School Quality and Earnings

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Abstract

The paper reviews the literature on the relation between school resources and earnings. Studies vary on whether there is a significant relationship, with studies that focus on more recent generations and that measure school resources of the actual school attended being less likely to find an effect. Even the most optimistic estimates suggest that increasing school resources is likely to increase wages by only a very small amount. Policies designed to keep students in school longer are likely to be more cost effective than increasing spending per pupil. The review also summarizes alternative explanations for the variations observed across studies.

What factors contribute to high quality schooling? A large literature studies the relation between class size, teacher qualifications, spending per pupil, and other measures of school inputs with gains in student achievement. This literature is quite useful, in part because it uses an outcome close in time to when the student enjoys the benefits of additional resources, and because one could reasonably expect better school resources to boost test scores.

A shortcoming of this approach is that test scores are only weakly linked to adult outcomes that policymakers really care about, such as employment and earnings. For this reason, social scientists have attempted to estimate a link between school resources and earnings of students once they leave school and enter the labor market.

This essay briefly summarizes the methods used in this literature, the findings, alternative explanations for the variation in findings across studies, and weaknesses of the methods used thus far in the literature.

Several patterns emerge:

1 -- Most of the studies that find no link or a weak link between school inputs and student outcomes measure school inputs at the level of the actual school attended; studies that do find a strong effect typically measure school resources at the level of the state.

2 -- Studies that find that school inputs have a strong link tend to examine workers schooled before the 1960s. The opposite holds for studies that find no link.

3 -- Studies that find no significant link often examine workers who are in their early thirties or their twenties at the time earnings are observed.

Estimation Methods Typically Used

The typical study estimates a variation of the following log earnings equation for person i whose wage is observed in year t, who attended school s in region b and who currently resides in region r:

(1) $\ln W_{isbrt} = \alpha + \beta Qual_{is} + X_{ist}\Gamma + V_{ib}\Phi + Z_{irt}\Psi + u_{isbrt}$

where the natural log of earnings (annual or hourly in most work) is assumed to depend on one or more measures of school characteristics $Qual_{is}$, personal characteristics X_{ist} such as age, gender, race/ethnicity, characteristics of the area where a student grew up V_{ib}, characteristics of the area where a person currently resides Z_{irt}, u_{isbrt} is an error term that captures unobserved factors, and the Greek letters indicate coefficients or vectors of coefficients to be estimated.

Several important variants of this equation have been estimated. Some authors have included years of schooling ED_{it} on the right-hand side of this equation, and interacted it with the measure(s) of school resources $Qual_{ist}$, in the belief that school resources should have a bigger effect on earnings the longer one stays in school. However, to the extent that years of schooling and earnings are jointly determined, such models will be biased because years of schooling ED_{it} is an endogenous variable, that is, a variable chosen by the person and influenced by other factors in (1) as well as by unobserved factors. Such models will tend to be biased because of correlation between ED_{it} and u_{isbrt}.

Researchers have measured observed school resources $Qual_{is}$ at different levels of aggregation. Equation (1) assumes that the researcher has data on the actual school attended, but many researchers have proxied for $Qual_{is}$ with measures of spending per

pupil, pupil-teacher ratios and other measures of school resources measured at the district level or even the level of the U.S. state in which the worker was born.

A third important source of variation derives from alternative approaches to modeling characteristics of the place b where a person attended school and the place r where the person resides at the time of the wage observation. Again, authors alternatively measure characteristics of local areas at a disaggregated level such as counties or cities, or more at a more aggregated level, typically U.S. states. Further, other researchers who observe workers in a wide range of years add fixed effects for states in which students attended school and currently reside. These fixed effects control for anything observable and unchanging over time from the regions b and r.

Methodological Weaknesses

The literature as a whole shares numerous weaknesses which make it difficult to treat estimates of β from (1) as estimates of the causal effect of the given measure of school resources on students' earnings years later. The first challenge to a causal interpretation is omitted variable bias: the error term u_{isbrt} likely contains many omitted personal, neighborhood and regional characteristics that directly influence wages. If these are correlated with the explanatory variables such as school resources, then we will obtain biased estimates. Closely related to this concern is endogeneity bias. Economists have shown that people self-select into neighborhoods that offer the mix of taxation and public services that they most prefer. School quality, or perceptions of school quality, clearly are related to families' choice of where to live. This creates a strong positive link

between average student achievement in a school and various measures of socioeconomic status of people living in a given neighborhood or city.

Two potential but partial solutions to this problem are to control for family and neighborhood demographics as well as possible, or to aggregate up beyond the neighborhood of residence to the school district or even the state. Neither of these methods is likely to yield causal estimates. The first method can at best only partially control for unobserved determinants of families' choices of school. The second method, involving aggregation, risks creating aggregation bias if the causal effects of school resources are non-linear. Another potential bias in models that observe school resources at the state level is the possibly non-random measurement error due to systematic differences between the location in which one was born (the most commonly used proxy for the state in which a student attended school in the many studies that use Census data), the state in which one attended school, and the state in which one lived at the time of the wage observation.

A problem that potentially afflicts the school-level studies is random measurement error in the measures of school resources, which will bias findings toward conclusions of a zero link to earnings. Small sample size is a second potential issue.

Summary of Findings

The literature review below, unless stated otherwise, discusses the relatively large U.S. literature

<u>Testing for a Significant Relation between School Resources and Earnings</u>

When a researcher asks "Does school quality matter for earnings of students?", this question can be interpreted in several ways. One response is to ask whether students who attend certain high schools tend to earn more than students who attend other schools. Both Betts (1995) and Grogger (1996a) find that earnings of adults vary significantly by U.S. high school attended, even after controlling for a host of personal characteristics.

But the literature that instead tests for a relation between school resources and earnings of students typically finds either a zero or only a small link between earnings and measures of school resources.

The measure of school resources most typically used is school spending per pupil in the district attended, or in the worker's state of birth. Other measures of school resources include the pupil-teacher ratio, or its reciprocal, various measures of teacher education, teacher salary, and in a few studies teacher salary, books per student or length of the school year.

Betts (1996a) reviews the U.S. evidence in detail. Because the patterns in the literature are fairly similar across measures of school resources, below we will focus mainly on the evidence regarding spending per pupil and the teacher-pupil ratio (or its reciprocal).

Most of the state-level estimates (83%) found a positive relation between spending per pupil and earnings, compared to 51% of the estimates based on district-level spending per pupil. The single existing estimate based on school-level spending per pupil found no significant link. This pattern, of more positive findings when one proxies school resources based on the worker's state of birth rather than based on the actual school or district attended, extends to most of the other measures of school resources.

For example, Betts (1996a) reports that the percentage of estimates that found a positive association between earnings and the teacher-pupil ratio when the teacher-pupil ratio was measured at the state, district, and school level were 19, 0 and 0 respectively.

Figure 1 shows for the U.S. studies the patterns of statistical significance across studies. Black bars indicate studies in which fewer than a third of results suggest a significant positive relation between school resources and earnings, while grey and white bars indicate cases where one-third to two-thirds and more than two-thirds, respectively, of estimates suggest a positive relation. The horizontal axis indicates the years in which the adults in the study were likely to have enrolled in grades 1 through 12. Vertically, the studies are arranged to display differences between studies that measure school resources at the school level, the district level, or by state of birth.

The figure shows that school-level studies are much more likely than the district-level studies, and especially the state-level studies, to find no statistically significant effects of school resources on earnings.

The figure also suggests that studies of workers who attended U.S. public schools in the late 1950's forward are much more likely to find no significant effects of school resources than are studies of earlier cohorts.

Results for U.S.Women and Workers in the United Kingdom

The literature that Betts (1996a) reviews includes only American studies. Remarkably, up to that point the American literature had studied only men's earnings but not women's earnings. A number of studies since that time partially fill in these voids.

For instance, Harmon and Walker (2000) and Dearden, Ferri and Meghir (2002) test for an association between earnings and school resources in the United Kingdom.

Harmon and Walker find that in England and Wales, there is no significant link between earnings and various measures of school resources such as pupil-teacher ratios, actual class sizes, teacher salaries or spending on textbooks. Similarly, Dearden, Ferri and Meghir find that in Britain pupil-teacher ratios are not significantly related to adult mens' wages.

Dearden, Ferri and Meghir (2002) model outcomes for British women and find some evidence that pupil-teacher ratios are significantly negatively related to women's earnings at age 33, but only for women of lower academic ability, as measured at age 11. Betts (2001) provides the first study of the relation between school resources and the earnings of women in the United States. For white women, no significant connection between school resources and wages emerges. But the pupil-teacher ratio and library books per student are significantly and positively related to black women's wages, even though overall spending per pupil in the district and teachers' salaries bear no relation to black female students' subsequent earnings.

Estimating the Size of the Relation between School Resources and Earnings

As we have seen, the level of aggregation at which school resources is measured appears to be related to the likelihood that a statistically significant relation to wages emerges. A second and perhaps related pattern is that the size of the estimated relation between resources and earnings tends to be bigger when the researcher proxies the school resources workers received based on their state of birth, than when resources are measured for the district or school actually attended. For example, the elasticity of earnings with respect to spending per pupil averages 0.128 in the state-level studies but

only 0.096 in the studies that measure actual spending per pupil at the district level. (Elasticity is a measure of how much one variable is predicted to change given a change in a second variable. The state-level elasticity of 0.128 implies that a 1% increase in spending per pupil is associated with a 0.128% increase in earnings of workers once they leave school.)

This pattern applies to all of the school resources studied in Betts' review. For instance, the average elasticity of earnings with respect to the teacher-pupil ratio in state, district and school studies is reported to be 0.099, 0.024 and -0.037 respectively.

In an absolute sense, are the elasticities discussed above big or small? To assess this, one can think of education as an investment. Just as a firm invests in equipment and worker training at a new plant with the expectation that the plant will generate revenues in future periods, one can think of an increase in spending per pupil today as an investment that will pay dividends in the future, as students who benefited from this spending graduate, enter the labor market, and earn more.

A difficulty with evaluating the returns to either type of investment is that all of the costs are up front, while the benefits do not accrue until the future. A dollar today is worth more than a dollar a year from now because if the discount rate (which can be thought of as an interest rate) is 10% (r=0.1), then a dollar saved today yields (1+r) dollars a year from now, or $1.10. The solution to this is to calculate the present discounted value of the investment project. The stream of benefits (higher wages less the costs of higher school spending) are expressed in today's money by discounting them to the base period. For example, consider a project which costs $1 today and produces

benefits next year and the year after of $1.21 and $1.33. Then with a discount rate of r=0.1, the present discounted value (PDV) is:

$PDV = -\$1 + \$1.21/(1+0.1) + \$1.33/(1+0.1)^2 = \$1.20$

The higher the present discounted value, the better is the investment project. A project with a negative PDV should not be undertaken.

Figure 2 shows estimates by Betts (1996a) of the present discounted value of increased spending per pupil, estimated at the state and district level, plotted against the discount rate. To provide a comparison, the figure also shows estimates of the present discounted value to society of an individual staying in high school for one year longer or attending college for one year. The present value of staying in school or college is far higher than the estimates of the present value of increased spending per pupil. Indeed, as the discount rate increases, the present discounted value of increased spending per pupil quickly becomes negative.

One way of comparing the returns to spending of the given type is to calculate the internal rate of return, that is, the discount rate at which the present value equals zero. At discount rates beyond the internal rate of return, no rational investor would undertake the project because it would produce a negative rate of return. Thus, better investment projects will have a higher internal rate of return. But what is a reasonable internal rate of return? One reasonable point of comparison is the average real rate of interest, that is, the interest rate minus the rate of inflation.

Figure 3 plots the internal rate of return to increasing spending per pupil (based on both state and district-level studies), with the average real interest rate overlaid as a horizontal line. The figure makes clear that a student who stays in high school or college

for an extra year is making a good investment. Conversely, even the more optimistic estimate of the effects of increasing spending per pupil suggests produces an internal rate of return below real interest rates. Betts (1996a) also estimates the internal rate of return to reducing the pupil-teacher ratio, and finds even lower rates of return.

One infers that policies to keep students in school longer, such as raising the school-leaving age, are likely to be more cost-effective than increasing spending per pupil. This of course raises an important question: are increases in educational resources associated with increases in years of schooling? This question is beyond the scope of this review. However, Betts (1996a) and Betts (2001) suggest either a weak or no relation between resources and educational attainment for men and women in the U.S. respectively.

Explanations for Variations in Results

Figure 3 suggests that the level of aggregation of the school resources matters, and that studies of American cohorts educated from the late 1950's forward are much less likely to exhibit a positive relation between school resources and earnings. Betts (1996a) also observes that many of the school-level studies focus on earnings of relatively young workers. What might explain these patterns?

Age Dependence

First, suppose that the effects on wages of attending schools with ample resources do not manifest themselves until workers are well into their careers. This alone could explain the general lack of significant results in the school-level studies. Betts (1996b)

addresses this question using Census data and also by projecting mid-career earnings of younger workers based on their occupation, and finds no evidence of positive age-dependence. Betts (2001), which provides the first U.S. evidence on school resources and women's earnings, uses a very long panel that observes women's wages from ages 18 to 50. This paper finds no positive age-dependence, and if anything, the effects of school resources appear to weaken as women become older.

Structural Changes?

The observation that studies focused on those educated in the late 1950's and later years are less likely to find positive relationships between school resources and earnings raises questions about whether some type(s) of structural change(s) might have occurred in American public schooling. Such changes could have arisen from diminishing returns, increasing bureaucratization and centralization of public schools, and rising teacher unionization. Betts (1996a) provides an overview of each of these ideas, in particular examining whether the returns to increased school resources may be diminishing as levels of school resources have risen over time.

Hoxby (2000) provides evidence that workers who attended large districts that face little competition from other districts tend to earn less than otherwise similar workers. This finding could hold relevance for the structural change hypothesis because of a rapid consolidation of school districts that took place in the United States between 1945 and 1970 (Betts, 1996a).

Hoxby (1996) studies the relation between school resources and earnings of former students, and how the unionization of teachers mediates this relation. She

replicates Grogger's (1996a) results from the same data-set that there is no significant link overall between school resources and earnings. But when she divides the sample into students who attended unionized versus non-unionized schools, she finds that some of the school resource measures do become significant predictors of adult outcomes in the non-unionized schools. Given that the percentage of U.S. public school teachers who were unionized tripled between 1960 and 1984, this finding could account for the apparent structural change that may have weakened the relation between school resources and earnings.

Hoxby and Leigh (2005) extend this teacher-union argument, focusing on the incentives for female graduates of selective universities to become teachers. They argue that unionization has compressed the variation in teachers' pay related to measures of teacher ability. This tendency, combined with the gradual opening of more career opportunities beyond education for women led to a sharp shift in the composition of the new female teacher labor force, towards women who graduated from the lowest-tier universities.

Specific Problems Potentially Afflicting State-Level and School-Level Studies

One reason why the school-level studies may find no effects are that the sample sizes are small, in which case the studies might have little statistical power. Betts (1995) finds evidence against this hypothesis in the case of the pupil-teacher ratio and teacher education, but evidence in the case of teachers' relative salary that a lack of variation in this variable could explain the insignificant results.

A second potential problem with the school-level studies is that the school inputs are measured with error, so that their coefficients will be biased toward zero. State-level analyses might reduce this problem, since they use an average taken across schools. One can test this hypothesis directly by rerunning the school-level analyses using two stage least squares (2SLS), with state-level school resources serving as instruments for the school-level variables. Both Grogger (1996a) and Betts (1995) take this step and find that the instrumented school inputs remain insignificant. This finding reduces the plausibility of the existence of significant measurement error. Grogger (1996b) tests for measurement error in a slightly different way and concludes that it is minor.

What issues may affect the validity of the state-level estimates?

Aggregation bias could be an issue if there is a non-linear relationship between school resources and student outcomes. Hanushek, Rivkin and Taylor (1996) develop this argument in detail, and Betts (1996a) surveys evidence in other studies to this effect.

Omitted variable bias seems likely in studies that proxy the resources at the school a worker attended by using average resources in that worker's state of birth. Both Rizzuto and Wachtel (1980) and Akin and Garfinkel (1977) report that in some of their state-level models school resources become insignificant once control for income per capita. Betts (1995) finds that state-level resources do sometimes enter significantly in his sample, but whatever association there is does not work through correlation with the resources at the actual school attended. This raises concerns that state-wide averages of school resources can sometimes proxy for other characteristics of a state.

Heckman, Layne-Farrar and Todd (1996) provide two key criticisms of the state-level literature. First, they show that once one allows for the returns to a year of

schooling to be non-linear, then the only workers whose earnings appears to remain correlated with state-level school resources is university graduates, who in the time frame they study constituted a distinct minority of the population. Second, these authors raise questions about non-random migration from state of birth, which could influence the coefficient estimates in studies that proxy school resources based on workers' state of birth.

Issues that Require Further Research

The literature suggests a fairly narrow range of estimates of the relation between school resources and earnings of students once they leave school. Some patterns emerge. In the United States, school resources may have become less strongly associated with earnings of workers over time. Also, studies that measure school resources at a finer level of geographic aggregation are less likely to find a positive association.

But the entire body of work appears to agree that the relation between school resources and earnings of adults ranges between none and small but positive. Even the most positive results, based on studies that measure spending per pupil based on each worker's state of birth, suggest an internal rate of return far below the rate of return to an extra year of high school or university, and below the real rate of interest.

Should we interpret these anemic effects as a sign that policymakers have been wrong to increase spending on schools, or that increased resources can never have an effect on adult earnings? The answer to both questions is probably no. There may be policy reasons for increasing school resources more generally that relate to student outcomes quite distinct from earnings. For example, suppose that increased school

resources improve student attitudes along lines that that society values. This could fruitfully be studied. Similarly, it would be inappropriate to extrapolate from the historical studies reviewed here to reach the conclusion that "more spending can never matter". It could be that if policymakers increased spending in different ways than has been done historically, the benefits could be greater.

For example the recent trend in the United States of coupling infusions of money with student testing and school accountability provides a distinct shift from that nation's past trends in educational spending.

Finally, note that none of the studies establishes a causal relationship between resources and students' subsequent earnings as adults. Rather, they study correlation. Increasingly, researchers use actual experiments to examine whether an educational intervention affects test scores, or quasi-experiments that try to minimize the possibility that school resources and student outcomes are co-determined by some other set of variables or policy influences. In some experimental studies of various school interventions, it may soon become possible to study the long-term consequences of these interventions on adult outcomes including earnings.

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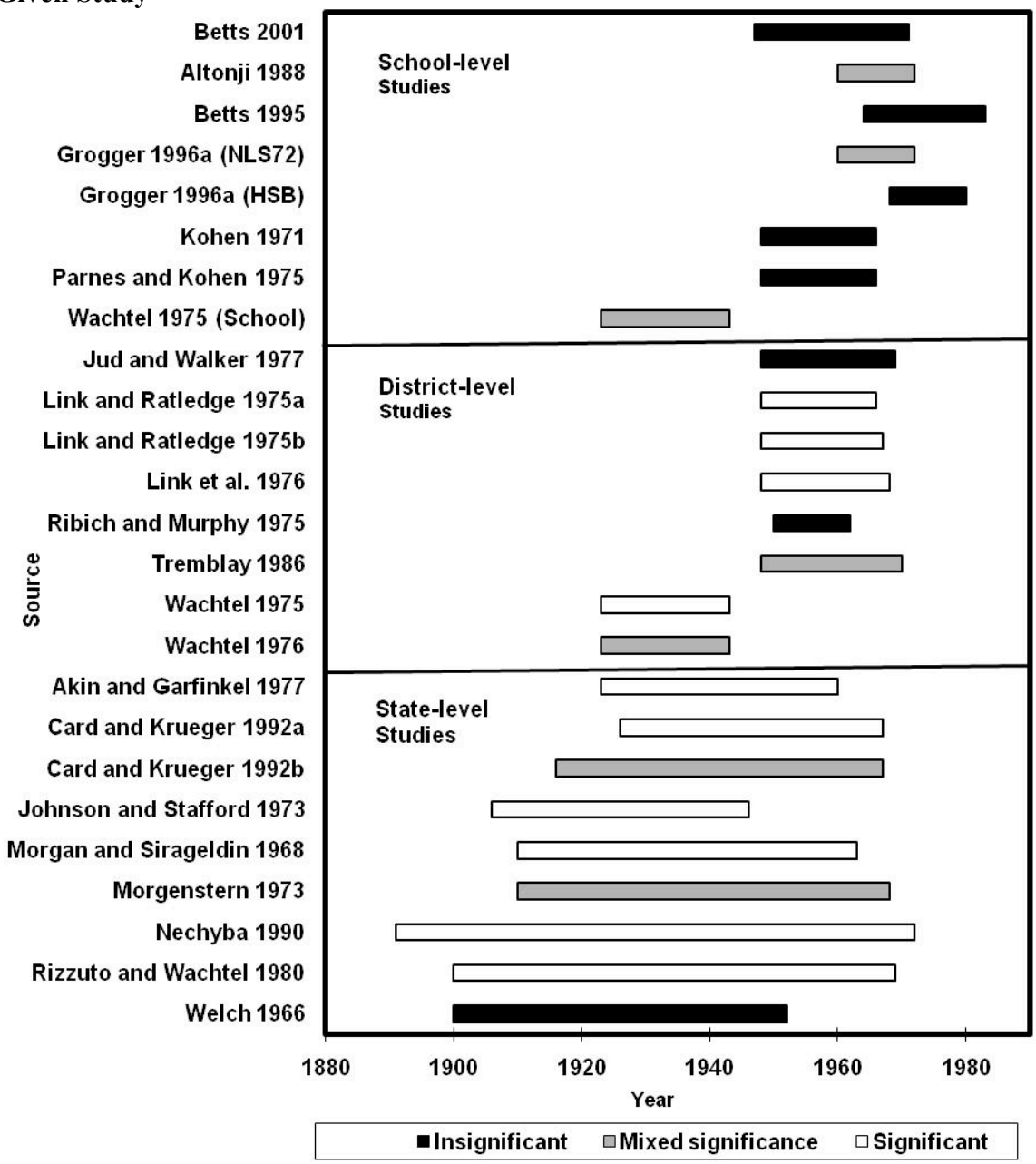
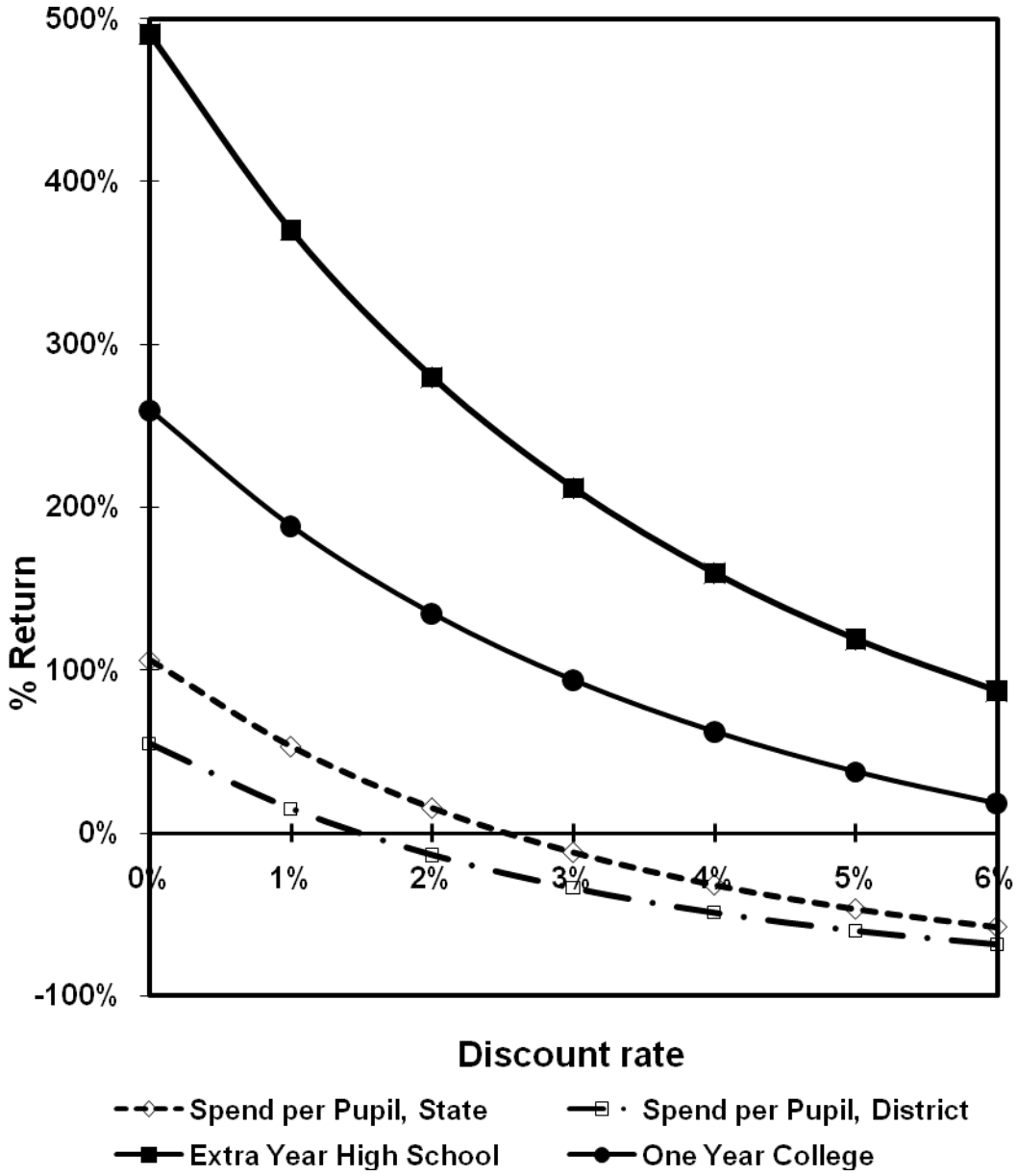
Figure 1 Patterns of Statistical Significance across Years Students Were Enrolled in Grades 1 to 12, and across Level of Aggregation of School Characteristics in the Given Study



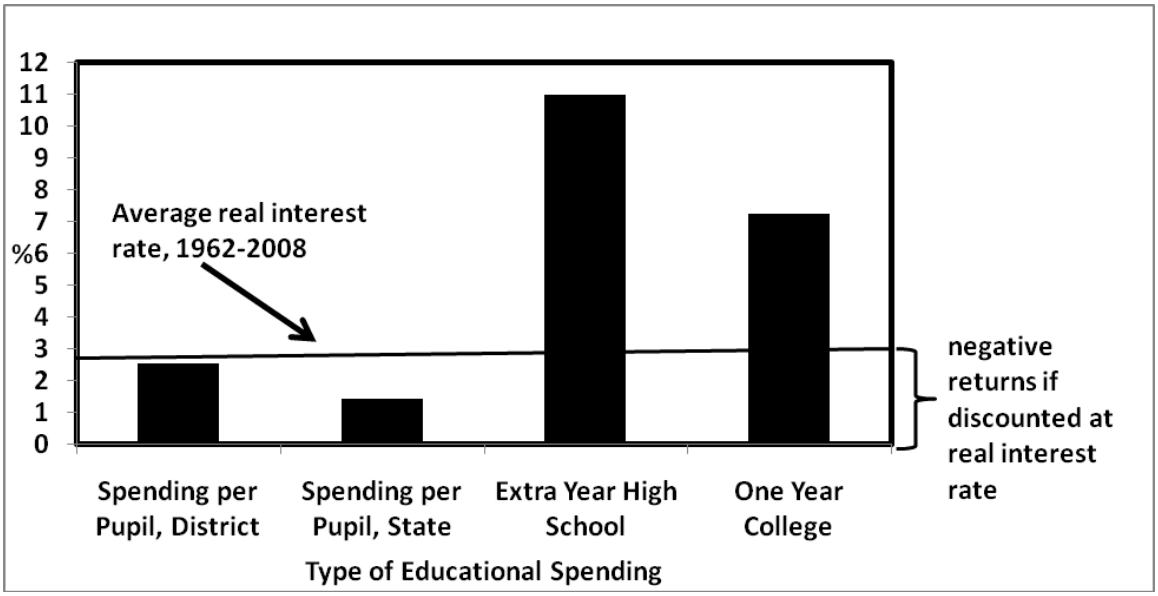
The bars indicate the range of years in which adults in the given study would have attended grades 1 through 12. The shading indicates the percentage of estimates of the relation between school resources and earnings are significant. Dark bars ("Insignificant" indicates studies in which none to 32% of estimates were significant, "Mixed Significance" indicates that 33-65% of estimates were significant, and "Significant" indicates that 66-100% of estimates were significant.

Figure 2 Net Percentage Return to Various Types of Educational Investments Plotted Against Discount Rate



Note: Based on results in Betts (1996a).

Figure 3 Comparison of Internal Rates of Return to Increased Spending per Pupil (from District and State-Level Studies) and Increased Time Spent Enrolled in High School or College



Note: The real interest rate was calculated as the average yield on ten-year U.S. Treasury bonds minus inflation in the U.S. Consumer Price Index, averaged over 1962-2008. It averaged 2.64 percent over this period. Historical data on Treasury bond interest rates and the Consumer Price Index were downloaded from, respectively, http://www.federalreserve.gov/releases/h15/data/Annual/H15_TCMNOM_Y10.txt and ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt.

Suggestions for Cross-References

Education and Economic Growth

Economic inequality and education

Human Capital

Teacher Quality in Education Production

Teacher unions

Cost-benefit and cost-effectiveness analysis

Education production functions - concepts

Education Production Functions: Developed Country Evidence

Biography

Julian Betts, Professor and Chair of the Department of Economics at the University of California, San Diego, is also a Research Associate at the National Bureau of Economic Research and an Adjunct Fellow at the Public Policy Institute of California (PPIC). His research focuses on the economics of education. He has written extensively on the link between student outcomes including test-score gains, course-taking and longer-term outcomes such as educational attainment and earnings and measures of public school resources (such as class size, teachers' salaries, and teachers' qualifications). He has authored or co-edited a number of volumes on school choice. He has also examined the role that standards and expectations play in student achievement. Current research includes federally funded studies of Career and Technical Education and magnet schools. Betts has also served on several technical review panels for the U.S. Department of Education, two National Academy of Science panels, and the national advisory committees for the National Charter School Research Center at the University of Washington. In 2001-2003 Betts served on the National Working Commission on Choice in K-12 Education. He is a member of the editorial board of Education Finance and Policy, published by MIT Press.