45-50 students per teacher. White schools in South Carolina had about 30 students per teacher, while white schools in North Carolina had about 35 students per teacher.

comparison involving all 18 states with de jure segregated school systems leads to a similar conclusion.

In our view, the remarkable similarity of the estimates from the various approaches used in the studies in Table 1 provides strong support for the hypothesis that higher school resources lead to systematically higher earnings for students.

B. School Resources and Educational Attainment

Several of the studies reviewed in Table 1 also report estimates of the effect of school spending (or some component of school spending) on average educational attainment. Table 2 presents a summary of the estimated elasticities of schooling attainment with respect to expenditures per pupil from these studies.[17] Like the elasticities of earnings with respect to spending, these elasticities are uniformly positive, although the range of the estimates is wider. The mean and median elasticities are 0.14 and 0.09, respectively. The elasticity based on the black-white differences in educational attainment for Southern-born men from Card and Krueger (1992b) is particularly high. As noted in that study, this estimate implies that virtually all of the convergence in schooling levels between black and whites born earlier (1900-1909) and later (1940-49) in the 20th century can be explained by the relative improvement in black school quality.

In interpreting the estimates in Table 2 it is important to recognize that the observed correlation between educational attainment and spending per pupil may give a downward-

[17]We have not attempted an exhaustive study of the literature on the effect of school quality on schooling attainment.

biased estimate of the "true" effect of per-capita spending on attainment. In other words, the reported estimate may well understate the actual effect of increased spending on student attainment. To see this, consider an increase in enrollment in a particular district or state induced by a change in family background or tastes for education. The rise in enrollment will tend to raise the pupil-teacher ratio and depress spending per student, unless school taxes and the number of teachers are increased in proportion to the new enrollment. Thus taste factors or family income changes that lead to increases in enrollment can lead to a decrease in per-student expenditures. In the statistical analyses, this "reverse causation" might partially offset any true positive effect of higher resources on attainment.

We reiterate a point made in reference to Figure 1: an extensive and highly sophisticated economics literature suggests that the acquisition of an additional year of schooling leads to a 7-9 percent earnings gain per year throughout an individual's working life. Thus, even if school resources have little effect on the test scores for students who reach a given grade level, more generous resources may still improve students' test scores and incomes by inducing them to stay in school longer. Furthermore, the estimates surveyed in Table 2 are consistent with a relatively strong effect of school quality on schooling attainment. This benefit of school resources is ignored in studies that relate the level of test scores (or their growth rate) to resources for students in a given grade level.

C. Interpreting the Estimates

How do the estimated economic returns to improved school resources compare to the cost of providing these resources? Here we focus on the effect of greater resources holding

constant years of schooling. Given the evidence in Table 2 that years of schooling also rise as school quality rises, and the fact that earnings will rise as a result of this extra education, our estimates should be interpreted as a lower bound.

Recall that the average elasticity of annual earnings with respect to school expenditures for the studies in Table 1 is 0.16. The following calculation indicates that an elasticity of this order of magnitude is quite substantial. Consider a school district that currently spends an average of $5,000 per student. Suppose the school district permanently increased its expenditures by 10 percent ($500 per student) to reduce class size, say. Now think about the effect this policy change has on today's kindergarten students. The costs of the policy change are incurred this year and each year until a student leaves school. This future flow of costs must be discounted to present dollars. The present value of the extra spending for a kindergarten student discounted over the next 13 years is $4,977, assuming a real interest rate of 3 percent.

The benefits of this increased spending are the higher earnings that the student will earn over his or her work life. To simplify matters, assume that the student earns $25,000 per year, begins working after leaving high school at age 19, and retires at age 60. If we assume an elasticity of 0.15, the student's earnings will rise by 1.5 percent, or $375, in each year in which he or she works as a result of the 10 percent increase in school expenditures. This future income must also be discounted back to the year in which the child enters kindergarten. Discounting is critical here because the income is earned several decades after the schooling expenditures are made. If we assume a 3 percent real interest rate, the present

discounted value of that extra income is $6,052: about 20 percent more than the present discounted value of the costs.

The benefits and costs of educational innovations will be multiplied by the number of students in the school district. For example, if we assume that this school district has 3,000 kindergarten students, the 10 percent increase in expenditures will cost a present value of $15 million, and raise students' subsequent income by $18 million, for a net gain of $3 million. These hypothetical calculations indicate that even modest increases in students' income as a result of increased expenditures can generate large net benefits to society because the benefits accrue each year the students work.

These calculations can be modified to take account of alternative assumptions. For example, a higher discount rate will tend to lead to a less favorable benefit-cost comparison, because the costs of education spending are incurred "up front" whereas the benefits are only accrued over the students' lifetimes. Another modification is to allow for interrupted or shortened career patterns. Some individuals never enter the labor market, enter later in life, or retire early. The direct earnings benefits of higher education spending for these individuals will be lower.

IV. Conclusion

Our review of the literature reveals a remarkable degree of consistency across studies regarding the effect of school quality on students' subsequent earnings. The studies typically find that a 10 percent increase in school expenditures is associated with a 1 to 2 percent increase in annual earnings for the students later in life. Increases in school resources are

also associated with significantly higher educational attainment, although the number of studies of this effect is relatively small and the range of estimates of the effect is wider. Because higher education is strongly positively related to higher earnings, this is an additional economic benefit of higher school spending.

Although one cannot be sure that educational resources and earnings are causally related, many of the studies in the literature control for family background, ability measures, and other factors that can undermine a causal interpretation. Other studies make use of comparisons between workers educated in different states but working in the same labor market, or between black and white workers educated in the South before desegregation. The similarity of the signs and magnitudes of the estimated school quality effects in the literature give us some added confidence that there is a true causal effect of quality on earnings.

A possible criticism of the economics literature on school quality relates to the time lag required to measure earnings effects. Studies of earnings or completed education require data on individuals who have completed their post-secondary education. This poses a significant problem for analysts who need to evaluate a new or on-going education program, and can also introduce biases associated with non-random follow-up of students from better and worse schools. Indeed, one of the advantages of using test scores as a evaluation tool is that tests can be administered easily and cheaply at any time in the education process.

One type of economic indicator of school performance that is available early in the life cycle is the high school graduation rate or college matriculation rate. Although some students who drop out of high school may eventually earn a degree or go on to college, most studies suggest that dropping out is associated with a substantially lower level of completed

education. An evaluation of the effect of school spending on high school graduation rates (and/or college matriculation rates) can therefore provide useful and timely data on the economic returns to higher or lower or spending levels.

As an example of this approach, a recent study by Sander (1993) correlates high school graduation rates by school district with measures of average family background in the district and measures of school spending (the pupil-teacher ratio, average teacher salary, noninstructional spending). Consistent with the studies in Table 2, Sander finds that a lower pupil-teacher ratio leads to a significantly higher graduation rate.[18]

Because changes in school resources may have different short-run and long-run effects on student achievement, however, we believe it is important to examine long-term outcomes like educational attainment and earnings. For example, higher quality education may have no short-run effect on test scores, but may influence students' willingness or ability to process and use information decades later. We are unaware of any study that relates working-age individuals' standardized test scores to their past school resources. But this is precisely the kind of evaluation (albeit using earnings) that is attempted in the economic literature. For these reasons, we recommend that educators devote at least some attention to evaluation of schools based on long-term outcomes, such as students' subsequent income and educational attainment.

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[18]Assuming that a high school graduate will eventually complete 2 more years of schooling than a high school drop out, Sander's estimates imply an elasticity of 0.04 (standard error 0.01) of completed education with respect to spending.

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Figure 1
Mean Hourly Wages of Adult Male Workers
By Level of Schooling

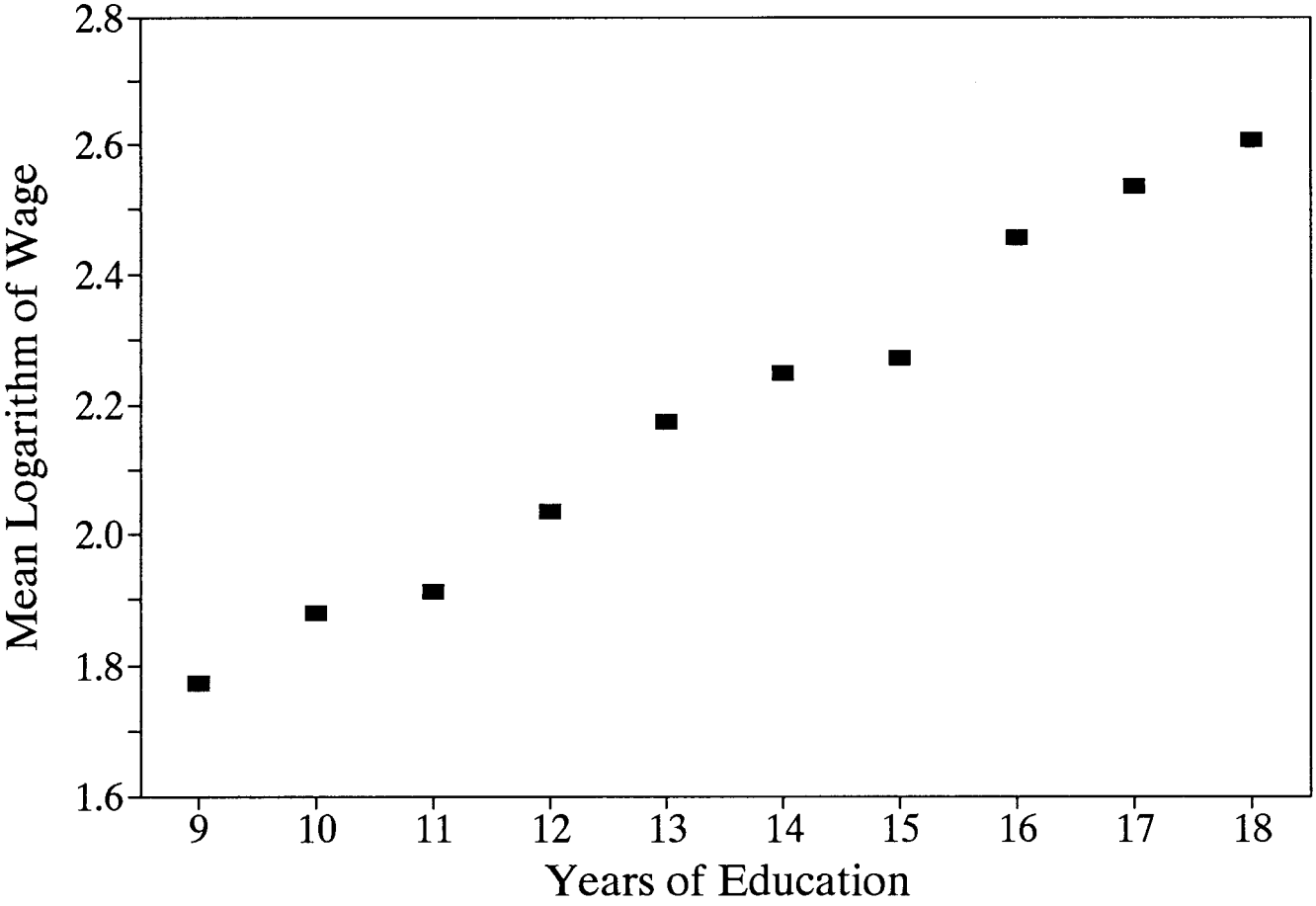

Figure 2
Hypothetical Effect of School Quality

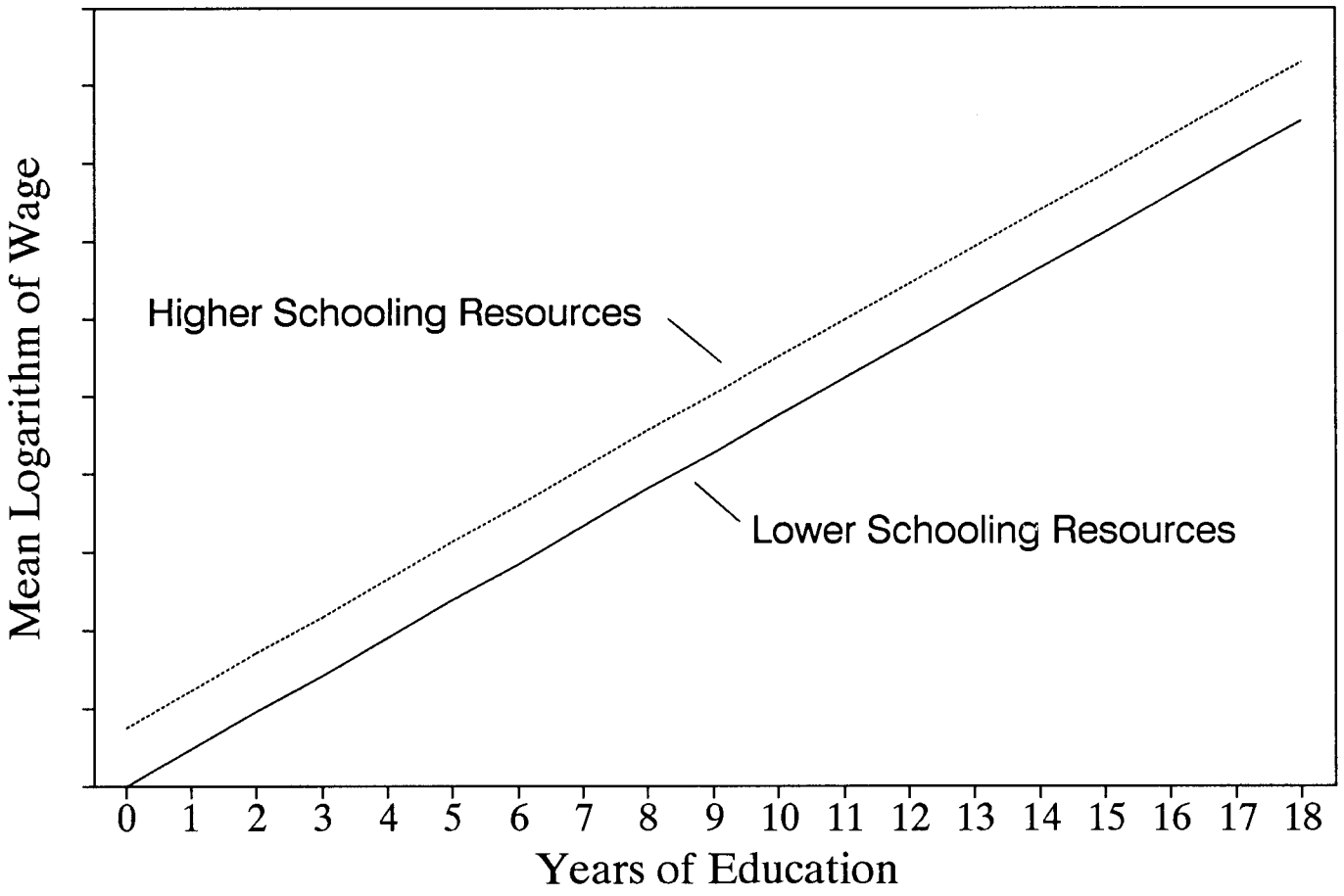

Figure 3
Hypothetical Effect of School Quality

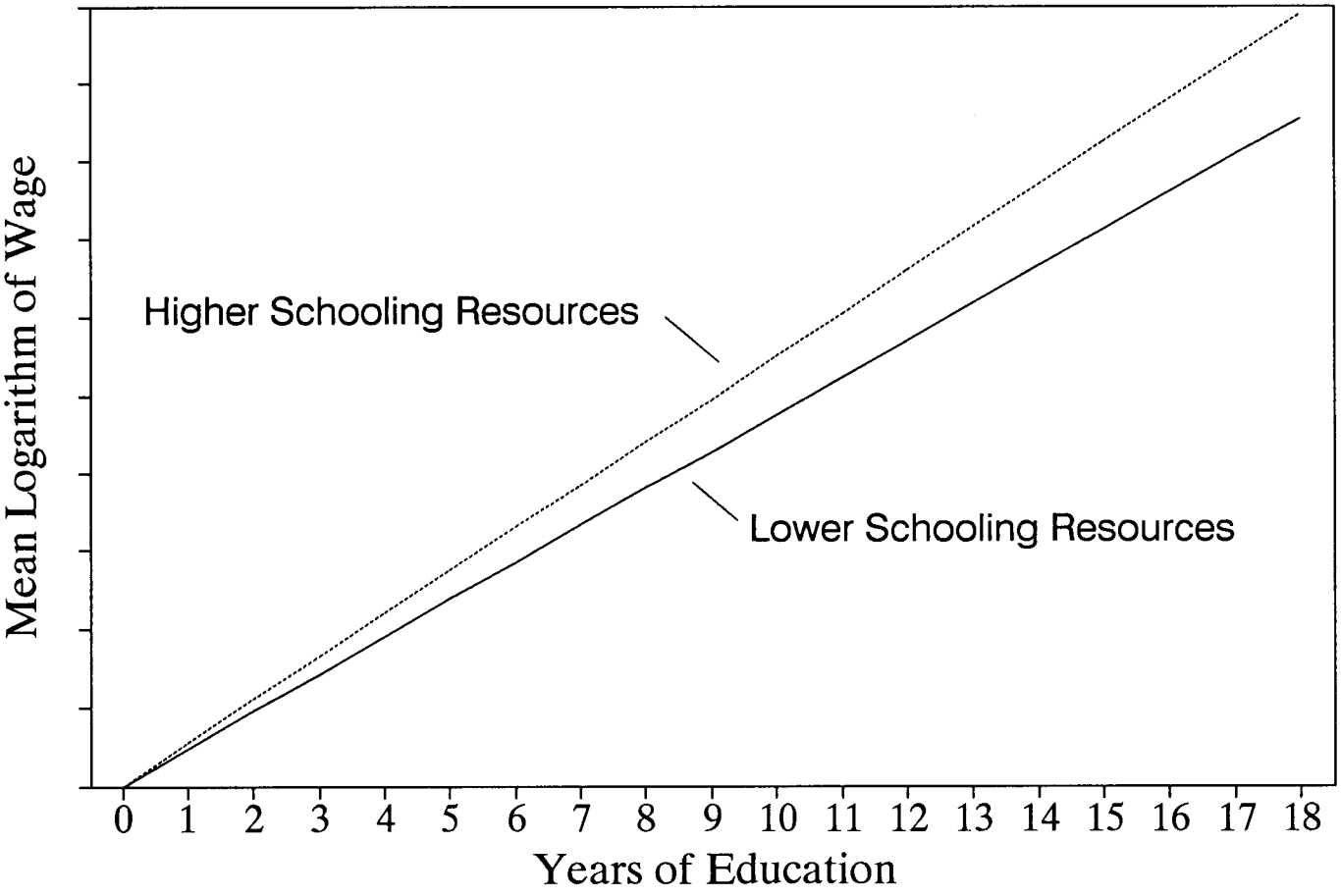

Table 1: Summary of Studies Estimating the Effect of School Quality on Earnings

Study	Sample	Methodology and Comments	Estimated Elasticity of Earnings w.r.t. $/pupil
1. Morgan and Sirageldin (1968)	1965 SRC Sample Family heads, not self-employed N=1,438	State expenditures (average of 1930, 1940, 1950) matched to individuals by state where they grew up. D.V.= log hourly wage in 1964. Stepwise regression. First step: remove yrs of education, age, sex, race, grew up on farm.	0.29
2. Johnson and Stafford (1973)	1965 SRC Sample White male non-farm heads; N=1,039	State*decade average expenditures matched to individuals by age/state where they grew up. D.V.= log hourly. wage in 1964. Other controls: years of education, experience, urban residence/birthplace, father's education.	0.20 (0.05)
3. Morgenstern (1973)	1968 Urban Problems Sample, conducted by ISR. N=1,624 heads of households. Black households oversampled.	State expenditures matched to individuals by state where grew up. D.V.=average hourly wage last year. Controls include gender, age, place of birth, experience, and parent's education.	Blacks 0.12 (0.04) Whites 0.13 (0.07)
4. Ribich and Murphy (1975)	Project Talent, 1959 9th grade men, re-interviewed in 1968. Blacks and Southerners under-represented. N=8,466	Expenditures per pupil collected from school survey. D.V.=estimated lifetime earnings, imputed from 1967 earnings (if employed) and education data. Other controls: years of education, AFQT, parental and school-average SES.	0.01 (0.02)
5. Wachtel (1975)	Thorndike-Hagen sample, men age 18-26 in 1943 (army veterans) N=1,812	School-district expenditures matched to individuals by name/location of high school. (1936-38 BSE data). D.V.= 1969 earnings. Other controls: yrs of education, experience, hours worked, test score, father's education.	0.20 (0.03)
6. Link and Ratledge (1975)	NLS Young Men age 16-26 in 1968, out of school $\geq$ 1 yr N=1,157	School-district expenditures (for 1968) matched by school district of school attended. D.V.=1968 log annual earnings. Other controls: years of education experience (quadratic), urban residence, IQ, hours worked.	Whites 0.15 (0.05) Blacks 0.55 (0.17)
7. Akin and Garfinkel (1980)	PSID male heads age 30-55 during 1968-72. N=1,049	State*decade average expenditures matched to individuals by state of residence at age 12. D.V.=log average wage 1968-72. Expenditures interacted with years of education. Other controls: IQ, father's income, indicators for family income.	Whites 0.30 (at ed=12) Blacks 0.14 (at ed=10.5)
8. Rizzuto and Wachtel (1980)	1960, 1970 Census white and black men age 14-65 not self employed N=26,204 (1960) N=27,729 (1970)	State expenditure data matched to individuals by state of birth and age interval. D.V.=1959/1969 log earnings. Other controls: years of education, experience, urban residence.	Whites 1960 0.12 (0.01) Blacks 1960 0.09 (0.03) Whites 1970 0.08 (0.01) Blacks 1970 0.11 (0.04)

Note: Table continues. See note at end of table. Estimated standard errors in parentheses.

Continued

Study	Sample	Methodology and Comments	Estimated Elasticity of Earnings w.r.t. $/pupil
9. Link, Ratledge and Lewis (1980)	NLS Young Men age 19-29 in 1969 N=2,127 PSID male heads as in study 6.	See comments for studies 6 and 7. D.V. for NLS = log average wage in 1971. D.V. for PSID = log average wage 1968-72. Expenditures interacted with years of education. Other controls in NLS: IQ, father's education. Other controls in PSID as in study 7.	NLS Whites 0.13-0.17 NLS Blacks 0.15-0.23 PSID Whites 0.24-0.32 PSID Blacks 0.13-0.15 (at mean education for group)
10. Tremblay (1986)	1976 NLS Young Men, age 24-34. N=247 Southern, 496 Nonsouthern	See comments for study 6. Expenditures interacted with education. D.V=log monthly income. Other controls include occupation and industry dummies, IQ, race, age, seniority, SMSA, marital status, occupational training dummy, and union status.	<u>High School:</u> South 0.12 Nonsouth 0.04 <u>College:</u> South 0.05 Nonsouth 0.03
11. Nechyba (1990)	1950-80 Census black and white males (published median incomes by state, race, and age)	State average teacher salary data by race for selected years matched to individuals living in the state by race and 10-year birth cohort. D.V.= state*cohort* Census black-white relative median income. Other controls: differences in black-white years of education and percentages urban residents, percentages of cotton picked by machine, number of affirmative-action complaints.	0.10 (0.02) (based on effect of relative teacher wages)
12. Card and Krueger (1992a)	1980 Census white men age 31-60, not self employed. N=1,018,477	State average school data for 1926-66 matched to individuals by state of birth and years of school attendance. D.V. = log weekly wage in 1979. Other controls: state of birth and state of residence, experience (quadratic), marital status, urban residence.	0.16 (0.02) (based on effect of pupil-teacher ratio)
13. Card and Krueger (1992b)	1960-80 Census black and white men born in South from 1910-49 N=728,284	State average school data for 1916-66 matched to race* state-of-birth*10-year cohort. D.V. = state*cohort*Census black-white log weekly wage gap. Other controls: cohort dummies, year dummies.	0.15 (0.05) (based on effect of relative pupil-teacher ratio)

Notes: Studies 12 and 13 regress wages (or wage differentials) on pupil-teacher ratios (or pupil-teacher differentials. Estimates are translated into expenditure elasticities assuming teacher salaries represent 60% of total expenditures, and assuming the average pupil teacher ratio is 23 (study 11) or 32 (study 12). D.V. denotes "dependent variable"; AFQT is armed forces qualifying test; SES is a composite socioeconomic status measure.

Table 2: Summary of Selected Estimates of the Effect of School Quality on Years of Completed Education

Study		Estimated Elasticity of Completed Education w.r.t Expenditures per Pupil
1. Johnson and Stafford (1973)[a]		0.05 (0.02)
2. Morgenstern (1973)	Blacks	0.15 (0.03)
	Whites	0.09 (0.03)
3. Ribich and Murphy (1975)		0.02 (0.01)
4. Wachtel (1975b) (sample as in Wachtel, 1976)		0.00 (0.01)
5. Card and Krueger (1992a)		0.19 (0.01)
6. Card and Krueger (1992b)		0.47 (0.03)

Notes: See description of studies in Table 1. Unless otherwise noted, specifications are similar to the models for wages reported for the same study in Table 1. Elasticity estimates assume average education of 12 years.

[a]In addition to controls noted in Table 1, models for educational attainment include father's education and family size.