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THE EDUCATION OF NEGROES AND WHITES

by

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## Abstract

### The Education of Negroes and Whites

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Submitted to the Department of Economics on August 13, 1968, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Within the field of public education, there is considerable concern and controversy over efficiency in the allocation of resources and equity in the distribution of educational services. However, the policy maker is handicapped in dealing with these issues by a lack of knowledge about the educational production process. This study offers a starting point in the quest for solutions to the efficiency and equity questions through the specification and estimation of educational production functions for one subset of the school population.

Using regression techniques, separate production functions were estimated for black and white sixth graders residing in the metropolitan Northeast and Great Lakes region. Because of data limitations, the analysis centered on mean achievement test scores for a school, rather than individual achievement. The estimates are necessarily rather crude and cannot be used to answer detailed questions about specific policies. However, they do provide several insights into the overall educational production function.

The major vectors of inputs are family backgrounds, attitudes, school factors and racial composition of the school. For policy purposes all of the inputs are not equally as interesting. Family backgrounds and attitudes exhibit a significant relationship with achievement. However, their role is generally deemphasized in the analysis since they are not very useful for immediate policy applications. Instead, the major effort is aimed at analyzing the effects of school quality and the racial composition of the school.

Contrary to the widely circulated opinion that schools have little effect on achievement, schools are shown to exhibit a significant impact on the education of both blacks and whites. Several measures of teacher quality provide the consistent impression that schools do affect educational output. Additionally, the production functions indicate that the rewards in education come from better quality teachers, not from increased quantity (reduced class size).

The production functions also offer some evidence that blacks react more than whites to differences in teacher quality. The evidence on this is scanty, and further research is definitely required on this point.

Racial composition effects on the education of both blacks and whites are small. While there are many compelling reasons for school integration, the effects of integration on black achievement test scores cannot be considered one of the major ones. In a properly specified model of the educational process, the effects of various racial compositions of the school are minimal. In an improperly specified model,

the beneficial effects of integration for blacks can be made to appear fairly large. However, the same misspecified model will make detrimental effects for whites appear worse.

Research into the educational process is just beginning and comes nowhere near supplying the needed answers to the questions which arise in managing the public educational system. The requirement for further analysis is obvious.

Thesis Supervisor: Edwin Kuh  
Title: Professor of Economics

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There were many people who offered comments and suggestions along the way. The most easily identified of these, but certainly not the only ones, came from Professors Edwin Kuh, Franklin Fisher and Samuel Bowles. To all who offered help, I wish to express my appreciation. Special thanks go to Professor John Kain, who originally suggested the area of study and provided constant encouragement in the efforts. Finally, I wish to thank Gretchen Jackson and Joyce Watson, each of whom produced an iteration of the manuscript under the pressure of very close deadlines.

All views expressed within are, of course, those of the author and should not be construed as representing the views of either the individuals or organizations mentioned above.

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## CHAPTER I

### TOPICS IN PUBLIC EDUCATION

Efficiency of resource allocation and distribution of educational services are the two critical issues in public education today. Each is the center of considerable public concern, controversy and emotion. Even though public elementary and secondary education consumes over \$27 billion annually, there is very little knowledge about the educational process itself, and, thus, it is exceedingly difficult to insure the efficient use of funds available for education. Additionally, since education is closely related to success in our society, the distribution of educational services plays a crucial role in deciding the distribution of jobs and income among individuals and groups.

The areas of resource allocation and distribution of educational services are very broad and complex. The goal of this study is to provide some insights into these areas, but necessarily only a fraction of the total set of problems can be analyzed. The focal point of this analysis is the specification and estimation of models of the educational production process. Such models provide insight into both educational issues since the relationship between inputs and educational output is central to any discussion of efficiency or equalization of educational benefits. Thus, this study offers a starting point in a complete analysis of the larger efficiency and distribution issues.



## Resource Allocation

Resource allocation is not a trivial matter in the case of school systems. In a loose sense, people want "more" education. However, school systems must do this in the face of increasing budgetary pressures. In metropolitan areas, both the central cities and the suburbs feel the budgetary squeeze, albeit for different reasons.

Central cities have experienced considerable changes in structure within the last two decades. There has been the flight to the suburbs of both population and industry.<sup>1</sup> However, the population movement has been quite selective with middle and upper income families being the ones moving out. These in turn are replaced by the in-migration of the rural poor. Thus, while central city total population has tended toward stability, the mixture of the population has changed. The changes in income distribution and employment patterns have resulted in the lowered fiscal ability of many central cities.<sup>2</sup> This has been accompanied by increases in the demands for many public services such as welfare, health, and fire and police protection. Thus, in the central cities revenues are becoming more difficult to raise, and there is increasing competition for the revenues that are available.

The pattern in suburban communities has generally been different but the effect has been the same--increased budgetary pressure on school systems. The rapid decentralization of population has been the heart of

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<sup>1</sup>See John F. Kain, "The Distribution and Movement of Jobs and Industry," ed. James Q. Wilson, The Metropolitan Enigma (Washington, D.C.; Chamber of Commerce of the United States, 1967), for an overview of the intrametropolitan area trends.

<sup>2</sup>Dick Netzer, The Economics of the Property Tax (Washington, D.C.: The Brookings Institution, 1967), gives a thorough account of the changes in tax base in the central city.

the suburban case. The rapid growth calls for sudden increases in many areas of public service--education, sanitation, fire and police protection. When financing is done through property taxes, large increases in tax rates are often called for. Additionally, where debt limits on localities exist, suburban governments must often go before the voters in a referendum to get approval for expenditures.<sup>3</sup> In recent years, voters have tended to turn down such proposals with increasing frequency.<sup>4</sup> Thus, suburban school systems also find themselves confronted with budgetary problems.

The budgetary pressures tend to dramatize the need for efficient operation of public school systems. Regardless of how the budget is determined, schools are faced with the task of providing "more" education with proportionately smaller resources. Certainly efficient allocation of resources--the maximization of educational output obtained from a given set of resources--is always a goal. However, the necessity of efficient operations is much more evident when faced with increased public pressure.

Efficient operation of schools is not simply a local problem. A significant portion of the school bill is paid with state and national funds. Thus, there is a considerable interest at higher levels of government in the efficiency of local school operations. While there are theoretical analyses which demonstrate that properly constructed grants to local governments can lead to efficient expenditures, they

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<sup>3</sup>James A. Maxwell, Financing State and Local Governments (Washington, D.C.: The Brookings Institution, 1965), shows that a majority of states have local debt limits requiring referendum votes for increased expenditures (pp. 194-199).

<sup>4</sup>For example, see "24 School Budget Defeats in the Suburbs Are Laid to 'Taxpayer Revolts,'" The New York Times, May 10, 1968, p. 39.

tend to neglect most of the significant practical impediments to efficient operation.<sup>5</sup> Therefore, the continual interest of all levels of government in local school efficiency is not unwarranted.

### Distribution of Educational Services

The second issue in public education today is the distribution of educational services. It is widely accepted that education is a necessary, if not sufficient, condition for success in our society. Many studies have shown a high correlation between education and personal income with a causal relationship from educational attainment to income frequently implied. If such is the case, discrimination in the provision of education is tantamount to unequal economic opportunity.

Key to the whole discussion of distribution is the concept of equity. Education differs from a pure public good in that individuals can be excluded from its consumption. It is therefore possible for the school board to prescribe the entire distribution of services. De jure segregation is an extreme case of this. If we assume that our social welfare function calls for no educational disadvantages, it is then possible to analyze the distribution of public educational services.

There are several ways in which one might look at the distribution of educational services or, under the now-popular rubric, equality of educational opportunity. The two most obvious approaches are to ascertain: 1) whether all individuals receive equal bundles of school

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<sup>5</sup>George Break suggests several alternative formulas for providing intergovernmental grants. However, they all seem to neglect many of the crucial issues of the efficiency problem as found in practice. Among other things, these analyses implicitly assume that local governments know the production function available. That is exactly what this study is attempting to uncover. See Intergovernmental Fiscal Relations in the United States (Washington, D.C.: The Brookings Institution, 1967).

inputs, or 2) whether there is equality in terms of outputs of the educational process. The input approach assumes a much more limited goal since large differences in preparedness are known to exist among children entering school. These differences are also highly correlated with family background. Thus, the simple equating of inputs will yield very divergent outputs at the end of the educational process. Output equality, the second approach, takes a much broader outlook at the educational process and assumes that children should enter the job market at the end of school with the same opportunities. (Discussion of the output approach is necessarily less precise as the object is not equating the educational output of all individuals. Since ability differences among children at the individual level are very large, it is necessary to go to a concept of group equality of outputs, e.g. between blacks and whites.) The choice of definitions for equality of educational opportunity is subject to considerable controversy. However, output equality appears to be more consistent with our democratic values. Thus, this appears to be the proper long-range goal even though equality of inputs is a desirable short-run policy.

While there are many possible dimensions in which the distribution of educational services can be analyzed, differences between the education of blacks and whites are by far the most important. Other stratifications of the population (e.g. regional, urban-rural, central city-suburb, or rich-poor) present some interesting problems, but the racial distinction is primary in terms of urgency for present public policy. As a group, blacks are worse off in terms of education than any of the other possible groups of study. Additionally, they are subject to discrimination in other sectors. Thus, educational disadvantages

are compounded. Education is often cited as the way out of the circle of discrimination and poverty faced by the Afro-American. However, the present school structure does not appear to be promoting such a solution to discrimination.

The differences in the distribution of education by race are not imaginary. In pure quantity terms, the median Negro has completed 8.2 years of school as compared to 10.9 years for the median white.<sup>6</sup> There are some changes in the specific numbers for different subsets of the population, e.g. the median years completed for urban Negro males is 8.5; for comparable whites it is 11.3. The qualitative impressions remain the same, however. Blacks complete significantly less schooling. Yet, the educational differences are even larger when one considers quality of education. By matching scores on standardized achievement tests for different grade levels, it is possible to gain some indication of the magnitude of educational disadvantage in quality terms.<sup>7</sup> Table 1-1 displays a comparative picture of education for blacks and whites in various regions. Using whites in the metropolitan Northeast as the standard, black twelfth graders in the urban Northeast are an average of 3.3 grade levels behind, i.e. the blacks still in school at the twelfth

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<sup>6</sup>U.S. Bureau of the Census. U.S. Census of Population: 1960 General Social and Economic Characteristics, United States Summary. Final Report PC(1)-1C. (Washington, D.C.: U.S. Government Printing Office, 1962), Table 76, pp. 1-207. These figures on median years of school completed refer to persons 25 years old and over. These figures do mask some changes in the distribution over time. In lower age groups the differences are not quite as large, but they by no means disappear.

<sup>7</sup>These figures result from a nationwide survey of public schools by the Office of Education in 1965. These data are described in detail in Chapter Two since they are used in the subsequent analysis. The tabulations are found in James S. Coleman et al, Equality of Educational Opportunity (Washington, D.C.: Government Printing Office, 1966), subsequently referred to as the EEO Report.

TABLE 1-1

ACHIEVEMENT DIFFERENTIALS BY RACE AND REGION; AVERAGE  
GRADE LEVELS BEHIND THE AVERAGE WHITE IN THE  
METROPOLITAN NORTHEAST, VERBAL ABILITY

Race and Region	Grade Levels Behind		
	Grade 6	Grade 9	Grade 12
White, nonmetropolitan			
South	7	1.0	1.5
Southwest	3	.4	.8
North	.2	.4	.9
White, metropolitan			
Northeast	. .	. .	
Midwest	1	.0	.4
South	5	5	9
Southwest	.5	.6	7
West	.3	.3	5
Negro, nonmetropolitan			
South	2.5	3.9	5.2
Southwest	2.0	3.3	4.7
North	1.9	2.7	4.2
Negro, metropolitan			
Northeast	1.6	2.4	3.3
Midwest	1.7	2.2	3.3
South	2.0	3.0	4.2
Southwest	1.9	2.9	4.3
West	1.9	2.6	3.9

Source: EEO Report, Table 3.121.1

grade are behind the average white ninth grader. The picture is even bleaker in other regions, reaching a pinnacle in the rural South where the average black twelfth grader is 5.2 years behind his white urban North counterpart. While there are some regional differences, it is obvious that being black is most important in quality terms. Thus, an adjusted median education figure which allowed for quality of education would present an even more alarming picture of racial differences than those previously presented.

Furthermore, the Negro faces discrimination in many sectors. Many studies have shown considerable racial discrimination in the job market; the prevalence of ghettos seems to be ample proof of discrimination in the housing market. It is plausible that the discrimination in the different sectors is more than a simple additive relationship and that educational deprivations magnify the problems in other areas. Such interdependencies, if they exist, would constitute prima facie evidence that the black-white dimension is most important.

Finally, in terms of political necessity, solution to the black educational problems seems to be crucial. Educational problems have been central in the civil rights movement and remain a major grievance of the black community. This is well documented in the Report of the National Advisory Commission on Civil Disorders.<sup>8</sup> The racial dimension is politically the most volatile aspect of the distribution of educational services. Pressures for rectifying the imbalance in education are mounting and are becoming more urgent.

Thus, throughout this study the subject of distribution of

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<sup>8</sup>Otherwise known as the Kerner Commission Report. [Otto Kerner et al.], Report of the National Advisory Commission on Civil Disorders (New York: Bantam Books, Inc., 1968).

educational services is taken as being synonymous to the study of differences in educational services for blacks and whites.

### Production Functions for Education

While there are many possible ways to analyze the problems of resource allocation and distribution of educational services, the analytic framework provided by the economist's concept of a production function appears to provide the most useful starting point. A production function describes the relationship tracing the maximum possible output level for a given set of inputs. This is a natural basis for making allocation decisions. It also provides a method of assessing the importance of differences in school inputs supplied to different groups (i.e. blacks and whites) and ascertaining how educational inputs can efficiently be adjusted to rectify adverse distributions in educational output.

What are called production functions in education do differ from those found in economic theory of the firm. In particular, inputs to the educational process are quite different from the traditional labor and capital that enter "normal" production functions. Part of the set of inputs are abstract quantities such as attitudes, and these cannot be purchased in the market. Moreover, the output is itself a service. The production functions in economic literature are usually defined in terms of goods or tangible articles. However, these differences do not nullify the usefulness of the concepts of the production function in studying education.<sup>9</sup>

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<sup>9</sup>A more thorough discussion of the concepts of production functions as applied to education can be found in Jesse Burkhead, Input and Output in Large-City High Schools (Syracuse: Syracuse University Press, 1967), Chapter 2; Martin T. Katzman, "Distribution and Production



The principal feature of the production function relevant to the analysis of the efficiency and distribution questions is the mapping of the output possibilities for a set of inputs. For policy purposes certain groups of inputs (and generally those which can be purchased in the market) are more interesting than others. The production function allows analysis of these sections while accounting for other inputs to the process (e.g. family background) which cannot be controlled by the policy maker.

### Directions of Analysis

The focal point of this study is the specification and estimation of educational production functions. The basic motivation for this evolves from the previously discussed questions of resource allocation and distribution of educational services. However, little effort is made at direct application of the production functions to specific aspects of these general problems. The models of the educational process which are analyzed are necessarily very simplified views of the actual complex process. It is difficult to use the estimated functions to make precise statements about the efficacy of individual projects. Nevertheless, the models give a useful portrayal of public education and the relationships between inputs and educational output.

The analysis explicitly considers only education in public elementary schools of the metropolitan North. Since the task was large and there was very little guidance from previous work, this one stratum

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in a Big City Elementary School System" (unpublished Ph.D. thesis, Yale University, 1967), Chapters 2 and 3; and Herbert J. Kiesling, "Measuring a Local Government Service: A Study of Efficiency of School Districts in New York State" (unpublished Ph.D. thesis, Harvard University, 1965), Chapter 2.

was chosen for intensive analysis. The main explanation for this choice is that the a priori probability of success seemed highest here. While the larger analysis of other regions and other levels of education is needed before policy conclusions about public education in general can be made, this restricted analysis provides a foundation for further work. It is also plausible to expect many findings from this study to apply to broader areas of education than just those sampled for the analysis.

A central concern throughout the analysis is the racial context of public education. Particular attention is paid throughout the modeling efforts to the identification and analysis of racial aspects of the educational process. Since many of the most important issues in education revolve around race, special care was taken to reduce any modeling errors in the dimension of racial composition of the schools and behavioral differences between blacks and whites. An essential feature of this concern over systematic differences in the educational process for blacks and whites was the estimation of separate production functions for the two races.

## CHAPTER II

### MODELING THE EDUCATIONAL PRODUCTION PROCESS

The objective of this chapter is the development of educational models which are amenable to statistical estimation. Even though allocation and distribution within education have been important public policy issues for a considerable length of time, little progress has been made toward developing models which provide meaningful insights into the educational process. There has been neither much theoretical nor empirical work into the overall educational process. There exists a considerable body of literature under the topical description of learning theory, but it is of little direct value in the school policy context.<sup>1</sup> Additionally, there is no other source of precise theoretical development of the overall educational production process. However, this does not mean that research into education is given no guidance. First, there has been some fragmentary research into various aspects of the process, which provides a series of partial pictures of the overall

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<sup>1</sup>Although it is difficult to make generalizations about the topics and thoughts embroiled in learning theory, the most striking features to an outsider are: 1) the "partial" viewpoint of the majority of discussion, i.e. the preoccupation with small, specific issues; 2) the concentration on the mechanisms involved, e.g. the memory process; and 3) the abundance of very subtle and complex notions which are exceedingly difficult to include in complete models. The combination of these three points limit the direct applicability of learning theory. However, it is obvious that the a priori formulation of models of the educational process do derive in part from knowledge catalogued under the domain of learning theory. For a discussion of learning theories, see Ernest R. Hilgard, Theories of Learning, 2nd edition (New York: Appleton-Century-Crofts, Inc., 1956).

process. Secondly, education is a process which both employs many people and touches a majority of the members of society. Therefore for what they are worth, there are an incalculable number of individual observations and judgments from lay and professional alike. Finally, there are aspects of the process which appear natural places for the application of related theoretical work. In particular, certain theoretical formulations of production functions in the microeconomic theory of the firm seem applicable.

The combination of the first two sources suggest a conceptual model of the educational production process which would command general acceptance. The third source indicates some particular conditions on the conceptual model which appear logical and provides some guidance in policy formulation from models of the educational production process. The abstract conceptual model provides a useful backdrop to an empirical analysis of the educational process. However, a sizable amount of detail must be added to this before it is operationally useful. The actual specification of the variables used to measure the inputs into the process is dependent upon a mixture of specific hypotheses suggested in discussions of various segments of education and the availability of data. As is always the case, the hypotheses about the process far exceed the data available for testing the various aspects of the production process. The remainder of this chapter discusses the abstract model of the production process, the data, and the actual statistical models to be analyzed.

#### The Conceptual Model

Equation 2-1 portrays a conceptual model similar to one which most students of the educational process would accept.

$$(2-1) \quad \underline{A}_{it} = F(\underline{B}_i(t), \underline{S}_i(t), \underline{E}_i)$$

where  $\underline{A}_{it}$  = a vector measuring the achievement of the  $i$ th student at time  $t$

$\underline{B}_i(t)$  = a vector measuring the background characteristics of the  $i$ th student cumulative to time  $t$  where background factors include the socioeconomic status and attitudes of the  $i$ th student and the socioeconomic status and attitudes of his peers

$\underline{S}_i(t)$  = a vector of school factors relevant to the  $i$ th student cumulative to time  $t$

$\underline{E}_i$  = a vector of initial endowments ("native ability") for the  $i$ th student

In general terms, education is a function of the student's background, the school factors relevant to him and his innate abilities

While the precise functional form and measurement of the various vectors are not specified, the abstract conceptual model introduces several important aspects of the educational process. First, the expected outcome of the process is a multidimensional factor. Schools contribute to developing a set of job-related skills in the individual. This involves communications ability, basic arithmetic, elementary problem solving, etc. In some cases it even includes specific techniques for various jobs, e.g. in vocational courses. Additionally, there are many other dimensions of schooling which fall under the rubric of socialization. These include promoting certain principles of democracy, developing acceptable behavior patterns, and a host of other difficult to define (but no less real) dimensions of societal values.

The second concept introduced by Equation 2-1 is the total nature of the educational process. The educational level of an individual depends on the entire spectrum of influences on him. Particularly important is the notion that education is a cumulative process. Not

only do present inputs affect educational attainment, but all past inputs are also felt in the present. (It is probably this aspect of the conceptual model that is most directly linked to learning theory per se. The cumulative aspect incorporates many of the concepts of reinforcement in learning; however, it also relates to a set of more general notions.)

Finally, it is necessary to clarify the inclusion of an initial endowments or innate ability element in the conceptual model. In particular, the theoretical desirability of this concept should not be confused with analytical problems surrounding its measurement. This is a pure heredity term and should not be confused with commonly measured quantities such as IQ. Perhaps this is best defined in units of pounds of gray matter. However, there is no pretense of being able to measure this term. Additionally, without breaching a new area of debate, it should be noted that the conceptual model implicitly allows for genetic-environmental interaction. In no way does this conceptual formulation imply fixed intelligence or predetermined ability.<sup>2</sup>

### The Data

The empirical analysis relies upon Office of Education data which was collected to satisfy a Congressional requirement of conducting a survey to ascertain the extent of discrimination in public schools.<sup>3</sup>

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<sup>2</sup>A detailed discussion of heredity-environmental interaction and the alternatives is found in J. McV. Hunt, Intelligence and Experience (New York: The Ronald Press Co., 1961), especially Chapters 2, 8 and 9.

<sup>3</sup>Section 402 of the Civil Rights Act of 1964 stated:

The Commissioner [of Education] shall conduct a survey and make a report to the President and the Congress, within two years of the enactment of this title, concerning the lack of availability of equal educational opportunities for individuals by reason of race,

(The data source is referred to as the OE Survey to distinguish it from the subsequent analyses which rely upon it.) A stratified probability sampling technique which called for the overrepresentation of Negroes was used to choose public high schools to be included in the survey. Feeder schools for the chosen high schools were included on a probability basis depending on the percentage of students going to the selected secondary schools.<sup>4</sup> While the sample size was originally administratively set at 900,000 students, nonresponses reduced the usable sample to approximately 570,000 students. These students were divided among grades 1, 3, 6, 9 and 12. Students were given ability and achievement tests and completed a questionnaire concerning family background and attitudes. Additionally, for the 3,155 schools which the students attended, data were gathered from teachers, principals and school system superintendents. Teachers completed a questionnaire including background, attitudes and school factors along with an optional verbal facility test. Principals and superintendents supplied information about their backgrounds and attitudes and about school facilities in their particular school or district.<sup>5</sup>

Several points about the data deserve emphasis. First, the sample size is not so large as it appears. The effective size (for most statistical analyses) is not 570,000 observations but instead the number of schools. (For elementary schools this number is approximately 2,400 )

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color, religion, or national origin in public educational institutions at all levels in the United States, its territories and possessions, and the District of Columbia

<sup>4</sup>A detailed discussion of the sampling procedures can be found in the EEO Report, pp. 550-558

<sup>5</sup>Complete questionnaires and samples of test items are found in the EEO Report, pp. 575-737.

This reduction in effective sample size is caused by failure to collect the relevant school data for individual students. While this sample size is still large, it is reduced considerably if stratification is necessary (e.g. by race, region, and grade).

The survey itself is plagued by nonresponse and faulty response. This problem is prevalent at the school level.<sup>6</sup> However, in the study of the educational process the problem of missing schools is not as serious as the problem of nonresponse or faulty response to individual questionnaire items. Analysis of the raw data indicated that many items could not be used in the production function estimation because of the severity of the nonresponse problem. This was particularly true in the case of emotionally sensitive questions such as the principal's attitudes toward bussing, neighborhood schools, and faculty integration.<sup>7</sup> Faulty response also adds uncertainty to many questionnaire items.<sup>8</sup> This problem is more difficult to document. However, some feel for the problem can be gained from analysis of numerical items such as number of students or teachers. (The vast majority of questions call for multiple

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<sup>6</sup>Of those high schools originally picked for the sample, 59 per cent could be included in the final sample; 74 per cent of the feeder schools picked for those high schools responding were included. In terms of making inferences about the population, extreme care must be exercised. There are indications of systematic nonresponse as several large central cities in the North failed to respond. (The exact character of this type of nonresponse cannot be analyzed due to the anonymity requirements of the survey.)

<sup>7</sup>For example, the principal's questionnaire contained three questions about attitudes on racial mix of the faculty under different racial compositions of the students. In a sample of approximately 300 elementary schools in the Northeast, over one third of the principals failed to answer one or more of the questions.

<sup>8</sup>The OE Survey did include one, small-scale reliability test for student answers. However, this did not seem sufficient, especially after looking at the data.



choice response as opposed to furnishing a numerical answer.) Since these can be cross-checked with other parts of the survey, they give some indication of the severity of the problem. Over ten per cent of the principals in Northeastern metropolitan elementary schools recorded an obviously incorrect answer--often due to left-justifying answers and, thus, creating decimal point errors. Since these questions required numerical coding (as opposed to the normal multiple choice questions), the expectation of faculty responses is greatest for these questions. However, from a further check by comparing responses in schools with two principals, it is obvious that the problem is not restricted to these items.<sup>9</sup>

Nevertheless, for the modeling of the educational process, the most severe problem with the data sources arises from a basic weakness, or incompleteness, in the questionnaires. There are several distinct and important dimensions to the incompleteness. There are the lack of historical information, the error in measuring contemporaneous inputs, and the neglect of several important sets of inputs.

While the conceptual model indicated that the history of inputs into the process is important in determining current educational output, there is a definite lack of such information. This failure, arising from a neglect to include any questions about previous factors, impinges upon the measurement of all inputs. However, it is potentially more severe in the case of school inputs. School inputs have more of the characteristics of flows, and a cross sectional glimpse of contemporaneous

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<sup>9</sup>The simple check of question responses in dual principal schools provided the basis for many qualitative judgments which went into the variable construction and basic modeling efforts in the present analysis. The subjective evaluation of the reliability of various questions will be discussed in later chapters.

inputs does a relatively poorer job of measuring the stream of inputs (as opposed to cross sectional measures of the family inputs into the educational process). This problem is particularly acute in later grades of school as high schools and even junior highs tend to draw students from quite heterogeneous feeder schools. Obviously, the size of historical errors of measurement increases over time

Yet, even at measuring the contemporaneous values of inputs into the educational process, the OE Survey has its difficulties. The most crucial problem on these grounds is the failure to collect data on the school inputs relevant to the individual student. All school information comes from the principal or superintendent responses without regard for how the total available inputs are distributed by individual. It is obvious that students attending the same school do not receive the same school inputs. The presence of science laboratories does not affect a student in a business course. Extracurricular activities are largely irrelevant to a lower class person who must work after school. The list of differentiation in inputs is unending. The simple presence of a particular input does not imply that the factor enters the educational process of any given individual. Furthermore, there are some systematic components to such errors in the measurement of school inputs for the individual. Certainly the errors are very much dependent on the school organization. The error component of the school inputs can be enormous in the case of the comprehensive high school. Basically, the larger and more complex the school, the larger is the expected error in the measurement of school inputs for the individual. The errors will also be correlated with other inputs into the process such as social class since choice of curriculum and schools is correlated with social class

(To the extent that these errors are systematic, sizable errors will arise when statistical estimation is undertaken. These will be discussed later.)

The final problem area with the questionnaires arises from a tendency to stop short of asking many logical and important questions. This is most evident in the case of school inputs; however, it does arise in the nonschool areas. The best description of this problem is a failure to gather qualitative information about the various inputs. There are many questions pertaining to presence of facilities or programs but few pertaining to quality. For example, there is extremely little information on school organization; there is no information on the adequacy of facilities such as laboratories or even the overall plant. This lack of a quality dimension makes it extremely difficult to differentiate among schools in terms of many school inputs.

Nevertheless, the discussion of the problem areas with the data should not be construed as implying that the data are worthless. Quite clearly the data are not ideal. However, the survey does contain much new and valuable information. The OE Survey provides a large sample of consistent data which can be used to analyze many questions of current interest in education. The findings will necessarily be less conclusive than if an ideal set of data were available. Yet, by recognizing the sources of errors in the data it is possible to devise models of the educational process which minimize the problems

#### Choice of Sixth Grade

While the OE Survey did include data on students at five different grade levels, only the sixth grade is analyzed in this study. The general discussion of the data in the OE Survey makes one point clear--

the data at the elementary school level contain less error in school factors. However, there is a trade-off since at the first and third grades the information on student backgrounds is scantier and less reliable. Thus, in terms of errors of measurement, the sixth grade appeared to represent a median position.

Elementary schools also are more desirable for this analysis since the structure of the school organization is generally simpler, the curricula more standardized, and the size more homogeneous than in secondary schools. With ideal input data, modeling the educational process within a comprehensive high school, or even a junior high, would be very difficult. There is simply little information about the process itself. Given the lack of information on the crucial issues of organization and curriculum, modeling the elementary school appears to be much more profitable than attempts at secondary schools. There are obvious reasons to take advantage of simplifications in the institutional structure when attempting to model a process as complex as the educational production process.

#### The Basic Statistical Model

From the OE Survey data it is possible to estimate educational production functions. The basic statistical technique is multiple regression analysis. However, the abstract model of Equation 2-1 is not directly applicable to statistical analysis. Obviously, it is necessary to specify the components of the various vectors and the functional form itself. The task now is to fill in the details to the statistical analog of the conceptual model. However, before explicitly considering the model of education to be estimated, the basic framework of the analysis must be discussed.

Instead of estimating the individual relationships depicted by Equation 2-1, a "school" production function is analyzed. In other words, schools--not individuals--are used as the basic observational unit in the statistical analysis. Aggregate school characteristics are substituted for the individual characteristics in the conceptual model.

While the use of individuals would be preferable, the data will not support such a procedure. The major reason for using a school model is the lack of information about school inputs for the individual student. While the OE Survey included data on individual achievement and socioeconomic background, it did not include information on individual school inputs. The errors in measurement introduced at the individual level by this failing would surely lead to considerable bias in any statistical estimates of individual models of the production process.

Moreover, problems of nonresponse and ~~faulty response~~ also suggest the use of school production functions. Many of the key individual socioeconomic questions are subject to considerable nonresponse. If estimation were done at the individual level, this problem could introduce severe biases since the evidence indicates that much of the nonresponse was systematic (by race and social class). While nonresponse will cause problems at any level of estimation, it is less severe at the school level. At least for elementary schools the general consistency of neighborhood composition (with the prevalence of neighborhood attendance districts) insures that any missing observations will not affect the school aggregates by very much.<sup>10</sup> Similarly, faulty

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<sup>10</sup>In a formal statistical sense, the concern is over the size of the variance in the measurement errors relative to the variance in the true variable. Compared with the individual variables, the errors at the school level are almost certainly less severe.

response will not have an overpowering influence at the school level. The pervasiveness of these data problems provides considerable support for the position that any production functions using OE Survey data must be estimated at the school level.

### Outputs and Inputs

For the statistical analysis, a single measure of output, rather than the multidimensional output of Equation 2-1, is used. As alluded to previously, there is no standard measurement for the output of schools. While one is interested in the student's knowledge as it relates to his future employment and productivity within society, one is also interested in developing social and political values in the student. Throughout the limited history of production function estimation, several measures of output have been used. For example, basic course grades, test scores, retention rates, estimates of future income streams and educational expenditures per student have been used as a measure of school output. The production functions estimated in this analysis rely upon standardized test scores for a measure of school output. In many ways these tests are aimed at measuring the general preparedness of the student to exist and compete in our society. These tests are admittedly not "culturally fair."<sup>11</sup> However, for our purposes this does not seem very damaging as a good argument can be made that the middle-class standards measured by these tests are precisely the standards that are applied in a vast majority of employment decisions. Furthermore, many people attempt to justify discrimination in employment and housing by the fact that minority people are a "different" kind of

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<sup>11</sup>Cf. EEO Report, p. 218.

people, i.e. not "good middle-class citizens." Therefore, since we generally do not desire education merely as an end in itself but for what desirable effects it has in terms of employment, citizenship, etc., it does not seem harmful to use a culturally oriented measure of educational output. Certainly, these test measurements are not the only dimension of output. However, it is sufficient that they capture one of the significant dimensions of expected educational output.

The OE Survey included four separate tests at the sixth grade: verbal ability, nonverbal ability, mathematics achievement, and reading achievement.<sup>12</sup> There is no clear decision rule for choosing among these tests to arrive at a measure of educational output.

The difference in scope of the ability and achievement tests provides one consideration in the choice of output measure. Ability tests have been designed to measure learning capacity or IQ; achievement tests on the other hand are concerned with specific subject matter. However, there has been considerable recent evidence suggesting that such distinctions are not meaningful.<sup>13</sup> While few people now consider ability tests as anything more than broader achievement tests, it is this difference in scope that is meaningful in formulating an output scale.<sup>14</sup> If ability tests cover a different scope than achievement

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<sup>12</sup>The verbal ability test was the Educational Testing Service's School and College Ability Test (SCAT); nonverbal ability was the Inter-American Test; reading and mathematics achievement were ETS Sequential Tests of Educational Progress (STEP).

<sup>13</sup>See Benjamin S. Bloom, Stability and Change of Human Characteristics (New York: John Wiley and Sons, Inc., 1964), for a synopsis of longitudinal studies depicting changes in ability as commonly measured. Also, Hunt, Intelligence and Experience, presents similar evidence along with a discussion of fixed versus interactive theories of intelligence.

<sup>14</sup>Cf. EEO Report, p. 293.

tests, it is useful to evaluate differences in school impact in producing the differently measured output.

Prior beliefs about components of the process when measured in different directions offer the second guide in selection of a specific output measure. Intuitively, it seems that measures of verbal factors would be more closely linked to home environment and, thus, harder for schools to affect than other possible measures. The main source of verbal instruction is the home; children are constantly under the influence of the speech patterns of the family. The school either refines the basics learned elsewhere or attempts the much more tedious job of overthrowing incorrect verbal patterns introduced outside of the school. Which job the school undertakes depends on the quality of the student's background. Schools could be operated much more independently in areas less tied to nonschool influences, e.g. "new" math. This implies that schools could have a differential impact on output measured in different directions. A priori the impact of schools would be less in the case of verbal ability than in the case of the other output measures.

While these considerations do not make a strong case for selecting a particular measure of output, they do provide motivation for analyzing more than one. In order to test the two inter-output hypotheses about school effects, two separate production functions were estimated: 1) verbal ability, and 2) mathematics achievement. Verbal ability was chosen as verbal skills appear to be highly rewarded in hiring and advancements. Additionally, most subsequent analyses of the OE Survey data center on the production of these verbal



skills.<sup>15</sup> Math then provides the comparison of measures.

Specifying the precise components of the input vectors is even more difficult than defining an output measure. Past theoretical and empirical work takes us little beyond Equation 2-1. Many people have a priori notions about what factors are relevant in the production process. However, these thoughts are seldom refined enough to be operationally testable hypotheses.

At this point it does not seem profitable to go into great depth about the specific hypotheses to be tested. Some of the general variables to be analyzed--ones often mentioned by writers in the field--are class size; specialized teachers; kindergarten, nursery school and Head Start programs; availability of libraries, health programs, etc; teacher attitudes and quality (as measured by verbal test scores); socioeconomic characteristics of the student; parental attitudes; school peers; and neighborhood conditions and attitudes.

One particular opinion about inputs to the process does deserve attention, however. Largely from popular interpretations of Equality of Educational Opportunity, it is becoming widely circulated that school inputs have little bearing on achievement.<sup>16</sup> The analytic problems

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<sup>15</sup>Equality of Educational Opportunity and Racial Isolation in the Public Schools both base their findings exclusively on the relationships involving verbal ability. (The EEO Report presents a very unconvincing argument for doing this based on relative amounts of variance in the test scores found between schools and an even weaker argument making intergrade variance comparisons.) However, in addition to these published works, all reanalysis is, to my knowledge, concentrating on verbal achievement.

<sup>16</sup>This finding is also found in Burkhead, Input and Output in Large-City High Schools (Syracuse: Syracuse University Press, 1968). The conclusion in this study, however, is based on very thin evidence derived from quite small samples of schools in Atlanta and Chicago.

which tend to produce this conclusion are discussed elsewhere.<sup>17</sup> It should be noted, though, that this is a very serious charge leveled against the public school system and deserves considerable attention in the analysis of the educational production functions. The concern is whether schools are serving their assigned function, regardless of any efficiency consideration. This hypothesis implies that the entire vector of school inputs in Equation 2-1 should be excluded from the model. This issue will be covered in considerable detail in the empirical sections.

#### Functional Form

As we have little theoretical guidance in even the selection of inputs to the educational production process, we can hardly hope for help on the precise functional form. The only loose help is borrowed from economic production theory which suggests that individual inputs should exhibit diminishing marginal product after some level. However, this is very little guidance as many functions have this property. Additionally, it is very possible that certain inputs could be in a range of increasing or constant marginal product.

There is no theoretical way to resolve the question of functional form. Some experimentation is called for to gain more information on this point. In actuality, only two functional forms were used in estimation, and those used were highly dictated by ease of estimation

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<sup>17</sup>Eric A. Hanushek and John F. Kain, "On the Value of Equality of Educational Opportunity as a Guide to Public Policy," Discussion Paper No. 36, Program on Regional and Urban Economics, Harvard University [1968], and Samuel Bowles and Henry Levin, "The Determinants of Scholastic Achievement--An Appraisal of Some Recent Evidence," The Journal of Human Resources (Winter 1968) both present a detailed description of the systematic biases in the EEO Report which point toward a no-school-effect conclusion.

procedures. The main contenders were the linear model and the log-log model for they lend themselves to easy estimation and, lacking other information, they provide a good starting point

The linear model, such as depicted in Equation 2-2, is often

$$(2-2) \quad A_i = a_0 + a_1 X_{1i} + a_2 X_{2i} + \dots + a_n X_{ni} + u_i$$

where  $A_i$  = achievement in the  $i$ th school

$X_{1i}, X_{2i}, \dots, X_{ni}$  = independent variables (inputs) for the  $i$ th school

$a_1, a_2, \dots, a_n$  = parameters of the production function to be estimated

$u_i$  = unexplained residual term for the  $i$ th school

justified by the fact that many functions look linear over a range, and, thus, the linear model can be used as an approximation for the true, nonlinear relationship. However, the implications of the straight linear model are quite strong. First, the linear model exhibits constant marginal product, i.e. the effect on achievement of increasing any input by one unit is the same regardless of the absolute level of usage of that input. For example, the additional impact of one guidance counselor is the same when moving from none to one as when moving from five hundred to five hundred and one. (This is actually an overstatement as, strictly speaking, all of the estimated parameters must be interpreted as being conditional estimates given the range of the particular independent variable.) Secondly, the linear form does not allow for interaction between the various inputs. Thus, a given level of input brings forth the same effect on output even if all other inputs are absent or available in such quantities as to be superfluous.

The log-log form, or Cobb-Douglas form, has several advantages

over the linear form. The precise model looks like Equation 2-3.

$$(2-3) \quad A = B X_1^{a_1} X_2^{a_2} \dots X_n^{a_n} e^u \quad (\text{Note: Subscripts for schools eliminated})$$

This in turn can be transformed by taking natural logarithms into Equation 2-4 which is used for estimation purposes. This model lends itself to same simple and direct application of linear regression techniques

$$(2-4) \quad \log A = \log B^* + a_1 \log X_1 + a_2 \log X_2 + \dots + a_n \log X_n + u$$

The log-log model, like the linear model, can also be used to approximate other functions. The desirable features, conceptually, of this formulation are the provision for diminishing marginal product of the various inputs and the allowance of interaction, albeit restrictive, among the various inputs. Nevertheless, these reasons are far from overpowering, and the proof is still in the estimation.

### Specific Models

A strong case was made for using aggregate school characteristics in the statistical models of the process. However, there are a variety of reasonable approaches to forming aggregate variables for the schools. The simplest approach, and the one emphasized throughout this study, is the use of mean school quantities or, at least, mean quantities for a given racial subset within the school. Thus, the relevant output of the process is mean school achievement, and for student factors the inputs are various mean student body characteristics. This approach appeared to be most promising, at least in terms of immediate pay-off. These models form the basis for all conclusions of this study.

Nevertheless, there are several other models which offer some hope of providing different information about the educational process.

Preliminary efforts at developing three different models were undertaken. However, in the initial attempts none appeared to provide much additional information to the more straightforward mean models. Thus, attention was focused on school mean production functions for the races. However, since this choice was made fairly early in the developmental stages of the alternative models, a brief description of the alternatives is presented.

A natural extension of the mean models involves using first grade scores within the same school as a measure of the inputs with which the present sixth graders entered the process. The data are strictly cross-sectional and pertain only to the students within the schools at one point in time. Yet, if it can be assumed that the current first graders are similar to the current sixth graders when they were in the first grade, the contemporaneous first grade test scores provide a measure of inputs into the process. However, these models did not prove very successful, and, since only half of the sampled elementary schools included first grade data, the loss of sample information leads to deemphasis of these models. The preliminary efforts in this "growth" approach are displayed in Appendix C.

There is some question in modeling the school of whether the production function is the same for all students within the school. In fact, throughout the analysis the school population is stratified by race to allow for behavioral differences which might exist. An alternative concern along these lines is whether there are differences in the production process at different levels of achievement. In order to analyze this possibility, the school output can be redefined to measure the per cent of students above or below a certain achievement level. In

other words, how does a school produce high or low achievers? By aggregating school characteristics over the set of high or low achievers, it is possible to consider producing the extremes of the distribution of achievement. Again, the preliminary attempts at estimating such a production function did not appear very profitable. Little information was gained over that contained in the mean models. Examples of these models are found in Appendix D

Finally, in order to analyze differences in achievement between blacks and whites, an explicit model of the intraschool achievement gap was developed. Differences in black and white achievement within a school were described as a function of differences in background characteristics and of school factors which can be used as a policy instrument for closing gaps. However, these models are very complex and difficult to interpret. At the present stage of development they do not add much to analysis of differences in the production functions for black and white achievement. The best models of the achievement gap within integrated schools are found in Appendix E

Again, each of the different models has its own conceptual merit. However, the educational process is very complex, and present knowledge is not large. Thus, the bifurcation of effort through additional analyses of any of these alternative models did not seem profitable at this time. The first generations of these models are presented in the appendices because the possibility of additional information about the production process from intensive analysis of these seems fairly high.

## CHAPTER III

### THE EDUCATION OF WHITES

Separate production functions for sixth grade whites and blacks were estimated using the OE Survey for Northeast and Great Lakes region schools. While there are many similarities between these models, discussion of the black educational process is reserved for Chapter Four.

The basic production function estimates for white sixth graders proved quite acceptable. Certainly the models do not provide an authoritative answer to all questions about the educational process. However, they do provide a crude test of many of the more important hypotheses about public education. As such they lend a fair amount of insight into broad educational issues and offer a basis for future research into the area.

These estimated production functions, first of all, confirm the value and meaningfulness of considering school production functions. While the relationships are necessarily highly aggregative, the models conform with a priori views on factors entering into the process. Additionally, the relationships discovered in this analysis are fairly stable across samples, i.e. there is a high qualitative consistency of these models with models estimated for a much more restricted sample.<sup>1</sup>

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<sup>1</sup>The preliminary work in this analysis involved estimating production functions for a sample of approximately one half of the schools contained in this sample. These schools were contained entirely in the Northeast and Mid-Atlantic regions defined by the Bureau of the Census. These models were very similar in both overall specification and effect of individual variables.

The most interesting finding of the estimation is that, contrary to the impression given by the EEO Report, schools have a significant effect on achievement. While there are many reasons to believe that the effects of school quality are underestimated, the effects are quite strong. Using only the minimal measures of teacher quality available in the OE Survey, strong positive relationships are found between teachers and achievement.

The models also affirm the strong influence which family background has on achievement. However, this does not seem to be an area of either much debate or much relevance to public policy. The models furthermore analyze the effects of racial composition of the school on white achievement and find it to be negligible.

#### The Sample

The white production functions were estimated from a sample of 471 elementary schools. These are all OE Survey schools with complete information and more than four white sixth graders found in standard metropolitan statistical areas (SMSA's) in a geographic region covering the New England, Mid-Atlantic and Great Lakes states <sup>2</sup>

This region was chosen on the basis of relevance to educational policy and an a priori view that it was relatively homogeneous in terms of culture and attitudes. The major reason for stratification of the

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<sup>2</sup>SMSA's follow the Bureau of the Census definitions used in the 1960 Census of Population. SMSA's follow county boundaries and include contiguous counties to a county containing a city of 50,000 or more people.

The states included in the sample along with their number of sample schools are: Connecticut (24), Delaware (6), Illinois (28), Indiana (35), Maine (10), Maryland (13), Massachusetts (42), Michigan (51), New Hampshire (0), New Jersey (36), New York (89), Ohio (22), Pennsylvania (64), Rhode Island (0), Vermont (0), Washington, D.C. (2), and Wisconsin (49).



OE Survey schools is a concern over homogeneity, although the issue of data manageability does enter. If the observations are not part of the same population (i.e. do not follow the same behavioral relationships), the estimated production functions will be meaningless. It seems plausible that rural schools operate under a different production process due to different organizational structures, size considerations, variations in parental attitudes and the impact of socioeconomic standards, etc. There is some empirical verification for the assertion that there are urban-rural differences found in Kiesling's study.<sup>3</sup> Even so, this division is not too critical in terms of making inferences about the population as 78 per cent of the people in the sample region reside in urban places.<sup>4</sup>

Homogeneity considerations also entered into restriction of the sample to the North region. Different characteristics of the various regions of the country in terms of attitudes, support of schools, cultural influences, etc. suggest stratification for the production function estimation. The OE Survey itself provides information about the considerable differences in both inputs and outputs in different regions of the country. While this does not establish the necessity of stratification, the magnitude of these differences plus prior knowledge about differences in social climate, economic conditions and migration

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<sup>3</sup>Kiesling, "Efficiency of School Districts," notes very different expenditure and size characteristics for rural schools. His regression analyses of district achievement also indicates quite different production relationships. See especially Chapter 3.

<sup>4</sup>These are 1960 figures for the entire population, not just school age children. U.S. Bureau of the Census. U.S. Census of Population: 1960. General Social and Economic Characteristics, United States Summary. Final Report PC (1) - 1C. (Washington, D.C.: U.S. Government Printing Office, 1962), pp. 1-250.

patterns afford prima facie evidence for this procedure.<sup>5</sup> While it would be desirable for policy purposes to have a complete picture of education in all sections, the magnitude of such an undertaking forced selection of one region for this study. As mentioned previously, the north was chosen as this is the center of much of the current controversy over education. This is especially true when one considers differences in education by race.

In forming the sample, all schools with four or less white sixth graders were eliminated. This arbitrary cutoff point was established to insure that the admonitions about individual production functions were not violated. The effect of this sampling decision was to eliminate 57 schools which contained one to four white sixth graders. This drastically reduced the number of observations of schools with high concentrations of blacks and other minorities. However, reduction in range of some characteristics seems more than compensated for by the reduction in errors of the explanatory variables.

After the elimination of "small schools,"<sup>6</sup> there are still observations across the entire range of black-white composition, but, as Appendix F displays, the distribution drops off sharply.<sup>7</sup> Of the 471 white schools in the sample, 169 schools have five or more black sixth graders. Even so, this sample does not belie the true situation in public schools. The extent of racial concentrations within school

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<sup>5</sup>The tremendous regional differences, especially North-South differences, are well documented in Chapter 2 of the EEO Report.

<sup>6</sup>Small here applies to the number of whites, not the total school population.

<sup>7</sup>The figure does misrepresent the composition of schools to the extent that other minorities are present. For whites the proportion of all minorities seems more relevant.

systems is described extensively in the Civil Rights Commission Report, Racial Isolation in the Public Schools.<sup>8</sup> In a sample of 75 school systems from the entire country, 83 per cent of the white elementary students attended schools with over 90 per cent white,<sup>9</sup> (At the same time, 75 per cent of the black elementary students attended schools which were over 90 per cent Negro.) Thus, while there are some questions about the representativeness of the sampled schools, in these aggregate terms the sample seems reasonable.

Of the sampled schools half are located in central cities. In size they range from five to 160 white sixth graders. The average total number of sixth graders in the sampled schools is 72 and the average total school size is 600. (This latter figure is somewhat misleading for the sampled schools vary widely in grade composition.)

Background variables for the student body are defined only over the subset of white students. The characteristics of black and other minority do not enter in computing socioeconomic variables and attitude variables for the "school." Thus, while there are integrated schools in the sample, the 471 schools with over four whites will be referred to as the "white school sample." Similarly, the black production functions in Chapter Four are estimated from a sample of 242 "black schools" even though 169 of these are also in the white school sample.

#### Educational Production Functions for White Sixth Graders

Within an area such as education where very little is known about the production process, a certain amount of experimentation with

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<sup>8</sup>U.S. Commission on Civil Rights, Racial Isolation in the Public Schools (Washington, D.C.: Government Printing Office, 1967).

<sup>9</sup>Racial Isolation, p. 3.

model specification is both necessary and desirable. There are a plethora of hypotheses about the educational process--everyone has his favorite. An attempt was made to test as many of the major hypotheses as possible given the data limitations, but, since many of the hypotheses are vague and ill-defined, it is very difficult to provide conclusive tests. Because the empirical knowledge in this area is so meager, an effort has been made at noting the various modeling attempts that failed. The models presented are the most promising ones of the educational process and were selected through the informal application of two criteria: 1) conformity with a priori views about the process, and 2) statistical properties of the estimated models, chiefly significance of individual parameters. These two criteria were never in serious conflict.

Estimated educational production functions for white sixth graders are presented in Equations 3-1 and 3-2. The variable definitions

$$\begin{aligned}
 (3-1) \text{ VERBAL}^* &= -1.18 - .023\text{CC} + .618\text{G}^* + .169\text{E}^* - .064\text{FS}^* \\
 &\quad (-3.0) \quad (-3.8) \quad (10.6) \quad (6.0)^{\text{f}} \quad (-2.3) \\
 &\quad + .004\text{NS}^* - .006\text{M}^* + .290\text{HS}^* - .026\text{S}^* \\
 &\quad \quad (2.3) \quad (-2.0) \quad (4.4) \quad (-5.6) \\
 &\quad + .125\text{T}^* + .019\text{E}^* - .023\text{NT}^* - .037\text{N}^* \\
 &\quad \quad (2.4) \quad (3.0) \quad (-6.8) \quad (-3.4) \quad 75-100 \\
 &\hspace{15em} \text{SE} = .38
 \end{aligned}$$

$$\begin{aligned}
 (3-2) \text{ MATH}^* &= -1.84 - .022\text{CC} + .471\text{G}^* + .225\text{E}^* - .119\text{FS}^* \\
 &\quad (-4.3) \quad (-2.8) \quad (6.3) \quad (6.4)^{\text{f}} \quad (-3.3) \\
 &\quad + .003\text{NS}^* - .009\text{M}^* + .419\text{HS}^* - .033\text{S}^* \\
 &\quad \quad (1.6) \quad (-2.2) \quad (6.8) \quad (-5.6) \\
 &\quad + .089\text{T}^* + .016\text{E}^* - .020\text{NT}^* \\
 &\quad \quad (1.3) \quad (2.1) \quad (-4.6) \\
 &\hspace{15em} \text{SE} = .49
 \end{aligned}$$

Note: Asterisks denote logarithms of variables. t-statistics are displayed in parentheses below each coefficient. SE is the standard error of the weighted regression in logarithmic form.

TABLE 3-1

VARIABLE DEFINITIONS FOR THE WHITE EDUCATIONAL  
PRODUCTION FUNCTIONS

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VERBAL	mean verbal ability test score for white sixth graders
MATH	mean mathematics achievement test score for white sixth graders
CC	central city dummy variable = 1 if school is in central city of SMSA = 0 otherwise
G	goods index; average of per cent of white sixth graders whose family owns automobile, television, refrigerator, telephone and record player
$E_f$	mean father's education (years) for white sixth graders
FS	mean family size (total number of people in home) for white sixth graders
NS	per cent of white sixth graders who attended nursery school
M	per cent of school population that moved away last year
HS	per cent of white sixth graders who wish to finish high school or more
S	per cent of white sixth graders who feel that people like self do not have much chance for success
T	mean teacher verbal test score (for teachers who teach in the sixth grade or lower)
E	mean years of teaching experience (for teachers who teach in the sixth grade or lower)
NT	per cent of white sixth graders who had a nonwhite teacher during the last year
$N_{75-100}$	Negro concentration = per cent Negro sixth graders if greater than 75 per cent = 0 otherwise

TABLE 3-2

MEANS AND STANDARD DEVIATIONS FOR VARIABLES IN  
THE WHITE EDUCATIONAL PRODUCTION FUNCTIONS

Variable	Mean	Standard Deviation
VERBAL	35.70	4.54
MATH	15.85	2.15
CC	.51	
G	92.49	7.29
E <sub>f</sub>	11.67	1.87
FS	4.48	.52
NS	15.23	14.25
M	7.79	6.88
HS	94.33	6.87
S	9.81	6.71
T	24.77	1.43
E	11.88	4.56
NT	13.42	16.03

are found in Table 3-1, and the means and standard deviations for the included variables are found in Table 3-2. The equations were estimated using weighted regression techniques on the 471 observations previously described.<sup>10</sup> Both equations are in log-log form, i.e. all of the variables (except the central city dummy variable) were transformed into natural logarithms before estimation.<sup>11</sup> In this case, the parameters may be interpreted as elasticities.<sup>12</sup> Thus, a coefficient estimate of .1 indicates that a ten per cent increase in the given independent variable, ceteris paribus, will result in a one per cent increase in the dependent variable (educational achievement).<sup>13</sup>

The logarithmic form of the equation was chosen over the linear additive form. The logarithmic form was generally more consistent with a priori views about the educational process. Additionally, the

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<sup>10</sup>When aggregate relationships using average values are estimated, the use of weighted regression techniques are justified for two reasons. First, intuitively one wants to predict better where the most students are found. Second, if one assumes homoscedasticity for the individual student relationships, the aggregate relationship will necessarily be heteroscedastic. Therefore, for efficiency in estimation, weighted regression is used where the weights are the number of sixth grade whites. Appendix A contains a more detailed discussion of weighted regression with particular reference to estimating school production functions.

<sup>11</sup>Since the natural logarithm is undefined for negative numbers and equals minus infinity for the value of zero, some care must be exercised in defining the variables before transformation.

Zero output is not a reasonable expectation if some variable is zero in the aggregate relationship. Therefore, variables which could assume zero values were redefined by adding one to them. This insures that the logarithm is greater than or equal to zero.

<sup>12</sup>Note that these will be elasticities in terms of the transformed variables, i.e. after adding one to the original variables.

<sup>13</sup>Some care must be exercised in interpreting the parameters as many of the variables are defined as percentages. The elasticity applies to the absolute size of the variable. Thus, a change of a variable value from five per cent to ten per cent is a 100 per cent increase in the variable.

statistical properties of the equation seemed better; in particular, the parameter estimates were more precise (higher values of t-statistics). Given these considerations and the conceptual superiority of the logarithmic form, the logarithmic models were chosen as the better representation of the educational production process. The linear models of the process are presented in Appendix B.

The most notable overall feature is that the production relationships for verbal and math are very similar. While there were conceptual reasons for expecting differences in the two equations, it is difficult to separate the two empirically. The simple correlation between math achievement and verbal ability test scores at the individual level is .70.<sup>14</sup> For school mean scores, this correlation is .89. The implication of this correlation is that there is very little independent variation in the two output measures.

For policy purposes it would be desirable to ascertain the reason for this high intercorrelation in test measures. There are three plausible explanations for this occurrence. First, there could be just one dimension (or slightly more) of learning in nature. This explanation implies that differences in measured output are just random noise and that no meaning should be attached to differences in parameter estimates. However, there is considerable evidence suggesting this is not the case.<sup>15</sup> Second, the math test might rely heavily on verbal skills

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<sup>14</sup>This is the simple correlation for the 26,093 individual white sixth graders in the "North" region in which the schools are found. Students were included in this calculation even though the school they attended might not be in the sample of 471. Exclusion from the regression sample arose from either missing principal data or having less than five whites in the school.

<sup>15</sup>An example of experiments showing different dimensions is found in Susan S. Stodolsky and Gerald Lesser, "Learning Patterns in the



so that the high correlation is merely a testing aberration. Finally, all learning in our schools (as presently organized) could be dependent upon verbal skills to a considerable extent. The last two explanations have different implications for interpreting the estimated production functions and for public policy.

If the testing reason holds, the meaning which should be attached to the MATH equation is ambiguous; it is difficult to ascertain whether it is anything different from another VERBAL production function. The school structure theory implies that, if different educational outputs are valued independently, major efforts should be made at either freeing parts of the curriculum or intensifying the study of basic verbal sections even at the slighting of other subjects. Unfortunately, it is impossible with the OE Survey data to distinguish between the last two hypotheses. The similarity of the two equations does free us from attaching much meaning to differences in the processes. The discussion of the estimates will explicitly consider only the VERBAL estimates with passing reference to any differences in the two equations

The production functions are best considered in blocks which correspond roughly to the vectors of inputs in the conceptual model (Equation 2-1). In actual practice, however, variables do not fit neatly into these vectors. The actual educational production process is very complex. The models of the process presented in Equations 3-1 and 3-2 necessarily simplify parts of the process and combine groups of factors together. Thus, some of the conceptual clarity is lost. Nevertheless, the crude division into these terms provides a useful taxonomy

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Disadvantaged," Harvard Educational Review, XXXVII, Fall 1967, pp 547-593. Also see the summary of different investigations in Bloom, Stability, pp. 85-87.

for the policy implications differ in a systematic manner associated with the vectors.

### Central Cities

The first variable in the equation (CC) is a dummy variable for central cities. If a particular school is located in the central city of an SMSA, this variable has a value of one; if it is in the suburban ring, it has a value of zero. The negative coefficient indicates that, all other inputs being equal, the achievement in central cities will be less than in the suburbs. The use of the dummy variable is forced by a lack of data and a certain amount of ignorance about community factors entering the production function. Certainly this variable acts as a surrogate for other conditions. The most probable factors are differences in housing conditions, the existence of ghettos, bureaucratic rigidities (both inside and outside of the school system), fiscal pressures, attitudes toward schooling, and dynamic characteristics which differ between central city and suburb. The adjustment in the intercept of the equation is an approximation for a more complex relationship which surely exists. For policy purposes it would be desirable to model the causes of this decrement in achievement.

The existence of this negative adjustment to the process indicates that central city students leave schools disadvantaged when compared with suburb students. The model implies that, with identical inputs into the process, a student in a central city school system only reaches 97.6 per cent of the achievement level of the suburban school.<sup>16</sup> This is over and above the fact that central city students are often

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<sup>16</sup>The value of  $e^{-.023}$  is .976 which is multiplied times the entire equation in calculating the predicted achievement level.

disadvantaged in terms of both school and nonschool inputs, which are measured by the other variables in the equation. The across-the-board disadvantage for central city students adds an additional consideration to analysis of the distribution of educational services.

### Family Background

Numerous studies have shown a positive influence of higher social and economic position on achievement.<sup>17</sup> Obviously, family background must be included in any properly specified model. Nevertheless, this is not an essential policy section of the educational model which we are constructing. Proper statistical analysis required adequate representation of family background; however, including this does not imply equal interest from a policy point of view.

Even if one believed that there was a causal relationship running from family background (as measured by income-related variables) to achievement, the idea of changing all income levels to bring about achievement changes is a priori unreasonable. It would be extremely expensive to alter education in this manner. Moreover, the sensible hypothesis about family background is not that one buys achievement with higher income but that income levels do a good job of proxying a set of family characteristics which are important to education.<sup>18</sup> In other

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<sup>17</sup> The study of environmental influences on achievement has been the subject of an untold number of studies of man and animal. The reactions of white mice and the abilities of separated twins have confirmed the effect of favorable environment on raising educational levels. The important environmental factors are additionally highly correlated with socioeconomic status. Surveys of important pieces of research in this area are found in Bloom, Stability, and Hunt, Intelligence and Experience.

<sup>18</sup> This must be qualified at least at the lower extreme of the distribution. There are two relevant considerations at the lower end. The partial equilibrium nature of this study is crucial since income

words, a causal relationship does not exist between income level and achievement but between achievement and a group of other factors which are correlated with, but not necessarily causally related to, income.<sup>19</sup> These factors include providing a good model of language usage, encouragement in language and problem-solving development, interest in education, parental attention, and help with homework

Social class would also be expected to enter in conjunction with innate abilities. Most people accept that genetic endowments or innate abilities have a complex effect on achievement through both an independent effect and an interaction with environment. If innate ability is partially hereditary and social mobility through ability exists, socioeconomic variables will partially proxy the unmeasured innate abilities. Further, socioeconomic variables will pick up some of the interaction effects. Thus, measured background will have an inflated effect on achievement due to model misspecification (the lack of data on innate abilities).<sup>20</sup>

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redistributions are generally the product of other considerations and, thus, would not be evaluated solely in terms of educational benefits. Second, at the extreme it might be possible to buy education, i.e. a causal model might be applicable. To the extent that a poor diet yields permanent mental damage or even that overcrowded housing prohibits studying by an otherwise well-motivated child, achievement can be bought. Nevertheless, for the vast majority of children, the other factors proxied by contemporaneous socioeconomic status seem much more important.

<sup>19</sup>An additional qualifier is needed at this point. People do buy education to the extent that schools enter their residential location decision. However, this is something different from what is discussed above. People do not generally buy the family background inputs to the process. To the extent that school inputs are adequately measured, this element of "buying" education through location decision is accounted for.

<sup>20</sup>The misspecification through missing data coupled with the hypothesized correlation with included variables causes some problems in the statistical estimation. To the extent that such a correlation between the error term and the explanatory variables occurs, the

The model contains three "pure" socioeconomic measures; two of these picture the income and wealth of the family while the third measures family size. (There is another set of variables which has some of the attributes of socioeconomic measures but also contains distinctive dimensions which call for division from the "pure" measures.) The goods index (G) which summarizes major items in the home and mean father's education ( $E_f$ ) are the basic measures of socioeconomic status (SES). The goods index a priori would be weighted as the most reliable of the various possibilities for measuring SES. It is easy for a sixth grader to list major items in the home; it is not so easy to give parents' education accurately.<sup>21</sup> Nevertheless, family educational level, albeit less reliable, suggests a different dimension of SES, and (as opposed to educational level) items in the home does not possess the same amount of intuitive meaning. It is not necessary to dwell on problems of interpretation or errors since the parameter estimates in this section are not the most interesting for policy application. The choice of SES measures is not critical, as parameter estimates in other parts of the model are very stable under alternative socioeconomic measures

Many authors have hypothesized that mother's educational level is much more important in training children than father's education

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assumptions of the least squares estimation procedure fail and the parameter estimates for socioeconomic variables will be biased and inconsistent. However, by deemphasizing the background section of the model, this does not appear to be a crucial point. It would only be important if the point estimates of the parameters would be put to some use.

<sup>21</sup>Parents' education questions are subject to considerable nonresponse, and this appears to be systematic. The education measures in this study assigned the nonrespondents the school mean value. While this probably yields an overestimate, there is no clearly preferable alternative.

This argument is most applicable to the matriarchial societies found in disadvantaged neighborhood. The difference in effect cannot be examined empirically, for the simple correlation between mother's education and father's education is .79 at the school level. In this case, the problem of multicollinearity is severe enough to make estimation of individual parameters for mother's and father's education impossible.<sup>22</sup> Father's education is justified as it would provide a better picture of the income level. (This seems quite analogous to the frequent use of the white-collar/blue-collar distinction.) The basic modeling efforts included alternative specifications with mother's education and similar interaction terms. There was little effect on the overall characteristics of the model.

A final note on the goods index appears in order. The items (car, TV, telephone, refrigerator, and record player) seem very gross and unable to provide satisfactory differentiation. However, this is not the case. While there is some "topping out" of the index, it appears to do a good job of differentiating the middle and lower ranges of the social class scale. The index does have a fair amount of

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<sup>22</sup>When the explanatory variables are very highly correlated with each other, the independent effects of each cannot be separated. At the extreme, when a perfect linear relationship exists among the explanatory variables, it is impossible to obtain individual parameter estimates. The more usual case is that the variables approach a linear dependency. With this it is not possible to obtain parameter estimates with any precision. Some feel for the extent of collinearity between father's and mother's education can be derived from the value of the determinant of the moments matrix. With orthogonal variables this has a value of one; with linear dependent variables it has a value of zero. As suggested by Farrar and Glauber in "The Problem of Multicollinearity Revisited," Review of Economics and Statistics (February 1967) the range between the extremes has not been mapped out. However, on the step at which both variables are entered the determinant goes from .12 to .00004, a dramatic enough change to indicate the inseparability of effects of the two variables.

variation with a standard deviation in the sample of 7.3 (mean = 92.5). Also, there exists outside evidence that there is variation in the population. In 1960 only 68 per cent of central city residents owned automobiles, 81 per cent had telephones, and 88 per cent had televisions. For the suburban ring, these figures were 89, 86, and 93 per cent, respectively.<sup>23</sup> This index is admittedly fairly crude, but, averaged over a school, seems to capture many of the essential differences in socioeconomic status.

These two measures (the goods index and father's education) as expected have a strong influence on education. The estimates are statistically very significant and indicate very high elasticities. It is not the least bit surprising that family background exerts such a significant impact on achievement as such a high percentage of a child's life is spent under the sole influence of his nonschool environment.

The last "pure" SES factor is family size (FS). There are several reasons why one expects a negative effect on achievement from increases in family size. The negative effect is consistent with a lessened attention hypothesis. With larger families there is less time to be spent with each child, each gets less help, etc. It is also consistent with a standard of living adjustment, i. e. that wealth (goods index) must be adjusted for family size to consider different costs. This is very plausible in the multiplicative formulation of the model. However, it is not possible to hold strictly to this interpretation as a standard of living adjustment must consider family makeup, e. g. whether

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<sup>23</sup>U.S. Bureau of the Census. U.S. Census of Housing, 1960. Volume I, States and Small Areas. Part 1: United States Summary (Washington, D.C.: U.S. Government Printing Office, 1963), pp. 1-44. The figures apply to all SMSA's in the United States. The suburban ring includes all of the SMSA except the central city.

two adults are present. Also, the marginal costs of additional children are probably not truly measured by our constant elasticity model (and even less so in a linear model which includes something like per capita wealth). Nevertheless, this adjustment appears reasonably good with a t-statistic of 2.3. For our purposes it is unnecessary to sort out the alternative hypotheses which could account for a negative relationship.

The OE Survey does contain other measures, both objective and subjective, of family background. Most notable is the occupation variable included in the student questionnaires. However, the combination of poor formulation and nonresponse or faulty response led to the exclusion of this measure.<sup>24</sup> Other objective measures such as structural integrity of the home were evaluated but judged insignificant. Several subjective measures were also tested but found to be statistically insignificant. (These measures will be discussed in more detail later.)

The three measures of socioeconomic status used in the model appear to capture most of the important dimensions of environment in the learning process. While they strictly apply to only contemporaneous factors, there does not appear to be large errors in variables at least at the school level. Since these factors are all so collinear, little is gained by adding more SES variables. These factors exhibit a very stable effect on achievement, independent of specific formulations of the remaining effects on achievement, i.e. independent of the measurement of school effects on achievement.

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<sup>24</sup>A reliability test of the OE Survey occupation question by J David Colfax and Irving Allen indicated that among their sample of sixth graders, over 50 per cent either failed to respond or responded incorrectly. See "Pre-Coded versus Open-Ended Items and Children's Reports of Father's Occupation," Sociology of Education, XL (Winter 1967), pp 96-98. Additionally, the question is divided in such a manner that it is not possible to sort occupations along traditional white collar and blue collar lines.



### Pre-School

Nursery school (NS) represents a combination of factors. Partly it measures another dimension of socioeconomic position. It offers vivid proof of parents' interest in the education of their children. Additionally, and more importantly for policy purposes, it appears to measure the effect of earlier training. To the extent that the latter holds, there is confirmation of an often hypothesized, crucial effect of starting early in the learning process. This early impact derives from the sequential nature of learning and the rapid development before age six.<sup>25</sup> There is no strong test for separating these two factors with the data from the OE Survey. However, indirect tests indicate that the early schooling hypothesis could well be the stronger. Various measures of parental attitudes and interest in education were modeled, but none showed a significant influence on achievement even when nursery school was excluded from the model.<sup>26</sup> This indicates that we can be a little more confident in accepting the straightforward pre-school hypothesis.

While the elasticity of .004 on the surface indicates that this exerts a weak influence on achievement, there are reasons to believe that the effect could be considerably larger. This variable is subject to considerable error in measurement since all nursery schools are rated

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<sup>25</sup> Cf. Bloom, Stability, pp. 214-216.

<sup>26</sup> The OE Survey includes several questions about parental attitudes as perceived by the student. For example, in a multiple choice framework, how good a student does your mother want you to be in school? How often do you and your parents talk about your school work? These questions were transformed into percentages for the school, e.g. per cent with pushy mothers (per cent whose mother wished above average performance). Certainly these are not ideal data on attitudes. However, the fact that none of them will demonstrate a significant influence on education, even when nursery school is excluded, provides some evidence that nursery school is not solely, or even chiefly, another socioeconomic variable measuring an attitude dimension.

as being of equal quality. In reality there is known to be a large variance in quality and quantity of schooling among pre-schools. In quality terms, there are "organized play" programs and more scholastically orientated programs such as Headstart. In quantity terms, there are large differences in both length of day and number of days for the program. Such errors in measurement would lead to a downward bias in the estimated parameter.<sup>27</sup>

The fact that any effect of nursery schooling is found in the sampled sixth graders is somewhat surprising. The indications that the effect might be larger than pictured are encouraging since nursery school programs represent a readily available policy tool. Certainly more research into this area is needed.

### Migration

The per cent of the school population that moved away during the past year,  $M$ , has the expected negative relationship with achievement. This is consistent with two plausible hypotheses about the educational process. The most obvious interpretation is that there is a cost in terms of continuity attached with moving. This disruption factor for the individual students involved is sure to be present. Moreover, it can also affect teaching. If a school has a very high turnover, it is difficult to map a sequential learning program through the grades. When a high percentage of a class starts at different levels, the teaching must be revised from the situation where everybody starts together. This cannot help but have a detrimental effect on learning when compared to schools with low migration rates.

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<sup>27</sup>Cf. J. Johnston, Econometric Methods (New York: McGraw-Hill Book Co., 1963), pp. 148-150.

While the elasticity estimate of .006 appears quite low, the possibility of large differences in migration rates exist. The model indicates, ceteris paribus, that doubling the migration rate is associated with a .6 per cent decline in mean achievement. Within the sample, there are frequent cases of migration rates for schools within the same city differing by a factor of ten, e.g. ranging from two per cent to 20 per cent. With other factors held constant, a change from the low to the high migration rate would yield a six per cent drop in the achievement level.

### Attitudes

Another set of variables which are related to socioeconomic background involve the attitudes of the student. The chief reason for splitting these away from the socioeconomic variables is that these measures relate directly to the individual as opposed to his family. As such they are under the control of the individual, and, even though they might be influenced by family socioeconomic factors, these subjective factors are clearly produced by a complex process which includes more than just family SES.

Two principle attitude measures were used in the production functions which were estimated. The first, reflecting the educational aspirations of the student body, is the percentage of students who wish to complete high school or more (HS). This displays a very significant effect ( $t=4.4$ ). As expected, high educational desires are associated with high achievement. The elasticity is quite high, .29 in VERBAL production and .42 in MATH production.

The other attitude variable (S) measures fate control. Higher values of S are associated with greater pessimism as more people think

that "people like me don't have much of a chance to be successful in life." As one would expect, this negative attitude exhibits a detrimental effect on achievement. However, the low elasticity of .03 indicates that this does not have an overpowering influence on achievement.

The interpretation of attitudes is not as simple, however, as suggested above. First, for many reasons it would be desirable to know how attitudes are formed. Attitudes are not changed by decree. People often attempt to promote more healthy attitudes as in television commercials advocating staying in school or suggesting the wide range of vocational opportunities available. If these methods will affect attitudes, the production functions suggest that they will have favorable effects on the quality of education. Attitude formation is also of interest when considering the effects of schools on achievement. For policy purposes we would like to know the total effect of school factors on education. Therefore, if school inputs (teachers, facilities and curriculum) have an effect on attitudes, the direct effect given by the estimated parameters for school inputs will understate their total effect on achievement. While we are unable to specify and estimate a complete attitude formation model, we can gain some insight into the extent of this indirect effect on achievement of school inputs. By eliminating the attitude variables from the equation, we obtain an upper bound on the indirect effect through attitudes. When this is done, there is practically no effect on the school inputs.<sup>28</sup>

A more serious consideration in interpreting the results is the

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<sup>28</sup>The elasticity for teacher verbal ability goes from .125 to .119; for experience from .019 to .022; and for nonwhite teachers from -.023 to -.025. Thus, for the interesting section of the educational production function, there is little difference in the parameter estimates for the structural equation and the reduced form equation.

possibility that attitudes and achievement are simultaneously determined. This is the case if the student includes indications of his achievement in forming attitudes. When this is the case, the assumptions underlying the least squares estimation procedure fail, and the parameter estimates are biased and inconsistent.<sup>29</sup> This suggests that least squares is not the appropriate estimation technique and that some consistent estimator should be used. However, two factors enter into deciding upon this point. First, even though specification of the attitude model is a treacherous task in itself, the roughest a priori specification of this model would include many essential factors for which we have no data, e.g. neighborhood and housing characteristics, attitudes of friends and siblings, etc. Most consistent estimators for simultaneous equations require specification of the system of equations and data for the specified exogenous variables in the system. Secondly, there are a priori reasons to believe that the simultaneity might not be "too great" in the sixth grade. The simultaneity arises when the student readjusts his goals due to cues from achievement. However, one could imagine that there have not been enough cues or strong enough cues for the majority of the students to need much revision in aspirations and attitudes formed elsewhere. If the simultaneity is not large, i.e. achievement is not one of the prime determinants of attitudes, the parameter estimates from ordinary least squares techniques will approach consistent estimates, and one might opt for this more efficient procedure.<sup>30</sup>

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<sup>29</sup> A parameter estimate is biased when the expected value of the estimate does not equal the true value. It is inconsistent if the estimate does not converge on the true value in the probability limit.

<sup>30</sup> The essential feature is that inconsistency is not a discrete process but a continuous process. It is sometimes desirable to trade some inconsistency for the desirable properties of least squares (e.g.

This is the route followed here, especially since the missing attitude formation factors would result in very inefficient estimates if instrumental variable techniques were used with the given data.

Again the major policy implications are found elsewhere. Attitudes were included in order to achieve better overall model specification. The lack of a good attitude formation model severely limits any policy aimed at altering attitudes so as to increase educational output. Additionally, the uncertainty about the properties of the parameter estimates causes hesitancy in placing great weight on this section of the model.

### School Effects

The remainder of the model holds more interest for us. This section describes the effects of schools on achievement. Since the publication of Equality of Educational Opportunity, it has been widely circulated that schools have no effect on achievement. There are a number of conceptual and methodological reasons why one should expect this result. These issues are discussed at length elsewhere.<sup>31</sup> However, these articles merely suggest why the EEO Report fails to provide a reasonable test of the effect of schools on achievement; they do not show that the real situation is one where there is a significant school effect on achievement. The models of education presented in Equations

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minimum variance). Cf. Franklin M. Fisher, "On the Cost of Approximate Specification in Simultaneous Equation Estimation," Econometrica, XXIX (April 1961), pp. 139-170.

<sup>31</sup>A discussion of the explicit shortcomings of the EEO Report is found in Hanushek and Kain, "On the Value of Equality of Educational Opportunity As a Guide to Public Policy" and in Bowles and Levin, "The Determinants of Scholastic Achievement--An Appraisal of Some Recent Evidence."

3-1 and 3-2 offer evidence that the EEO Report view in fact is not the way that education in the United States looks. Schools do have a significant effect on achievement. The models presented here for whites (and in Chapter Four for blacks) demonstrate that even the crude measures of school factors which we have appear significant in describing the educational production process. The popular interpretations of the EEO Report could only leave one extremely pessimistic about the educational system. Yet these results suggest that much of the pessimism is unwarranted.

There are three school input measures included in this analysis. These are the average score on the teacher verbal test (T), the average years of teacher experience (E), and the per cent of students who had a nonwhite teacher during the past year (NT). Taken together, these indicate a considerable effect from schools and, in particular, higher quality teachers.

The teacher verbal test score represents the best measure of teacher quality contained in the data. This provides a method of making standardized comparisons across teachers. Nevertheless, this is a crude measure of teacher quality at best. This gives some measure of technical competence of the teaching staff in one particular dimension-- verbal ability.<sup>32</sup> However, there are many other dimensions of teaching which cannot be measured by this. For example, rapport with the class, empathy, warmth, cogent presentations and knowledge of subject matter

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<sup>32</sup>It has been suggested that this might also measure the collective technical ability of the faculty due to collusion in the taking of the test. However, this is merely speculation. Additionally, even if this were the case, it is not obvious that it is that harmful when school means are used. There might be some upward bias in each score, but for our purposes the variation among schools is more important, i.e. whether schools still fall in the same relative position.

are all valuable facets of teaching. The verbal test measure of quality touches on none of these factors.

Given these shortcomings, the magnitude of the effect is significant. The elasticity of .13 for such a poorly measured indicator of teacher quality provides considerable encouragement in the ability of schools to affect children.<sup>33</sup> The reduced elasticity (.09) and greater imprecision of the estimate ( $t=1.3$ ) in the math production function lends support to a strict technical capabilities interpretation of the test score variable as opposed to a broader, overall ability interpretation. This provides another piece of evidence that the test is quite incomplete and suggests that better measures of "teaching ability" would show a stronger relationship with achievement.

Table 3-2 indicates that there is a small amount of variation in this measure with a standard deviation of only 1.4 and a mean of 24.8 (maximum possible score equals 30). Nevertheless, redistributions of teachers, even within the same city, can have a significant impact on mean school achievement. For example, within one sampled city there exist differences of 40 per cent in mean teacher verbal test scores. If these faculties were switched, the mean achievement level in the lower quality school would increase by 4.5 per cent.<sup>34</sup> Additionally there are a number of reasons, which will be mentioned later, to believe that this significantly underestimates the actual increase that would occur if

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<sup>33</sup>While unidirectional causality from teacher quality to student achievement is always assumed in this study, it should be noted that there are hypotheses to the contrary. Emil J. Haller in "Pupil Influence in Teacher Socialization: A Socio-Linguistic Study," Sociology of Education (Fall 1967), pp. 316-333, suggests that causality might run in the opposite direction. His tests were unconvincing, and this author has no qualms about assuming unidirectional causality.

<sup>34</sup>The experience levels of these two faculties were roughly equal.



such a change were undertaken.

Teacher experience also exhibits a significant effect on achievement. The presence of more experienced teachers is positively correlated with achievement. Thus, over and above other quality factors, teaching experience helps. Certainly one would expect a positive effect of experience in comparing the first year or two of teaching with subsequent years. However, this indicates that it holds true for the whole spectrum of teaching experience.<sup>35</sup> Again, while the effect does not appear overpowering with an elasticity of .02, the significant relationship with achievement is interesting.

With the experience measure some care must be exercised in interpretation, however. Given the prevalence of "seniority rights" in city school systems which allow the more senior teachers to choose their school, part of the experience influence is undoubtedly due to a school selection phenomenon. However, indirect evidence arising from the insignificance of explicit measures of selection implies that there exists a pure experience effect.<sup>36</sup>

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<sup>35</sup>Note that this is not a linear effect, however. There is a nonlinear relationship implied by the logarithmic transformation of the variables. No other nonlinear relationships were analyzed.

<sup>36</sup>Two questions provide information on teachers' choice of schools:

29. How did you happen to be assigned to this particular school rather than some other school in this district?
  - (A) I asked to work in this school
  - (B) I was placed in this school
  
38. If you could choose, would you be a faculty member in some other school rather than this one?
  - (A) Yes
  - (B) Maybe
  - (C) No

The final measure of teacher quality is the percentage of sixth graders who had a nonwhite teacher during the last year. This is interpreted as a measure of part of the teacher quality distribution, i.e. the lower end of the teacher distribution. This interpretation arises from our knowledge of the education provided to blacks. Many studies, including a survey of colleges presented in the EEO Report, show the general quality gap between Negroes and whites who go into teaching.<sup>37</sup> This is not particularly surprising given that Negroes are given inferior elementary and secondary school education and then proceed to segregated colleges which tend to widen the educational gap (by race). Thus, the nonwhite teacher variable tends to capture the lower end of the distribution of teachers.

It is interesting that NT has such a small standard error connected with the parameter estimate ( $t=6.8$ ). This variable is the most accurately measured school factor that is found in the data for this applies to the particular students in question and does relate specific students to specific inputs.<sup>38</sup> By doing this, a priori one would expect less error in this particular variable and indeed the precision of the estimate indicates that this is true.

It is particularly important when assessing the importance of the school variables to consider the errors present in the variables. The conceptual model presented in Equation 2-1 suggested that the whole past history of school inputs relevant to the particular individual were

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<sup>37</sup> EEO Report, Chapter IV and James A. Davis, Undergraduate Career Decisions (Chicago: Aldine Publishing Co., 1965).

<sup>38</sup> This variable comes from the student questionnaire and, thus, relates to the specific teacher which the student had in the past year as opposed to the school-wide average.

important in modeling the educational process. When we went from the individual model to the school model, we did not eliminate the requirement for having the past history of school factors nor for having those pertaining to the individuals in the aggregate production function. We fall far short of having this information. The essential problems revolve around migration--both teacher and student. To the extent that any migration occurs, errors are introduced into our school measures. When this is considered in the standard errors in variables format, it can be shown that the coefficients will necessarily be biased downward.<sup>39</sup> While it is not possible to know the extent of any bias, it is known that an average of 45 per cent of the sixth graders in the sample have attended at least one other school and an average of 8.8 per cent of the teachers in each school left during the past year. These figures only provide some idea of the potential bias. Without further knowledge about the educational production function, it is impossible to assess the magnitude of bias. For example, if the process attaches declining weights to more distant experiences, the migration figures tend to overstate the size of potential bias. However, it is plausible that the early experiences count more in the process.<sup>40</sup> If this is the case, the errors as indicated in the migration figures could be quite substantial.

The study of school production functions does confound the issue of errors in variables in the teacher inputs. Certainly there is a

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<sup>39</sup>Cf. J. Johnston, Econometric Methods, pp. 148-150.

<sup>40</sup>Something similar to this seems to be suggested by Bloom who traces out the longitudinal pattern of achievement growth and concludes the following about the first few years of schooling: "These are the years in which general learning patterns develop most rapidly, and failure to develop appropriate achievement and learning in these years is likely to lead to continued failure throughout the remainder of the individual's school career." Bloom, Stability, p. 127.

potential for error by considering teachers which none of the sixth graders under study have had, e.g. new teachers to the school in the lower grades. However, the school figures for teacher ability and experience are not a priori bad measures of school inputs for the students under consideration. The important consideration is the dynamic allocation process by which teachers are hired by the school. To the extent that "school character" is stable over time, the school averages of contemporaneous faculty could provide fair pictures of the historical inputs to the students.

In summary, the estimated model of the educational process is quite encouraging. Even though the measures of school quality are crude and error prone, a strong relationship between our measures and achievement is found to exist. The measurement problems also suggest that our estimates are, in fact, minimum estimates of the effects of schools on achievement. There are a number of reasons to expect that the actual point estimates of the educational parameters are biased toward zero. Thus, if one starts with the impression given by the EEO Report that schools don't matter, these results provide some reason for optimism.

The OE Survey does contain additional measures of teacher quality, and several other aspects of the teachers were included in the models but proved insignificant in their effect on achievement. These included the per cent of teachers with a master's degree or more, per cent male teachers,<sup>41</sup> per cent of teachers who read educational journals,

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<sup>41</sup>This particular variable actually provides a poor test of two competing hypotheses. Mel Ravitz advocates more male teachers for the disadvantaged because of the matriarchal structure of the family. See "The Role of the School in the Urban Setting," Education in Depressed Areas, ed. A Harry Passow (New York: Teachers College Press of Teachers

choice of schools, per cent without teaching certificate,<sup>42</sup> per cent who are leaving teaching after present school year, and average age of teaching staff. Certainly there are many measurement problems with these variables, and caution must be exercised in inferring that these have no effect on achievement. The errors in measurement will affect the significance levels. Nonetheless, within this sample and the data limitations, the various dimensions of teacher quality represented by these specific variables prove to have no effect.

One specific hypothesis should be mentioned. A commonly used measure of school inputs is per student expenditure.<sup>43</sup> While there is no measure of total per pupil expenditures for each school,<sup>44</sup> it is

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College, Columbia University, 1963). This would suggest that more male teachers should have a positive relationship with achievement. On the other hand, since male teachers are generally of lower quality (see Davis, Undergraduate Career Decisions), this variable could be interpreted as another teacher quality measure with an expected negative relationship. This conflicting aspect could be responsible for the insignificant effect on achievement.

<sup>42</sup>Obviously this variable is quite weak in this cross-state study where there are very different requirements for certification. Also, there are complexities introduced since those without certificates might be higher quality as lack of certification could indicate majoring in something other than education and not going to a teachers college. This is further confused by the fact that many without certificates are actually substitute teachers. High levels of substitutes would be expected to have a negative effect on achievement.

<sup>43</sup>This measure is used extensively by Kiesling, "Efficiency of School Districts." It is also a standard means of comparing schools as in the Civil Rights Commission report, Racial Isolation

<sup>44</sup>The OE Survey contains district-wide expenditure data. These were used by the EEO Report in constructing a per pupil expenditure figure for school districts. However, large differences in expenditures are known to exist within systems. These differences are systematic both by the grade level of the school (high school, junior high, elementary) and by social class and race. (Cf. Katzman, "Distribution and Production in a Big City Elementary School System," and Patricia Cayo Sexton, Education and Income [New York: The Viking Press, 1961]). These systematic errors make the district figure worthless for our purposes.

possible to construct a measure of instructional expenditures per pupil for each school from the teacher salary data. Since instructional expenditures comprise 70 per cent of current operating expenditures, this seems to be a worthwhile test of the usefulness of per pupil expenditures as a measure of the provision of school inputs.

This variable has an insignificant effect on achievement in the model of the educational process. This holds even if other measures of school inputs are excluded from the relationship. However, this should not be interpreted that school systems are operating inefficiently. While per pupil expenditures would not be a good measure of school quality if schools did act inefficiently, i.e. did not spend their budgets on inputs so as to maximize output, there are other plausible explanations of finding no relationship between expenditures and output. First, if school inputs did not matter in the educational production process, there would be no significant relationship. However, the other evidence in the models presented suggests this is not the case. There is another, and very plausible, explanation for this phenomenon. In the presence of sizable differences in factor prices, comparisons of per student expenditures lose their meaning. It is believed that this is the situation in the sample for the region is quite large and inhomogeneous in terms of input price. Large price variations are known to exist even within metropolitan areas.<sup>45</sup> Thus, without the aid of a price index, one

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<sup>45</sup> Levin gives some insight into this. He shows differences between teacher costs in different regions which are applicable to this study. Both his Eastmet and Midmet are metropolitan areas which fall within the sample for this study. Additionally, he shows that there are cost differences between teachers in the central city and the ring and differences within the same city arising from difficult schools. See Levin, "Recruiting Teachers for Large City Schools" (unpublished manuscript, The Brookings Institution, 1968), especially Chapters VI and VII.

cannot expect per pupil expenditures to act as a good index of school quality.

### Negro Concentration

The preliminary modeling efforts involved the percentage Negro as a continuous variable. The obvious hypothesis tested was that either classroom disruption due to racial tension or differences of Negro backgrounds (with an adjustment in teaching techniques) led to a reduction in the education of whites. However, the independent effect of racial composition on whites was insignificant when measured in this manner. A second hypothesis was that there was a differential effect for different degrees of racial mixing. This general hypothesis also considers possible threshold effects of racial composition. In order to test this, the percentage Negro sixth graders was divided into a number of mutually exclusive ranges. For example, there was one variable equal to the per cent Negro if less than 25 per cent and equal to zero otherwise; there was another for the range 25 per cent to 45 per cent; etc.

For white achievement the only significant range for racial composition was 75 to 100 per cent Negro ( $N_{75-100}$ )<sup>46</sup> (The parameter estimates for all other ranges were less than their standard errors.) Additionally, this factor is only important in the VERBAL production process. The construct of this variable leads to some interpretative problems since a literal acceptance of this formulation implies that white achievement falls by 13 per cent when the racial mix goes from 74 to 75 per cent black. It is doubtful that a precise threshold exists,

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<sup>46</sup>There are nine schools in the white sample which fall in this range of racial composition. While this number is small, it is encouraging that only two are in the same SMSA, and, thus, this variable is not just measuring one poor school system.

and the paucity of schools within this upper range makes the cut-off arbitrary. A better interpretation of this variable is that racial composition does not affect white achievement until the school is two-thirds to three-quarters black. After such a point, there is a steady decline in white achievement.

The explanation of this decline appears to be imbedded more in poor measurement of various factors than in racial tensions. There are several factors which could contribute to this negative relationship. The most plausible explanation is that these are especially poor schools and that the measures of school quality do not adequately distinguish these extreme schools. Furthermore, measurement of socioeconomic factors must be considered as these whites are people who, although not faced with housing discrimination, are living in the ghetto. It could well be that the measures of SES used in the analysis are unable to distinguish the tail of the distribution, and this is a measure of whites who cannot because of poverty, ignorance or whatever move from the black ghetto.

### Facilities

Throughout the discussion of school effects the real issue was teacher effects on achievement. To the economist this seems to be the natural place to look for school effects as instructional expenditures represent 70 per cent of variable costs and 55 per cent of total costs.<sup>47</sup> Thus, any presumption of rationality in resource allocation indicates

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<sup>47</sup>These figures apply to 1963-64 elementary and secondary school operations. For elementary schools alone, the figures would be larger. Kenneth A. Simon and W. Vance Grant, Digest of Educational Statistics: 1967 Edition (Washington, D.C.: Government Printing Office, 1967), p. 59.



that indeed teachers are what count. Nevertheless, it appears that sociologists and educators do not look at the problem in this manner. The EEO Report in particular often tends to speak only of facilities and curriculum when analyzing school inputs and their effects.<sup>48</sup> First it is apparent that this leads to confusion in assessing the EEO Report findings. However, past the semantics of the issue, there is a more substantive point. Conceptually, it is far from obvious that facilities are going to have a strong direct effect on achievement. A better model of education pictures tinted windows, green boards, and the like as entering into attitude formation and, thus, only indirectly into achievement.<sup>49</sup> Even here, the expected effect on attitudes is not strong. At least this is the case for any causal element which is what is important for policy purposes. It could well be that parents with strong interest in education will support more elaborate and better maintained facilities. In such an instance it is hard to claim that the facilities motivate (cause) good attitudes in the students.

Nevertheless, even if others do not support these a priori views,

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<sup>48</sup>James Coleman makes this clear in an article discussing the findings in Equality of Educational Opportunity. In part he states:

Even the school-to-school variation in achievement, though relatively small, is itself almost wholly due to the social environment provided by the school; the educational backgrounds and aspirations of other students in the school, and the educational backgrounds and attainments of the teachers in the school. Per pupil expenditure, books in the library, and a host of other facilities and curricular measures show virtually no relation to achievement if the "social" environment of the school--the educational backgrounds of other students and teachers--is held constant. [his emphasis]

James S. Coleman, "Equal Schools or Equal Students," Public Interest (Fall 1966), p. 73.

<sup>49</sup>This would be modified at the extreme where physical discomfort, noise, or overcrowding may limit teacher effectiveness.

the OE Survey does not provide the data required to test many hypotheses about facilities effects. Probably the weakest aspect of the survey is the measurements of the school plant and curriculum. The survey is riddled with nonresponse to specific questions. Since there is only one source of this data (the principal), errors cannot be reduced by averaging as in the case of student data. Furthermore the questions are very insensitive to quality differences and neglect many important aspects of the school. For example, a biology laboratory can be defined by a cabinet housing a microscope and possibly a nearby washbasin. Merely asking the principal whether the school has a biology laboratory or not does not gain much information (especially given natural pride which would tend to lead to liberal definitions by principals). The lack of qualitative features is particularly noticeable. Such low information questions are prevalent in more than descriptions of the physical plant. There is little information on the school organization, e.g. the use of specialized teachers. While there are a few questions about the use ability grouping or tracking, they are so broad and open to such diverse interpretation that they do not appear to be reliable measures. In terms of facilities and organization, it is even difficult to model such apparently straightforward aspects as class sizes and numbers per room. This arises from the considerable error in coding these variables and a range of conceptual difficulties. Overall pupil-teacher ratios for a school do not provide a very good analog to the conceptual input of effective class sizes. Schools may choose to have larger classes but more specialized teachers and more free time for teachers. The differences in length of school days in itself provides a difficult problem in analyzing the effects of class sizes on the educational process. This

modeling problem is not atypical of those found in the facilities and curriculum section of the model.

Measuring facility inputs for the sample of schools is further complicated by the heterogeneity of organization. Some schools are first through sixth; some first through eighth; some fourth through eighth. The particular organization has a definite effect on facilities, e.g. presence of science labs, libraries, etc. However, when these facilities are provided for eighth graders, it is not necessarily true that they are relevant to sixth graders. Information for teachers can be restricted to cover only those teaching sixth grade or below; facilities cannot be easily segregated in this manner.

Numerous additional examples of data problems can easily be found. However, the above examples appear sufficient to establish the case of crudeness of facilities and curriculum measures. Thus, even though several measures of school facilities and characteristics were attempted (but discarded) in modeling the educational production process, it is difficult to consider such efforts a legitimate test of the effects of plant and curriculum on achievement.<sup>50</sup> While I personally discount the importance of facility items in the educational process, the data are insufficient to construct reasonable tests of the various facilities hypotheses which are made.

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<sup>50</sup> Among the measures of school inputs other than teachers attempted were per cent students attending less than normal day, library volumes per student, presence of special classes for rapid learners and adjustment problems, average attendance rate, presence of remedial reading and math classes, number of remedial reading teachers per student, guidance counselors per student, use of high and low tracking, overall pupil-teacher ratio, presence of a librarian, and age of main buildings. There are numerous problems with each of these variables, not the least of which is nonresponse of varying degrees. Most variables were heavily edited to eliminate obvious errors and to fill in values for nonresponses.

### The Education of Whites

The picture of the educational process presented in Equations 3-1 and 3-2 is a highly simplified view of a complex relationship. Yet, while the crude measures of inputs and the aggregative nature of the variables confuse some interpretations, the overall lesson is quite clear. Contrary to the popular interpretation of the EEO Report findings, white achievement is significantly affected by the schools and, in particular, by teacher quality.

The collection of teacher inputs considered in the models have a significant effect upon the output of the schools. Additionally, there are a number of reasons to believe that the parameter estimates for these teacher measures are biased toward zero. While it is not possible to ascertain the extent of this bias, the potential size of errors of this kind is great. This implies that teacher quality has a greater effect on achievement than a literal interpretation of the production function would indicate.

## CHAPTER IV

### THE EDUCATION OF BLACKS

It is time to start dealing with the hard, cruel facts of the problem of the ghetto schools, which is in turn the very core of the race problem in the United States.<sup>1</sup>

--Joseph Alsop

While the web of racial discrimination and racial conflict is complex, there is little question that black education is central to the problem. The question remains, however, how one should approach the objective set forth by Joseph Alsop of dealing with the ghetto schools. This chapter lends insight into the "how" through the presentation of empirical evidence on the educational production process for Negroes. Chapter Five considers interracial aspects of public education, namely de facto segregation and racial composition of the school.

The analysis of educational production functions for black sixth graders is perfectly analogous to the modeling efforts for whites presented in the previous chapter. Within the same conceptual framework and using the same data source, school production functions for blacks were estimated. The study of the educational process was divided into separate studies of the education of whites and the education of Negroes for two reasons. First, the extent of psychological, economic and cultural differences between blacks and whites led to the a priori

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<sup>1</sup>Joseph Alsop, "No More Nonsense About Ghetto Education," The New Republic (July 22, 1967), p. 18.

belief that the structure of the educational process would differ between the two. It seems reasonable to expect different behavioral relationships in the two cases. In such a case, the stratification of the school population is a necessary precondition for estimation of the production function. Second, and somewhat subtler, is the notion that the economic and cultural differences between the black and the white population imply an inconsistency in the measurement of many socioeconomic factors when blacks and whites are considered together. As explained in the discussion of the white production function section, several variables are used to measure current socioeconomic status, but their importance is more in terms of the implied parental attitudes and home environment than in terms of current income and wealth. These measures simply act as good surrogates for a collection of factors directly related to educational achievement. However, the same nominal variables measuring SES may not have equivalent meanings when taken across racial lines. It is easy to see that such measurement considerations could also enter into student attitude variables. The simple point of this discussion is that the variable definitions possibly do not represent the same unit of measurement for Negroes and whites. If there is a different relationship between these income-related factors and the home educational environment in the white and the black community, it is inappropriate to consider whites and Negroes together in the production process.

The estimated production functions for black sixth graders are qualitatively very similar to those for white sixth graders. The overall model specifications are practically identical. More than that, the policy implications are extremely similar. Schools, as measured by the

teaching staff, do have a significant effect on the achievement of Negroes. Again, while there are reasons to suspect that the estimated parameters understate the actual relationships which exist, the estimates do provide encouragement as to the strength of schools in determining achievement.

### Black Sample

The black sample is made up of 242 schools in the metropolitan North which have over four black sixth graders.<sup>2</sup> In the process of going to large schools (over four Negroes) 141 sampled schools with one to four Negroes were discarded. A majority of the discarded schools fell within the suburban ring, and the percentage of schools in the central city went from 62 per cent to 76 per cent when the sample was reduced. Nevertheless, the data problems seem sufficiently large to justify this exclusion of schools.

The mean percentage Negro in the sixth grade is 50 per cent. However, this belies the true character of the distribution of schools as the distribution tends to be bimodal. The entire distribution is depicted in Appendix F. The nature of the distribution of schools is not surprising from what we know about the extent of housing market segregation in metropolitan areas.<sup>3</sup>

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<sup>2</sup>The included states with the number of sample schools are: Connecticut (11), Delaware (3), Illinois (5), Indiana (9), Maine (0), Maryland (10), Massachusetts (1), Michigan (33), New Hampshire (0), New Jersey (23), New York (52), Ohio (9), Pennsylvania (49), Rhode Island (0), Vermont (0), Washington, D.C. (11), and Wisconsin (26).

<sup>3</sup>The extent of ghettoization of cities is described in Karl E. Taeuber and Alma F. Taeuber, Negroes in Cities (Chicago: Aldine Publishing Co., 1965). With neighborhood schools and concentrations of Negroes in ghettos, the percentage of Negroes will cluster at the two extremes.

Educational Production Functions for  
Black Sixth Graders

The estimates of the educational production functions for blacks were quite satisfactory. They exhibited statistically strong relationships which were consistent with a priori views about the process. Equations 4-1 and 4-2 represent models estimated by weighted regression techniques from the 242 observations of black schools. Variable definitions are found in Table 4-1, and sample means and standard deviations are displayed in Table 4-2. Again, the log-log specification was judged superior to the simple linear functional form. Both conceptual reasons and statistical findings suggested this multiplicative form. (The estimated linear models are presented in Appendix B.) The overall model of the process is qualitatively very similar to that for white education.

$$\begin{aligned}
 (4-1) \text{ VERBAL}^* &= -2.47 - .040CC + .666G^* + .035E^* - .170FS^* \\
 &\quad (-4.2) \quad (-2.4) \quad (7.9) \quad (1.2)^f \quad (-2.8) \\
 &\quad + .578HS^* - .027S^* + .164T^* + .045E^* - .024NT^* \\
 &\quad \quad (5.4) \quad (-2.2) \quad (1.9) \quad (2.6) \quad (-1.7) \\
 &\quad - .012N^*_{45-75} - .007N^*_{75-100} \\
 &\quad \quad (-2.9) \quad (-1.7)
 \end{aligned}$$

SE = .56

$$\begin{aligned}
 (4-2) \text{ MATH}^* &= -1.58 + .429G^* + .061E^*_f - .193FS^* \\
 &\quad (-2.4) \quad (4.7) \quad (1.5)^f \quad (-2.9) \\
 &\quad + .497HS^* - .036S^* + .085E^* - .021NT^* \\
 &\quad \quad (4.0) \quad (-2.6) \quad (4.3) \quad (-1.3) \\
 &\quad - .017N^*_{45-75} - .012N^*_{75-100} \\
 &\quad \quad (-3.4) \quad (-3.0)
 \end{aligned}$$

SE = .66

Note: Asterisks denote logarithms of variables. t-statistics are displayed in parentheses below each coefficient. SE is the standard error of estimate.



TABLE 4-1

VARIABLE DEFINITIONS FOR THE BLACK EDUCATIONAL  
PRODUCTION FUNCTIONS

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VERBAL	mean verbal ability test score for black sixth graders
MATH	mean mathematics achievement test score for black sixth graders
CC	central city dummy variable = 1 if school is in central city of SMSA = 0 otherwise
G	goods index; average of per cent of black sixth graders whose family owns automobile, television, refrigerator, telephone and record player
$E_f$	mean father's education (years) for black sixth graders
FS	mean family size (total number of people in home) for black sixth graders
HS	per cent of black sixth graders who wish to finish high school or more
S	per cent of black sixth graders who feel that people like self do not have much chance for success
T	mean teacher verbal test score (for teachers who teach in the sixth grade or lower)
E	mean years of teaching experience (for teachers who teach in the sixth grade or lower)
NT	per cent of black sixth graders who had a nonwhite teacher during the last year
$N_{75-100}$	Negro concentration = per cent Negro sixth graders if greater than 75 per cent = 0 otherwise
$N_{45-75}$	Negro concentration = per cent Negro sixth graders if between 45 and 75 per cent = 0 otherwise

TABLE 4-2

MEANS AND STANDARD DEVIATIONS FOR VARIABLES IN THE  
BLACK EDUCATIONAL PRODUCTION FUNCTIONS

Variable	Mean	Standard Deviation
VERBAL	26.68	4.20
MATH	11.05	1.78
CC	.76	. .
G	84.52	8.37
E <sub>f</sub>	10.60	1.90
FS	5.08	.65
M	10.94	7.43
HS	92.14	6.67
S	18.61	9.95
T	23.98	1.80
E	11.29	4.00
NT	44.72	19.38

The estimates of the parameters for black education are slightly less precise, and the overall model for blacks is not as good as for whites with a standard error of estimate equal to .56 (as opposed to .38 for whites).<sup>4</sup> Nevertheless, the models do very well at portraying the basic input-output relationships in the education of black sixth graders. The parameter estimates are reasonable, and the relationships are statistically very strong.

The VERBAL and MATH production processes are very similar, although there is a larger difference between the two black models than was the case in the two for whites. The simple correlation of the verbal ability and mathematics achievement test score at the individual level is .66.<sup>5</sup> At the school level this correlation is .81. This value suggests that there is a fairly small amount of independent variation between the measures. The differences in the models will be interpreted as if the nominal titles of the output dimension apply. However, the high correlations, similar to those encountered in the white sample, lead to some suspicion about the differences in the tests and whether they measure what they purport to measure. The possibility that the difference between the measures is simply a random error cannot be disregarded.

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<sup>4</sup>The figures for the standard error of estimate in the VERBAL equation result from the weighted regression analysis in the logarithmic form. Thus, there is some difficulty in attaching meaning to the absolute values. However, the comparison between models (of the same output measure) does have meaning. The output measures for Negroes and whites were arrived at from the same tests and reflect positions in the same total population. The comparable figures for MATH standard errors are: black, .66; white, .49.

<sup>5</sup>This is computed for the 10,286 individual black sixth graders in the sample region. Again, not all of these individuals will be in the 242 included schools.

The great similarity of the hypotheses about the educational process for blacks and whites suggests analyzing the resultant black models by contrasting them to the white models. A cursory glance at the models indicates a considerable correspondence between the overall models. This similarity should not be interpreted as an arbitrary decision to present equivalent models of the process. On the contrary, the black and white modeling efforts were carried out in relative isolation from each other. The best models, according to the criteria of a priori acceptability and statistical reliability, proved to be very similar in overall specification. While these modeling efforts are by no means independent of each other as they rely upon the same data source, the similarity is encouraging since it provides prima facie evidence for the existence of a consistent set of underlying behavioral patterns in terms of school inputs to the educational process.

The remaining sections of this chapter will compare the estimated production functions for blacks with those for whites. The main emphasis is on differences between the two in the underlying hypotheses about the process; in the interpretation of the models; and in the parameter estimates. While the caveats from the previous section are equally as applicable, they will not be restated in this section. Also, the various modeling efforts described in the previous section will not be explicitly reconsidered here. It seems profitable to shift the emphasis to specific aspects of the models, especially differences between the black and white educational process.

#### Some Minor Differences

The overall model specification differs between blacks and whites in two variables. The black production process includes neither nursery

school influences (NS) nor migration influences (M). There is little that can be said about this difference in specification. Migration and nursery school had the smallest elasticities of any variables in the white production function. Thus, their exclusion from the black model does not indicate a major structural difference. Additionally, both variables are measured with considerable error. The error could have been sufficient to mask any real behavioral relationship which might exist (and which is suggested by their inclusion in the white model). However, this is pure speculation.

It might be noted, however, that past experiences have indicated that any immediate advantages offered by early schooling such as Head-start or nursery school can be obliterated by poor subsequent schooling experiences. This factor could enter into the black equations with more force as the probability of lower levels of school inputs for blacks is higher.<sup>6</sup>

A further minor difference is found in the influence of the central city. Residing in the central city has a mixed effect in the

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<sup>6</sup>The evidence on input differences is mostly fragmentary, but it is consistent across studies. There are many studies which show differences in inputs between central cities and suburbs, e.g. the per pupil expenditure figures presented in the Civil Rights Commission Report, Racial Isolation in the Public Schools. The central city-suburb distinction is, in many ways, a black-white distinction. Also, there is some evidence of systematic differences in school inputs by race within the same city, e.g. Patricia Cayo Sexton, "City Schools," The Annals of the American Academy of Political and Social Science 352 (March 1964), pp. 95-106; Martin Katzman, "Distribution and Production in a Big City Elementary School System;" A Report by the Governor's Commission on the LA Riots: Violence in the City--An End or a Beginning? (December 1965), pp. 49-61. There is considerable controversy over the extent of discrimination in school inputs by race. Unfortunately, Equality of Educational Opportunity did not provide the answers to these distribution questions. There are indications that the Title I money that goes to schools with disadvantaged children is changing these patterns of input distribution. Nonetheless, these funds did not exist for the children in this study.

education of blacks. In VERBAL production the estimated effect of the core city (CC) is slightly greater for blacks than for whites (although this difference is not statistically significant). The VERBAL output of the central city black school, ceteris paribus, will be 96 per cent that of the suburban black school. However, central city education appears to have no bearing on MATH production. The most plausible explanation for the differential impact of central cities centers upon the errors in variable problem.

The central city dummy is used as an approximation for a series of factors which systematically differ between central city and suburb. As in the white models, both a lack of knowledge and a lack of data prevented taking any steps toward specifying and estimating the underlying influences which are associated with central cities. Nevertheless, one would expect the severity of the central city and suburb differences to vary among SMSA's. If this is the case, the dummy variable specification is incorrect and will only give an average effect for the different central cities.

There are also reasons to suspect that the measurement problems would be worse for Negroes than for whites. The special characteristic of housing market discrimination and the subsequent presence of black ghettos surely enters into the educational process through the central city dummy. There are sizable differences among cities in the conditions which produce the urban Negro environment. There are differences in the housing stock, e.g. age and density. There are differences in the level of provision of municipal services; for example, police and fire protection, garbage collection and street cleaning, and the system of welfare payments. Additionally, the central city and suburb

differences are much more sharp in the case of the Negro who often faces a restricted residential location choice. It is not choice that leads blacks to opt for the ghetto tenement. To the extent that there is a larger variance in relevant attributes among central cities for the black population than for the white population and to the extent that the central city and suburb division is sharper and more meaningful, the poor specification from the use of the dummy variable weighs more heavily on the black model. Another set of errors is also present. In some cases, e.g. in the industrial suburb, the classification of a school as suburban may be simply nominal. In considering the two samples of schools, this type of error will be more severe for blacks than for whites. The errors in variables introduced by this specification will tend to bias the coefficient toward zero. The possibility of fairly severe errors in this area could go a long way toward explaining why the central city appears to enter in VERBAL production and not in MATH. The possibility of differing importance of the errors also makes black-white comparisons tenuous. We can only conclude that the proper specification of the real factors entering into the central city differences would be useful, especially since many of these are amenable to public policy.

#### Family Background and Attitudes

Direct comparisons of the individual components of family background do not appear profitable. Since the model of the educational process relies upon income and wealth measures as proxies for a much larger and more complex set of attitudes, interests and educational backgrounds, comparisons of parameter estimates are meaningful only if the transformation between income and the relevant background attributes is the same for blacks and whites. There are good a priori reasons to

believe that the transformation is not the same due to the psychological and economic distortions introduced by racial discrimination. In fact, these beliefs were important in the decision to stratify students by race.

Nevertheless, while direct comparisons of the parameters do not seem useful, comparisons of the overall specification of family factors in the white and black models are worthwhile. With blacks as with whites, the main interest is insuring that background characteristics are adequately measured so that model misspecification does not distort the results in the more interesting sections of the model. The SES measures included in the white models appeared to capture most of the significant dimensions in background. For blacks the same three "pure" SES variables, i.e. goods index, father's education, and average family size, were included in the model. There are reasons to suspect that these variables do not measure the educational inputs as well in the black models as in the white models. Still they appear to provide an adequate representation of the relevant family environment inputs.

Within the black community there is more concern about heterogeneity of the population with regard to the relevant background characteristics. Much of this arises from the great sectional differences of the country from the Negro point of view. The South has not long been away from de jure segregation of Negroes, and the psychological, educational and economic impact of the South on the black population is considerably different from that found in the rest of the country. Even though this study is confined to education in the North, these sectional differences are very important because of the strong link between the



North and South through migration.<sup>7</sup> In 1960 three-quarters of the Negro household heads living in the North were born in the South (as opposed to eight per cent of the white heads of households).<sup>8</sup> Over and above the larger variation in background by region, the regional differences are more significant for blacks.<sup>9</sup> Thus, there is reason to suspect that the current SES measures used to proxy family educational environment tend to be poorer measures, i.e. prone to more error, since the population is more heterogeneous. However, a wide range of different measures of Negro background were used, and it was found that different specifications had little effect on the structure of the rest of the model. (The different modeling efforts will be discussed in more detail below.) This leads to some optimism that any excluded dimensions of family background are uncorrelated with the included school factors and, thus, that the parameters in the more interesting section of the model are not biased by any such errors.

Many previous studies would suggest special elements of the Negro family structure that would call for different specification of the Negro

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<sup>7</sup>The importance of migration is well documented in a number of sources. See John Kain and Joseph Persky, "The North's Stake in Southern Rural Poverty," Discussion Paper No. 18, Program on Regional and Urban Economics, Harvard University [1967]; Karl E. Taeuber and Alma F. Taeuber, Negroes in Cities, Chapter 6; Eva Mueller and William Ladd, "Negro-White Differences in Geographic Mobility," Negroes and Jobs, ed. Louis A. Ferman, Joyce L. Kornbluh, and J.A. Miller (Ann Arbor: University of Michigan Press, 1968).

<sup>8</sup>These figures are tabulated in Kain and Persky, "The North's Stake in Southern Rural Poverty," p. 26, from data in the One in a Thousand sample of the 1960 Census of Population.

<sup>9</sup>In the realm of education these differences are well-documented in Equality of Educational Opportunity. Regional differences coincide with much larger quality differentials for blacks than whites as is vividly shown in the graphs of educational output by race and region, e.g. on page 242.

background variables. In particular the controversial analysis by Daniel P. Moynihan suggests that some measure of family stability is important. He states: "There is no one Negro problem. There is no one solution. Nonetheless, at the center of the tangle of pathology is the weakness of the family structure."<sup>10</sup> Moynihan is neither the only nor the first to suggest the strong influence of family structure.<sup>11</sup> Also, the data on Negro and white differences in structural integrity are compelling; over 20 per cent of the urban Negro families exist without the husband being present, as compared with eight per cent for whites.<sup>12</sup>

These arguments suggest that family structure is an important dimension of Negro family background and should be included in the model of the educational process. Also, the use of father's education is possibly unjustified. Nevertheless, various attempts to include different family attributes and structure in the educational model failed. Variables measuring presence of father or male adult were insignificant. Also, different family education variables (mean mother's education and mean highest education of parents) added little to the overall model. Thus, even though the estimates for the father's education were quite imprecise with a t-statistic of 1.2, this formulation was retained to facilitate comparisons with the white models. The model offers no

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<sup>10</sup>[Daniel Patrick Moynihan], The Negro Family: The Case for National Action (Office of Policy Planning and Research, United States Department of Labor, March, 1965), p. 30.

<sup>11</sup>For example, discussions of family structure and the matriarchal system are found in Thomas F. Pettigrew, A Profile of the Negro American (Princeton, N.J.: D. Van Nostrand, Inc., 1964); Harold L. Shepard and Herbert D. Striner, "Family Structure and Employment Problems" in Negroes and Jobs, pp. 174-187; and Mel Ravitz, "The Role of the School in the Urban Setting."

<sup>12</sup>U.S. Bureau of Census. Census of the Population, 1960, Non-white Population by Race, PC(2) 1c (Washington, D.C.: U.S. Government Printing Office, 1963), pp. 9-10.

confirmation of the hypothesis of detrimental influences on education due to family instability.

The issue of family composition does raise additional doubts about the naive modeling of average family size. Certainly the implications of two adults and three children differ from those for one adult and four children. As suggested, such errors would be much more prevalent in Negro rather than white models. Nevertheless, average family size proves to be very significant with a coefficient three times the size of its standard error. Additionally, the magnitude of the parameter and its significance level remained unchanged in the presence of the different measures of structural integrity. Previously two hypotheses about the negative influence of family size were mentioned. Different family structures have opposite effects on the cost of living and the attention paid to children. This interaction might lessen the effect of errors due to different structures.

It does not seem profitable to dwell on the family background attributes of the model. There are reasons to suspect that the background measures for blacks contain more error than for whites. This arises from considerations of heterogeneity of the population and different family structure. Nevertheless, the three "pure" background measures of the goods index, the father's education and the average family size appear to account for most of the significant dimensions of family background inputs to the educational process. The model characteristics are very stable under different specifications. The parameter estimates for the variables differ between whites and blacks, but it is not legitimate to compare these directly.

The consideration of attitude influences on educational

production is very similar to that for background factors. At least in the short run, attitudes are not a key element of the model for policy purposes.<sup>13</sup> Even less is known about the attitude formation process than about the educational production process. More than that, the statistical complexities surrounding the possibility of a simultaneous relationship between achievement and attitudes imply that little faith should be placed in the specific parameter estimates for attitudes in the structural equation for achievement.

For these reasons, direct comparisons of black and white parameter estimates for attitude variables does not seem worthwhile. Additionally, there are good reasons to believe that the attitude measures between races are not directly comparable. Especially in the case of S, the per cent of students who believe that people like themselves don't have much chance for success, the possibility of having different meanings for blacks and whites seems high. Thus, the variables would only be nominally the same; the behavioral content would be different.

Nevertheless, the implications of different levels of attitudes are still present. For the two samples of schools, whites tend to aspire for more education and tend to be less pessimistic about their chances for success. For the "average" black school, a movement to the mean white values for the two attitude variables would result in a three per cent increase in mean black achievement.<sup>14</sup> The uncertainty about

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<sup>13</sup>In the long run, attitude change might be a policy instrument. In fact, recent movements within the black community have been aimed at changing attitudes. The main thrusts have been made at developing self-pride in the Negro race. The implications of this for the educational process are unknown.

<sup>14</sup>"Average" black school implies a school having the mean black sample values shown in Table 4-2.

attitude formation does make this more a descriptive figure than an area for public policy.

### The Effect of Schools

The focal point of the educational production functions is the school sector, for it is this set of inputs which is most amenable to educational policy decisions. Much hope is pinned on the effectiveness of the public schools in providing equal opportunities to all members of the society. However, there has been an increasing concern about the quality of education which is provided to minorities. The clearest finding of Equality of Educational Opportunity was the considerable difference in output levels (test scores) by race. Blacks systematically score considerably lower than whites, even within the same geographic region. Many conclude from this that our schools have failed in their task by allowing such educational gaps to persist. Others imprudently carry this further and conclude that schools are incapable of altering the output levels prescribed by nonschool inputs, i.e. by family background. This conclusion is furthered by popular interpretations of the EEO Report which suggest schools have little effect. However, the models of the educational process presented in Equations 4-1 and 4-2 indicate that schools do have an effect on education.

The same three measures of school inputs found in the white models proved valuable in describing the educational process for black sixth graders. Teacher verbal ability (T), average teacher experience (E) and the per cent of black sixth graders who had a nonwhite teacher last year (NT) again represent the best teacher quality measures found in the OE Survey data. While it is useful to analyze quantitative black-white difference in the specific inputs to the process, the overall

picture of the school impact is much more important. While many similar points were made in the past chapter, the interpretation of the school effects is so fundamental that repetition found below appears justified.

The three variables represent the best macro quality measures available. The variables are best considered collectively rather than placing great emphasis on the literal definitions of individual variables. As such, they are very crude measures of what goes on in the schools and what factors bear directly on the student. There are many reasons to suspect substantial "errors" in measurement to exist. These "errors" arise not so much from faulty recording of teaching experience (although this type of error is plentiful). Instead, the errors in measurement relate to inaccurate measurement of the conceptual inputs into the educational process. The average figures for the school are only approximations of the relevant stream of educational inputs encountered by the students. Additionally, the dimensions of measurement, e.g. teacher verbal facility, are only inaccurate thrusts at the significant dimensions of teaching. The errors in measurement imply that the estimated parameters in the model will be biased toward zero. The fact that any school factors of the form available from the OE Survey have a significant impact on achievement is somewhat surprising. The strength of the measured relationships is encouraging. In order to make comparisons with the white production functions, it is necessary to revert to a consideration of individual variables. Nevertheless, the total picture of school influences should not be forgotten in the analysis of individual inputs into the process.

Teacher verbal ability exhibits a strong effect on VERBAL output with an estimated elasticity of .16. Thus, all other things equal, a

twenty-five per cent increase in the school level of teacher verbal ability (e.g. moving from an average of 20 to 25) corresponds to a four per cent increase in the mean VERBAL output level of the school. It is not difficult to find schools within the same city which differ by more than 25 per cent in teacher verbal ability. Between the central city and suburbs in the same SMSA, which may reasonably be considered one market for teachers, even greater differences can be found in school levels of teacher inputs.

The elasticity estimate for teacher verbal influence is slightly higher in the black model of VERBAL output than in the white model (.16 as opposed to .12). However, this small difference between the two is not statistically significant. The interpretation that teacher verbal facility is a specific technical dimension of teacher quality is furthered by the fact that its effect on MATH output is completely insignificant ( $t = 0.8$  when included in the model). This is similar to the finding in the white production functions.

Teacher experience is the second teacher quality measure included in the model. The influence of experience in the black models is significantly more than in the white models. This variable, E, has an elasticity of .045 in the production of black VERBAL ability as opposed to .019 for whites. In the MATH equation the effect of experience is even more pronounced. The elasticity for blacks equals .085, compared with .016 for whites. (However, it must be remembered in comparing the black and white MATH equations that teacher verbal does not enter the black equation but does enter the white equation.)

The issue of teacher selection could be more important in the case of teachers for black students than for white students. The

"seniority right" of school selection which often comes with time in the school system could account for the increased influence of experience. Higher average experience levels in a school tend to indicate satisfied teachers, as they don't move even though they have the opportunity to do such. There are reasons to suspect that this is more important in black education since some school systems are known to use "difficult" (read black) schools as "proving grounds" for new teachers. Also, the presence of black students is a very visible means by which teachers assess school quality. As noted in testimony before the Civil Rights Commission, "the Negro school carries with it a stigma that influences the attitudes both on the part of outsiders and on the part of parents, students, and teachers . . ." <sup>15</sup> Thus, it seems that, other things equal, a more experienced faculty for blacks will be more dedicated. Nevertheless, the direct measures of teachers' choice of schools proved insignificant in the models, even when the experience measure was removed from the model. This could happen even if the selection hypothesis was applicable, though. The direct measures represent strong choice (would you choose this school?). Experience could include less strong attitudes, i.e. content with the school but not wild enthusiasm. Again, it is impossible to separate the pure experience hypothesis from the selection hypothesis. However, prior knowledge suggests that selection could be relatively more important in the black case (as compared with the white case).

The final teacher quality measure is NT, the per cent of students with a nonwhite teacher last year. This has the expected negative

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<sup>15</sup> Racial Isolation, p. 104, quoted from the testimony of Dr. Charles Pinderhughes at the Boston Hearings of the Civil Rights Commission.



relationship with achievement which reflects the general lower quality of the nonwhite teacher. The elasticity estimates for Negroes and whites are practically identical. However, the level of significance in the black equations is lower. Instead of the very high t-statistics encountered in the white models, the parameters in the black models have t-statistics of only -1.7 and -1.3. This lowered significance level indicates lower reliability of the estimated relationship. This could well result from a lower ability to differentiate between black schools by this variable. It also is consistent with a hypothesis that some black teachers know the problems faced by the black student and know how to teach to him. Thus, empathy, common backgrounds and so forth might be enough to compensate for some quality differences. It is interesting that an average of 46 per cent of the black sixth graders in each school had nonwhite teachers while only 13 per cent of the white students had a nonwhite teacher. The change from 13 per cent to 45 per cent with a nonwhite teacher represents over a seven per cent decrease in mean school achievement.

The picture that emerges from the analysis of the separate components of the school input vector is that blacks tend to react slightly more than whites to quality differences in school factors. Certainly the differences are small. Yet, they seem to be consistent. Experience has a significantly stronger influence on blacks than on whites. Teacher verbal ability displays a slightly stronger impact on Negroes. Finally, the influence of nonwhite teachers, the measure of the lower ranges of teacher quality, is the same for blacks and whites. The errors in variables lead to some doubts about the general reliability of the point estimates of the parameters. However, there seems to be little

reason to believe that the errors would introduce greater bias in the white equations than in the black equations.<sup>16</sup> The evidence on specific differences between the black and white process with respect to schools is quite circumstantial. However, differential impacts of the vector of school inputs or various components are important policy concerns. If various components have different influences, a simple redistribution of teaching personnel might yield significant gains in total educational output. Also, it might indicate special characteristics of teachers which were advantageous in ghetto schools.

#### Racial Composition

The final aspect of the educational production functions is the racial composition of the school. It is not surprising that the racial composition effects in the educational production functions differ between black and white. While the method of modeling racial composition is similar, both the estimates and the interpretation of the parameters differ between races. Thus, this section breaks from the comparative mode of analysis.

The racial composition of the school in the black model is measured by two variables,  $N_{45-75}$  and  $N_{75-100}$ . These variables equal the per cent Negro sixth graders if within the relevant range (45 to 75 per cent or 75 to 100 per cent) and equal zero otherwise. As noted in Chapter Three, the per cent Negro was divided into a number of variables in order to test for different impacts of racial composition over various

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<sup>16</sup>It is possible that the poorer measure of background characteristics contributes to the measured differences between blacks and whites. This would arise if there were significant errors in the background measures that were correlated with school quality. This source of bias does not seem extremely important. The background measures for blacks appear adequate.

ranges. The divisions were fairly arbitrary (although ranges smaller than 25 per cent were analyzed but subsequently aggregated). The use of variables in this form provides an approximation of a nonlinear function. This construction (the use of slope dummies) allows for a continuous relationship with racial composition within the given range and, thus, is conceptually superior to the use of ordinary dummy variables which merely change the intercept for different categories but allow no variation within categories.

As in the white models, racial composition variables for the entire range of schools were tested. However, only those pertaining to concentrations over 45 per cent were significant. Again, it is not sensible to apply a strict interpretation to the variables. They represent approximations of a nonlinear function. Especially with the arbitrary definition of ranges, the implication that there is a sudden drop in achievement when a boundary is crossed is not realistic. A looser interpretation is better in this case.

Both racial composition variables exhibit a negative relationship with achievement. However, the estimated coefficients of  $-.012$  for  $N_{45-75}$  and  $-.007$  for  $N_{75-100}$  are the lowest elasticities of the eleven inputs into the educational process. Thus, there is a very small marginal effect of changing the racial composition. By a strict interpretation at the most detrimental point of racial composition (75 per cent Negro) the mean educational output for blacks is, ceteris paribus, 95 per cent of the level for a school with less than 45 per cent Negro sixth graders. At other levels of racial composition, the achievement effects are less.

It is likely that these estimated parameters are actually greater

(in absolute value) than the true value, i.e. that the estimates are biased away from zero. This conclusion is a result of a priori knowledge that there is often a considerable amount of internal segregation in schools. Internal racial division results from both overt policies and such magnificent segregators as tracking or grouping by ability. If internal segregation exists, the effective or true percentage is greater than the measured percentage Negro. This systematic error component will lead to overstating the racial composition parameters. The estimates in Equations 4-1 and 4-2 appear to be outside limits for the true effect of racial composition.

There are several reasonable interpretations of the total racial composition relationship, and the data are insufficient to differentiate among them. The overall relationship is consistent with the observation that Negro schools often receive less school resources. It is possible that per cent Negro in a school is a good measure of overall school quality. The racial composition of the school is also a good measure of many neighborhood and community factors. Higher concentrations of blacks are systematically related to worse housing conditions, higher unemployment rates and a series of community conditions which undoubtedly affect the school experiences of the black child. Finally, there could be a "pure" segregation effect, i.e. that racial isolation in schools per se leads to lower achievement. While more will be said about this last explanation in Chapter Five, two general comments can be made at this point. First, it is not possible to separate the different factors which go into the negative relationship between high concentrations of blacks and achievement. However, it is likely that the relationship includes elements of all three. Second, the combination of the three different

elements is quite small, indicating that the independent contribution of any one factor is minute.

The coefficients for the two ranges are quite close.<sup>17</sup> Still, the differences are interesting enough that they are presented separately (though doubts about the actual magnitude of difference remain). If this is a fair picture of the production process, racial composition has no effect on black achievement until about half of the student body is Negro. After that point, mean Negro achievement is lower. However, when a school is over three-quarters black the detrimental effect is not as great. Again a literal interpretation of the function is unwarranted. It is the general U shape of racial composition that is interesting.

There are two plausible explanations for the differential impact over these two upper ranges. The added disadvantage in the mid-range could be a reflection of dynamic factors at work. Racial compositions in this range may signify "transitional" neighborhoods which are moving from white to black. Increased tensions are certainly a symptom of the much observed "tipping" of neighborhoods. This could lead to the lowering of educational attainment during the period of change. A second explanation is more speculative. If teachers tend to "teach to whites" until the point where blacks are the overwhelming majority, this differential effect would be possible. This assumes that, when the class is all black, teachers make an effort to relate school to the black experience. It has often been suggested that efforts in this direction would improve the achievement of disadvantaged children. However, it is not known if this mode of teacher behavior was found in the sample.

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<sup>17</sup>In the VERBAL equation, the t-statistic for the null hypothesis that the coefficients are identical equals 1.5. In the MATH equation, the t-statistic equals 1.04.

More information than is available in the sample is needed to separate these hypotheses. Knowledge about dynamic community characteristics and/or detailed information on classrooms is needed. For policy purposes it would be valuable to know which factor was dominant for each suggests much different policies. In particular, the latter hypothesis that teacher methods bring about improved performance has implications for the borrowing by central cities of "new and improved" methods and curricula developed in the progressive suburban systems. Instead more localized solutions are called for.

In summary, the influence of racial composition on black education is complex. The results are consistent with several quite different hypotheses, and with the available data it is not possible to distinguish between the various hypothesized relationships. Nevertheless, one point is clear. The combined effect of the different factors measured by racial composition is small. Moreover, there are reasons to suspect that the estimates are actually biased upward.

### Miscellany

In the white production functions the lack of good facility measures did not seem too damaging. Within the general range of facilities in the white sample, the expectations of direct effects of plant and equipment are not very large. Even so, the available data on facilities are insufficient to provide reasonable tests of facility effects on white achievement.

For modeling black achievement, the data are no better. However, there is reason to be more concerned about this lack of information for black models. To the extent that facilities bring physical discomfort, are poorly lighted or have no sound proofing, it is necessary to modify

the basic model which specifies that facilities don't enter directly into achievement. In other words, at the lower end of the distribution of facilities there is a higher probability that facilities are an important argument of the production function. Given that ghetto schools tend to be older and less well maintained, it is more probable that facilities are directly important in producing achievement. As shown in Table 4-3, Negroes in northern metropolitan areas attend older schools and schools with more makeshift rooms.<sup>18</sup> Most striking is the comparison between Negroes and whites for percentage attending schools over 40 years old. The measure of classroom age does not have a significant effect on achievement, but this does not relieve the concern. The variance in renovations and maintenance seem large enough to obscure an age-achievement relationship. We can only conclude that the chance for error due to facility effects seems higher in the black models.

### The Education of Blacks

The necessity of analyzing individual components of the educational process tends to obscure the overall picture. The school production functions for black education are qualitatively very similar to those for white education. Both appear to be fair attempts at estimating a statistical model of the educational process. The educational process is extremely complex, and the models here are highly simplified versions of elementary education. Nevertheless, they provide several useful insights into the process.

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<sup>18</sup>The work with the raw data from the OE Survey required for this analysis leads to some doubts about the information on makeshift rooms, as there was a fairly large nonresponse problem with this and very little information by which this could be estimated. These data on makeshift rooms are included from the EEO Report with reservations

TABLE 4-3

FACILITY CHARACTERISTICS OF ELEMENTARY SCHOOLS FOR BLACKS  
AND WHITES--METROPOLITAN NORTHEAST AND MIDWEST

	Northeast		Midwest	
	Black	White	Black	White
Per cent of students in schools which are:				
less than 20 years old	31%	59%	28%	63%
20 to 39 years old	23	23	18	18
40 or more years old	43	18	53	18
Average number of make-shift rooms per building	1	0	1	0

Source: EEO Report, p. 68.



The clearest point in both the black and the white models is that schools definitely have a significant effect on achievement. Using very crude measures of the teaching staff, it was discovered that there are rewards in terms of better education if the teacher quality is raised. In comparing the black and white models of the process, it appears that blacks are more sensitive than whites to changes in quality of teachers. These differences are small, but the total impression is one where schools have a larger impact on Negroes.

Finally, high concentrations of Negroes are associated, ceteris paribus, with lower Negro achievement. At this point, we merely note that this simple finding belies the complexity of the actual situation. The measured effect is very small, and even that is probably biased upward.

## CHAPTER V

### RACIAL COMPOSITION EFFECTS ON ACHIEVEMENT

De facto school segregation, a condition found in every Northern metropolitan area, has received considerable attention during the 1960's. Concern over the racial composition of schools originates in a presumption that school segregation is inherently detrimental to minority children. While previous chapters have emphasized the racial context for the educational process, those analyses apply only tangentially to the issue of de facto segregation in the public schools. This results from the use of a very specialized measure of educational output (test scores), a measure which seems much too narrow for discussions of racial composition effects. Nevertheless, since the segregation issue is so fundamental and since other analyses have focused on verbal ability in studying it, a careful exposition of the implications of the previously presented educational models is profitable.

#### The Problem

The title de facto segregation signifies racial isolation which results from sources other than school segregation laws. In 1954 the U.S. Supreme Court ruled that de jure segregation, the explicit assignment of pupils to schools by reason of race, was unconstitutional. Yet, in Northern metropolitan areas discrimination in the housing market and neighborhood schools with frequently gerrymandered attendance lines yield much the same picture as de jure segregation. In Washington, D.C.

90 per cent of the Negroes attend schools that are over 90 per cent black; in Gary, 89 per cent attend black schools; in Cleveland, 82 per cent; in Philadelphia, 72 per cent.<sup>1</sup> Additionally current population trends indicate that central cities are becoming blacker as Negro in-migrants replace whites who are moving from the central cities to the suburbs. Thus, the further concentration of blacks in black schools seems assured.

Concern about segregated education arises from a belief that such a racial division engenders many detrimental effects for minority children. These effects appear both serious and long lasting. The psychological effects on the Negro have been well documented. Segregated education has a significant and harmful effect on black attitudes. The OE Survey itself indicates a considerable difference in attitudes between Negroes and whites in "fate" control. Almost twice as many Negroes as whites in the metropolitan North believe that luck is more important than hard work and that they don't have much of a chance for success.<sup>2</sup> Further, these attitudes within the Negro population are adversely affected by having fewer white classmates.<sup>3</sup> Black children who grow up in the ghetto and attend black schools are ill-prepared to participate in the essentially white society where their future jobs are found. They are uneasy in dealing with whites; they are distrusting of whites;

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<sup>1</sup>These figures apply to the 1965-66 school year (except for Cleveland which is 1962-63). Racial Isolation, pp. 4-5. A more complete tabulation of the extent of segregation is found in the Racial Isolation, Vol. II (Appendices), pp. 2-19.

<sup>2</sup>EEO Report, pp. 289-290.

<sup>3</sup>Racial Isolation, Vol. II (Appendices), pp. 63 and 65. It is important, however, to recognize that these observations about racial composition effects on attitudes are arrived at through very incomplete attitude models. Thus, they are subject to many of the criticisms below.

and they tend to be antagonistic toward whites.<sup>4</sup> These psychological aspects are summarized by the Group for the Advancement of Psychiatry.

Whenever segregation occurs, one group, in this instance the Negroes, always suffers from inferior social status. The damaging effects of this are reflected in unrealistic inferiority feelings, a sense of humiliation, and constriction of potentialities for self-development. This often results in a pattern of self-hatred and rejection of one's own group, sometimes expressed by antisocial behavior toward one's own group or the dominant group. These attitudes seriously affect the levels of aspiration, the capacity<sup>5</sup> to learn, and the capacity to relate in interpersonal situations.

The existence of de facto segregation also has a direct bearing on future jobs of Negroes as the general lack of background variance in black schools limits occupational aspirations. A statement about ghetto students before the Civil Rights Commission offers an adequate summary. "They didn't think that they could do anything because their fathers had common labor jobs and they didn't think they could ever get any higher and they didn't work, some of them."<sup>6</sup> The probability of obtaining job information is also lowered. The ways of gaining information about occupations and specific jobs are of such a nature (generally from

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<sup>4</sup>These impressions arise from a variety of sources. Irwin Katz reviews evidence relating to behavioral pressures on Negroes when they are mixed with whites. See "Review of Evidence Relating to Effects of Desegregation on the Performance of Negroes," American Psychologist, XIX (1964), pp. 381-99. Also, Thomas F. Pettigrew, A Profile of the Negro American (Princeton: D. Van Nostrand Company, Inc., 1964), especially Chapter 2, discusses the various attitudes of Negroes to segregation in general and their relations with whites. The Kerner Commission Report, pp. 174-178, presents evidence on Negro attitudes in the Newark and Detroit ghettos after the riots. A thorough review of the psychological development of the segregated Negro is found in David P. Ausabel and Pearl Ausabel, "Ego Development Among Segregated Negro Children" in Passow (ed.), Education in Depressed Areas, pp. 109-141.

<sup>5</sup>From Group for the Advancement of Psychiatry, Psychiatric Aspects of School Desegregation (New York: GAP, 1957), p. 10, as quoted in Katz, "Desegregation," p. 387.

<sup>6</sup>Statement by Calvin Brooks at the Cleveland Hearings of the Civil Rights Commission as quoted in Racial Isolation, p. 104.

friends or relatives) that the restricted nature of the schooling experience cannot help but have lasting effects.<sup>7</sup>

The benefits from reducing the extent of de facto segregation are not restricted to the black community. The civil disorders of 1966 and 1967 provided dramatic evidence that society as a whole would benefit from more amicable race relations and better understanding between blacks and whites. Corrections of distortions in the job market would yield additional benefits. Finally, considerations of equity and civil rights are relevant in the discussion of segregated schools.

The essential point to be made about de facto segregation in the schools is that the issues are very fundamental to our society. There are many broad reasons for believing that de facto segregation has a detrimental effect on minority students and society as a whole. These reasons led the Kerner Commission to conclude in their discussion of schools:

We have seen in this last summer's disorders the consequences of racial isolation, at all levels, and of attitudes toward race, on both sides, produced by three centuries of myth, ignorance, and bias. It is indispensable that opportunities for interaction between the races be expanded. "The problems of this society will not be solved unless and until our children are brought into a common encounter and encouraged to forge a new and more viable design of life."<sup>8</sup>

While the magnitude of costs arising from de facto segregation is unknown, the fragmentary evidence presented suggests that they could be considerable.

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<sup>7</sup>In a summary of Negro job market studies, Melvin Lurie and Elton Rayack point out that well over half of all jobs are found by informal search procedures (friends, relatives, etc.). "Racial Differences in Migration and Job Search: A Case Study," The Southern Economic Journal, July 1966.

<sup>8</sup>Kerner Commission Report, p. 438. The concluding sentence was part of the testimony of Dr. Dan W. Dodson.

### The Narrow Analysis of De Facto Segregation

In any empirical analysis of de facto segregation the measurement of output is crucial. The previous analysis of educational production functions used test scores as a measure of educational output on the grounds that these were highly correlated with future incomes and success in society. However, in studying the effects of racial composition on output, this choice does not seem nearly as reasonable. The issues involved in de facto segregation are much more fundamental than the technical dimension measured by achievement scores. It is unreasonable a priori to expect racial composition to have a major effect on verbal skills.

Even so, considerable weight has been attached to investigations of de facto segregation in the dimension of verbal ability scores. The EEO Report has been interpreted as providing a case for integration through its analysis of verbal ability and racial composition.<sup>9</sup> The Civil Rights Commission report, Racial Isolation in the Public Schools, is a second document using OE Survey data on verbal ability to analyze integration. While this latter report does a good job of identifying various aspects of the de facto segregation problem, it relies almost entirely upon analysis of the narrow output measure (verbal scores) for empirical support in its plea for remedial action. This analysis has been widely quoted and appears to have had considerable influence.

School integration is an important and controversial area of public policy. Since emphasis has been placed on achievement aspects of

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<sup>9</sup>It should be noted that the authors of the EEO Report did not emphasize the integration analysis. Most of their effort went into other analysis, and the discussion of integration was presented almost as an interesting sidelight.

de facto segregation, it is profitable to review the evidence in this area. The production functions previously presented offer some evidence about the effects of racial composition. The major effort in this section will be to relate the analysis in Racial Isolation to the previously estimated models of the educational process. The findings presented there can best be considered through such an analysis.

The prime objective of this section is insuring that the entire case for integration is not discredited by a faulty analysis of the narrow questions of achievement effects. A demonstration of adverse achievement effects from de facto segregation might provide good supporting evidence for an integration case. However, it is folly to build up this narrow facet to the point where the entire case wins or loses on such a demonstration.

#### Incomplete Models of Education

Many logically separable issues are often confused in discussions of de facto segregation and education. When it is observed that minority group children in segregated schools score lower on achievement tests, it cannot be concluded that segregated education per se is bad. Such lower achievement could come from different levels of family inputs (a cultural deprivation hypothesis), from inferior school inputs (a discrimination or lack of political power hypothesis), from segregated education being inherently detrimental, or from a combination of the three.<sup>10</sup> The above distinctions are more than semantical distinctions for, if the objective is simply raising achievement, each cause calls for different

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<sup>10</sup>The clearest exposition of the different aspects, especially social class and racial composition, can be found in Racial Isolation.

remedial action. Background deficiencies call for improvement in black social status, compensatory education or programs to lessen family influence, e.g. Headstart or longer school days. Poorer school inputs obviously call for input equalization. Inherent inequities of school segregation call for integration plans of some sort; for example, busing or open attendance districts. A mixture of causes probably calls for a mixture of remedies.<sup>11</sup>

The components for an analysis of racial composition which are suggested by the various concerns are very similar to the vectors of inputs into the conceptual model of the educational process (Equation 2-1). In fact, analysis of the independent effects of racial composition on achievement is best done within the framework of the production function for education since this allows a separation of the various aspects of the problem. There are two issues to be considered: 1) the correspondence of the production function analyses and the analysis in Racial Isolation and 2) the implications for integration of the production functions of Chapters Three and Four.

The link between the production function analysis and the presentation in the Civil Rights Commission report is not always easy to make. Yet, establishing the correspondence is a precondition to demonstrating the analytic problems surrounding its discussion of integration in the narrow framework of verbal ability. Racial Isolation bases the majority of its conclusions on an analysis of the OE Survey data and, primarily, the data for twelfth grade students in the metropolitan Northeast. The production functions of Chapters Three and Four were

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<sup>11</sup>A discussion of the various remedies that have been proposed is beyond the scope of this section. Analyses of different proposals can be found in Racial Isolation, Chapter 4, and in the Kerner Commission Report, pp. 424-456.



estimated for sixth grade schools in a somewhat larger metropolitan North region.<sup>12</sup> The different regional breakdowns do not appear very serious as one would expect this to be a fairly homogeneous group of states. However, the different grade levels for the analyses and the difference between individual and school production functions are serious. The discussion in Chapter Two about errors introduced by both factors holds with equal force now. As explained, the school analysis at the elementary school level represented an effort to minimize such error. Some difference could be introduced by the different grade levels due to substantive differences in integration effects (as opposed to the historical errors of measurement discussed earlier). However, if there is a strong relationship between racial composition and achievement, there is little reason to believe that its effects are qualitatively different between the sixth and twelfth grades. (Many people hypothesize that the impact of segregation is strongest in younger children; thus, one could expect that isolating racial composition effects would be easier and more conclusive in the sixth grade.)

A final difference between the analyses is the analytical methods. Racial Isolation rests its conclusions on a series of models of education which are analyzed through contingency tables. Such tables represent nonparametric tests of a set of hypotheses about the educational process. The various attributes of the model under consideration are divided into discrete intervals (e.g. whether average parents' education level in a school is above or below high school). Different attributes are then cross-tabulated, and mean verbal scores for the

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<sup>12</sup>The additional states in the production function analysis are Indiana, Illinois, Michigan, Ohio, and Wisconsin.

individuals in the different cells are computed. Such a nonparametric analysis does not require specifying a particular relationship. One of the greatest virtues of this technique is its simplicity. Such an easily understood method makes it possible for a larger audience to consider the analysis than if other techniques in the realm of multivariate statistics are used. However, three characteristics of contingency tables are important. First, information is lost through the division of variables into discrete intervals. Second, it is very difficult to determine more than the direction of effect. Third, it is extremely difficult to test more than a two or three dimensional hypothesis. Since it is possible to approximate different functional forms in multivariate regression analysis, the advantages of the parametric production function estimation seem overwhelming. Thus, the best strategy for linking the previous production function estimates to the results presented in Racial Isolation appears to be the estimation of the models used in the Civil Rights Commission analysis within the production function framework.

The Commission tests a series of two and three dimensional models of the educational process and supports most of its conclusions by such an analysis of achievement. The central conclusion in Racial Isolation and the one most important for this section is: "In addition to these factors [family background, school inputs, and peers], the racial composition of schools appears to be a distinct element. Racial isolation tends to lower students' achievement . . ." <sup>13</sup> The primary model which is used to support this conclusion "controls for" student and school social class and presents average achievement levels for

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<sup>13</sup>Racial Isolation, p. 114.

Negroes under different racial mixes.<sup>14</sup> It is this basic model which was reanalyzed within the production function framework for the 242 schools with black sixth graders. Equation 5-1 is a simple linear regression model of mean verbal achievement of black sixth graders. Equation 5-2 is a log-log model with the same variable specification. These may be considered more sophisticated tests of the models in Racial Isolation. Three measures of social class are used: G is the goods index for the school,  $E_f$  is mean father's education, and FS is mean family size. The variable of interest in this analysis is N, the percentage of sixth graders who are Negro.<sup>15</sup> All variables are allowed to be continuous over the relevant range of values. Estimation was done by ordinary least squares (unweighted).

$$(5-1) \text{ VERBAL} = 2.61 + .310 + .101E_f - .358FS - .028N$$

$$(\text{.9}) \quad (\text{12.6}) \quad (\text{1.0}) \quad (\text{-1.1}) \quad (\text{-4.1})$$

$$\text{SE} = 3.10 \quad R^2 = .46$$

$$(5-2) \text{ VERBAL}^* = -.78 + .769G^* + .035(E_f^*) - .094FS^* - .046N^*$$

$$(\text{-2.0}) \quad (\text{12.8}) \quad (\text{1.8}) \quad (\text{-1.4}) \quad (\text{-4.2})$$

$$\text{SE} = .13 \quad R^2 = .45$$

Note: Asterisks indicate logarithms of variables. t-statistics are found below each coefficient. SE is the standard error of the regression (unweighted ordinary least squares).

The equations represent two alternative specifications of the racial composition effect. While other forms of the racial mix variable

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<sup>14</sup>The first test of the racial composition hypothesis is found on page 90 of Racial Isolation. This appears to be the basic test of the racial composition hypothesis. The plethora of alternative models makes precision in documenting the analysis difficult.

<sup>15</sup>Racial Isolation uses the per cent white classmates last year (divided into the ranges none, less than half, about half, more than half). This represents a slightly different factor to the extent that other minorities are present and present racial composition differs from that last year.

were tested, there was little indication that any other form was more appropriate. In the presented equations, the racial composition coefficient is over four times its standard error. The models imply that, holding the effects of socio-economic background constant, higher black achievement is associated with lower proportions of black students. It is difficult to compare the production function estimate directly to the contingency table analysis of Racial Isolation.<sup>16</sup> However, the qualitative impressions are very similar. Equation 5-1 and 5-2 both imply significant and strong effects of integration over and above the influence of social class.

Does this imply that the case for integration has been established? It does not! Equations 5-1 and 5-2 are nothing more than misspecifications of the previously presented models of the educational

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<sup>16</sup>As mentioned previously, it is difficult to discover much more than direction of movement from the contingency table analysis. It was hoped that through aggregating the contingency tables over individuals some rough comparisons of achievement differences between the two extremes could be made, i.e. comparisons of achievement levels in few Negro and all Negro schools of a given social class. However, there is a units problem in relating the two analyses as Racial Isolation uses "scale scores" and the production function estimates here are based on raw test scores. The scale scores are two steps removed from the raw scores. First, the raw scores were converted to a national mean equal to 50 with a standard deviation of 10. (Raw scores in the sixth grade range from 0 to 50.) The scale scores represent conversions of these standardized scores according to the following formulas found on p. 36 of Racial Isolation:

$$12\text{th grade stnd. score} = (\text{scale score} - 220) \times .6254 + 10.2571$$

$$9\text{th grade stnd. score} = (\text{scale score} - 220) \times .6539 + 16.8845$$

There were two problems. First, no handy formula was given for the sixth grade and, thus, direct comparisons with the sixth grade contingency tables are not possible. (Extrapolation from the two formulas seemed hazardous.) Second, reaching the standardized scores from the raw scores requires a nonlinear transformation which was unknown. Consequently, even rough comparisons with ninth or twelfth grade were not possible.

process. When a complete model of the educational process is analyzed, one returns to the results presented in Equation 4-1. This equation, the production function for black sixth graders, contains a number of insights into Equations 5-1 and 5-2 and the whole issue of de facto segregation. First, in the modeling efforts of Chapter Four it was discovered that racial composition was only important in the higher ranges of per cent Negro (greater than 45 per cent). Additionally, the magnitude of the effects were very small. In the log-log model of Equation 4-1 (which is comparable to Equation 5-2), the estimated elasticities were  $-.012$  in the range 45 to 75 per cent Negro and  $-.007$  for greater than 75 per cent Negro. The estimated effect in the Racial Isolation model ( $-.046$ ) is four times the maximum value found in the complete model. And, there were doubts expressed in Chapter Four as to whether the true value was really as large as the estimated parameter.

It is obvious what has happened. In the misspecified models presented in Racial Isolation, the racial composition of the school does a good job of proxying school quality. When school inputs are included in the model of the educational process, racial composition only enters in a very special manner (with slope dummies for higher ranges of per cent Negro), and the apparent effect of racial composition is considerably reduced. As expressed previously, there are also some interpretative problems associated with this effect since racial composition tends to act as a good surrogate for several other inputs to the process.

A final note on the use of test score justifications for integration is necessary. When reliance is placed on this dimension, closer attention must be paid to the structure of benefits from integration. In particular, the most fundamental returns to integration (mainly

attitudes and interracial experience) are positive for both blacks and whites. However, it is conceivable that this is not the case for technical output and that integration is more like a zero sum game with whites losing what blacks gain. In fact, if one uses the same simple model of racial composition effects that was used in Racial Isolation for whites, there is a definite negative effect of integration.<sup>17</sup> In a linear estimate of VERBAL achievement for whites as a function of the three "pure" SES factors and per cent Negro sixth graders, the per cent Negro variable had a statistically significant ( $t = -6.3$ ) negative effect on white achievement. Additionally, the estimated parameter of  $-.041$  is larger than the corresponding parameter in Equation 5-1. Thus, naively interpreted, it appears that white mean achievement is lowered by more than Negro mean achievement is raised if racial compositions are adjusted. (Similar results hold for a logarithmic form of the white equation.) However, the more complete models in Chapter Three portray a different picture. The most reasonable interpretations of Equations 3-1 and 3-2 (the complete white models) indicate that no evidence of detrimental integration effects was found. In the VERBAL equation, but not the MATH equation, high concentrations of Negroes (over 75 per cent) were negatively related to achievement. However, this is best thought of as a mixture of poor school quality and an extreme of the white SES distribution. The simple white models do demonstrate the dangers of naive reliance on misspecified models.

The point of this entire section is simple. It seems imprudent to defend integration in the very narrow terms of verbal ability test

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<sup>17</sup>Racial Isolation, p. 160, makes passing reference to evidence that whites are not hurt by integration. They do not seriously analyze this question.

scores. The educational production functions for black sixth graders presented in the previous chapter considered the effects of racial composition on achievement. With even the most charitable interpretation, the independent effects of de facto segregation on black achievement are modest. Large integration effects are only found in misspecified models of the educational process. The arguments for integration are much more fundamental than any effects on verbal learning. By overemphasizing this narrow analysis, the chances of discrediting the entire case are high.

#### A Qualification

The fact that integration per se does not have a strong effect on verbal achievement does not tell the entire story. It is plausible that positive school peer effects exist for individuals, i.e. better student bodies have a positive effect on individual students. It is not possible to test this hypothesis with the OE Survey data.<sup>18</sup> However, on the assumption that this effect exists, a better case for integration using verbal ability score evidence can be made.

The peer group hypothesis is usually stated that lower class children benefit from being in schools with middle and upper class children but that these middle and upper class children do not suffer. The obvious implication of this hypothesis is that social class integration in schools is a net gain to society for nobody loses but some gain.

However, the factor of race confounds the situation. It is not

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<sup>18</sup>This inability to test peer effects relates to the inappropriateness of the data for modeling individual education. Peer effects have been widely discussed recently. However, most of this discussion arises from "findings" of the EEO Report which used the OE Survey data for individual analysis.

feasible to achieve social class integration within the black community. By any reasonable standard, no more than a third of the Negro families could be considered middle or upper class. Thus, if social class integration is the goal, racial integration must be undertaken. To the extent that racial integration brings social class integration, the peer group hypothesis suggests a consequent gain in achievement scores of the Negroes.

Nevertheless, it does not seem profitable to judge the gains of integration by points of verbal ability. While the gains due to peer influences brought about through racial integration might be significant, the most pervasive reasons for integration are still found elsewhere. Peer effects cannot be analyzed with the OE Survey data and, thus, no statements about this aspect of integration can be made.



## CHAPTER VI

### MODELS OF EDUCATION IN PERSPECTIVE

The previous chapters have presented a series of models of the educational process. The complexity of the process itself yields a certain amount of expositional complexity for the required simplifications in modeling the process promote sizable interpretative problems. Hence, it is profitable to summarize the principal findings and offer some perspective to the analysis. It would be imprudent to claim too much for the results. While the models provide several useful insights into the process, there are many obvious limitations. Thus, as a supplement to the analysis, an effort is made to delineate the major qualifications. Additionally, the various avenues of further research suggested by this study are considered briefly.

The motivation for this study was a desire to develop an analytical base from which policy decisions about resource allocation and distribution of educational services could be made. Certainly, these are complex and controversial issues which are not open to simple solutions. The estimates of educational production functions discussed previously offer a starting point in the development of more complete solutions to the allocation and distribution questions. The results do not provide conclusive answers to detailed questions about alternative educational policies. Instead, they provide a broad overview of the production function for elementary education.

The heart of the study is the specification and estimation of models of the educational process. There is little disagreement about the general inputs to the process. Home environment, attitudes, school inputs and innate abilities combine and interact to define the level of achievement of the individual. Yet past theoretical and empirical works provide little assistance in refining these abstract entities into quantifiable factors which can be used in describing the precise process of education. The plethora of partial and vague hypotheses which abound in the field of education do yield a starting point, albeit quite imprecise. The final models are the outgrowth of the author's judgments about alternative specifications. These judgments, in turn, represent the end product of an interaction between a priori views, statistical attributes of the models and simple data availability.

The entire modeling effort centered on the educational process for elementary schools. Through a sample of schools in the metropolitan North, models of the mean sixth grade achievement of whites and blacks were estimated. Data limitations forced the estimation of models at the school level, rather than the individual level. All models used achievement test scores as the single measure of educational output.

The models are best considered in terms of vectors of different attributes. Although the estimated relationships include up to eleven specific variables, the individual factors are not as meaningful as the vector representation of input groups. This arises from the fact that the nominal labels for variables in the simplified views of the process are not accurate and that the variables actually act as surrogates for a collection of inputs. The most profitable taxonomy of inputs divides the variables into socioeconomic factors, attitudes, school factors, and

racial composition measures. These are fairly natural divisions and tend to be useful in the context of discussing public policy with regard to education. Each of the vectors carries with it a specific set of policy prescriptions.

Within this study, both socioeconomic factors and attitude inputs are deemphasized. While they must be included within the model for estimation purposes, they do not hold equal interest for policy purposes. Not surprisingly, family background and attitudes demonstrate a strong relationship with achievement. Yet, the family background component does not seem readily available for policy purposes, and attempts to adjust educational output through operating on family backgrounds are almost certainly extremely inefficient. Aside from doubts about the statistical properties of the estimated attitude effects, the use of policies centering upon attitude transformation do not appear worthwhile, at least in the short run, because of the considerable ignorance about the attitude formation process. Thus, socioeconomic and attitude inputs are given less attention than other inputs in this analysis.

The strongest implication of this production function analysis relates to the impact of schools upon achievement. Recently there has been a widely circulated belief that schools are not very important in the production of education. If school quality did not affect school output, one would be left with substantial doubt about the efficacy of many educational expenditure programs. This is particularly true of compensatory programs which are designed to raise the achievement levels of groups through increased school inputs. For example, the Elementary and Secondary Education Act of 1965 provides massive support for special

programs designed to aid disadvantaged students.<sup>1</sup> Such expenditures implicitly assume that schools can have an effect on achievement levels.

The evidence on the impact of schools on achievement is clear. Schools do have a substantial effect on educational output. Three specific variables of teacher quality (verbal facility, experience and race) provide considerable evidence that school inputs affect educational output. Even strictly interpreted, the models of the educational process indicate that there exists a significant impact of teacher quality on achievement. Yet, there are compelling reasons to believe that the effects of schools are understated in the models. The true relationships between school quality and achievement are almost certainly stronger than those implied by a literal interpretation of the estimated relationships.

In addition to disputing the gross, no-school-effect hypothesis, the models provide information relevant to educational policy. In particular, they emphasize the importance of distinguishing between teacher quality and teacher quantity. Educational programs are often designed to increase teacher quantity (reduce pupil-teacher ratios). Experience has shown that, in addition to being extremely expensive, these programs tend to be ineffective. This is precisely what the previous modeling efforts emphasized. The returns to school expenditures are found in quality changes, not quantity changes. (This holds at least within the fairly wide range of school inputs found in the sample.) When costs are considered, the case for purchasing quality instead of quantity becomes

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<sup>1</sup>Title I of this act provides Federal aid to school systems based upon the level of school expenditures within the state and upon the number of low income people within the particular school system. During FY 1966, these expenditures exceeded \$1 billion, over half of which went to elementary schools.

even stronger. It is simply cheaper to buy significant changes in the quality sphere.<sup>2</sup>

The racial divisions which exist within our society appeared pervasive enough to force the development of separate models for black and white education. The social, economic and psychological differences between the black and white communities do not permit direct comparisons of the effects of many inputs into the educational process (e.g. SES and attitude variables). However, comparisons of school effects are meaningful. It is apparent, as stated previously, that school quality affects the educational output for both blacks and whites. However, there is some evidence that blacks react more than whites to differences in school quality. Any such differences in behavior are important for policy purposes. If, for example, teacher experience is considerably more important for blacks than whites, a redistribution of teacher staffs

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<sup>2</sup>The cost impressions for quality are readily confirmed by analyzing pay differentials by occupation. It seems apparent that significant gains in quality could be made by going outside of the current teacher market. The true costs of bidding higher quality people away from other occupations would not be that large in comparison to simply increasing numbers of teachers, especially when output effects are considered.

Furthermore, while it is not profitable to overemphasize the specific quality measures within the models, there are indications that inside the current teacher market, teacher quality is rather cheap. Levin, in "Recruiting Teachers," estimates that a point of teacher verbal facility costs approximately \$25. Thus, a very small per-pupil expenditure can bring about a large teacher quality change and, consequently, a large output effect. (These results are conditional upon the given range of the teacher test and the current market. However, in practice, it seems feasible to expand the range for a higher price and possibly somewhat reduced impact on achievement.) While this is only meant to be indicative of the policy alternatives, the specific numbers are quite compelling. Strictly interpreted, \$10 per pupil could bring about a five to ten per cent increase in mean verbal achievement. While there is the possibility of considerable error in these specific calculations, several current compensatory programs offer hundreds of dollars of additional expenditures per pupil. The evaluation of such programs is considerably beyond the scope of this analysis. However, the rough calculation of quality impact does provide some perspective for the models.

among schools might yield a significant increase in black achievement with little detrimental effect on white achievement. The findings here are not conclusive for, while the evidence is consistent throughout the measures of school quality, the differentials between blacks and whites are not large. The prospects are worth noting, however.

Even though this analysis has underscored racial aspects of education by estimating separate production functions for blacks and whites, it has little to say about the most controversial interracial issue--school integration. The measures of technical capabilities (test scores) which were used as outputs in the analysis of the educational process are much too restricted in this context. The goals of school integration are much more fundamental than the specific skills captured by standardized achievement tests. The effects of racial composition on educational achievement were considered in the models of the educational process and found to be quite small. Additionally, it is difficult to conclude that the measured effects were segregation effects per se for the interpretation is complicated by school quality factors and socio-economic considerations. Verbal or math achievement is simply not the most significant dimension for consideration of the effects of racial composition.

#### The Question of Efficiency

One of the objectives of the study was to provide a device which would enable rational allocation decisions to be made. A production function serves this purpose and, thus, allows for efficient allocation of resources. However, there remains some question as to whether or not the models which were labeled production functions actually possess all of the properties of production functions. In particular, the estimation

procedure requires that all of the sampled schools are operating efficiently. The regression analysis traces a plane which represents the production frontier if the sampled schools used in drawing the plane are on the frontier. If they are not, the plane does not describe the frontier. This is a continuous relationship; the closer the sample points are to the frontier, the closer the estimate is to the actual production function. Thus, the analysis assumes, rather than demonstrates, efficient operation of the sampled schools.

In terms of the previous discussion of school effects, the fact that some schools could be operating less than efficiently adds further support to the contention that the estimates of quality impacts are indeed minimum estimates. If, for example, the best teachers in terms of verbal facility were teaching physical education instead of English, the estimated parameters would tend to be lower than those found in the true production function. While the issue of efficiency is unresolved in this analysis, the effect of inefficiency on the estimates is known. The apparent effect of school quality will be smaller than the actual effect.

#### A Note on the Scope of the Analysis

The analysis within this study has explicitly considered only sixth grade education in the metropolitan North. This basic sample choice resulted from the combination of several factors. The data and modeling problems seemed least severe at the sixth grade level since the school organizations are less complex, the history of school inputs is shorter, and the effects of schools are more easily identified. The geographic division was called for by considerations of sample homogeneity. The possibility of students from different regions operating

under different educational production functions seemed large. The metropolitan North was selected for two reasons. The author's knowledge of the social patterns and the educational systems is greatest for this area of the country. Secondly, much of the present concern and controversy about public education centers upon this area. This area not only contains a significant proportion of the population of the United States, but it also presents the archetype of the mature metropolitan area replete with de facto segregation and any number of other central city ills. Pure size considerations made it infeasible to test the validity of the considerations which led to the sample stratification and the choice of grade level for the analysis.

An effort has been made not to overemphasize specific policy implications of the models presented because of this limitation in scope. The models provide useful benchmarks in the analysis of education and indicate where profitable directions of study lie. Nevertheless, for policy use it is necessary to ascertain the general acceptability of these models for the entire spectrum of public education.

It seems very possible that structural differences in the educational models could appear in a number of directions. The least likely area of disagreement in the production functions is consideration of different grade levels, especially other elementary grades and junior high school grades. It is very reasonable to expect the same general teacher quality effects on schooling when output is measured in similar technical dimensions. The chance of significant structural differences for other regions of the country seems larger. Especially in the case of the Negro, North-South and urban-rural differences appear to be extremely important. It is difficult to believe that the different



cultural backgrounds, the different social and economic considerations and the different psychological pressures do not lead to different behavioral patterns between the Northern black and the Southern rural black.

The analysis presented in this study has focused on one specific segment of public education as the chances of producing meaningful results appeared highest there. To the extent that there are not significant differences in the educational production functions for other grades and other geographic regions, these models of the educational process provide insight into general questions of educational policy. However, further confirmation of the conclusions through the replication of this analysis for other samples seems necessary

#### The Measurement of Output Reconsidered

This entire study has relied upon a very specialized set of output measures, i.e. verbal and mathematics achievement test scores. For many purposes these are very good indications of the output of schooling. Yet, two issues must be considered in conjunction with the possibilities for further research into the educational process. First, there are many other dimensions of school output which could be considered within the same analytical framework. To the extent that schools have a partial responsibility for developing behavioral standards, juvenile delinquency rates may be considered an output of schools. Overall school retention rates, i.e. quantity measures of schooling, forms another dimension of output. Future income streams of students provide an alternative measure. Finally, college attendance rates include some aspects of the output of schools. Certainly each of these output measures has its own special features and problems. However, at

the same time they are amenable to similar modeling efforts as the achievement test scores and, in such a format, would provide additional information for the educational decision maker. To the extent that each measures a different dimension of education, it is important to know how policy measures designed to affect achievement influence these dimensions. In particular, it is vital to recognize any conflicts in producing the various dimensions of output. On the other hand, if these different variables all measure the same basic dimension of schooling, albeit with error, attempts at formulating educational production functions in the different dimensions would provide an indication of the reliability of the production functions presented. In either case, replication of the estimates of the educational production process using different output measures appears profitable.

The second aspect of the measurement of output concerns transforming the achievement test scores into a unit of measurement which is meaningful in formulating educational policy. Points on achievement tests have little intuitive appeal. Instead it would be useful to be able to transform these measures into the perspective of value to society. The necessity of this is obvious when one attempts to analyze the efficacy of different proposals to affect the output level.<sup>3</sup>

It is merely mentioned at this time that the valuation of education is extremely complex, especially if one is interested in the value to society. In calculating the benefits to society, the estimation of

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<sup>3</sup>It is important to note that this section is concerned with the overall investment decision. If schools are given a fixed budget, the maximization of output measured in the technical dimension of test scores (or any monotonic transform of these) can be accomplished with the simple test score measure as long as it is possible to separate the different dimensions of output. Introducing a value measure for output is important when present value calculations for an investment are undertaken.

educational effects on personal income streams could lead to erroneous results.<sup>4</sup> The transformation of quality units of schooling into societal value units is itself a major research project, and no efforts along this line have been undertaken here. One should simply be aware of the fact that the educational production functions presented are not sufficient to answer overall questions about whether or not to invest in given public education projects.

Both points about the measurement of output are simply stated. The use of test scores is profitable for it does measure a significant dimension of scholastic output. Nevertheless, it is not the only possible measure of output, and analysis of alternative measures would both provide additional information for policy purposes and supply perspective to the test score analysis.

#### The Outlines of a Research Program

The closing section is rightfully reserved for a brief consideration of a more ideal research design aimed at disentangling the elements of the educational production process. The present study has provided some useful information on the production function for education. Nevertheless, it is not without its problems, and a fair amount of uncertainty about specific aspects of education remains. These are problems which will not be eliminated by further analysis of the OE

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<sup>4</sup>There are many reasons found in the theoretical economic literature for the divergence of private and social benefits. A discussion of these would take us far afield. The existence of such divergences is easily shown, however. For example, in Randall D. Weiss, "The Effect of Scholastic Achievement Upon the Earnings of Whites and Negroes: Experiments with Single Equation and Recursive Models" (unpublished undergraduate honors thesis, Harvard College, 1968), one finds that quality adjusted years of education have very little effect on Negro earnings. However, very few people would hold that black education has no social value.

Survey data. Thus, the remaining issue is what data are desirable.

The most immediate need is accurate information about individuals and the educational inputs provided to specific students. The school production functions provide only an aggregative picture of education and, necessarily, cannot possess very detailed information about specific inputs and their relationships with achievement. A more detailed tableau of individual education would enable much more precise analysis of particular proposals for public education.

An important aspect of the previous point is the necessity of historical information about the inputs to the production process. Education is obviously a process over time. The estimated production functions were produced from cross sectional data about education. The reliance upon cross sectional data, especially those which contain only contemporaneous factors, produces many problems. There can be serious errors of measurement introduced to the extent that contemporaneous inputs are poor surrogates for the historical inputs into the process. Either a time series (longitudinal) study is required or a serious effort at collecting detailed historical information must be made in a cross sectional study.

Finally, the results of the models of education are conditional upon the range of the inputs into the process. It is risky to infer that the structure of the process is the same for all conceivable values of an input as it is for the sample range of the input from which the estimates are obtained. For example, the impact of one teacher for each student would most likely differ from the impact of the same teacher in a classroom with 25 students. The desire for sample information on a large range of inputs into the process is obvious. When making decisions

on public education, one wants to be able to judge from a full set of alternatives.

There are alternative methods of satisfying these data requirements for a more ideal study of education. A strengthened cross sectional data collection effort following the initial efforts of the OE Survey could provide much of the desired individual and historical information. Similarly, adaptations of time series efforts such as Project TALENT could meet most of the first two requirements. Nevertheless, the third consideration--analysis of a broad range of programs and inputs--is hard to meet within these data collection strategies. It is simply difficult to create a good sample of schools which exhibit large differences in school inputs. The normal range of inputs found in public schools is quite small.

The most profitable solution to the analytic requirements appears to lie in a large-scale program of school experimentation. This has several advantages. It is possible to analyze various innovative plans and to obtain information on a broad spectrum of inputs. Thus, a much larger section of the production function for education could be mapped out. Also, it would allow for more detailed study of causal patterns which exist within the school systems. The causal relationships are important for policy considerations since the relevant information is how much change in output can be expected from a given change in input to the educational process. Information on causal patterns within the estimated production functions presented earlier comes from outside of the data. Through a priori knowledge it is possible to attach some causal significance to various inputs in the process. However, there is often concern about the precise nature of the relationship in such a

study. For example, does the effect of teacher experience on achievement arise from the fact that teacher quality increases with teacher experience or from a school selection process on the part of more senior teachers? A careful experimental design would allow inferences about the causal structure to be made.

The specification of precise experiments into the educational process is not the aim of this section. However, the requirements are straightforward. There must be a well-formulated series of educational experiments which offer a wide range of alternative programs. The participating students should be selected so as to include the gamut of individual experiences. The main emphasis is on diversity of inputs and accuracy of measurement. Such a program offers the highest probability of uncovering the detailed information needed to allocate efficiently the \$27 billion currently spent each year on elementary and secondary school education. While such a program of research would be costly, the expected rewards are high.

Yet, until the time that such a program is undertaken, it is necessary to rely upon the more general impressions garnered from the crude estimates of educational production functions.

## APPENDIX A

### WEIGHTED REGRESSION ANALYSIS

The ordinary least squares procedure holds a high place in econometric work because, if certain conditions concerning the error terms of the model hold, the Gauss-Markof Theorem shows that the parameter estimates must be the best (minimum variance) estimator among the class of unbiased linear estimators. The critical assumption for this work is that the variance-covariance matrix for the error terms can be represented as  $\sigma^2 I$ .<sup>1</sup> However, there is good reason to believe that in fact the actual error matrix for the school production function estimation is not  $\sigma^2 I$  but instead has a nonconstant variance. In other words, conceptually one expects heteroscedastic errors, and heteroscedastic errors of a particular type.

This is best seen if one hypothesizes an individual production process such as in Equation A-1 with homoscedastic errors, i.e. the

$$(A-1) \quad A = X\beta + u$$

variance-covariance matrix for the errors can be represented as  $\sigma^2 I$ . If it is assumed that this relationship holds for all the individuals in

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<sup>1</sup>Throughout the following discussion, matrix notation will be used. The standard regression problem which is considered has  $t$  observations on  $k$  independent variables. Thus, in the basic assumption about the error matrix,  $I$  represents a  $t \times t$  identity matrix. For the individual case,  $A$  is a  $(t \times 1)$  vector;  $X$  is a  $(t \times k + 1)$  matrix;  $\beta$  is a  $k \times 1$  vector; and  $u$  is a  $(t \times 1)$  vector. For the aggregate case,  $\bar{A}$  is  $(t^* \times 1)$ ;  $X$  is  $(t^* \times k)$ ;  $\beta$  is  $(k \times 1)$ ; and  $u$   $(t^* \times 1)$ . Similar representations of the standard linear model can be found in Johnston, Econometric Methods, Chapter 4.

the sample and proceed to take expected value across individuals in a school, we arrive at Equation A-2. However, if the errors in A-1 were

$$(A-2) \quad \bar{A} = \bar{X}\beta + \bar{u}$$

indeed homoscedastic, the errors in A-2 will necessarily be heteroscedastic. This is the case as the variance of  $u_j$  will be  $\sigma^2/n_j$  where  $n_j$  is the number of students in school  $j$ .

In this case, the ordinary least squares estimates of the parameters will no longer be the minimum variance estimates. However, through the use of Aitkin estimators or generalized least squares it is possible to obtain the minimum variance parameter estimates. Instead of the normal least squares estimates of

$$(A-3) \quad \hat{\beta} = (\bar{X}'\bar{X})^{-1}\bar{X}'\bar{A}$$

the Aitkin estimates are obtained by

$$(A-4) \quad \hat{\beta}^* = (\bar{X}'\Omega^{-1}\bar{X})^{-1}\bar{X}'\Omega^{-1}\bar{A} \quad \text{where } E(uu') = \sigma^2\Omega$$

In the case of using averages for the estimation, the matrix is simply a diagonal matrix whose elements are  $1/n_j$ . In practice the estimation of the model can be accomplished by multiplying the vector  $\bar{A}$  and the individual columns of  $\bar{X}$  by a vector whose elements are  $(n_j)^{-1/2}$

The rationale throughout for weighting the regression is to obtain more efficient estimates of the individual parameters for the production functions. The Aitkin estimates are easily shown to be the best estimates of the parameters of the equations when the error variance-covariance matrix can be specified. While the parameter estimates obtained from the unweighted regression are unbiased, they are inefficient estimates. Also, the t-statistic in the unweighted case will be incorrect as it has assumed that the error matrix can be represented as  $I$ . However, in a more intuitive manner, the interest is



really in the individual students. Therefore, it is desirable to "do better" at predicting in the places where more students are found. This is accomplished through weighted regression.

It should be noted that the summary statistics of  $R^2$  and standard error have little natural meaning in the presence of weighted variables. The standard error can be arbitrarily increased or reduced by scaling the weights up or down. (It can be used to compare equations with the same weighting scheme.) If the variance of the weights is much larger than the variance of the dependent variable, the calculated  $R^2$  from the weighted observations will be very high. Intuitively, this arises from the fact that the intercept term in the weighted regression is the vector of weights. Thus, we are regressing the variable with the most variance on a multiple of itself.

## APPENDIX B

### LINEAR MODELS OF THE EDUCATIONAL PROCESS

The linear models of the educational process were judged slightly inferior to the log-log models presented in Chapters Three and Four. However, the differences were relatively small, and the linear form is more common in alternative studies of the educational process. Therefore, the corresponding linear models are presented below.<sup>1</sup> Variables in the white sixth grade models are defined in Table 3-1; variables in the black models are defined in Table 4-1.

#### White Linear Models

$$\begin{aligned}
 \text{(B-1) VERBAL} &= 5.66 - .739\text{CC} + .130\text{G} + .007(\text{E}_f \cdot \text{G}) - .311\text{FS} \\
 &\quad (1.5) \quad (-3.5) \quad (4.5) \quad (8.2) \quad (-1.4) \\
 &+ .101\text{HS} - .121\text{S} - .030\text{M} + .129\text{NS} + .135\text{T} \\
 &\quad (4.1) \quad (-6.7) \quad (-2.1) \quad (2.4) \quad (1.8) \\
 &+ .072\text{E} - .044\text{NT} - .044\text{N}_{75-100} \\
 &\quad (3.6) \quad (-6.0) \quad (-2.2)
 \end{aligned}$$

SE = 12.84

$$\begin{aligned}
 \text{(B-2) MATH} &= 4.53 - .273\text{CC} + .027\text{G} + .004(\text{E}_f \cdot \text{G}) - .350\text{FS} \\
 &\quad (2.0) \quad (-2.3) \quad (1.4) \quad (8.2) \quad (-2.7) \\
 &+ .062\text{HS} - .062\text{S} - .019\text{M} + .036\text{NS} + .039\text{T} \\
 &\quad (4.2) \quad (-5.8) \quad (-2.3) \quad (1.2) \quad (0.9) \\
 &+ .024\text{E} - .016\text{NT} \\
 &\quad (2.0) \quad (-3.6)
 \end{aligned}$$

SE = 7.62

---

<sup>1</sup>The t-statistic is presented below each estimated regression coefficient in parentheses. SE is the standard error of the weighted linear regression.

Black Linear Models

$$\begin{aligned}
 \text{(B-3) VERBAL} &= -2.12 - .925\text{CC} + .138\text{G} + .002(\text{E}_f \cdot \text{G}) - .793\text{FS} \\
 &\quad (-0.5) \quad (-2.1) \quad (5.3) \quad (4.3) \quad (-2.6) \\
 &+ .160\text{HS} - .065\text{S} + .118\text{T} + .136\text{E} - .020\text{NT} \\
 &\quad (5.2) \quad (-3.0) \quad (1.1) \quad (3.0) \quad (-1.7) \\
 &- .021\text{N}_{45-75} - .011\text{N}_{75-100} \\
 &\quad (-2.8) \quad (-2.1)
 \end{aligned}$$

SE = 14.60

$$\begin{aligned}
 \text{(B-4) MATH} &= 3.50 + .044\text{G} + .001(\text{E}_f \cdot \text{G}) - .350\text{FS} + .061\text{HS} \\
 &\quad (1.6) \quad (2.7) \quad (1.8) \quad (-2.3) \quad (4.0) \\
 &- .030\text{S} - .046\text{T} + .088\text{E} - .007\text{NT} - .011\text{N}_{45-75} \\
 &\quad (-2.8) \quad (-0.9) \quad (4.0) \quad (-1.2) \quad (-3.0) \\
 &- .008\text{N}_{75-100} \\
 &\quad (-2.9)
 \end{aligned}$$

SE = 7.27

TABLE B-1

ELASTICITIES AT THE POINT OF MEANS FOR VARIABLES  
IN THE LINEAR MODELS OF THE EDUCATIONAL PROCESS

Variable	White		Black	
	Verbal	Math	Verbal	Math
CC	-.009	-.008	-.028	. . .
G	.328	.132	.584	.344
E <sub>f</sub> · G	.228	.301	.064	.115
FS	-.038	-.096	-.152	-.162
HS	.264	.364	.559	.513
S	-.031	-.036	-.046	-.052
M	-.006	-.009	. . .	. . .
NS	.008	.005	. . .	. . .
T	.092	.060	.106	-.100
E	.023	.018	.056	.087
NT	-.014	-.012	-.035	-.030
N <sub>45-75</sub>	. . .	. . .	-.012	-.015
N <sub>75-100</sub>	-.001	. . .	-.014	-.023

## APPENDIX C

### GROWTH MODELS OF EDUCATIONAL ACHIEVEMENT

The conceptual model of Equation 2-1 emphasized the cumulative aspects of the educational production process. However, the OE Survey data are cross sectional and contain negligible historical information. The survey design did indicate the possibility of placing the process into historical perspective through the matching of mean achievement scores for different grades within the same school. Thus, with assumptions about the consistency of the school population between grades, the contemporaneous testing of first graders could be considered a good proxy for the true first grade scores of the present sixth graders. The scores of first graders thus become a measure of the raw inputs which the school had in producing the sixth grade output.

There are two plausible methods of including the first grade scores into the analysis. One can either define the output as the difference in sixth and first grade performance or include the first grade score as an input (explanatory variable) to the process. The first method is actually a special case of the second where the parameter is constrained to equal unity. This and the fact that it allows for no interaction with other explanatory variables led to discarding the simple difference formulation of the "growth" analysis.

The major complication of this analysis is that the survey design called for sampling only half of the first graders in the sampled feeder

schools. Since the selection was by school, over one half of the 471 schools included in the total white school sample were eliminated, leaving only 198 schools.<sup>1</sup> The method of choosing this sample was never explicitly stated. The means for the variables tend to approximate those of the complete white sample. However, the variances in the first grade sample are consistently smaller.

The estimated production function for the time series model is presented in Equation C-1. These models are also in log-log form and were estimated with weighted regression techniques. All variables are as defined in Table 3-1 with the following additions: SR is the per cent of teachers who perceive their school reputation as being above average;  $N_{45-75}$  is the per cent Negro sixth graders with nonzero values over the range 45 to 75 per cent Negro; and  $NV_1$  is the mean white first grade nonverbal ability test score.<sup>2</sup>

Although two first grade tests were given, verbal and nonverbal ability, only the nonverbal first grade score had a significant effect upon sixth grade achievement. Additionally, first grade scores influenced only sixth grade verbal, not sixth grade math. At first sight there appears to be some change in the parameters as compared with Equation 3-1. In particular, the elasticities on the SES factors appear decreased (as would be expected), and there is some change in the description of school inputs. The perception of school reputation is used as a general quality index and replaces the teacher verbal test

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<sup>1</sup>More than half of the sample is lost because of different school system organization. Some schools with sixth grades do not have first grades. Also, there could be different response rates to the OE Survey for schools asked to provide first grade information and those not asked to do so.

<sup>2</sup>The first grade tests were Inter-American Tests of General Ability.

$$\begin{aligned}
 \text{(C-1) VERBAL*} &= - .09 - .019\text{CC} + .160\text{G*} + .118(\text{E}_f \cdot \text{G})^* + .014\text{NS*} \\
 &\quad (-.2) \quad (-2.0) \quad (1.4) \quad (2.5) \quad (2.6) \\
 &\quad - .011\text{M*} + .432\text{HS*} - .030\text{S*} + .020\text{E*} - .026\text{NT*} \\
 &\quad (-1.8) \quad (3.7) \quad (-4.2) \quad (1.7) \quad (-5.2) \\
 &\quad + .011\text{SR*} - .012\text{N*}_{45-75} - .030\text{N*}_{75-100} + .063\text{NV*}_1 \\
 &\quad (1.9) \quad (-1.8) \quad (-2.3) \quad (2.1)
 \end{aligned}$$

$$\begin{aligned}
 \text{(C-2) VERBAL*} &= - .23 - .018\text{CC} + .222\text{G*} + .140(\text{E}_f \cdot \text{G})^* + .014\text{NS*} \\
 &\quad (-.4) \quad (-1.9) \quad (1.9) \quad (3.0) \quad (2.6) \\
 &\quad - .013\text{M*} + .411\text{HS*} - .030\text{S*} + .023\text{E*} - .027\text{NT*} \\
 &\quad (-2.2) \quad (3.5) \quad (-4.2) \quad (2.0) \quad (-5.4) \\
 &\quad + .011\text{SR*} - .012\text{N*}_{45-75} - .032\text{N*}_{75-100} \\
 &\quad (1.8) \quad (-1.8) \quad (-2.4)
 \end{aligned}$$

Note: Asterisks indicate logarithms of variables. t-statistics are presented in parentheses under each coefficient.

score as a significant explanatory variable.

However, as Equation C-2 indicates, these differences are more a function of the sample of schools than of the different model specification. When the first grade score is eliminated from the model, there is practically no change in the parameter estimates for the remaining inputs. Given this, the "growth" models have been given little emphasis. The loss of information by the dramatic reduction in the sample appears greater than the gain from the inclusion of the measure of raw inputs to the process.

Efforts at developing time series models for black sixth graders also proved completely unsuccessful. For the 98 schools with both first and sixth grade black students, models of education using first grade scores as raw inputs to the sixth grade process were estimated. Both the mean first grade verbal and nonverbal ability scores were insignificant in the production of VERBAL and MATH at the sixth grade.

There are several plausible explanations for finding no effect

when raw inputs are included in the model. The most obvious is that the assumptions about similarity of first and sixth graders within the same school are not a good picture of reality. Migration is known to be high (an average of 45 per cent of the sixth graders in each school have attended more than one school). However, it requires that the character of the student body changes. The evidence on this is ambiguous. There is a fairly high correlation between first and sixth grade SES measures, but it is not conclusive.

The second explanation is that the tests given at the first grade are not good measures of the inputs to schools. The fact that first grade verbal score does not exhibit a significant relationship with sixth grade verbal lends some support to this. However, this is not an area where an economist is qualified to make judgments. It is known that fairly high correlations between test scores at the first grade level and later grades have been found in various longitudinal studies, indicating that reliable measures can be constructed.<sup>3</sup>

Third, if raw inputs were randomly distributed among schools and schools did have a strong influence on achievement, first grade scores would be insignificant. While this cannot hold completely, as first grade inputs are known to be correlated with other factors in the process, this could provide part of the explanation for the failure of these models.

The combination of measurement errors between the first and sixth grade and poor measurement of inputs to the school suggests that contemporaneous measures of socioeconomic status for the sixth graders does a better job of measuring the inputs which the school had to work

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<sup>3</sup>See Bloom, Stability, Chapters 3 and 4.

with. The negligible effect on the school factor parameters from inclusion of first grade scores does increase confidence in interpreting the school parameters as marginal characteristics (as opposed to measurements of level aspects of achievement).



## APPENDIX D

### THE PRODUCTION OF HIGH ACHIEVERS

An alternative output to mean achievement for schools is the production of high and low achievers. That is, it seemed plausible that the production relationships at the extremes of the achievement distribution were different from those for mean achievement. In order to analyze this possibility, models of extreme achievement were developed and estimated. The output of the process under consideration is defined as the percentage of sixth graders (by race) who scored over one standard deviation above the racial mean on the given test. (A similar analysis was carried out for the bottom tail of the distribution but is not reported here.) The preliminary efforts in this direction did not look very promising. They appeared to give little additional information. Thus, this line of attack was shelved rather early in its development. The first generation models for high achievers are presented below. All of the models are in log-log form and were estimated using weighted regression techniques. Equations D-1 and D-2 are the white models; Equations D-3 and D-4 are the black models. Variable definitions are found in Table D-1.

White High Achievers

$$(D-1) \quad V_{\epsilon}^* = -9.36 - .0945CC + 1.602G^* + .056S^* + .137NS^* \\
\begin{matrix} (-2.5) & (-1.9) & (2.3) & (2.1) & (8.0) \\ & & \epsilon & \epsilon & \epsilon \end{matrix} \\
+ .392FS^* + 1.021T^* + .153SR^* \\
\begin{matrix} (1.9) & (1.8) & (4.4) \\ & & \epsilon \end{matrix}$$

SE = 1.24

$$(D-2) \quad M_{\epsilon}^* = -10.63 - .151CC + 2.003G^* + .119NS^* \\
\begin{matrix} (-2.5) & (-2.7) & (2.5) & (6.2) \\ & & \epsilon & \epsilon \end{matrix} \\
+ 1.059T^* + .175SR^* \\
\begin{matrix} (1.6) & (4.3) \\ & \epsilon \end{matrix}$$

SE = 1.43

Black High Achievers

$$(D-3) \quad V_{\epsilon}^* = -3.47 + 1.188G^* + .097NS^* - .047NT^* + .042(V/S)^* \\
\begin{matrix} (-2.2) & (3.4) & (4.5) & (-1.9) & (3.0) \\ & & \epsilon & \epsilon & \epsilon \end{matrix} \\
+ .319E^* + .066SR^* + .122N_{0-25}^* - .030N_{75-100}^* \\
\begin{matrix} (3.5) & (2.3) & (3.5) & (-2.0) \\ & & & \epsilon \end{matrix}$$

SE = 1.12

$$(D-4) \quad M_{\epsilon}^* = -8.50 + 2.139G^* + .140NS^* + .195R \\
\begin{matrix} (-4.1) & (4.5) & (4.5) & (2.2) \\ & & \epsilon & \epsilon \end{matrix} \\
+ .296E^* + .103SR^* - .071N_{75-100}^* \\
\begin{matrix} (2.3) & (2.6) & (-3.9) \\ & & \epsilon \end{matrix}$$

SE = 1.58

Note: Asterisks indicate logarithms of variables. t-statistics are shown under the coefficients. SE is the standard error of the weighted regression.

TABLE D-1

## VARIABLE DEFINITIONS FOR MODELS OF HIGH ACHIEVERS

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$V_{\epsilon}$	Per cent of black or white sixth graders scoring over one standard deviation ( $\sigma_v$ ) above racial mean ( $\mu_v$ ) on verbal ability test
$M_{\epsilon}$	Per cent of black or white sixth graders over one standard deviation above racial mean on math achievement test
CC	Dummy variable for central city: = 1 if school is in central city; = 0 otherwise
$G_{\epsilon}$	Goods index for high verbal achievers (greater than $\mu_v + \sigma_v$ )
$S_{\epsilon}$	Per cent of high verbal achievers who feel that they don't have much chance of success
$NS_{\epsilon}$	Per cent of high verbal achievers who attended nursery school
$FS_{\epsilon}$	Average family size for high verbal achievers
T	Average teacher verbal ability test score
SR	Per cent of teachers who perceive their school as having above average reputation
R	Rapid learner dummy variable: = 1 if school has special classes for rapid learners; = 0 otherwise
$NT_{\epsilon}$	Per cent of high verbal achievers who had nonwhite teacher
V/S	Average volumes in library per student
E	Average years of teacher experience
$N_{0-25}$	Per cent Negro dummy: = per cent Negro if $0 \leq N \leq 25$ ; = 0 otherwise
$N_{75-100}$	Per cent Negro dummy: = per cent Negro if $75 \leq N \leq 100$ ; = 0 otherwise

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## APPENDIX E

### THE RACIAL GAP IN ACHIEVEMENT

Since much of the concern over racial aspects of education centers upon the difference in education between blacks and whites, a specific analysis of achievement differences within integrated schools was undertaken. The general picture of integrated schools was quite interesting. The mean school score for white achievement in the 169 integrated schools was 33.05.<sup>1</sup> In only twelve schools did black output exceed this white mean. Additionally, the total sample mean for the 472 white schools used in the previous production function analysis was 35.70. Only four of the integrated schools produced black achievement in excess of this. Such statistics give dramatic insight into the distribution of output by race.

It was hoped that insight into the causes of the racial gap could be gained by focusing upon the within school differences. The advantage of this procedure would be the minimization of the effects of extraneous factors which would be constant for both groups within the same school. The output of the process considered was the difference in white and black achievement. The inputs were differences in background factors plus school factors which could be used for policy purposes in reducing the gap. Additionally, the absolute level of black achievement was

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<sup>1</sup>To be included in the sample, a school was required to have both five white and five black sixth graders. The intersection of the black and the white samples is 169 schools.

entered as an explanatory variable in explaining the difference. The rationale behind this was twofold: 1) this could account for nonlinear difficulty of the tests, and 2) it could act as a surrogate for unmeasured school quality factors. (The natural null hypothesis for the t-test on this variable is that the coefficient equals -1, not that it equals zero.) Nevertheless, these models did not prove immediately useful, as they are extremely difficult to interpret. As such they add little to the simple analysis of overall differences in the production functions. The difficulty chiefly results from the unnatural dimension in which the dependent variable is measured.

The best models for explaining the achievement gap are presented below. Throughout the models, the subscript w applies to the white variable, n to the Negro variable. All variables are defined in Table 3-1 on page 38 with the following additions: V is VERBAL; M is MATH; N is per cent of sixth graders who are Negro; TM is per cent teacher turnover last year; and C is the per cent of teachers who would choose voluntarily to teach in their present school. Equations E-1 and E-2 represent linear forms of the gap models. Equations E-3 and E-4 represent logarithmic extensions of the gap models. (The natural extension to logarithms is the difference between the logarithms which is equivalent to taking the logarithm of the ratio of achievements.) The variable means for the racial differences are presented in Table E-1.

$$\begin{aligned}
 \text{(E-1)} \quad V_w - V_n &= - .84 + .254(G_w - G_n) - .003(G_w - G_n) \cdot N \\
 &\quad (-.2) \quad (4.6) \quad (-2.3) \\
 &+ .087(HS_w - HS_n) + .046(NS_w - NS_n) + .0358T \\
 &\quad (5.2) \quad (2.8) \quad (2.0) \\
 &+ .118E - .036(NT_w - NT_n) - .051N_{75-100} - .175V_n \\
 &\quad (2.0) \quad (-2.7) \quad (-3.6) \quad (-13.0)
 \end{aligned}$$

$R^2 = .46$

$$\begin{aligned}
 \text{(E-2)} \quad M_w - M_n &= - .88 + .0008(G_w - G_n) \cdot N + .061(HS_w - HS_n) \\
 &\quad (-.4) \quad (2.1) \quad (2.8) \\
 &+ .022(NS_w - NS_n) + .188T + .056E \\
 &\quad (2.8) \quad (2.1) \quad (2.0) \\
 &- .016(NT_w - NT_n) - .011N_{75-100} - .0095M_n^2 \\
 &\quad (-2.4) \quad (-1.5) \quad (-3.5)
 \end{aligned}$$

$R^2 = .36$

$$\begin{aligned}
 \text{(E-3)} \quad (V_w/V_n)^* &= - .09 + .472(G_w/G_n)^* + .492T^* + .114E^* \\
 &\quad (-.2) \quad (5.3) \quad (3.2) \quad (4.6) \\
 &- .015(S_w/S_n)^* - .021SM^* + .04TM^* - .008N_{45-100}^* \\
 &\quad (-2.6) \quad (-1.9) \quad (3.3) \quad (-1.7) \\
 &- .041N_{75-100}^* - .024C^* - .452V_n^* \\
 &\quad (-4.5) \quad (-1.4) \quad (-16.5)
 \end{aligned}$$

$R^2 = .55$

$$\begin{aligned}
 \text{(E-4)} \quad (M_w/M_n)^* &= -1.4 + .178(G_w/G_n)^* + .382(HS_w/HS_n)^* \\
 &\quad (7.1) \quad (2.1) \quad (8.4) \\
 &+ .012(NS_w/NS_n)^* + .371T^* + .075E^* \\
 &\quad (2.2) \quad (2.4) \quad (3.2) \\
 &- .010(S_w/S_n)^* + .026TM^* - .492M_n^* \\
 &\quad (-1.7) \quad (2.2) \quad (-8.97)
 \end{aligned}$$

$R^2 = .55$

TABLE E-1

MEANS AND STANDARD DEVIATIONS FOR VARIABLES  
IN THE INTEGRATED SCHOOL SAMPLE

	Mean	Standard Deviation
$V_w$	33.05	5.17
$V_n$	27.42	4.29
$V_w - V_n$	5.63	4.00
$G_w - G_n$	2.82	7.85
$(G_w - G_n) \cdot N$	34.65	330.08
$HS_w - HS_n$	0.82	11.05
$NS_w - NS_n$	0.45	15.46
T	24.58	1.40
E	11.62	4.28
$NT_w - NT_n$	-17.34	18.24
$S_w - S_n$	-7.29	13.41
M	11.47	7.87
TM	8.55	9.43
C	56.47	18.86

APPENDIX F

DISTRIBUTION OF SAMPLE SCHOOLS BY RACIAL COMPOSITION

TABLE F-1

DISTRIBUTION OF WHITE SCHOOLS BY PERCENTAGE OF  
SIXTH GRADERS WHO ARE NEGRO

	Per Cent Negro										
	None	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
No. of Schools	157	158	46	27	30	12	17	10	8	5	1
Per Cent	33	33	10	6	6	3	4	2	2	1	0

TABLE F-2

DISTRIBUTION OF BLACK SCHOOLS BY PERCENTAGE OF  
SIXTH GRADERS WHO ARE NEGRO

	Per Cent Negro										
	None	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
No. of Schools	0	22	39	24	30	12	21	17	21	35	21
Per Cent	0	9	16	10	12	5	9	7	9	14	9



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