Note: This paper has been published as:
(2001), "The Impact of School Resources on Women's Earnings and Educational Attainment: Findings from the National Longitudinal Survey of Young Women", *Journal of Labor Economics*, (**19**:3), pp. 635-657.

The Impact of School Resources on Women's Earnings and Educational Attainment: Findings from the National Longitudinal Survey of Young Women

Julian R. Betts
Department of Economics
University of California, San Diego
La Jolla, CA 92093-0508
(858) 534-3369
e-mail: jbetts@ucsd.edu

May 2000

This research was supported by a grant from the Bureau of Labor Statistics, U.S. Department of Labor and the Institute for Research on Poverty at the University of Wisconsin. I thank Ron White for excellent research assistance, and Edward Lazear for helpful comments.

ABSTRACT

The paper measures the impact of high school resources on women's educational attainment and earnings. No link emerges between education and school resources – as measured by the pupil-teacher ratio, spending per pupil, teachers' starting salaries or books per student. For white women, no significant connection between school resources and wages is found. But school inputs are in several cases significantly and positively related to black women's wages. Wage elasticities with respect to school inputs are uniformly larger for black women. Finally, the impact of school resources on earnings remains constant or in some cases weakens as workers grow older.

I. Introduction

Each year public authorities spend approximately 200 billion dollars on educating the nation's children in primary and secondary schools.[1] Administrators must decide how to allocate these resources along a variety of margins. Historically, increases in the school-leaving age have raised total educational spending at the extensive margin because the proportion of young people enrolled rose in response. More recently, educational expenditures have risen at the intensive margin as government has increased real spending per pupil. Hanushek (1986, 1989, 1991) notes that real spending per pupil more than doubled between the mid 1960's and the mid 1980's. During the same period, the pupil-teacher ratio dropped by approximately one third, and the percentage of teachers who held postgraduate degrees more than doubled.

Given the scarcity of public funds, it becomes important to measure the overall effectiveness of educational expenditures. It is also important to know if some margins of spending -- teacher salaries, spending to reduce class size, or instructional resources such as school books -- are more effective than others. In the aforementioned reviews, Hanushek finds that most studies of test scores have found that additional expenditures do not have a systematic relationship with students' test scores or gains in test scores.

A smaller literature attempts to measure student outcomes based on students' earnings once they enter the labor market, or their ultimate level of educational attainment. These provide useful approaches because one of the main goals of public education is to prepare students for the labor market. Betts (1996a) reviews this literature and finds mixed results. Studies that use proxies for the school resources allocated to

[1] U.S. Bureau of the Census, 1992, page 280.

each student based on his state of birth and state-level averages of school resources typically find a positive and significant link to both earnings and educational attainment. However, Betts (1996a) finds that the internal rate of return to school spending based on these measures is quite low, on the order of 2-3%. Moreover, recent work by Heckman, Layne-Farrar and Todd (1996) reports that the estimated impact of school resources on earnings becomes much weaker in the state-level literature once one allows for non-linear returns to education. Betts also summarizes several studies that measure school resources at the actual school attended; these studies generally report no significant link between school resources and earnings, and smaller elasticities than in the state-level literature. Recent examples include Altonji (1988), Betts (1995) and Grogger (1996).

Surprisingly, each of the 23 studies reviewed by Betts (1996a) examines the impact of school resources on the earnings of adult men only. This gap in our knowledge greatly restricts our ability to gauge the effectiveness of school spending. If the returns are higher for women, the case for further increasing school spending could be much greater than stated in the literature review by Betts.

The goal of this paper is to present the first study that specifically examines the impact of school resources on labor-market outcomes of women.[2] The paper uses the National Longitudinal Survey of Young Women (NLS-YW). Two measures of adult outcomes are used. First, the educational attainment of women is modeled as a function of various measures of school inputs and other background variables. Second, the log hourly wage of women is modeled. Because selectivity bias arises in models of women's

[2] A recent paper by Altonji and Dunn (1996) models the impact of school inputs on earnings using a pooled sample of men and women, but does not present separate estimates for women.

earnings due to endogenous labor force participation, the paper uses the Heckman two-step correction for selection into employment.

The NLS-YW is a useful dataset for modeling the impact of school resources on outcomes for women. A first advantage is that school inputs such as teacher salaries and class size are available for the actual high school or school district attended by each woman, based on a 1968 survey of each of the schools. Second, the NLS-YW provides a very long series of observations on labor force outcomes for women. The survey began in 1968, and provides a series of annual surveys up to 1973, and thereafter provides survey data spaced from one to three years apart, for a total of 16 surveys. The paper analyzes all the available data up through the 1991 interview. This allows one to follow the labor-market progress of women from their teens up through their ages in 1991, which ranged from 37 to 50.

The broad range of ages allows for a convincing test of whether the impact of school resources on adult outcomes increases with the worker's age. As Betts (1996a) notes, one way to explain the weak or non-existent estimated impact of school resources on adult earnings in the earlier studies which measure school inputs at the level of the actual school attended is to appeal to age dependence. With one exception (Wachtel, 1975) all of these school-level studies observe earnings of workers when they are aged between 17 and 32. Card and Krueger (1996) suggest that the school-level literature, in particular papers by Betts (1995) and Grogger (1996), does not provide good measures of the lifecycle effect of school spending on wages for precisely this reason. Recent evidence by Betts (1996b) suggests that the effect of school spending on earnings is not

age dependent for white males.[3] The NLS-YW, with its unusually wide range of ages, combined with detailed data on the schools attended by each woman, provides a unique opportunity to test this hypothesis further.

The next section describes the data-set, and section III details the results, first for educational attainment, and second for a model of log wages.

II. Data

The paper studies outcomes for all black and white women who were interviewed as part of the NLS-YW. Means and standard deviations are provided for both samples, based on the observations used in the education model, in Table 1.[4] The paper uses four principal measures of the resources devoted to education: spending per pupil in the student's school district, the pupil-teacher ratio in the school, salaries of inexperienced teachers with a Bachelor's degree in the school district, and library books per student in the school. Both the spending per pupil and teachers' salary variables are adjusted for variations in the cost of living in the given city by the administrators of the NLS surveys. This adjustment is important. It reduces the risk that these financial variables will be biased upward in wage models simply because they are acting as proxies for the cost of living in an area (and for the subsequent earnings of women after they leave school and start working in the area). Because the most detailed information provided on the

[3] Betts replicates earlier work which models Census earnings data as a function of school resources in the worker's state of birth, and explicitly tests for age dependence. He finds that the estimated impact of school spending is just as strong for workers in their twenties as for older workers. He also models predicted mid-career earnings of workers in the National Longitudinal Survey of Youth based on the occupation which they held in 1989, when they were 32 years old or younger, and fails to find a significant link between these predicted earnings and school resources.

[4] Sample means and standard deviations from the sample used to estimate women's log hourly wages are highly similar, and are available from the author on request. The mean (and standard deviation) of log

location of the school is the (nine-level) Census region, it is not possible to control for variations in the cost of living nearly as accurately by adding region dummies.

The models of educational attainment use the latest observation available on years of schooling obtained for each woman. The section that models log hourly wages uses all observations for which the woman is 18 or older and does not report attending school or college. (Wages during years in which the woman is enrolled are dropped from the sample to avoid the possibility that the coefficients on the high school resources might be biased downward if women who attend better high schools are more likely to attend college, and at the same time take poorly paying temporary jobs to pay for college.)

III. Results

A. Educational Attainment

The first goal of the paper is to model educational attainment, in the final year in which information on educational attainment is available for each woman. Recent evidence by Heckman, Layne-Farrar and Todd (1996) suggests that the returns to education, and to school spending, are highly non-linear, exhibiting jumps when people obtain high school or postsecondary degrees. Therefore, each woman is allocated to one of five categories based on two variables, years of education (EDUC) and the degrees which she has obtained, HDEG. Below HDEG, the highest degree, is either a high school diploma, Bachelor's or postgraduate degree:

---

hourly wages for white and black women in the regression samples are 1.375 (0.720) and 1.272 (0.706) respectively.

$$(3\text{-}1) \quad ED = \begin{cases} 1 \text{ if } EDUC < 12 \\ 2 \text{ if } HDEG = \text{ High School Diploma and } EDUC \leq 12 \\ 3 \text{ if } HDEG = \text{ High School Diploma and } EDUC > 12 \\ 4 \text{ if } HDEG = \text{ Bachelor's} \\ 5 \text{ if } HDEG = \text{ Master's or Ph.D.} \end{cases}$$

All women who hold a high school diploma but not a Bachelor's or higher, and who report more than 12 years of education, are coded as ED=3, signifying 'some college'.[5]

An important characteristic of the data is that in the final year in which educational attainment was observed, about 7% of women were enrolled in formal education, even though the average woman in the sample is in her late thirties at that time. (See Table 1.) A simple ordered probit is likely to produce biased estimates if this problem is ignored. Accordingly, an ordered probit model which controls for right censoring due to enrollment was estimated. The loglikelihood function is given by the following expression, where X_i is the set of explanatory variables for person i, $ENROLL_i$ is a dummy variable indicating whether the person was enrolled, β is the set of coefficients and α_1, α_2 and α_3 are the thresholds in the underlying latent variable model:

[5] An alternative would have been to categorize women with an Associate degree as distinct from those with some years of college but no postsecondary degree, but the number of women reporting holding an Associate degree as their highest degree was very small relative to the number who were high school graduates with one or more years of college education. Since the goal here was to estimate an ordered probit model, and there is no obvious ordering of these two groups, women with Associate degrees were combined with the larger pool of women with high school diplomas and some years of college with no degree.

$$(3\text{-}2) \qquad \log L =$$

$$(1-ENROLL_i)\left(\begin{array}{l}\sum_{ED_i=1}\log F(-X_i\beta)+\sum_{ED_i=2}\log[F(\alpha_1-X_i\beta)-F(-X_i\beta)] \\ +\sum_{ED_i=3}\log[F(\alpha_2-X_i\beta)-F(\alpha_1-X_i\beta)]+\sum_{ED_i=4}\log[F(\alpha_3-X_i\beta)-F(\alpha_2-X_i\beta)]\end{array}\right)$$

$$+ENROLL_i\left(\begin{array}{l}\sum_{ED_i=1}\log(1)+\sum_{ED_i=2}\log[1-F(-X_i\beta)] \\ +\sum_{ED_i=3}\log[1-F(\alpha_1-X_i\beta)]+\sum_{ED_i=4}\log[1-F(\alpha_2-X_i\beta)]\end{array}\right)+\sum_{ED_i=5}\log[1-F(\alpha_3-X_i\beta)]$$

Note that the contribution to the loglikelihood function for those who already have a postgraduate degree does not depend on whether the person is currently enrolled, while a person who is currently enrolled and for whom ED=1 provides no information at all, since her ultimate level of education could range from level 1 through 5.

The regressors comprising the vector X_i are a constant, age and its square, number of children, dummies indicating whether the woman was married, lived in the south, or lived in a city of 25,000 or more at the time of the education observation, and dummies indicating location of the school for 8 of the 9 Census regions. Given Taubman's (1989) summary of the importance of family background in determining educational achievement, the model also includes four family background variables which derive from questions asked in 1968, the first year of the survey: father's and mother's years of education, the Duncan socioeconomic index of the job held by the head of the person's household when she was 14 years old, and the number of siblings which the woman had in 1968. Some observations had missing values for one or more of these four variables.[6] It clearly would not be appropriate to discard such people, and so the variables were set

[6] See Table 1 for the proportion of each variable missing. It is particularly high for father's education for black women.

to 0 in such cases. Four dummy variables were added to the regression to control for observations which were missing one of these background variables.

Tables 2 and 3 show the results of the ordered probits with censoring for white women and black women respectively. In order to increase the precision of the estimates, each of the measures of school resources is entered in separate equations. [7] For both white and black women, the personal and family background variables are highly significant predictors of educational attainment. Particularly striking is the degree of intergenerational transmission of educational attainment between mother and daughter. The sample of black women is much smaller than that for white women, and so in general the levels of significance are lower in the black sample. Note that the impact of some of the background variables on educational attainment, in particular marital status and the number of children, differs substantially between the two races.

Despite the smaller sample size for black women, there typically appears to be greater evidence of a positive and significant link between school resources and educational attainment among black women than for white women. In the white sample, the coefficients on the pupil-teacher ratio and spending per pupil have perverse signs. The only school resource that appears to have even a weakly significant effect on educational attainment among white women is books per student. The results for the black sample are similar in that no school resource is significantly related to educational attainment, but the coefficients on three of the four school resources are larger. The only exception is spending per pupil, which in both samples has a negative relation to educational attainment.

As a robustness test, tobit models of actual years of schooling that account for right censoring among those still enrolled in school or college at the time of the final observation were run. The results, not shown, are highly similar to those in Tables 2 and 3. Among black women, in all cases except for spending per pupil the coefficients are larger than for white women in that additional school inputs have a larger predicted impact on years of schooling. None of the school inputs are significant at 5%, though. [8]

One advantage of the tobit models is that the coefficients can be interpreted as the marginal impacts on years of schooling. The predicted impacts of additional school inputs on years of education for black women are in some cases meaningful. Most impressively, a 10% increase in the starting salary of teachers with a Bachelor's degree, or $605, is predicted to increase black women's education by about 0.1 year. A 10% reduction in class size is predicted to increase black women's educational attainment by 0.07 year. Similar proportional changes in the other two school inputs do not lead to changes in education which are as large. (In the case of spending per pupil, education is predicted to fall.) The corresponding changes predicted for white women are much smaller: only for teachers' salary and books per student is there a positive measured link between education and inputs, and the coefficients are in both cases much smaller than they are for black women.

In these models, omitted variable bias is a concern. Although the models condition on four measures of family background, there may exist omitted family

---

[7] The school inputs are in almost all cases positively correlated with each other (negatively correlated with the pupil-teacher ratio). The absolute value of the correlation coefficients between the four measures of school resources is typically in the range 0.05 to 0.4. Details are available upon request.

[8] For black women, teachers' salary is weakly significant (p-value=0.09), while the level of significance for the pupil-teacher ratio and books per student is in the 10-15% range. For white women, there is one school input that is nearly significant at 5%: books per student.

socioeconomic traits that are related to educational attainment of women. If these are correlated with school resources, biased estimates could result. If unmeasured family socioeconomic status (SES) is positively correlated with school resources (which is likely due to the large extent to which local property taxes finance public schools), then the coefficients on the school resources could be biased upward. On the other hand, as a result of a long series of court decisions, compensatory finance reforms designed to increase school expenditures for minority students could conceivably have created a *negative* correlation between unmeasured SES and school resources.

Without full measures for family background, it is not possible to test for these two possibilities explicitly. One indirect method of checking the direction of the bias is to compute correlations between the four school inputs and the four family background measures that are included in both the educational attainment models and the wage regressions to be discussed later. [9] For both races, there appears to be a weak but positive association between school resources and measures of family SES. The correlations tend to be stronger and more consistent among blacks. For instance, among black women an increase in father's years of schooling is associated with a smaller pupil-teacher ratio, higher spending per pupil, higher teacher salaries and more books per student. Among white women the same patterns hold except for teachers' salaries, although the correlations are typically weaker.

If school resources are similarly correlated with unmeasured family SES, and if this unmeasured component of SES is positively related to educational attainment, then the foregoing models will have overstated the impact of school spending on educational attainment. The upward bias that would result would probably be higher for blacks than

for whites, given the relative strengths of the correlations. The same problem may occur in the wage models described below.

In summary, the data suggest a strong link between educational attainment and personal background, but at best a statistically weak link between attainment and school resources. An interesting pattern emerges: perhaps due to smaller sample size, the sample of blacks shows a lower level of significance of the personal background variables. But the black sample reveals a more statistically significant impact of spending on teachers' salaries and on reducing the pupil-teacher ratio than does the much larger white sample. But even for black women, the links are only weakly significant. The size of the coefficients on school resources is also larger in the black sample for the pupil-teacher ratio, teachers' salary and books per student variables. The only school input which is even marginally significantly linked to white women's educational attainment is books per student.

[9] The results are not shown, but can be found in Table A-4 of Betts (1996c).

B. The Determinants of Women's Earnings

This section examines the impact of school resources on women's earnings. Evidence from the above section strongly suggests that years of schooling is an endogenous function of personal background (and perhaps of school resources). Therefore this section estimates a reduced form wage equation which does not condition on educational attainment. A second advantage of estimating a reduced form model is that it avoids the difficult issue of deciding whether school resources affect earnings directly (a levels effect) or only by increasing the returns to years of education (an interaction effect), or both. Heckman, Layne-Farrar and Todd (1996), in the context of the literature which models Census wages on school resources proxied by school resources in the worker's state of birth, show that the estimated impact of term length and teacher salary on wages weakens considerably once one allows for a levels as well as an interaction effect. For class size, they find that this change can either weaken or strengthen the estimated impact on wages, depending on the specification and Census year used. Thus, estimation of a reduced form reduces the risk of misspecification.

The dependent variable is the natural log of the hourly wage. Given that the models represent a reduced form, the regressors include the same regressors used to model educational attainment in the previous section. In addition, dummies for the year in which the wage is observed are added for all survey years except 1991.[10]

In order to control for selection into employment by women, a Heckman two-step estimator is used. In the first-stage probit model for whether the woman is employed at the time of the given survey the regressors include the complete set of wage equation

regressors, in addition to a variable indicating the woman's number of children under two years old. This variable is in addition to the total number of children, which appears in both the wage regression and the probit for employment status. The presence of very young children in the household is likely to (and in fact does) have a significant negative impact on labor force participation, because it will increase the reservation wage. But it is less likely to affect current wages conditional upon working: if child-raising reduces women's human capital in the formal labor market due to reduced work experience and on-the-job training, then it is the cumulative number of children, rather than the number of young children at the time of the interview, which should have the main effect on the woman's stock of human capital, and hence her wage.

Although the first-stage probits are not shown, the additional variable -- the number of children under two years of age -- performs well, with t-statistics of -17 to -18 for white women and -7 to -8 for black women.

Tables 4 and 5 show the main earnings equations for white and black women respectively. All t-statistics are corrected for heteroskedasticity induced by use of the selectivity correction. The wage models include the same background regressors used in the models of educational attainment. The personal background variables enter in a highly significant fashion, in the expected directions. Some notable differences between the wage functions of black and white women emerge, in particular with respect to the sign of the marital status dummy and the relative sizes of some of the coefficients on the background variables, such as the dummy indicating residence in the South.

[10] Thus the regressions, which use the log of nominal wages as the dependent variable, are equivalent to a model with log wages which are expressed in 1991 prices for all years.

Regression #1 in the two tables shows the estimated impact of the pupil-teacher ratio for black and white women. The pupil-teacher ratio is large, negative, and highly significant for black women. In contrast, using the white women sample, the pupil-teacher ratio is significant but has a positive sign. (Grogger, 1996, reports similar findings for males using both High School and Beyond and the National Longitudinal Study of the High School Class of 1972.) The bottom of the table lists the elasticity of the wage with respect to the pupil-teacher ratio.

Regression #2 in the two tables reports results for models which include spending per pupil in the school district as an explanatory factor. Spending per pupil is not significantly related to the log hourly wage for either sample. For white women the coefficient again has a perverse sign.

Regression #3 shows the findings when the starting salaries of teachers with Bachelor's degrees are used as an explanatory factor. In neither sample is this school input significantly related to earnings, although it becomes significant at 7% in regression #3 for black women. As with the other school inputs, the elasticity of wages with respect to teachers' starting salaries is larger for black women than for white women.

Regression #4 in Tables 4 and 5 shows that books per student are strongly positively related to wages for black women, but strongly negatively related for white women. Earlier work by Betts (1995), Kohen (1971) and Parnes and Kohen (1975) reports no significant link between men's earnings and books per student at high schools.[11]

[11] However, the latter two papers use books per student as part of a 'school quality' index, so that it is not possible to state with certainty that books per student have no effect on earnings in their sample.

In sum, a clear pattern emerges in the wage regressions. For all four measures of school resources, the elasticity of earnings with respect to spending on the given resource is much higher for black women than for white women. Consider first results for black women. The statistically most significant results for black women are findings of a positive link between their earnings and spending on books per student or spending aimed at reducing the pupil-teacher ratio. The impact of teacher's salaries is positive and moderately significant. For spending per pupil, the coefficient was not significant but was positively signed. The results for white women contrast quite sharply. Three of the inputs -- pupil-teacher ratio, spending per pupil and books per student -- have the 'wrong' sign, and in two cases were significant. The strongest positive result from the analysis of white women's wages concerns teachers' salaries, where the estimated wage elasticity (and t-statistic) were 0.065 (1.47).

Testing for Age Dependence

A key question in the school quality literature is whether the returns to school spending depend on the worker's age. An important goal of this paper is to test further the hypothesis that past school-level analyses have understated the returns to school spending because their samples have typically been confined to young workers in their early twenties. The NLS-YW is particularly suited to addressing this question since wage observations in the samples range from age 18 up to age 50 for white women and 18 to 49 for black women. No similar longitudinal sample with school-level data yet exists for men in the United States. Accordingly, all of the regressions in Tables 4 and 5 were

repeated with the addition of an interaction between the worker's age and the given school resource.

Table 6 shows the coefficients and t-statistics on the given school resource and the interaction between the worker's age and the school resource, for each of the eight models. As shown in the top panel, in the white sample there is no evidence that the impact of changing the pupil-teacher ratio changes with age of the worker. For the black sample, there is some evidence of the effect strengthening with the worker's age, but the interaction term is not significant at 5%. Note that in the sample of black women, there is highly significant evidence that the impact of spending per pupil on earnings *declines* with the age of the worker -- in other words, the impact of school resources appears to depreciate once workers enter the labor market. For white women, the interaction of spending per pupil with age is also negative, but is not statistically significant. Neither sample suggests that the impact of teachers' starting salary on students' later wages increases with the workers' age. The impact of books per student on white women's wages appears to weaken with the workers' age, although the interaction term is not quite significant at 5%.

Thus, there were only two cases of statistically significant age dependence near or above the 5% level, and here the dependence was negative (for spending per pupil for black women and books per student for white women), suggesting the depreciation of human capital with age. For the other inputs and samples, the evidence suggests no age dependence. These findings thus support the findings in Betts (1996b) who uses both Census data and projected mid-career earnings from the National Longitudinal Survey of Youth, and finds little evidence in favor of age-dependence.

Formal Tests for Different Returns for Black and White Women

The paper presents the above analysis separately for black and white women, given that the coefficients on many background variables vary by race. But it remains important to test formally whether the impact of school resources is significantly different between black and white women. Therefore, all of the models in Tables 4, 5 and 6 were re-estimated after pooling black and white women, and adding interactions between every regressor (including the constant) and the dummy variable BLACK. In the models with no age interaction with the school input, the t-statistic on the school input interacted with BLACK provides a test for equal effects between the two races. In the case of the models with interactions between the school input and age, a likelihood ratio test was performed for the hypothesis that the two interactions (between BLACK and the school input and between BLACK, the school input and age) do not belong in the model.

The results of these tests confirm the impressions given by Tables 4-6. With a p-value of less than 0.01, the hypothesis of equal effect of school inputs on wages for black and white women is rejected for the pupil-teacher ratio, (both models), and for books per student (both models). For teacher's salary, the hypothesis was retained in both models; for spending per pupil, the hypothesis was retained in the model with no age interactions but was rejected (p-value=0.028) in the model with age interactions. Thus the apparent inter-racial differences in the effectiveness of the pupil-teacher ratio and books per student, and to some extent overall spending per pupil, are statistically significant.

Tests of Robustness

Several alternative estimation techniques were used. First, to guard against the possibility that outliers in the school inputs are driving the results, the basic models in Tables 4 and 5 were re-estimated after eliminating apparent outliers. [12]

Because of space constraints, the results are not shown, but it is easy to summarize the results. [13] For white women, the exclusion of potential outliers does not appreciably affect the results. The most important change is that the sign on spending per pupil becomes positive for white women in the trimmed sample, although it remains insignificant. For black women, the trimming of the sample has negligible effects for the coefficients on the pupil-teacher and books per student regressors, but in the case of both spending per pupil and teachers' starting salary, both coefficients and t-statistics more than double. In the trimmed sample, spending on all four measures of school resources is positively and significantly related to black women's earnings after leaving school. [14]

Two other wage models were also estimated, in which a random effects estimator was used to take account of repeated observations on each school, based on the full sample and the trimmed sample. [15] The results suggest no major changes in interpretation for the results on white women: the coefficients rise or fall, depending on

[12] The potential outliers were chosen by plotting histograms of the school input for the regression sample, and then removing observations that appeared to be isolated observations on either tail. The lower and upper cutoffs for each of the four school inputs was as follows: for the student-teacher ratio, 10 and 50, for expenditures per pupil, 200 and 1000, for starting teachers' salaries, 4000 and 8000, and for books per student, 10 and 300. In practice about 0.5% of the sample was removed from either tail for most school inputs. The exception was spending per pupil, where approximately 1.5% of the black and white sample observations came from schools with spending per pupil above the upper cutoff of $1000.

[13] For the full set of regression results discussed in this section, see Table A-5 of Betts (1996c).

[14] The ordered probit and tobit models of education were also re-run using the same criteria to trim the sample. There were only two major changes. First, for white women, in both models books per student, while still positive, becomes insignificant at even 10%. Second, for black women, in both models the coefficient on teachers' starting salary becomes significant at 5%, and is larger than in the full sample model. For instance, in the tobit model the coefficient (and t-statistic) on teachers' salary rise from 0.0002 (1.70) to 0.00038 (2.55) respectively.

the input in question, and the t-statistics are slightly lower. For the regressions using black women, the changes are more dramatic. For both the pupil-teacher ratio and books per student, the coefficients and t-statistics fall by over half. For spending per pupil and teachers' starting salary, the coefficients generally rise, but the t-statistics fall. The only input that remains highly significant for black women in the random effects model is teachers' salary.

Unfortunately, Hausman tests for the consistency of the random effect estimators strongly rejects consistency in every model. These models are likely to have inconsistent coefficients and inconsistent t-statistics as well. Thus, although the models suggest that the relation between school inputs and black women's wages is much less significant than indicated by the OLS models, the random effects estimators are not the preferred estimators given the fact that the null of consistency is strongly rejected in every case. Nevertheless, the results suggest that the high levels of significance of the school inputs in the OLS regressions for black women need to be interpreted with caution.

In summary, the alternative specifications suggest that some of the estimates for black women are less certain in magnitude and significance than stated in Tables 4 and 5. The random effects estimates for black women suggest that the school inputs are only weakly significant, with the exception of teachers' starting salary, which remains moderately or strongly significant, depending on the sample. However, this information is of limited use given evidence that the random effect estimators are inconsistent. The estimation of models which exclude potential outliers in the school inputs suggest that both the size and level of significance of spending per pupil and teachers' starting salary

[15] Again, results from these models can be found in Table A-5 of Betts (1996c).

are understated in the OLS models for black women. In contrast, the robustness tests suggest no major changes in the interpretation of the results for white women.

Comparing the Results to Findings from the Literature for Men's Wages

Table 7 restates the wage elasticities with respect to school resources estimated in this paper for women, while the box on the right side lists average elasticities estimated for men in the existing literature, as reported by Betts (1996a). The latter paper found that wage elasticities for men tend to rise with the level of aggregation of school resources, from school to district, to state of birth. The comparisons between the current estimates for women and the results in the literature for men vary. But in general, the pattern that emerges is that the current estimates for black women are similar to state-level results for men while the results for white women are smaller and closer to the school-level estimates for men.

For instance, the elasticity on pupil-teacher ratio for black females is very close to the level of -0.099 that Betts (1996a) calculates as the average in the literature on men's earnings which measures class size at the state level. In contrast, existing school-level analyses of the effect of class size on men's earnings on average report a perverse elasticity of earnings with respect to the pupil-teacher ratio of 0.037. Thus the elasticity for white women found here is very close to the school-level elasticities found for men, while that for black women is very close to the more optimistic results typically found for males in the state-level literature.

Both samples produce estimated elasticities of hourly earnings with respect to district-level spending per pupil which are far below the average found in studies of the impact of district level spending on adult males' earnings.

Recall that in the current study the teacher salary variable is based on district-wide averages. The elasticities reported here (0.06 for whites and 0.11 for blacks) fall below the average of 0.22 for existing district-level studies but well above the school-level average of -0.03, as reported in the literature review by Betts (1996a).

Finally, the results for library books per pupil for black women exceed the lone estimate available for white men (from Betts, 1995), while the results for white women are smaller.

All in all, the results are fairly similar to what has been found for men.

IV. Conclusion

This paper provides the first attempt to test specifically for a relation between high school resources and the educational attainment and earnings of women after they leave school. The most striking finding of the paper is a pattern in which school resources in general have a stronger effect on wages for black women than for white women, both in terms of statistical significance and elasticities.[16] For white women, in no case did the results suggest a positive link between school resources and earnings at the five percent level. In contrast, for black women school resources were positively and moderately or strongly significantly linked to wages in three of four cases.[17] The higher

[16] For both races, the school inputs were typically insignificantly linked to educational attainment, but in two cases the elasticities for black women were quite high.

[17] Perhaps the most similar result between races was a weakly significant impact of teachers' salaries on earnings, with an elasticity for white women about 60% that for black women.

level of statistical significance and the higher elasticities for black women is especially notable given that the wage sample for blacks was only a third that for whites. Perhaps the most robust finding in the paper is that of a positive and fairly significant link between black women's wages and starting teachers' salaries.

The earlier school-level literature has focused mainly on samples of male workers in their twenties. It may be that this literature has typically found no or weak effects of school resources because it takes some time after students graduate for the benefits of school spending to manifest themselves. The NLS-YW provides a good opportunity to test this possibility, because it contains wage observations on workers between the ages of 18 and 50. The evidence suggests that the age-dependence hypothesis is wrong. For most regressions the null of no age dependence was strongly retained; the only strongly significant age dependence in the data was *negative*, suggesting that if anything the impact of school resources depreciates as workers age.

Overall, the size of the estimated impact of school resources on women's wages is similar to that found in the large existing literature that focuses on men. Betts (1996a) finds that in this literature estimated wage elasticities with respect to school resources tend be higher when school resources are measured at the state level rather than at the level of the individual school attended. This range of estimates for men generally brackets the wage elasticities for women found in the current paper. For white women the wage regressions are quite consistent with the existing school-level literature for males, which finds that educational resources generally have low wage elasticities and low levels of significance. The results for black women, in contrast, produce larger and

more significant wage elasticities which are closer to the more optimistic results often found in the state-level literature on men's earnings.

The results provide some support for the idea that redistribution of schooling resources between black and white women could narrow somewhat the earnings gap between the races. But such a conclusion is somewhat speculative: it may not apply as strongly today as in the 1960's, given the convergence between the races in family environment variables such as parental education over the last 30 years. Also, there are grounds to believe that the inter-racial disparities in school resources evident in the NLS-YW data, based on a 1968 survey of schools, have to a large extent narrowed over time. For instance, Grogger (1996) reports that in the 1980 survey High School and Beyond, class size, term length and the level of education of teachers were virtually identical for black and white males. On the other hand, Betts, Danenberg and Rueben (2000, Table 4.4), in an analysis of a census of all California classrooms in the 1997-98 school year, report that gaps in teacher preparation continue to exist among students of different races and ethnicities.

Various interpretations of the differing results between black and white women are possible. One explanation is diminishing returns. [18] In the wage samples, for black women on average the pupil-teacher ratio was 7 percent higher, spending per pupil was 8 percent lower, teachers' starting salaries were 1.2 percent lower, and the ratio of books per student was 14 percent lower than for white women. If the private returns to school expenditures are sharply diminishing, then these disparities could explain why the observed returns are so much lower for white women. A related issue concerns whether

[18] Betts and Johnson (1998) find evidence using state-level data that there are diminishing returns to spending on school resources, especially with respect to spending on reducing class size.

the family's socioeconomic status is a substitute or a complement to school spending. If it is a substitute, then this would help to explain the much lower returns to school spending for white women relative to black women. To give just one example of the gap in socioeconomic status between the families of black and white women in the wage sample, the average years of schooling among the fathers of the white women was 8.9 years; among black women, the average for father's years of schooling was only 4.7.

A second explanation for the stronger results among black women relative to white women may be omitted variable bias that is more serious in the case of black women. Recall the paper's finding of a positive correlation between most school resources and the four measures of family socioeconomic status used in the models. If a similar correlation exists between school resources and any unmeasured components of socioeconomic status, then the estimated impacts of school resources on schooling and wages may be biased upward. Based on the observed correlations, this problem is likely to be more severe in the sample of black women.

A third explanation for the stronger results for black women relative to white women may be that white families have traditionally been more mobile. [19] In the likely event that there are unmeasured characteristics of communities that affect students' long-term outcomes, and if these unobserved characteristics are on the whole negatively related to school resources, we should expect school resources to matter less for whites. Certainly the finding reported in III.A that there is a much stronger positive correlation between school resources and family background among black women than white women suggests that high SES white families are choosing home location based on other criteria than school resources alone.

A final possibility is that white families in the 1960's may have found it easier than did black families to compensate for low levels of school spending by substituting learning activities in the home. Specifically, higher levels of income and parental education in white families may have afforded these families with avenues for helping their children learn in cases where school resources were lacking. The possibility of parental effort acting as a substitute for school quality merits further research.

[19] I thank Ed Lazear for suggesting this possibility.

Table 1

Sample Means and Standard Deviations for Key Variables in White and Black Subsamples Used in Models of Educational Attainment

Note: The statistics are given for observations for which all of the regressors apart from the school resources are available, and at least one of the school input variables is available. (For all of the variables apart from the school inputs, the number of observations is 2551 for white women and 801 for black women. For the school inputs, the sample sizes are identical to those reported in Tables 2 and 3.)

	White Women		Black Women	
Variable	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
School Characteristics				
Pupil-Teacher	20.290	5.332	21.610	3.839
Spending per Pupil	589.741	164.129	552.812	147.850
Teachers' Salary	6075.830	503.473	6045.593	618.504
Books per Student	88.465	51.505	74.454	38.307
Women's Characteristics				
Years of Education	13.209	2.248	12.622	2.103
Age	39.436	7.601	37.703	7.924
Married	0.699	0.459	0.412	0.493
Number of Children	1.287	1.191	1.422	1.232
Father's Education	8.933	5.084	4.724	4.749
Mother's Education	10.210	3.881	7.584	4.416
Duncan Index, Family Head	34.399	25.048	15.458	14.941
Number Siblings	2.821	2.054	4.865	2.901
Missing Father's Education	0.169	0.375	0.396	0.489
Missing Mother's Education	0.071	0.257	0.161	0.368
Missing Duncan Index	0.065	0.247	0.144	0.351
Missing Number Siblings	0.004	0.063	0.011	0.105

Table 2

Ordered Probit of Educational Attainment of White Women with Right Censoring

Other regressors not shown are dummies for 8 of 9 Census regions to indicate the location of the school, and four dummies indicating missing values for the four family background variables (parental education, Duncan index and number of siblings). T-statistics are shown in parentheses.

Variable	#1	#2	#3	#4
Constant	-3.0085	-2.9285	-3.0659	-3.0124
	(-5.91)	(-5.57)	(-5.30)	(-5.76)
Pupil-Teacher	0.0013			
	(0.31)			
Spending per Pupil		-0.0001		
		(-0.69)		
Teachers' Salary			0.00002	
			(0.42)	
Books per Student				0.0009
				(1.79)
Age	0.118	0.1168	0.1197	0.1191
	(4.07)	(3.90)	(4.14)	(3.97)
Age Squared	-0.0013	-0.0013	-0.0013	-0.0013
	(-3.13)	(-2.97)	(-3.23)	(-3.05)
Married	-0.106	-0.1031	-0.0928	-0.1132
	(-2.02)	(-1.89)	(-1.78)	(-2.10)
Number of Children	-0.0573	-0.0658	-0.0603	-0.0611
	(-2.79)	(-3.06)	(-2.93)	(-2.87)
Father's Education	0.0592	0.0577	0.0569	0.0561
	(6.33)	(5.96)	(6.10)	(5.80)
Mother's Education	0.1115	0.1125	0.1083	0.1137
	(10.62)	(10.38)	(10.43)	(10.52)
Duncan Index, Family Head	0.0067	0.0062	0.0071	0.0065
	(5.90)	(5.21)	(6.24)	(5.45)
Number Siblings	-0.0483	-0.0438	-0.0474	-0.0512
	(-4.20)	(-3.69)	(-4.19)	(-4.33)
City	-0.0342	-0.0062	-0.0313	0.0124
	(-0.72)	(-0.13)	(-0.66)	(0.25)
South	-0.0635	-0.0623	-0.0482	-0.0711
	(-0.95)	(-0.89)	(-0.72)	(-1.01)
Log Likelihood	-2963.3	-2775.3	-3001.9	-2766.2
Number of Observations	2459	2298	2495	2313

Table 3
Ordered Probit of Educational Attainment of Black Women with Right Censoring

See notes to Table 2.

Variable	#1	#2	#3	#4
Constant	-4.7510	-4.5007	-5.7828	-4.9311
	(-4.52)	(-4.01)	(-5.07)	(-4.70)
Pupil-Teacher	-0.0149			
	(-1.22)			
Spending per Pupil		-0.0005		
		(-1.42)		
Teachers' Salary			0.0001	
			(1.57)	
Books per Student				0.0016
				(1.42)
Age	0.2521	0.2230	0.2492	0.2537
	(4.88)	(4.09)	(4.84)	(4.80)
Age Squared	-0.0033	-0.0029	-0.0033	-0.0034
	(-4.49)	(-3.71)	(-4.44)	(-4.45)
Married	0.1187	0.1424	0.1507	0.1188
	(1.42)	(1.61)	(1.79)	(1.37)
Number of Children	-0.2083	-0.2276	-0.2233	-0.2236
	(-5.83)	(-6.05)	(-6.20)	(-5.90)
Father's Education	0.0331	0.0364	0.0300	0.0277
	(1.98)	(2.05)	(1.78)	(1.61)
Mother's Education	0.0978	0.0862	0.0960	0.0898
	(5.95)	(4.90)	(5.84)	(5.30)
Duncan Index, Family Head	0.0105	0.0097	0.0106	0.0104
	(3.31)	(2.90)	(3.31)	(3.14)
Number Siblings	-0.0216	-0.0191	-0.0233	-0.0223
	(-1.44)	(-1.20)	(-1.54)	(-1.47)
City	0.0109	0.1416	-0.0168	0.0443
	(0.11)	(1.43)	(-0.17)	(0.46)
South	-0.0468	-0.0640	-0.0621	-0.0355
	(-0.48)	(-0.61)	(-0.63)	(-0.36)
Log Likelihood	-926.67	-830.63	-920.23	-873.64
Number of Observations	777	697	775	734

Table 4. Models of Log Hourly Wages for White Women

T-statistics for the coefficients and for the elasticity of wages with respect to the school input appear in parentheses. The t-statistics are based on White standard errors. Other regressors are dummies for 8 of 9 Census regions indicating location of the school, four dummies indicating missing values for the four family background variables, and dummies for all years but 1991.

Variable	#1	#2	#3	#4
Constant	-0.5082	-0.4325	-0.5441	-0.4121
	(-5.61)	(-4.58)	(-5.55)	(-4.44)
(Pupil-Teacher)/1000	2.1658			
	(3.42)			
(Spending per Pupil)/1000		-0.0151		
		(-0.66)		
(Teachers' Salary)/1000			0.0106	
			(1.47)	
(Books per Student)/1000				-0.2282
				(-3.12)
Age	0.1338	0.1326	0.1353	0.1331
	(23.75)	(22.56)	(24.18)	(22.99)
Age Squared	-0.0017	-0.0017	-0.0017	-0.0017
	(-18.90)	(-17.96)	(-19.31)	(-18.32)
Married	-0.0558	-0.0581	-0.0501	-0.0569
	(-4.61)	(-4.74)	(-4.24)	(-4.53)
Number of Children	-0.1239	-0.1302	-0.1255	-0.1252
	(-16.26)	(-16.56)	(-16.64)	(-16.23)
Father's Education	0.0036	0.0052	0.0030	0.0027
	(2.66)	(3.74)	(2.19)	(1.87)
Mother's Education	0.0149	0.0140	0.0148	0.0168
	(9.68)	(8.80)	(9.79)	(10.57)
Duncan Index Family Head	0.0012	0.0011	0.0013	0.0010
	(6.98)	(6.21)	(7.88)	(5.89)
Number of Siblings	-0.0073	-0.0064	-0.0057	-0.0065
	(-4.39)	(-3.77)	(-3.55)	(-3.85)
City	0.0775	0.0876	0.0773	0.0806
	(11.37)	(12.47)	(11.34)	(11.01)
South	-0.0910	-0.0866	-0.0870	-0.0903
	(-7.30)	(-6.57)	(-6.94)	(-6.83)
Inverse Mills Ratio	0.1917	0.2116	0.1855	0.1984
	(4.47)	(4.79)	(4.38)	(4.51)
Number of Observations	18415	17167	18727	17326
R Squared	0.6366	0.6365	0.6371	0.6355
Adjusted R Squared	0.6358	0.6356	0.6363	0.6347

Continued…

Continued:

Elasticity	0.0441	-0.0089	0.0646	-0.0202
	(3.42)	(-0.66)	(1.47)	(-3.12)

Table 5. Models of Log Hourly Wages for Black Women

T-statistics for the coefficients and for the elasticity of wages with respect to the school input appear in parentheses. The t-statistics are based on White standard errors. Other regressors are dummies for 8 of 9 Census regions indicating location of the school, four dummies indicating missing values for the four family background variables, and dummies for all years but 1991.

Variable	#1	#2	#3	#4
Constant	0.6099	0.4528	0.4590	0.8258
	(3.28)	(2.36)	(2.51)	(4.33)
(Pupil-Teacher)/1000	-5.3075			
	(-3.44)			
(Spending per Pupil)/1000		0.0457		
		(1.06)		
(Teachers' Salary)/1000			0.0176	
			(1.79)	
(Books per Student)/1000				0.3814
				(2.67)
Age	0.0952	0.0978	0.0940	0.0790
	(7.74)	(7.24)	(7.71)	(6.12)
Age Squared	-0.0014	-0.0014	-0.0014	-0.0012
	(-6.86)	(-6.38)	(-6.85)	(-5.53)
Married	0.0592	0.0606	0.0606	0.0606
	(5.62)	(5.42)	(5.78)	(5.63)
Number of Children	-0.0649	-0.0667	-0.0688	-0.0566
	(-7.92)	(-7.22)	(-7.93)	(-6.71)
Father's Education	0.0142	0.0138	0.0145	0.0135
	(6.87)	(6.15)	(6.91)	(6.35)
Mother's Education	0.0145	0.0109	0.0136	0.0087
	(5.47)	(3.79)	(5.35)	(3.21)
Duncan Index Family Head	0.0029	0.0027	0.0027	0.0027
	(7.20)	(6.38)	(6.61)	(6.55)
Number of Siblings	-0.0025	-0.0057	-0.0051	-0.0023
	(-1.24)	(-2.52)	(-2.44)	(-1.11)
City	0.0569	0.0755	0.0537	0.0738
	(4.40)	(5.61)	(4.06)	(5.67)
South	-0.2590	-0.2541	-0.2575	-0.2667
	(-16.89)	(-15.07)	(-17.16)	(-17.23)
Inverse Mills Ratio	0.0003	-0.0288	0.0114	-0.0645
	(0.00)	(-0.33)	(0.14)	(-0.76)
Number of Observations	6027	5378	6007	5730
R Squared	0.6914	0.6873	0.6908	0.6939
Adjusted R Squared	0.6894	0.6850	0.6888	0.6918

Continued…

Continued:

Elasticity	-0.1158	0.0248	0.1054	0.0285
	(-3.44)	(1.06)	(1.79)	(2.67)

Table 6

Models of Log Hourly Wages that Allow for Interaction between School Resources and Worker's Age

T-statistics for the coefficients appear in parentheses. The t-statistics are based on White standard errors. Other regressors are as shown and listed in the notes to Tables 4 and 5. Below, results from eight separate models, one for each race and school input, are shown, so that pairs of coefficients for the given school resource and its interaction with age refer to a separate regression.

Variable	White Women	Black Women
(Pupil-Teacher)/1000	1.4631	5.1819
	(0.60)	(0.84)
Pupil-Teacher*Age/1000	0.0234	-0.3500
	(0.26)	(-1.68)
(Spending per Pupil)/1000	0.1039	0.6215
	(1.21)	(4.13)
Spending per Pupil*Age/1000	-0.0039	-0.0190
	(-1.35)	(-3.74)
(Teachers' Salary)/1000	-0.0064	0.0048
	(-0.24)	(0.13)
Teachers' Salary*Age/1000	0.0006	0.0004
	(0.62)	(0.33)
(Books per Student)/1000	0.3574	0.4889
	(1.23)	(0.79)
Books per Student*Age/1000	-0.0193	-0.0036
	(-1.92)	(-0.17)

Table 7

Wage Elasticities with Respect to School Resources from the Current Results for Women and Results in the Literature for Men, by Level of Aggregation at Which School Resources were Measured

Results for women are taken from Tables 4-5. Results from the existing literature for men are taken from Betts (1996a). The lone exception is the result for library books per student for men, which are based on author's calculations from regressions discussed in the text of Betts (1995). "N/A" indicates that no estimates are available in the literature reviewed by Betts (1996a).

School Resource	White Women (NLS-YW)	Black Women (NLS-YW)	Men (School-Level)	Men (District-Level)	Men (State-Level)
Pupil-Teacher Ratio	0.0441	-0.1158	0.037	-0.024	-0.099
Spending per Pupil	-0.0089	0.0248	N/A	0.0961	0.1281
Teachers' Salary	0.0646	0.1054	-0.0338	0.2239	0.1022
Books per Student	-0.0202	0.0285	0.00021	N/A	N/A

References

Altonji, Joseph G., "The Effects of Family Background and School Characteristics on Education and Labor Market Outcomes," (1988). Manuscript, Department of Economics, Northwestern University.

Altonji, Joseph G. and Dunn, Thomas A. "Using Siblings to Estimate the Effect of School Quality on Wages." *Review of Economics and Statistics* 78 (November 1996): 665-671.

Betts, Julian R., "Does School Quality Matter? Evidence from the National Longitudinal Survey of Youth," *Review of Economics and Statistics*, 77 (1995), 231-50.

---, "Is There a Link between School Inputs and Earnings? Fresh Scrutiny of an Old Literature," in Gary Burtless, ed., *Does Money Matter? The Effect of School Resources on Student Achievement and Adult Success* (Washington, D.C.: Brookings Institution, 1996a).

---, "Do School Resources Matter Only for Older Workers?" *Review of Economics and Statistics*, 78 (November, 1996b).

---, "The Impact of School Resources on Women's Earnings and Educational Attainment: Findings from the National Longitudinal Survey of Young Women," UCSD Discussion Paper 96-24, (1996c).

Betts, Julian R., Kim S. Rueben and Anne Danenberg, *Equal Resources, Equal Outcomes? The Distribution of School Resources and Student Achievement in California*, (San Francisco, CA: Public Policy Institute of California, 2000).

Betts, Julian R. and Eric Johnson. "A Test for Diminishing Returns to School Spending", Manuscript, Department of Economics, UCSD, (1998).

Card, David, and Krueger, Alan B. "Labor Market Effects of School Quality: Theory and Evidence." In *Does Money Matter? The Effect of School Resources on Student Achievement and Adult Success,* edited by Gary Burtless. Washington, D.C.: Brookings Institution, 1996.

Grogger, Jeff, "Does School Quality Explain the Recent Black/White Wage Trend?," *Journal of Labor Economics*, 14 (1996), 231-53.

Hanushek, Eric A., "The Economics of Schooling: Production and Efficiency in Public Schools," *Journal of Economic Literature*, 24 (1986), 1141-77.

---, "The Impact of Differential Expenditures on School Performance," *Educational Researcher* (1989), 45-51, 62.

---, "When School Finance "Reform" May Not be Good Policy," *Harvard Journal on Legislation*, 28 (1991), 423-56.

Heckman, James J., Anne S. Layne-Farrar, and Petra E. Todd. “Does Measured School Quality Really Matter? An Examination of the Earnings-Quality Relationship,” in Gary Burtless, ed., *Does Money Matter? The Effect of School Resources on Student Achievement and Adult Success* (Washington, D.C.: Brookings Institution, 1996).

Kohen, Andrew Ivor. "Determinants of Early Labor Market Success Among Young Men: Ability, Quantity and Quality of Schooling -- A Preliminary Report." Research Report, Columbus, OH: Center for Human Resource Research, The Ohio State University, 1971.

Parnes, Herbert S., and Andrew I. Kohen, "Occupational Information and Labor Market Status: The Case of Young Men," *Journal of Human Resources*, 10 (1975), 44-55.

Taubman, Paul, "Role of Parental Income in Educational Attainment," *American Economic Review*, 79 (1989), 57-61.

U.S. Bureau of the Census, *Statistical Abstract of the United States* 112th ed. (Washington, D.C.: U.S. Government Printing Office, 1992).

Wachtel, Paul, "The Effect of School Quality on Achievement, Attainment Levels, and Lifetime Earnings," *Explorations in Economic Research*, 2 (1975), 502-36.