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ABSTRACT

In this essay, possible mechanisms which may lead to discrimination in the allocation of inputs to public education are discussed. A model of market discrimination in the supply curve for public school teachers is explained and tested using data from the Boston Metropolitan Area. The consequences for the distribution of teacher inputs in the Boston area of the measured discrimination are then explored. School systems with more non-white students, other things being equal, in the Boston area appear to have greater expenditures per pupil. Although these same systems receive more of some of the measures of teacher quality, relative expenditures per student, for these communities, is much greater than relative measured input per student. State and Federal aid appear to go more to school systems with more non-whites, especially Federal aid. There is little evidence that aid programs are generally redistributive towards low-income groups. The results of the study raise the possibility that decentralized ghetto school systems may have to pay a very high price for teachers in a free market. (Author/JW)

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THE DISTRIBUTION OF PUBLIC SCHOOL TEACHERS BY RACE AND INCOME CLASS IN AN URBAN METROPOLITAN AREA

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SUMMARY

In this essay, possible mechanisms are discussed which may lead to discrimination in the allocation of inputs to public education. A model of market discrimination in the supply curve for public school teachers is explained and tested using data from the Boston Metropolitan Area. The consequences for the distribution of teacher inputs in the Boston Metropolitan Area of the measured discrimination are then explored.

Discrimination is defined to be a situation in which a shift of inputs from either blacks to whites, or from low-income communities to wealthy communities could lead to increased efficiency in the allocation of resources. Thus, inequalities in inputs resulting from increased self-taxation and spending of wealthier towns are not considered discrimination. Two kinds of discrimination are discussed: discrimination within a school system, which would result from less inputs being allocated by the system to schools with more blacks and/or poor, and discrimination between systems, which might result from different systems facing unequal prices for the same educational inputs.

Little evidence is available to confirm or to deny the possibility of within system discrimination. The hypothesis of between system discrimination is tested using data on public secondary and elementary school teachers in the Boston Metropolitan Area. Much evidence is found to substantiate the hypothesis that school systems with more non-white students, cet. par., must pay a higher price for the same standardized unit of teacher input. It is estimated that the measured discrimination coefficient raises the cost of public education in the city of Boston by between 5 and 10 percent. It is possible that the price differential may result from some characteristic unique to the central city, rather than blackness, although more detailed testing appears to support the racial interpretation.

The distribution of a standardized unit of teacher input is only important if the component characteristics which are used in computing the teacher quality index are themselves indicators of how well teachers can educate students. Results from previous studies of educational production functions indicate that the teacher characteristic measures used in this study are important, although other important measures are left out because of unavailability of data.

School systems with more non-white students, other things equal, in the Boston Metropolitan area, appear to have greater expenditures per pupil. Although these same systems receive more of some of the measures of teacher quality, relative expenditures per student, for these communities, is much greater than relative measured input per student. State and federal aid appear to go more to school systems with more non-whites, especially federal aid. There is little evidence that aid programs are generally redistributive towards low-income

groups.

The results of the study raise the possibility that decentralized ghetto school systems may have to pay a very high price for teachers in a free market. This implies that decentralization programs ought to be accompanied by compensatory state and/or federal aid to those communities which are likely to be faced with higher costs.

CHAPTER 1

INTRODUCTION: POSSIBLE METHODS OF DISCRIMINATION IN THE ALLOCATION OF RESOURCES TO PUBLIC EDUCATION

Equality of educational opportunity is an often stated and widely accepted goal of government policy. Nevertheless, recent government studies have shown that much inequality exists, both by race and income class.[1] Unfortunately, the definition of criteria for measuring equality, and how equality relates to equity, or fairness, is often unclear. Inequality does not necessarily imply the existence of discrimination. Indeed, the very notion of discrimination, particularly when considering the allocation of public resources, must be based on some clear concept of what is meant by fairness in the distribution of resources.

In this study, the author, using the most conservative criterion of fairness, will examine under what circumstances discrimination against blacks and low-income groups might exist in the provision of resources to public education. The distribution of educational resources within a political unit is compared to the distribution between independent political units. Theories concerning the sources of discrimination, and the effects of discrimination on the distribution of inputs, are then tested using samples of data on characteristics of teachers in public schools in the Boston Metropolitan Area and in the entire state of Massachusetts.

The outline of the succeeding chapters is as follows. In this chapter, some possible standards for equity are briefly discussed and the choice of criteria to be used is explained. A corresponding definition of discrimination is provided. Two alternative behavioral models which could lead to racial discrimination in the allocation of educational resources, one based on deliberate political discrimination and the other based on market behavior of individuals, are presented and their applicability is briefly discussed. Chapters 2 and 3 are concerned with evaluation of the market discrimination model. In chapter 2, the economic and statistical basis for an empirical test of the market discrimination model is presented. An explanation of a quality-supply function for teachers is set forth. Econometric problems in interpreting the results are analyzed, and the sample data upon which the study is based is described. In chapter 3, regression estimates of the quality-supply function are presented for three samples: public school teachers in the Boston Metropolitan Area, public school teachers in the state of Massachusetts, and graduates of Tufts University placed in the Boston Area schools in the years 1966-1969. Possible interpretations of the regression results are examined. In chapter 4, the distribution of teacher inputs by race and income class in the Boston Metropolitan Area and the state of Massachusetts is described. Chapter 5 reports tentative conclusions of the study and possible policy implications.

In formulating economic policy, the twin objectives of efficiency and equity are often in conflict. A familiar theorem in price theory tells us that, in the absence of public goods and externalities, pure competition leads to an efficient allocation of resources: efficient in the sense that it is impossible to improve the welfare of one individual without harming someone else.[2] Even with the knowledge that most markets in the real world can not be classified as purely competitive, economists believe that the competitive model represents a serviceable approximation of reality, in that it can be used to predict market behavior.[3] Further, it has been estimated that the loss of allocative efficiency due to market imperfections is small relative to the national product.[4] Thus, in most cases government intervention in the economy is not warranted as a device to improve efficiency.

On the other hand, few would claim that the distribution of income resulting from a market system is necessarily in accord with our ethical beliefs. Large differences in initial factor ownership between individuals can generate substantial inequality in the distribution of income even in the absence of monopolistic regulations and discrimination. It is widely believed that there is some role for government intervention to alter the distribution of income generated by the free market.[5]

In general, economists have concentrated more on the efficiency issue than the equity issue.[6] This is understandable, since the tools of economics are much better designed to handle the efficiency problem. Objective criteria, such as price being equal to marginal cost, or in the case of public investment, the discounted stream of marginal benefits, defined in market terms, being equal to the discounted stream of marginal costs, can be set up and policies evaluated on that basis, despite formidable difficulties in analysis. In the area of equity, there can be no such apparent objectivity. What kind of income distribution one thinks is "fair" is a matter of personal taste. Even if all were agreed on the proper shape of the income distribution, the question of how much efficiency should be sacrificed to reach that goal would be left unanswered.

Government intervention in the field of education can be justified on the grounds of both efficiency and equity. Many writers feel that the concept of externalities, or neighborhood effects, applies to the area of education.[7] The social benefits of educating an individual exceed the private benefits since most people would be willing to pay a positive price to promote the basic education of their fellow citizens. It is believed that an educated citizenry is vital to the functioning of a modern democracy with an advanced economy.[8]

It does not necessarily follow that the subsidies to elementary and secondary education implied by the externalities argument must take the form of government operation of public schools. Milton Friedman for one has advocated supplying government subsidies to parents of school age children in the form of education vouchers.[9] Whatever the merits of the Friedman plan may be, our present method of subsidizing education is mainly through the public schools. The equity, or distribution problem therefore follows, since whenever a good is provided free to the public and financed through general taxes some redistributional effects are inevitable. It can be argued that subsidizing education of low-income individuals is a good way to accomplish the redistribution desired by society. It corrects one of the major causes of inequality, differences in the ownership of productive resources: in this case, human capital.[10] On the other hand, all public allocation decisions are inefficient in that they provide a uniform level of consumption of the service within the given political unit. Therefore, they can't satisfy the differing demands of different individuals. In that sense, the Friedman plan is the most efficient possibility: a general subsidy is given for the externalities and individuals are then free to increase expenditures at the margin by choosing among alternate private and/or public schools. If the individual values additional units of education enough to pay an extra price, presumably he will do so and the market system will then respond to best satisfy consumer preferences. A decentralized system of public schools, with funds raised by each local community in accordance with its "taste" for education and with a general subsidy from the Federal and State governments to localities to pay for the external benefits which accrue to the entire nation comes very close in effect to the Friedman plan. Individuals can choose between a high-tax, good public education community and a community which provides less public education, but offers either lower taxes or a larger quantity of other public services.

Thus, there are a number of possible goals that government intervention in education can seek to meet, and the equity and efficiency objectives are often in conflict. Let us consider four possible concepts of distribution for elementary and secondary education, ranked from the most egalitarian to the most efficient.

i) The goal could be to equalize the <u>outputs</u> of education, where outputs might be defined as scores on nationwide achievement tests. Given the unequal distribution of ability among individuals, the goal is impossible to achieve as stated. So, one may advocate achievement of equality of output among groups. In this view, children from low-income families should be raised to the same level of educational performance as children from high-income families. This goal, of course, requires compensatory education: more dollars invested per capita in the education of the poor. Since income is to some extent correlated with intellectual ability,[11] and inheritance is a factor in the determination of ability,[12] students from low income backgrounds are likely to require more inputs to match students from high income backgrounds. Thus, apart from the desirability of the goal of equalizing output for different social classes, it is hard to consider it a realistic one in any society in which a free market generates considerable income inequality and in which attributes positively correlated with success in the market place are also positively correlated with academic performance.[13]

ii) The goal could be the more modest one of equalizing the inputs to education. Equality of inputs conforms to one notion of fairness. Everyone, it is believed, deserves an equal chance. Yet, it is almost as impractical to achieve as the goal of equalizing output. For any level of public expenditure on education, some individual may wish to purchase more education for his children, either with private schools or private tutors. Either such arrangements would have to be banned, or else educational inputs made to conform to the tastes of the wealthiest and most education-loving member of society--surely a wasteful and extravagant procedure. A more modest goal is equalizing public inputs to education for all individuals. Though the educational voucher plan might accomplish this, under present institutional arrangements it is a difficult goal to achieve. It means that either expenditures per pupil would have to equal the level of the wealthiest suburb, or that towns not be allowed to have separate public school systems. The former would result in a huge increase in the share of GNP going to public education, at the expense of other urgent priorities. The latter would mean reducing the benefits in terms of efficiency and in terms of the power of the individual to exert influence over his own school board. Groups of people who wish to spend more than the national average on education would no longer have the option of moving to a community with higher taxes and better schools.[14] Their only option would be to pay the cost of tuition to a private school in addition to their share of the cost of public schools.

iii) The goal could be to provide every student with a "decent" education. Some minimally acceptable level of input would be provided for everyone. This goal is analogous to the often stated goal of eliminating poverty.[15] Instead of, or in addition to a floor under minimum income, a floor could be provided under the minimum educational input, at some level above what is provided by the poorest of our school districts. The overall distribution, above the lower part, would not be greatly affected. The problem here is in defining what is a "minimally acceptable" level of education. Although this question could be answered in some sense by the political process, it is impossible for the author to claim an arbitrary amount of expenditure to be "inadequate," from the point of view of defining discrimination.

iv) The final possible goal would be to allocate educational resources in the most efficient manner possible without regard to distributional considerations. Assuming parents are fully aware of the private benefits of education, and can choose wisely among alternatives, the voucher system with the subsidy set to the "external" benefit would accomplish this objective, and decentralized school systems receiving state and federal grants-in-aid approximate it. Current institutions are a mix, consisting of some large, heterogeneous school systems (central cities, usually) and some small, relatively homogenous ones. Assume that current institutional arrangements involving the size of school districts are fixed. Then, one can at least speak unambiguously of a sub-optimization policy. Given institutional constraints, efficiency is maximized within a community if inputs are allocated so as to equalize the rate of return on additional inputs for all groups of students. Efficiency in the allocation of inputs between communities is maximized so long as there are no artificial barriers to flows of resources between communities.[16]

The disadvantage of goal iv) is that it almost completely ignores the valid goal of making some use of the educational system as a means towards the redistribution of income, or at least the promotion of equality of opportunity. It treats the distribution of benefits from education just as it treats the distribution of benefits from consuming any private good, such as automobiles. Criterion iv) is clearly inconsistent with stated national policy objectives.

For the definition of discrimination in the chapters that follow, a modified version of criterion iv) will be used as a standard. The boundaries of current school systems will be assumed to be fixed. Within that constraint, any policy, public or private, which causes a departure from an efficient allocation of resources, and in addition involves a redistribution against either low income groups, or against blacks vis-a-vis whites of equal income will be defined as discrimination. Thus, discrimination within a system will be defined as a distribution of inputs which results in a higher marginal gain in educational output for dollars spent on blacks than on whites, and a higher marginal return for investing in poor students than in rich students. Discrimination between school systems will be defined as anything which makes the ability to obtain the same inputs more difficult or more expensive for school systems with more low income people and more blacks. It should be stressed that the criterion used here is a very conservative one. Anti-egalitarian measures are only considered discrimination if they also involve a loss of economic efficiency. No doubt some investigators may prefer to use a looser definition of discrimination.[17]

The above definitions imply the existence of two possible behavioral models of discrimination in education. The first might be labelled a political-model of discrimination, the second a free-market model. Most of the remainder of this paper will be devoted to discussion of tests performed on the free-market model, with the political model mentioned only in passing. Below, a brief discussion and comparison of the two models is presented.

In the political model, it is assumed that both blacks and whites reside within the same fiscal decision-making unit, though black and white children attend separate schools. Whites, being the dominant political and economic majority, have more influence than the blacks in determining the pattern of school inputs. Subject to some legal, moral and social restraints, they allocate resources in such a fashion as to give less educational inputs to black students than would be dictated by conditions of efficiency.

Considering the amount of discussion of the problem of educational opportunity, and the well-publicized diagnosis of white racism as the cause for social problems,[18] it is surprising that so little has been done to test the hypothesis of deliberate political discrimination. The Coleman Report has shown that many school inputs are distributed unequally, to the advantage of whites, especially in the South.[19] But the sample from which these inferences are made includes schools both within and outside of central cities. Thus it is impossible to conclude that the input differences reflect discrimination, and not increased self-taxation and spending by white communities. There are three possible ways in which the discrimination as implied by the political model can occur.

i) State aid funds can be awarded disproportionately to school districts with more whites.

ii) Cities can spend more per pupil in white schools than in black schools. Assuming the production functions for both white and black education are the same, unequal inputs conform to our definition of discrimination.[20]

iii) Through tracking, whites within a school may receive more educational inputs than blacks.

Evidence of i) has been indicated by the Kerner Report where it is pointed out that in twelve metropolitan areas studied by the Civil Rights Commission, suburban schools received more state aid per pupil than city schools in seven of the areas.[21] Since in many states, state aid is proportional to a measure of tax effort,[22] and tax effort of suburban communities may be higher, the Kerner finding does not necessarily imply discrimination.

Evidence of ii) is provided by Patricia Sexton in a study of Detroit schools and in a reference to Chicago schools in a later article.[23] Also, Katzman's study of Boston elementary schools shows a positive regression coefficient of expenditures per pupil on percent pupils white, but the coefficient is not statistically significant ($t=1.19$). Katzman does show a significant relationship between expenditures per pupil and voting-participation rate in the school district.[24]

Evidence of iii) has been noted in many educational studies.[25]

In conclusion, little work has been done to date to test the hypothesis of deliberate political discrimination and that evidence which bears on the question does not provide strong reason to either accept or reject the hypothesis.[26]

The free-market model is the one which will be tested in the remainder of this essay. It is based on the economic theory of discrimination developed by Becker.[27] In Becker's theory, discrimination is treated as a taste coefficient which represents the price the majority group (whites) is willing to pay to avoid contact in economic exchanges with the minority group (blacks). Individuals maximize a utility function which includes their "taste" for discrimination as an argument along with money income. Becker then sets up an international trade model in which output is a function of capital and labor in each sector, the black sector is relatively labor-intensive and the white sector is relatively capital-intensive, and trade consists of blacks exporting labor to (or importing capital from) the white sector. Becker treats discrimination as analogous to trade barriers, and shows that both white and black income will be reduced by the existence of tastes for discrimination in a competitive economy. (However, since whites are both a numerical majority and an economic majority, it is shown that the loss to the white community from discrimination is very small compared to the loss to the black community). He then shows how the extent of market discrimination depends on the magnitude and distribution of individual tastes for discrimination, the degree of competition and the relative number of blacks. The theory may be used to explain employment discrimination (blacks receiving lower wages for work requiring the same effort and skill), housing discrimination (blacks paying higher rent for the same quality housing), consumption discrimination (blacks paying a higher price for the same grocery store goods), and other types of discrimination that occur in the market place.

It is crucial to note that by "taste for discrimination," Becker does not necessarily mean the cruder forms of race hatred. If an individual prefers to have economic dealings with members of his own ethnic group because he loves them, rather than because he hates others, the market effects are exactly the same. In Becker's words,

> The social and economic implications of positive prejudice or nepotism are very similar to those of negative prejudice or discrimination.[28]

The key element in the theory is that the market behavior of individual whites, <u>whatever the motive may be</u>, will lead to a situation in which blacks face a lower demand price for the things they wish to sell, and a higher supply price for the things they wish to buy. Further, prejudice of individuals in economic behavior is only important if it is widespread enough to result in effective market discrimination.

Becker's conclusions are not strictly correct, since subsequent work has shown that whites can gain from market discrimination in much the same manner that a nation can increase its income through an optimum tariff policy.[29] Assuming that the white sector is relatively capital-intensive, restriction of capital flows to black areas will, up to a point, increase white income. White income is maximized at a point where the rate of return on capital is higher when combined with black labor.[30] It does not follow that whites collectively will restrict "capital flows" to black areas, i.e. discriminate in the employment of blacks. The individual employers themselves have no purely monetary incentive to practice discrimination. Nonetheless, if white employers in fact practice discrimination for other reasons, white society as a whole can realize a pecuniary gain, even though capitalists must lose both individually and collectively.

The free-market model of discrimination in educational inputs is a very simple extension of the Becker model applied to the supply of public school teachers. Consider the good being produced to be educated students. The inputs to production are uneducated students (i.e., labor) and teachers (i.e., capital). Since the black sector is relatively labor-intensive, it must import white capital (teachers). But white teachers demand a higher monetary return to teach in the black sector. In other words, black communities must pay a higher price for the same quality of teacher input. It is clear, then, that white students gain at the expense of black students from this form of discrimination. Whether whites as a whole gain is not clear from the model,[31] but it is certain that the black sector, a numerical and economic majority, will lose.

The reader should be warned that the statistical tests in the succeeding chapters are not tests of whether or not public school teachers are prejudiced against blacks. No statistical analysis of patterns of market behavior can serve as a measure of the psychological and emotional feelings of people. What is sought here is a test of whether school systems with more blacks, all other things equal, or with more of the very poor, all other things equal, must pay a higher price for an equivalently qualified teacher than school systems with white, middle-class students. The test is whether or not effective market discrimination exists.

Real world institutions permit the possibility of both political and free-market discrimination existing simultaneously. School systems with a high proportion of black students, while discriminating internally, may still have to pay a higher price for teachers than neighboring all-white systems.

In the succeeding chapters, a model to test for free-market discrimination is explained and tested.

CHAPTER 2

THE SUPPLY OF TEACHERS IN THE BOSTON METROPOLITAN AREA: THE SAMPLE AND ESTIMATION PROBLEMS

In this chapter, the econometric model used to test the hypothesis of free market discrimination is explained. The hypothesis states that school systems with specified social and economic characteristics, such as a high proportion of non-white students or a high percentage of students from low income families, will have to pay a higher price to obtain the same quality teacher. The method of selecting an index of quality, and the probable nature of the bias resulting from that measure is discussed, along with an explanation of the meaning of a quality-supply function. A description is provided of data used, and the methods of variable construction, and some discussion is included of the important statistical problems encountered in estimating the model.

A single-equation model is used to estimate a supply function for teachers from data on mean salaries of teachers and mean characteristics of teachers in different school systems. In the samples used, each town or city has a separate school system which it finances independently, excluding aid from state and federal subsidies. Data on socioeconomic variables are available for every town. Mean salary paid to teachers in a school system is regressed on 1) a set of characteristics of teachers in that system, and 2) a set of socioeconomic variables for the corresponding city or town which are presumed to affect the desirability of that community to teachers.

$$P = F(Q, S, \mu) \qquad (2.1)$$

where:

P = mean teacher salary for the school system
Q = a vector of average teacher characteristics in the school system
S = a vector of student characteristics in the school system and socioeconomic characteristics in the corresponding town
μ = a random disturbance term

Equation (2.1) can be considered a "quality-supply" equation for teachers. The interpretation of (2.1) as a quality-supply equation is explained below.

The determination of price and quantity exchanged in any market results from the simultaneous interaction of demand and supply. Thus, observed changes in quantity and price over time, or observed differences in quantity and price over space, may result from either a shift in the desired demand at any price, a shift in the desired supply at any price or a combination of the two. In any attempt to estimate a demand (or supply) relationship it must be assumed that the relationship being measured is the more stable of the two; if the demand (supply) relationship has more random shifts, then the equation estimated is identified as a supply (demand) relationship.[1]

Equation (2.1) is not a supply schedule in the usual sense. It is not an estimate of the additional quantity of teachers that would be supplied at a higher market price. In this model, the quantity-supply schedule is assumed to be horizontal. Each school system is assumed to be able to purchase as many teachers as it wishes at the prevailing market price. The assumption of a horizontal supply schedule is equivalent to the assumption that school systems are purchasing teachers in a purely competitive market. No one system is a large enough buyer to be able to affect the market price. The school system purchasing teachers is in an analogous position to an individual consumer of a privately-supplied good for which there are many buyers. Each buyer is a price-taker, although the sum of the effects of the actions of all buyers does affect the market price.

Each school system is then faced with a set price for a given quality-level of teacher. At that price, it can hire as many teachers as it wants of the specified quality. The price differs for each school system. School systems with "less desirable" characteristics will face a higher supply price; they will have to pay more for the same quality teacher.

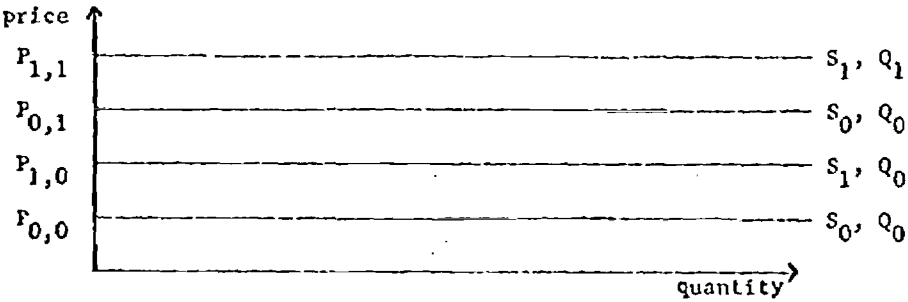

Figure 2.1

Quality-Supply Schedules

In Figure 2.1

$P_{1,1}$ = the price that system 1 has to pay for quality q_1.

$P_{0,1}$ = the price that system 0 has to pay for quality q_1.

$P_{1,0}$ = the price that system 1 has to pay for quality q_0.

$P_{0,0}$ = the price that system 0 has to pay for quality q_0.

Figure 2.1 shows that system 1 is less attractive to teachers than system.0. The mean price paid varies directly with the level of teacher quality and inversely with the desirability to suppliers of the school system.

An increase in the quantity of teachers demanded, given no change in the average quality level, will have no effect on the market price, in any system.

How valid is the horizontal-supply assumption? In the sample used, the Boston Metropolitan Area, there are 78 separate school systems, of which 65 are included in the sample under study. If each system were of equal size, it would contribute only 1/78 (approximately) to market demand and thus, for all practical purposes, it would appear reasonable to treat the supply curve facing it as horizontal. Two factors tend to weaken the plausibility of the horizontal-supply assumption. First, the city of Boston employs over 20 percent of the public school teachers in the Boston SMSA, and thus may have some monopoly power. Boston may have some effect on the market price by the quantity it chooses to hire. Second, teachers having characteristics which might be defined as reflecting superior qualities may be in fact so scarce that even a small increase in demand raises their market price. Figure 2.2 depicts two school systems with identical socioeconomic characteristics, employing the same average quality of teacher. The teacher quality is assumed to be scarce, and the only difference between the school systems is that system 2 desires to hire a greater quantity of teachers than system 1 for any given price.

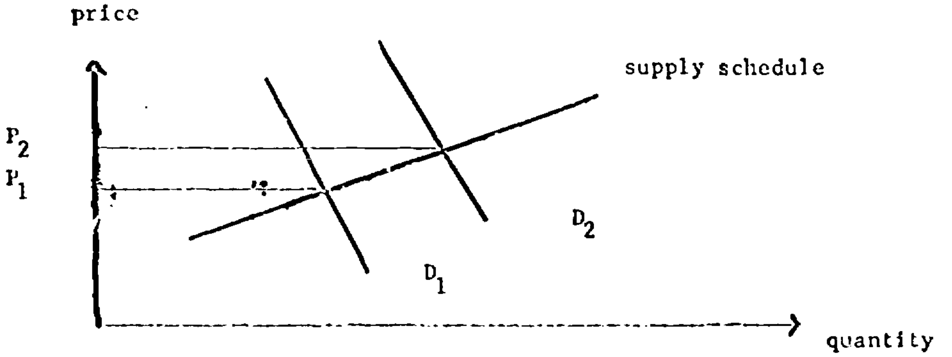

Figure 2.2

Quality-Supply Model With Rising Supply Schedule

P_1, P_2 represent market price in systems 1 and 2, respectively.

D_1, D_2 represent demand functions for teachers of systems 1 and 2.

Figure 2.2 shows that if the supply schedule for a given quality is not horizontal, price differentials between systems will reflect differences in demand. Therefore, the estimates of the quality-supply relationship will be biased. The question of bias in the estimation of equation (2.1) is explained more thoroughly below.

Equation (2.1) is meant to depict a long-run equilibrium in the market. The price data is the mean salary for all teachers in the system and the data on characteristics from which the quality index is constructed are data on the entire stock of teachers at a given point in time. Thus, the teacher characteristics data is affected by decisions by prospective teachers over a long period of time. It is not denied that the short-run supply facing any system may not be perfectly elastic; it may have to raise its salary to hire a greater number of equivalently qualified teachers <u>this year</u>. It has been noted elsewhere that all firms probably have some dynamic monopsony power in the short-run.[2] What is argued here is that in the long-run the supply schedules are likely to be very elastic. The longer the time period under consideration the less "scarce" the qualities become, as more individuals either 1) enter the teaching profession or 2) acquire more education to meet the requirements of those systems attempting to hire teachers with "scarce" qualifications.

In conclusion, equation (2.1) is to be interpreted as an estimate of shifts in the long-run supply schedule facing different school systems. The shifts result from 1) differences in mean characteristics of the teachers employed in each school system and 2) differences in characteristics of the school systems which affect their ability to attract teachers.

The major problem in the practical application of the free-market model is the definition of a suitable quality index. It would be hard to find widespread agreement on exactly what is meant by the "quality" of a teacher. There are so many attributes that the schools attempt to impart to students; they include not only measurable things such as verbal and mathematical facility and development of specific skills and knowledge, but also unmeasurable characteristics which relate to an individual's ability to be a "good citizen" and to conform to whatever social standards the authorities are seeking to impart. Even if all of the outputs of the schools were measurable, constructing a set of weights for relative importance would be impossible.

The procedure used in this essay is to define "quality" by means of a hedonic index. The hedonic index is a weighted average of measured teacher characteristics, where the weights are the regression coefficients in the regression of price on teacher characteristics (equation (2.1)). For example, suppose that an additional year's experience contributes on the average, $100.00 to a teacher's market price, while an additional year of college completed contributes an extra $500.00. Then, if a new teacher replacing a retiring teacher has one more year of education and five less years of experience, he has the same measured quality. The weights in the hedonic quality index are determined, in effect, by the school systems themselves and how much they are willing to pay for specified teacher characteristics.[3]

It should be noted by the reader that the question of which characteristics of teachers constitute quality, while in itself an important and interesting issue, is not the primary subject of the essay. Many previous studies have attempted to relate teacher characteristics to objective measures of student performance.[4] Some work even suggests that school systems themselves are not only unaware of the relation of teacher inputs to teacher outputs, but greatly misallocate resources by choosing the wrong teacher characteristics.[5] It cannot be stressed too strongly that the quality index used here should not be construed, even in intent, to be a measure of any kind of intrinsic quality. Let the reader understand that the word "quality," as used throughout the remainder of this study, means nothing more than those attributes which contribute to a teacher's marketability: those attributes which, on the average, administrators appear to prefer.

There are two ways, then, in which a teacher characteristic may be positively related to mean teacher salary in the regression analysis.

1) Fixed teacher salary schedules may be an explicit function of that characteristic. In Massachusetts, all towns' salary schedules are a function of teachers' experience, and most a function of the teachers' level of education.[6]

2) Given their salary schedules, administrators will try to recruit the best teachers possible. Those that pay more will be able, <u>cet. par.</u>, to attract better teachers. Thus, other characteristics, not reflected in stated salary schedules, may be positively correlated with price.

Ordinary least squares estimates are best linear unbiased only if i) the disturbances are uncorrelated with the independent variable ($Q\mu = 0$, $S\mu = 0$, and ii) the disturbances are fixed and uncorrelated with each other ($\mu_i\mu_j = 0$, $i \neq j$, $\mu_i\mu_j = \sigma^2$ for $u = j$).[7] Although these assumptions are hardly ever strictly true in econometric work, it is often possible to treat them as such, for all practical purposes. Below is an explanation of why the possible bias and inefficiency resulting from mis-specification cannot be ignored in interpreting results from the estimation of equation (2.1).

i) Bias

The disturbance term includes all left-out variables, i.e. those variables which would add explanatory power to the regression, but for which data is unavailable. If there is a significant correlation between the left-out variables and included variables, the resulting bias can be serious.[8] The formula for the bias can be written:

$$E(b_i) = B_i + p_{iq}B_q \tag{2.2}$$

where:

b_i = estimated value of the i^{th} coefficient

B_i = "true" value of the i^{th} coefficient

B_q = "true" value of the coefficient of the left-out variable

p_{iq} = coefficient of the i^{th} variable obtained from an "auxiliary" regression of the left-out variable on all the independent variables.

The most important "left-out" variable is some adequate measure of teacher quality. For given experience and education level, there is surely a great variance in the quality of teachers available. The regression results in chapter 3 indicate that percent of teachers graduated from colleges outside Massachusetts (STGOS) has a significant positive relationship with salary. This may perhaps be explained by the possibility that the better school systems recruit nationwide, and are well known to prospective teachers from outside the Boston area.[9] Then, STGOS, becomes a proxy for some, but only a fraction, of left-out quality. In Levin's analysis of the Coleman data, in which individual teachers' salaries for a whole metropolitan area were regressed on a set of teacher characteristics, it was found that teachers' verbal scores on a standardized test had a significant, positive relationship with salary.[10] Levin's regression included terms for experience and level of teacher education. Unfortunately, the Coleman Survey did not include the boston Metropolitan Area, so that it was impossible for the author to obtain any measure of teacher verbal ability by school system. The absence of a measure of teacher verbal ability, among other left-out attributes, makes it highly probable, therefore, that $B_q > 0$, where B_q is the coefficient of the left-out variable: unmeasured teacher quality.

One can only then infer the probable bias of each of the other coefficients on the basis of presumed signs of the p_{iq}'s. In a sample of teachers graduated from Tufts University, also tested in chapter 3, some additional dimensions of "quality" which were absent from the sample of school systems in the Boston SMSA and the State of Massachusetts were present. These extra quality dimensions were used to estimate "auxiliary" regressions: i.e., to try to measure the p_{iq}'s. The signs of the p_{iq} terms in these regressions tend to be as expected, and help strengthen the presumptions about the probable direction of the bias which are made below.

Two coefficients for which the bias was a matter of concern were the coefficients attached to median income and to percent students non-white. In the case of median income, the coefficient is consistently positive and statistically significant. On the surface this would indicate that wealthy communities must pay more for an equivalently qualified teacher; a highly unlikely situation. If S_i = median income, then b_i is clearly biased upwards, since we can presume that $p_{iq} > 0$. In effect, median income becomes in part a proxy for the left-out measure of teacher quality.

An alternative explanation of the positive sign of the median income coefficient would be the existence of simultaneous equations bias. One should expect a positive correlation between price per teacher and median income of a community, if the price is considered the demand price. In this case, again, the supply function estimate would be biased because the independent variable is correlated with the residual. This is exactly the same mathematical condition as the condition for a specification error due to a left-out variable. But the "left-out" variable is the real problem. If all the teacher quality variables were included, then "demand" is on both sides of the equation, and the partial relation between price and income can only be interpreted as a "quality-supply" relationship.

If the assumption of a horizontal supply schedule facing each school system is incorrect, then there will be a simultaneous equations bias in the estimate of the income term. Then, observed price would tend to vary directly with quantity demanded even if all the relevant teacher quality variables are included. If the demand schedule shifts to the right, it will intersect a rising supply curve at a higher price. Since income is likely to be positively correlated with demand, the demand relationship will make it positively correlated with price.

The bias in estimating percent students non-white is of concern because the existence of a "discrimination coefficient" is the main hypothesis being tested. If S_j = percent students non-white, then b_j is not likely to be biased downwards, since it is unlikely that p_{jq}, the partial coefficient in a regression of left-out quality on percent students non-white is positive. If anything, the bias in the estimation procedure resulting from left-out teacher quality variables leads to an underestimate of the size of the discrimination coefficient. It also, by the same reasoning, underestimates the coefficient attached to measures of poverty and social disintegration.

ii)

There is a large variance in the size of our observations. Each observation is an average of the characteristics of different numbers of individuals. Therefore, if the variance of the error term is the same for each individual teacher, the assumption of a constant variance of the error for each observation may be incorrect. To correct for the possibility of heteroscedasticity,[11] weighted least-squares estimates, which assume the variance of the error is proportional to 1/N (where N is the population of the town) are presented for all regressions, along with the simple least-squares estimates.[12]

A further problem in interpretation of the results is caused by the existence of multicollinearity in the sample. In the discussion below of the nature of the sample and the construction of the variables that were tested, the problem of multicollinearity is fully explored.

Three sets of regressions are performed in chapter 3 on different samples. The first sample consists of 66 of the 78 school systems in the Boston Metropolitan Area. The 12 systems removed from the sample were those which do not have separate secondary schools. The second sample consists of 137 school systems, spread across the entire state of Massachusetts. The 137 school systems chosen, out of 351 in the state, were those for which i) a sufficient amount of data was available, and ii) separate secondary school systems exist. The data for both samples consists of statistics on average characteristics of teachers and mean salary paid, which was supplied to the author by the Massachusetts State Department of Education Research Center, and statistics on population, income and socioeconomic variables published by the Massachusetts Department of Commerce and Development,[13] the Massachusetts Department of Welfare,[14] and the Boston Safe Deposit Company.[15] Data on SAT scores was supplied by Arthur J. Corazzini, from a survey of students in the Boston SMSA.[16] The third sample consists of a set of individual teachers, who were placed at schools in the Boston Metropolitan area in the years 1967-1969 by the Tufts University Department of Education. Most, but not all of these teachers are graduates of Tufts University or Jackson College. The additional data required for the Tufts sample was supplied by the Tufts Department of Education and the Tufts University Records Office.

Each town or city in Massachusetts coincides with a separate school system. The study only examines the allocation of teachers among school systems; the important question of allocation to schools within a system is ignored in estimating equation (2.1). The advantage of this procedure is that the interpretation is clearly a market interpretation. Within a system, the allocation of teachers results from some unknown combination of teacher preference and administrative fiat. Thus, it would be improper to interpret regression results on observations of individual schools within the same system to be a "quality-supply" schedule.

The Boston area has some characteristics which make it particularly suitable as a sample for this investigation. First, as mentioned above, the towns and cities in the area each correspond to a separate school system. Thus, it is possible to match teacher characteristics data collected from the school systems with socioeconomic variables gathered from census data. Second the city of Boston itself constitutes a relatively small fraction of the total metropolitan area. In 1965, the population of Boston itself was 616,326; the population of the Boston SMSA was 2,605,452. Many of the separate towns and cities surrounding Boston are themselves densely populated urban areas, which are much more similar sociologically to Boston than to the farther-out suburbs.[17] Thus, it is possible to look at a choice between different "cities" which are located close enough together to constitute one market area. Third, the 66 towns and cities under study vary greatly in their social and economic characteristics and in the amount of resources devoted to public education.[18] Fourth, the sample size is certainly adequately large for statistical inference purposes. Finally, examination of the data reveals less multicollinearity among the socioeconomic variables than one might fear. Although the simple correlation coefficients between most pairs of variables have the expected sign, they are in most cases sufficiently small to make it possible to separate the contribution of one variable from another. (A table of correlations between independent variables is printed below.) In particular, the existence of very poor communities with a small proportion of blacks, makes it possible to have some indication of the separate effects of race and poverty on the supply schedule.

One deficiency of the sample is that relatively few towns have any sizeable fraction of blacks in the population. For that reason, the existence of a positive discrimination coefficient may reflect characteristics specific to several towns (e.g. Boston and Cambridge) which are not measured by other socioeconomic indicators used. A dummy variable for central city was used in the regression, but this proved to be highly correlated with percent students non-white in the public schools, and so separate estimates of the effect of "central city" and race were impossible to obtain. To correct for the problem, the statewide sample was used for the same regressions. The statewide sample includes other metropolitan areas which have a fairly sizeable black population (e.g. Springfield - Chicopee - Holyoke SMSA, New Bedford SMSA) plus other metropolitan areas which have practically no blacks (e.g. Lawrence - Lowell, Pittsfield, Worcester and others).

Table 2.1 lists the teacher characteristic variables used in estimation of the Boston SMSA and Massachusetts samples.

Table 2.2 lists the socioeconomic variables used as characteristics of the school systems and towns.

The problem of multicollinearity in the sample can be separated into two sub-problems.

First, high correlation between a pair of independent variables will make it impossible to determine which one belongs in the final regression. In the results printed in chapter 3, variables included are those which make the maximum addition to the explanatory power of the regression. Only variables whose coefficients are statistically significant are included. This procedure does not always give the right results. For example, suppose two variables X_1 and X_2 are highly correlated with each other and each one individually adds to the explanatory power of the regression. The standard errors of the estimates of the coefficients of X_1 and X_2 will be very large if both are included in the regression together. If X_1 adds more to the regression than X_2. after including all other variables, it does not

Table 2.1

Teacher Characteristic Variables

Variable Name	Variable Description	Source
STSAL	mean salary, secondary teachers (1968-69)	1
STYPS	mean years in public school, secondary teachers (1968-69)	1
STED	mean value of code for highest level of educational attainment, secondary teachers* (1968-69)	1
STMALE	percent teachers male, secondary teachers (1968-69)	1
STCOS	percent teachers with college degrees from outside Massachusetts, secondary teachers (1968-69)	1
STCERT**	percent teachers certified, secondary teachers (1968-69)	1
ETSAL	mean salary, elementary teachers (1968-69)	1
ETYPS	mean years in public school, elementary teachers (1968-69)	1
ETED	mean value of code for highest level of educational attainment, elementary teachers (1968-69)*	1

Table 2.1 (cont'd)

Variable Name	Variable Description	Source
ETMALE	percent teachers male, elementary teachers (1968-69)	1
ETGOS	percent teachers with college degrees from outside Massachusetts, elementary teachers (1968-69)	1
ETCERT	percent teachers certified, elementary teachers (1968-69)	1

*The highest level of educational attainment code has been developed from the following scale:

1 = High School Diploma
2 = Freshman Year of College
3 = Sophomore Year of College
4 = Associate Degree
5 = Two year School Graduate
6 = Junior Year of College
7 = Three Year School Graduate
8 = Completed Senior Year of College (No Degree)
9 = Bachelor's Degree Earned
10 = Bachelor's Degree Plus 30 Hours or More
11 = Master's Degree Earned
12 = Master's Degree Plus 30 Hours or More
13 = Other Secondary Level Degree or Advanced Certificate
14 = Doctor's Degree Earned

**Available only for SMSA sample.

Sources

1 = Massachusetts State Department of Education Research Center, Teacher Profile Data.

Table 2.2

Socioeconomic Variables

Variable Name	Variable Description	Source
POP	population (1965) of town	2
ASNW*	percent students non-white in public schools (1968-69)	1
POVTY**	percent of families with income under $3,000 (1960)	2
PROFTK	percent of employed population classified as professional, technical and kindred (1960)	2
ADPC	aid to parents of dependent children per capita (1968)	3
POPFOR	percent of population of foreign stock (1960)	2
IRITAL	(percent of population of foreign stock (1960)) x (percent of foreign stock of Irish or Italian origin (1960)) = percent of population of Irish or Italian origin	2
RUSS**	percent of population of Russian origin = (percent of foreign stock of Russian origin (1960)) x (percent of population of foreign stock (1960))	2
DISBOS**	distance of center of town from center of Boston	2
MEDINC	median family income (1960)	2
VALPRP	value of taxable property per capita (1968). It is equal to $\frac{V/R}{N}$ where V = assessed value of taxable property (1968) R = estimated assessment ratio (1968) N = population (1965)	4

Table 2.2 (cont'd)

Variable Name	Variable Description	Source
POPDEN	population density per square mile (1965)	2
CITY	dummy variable for central city; 1 if classified by U. S. Census as central city of an SMSA; 0 if otherwise	2
BOSTON***	dummy variable for city of Boston; 1 if Boston; 0 otherwise	
SMSA	dummy variable for Boston SMSA; 1 if town in Boston SMSA; 0 otherwise	
POPNW*	percent of population non-white (1960)	2
POPGRO	long-run growth of population $= \frac{\text{population (1960)}}{\text{population (1930)}} \times 100$	2
SSTRAT	secondary student-teacher ratio	1
ESTRAT	elementary student-teacher ratio	1
SPSS	students per secondary school	1
SSVSAT	mean verbal score - SAT	5
SSMSAT	mean mathematical score - SAT	5

*POPNW and ASNW include only black students. Puerto Ricans, Orientals, Mexican-Americans, etc. are not classified as non-white.

Table 2.2 (cont'd)

**Used in SMSA sample only.

***Used in statewide sample only.

<u>Sources</u>

1 = Massachusetts State Dept. of Education, "Teacher Profiles," unpublished.

2 = Massachusetts State Dept. of Commerce and Development, <u>Town Monographs</u>.

3 = Massachusetts Dept. of Welfare, <u>Aid to Families with Dependent Children in Massachusetts</u>, 1968.

4 = Boston Safe Deposit Co., <u>Financial Statistics of Massachusetts</u> (Boston, 1968).

5 = Corazzini, <u>op</u>. <u>cit</u>.

necessarily imply that changes in X_1, rather than changes in X_2 cause changes in the dependent variable. It may in fact be true, because of random errors and measurement errors, that X_2 is the cause of changes in the dependent variable and that X_1 enters the regression (without X_2) only because it is correlated with X_2.

The variables tested for the Massachusetts and the SMSA samples may be divided into three subsets: teacher characteristics, characteristics which serve as a measure of the level of income and/or wealth, and characteristics associated with racial composition of the population and measures of poverty and social disintegration. Within each subset, there is considerable multicollinearity; between the subsets little multicollinearity. There is some overlap in classification. Some variables can be placed in both of the two latter categories. Tables 2.3-2.5 show correlation matrices within each of the three categories for the Boston SMSA.

Tables 2.6-2.8 show correlation matrices for each of the three categories for the state of Massachusetts.

The tables can be summarized as follows:

i) There is no serious multicollinearity between pairs of variables for the teacher variables in either the SMSA sample or the statewide sample.

ii) Among the income-wealth variables, persons employed classified as professional, technical and kindred, median family income, and estimated value of taxable property per capita are all highly intercorrelated for both the SMSA and the statewide sample. Following the argument on probable bias of the estimates presented earlier in the chapter, each of the above variables can serve as a proxy for left-out teacher quality.

iii) In the SMSA sample, the variables POPNW, CITY, and ASNW are almost perfectly correlated with each other. Each can serve as a measure of "blackness"; it is impossible in the SMSA sample to distinguish between the non-white variable and the central city variable. ASNW is probably a superior measure to POPNW of "blackness" for two reasons. First, ASNW was measured in the year 1968-69, the same year for which the teacher characteristics data is available, while POPNW was measured by the 1960 census. To the extent that migration changed the pattern of non-white residency in the intervening nine years, ASNW is a more accurate measure of the distribution of blacks. Second, ASNW is a measure of proportion of blacks in the public schools, while POPNW is a measure of proportion of blacks in the population. Presumably, if anything the blacks in public schools would be a more relevant determinant of teacher choice among school systems than blacks in the communities. The two figures are different in part because of the existence of the METCO program, through which some black students residing in the central city attend public schools in those (mostly white) suburbs which participate in the program.[19]

Table 2.3

Correlation Matrices of Teacher Variables: SMSA Sample

1. Secondary Teachers

	STYPS	STED	STMALE	STGOS	STCERT
STYPS	1.00	0.36	0.06	0.02	0.02
STED	0.36	1.00	-0.05	0.35	-0.06
STMALE	0.06	-0.05	1.00	-0.26	0.08
STGOS	0.02	0.35	-0.26	1.00	-0.08
STCERT	0.02	-0.06	0.08	-0.08	1.00

2. Elementary Teachers

	ETYPS	ETED	ETMALE	ETGOS	ETCERT
ETYPS	1.00	-0.16	0.10	-0.34	-0.04
ETED	-0.16	1.00	0.02	0.44	-0.43
ETMALE	0.10	0.02	1.00	-0.25	-0.18
ETGOS	-0.34	0.44	-0.26	1.00	-0.34
ETCERT	-0.04	-0.43	-0.18	-0.34	1.00

Table 2.4

Correlation Matrix of Income-Wealth Variables

SMSA Sample

	POVTY	PROFTK	ADPC	MEDINC	VALPRP
POVTY	1.00	-0.51	0.66	-0.60	-0.41
PROFTK	-0.51	1.00	-0.53	0.76	0.69
ADPC	0.66	-0.53	1.00	-0.53	-0.56
MEDINC	-0.60	0.76	-0.53	1.00	0.66
VALPRP	-0.41	0.69	-0.56	0.66	1.00

Table 2.5

Correlation Matrix of Race-Poverty Variables

SMSA Sample

	ASNW	POVTY	ADPC	POPFOR	IRITAL	POMNW	POPDEN	CITY
ASNW	1.00	0.44	0.73	0.29	0.19	0.93	0.45	0.83
POVTY	0.44	1.00	0.66	0.33	0.23	0.48	0.51	0.30
ADPC	0.73	0.66	1.00	0.37	0.37	0.74	0.66	0.66
POPFOR	0.29	0.33	0.37	1.00	0.71	0.18	0.71	0.15
IRITAL	0.19	0.23	0.37	0.71	1.00	0.23	0.64	0.19
POMNW	0.93	0.48	0.74	0.18	0.23	1.00	0.41	0.80
POPDEN	0.45	0.51	0.66	0.71	0.64	0.41	1.00	0.28
CITY	0.83	0.30	0.66	0.15	0.19	0.80	0.28	1.00

Table 2.6

Correlation Matrices of Teacher Variables

Statewide Sample

1. Secondary Teachers

	STYPS	STED	STMALE	STGOS
STYPS	1.00	0.24	-0.07	-0.04
STED	0.24	1.00	-0.25	0.08
STMALE	-0.07	-0.25	1.00	-0.05
STGOS	-0.04	0.08	-0.05	1.00

2. Elementary Teachers

	ETYPS	ETED	ETMALE	ETGOS	ETCERT
ETYPS	1.00	-0.20	0.00	-0.32	0.00
ETED	-0.20	1.00	-0.09	0.30	-0.04
ETMALE	0.00	-0.09	1.00	-0.16	-0.04
ETGOS	-0.32	0.30	-0.16	1.00	-0.03
ETCERT	0.00	-0.03	-0.04	-0.03	1.00

Table 2.7

Correlation Matrix of Income-Wealth Variables

Statewide Sample

	PROFTK	ADPC	MEDINC	VALPRP
PROFTK	1.00	-0.39	0.80	0.08
ADPC	-0.39	1.00	-0.47	0.59
MEDINC	0.80	-0.47	1.00	0.04
VALPRP	0.08	0.59	0.04	1.00

Table 2.8

Correlation Matrix of Race-Poverty Variables

Statewide Sample

	ASNW	BOSTON	ADPC	POPFOR	IRITAL	POPDEN	POPNW	CITY
ASNW	1.00	0.62	0.63	0.16	0.09	0.37	0.92	0.42
BOSTON	0.62	1.00	0.51	0.10	0.16	0.28	0.55	0.26
ADPC	0.63	0.51	1.00	0.36	0.19	0.54	0.57	0.52
POPFOR	0.16	0.10	-0.34	1.00	0.42	0.54	0.02	0.31
IRITAL	0.09	0.16	0.19	0.42	1.00	0.55	0.09	0.06
POPDEN	0.37	0.28	0.54	0.54	0.55	1.00	0.29	0.19
POPNW	0.92	0.55	0.57	0.02	0.09	0.29	1.00	0.34
CITY	0.42	0.26	0.52	0.31	0.06	0.19	0.34	1.00

The simple correlation between ADPC, aid to parents of dependent children per capita, and ASNW, percent students non-white in the public schools, is .73; i.e. ADPC accounts for slightly over half the variance in ASNW. ADPC is meant to be a measure of the general level of social disintegration in the community. Although ADPC enters with a positive coefficient in some runs for which ASNW is excluded, it in no case enters with a positive sign when some measure of blackness is included. In the statewide sample the correlation between ADPC and ASNW is lower (.63).

In the statewide sample, ASNW and POPNW remain closely correlated, but the simple correlation between ASNW and a dummy for the city of Boston is reduced to .66. Another variable, dummy for central city of an SMSA, has only a slight (.24) positive correlation with ASNW.

In conclusion, multicollinearity between pairs of variables does not entirely prevent identification of the separate effects of race and poverty in a school system on the teacher supply function. In the SMSA sample, it makes it extremely difficult to differentiate between "blackness" and other attributes unique to a central city, but this problem is somewhat alleviated in the statewide sampl .

A second problem of multicollinearity is the imprecision in point estimates of the coefficients which results when two highly intercorrelated variables are both included in the regression. This problem is discussed in subsequent chapters, in relation to the specific equations estimated in which it is significant.

A fuller description of the sample, including means, variances and coefficients of variation of all the variables, and simple correlation coefficients between all the variables is presented in Appendix I for the interested reader.

In this chapter, a simple model has been presented to estimate the factors which might cause different communities to face different supply prices for public school teachers. Some of the problems, theoretical and empirical, of applying the model to teachers in the Boston Metropolitan Area and the State of Massachusetts have been assessed, and the crucial assumptions made by the author have been explained. In chapter 3, estimates of the "quality-supply" function are presented.

CHAPTER 3

THE SUPPLY OF TEACHERS IN THE BOSTON METROPOLITAN AREA: ESTIMATES OF THE FUNCTION

In this chapter, the hypothesis that different school systems must pay a different price to obtain public school teachers of equivalent qualifications is tested with samples of school system data from the Boston Metropolitan Area and the State of Massachusetts, and with a sample of individual teachers placed in schools in the Boston SMSA by the Tufts University Department of Education. It is shown below that much evidence exists to confirm the hypothesis of the existence of a positive discrimination coefficient. School systems with more black students must pay a higher price, cet. par., for teachers.

Regression estimates are performed for secondary and elementary teachers separately. Results using a linear and semi-log form for the dependent variable, and weighted and simple least-squares regressions are shown. The independent variables entering into the final regressions were selected from the list of variables in Tables 2.1 and 2.2 by means of stepwise regression, using a critical value of $t = 1.7$ to eliminate variables.[1] The actual selection of variables entering into the final regressions, and some consequences of possible alternate specifications, are discussed in more detail in Appendix II.

The equation estimated is re-written below.

$$P = F\ (Q,\ S,\ \mu) \tag{3.1}$$

where:

P = mean salary of teachers
Q = mean characteristics of teachers in each system
S = socioeconomic characteristics of the system (or town)
μ = a random disturbance term

A positive coefficient attached to a variable in the Q vector means that the variable measures a desirable attribute of teachers; something which leads to a higher teacher price. In the linear form, it represents the change in mean salary per unit change in the mean value of the characteristic. If the characteristic is measured as the percent of teachers in a specified category, the coefficient measures the increase in mean salary per teacher associated with a one percent change in the percent of teachers possessing the specified characteristic. A positive coefficient attached to a variable in the S vector measures the additional price per teacher that a community must pay per unit change in the S variable.

Tables 3.1-3.4 give estimates of the final regression equations for the quality-supply function for secondary teachers in the Boston SMSA, elementary teachers in the Boston SMSA, secondary teachers in the statewide sample, and elementary teachers in the statewide sample, respectively. Tables 3.5-3.8 give estimates of the same equation using a semilog-form for the dependent variable. Thus, coefficients in Tables 3.5-3.8 represent percent change in salary associated with a unit change in the corresponding independent variable.

The following are some of the results of the regression analysis:

i) The "non-white" coefficient is positive and statistically significant at the 5 percent level in all regressions.

The point estimates range from $23 to $45 per teacher per additional percent students non-white for the secondary systems, to an additional $17 to $22 per percent student non-white for the elementary systems. What this implies is that a city like Boston, with 30 percent of its students non-white, must pay an additional $510-$660 per elementary teacher and an additional $690-$1350 per secondary teacher compared with what it would pay were it an all-white system. Using the same line of reasoning, and recalling that the semilog regressions give us the percent increase in teacher salary for a one percentage point increase in non-white students, the mean salary for an elementary teacher in Boston is raised between 9 and 10.3 percent, and for a secondary teacher between 8.7 and 16.5 percent. Using a crude estimate that expenditures on teachers' salaries are approximately 60 percent of total public school expenditures,[2] the estimated "discrimination coefficient" amounts to between a five and ten percent "tax" on the public education expenditures of the city of Boston.

Regression results recorded in Tables 3.1-3.8 also show final regressions with statistically significant variables. In preliminary regressions, it was found that adding a dummy variable for the city of Boston in the Metropolitan area sample made both the coefficient attached to the non-white variable and the coefficient attached to the dummy variable smaller than their respective standard errors. Each variable by itself had a significantly positive coefficient, with the "non-white" variable in all cases adding more to the regression (See Appendix II). The high collinearity between the two variables makes it impossible to determine whether it is "blackness" alone or some other characteristic unique to the central city which is responsible for the higher estimated supply price. In the statewide regression, two dummy variables for central city were used: one for all the central cities in the state, using Census Department classification of standard metropolitan areas, and one for the city of Boston, to test for its possibly unique features as the (by far) largest city in the state. The central city dummy is not statistically significant for secondary teachers and in the simple regression for elementary teachers, and turns out to be negative in the weighted regression

Table 3.1

Quality-Supply Estimates: Secondary Teachers in Boston SMSA

Dependent Variable: STSAL

Coefficients (t-values in parenthesis)

Independent Variable	Ordinary Least Squares	Weighted Least Squares
STED	809.067 (6.48)	1034.35 (8.20)
STMALE	1[illegible]30 ([illegible]34)	18.0573 (3.53)
STYPS	. . . .	-398.167 (3.27)
STGOS	7.35605 (2.18)	. . . .
$(STYPS)^{1/2}$	726.624 (9.74)	3126.02 (4.06)
ASMW	26.2712 (3.49)	45.3974 (5.96)
ADPC	. . . .	-264.401 (3.47)
MEDINC	0.121390 (3.58)	. . . .
SSMSAT	. . . .	2.95537 (2.06)
Constant	-4353.87	-10,356.3
	R^2 = .8926	R^2 = .9981
	N = 66	N = 66
	F(6,59) = 81.7018	F(7,58) = 4356.24

Table 3.2

Quality-Supply Estimates: Elementary Teachers in Boston SMSA

Dependent Variable: ETSAL

Coefficients (t-values in parenthesis)

Independent Variable	Ordinary Least Squares	Weighted Least Squares
ETED	719.988 (8.15)	624.128 (6.84)
$(ETYRS)^{1/2}$	970.214 (11.92)	870.586 (9.50)
POPNW	78.9266 (3.11)	. . . .
ASNW	. . . .	22.9319 (4.32)
MEDINC	0.142270 (3.85)	0.182681 (3.92)
VALPRP	-0.0600264 (2.79)	-0.0591912 (2.28)
POVTY	156.689 (2.73)	152.587 (2.43)
$(POVTY)^2$	-7.81206 (3.13)	-7.58882 (2.82)
POPGRO	0.500339 (1.92)	. . . .
Constant	-3577.70	-2488.47
	R^2 = .8453	R^2 = .9980
	F(8,57) = 38.9417	F(7,58) = 4110.88
	N = 66	N = 66

Table 3.3

Quality-Supply Estimates: Secondary Teachers in Massachusetts

Dependent Variable: STSAL

Coefficients (t-values in parenthesis)

Independent Variable	Ordinary Least Squares	Weighted Least Squares
STYPS	-203.570 (2.45)	-351.02 (4.39)
STED	425.477 (5.20)	439.965 (6.23)
STMALE	7.11099 (2.08)	11.0408 (2.73)
$(STYPS)^{1/2}$	1922.60 (4.02)	2806.71 (5.72)
SMSA	292.929 (4.74)	359.963 (6.33)
MEDINC	0.171344 (5.97)	0.172425 (4.82)
ASNW	25.2995 (3.58)	25.3228 (8.51)
	Constant = -2103.74	Constant = -3900.03
	R^2 = .8216	R^2 = .9967
	F(7,129) = 84.8717	F(8,128) = 4807.26
	N = 137	N = 137

Table 3.4

Quality-Supply Estimates: Elementary Teachers in Massachusetts

Dependent Variable: ETSAL

Independent Variable	Ordinary Least Squares	Weighted Least Squares
	Coefficients (t-values in parenthesis)	
ETED	432.001 (7.45)	449.577 (7.77)
$(ETYPS)^{1/2}$	826.434 (15.03)	798.319 (13.15)
ETCER	. . . .	-3.68910 (2.04)
MEDINC	0.106327 (4.48)	0.12238 (4.33)
SMSA	118.528 (2.00)	242.021 (4.23)
CITY	-206.996 (2.28)	. . . .
ASNW	23.6907 (3.50)	17.2942 (6.46)
IRITAL	8.3922 (1.80)	7.88666 (1.73)

	Ordinary Least Squares	Weighted Least Squares
Constant	-3.80287	99.1893
R^2	.7866	.9970
$F(7,129)$	67.9113	6048.95
N	137	137

Table 3.5

Quality-Supply Estimates: Secondary Teachers in Boston SMSA

Dependent Variables: Log (STSAL)

Coefficients (t-values in parenthesis)

Independent Variable	Ordinary Least Squares	Weighted Least Squares
STED	0.0991776 (6.32)	0.122791 (8.02)
STMALE	0.00245763 (4.44)	0.00229791 (3.70)
STYPS	. . . .	-0.0558543 (3.78)
STGOS	0.000898635 (2.12)	. . . .
$(STYPS)^{1/2}$	0.0951919 (10.16)	0.431381 (4.61)
ASNW	0.00304691 (3.23)	0.0055129 (5.96)
ADFC	. . . .	-0.00328193 (3.55)
MEDINC	0.0000152244 (3.57)	. . . .
SSMSAT	. . . .	0.000365362 (2.10)
	Constant = 7.44371	Constant = 6.68878
	R^2 = .9059	R^2 = 1.0000
	F(6.59) = 94.6434	F(7,58) = 30[illegible]198
	N = 66	N = 66

Table 3.6

Quality-Supply Estimates: Elementary Teachers in Boston SMSA

Dependent Variable: Log (ETSAL)

Coefficients (t-values in parenthesis)

Independent Variable	Ordinary Least Squares	Weighted Least Squares
ETED	0.0917737 (7.92)	0.077081 (6.62)
$(ETYPS)^{1/2}$	0.129759 (12.16)	0.113890 (9.66)
POPNW	0.0103592 (3.11)	. . . .
ASNW	. . . .	0.00300889 (4.40)
MEDINC	0.0000189181 (3.90)	0.0000236368 (3.94)
VALPRP	-0.00000794202 (2.82)	-0.00000751804 (2.25)
POVTY	0.0205180 (2.72)	0.0205142 (2.42)
$(POVTY)^2$	-0.00103236 (3.15)	-0.00102614 (2.97)
POPGRO	0.0000661414 (1.94)	. . . .
	Constant = 7.48879	Constant = 7.64925
	R^2 = .8630	R^2 = 1.0000
	F(8,57) = 44.8802	F(7,58) = 272412
	N = 66	N = 66

Table 3.7

Quality-Supply Estimates: Secondary Teachers in Massachusetts

Dependent Variable: Log (STSAL)

Coefficients (t-values in parenthesis)

Independent Variable	Ordinary Least Squares	Weighted Least Squares
STYPS	-0.0323635 (2.95)	-0.0485832 (4.91)
STED	0.0545344 (5.06)	0.0587344 (6.57)
STMALE	0.000848955 (1.89)	0.00143586 (2.90)
$(STYPS)^{1/2}$	0.287199 (4.56)	0.382259 (6.30)
SMSA	0.0392653 (4.83)	0.0457445 (6.55)
MEDINC	0.0000214065 (5.66)	0.0000204423 (5.28)
ASNW	0.00309009 (3.32)	0.00641352 (3.31)
POPNW	. . . .	-0.0104975 (1.76)
	Constant = 7.63054	Constant = 7.43369
	R^2 = .8298	R^2 = 1.0000
	F(7,129) = 89.6459	F(8,128) = 326,110
	N = 137	N = 137

Table 3.8

Quality-Supply Estimates: Elementary Teachers in Massachusetts

Dependent Variable: ETSAL

Coefficients (t-values in parenthesis)

Independent Variable	Ordinary Least Squares	Weighted Least Squares
ETED	0.0578723 (7.26)	0.0590421 (7.61)
$(ETYPS)^{1/2}$	0.113758 (15.06)	0.107649 (13.21)
ETCER	. . . .	-0.000446181 (1.83)
MEDINC	0.0000145327 (4.45)	0.0000167939 (4.43)
SMSA	0.0162873 (2.00)	0.0308119 (4.02)
CITY	-0.027062 (2.17)	. . . .
ASNW	0.00300284 (3.23)	0.00220054 (6.13)
IRITAL	0.00114052 (1.78)	0.00108343 (1.78)
	Constant = 7.90306	Constant = 7.93102
	R^2 = .8000	R^2 = 1.0000
	F(7,129) = 73.7156	F(7,129) = 390660
	N = 137	N = 137

for elementary teachers. In general, central cities of a defined SMSA do not pay a higher price for teachers, all other factors held constant. Because the addition of the Boston dummy does not make the non-white coefficient insignificant in some of the statewide regressions, there is evidence that the non-white variable itself is important independent of the heavy concentration of the state's non-white population in the city of Boston.

In conclusion, the evidence appears to support the hypothesis that school systems with more non-whites, cet. par., face a higher supply price than other school systems.

ii) There is no evidence that any of the other measures of unfavorable social conditions, either the percent of families below the poverty line in the town or the per-capita cost of the aid to parents of dependent children program, lead, by themselves, to a higher teacher supply price. In short, there is no evidence found of a "poverty" discrimination coefficient.[3] It should be pointed out that the coefficient of ADPC, as explained in chapter 2, is probably biased downward. In the absence of more information about teacher characteristics, it is premature to conclude that there is in fact no compensating differential that must be paid to teachers in low income areas. Yet, it is revealing that, when both ASNW and ADPC were tested, ASNW always has a positive coefficient and ADPC never does. ADPC does have a positive sign in some of the preliminary regressions when non-white variables are excluded.[4]

iii) In all the regressions, the coefficients of SIED and $(STYPS)^{1/2}$ are large, positive and statistically significant. This result is easily explained by the fact that teacher salary schedules are explicitly a function of years of experience, in all systems, and level of teacher education, in most systems. In the preliminary regressions, two forms of the experience variable were tested: one linear and one using the square root. Salary schedules in all the systems rise with experience with a peak at about 14 years. Since an increase in the mean teacher experience results in part from an increased number of teachers with, for example, 30 years of experience rather than 20, and since increases in experience don't affect individual salaries past 14 years, it is expected that the mean salary of a system should rise less than proportionally with mean teacher experience. The quadratic form of the variable was inserted to capture this diminishing nature of the increase, and was found to perform better than a linear form.

Mean salaries actually paid per school system vary greatly between towns, although stated salary schedules are not that different. Most of the variance in mean salary can be accounted for by the fact that towns paying high mean salaries tend to hire a larger fraction of their teacher staff at the top end of their salary schedule. In Table 3.9, it is shown that experience and education level alone account for approximately 80% of the variance in mean teacher salary for secondary teachers and 75% for elementary teachers.

Table 3.9

Effect of Experience and Education Alone on Mean Teacher Salary
Dependent Variables: STSAL, ETSAL

Independent Variable	Secondary Teachers	Elementary Teachers
	Coefficients (t-statistics in parenthesis)	
education level	1170.04 (10.16)	771.724 (9.09)
$(\text{experience})^{1/2}$	708.404 (8.39)	918.703 (11.82)
Constant	-5813.04	-2407.11
R-Square	.8193	.7559
F(2,63)	142.802	97.5618
Number of observations	66	66

iv) The percent teachers graduated from out of state is a significant variable in the secondary regressions in the Metropolitan Area. The coefficient is 8.40. This means that a rise of one percent in the percent of teachers graduated from out of state is associated with an increase of $8.40 in the price per teacher; i.e. the extra teacher from out of state is receiving an additional $840. (This raises the average price by one percent of $840.) Naturally, there is nothing special about institutions located outside of Massachusetts, so it is probable that STGOS is correlated with some other desirable teacher characteristic. What may be true is that the better and more high-paying school systems advertise nationwide to attract the best possible teachers, and thus end up with more graduates of institutions outside Massachusetts on their teaching staff. STGOS is not significant in the statewide sample, perhaps because the Boston area attracts more out-of-state people and possibly because out of state is really "local" to a school system in Western Massachusetts. Preliminary experiments showed no effect of a variable for percent of teachers graduated from a public institution vis-a-vis a private institution. From conversations with individuals familiar with the schools in the Boston area, the author believes that a statistic on the number of students graduated from state teachers colleges would be negatively correlated with mean salary.[5] Students who attend the state teachers' colleges in Massachusetts have in general very low college board scores. Yet, a variable for public institutions also includes the University of Massachusetts whose students are above average for the state.[6] Thus, a gross measure of "public" versus "private" institution graduates in a school system provides very little information.

v) The variable "percent teachers male" has a positive coefficient for secondary teachers in both the statewide and Boston SMSA samples, but is not significantly different from zero for elementary teachers. A number of possible explanations are consistent with this result.

a. Secondary School systems discriminate against females by paying them a lower salary than equally qualified males. Although it is not built into the salary schedules explicitly, administrators may in fact practice discrimination by accepting males with lower qualifications, for the same pay. Since females have less other employment opportunities than males, it is possible for them to practice this form of discrimination. The lack of evidence for discrimination by sex in elementary schools may indicate that overall market discrimination is greater against females with more education, since secondary teachers, on the average, have more years of educational experience than elementary teachers.[7]

The school systems themselves may not be the source of market discrimination. It may just be that for the same price they can hire more qualified females, because of discrimination against females elsewhere in the labor market.

b. The characteristic "maleness" may have some positive attribute within some school systems. Perhaps it is considered desirable for some students, particularly adolescents, to be exposed to male authority figures in the classroom. Also, male teachers may be better equipped to handle discipline problems. Since discipline problems are not likely to be as severe in elementary schools, explanation b) is also consistent with the results.

c. Percent teachers male may be a proxy for some other variable which has not been measured, and which is correlated with percent teachers male but not specifically related to an individual's sex. It is possible that males teaching in the secondary schools are more likely to be trained specifically for that purpose than females, or that males may have more training in mathematics and science. It has been shown that, because of the existence in the secondary schools of a single salary schedule for all subjects, there tends to be a chronic shortage of math and science teachers.[8] Thus, many schools must use as math and science teachers individuals who have been trained in other fields. It should be expected then that schools with higher salary levels would have a greater proportion of their teaching staff with training in mathematics and science, and specific training to be secondary teachers. If both these characteristics are positively correlated with percent teachers male, explanation c) is also consistent with the results, since elementary teachers are not trained in specific subject areas.

The point estimates of the increase in mean salary range from $7 to $19 per one percent increase in percent teachers male. Thus, the premium for being a male ranges from $700 to $1900, according to the point estimates.[9]

Evidence from the sample of Tufts teachers, presented below, contradicts the hypothesis of discrimination against females. After adjusting for academic performance, major, and degree, the coefficient attached to the sex term in a regression of salary on teacher characteristics and school system characteristics shows no evidence of a lower salary for female teachers.[10]

vi) The coefficient attached to median family income is positive and statistically significant in all regressions, except the weighted regression for secondary teachers in the SMSA. As mentioned in chapter 2, MEDINC is biased upwards and is probably a proxy for left-out teacher quality measures. It appears that the negative term associated with ADPC, combined with the positive term associated with SSMSAT, play the same role in the weighted regressions of Tables 3.1 and 3.5 as the MEDINC variable in the other regressions.

vii) The sign of the SMSA coefficient in the statewide regression reveals that the price of teachers in the Boston SMSA is higher than the price outside of it. One possible explanation is that the cost of living is lower outside the Boston SMSA than within it. Therefore, teachers in Western Massachusetts, though paid a lower nominal salary are receiving the same real salary. Unfortunately, it is not possible to test this hypothesis with readily available data. The BLS regional price index is not published for any SMSA in Massachusetts except Boston. Nor is census data on the average rent of housing very useful, since none of this data adjusts for a standard housing quality. Therefore, higher average rents may not reflect a higher cost per standardized housing unit. Within the SMSA the living cost differences are likely to be unimportant, since teachers need not reside in the town where they are employed. Results from the Tufts sample show no indication that individuals are willing to accept a lower price to teach in their hometown. Students from the Boston area may prefer to teach within the same region, but there is no evidence that they prefer the specific town in which they were raised.

viii) Finally, there is little evidence that weighting the regressions improves the results. Standard errors are not too different in the simple and weighted regressions.[11] The semi-log form of the equation has a slightly closer fit than the linear form, but examination of the coefficients show them to be practically the same, if the absolute change in salary implied by the coefficients of the linear regression is converted into a percentage change by dividing by mean salary (to calculate the percentage change at the mean). Both sets of regressions are printed merely for convenience, not because the semilog estimations contain important additional information.

As a further check on the results above, a similar quality-supply function was estimated for individual teachers who were placed by the Tufts University Department of Education at schools in the Boston Metropolitan Area during the years 1967 through 1969. The equation estimated is:

$$P = f(T,S,Y,\mu) \quad (3.2)$$

where:
P = salary paid to individual teachers
T = a vector of characteristics of the individual teacher
S = socioeconomic characteristics of the towns and school systems
Y = year teacher was placed
μ = disturbance term

Salary paid to an individual was obtained from published salary schedules of the individual towns. For a teacher with a B.A. degree, salary was taken to be a weighted average of the starting and top B.A. salary for the town; for the teacher with an M.A. degree a weighted average of the starting and top M.A. salaries. It was assumed that individuals would make their location decisions on the basis of both starting salary, which would be his immediate pay, and top salary, which he might hope to attain if he received tenure and remained in the system. It was arbitrarily decided to choose to weight the starting and top salaries equally. Therefore,

Salary = 1/2 (Stated starting salary + stated top salary)

The sample of individual teachers includes some information not available in the previous samples. Students' grade point average, college and/or graduate major, whether or not they majored in education, and whether or not the job accepted was in the same town where the student attended high school were all available in the Tufts sample, but not in the State Dept. of Education data on Massachusetts school systems. Further, some of the students in the sample are summer school students who did not receive degrees from Tufts University. Assuming that Tufts University is a relatively superior institution, some evidence exists of the effect of quality of institution attended on salary.

The Boston SMSA and statewide samples are superior to the Tufts sample in two important ways. First, the Tufts sample is only for first jobs of beginning teachers; it gives no indication of a school system's holding power as indicated by the experience variable in the other samples. Second, the sample of teachers placed by Tufts is probably not a representative sample of teachers in the Massachusetts schools.

Table 3.10 lists the teacher variables used in the Tufts sample.

Table 3.11 shows the regression used to estimate the variable "predicted GPA" in Table 3.10.

The variable "year placed" is included to reflect the possibility of changing market conditions. All the salary figures are based on data for the academic year 1968-69.

Table 3.10

Teacher Characteristic Variables: Tufts Sample

Variable Name	Variable Description
SALARY	Estimate of salary received by individual teacher (average of town's minimum and maximum salaries for teachers of given level of eduation). Salary data used for year 1968-69.
YEAR	year in which teacher was placed (67, 68 or 69).
MASTER	dummy variable: 1 if teacher has MA or master of education; 0 otherwise.
SPEC	dummy variable: 1 if special student (degree not from Tufts); 0 if received Tufts degree.
EDMAJ	dummy variable: 1 for education majors (either MA or BA); 0 for others.
MTHSCI	dummy variable: 1 if math-science major; 0 otherwise.
HOME	dummy variable: 1 if took job in hometown; 0 otherwise.
LEVEL	dummy variable: 1 if secondary school teacher; 0 if elementary school teacher.
SEX	dummy variable: 1 if male; 0 if female.
GPA	student's grade point average.
GPA1	difference between student's grade point average and predicted grade point average.
GPA2	ratio of student's grade point average to predicted grade point average*

*predicted grade point average is estimated by a regression of grade point average on MASTER, SPEC, EDMAJ and MTHSCI. See Table 3.11.

Table 3.11

Regression to Compute the Variable "Predicted GPA"

Dependent Variable: GPA

Coefficients (t-statistics in parenthesis)

Independent Variable	Coefficient
MASTER	0.650136 (11.79)
SPEC*	0.617084 (7.15)
EDMAJ	0.015055 (0.25)
MTHSCI	-0.297675 (3.11)
Constant	2.76329
R-Square	.54
F(4,202)	59.2712
Number of Observations	66

*The special students only attended summer school courses. Thus, their courses are not of comparable difficulty to those taken by Tufts undergraduates.

The included "teacher quality" variables now include a measure of the teacher's past academic performance adjusted for the curriculum he was in and his major field. Still left-out are measures of a teacher's innate intelligence and measures of personal factors, which might be reflected by a rating as a student-teacher.

Separate regression equations were estimated for elementary and secondary school teachers, for teachers with BA's and MA's for males and females, and for the entire sample. The results of all the final regressions are printed in Tables 3.12-3.15.

In estimating the regression for the Tufts sample, it is found that the coefficient attached to the non-white student variable remains positive and statistically significant in all cases. But multicollinearity between ASNW and the variables POPNW, CITY and ADPC is much more serious in the Tufts sample and clouds the interpretation. It is found that the coefficient attached to each of the above variables, when the other variables are removed from the regression, is positive. All four variables seem to measure practically the same thing. (See Appendix II for further discussion of this problem, along with correlation tables and regression results using alternate specifications.)

The teacher variable previously positive, education level, remains positive. Salary is higher for starting teachers with MA's than BA's, as explicitly stated in salary schedules. There is no evidence that male teachers are paid more. In the one regression in which the sex variable is significant, and there only weakly (at the 10 percent level), the coefficient implies that a female teacher receives approximately $97 more than a male. The term SPEC has a negative coefficient, which means that those students who graduate from institutions other than Tufts receive a lower salary. Since only 24 of the 207 new teachers in the sample were "special students," the result is impressive; it strengthens the belief that "quality of undergraduate institution" is important in the administrators' preference functions. It was somewhat surprising that neither the GPA term nor two measures of grade point average adjusted for major and program appeared in any of the final regressions. Though positive in almost all of the regressions, the coefficient attached to GPA was not significantly different from zero.

The community characteristics coefficients were similar to those previously measured, except for the positive sign attached to population density. It appears that the Tufts graduates must be compensated to teach in school systems located in somewhat more densely populated towns; i.e. they have some preference for the farther-out suburbs.

Auxiliary regressions were performed using "teacher quality" attributes included in the Tufts sample but left out of the SMSA and statewide samples as dependent variables and socioeconomic variables as independent variables. The socioeconomic variables are the same variables used in the estimation of the SMSA and statewide samples.

Table 3.12

Quality-Supply Estimates: Tufts Teachers (Entire Sample)

Dependent Variable: Salary

Coefficients (t-statistics in parenthesis)

Independent Variable	Coefficient
MASTER	433.728 (8.32)
SPEC	-176.808 (2.16)
SEX	-97.7146 (1.71)
ASNW	116.735 (6.24)
POPNW	-145.123 (2.33)
MEDINC	0.189535 (8.17)
POPDEN	0.0386631 (5.13)
ADPC	-493.228 (5.24)

Constant	6060.64
R-Square	.7096
$F(8,198)$	60.4881
Number of Observations	207

Table 3.13

Quality-Supply Estimates: Tufts Teachers

Breakdown by Sex

Dependent Variable: SALARY

Coefficients (t-statistics in parenthesis)

Independent Variable	Female Teachers	Male Teachers
MASTER	442.600 (7.61)	386.250 (3.11)
SPEC	-166.065 (1.86)	. . . .
ASNW	103.821 (5.47)	134.953 (4.54)
POPNW	-142.853 (2.26)	. . . .
MEDINC	0.245368 (8.69)	0.0879654 (2.12)
POPDEN	0.0352078 (4.65)	0.0602891 (2.19)
ADPC	-345.295 (3.52)	-1194.90 (4.28)
Constant	5588.37	6774.31
R-Square	.7279	.7273
F(7,150	57.3125	
F(6,42)		18.6735
Number of Observations	158	49

Table 3.14

Quality-Supply Estimates: Tufts Teachers

Breakdown by Level

Dependent Variable: SALARY

Coefficients (t-statistics in parenthesis)

Independent Variable	Secondary Teachers	Elementary Teachers
MASTER	473.290 (7.42)	483.028 (6.02)
SPEC	. . . .	-230.349 (1.95)
ASNW	79.0072 (7.67)	122.764 (3.79)
POPNW	. . . .	-195.868 (1.89)
MEDINC	0.200096 (6.91)	0.108098 (2.74)
POPDEN	0.0411811 (4.44)	0.0702613 (4.12)
ADPC	-559.857 (4.96)	-951.967 (3.91)
CITY	. . . .	1195.55 (2.47)

	Secondary Teachers	Elementary Teachers
Constant	5862.52	6683.40
R^2	.7040	.7219
F	$F(5,124)$ = 58.9705	$F(8,68)$ = 22.0659
N	130	77

Table 3.15

Quality-Supply Estimates: Tufts Teachers

Breakdown by Degree

Dependent Variable: SALARY

Coefficients (t-values in parenthesis)

Independent Variable	Tufts BA's	Tufts MA's
MTHSCI	-177.533 (1.83)	. . . .
ASNW	94.9979 (5.19)	114.831 (4.95)
POPNW	. . . .	-161.173 (1.94)
MEDINC	0.212312 (3.51)	0.201672 (7.03)
POPDEN	0.0418214 (3.07)	0.0435713 (4.42)
ADPC	-710.013 (3.37)	-446.022 (3.57)
STRAT*	48.3869 (2.27)	. . . .
	Constant = 4705.70	Constant = 6318.27
	R^2 = .6217	R^2 = .6163
	F(6,80) = 21.9074	F(5,90) = 28.9153
	N = 87	N = 96

*Student-teacher ratio. Elementary student-teacher ratio for school system was used for those teachers placed in elementary schools; secondary student teacher-ratio for school system for those teachers in secondary schools.

The regressions were performed to gather further evidence concerning the assumptions made in chapter 2 about the probable bias of the coefficients of the socioeconomic variables. The results are shown in Table 3.16.

From Table 3.16, it can be seen that GPA1 is positively correlated with income, while SPEC, a negative quality attribute, is positively correlated with ADPC and student-teacher ratio, and negatively with population density. These results would imply, for the Boston SMSA regression, an upward bias to the income term and to population density, and a downward bias in the estimation of the coefficient of welfare payments, and student-teacher ratio. They are consistent with our assumptions about the probable bias of the income and poverty terms. No evidence is supplied on the bias of the non-white term.

Table 3.16

Auxiliary Regressions With Left-Out Quality Variables
Dependent Variables: GPA1, SPEC

Independent Variable	<u>Coefficients</u> (t-statistics in parenthesis) GPA1	SPEC
INCOME	0.0000103737 (1.94)	. . . .
ADPC	. . . .	0.0833759 (2.76)
POPDEN	. . . .	-0.0000109481 (1.80)
STRAT	. . . .	0.0169015 (1.74)
	Constant = 0.923065	Constant = -0.29783
	R^2 = .0187	R^2 = .0527
	F(1,205) = 3.89716	F(3,203) = 3.76072
	N = 207	N = 207

In conclusion, results from all three samples support the hypothesis that school systems with more non-whites must pay more for the same quality teacher. The results do not imply that teachers are necessarily prejudiced, whatever that may be defined to mean. Nor do the results preclude the possibility that there is some other socioeconomic variable, highly correlated with "blackness," which if entered into the regression would eliminate the sign of the non-white coefficient. For example, juvenile delinquency data, if available, might provide an equally good explanation of cost differences. It is conceivable that teachers may have to be compensated to teach in a school in which they believe discipline problems will be greater, and that "blackness" is associated in their minds with a higher crime rate. The economic effects on the black community, if this belief is widely held, are the same regardless of whether the belief is accurate. In either case, the costs to blacks, and to whites who live in the same community with blacks, of an equivalent amount of inputs to public education will be higher than to residents of all-white towns.[12]

The cost differential estimated is non-trivial, and seems to amount to between five and ten percent of total expenditures per pupil.

CHAPTER 4

THE DISTRIBUTION OF TEACHERS BY RACE AND INCOME CLASS IN THE BOSTON METROPOLITAN AREA

In the previous chapter, evidence was shown, in a study of public school teachers in the Boston S.M.S.A., that school systems with more blacks must pay a higher price for a teacher with the same qualifications. In this chapter, the implications of that result for the distribution of educational benefits will be developed.

There are two important questions to be asked:

i) How does the distribution of teacher inputs affect the present and future welfare of students? The answer to this question is by no means clear, as the research on educational production functions is still preliminary and very rudimentary.[1] Yet, previously published results do indicate that variation of levels of teacher inputs within small ranges does have a statistically significant effect on measures of student performance, such as scores on standardized achievement tests.[2] The knowledge and skills acquired in school, in turn, have been shown to have a clear, positive effect on a student's lifetime income.[3]

ii) Given the state of our knowledge on the relationship of teacher inputs to student outputs, how are the inputs distributed? Is there a significant difference between the distribution of expenditures and the distribution of actual inputs? In other words, does the non-white discrimination coefficient measured in chapter 3 cause an important change in the resulting distribution of inputs? Do school systems with more blacks tend to receive, *cet. par.*, less teacher inputs? If so, how does this distribution compare with the distribution of inputs to school districts with more blacks *within* the city of Boston? What are the interactions between race and income variables in determining the distribution of inputs? How are funds dispersed to the Boston S.M.S.A. from Federal and State governments distributed?

Previous Studies of Educational Production Functions

In the past few years, a number of investigators have attempted to estimate educational production functions; i.e. to relate school inputs to objective measures of student performance. Usually, these studies involve estimating an equation of the form

$$Y = f(X_1, X_2, X_3)$$

where:

Y = some measure of a student's output
X_1 = a vector of background characteristics of the student and his family
X_2 = a vector of teacher input characteristics
X_3 = a vector of other school input characteristics such as books in library, age of school buildings, science lab facilities, etc.

The difficulties involved in this kind of procedure have been detailed fully elsewhere.[4] Below, a few brief comments are made on some of the problems.

i) It is difficult to measure many of the "outputs" which schools are producing. Some of the outputs which have been used in studies are reading scores, scores on a nationally administered verbal test, SAT scores, dropout rates and admission to college (from high school) and/or to specialized high schools (from elementary schools). Other outputs, such as a school's contribution to a student's good citizenship, social ability, and feeling of self-esteem, among others, are unmeasurable,[5] though they rank among the more important products of schooling. Even for those outputs which are measurable, some studies show radically different production functions depending on the output, with even the signs of the input coefficients changing.[6] Therefore, even if all the outputs could be properly measured, one would have to weigh their relative importance with weights that are purely arbitrary.

ii) The function being measured does not really represent a production function in the sense that it gives the maximum output attainable for a given set of inputs. It cannot be assumed that educators have enough knowledge to combine inputs in the best way, or that the level of efficiency is the same in different schools in a cross-section. The estimated production functions can only be considered a relationship between average levels of inputs and average levels of outputs. In a way, this is helpful. Since the educators are not varying the inputs according to a set maximization formula (setting marginal product equal to price), the simultaneous-equations bias which has been shown to be present in a single-equation estimate of a production function can perhaps be safely ignored.[7]

iii) Much of the data which has been collected for these studies is either inaccurate or too incomplete. In particular, data from the EEO Survey,[8] which has been relied on by many investigators, is subject to serious shortcomings.[9]

iv) What an educational production function seeks to measure is the "value added" of educational inputs to a student's performance. To the extent that measures of a student's initial endowments and out-of-school learning during the time of his life when he is subject to the school inputs are inaccurate, the output variable does not properly measure what is being contributed by the school.

v) Student attitudes are an important input in the production function. Leaving them out will bias other coefficients. Yet, student attitudes cannot be considered exogenous to the system; they are obviously affected by past successes or failures on tests. Including attitude as an exogenous variable, leads to simultaneous-equations bias. Recent work by Levin in which the production function was estimated by two-stage least squares shows a considerable improvement over the results obtained by single-equation procedures.[10]

vi) Much multicollinearity in the data exists in almost all of the production function studies, making it difficult to measure the magnitudes of the separate effects of the various inputs.

Despite the above difficulties, and others, work on educational production functions has been useful. Three broad conclusions emerge from the studies.

i) Within the current range of variation of school inputs, equality of educational outputs cannot be reached by compensatory education programs. Most of the variation in student test scores can be explained by socioeconomic background variables alone. This does not imply that there does not exist some hypothetical level of school inputs which could raise the average performance of the ghetto child to the level of the highest school district in the nation. It only means that such a hypothetical level of inputs lies well outside the range of inputs currently used in any public school system.

ii) Though equalizing school inputs cannot by itself produce equality of output, school inputs, especially those relating to teacher quality, do have a significant effect on measured output. The studies confirm the widespread belief that teacher quality is important.

iii) Some evidence seems to suggest that schools do not select their teachers efficiently; $MP_i/P_i = MP_j/P_j$, where i,j are teacher characteristics, and MP and P are the marginal contributions of these characteristics to student outputs and teacher salary, respectively.[11] Further research is desirable on this point, since more detailed and conclusive results could be used to increase the efficiency of resource allocation within the schools.

Table 4.1 reviews the explanatory importance of teacher input variables in some of the production function studies. The rating scheme used is outlined in the table. The ratings selected are all based on the subjective judgment of this author. Interested readers should consult the original studies.

All the included inputs show some positive association with measures of student performance, at least in some of the studies. It should be noted that the level of a teacher's education does not have any effect in any study which includes data on teachers' verbal ability, but does appear in those which exclude verbal ability. If verbal ability and the level of education of teachers are positively correlated, teacher education level as included in the SMSA and

Table 4.1

Summary of Results of Production Function Studies

Author	Variable: Teacher's experience	Teacher's education level	Teacher's verbal score	Teacher-Student ratio
Kiesling[12]	. . . .	+	. . . .	++
Burkhead I[13]	+	0	. . . .	0
Burkhead II[14]	. . . .	. . . .	. . . .	+
Burkhead III[15]	++	. . . .	. . . .	. . . .
Katzman[16]	0	+	. . . .	-
Hanushek[17]	++	0	++	0
Bowles[18]	0	0	++	++
Levin[19]	++	. . . .	+	. . . .

Rating Scheme

++ = strong and consistent positive association between the input and measures of student performance

\+ = some evidence of a tendency towards a positive association between the input and student performance, but generally inconclusive

Table 4.1 (cont'd)

Rating Scheme (cont'd)

0 = either no evidence of the effect of the input on outputs, or mixed evidence, positive for some outputs and negative for others

- = some evidence of a negative tendency

-- = strong evidence of a negative association

if a cell in the matrix is left blank, it indicates that the particular variable wasn't tested in the study

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[12] Herbert J. Kiesling, *op. cit.*

[13] Jesse Burkhead *et al.*, *op. cit.*, chapter on Chicago Public Schools.

[14] *Ibid.*, chapter on Atlanta public schools.

[15] *Ibid.*, chapter on rural public schools.

[16] Martin T. Katzman, *op. cit.* The negative sign for teacher-student ratio probably results from the inclusion of a variable measuring the percent of students in crowded classrooms in Katzman's regression.

[17] Eric Hanushek, *op. cit.*

[18] Samuel Bowles, *op. cit.*

[19] Henry Levin, *op. cit.*

statewide samples may serve in part as a proxy for teacher verbal ability. Therefore, its distribution among communities has some meaning as an index of benefits received. The same may be supposed for the variable, percent teachers graduated from out of state, which is shown in chapter 3 to be positively related to mean teacher salary.

The Distribution of Inputs

In this section, the distribution of teacher inputs in the Boston Metropolitan Area and in the state of Massachusetts is examined. Three aggregate measures of teacher input are used:

i) Expenditures per pupil (EXPRST)

Expenditures per pupil is a standard measure of the quantity of educational input. To the extent that the hypothesis of this essay is correct, i.e. all school systems don't face the same supply price for inputs, expenditures per pupil is a poor proxy for teacher input per pupil.[12]

ii) Adjusted Secondary Teacher Input Per Student (INPUT)

The variable "INPUT" is calculated as the product of the number of teachers per student and the hedonic index for quality per teacher for secondary teachers. Secondary school data was used for the hedonic index rather than elementary teachers because the teacher characteristics explain a larger fraction of the variation in salary for secondary teachers than for elementary teachers.[13] Quality per teacher was calculated by adding the constant term in the quality-supply regression to a weighted sum of the teacher characteristic variables, where the weights are the regression coefficients of equation (3.1). The regressions used were the simple, linear least-squares regression for the Boston SMSA and the statewide sample, respectively. INPUT is a good representation of teacher-input per student only if a) all relevant teacher variables are included in the construction of the teacher quality index, and b) a dollar's worth of expenditures on improving teacher quality is considered to be equivalent to a dollar's worth of expenditures on increasing teacher quantity. From assuming that the systems know which characteristics are best, and how to weight their relative importance, it is only a small step to rely, for the purpose of this study, on their judgment as to the proper trade-off between quality and quantity.

Nonetheless, the results of this section should be interpreted with great caution. Neither assumption a) or b) can be considered to be approximately correct. It is clear that there are important left-out variables in the quality index, and that school systems do not necessarily allocate resources efficiently. The material below only tells us the following information: Given that school systems in fact impute a set of relative values to a given bundle of inputs, and that the market-determined bundle is more expensive to some systems than to others, in what manner does the cost difference manifest itself? Do the systems facing a higher price tend to pay more than the other systems and receive the same bundle, or do they pay the same and receive less of the standard input bundle? In other words, what is the effect of the price differential on the distribution of inputs? The tables printed below are not intended to indicate differences in the "true" quality of education received by students in different towns. As explained in chapter 3, a measure of the true quality of education is not provided by the hedonic index, and finding such a measure is beyond the scope of this paper.

Equation (4.1) gives the formula for computing the variable INPUT.

$$\text{INPUT} = \text{INDEX}/\text{SSTRAT}, \qquad (4.1)$$

where:

$$\text{INDEX} = -4353.87 + (809.067) \times (\text{STED}) + (19.1230) \times (\text{STMALE}) + (726.624) \times (\text{STYPS})^{1/2} + (7.35605) \times (\text{STCOS}), \text{ for S.M.S.A. sample.} \qquad (4.1a)$$

$$\text{INDEX} = -2103.74 - (203.570) \times (\text{STYPS}) + (425.477) \times (\text{STED}) + (7.11099) \times (\text{STMALE}) + (1922.60) \times (\text{STYPS})^{1/2} \text{ for statewide sample.} \qquad (4.1b)$$

Two sets of regressions are performed. In the first set, input measures are used as the dependent variables, and race, income level, and other socioeconomic indicators thought to affect the distribution of inputs as the independent variables. These regressions indicate to what extent percent students non-white is a determinant of the amount of teacher input a school system receives, after all other determinants of the level of input have been accounted for. Variables used in the first set of regressions are listed in Table 4.2.

In the second set of regressions, two-variable relationships between input measures and income alone, and between input measures and race alone are tested. Since blacks resided in poorer communities, school systems with high proportions of black students may receive less inputs per student, even if there is no discrimination. Similarly, the absence of discrimination as defined in chapter 1 does not imply that the poorer communities receive the same input per student.

Each set of regressions are performed both for the SMSA and the statewide samples, using as dependent variables i) both measures of aggregate input, ii) each individual input, and iii) figures on state aid per capita and federal aid per capita as the dependent variables. Tables 4.3 and 4.4 show the distribution regression for the measures

Table 4.2

Variables Used in Distribution Regression

Variable Name	Variable Description	Source
INPUT	product of hedonic quality index from supply regression and teachers per student equals "quality" input per student	1
EXPRST	expenditures per student in public schools (1968-69)	1
STED	level of education, secondary teachers in public schools (1968-69)	1
STYPS	years in public schools, secondary teachers in public schools (1968-69)	1
STMALE	percent teachers male, secondary schools (1968-69)	1
STGOS	percent teachers with degree from out of state college, secondary schools (1968-69)	1
SSTRAT	teacher-student ratio in secondary schools (1968-69)	1
STAID	state aid to education per student (1968-69)	1
FEDAID	federal aid to education per student (1968-69)	1
MEDINC	median income per town (1960)	2

Table 4.2 (cont'd)

Variable Name	Variable Description	Source
TAXCAP	estimated value of taxable property per capita = estimated value of taxable property (1968) divided by population (1965)	2,4
TAXSTD	estimated value of taxable property per student = estimated value of taxable property (1968) divided by number of public school students (1968-69)	2,4
STDPOP	students per population = (number of public school students (1968-69) divided by population (1965)) times 100	1,2
PROFTK	percent of employed classified as professional, technical and kindred (1960)	2
POPDEN	population density (1965)	2
ADPC	local revenues from aid to parents of dependent children program per capita (1968, 1965)	3
ASNW	percent students non-white in public schools (1968-69)	1
CITY	dummy variable for central city	
BOSTON	dummy variable for city of Boston (statewide sample only)	

Table 4.3

Distribution of Inputs
Dependent Variable: EXPRST

Independent Variable	Coefficients (t-statistics in parenthesis) SMSA Sample	Statewide Sample
MEDINC	0.04479 (8.81)	0.0304061 (4.90)
TAXSTD	4.605 (5.34)	4.95970 (8.14)
PROFTK	. . . .	4.14657 (2.82)
ASNW	12.884 (4.23)	4.11944 (3.32)
CITY	-234.553 (2.36)	. . . .
	Constant = 193.326	Constant = 232.798
	R^2 = .7449	R^2 = .7043
	F(4,61) = 44.5236	F(4,132) = 78.5057
	N = 66	N = 137

Table 4.4

Distribution of Inputs*
Dependent Variable: INPUT

Independent Variable	Coefficients (t-statistics in parenthesis) SMSA Sample	Statewide Sample
MEDINC	0.0169127 (6.31)	0.00424770 (1.30)
PROFTK	. . . .	2.05312 (2.65)
TAXSTD	1.44875 (3.19)	1.10187 (3.43)
ASNW	3.80337 (2.37)	1.33343 (2.04)
CITY	-66.9414 (1.28)	. . . .
	Constant = 145.962	Constant = 191.436
	R^2 = .5594	R^2 = .3678
	F(4,61) = 19.3679	F(4,132) = 19.2024
	N = 66	N = 137

*Independent variables in Table 4.4 were chosen to be the same used in Table 4.3 for purpose of comparison.

of aggregate input. Tables 4.5-4.9 show the distribution for the individual measures of input. Tables 4.10 and 4.11 show the pattern of distribution of state and federal assistance.

It should be pointed out that the distribution regressions cannot be interpreted as either demand or supply equations. The distribution will be affected both by community taste for education and ability to pay for education (demand), by the cost differences among communities (supply), and by the amount of outside financial assistance. The latter, of course, depends directly on characteristics of the community and on the community's own tax effort for education.

Variables entering the final equations were selected by stepwise regression, except in the equation for the index of input per student. In that equation, for purposes of comparison, the same independent variables were used as in the equation explaining the distribution of expenditures.

Table 4.12 gives the correlation matrix of all the independent variables tested for both samples.

Some of the major implications of the distribution regressions are the following:

1) School systems with more non-white students appear to receive more inputs than other systems, after taking into account the effects of all other significant variables,[14] whether we use aggregate expenditures or teachers per student, adjusted by the hedonic quality index, as a measure of input. Do these systems receive their money's worth from expenditures on education? One indication that they don't is the results of the quality-supply regressions in chapter 3; i.e. the positive sign attached to the non-white coefficient. For further evidence, compare the coefficients attached to ASNW in Tables 4.3 and 4.4. It can be seen by computing the percentage change of EXPRST and INPUT, with respect to a unit percentage change in ASNW, using as the denominator the mean values of EXPRST and INPUT, respectively, that changes in the percent of students non-white have a bigger effect on expenditures than on the index of real input received. For the SMSA sample, a 1 percent increase in ASNW raises EXPRST by 1.9 percent, and INPUT by 0.7 percent. For the statewide sample, a 1 percent increase in ASNW is associated with a 0.6 percent increase in EXPRST and in 0.4 percent increase in INPUT. Apparently, the additional expenditures of school systems with more non-whites does not result in an equal addition to the measure of teacher input.

The positive sign attached to the coefficient of ASNW in Table 4.4 does not necessarily imply that black students receive a higher quality of education than whites in similar economic circumstances. "Left-out" measures of teacher quality may be distributed disproportionately in favor of white school systems. Blacks within a large system may receive less inputs than whites within the same system, or

Table 4.5

Distribution of Inputs

Dependent Variable: STED

Independent Variable	Coefficients (t-statistics in parenthesis) SMSA Sample	Statewide Sample
MEDINC	0.000141959 (4.17)	0.000201560 (9.51)
TAXCAP	0.0000527497 (2.34)	. . . .
POPDEN	0.0000345154 (4.52)	0.0000337000 (4.50)
	Constant = 8.44121	Constant = 8.34783
	R^2 = .5167	R^2 = .4445
	F(3,62) = 22.0906	F(2,134) = 53.6138
	N = 66	N = 137

Table 4.6

Distribution of Inputs

Dependent Variable: STYPS

Independent Variable	Coefficients (t-statistics in parenthesis) SMSA Sample	Statewide Sample
STDPOP	-.175494 (5.94)	-.125718 (7.22)
PROFTK	0.147449 (3.39)	0.142441 (3.65)
POPDEN	0.000144436 (2.04)	0.000234820 (3.54)
ASNW	. . . .	0.186139 (3.13)
BOSTON	. . . .	-6.61999 (2.69)
SMSA	. . . .	-0.864616 (1.84)
	Constant = 11.4892	Constant = 10.1309
	R^2 = .6486	R^2 = .5281
	F(3,62) = 38.1509	F(6,130) = 24.2474
	N = 66	N = 137

Table 4.7

Distribution of Inputs
Dependent Variable: STMALE

Independent Variable	SMSA Sample	Statewide Sample
Coefficients (t-statistics in parenthesis)		
MEDINC	-0.00209032	-0.00217883
	(3.38)	(3.71)
CITY	. . . .	-4.16041
		(1.85)
SMSA	. . . .	-3.73209
		(2.50)
	Constant = 62.4418	Constant = 68.7668
	R^2 = .1512	R^2 = .2199
	F(1,64) = 11.3984	F(3,133) = 12.4952
	N = 66	N = 137

Table 4.8

Distribution of Inputs
Dependent Variable: STCOS

Independent Variable	SMSA Sample	Statewide Sample
Coefficients (t-statistics in parenthesis)		
TAXCAP	. . . .	0.818896
		(1.90)
PROFTK	1.02345	0.882350
	(4.80)	(4.20)
ADPC	-4.98506	. . . .
	(2.51)	
SMSA		-7.93319
		(4.16)
	Constant = 13.3063	Constant = 15.8679
	R^2 = .4815	R^2 = .2467
	F(2,63) = 29.2553	F(3,133) = 14.5184
	N = 66	N = 137

Table 4.9

Distribution of Inputs
Dependent Variable: STSRAT

Independent Variable	SMSA Sample	Statewide Sample
Coefficients (t-statistics in parenthesis)		
PROFTK	0.000567282	0.000397808
	(6.84)	(5.88)
POPPEN	. . . .	-0.00000340779
		(3.33)
	Constant = 0.0345947	Constant = 0.0391858
	R^2 = .4230	R^2 = .2604
	F(1,64) = 46.9138	F(2,134) = 23.5898
	N = 66	N = 137

Table 4.10

Distribution of Inputs

Dependent Variable: STAID

Independent Variable	SMSA Sample	Statewide Sample
	Coefficients (t-statistics in parenthesis)	
MEDINC	0.004408 (2.40)	0.00301330 (2.03)
TAXSTD	-2.3238 (7.83)	-2.29615 (8.98)
STDPOP	. . . .	-0.556512 (3.13)
ASNW	1.47136 (2.51)	. . . .
	Constant = 110.887	Constant = 142.845
	R^2 = .5042	R^2 = .3900
	F(3,62) = 21.0169	F(3,133) = 28.3452
	N = 66	N = 137

Table 4.11

Distribution of Inputs

Dependent Variable: FEDAID

Independent Variable	SMSA Sample	Statewide Sample
	Coefficients (t-statistics in parenthesis)	
TAXCAP	. . . .	-12.0893 (6.96)
TAXSTD	. . . .	3.90467 (7.20)
STDPOP	. . . .	285.250 (9.36)
ASNW	1.8883 (4.92)	2.30126 (4.58)
CITY	. . . .	21.8031 (3.14)
	Constant = 20.9905	Constant = -78.3547
	R^2 = .2742	R^2 = .5471
	F(1,64) = 24 1808	F(5,131) = 31.6541
	N = 66	N = 137

Table 4.12

Correlation Matrix of Independent Variables

I. SMSA Sample

	MEDINC	TAXCAP	TAXSTD	STDPOP	PROFTK	POPDEN	ADPC	ASNW	CITY
MEDINC	1.00	0.66	0.27	0.23	0.76	-0.38	-0.53	-0.20	-0.15
TAXCAP	0.66	1.00	0.50	0.31	0.69	-0.49	-0.56	-0.26	-0.25
TAXSTD	0.27	0.50	1.00	-0.61	0.31	0.25	-0.11	0.09	-0.09
STDPOP	0.23	0.31	-0.61	1.00	0.29	-0.74	-0.38	-0.31	-0.17
PROFTK	0.76	0.69	0.31	0.29	1.00	-0.42	-0.53	-0.07	-0.13
POPDEN	-0.38	-0.49	0.25	-0.74	-0.42	1.00	0.66	0.45	0.28
ADPC	-0.53	-0.56	-0.11	-0.38	-0.53	0.66	1.00	0.73	0.66
ASNW	-0.20	-0.26	0.09	-0.31	-0.07	0.45	0.73	1.00	0.83
CITY	-0.15	-0.25	-0.09	-0.17	-0.13	0.28	0.66	0.83	1.00

Table 4.12 (cont'd)

II. Statewide Sample

	MEDINC	TAXCAP	TAXSTD	STDPOP	PROFTK	POPDEN	ADPC	ASNW	CITY	BOSTON	SMSA
MEDINC	1.00	0.49	0.27	0.18	0.30	-0.05	-0.47	-0.17	-0.24	-0.06	0.51
TAXCAP	0.49	1.00	0.66	0.27	0.60	-0.17	-0.36	0.06	-0.32	-0.11	0.30
TAXSTD	0.27	0.66	1.00	-0.43	0.36	0.27	-0.08	0.05	-0.13	-0.04	0.30
STDPOP	0.18	0.27	-0.43	1.00	0.24	-0.47	-0.34	-0.03	-0.28	-0.11	-0.01
PROFTK	0.30	0.60	0.36	0.24	1.00	-0.03	-0.39	-0.02	-0.22	-0.03	0.56
POPDEN	-0.05	-0.17	0.26	-0.47	-0.03	1.00	0.54	0.37	0.19	0.28	0.40
ADPC	-0.47	-0.36	-0.08	-0.34	-0.39	0.54	1.00	0.63	0.52	0.51	-0.07
ASNW	-0.17	-0.06	0.05	-0.03	-0.02	0.37	0.63	1.00	0.42	0.62	0.02
CITY	-0.24	-0.32	-0.13	-0.28	-0.22	0.19	0.52	0.42	1.00	0.26	-0.25
BOSTON	-0.06	-0.11	-0.04	-0.11	-0.03	0.28	0.51	0.62	0.26	1.00	0.09
SMSA	0.51	0.30	0.30	-0.01	0.56	0.40	-0.07	0.02	-0.25	0.09	1.00

even within the same school. Our evidence, however, gives no indication that blacks receive less of the observed input bundle than whites living in communities with similar characteristics.

Looking at the specific inputs, the only individual input for which there is any evidence of distribution in favor of blacks is teacher experience. There is no evidence that communities with more non-white students have teachers of a higher education level or a smaller student-teacher ratio.

2) The coefficients attached to the median income and tax base terms appear as positive in practically all the regressions. Of the two measures of taxable capacity, value of property per student performs better in the regressions than value of property per capita. In an earlier version of this paper, most input measures declined as the percentage of the population of student age increased. The effect of the ratio of public school students to the total population, interpreted previously as a financial constraint variable, was eliminated in most cases when the variable TAXSTD was used as a measure of a community's capacity to pay for schools, in place of TAXCAP.

3) PROFTK and POPDEN are both important variables affecting the distribution of inputs. In most cases, communities with greater population density and with a higher fraction of the population employed classified as professional, technical, and kindred, receive more teacher inputs in public schools. It seems reasonable to consider PROFTK and POPDEN as taste variables affecting demand, since neither one appears as significant in the quality-supply regressions. Towns with more professionally educated people in particular, seem to prefer smaller class sizes and more teachers with degrees from outside Massachusetts.[15] The latter is the only variable, aside from STMALE, which is positively related to mean teacher salary and is not explicitly included in the salary schedules. The distribution of the variable STMALE is the one least well explained by community characteristics. It appears that low income communities receive more male teachers.

4) Both State and Federal Aid payments are greater to school systems with more non-whites, after adjusting for the influence of other variables. The premium paid to communities with non-white students by the Federal government is greater than that paid by the state government. Two components of the sign of the non-white coefficient in the FEDAID regression are i) programs aimed specifically at inner-city schools, and ii) the METCO program, in which some of the suburban school systems participate. Tuition and busing costs for students in the METCO program are financed by the U. S. Office of Education and the Carnegie Corporation. METCO exists specifically for non-white inner-city residents; white Boston parents were refused permission by METCO officials to send their children to suburban public schools.[16]

It is difficult to explain the coefficient of STDPOP in the FEDAID regression. One contributing factor is the busing program, which raises STDIOP and FEDAID in the receiving communities, but there may be other explanations.

There is no evidence that FEDAID is distributed in favor of low-income communities per se.

The distribution of STAID is determined, with some adjustments, qualifications and limitations, by the formula[17]:

$$S = \frac{E\ (1-.65\ TAXSTD\ (local)}{TAXSTD(average\ for\ state)} \qquad (4.2)$$

where:

S = state aid
E = the town's reimbursable expenditures

Teachers' salaries are included among reimbursable expenditures.

Equation (4.2), the stated policy of Massachusetts, explains the *negative sign of the TAXSTD sign in Table 4.10. After adjusting for financial ability, more state aid goes to those towns with higher median* income, perhaps because the expenditures of a town relative to its tax base rise as its income rises. Perhaps greater effort is also the explanation for the positive coefficient attached to the non-white term in the SMSA regression.

Both the U. S. Government and the state of Massachusetts, in the direction if not the intent of their aid programs, act to compensate the non-white communities for the disadvantage of facing a higher supply price for educational inputs. Given the incompleteness of our quality measures, the author believes it would be pointless to attempt to estimate whether or not the aid programs fully compensate the black community for the losses suffered from market discrimination.

In studying the distribution of inputs, it is worth knowing, not only whether non-white and low-income communities receive less inputs than one would predict from other community characteristics, but whether they actually, in a gross sense, receive less inputs. Table 4.13 shows the simple correlation of the input measures with income and percent students non-white for both the Boston SMSA and the state-wide samples.

The results show that the non-white variable is not positively correlated with any of the aggregate measures of inputs at a level significantly different from zero. It is positively correlated with two inputs: school systems with more non-whites tend to have a more experienced teaching staff, and tend to receive more federal aid per student. The aggregate measures of input, and all of the individual input components except teacher experience and percent teachers male, are positively correlated with the town's median income, while federal aid seems to be to some extent redistributive. From Table 4.11 and from the negative simple correlation between percent students non-white and median income listed in Table 4.12, it can be seen that

Table 4.13

Simple Correlations Between Input Measures, Racial Composition, and Community Income

	SMSA Sample		Statewide Sample	
Input Measure	MEDINC	ASNW	MEDINC	ASNW
EXPRST	.65**	.20	.67**	.11
INPUT	.61**	.13	.22**	.22**
STED	.59**	.09	.60**	.08
STYPS	-.05	.32**	-.01	.26**
STMALE	-.39**	.11	-.41**	.11
STGOS	.56**	-.20	.28**	-.10
STSRAT	.55**	.03	.37**	.03
STAID	-.02	.17	-.09	.01
FEDAID	-.15	.52**	-.17**	.48**

**Statistically significant at 5 percent level

Federal Aid is redistributive only towards those low income communities with substantial numbers of blacks in the public schools.

Little evidence is available on the distribution of inputs within a school system. Katzman's study of the distribution of educational inputs among elementary schools within the city of Boston concludes that the distribution slightly favors white and upper-income school districts. He attributes these inequities to teacher choice (given seniority rights, etc.) within the context of a single-salary schedule rather than to the conspiracy theory that the administrators' decisions deliberately favor rich whites.[18] It appears from a rough comparison of our results with Katzman's that blacks fare better in the between system distribution of inputs than in the distribution within the central city.[19]

In conclusion, no evidence has been found that school systems with more non-whites receive less teacher inputs per student than other systems.[20] It has been shown, though, that the systems with more non-whites must spend more to receive the same measure of input. Income and tax base per student of a community are the most important determinants of the amount of teacher input a town receives, as well as the level of expenditures. Federal and state aid is more re-distributive to school systems with many blacks than to low income communities in general, especially federal aid.

CHAPTER 5

CONCLUSIONS AND POSSIBLE IMPLICATIONS

In this essay, mechanisms by which discrimination in the allocation of educational resources can occur have been discussed. Defining discrimination to occur when a reallocation of resources to black and low-income communities would improve economic efficiency, it has been shown that discrimination can occur within a school system through administrative misallocation and between school systems if suppliers of educational services must be given extra compensation to work in black or low-income communities. The latter model, which resembles Becker's theory of discrimination,[1] was tested using data on public school teachers in Massachusetts. It was found that substantial evidence exists to confirm the hypothesis that school systems with a large percentage of non-white students face a higher supply price for an equivalently qualified teacher. No evidence was found to confirm the hypothesis that communities with a large incidence of poverty and high welfare payments under the aid to families with dependent children program must pay a higher price for teachers, when the effects of race differences are held constant. Since the estimation procedure tends to impart a downward bias to the coefficients of both poverty and race, it is not certain that incidence of poverty has no effect on the supply price.

The finding of a discrimination coefficient does not imply that racial prejudice among public school teachers is widespread. The compensating differential may exist because percent students non-white is correlated with undesirable community characteristics, such as incidence of crime, for which we have been unable to obtain data, or because public school teachers erroneously believe there is such a correlation. From the economic viewpoint of the black community, the effect of the findings of a higher supply price is the same, regardless of the underlying cause. It is also possible that the racial coefficient is really a "central-city" coefficient, although the inconclusive evidence available appears to support the "racial" interpretation.

The finding that some school systems need to pay a higher price for teachers of given characteristics is only important insofar as those characteristics themselves have some meaning as a measure of the quality of education received by students. Previous work on educational production functions provides indications that the input measures used in this study are indeed of some importance, although many other important inputs are left out.

School systems with more non-white students do not receive less of the measured inputs than other systems, and receive more, if income, population density and tax base are held constant. It appears that inequality of inputs by race is greater within the city of Boston than between towns and cities in the Metropolitan Area. However, relative expenditures per student, for communities with more non-whites, is even greater than relative input per student. The latter finding further confirms the hypothesis that school systems with more blacks must spend more to receive the same educational inputs.

Since many important inputs are left-out, and since we are only observing average values for entire school systems, the above findings on the distribution of inputs do not imply that black students receive more educational inputs than whites.

State and Federal Aid are much more redistributive by race than by income. In particular, Federal assistance is more redistributive by race than state aid, and is not at all redistributive in favor of low income communities, when the racial variable is held constant. The pattern of outside assistance, especially Federal, can be justified as compensation to blacks, and to whites living in towns with large numbers of blacks, for the additional costs imposed on them by discrimination in the market for educational services. It is not suggested here either that the magnitude of compensation is correct, or that Federal policies have been formulated with this kind of compensation in mind.

Much further research is necessary to validate the tentative findings suggested by this paper. A thorough survey of teachers in Boston, or another metropolitan area, which gave more complete information on teacher attributes, student characteristics, and personal factors influencing a teacher's location decisions would make the estimated regression coefficients, using the same model, much more meaningful. It would also be useful to perform the study in a metropolitan area which i) contains more blacks as a percent of the total population, and ii) a larger fraction of blacks outside the central city.

It is hazardous to venture to make policy suggestions from a study as tentative as this one. The author only wishes to point out two possible implications: 1) that school systems undertaking decentralization plans, which may be desirable on other grounds, take into account the increased supply price which may be faced by all-black systems, and 2) that federal, state, and local governments, in formulating aid policies, be cognizant of the possibility that school systems with more non-whites may find it costs more to provide the same quality of educational input.

REFERENCES

Chapter 1

1. For examples, see James S. Coleman et al., Equality of Educational Opportunity (Washington, D. C., U. S. Government Printing Office, 1966) and Otto Kerner et al., Report of the National Commission on Civil Disorders (Washington, D.C., U. S. Government Printing Office, 1968). Also see U. S. Civil Rights Commission, Racial Isolation in the Public Schools (Washington, D. C., U. S. Government Printing Office, 1967).

2. See Henderson and Quandt, Microeconomic Theory (New York, McGraw-Hill, 1958).

3. For an exposition of this view, see Milton Friedman, Essays in Positive Economics (Chicago, University of Chicago Press, 1956).

4. Arnold C. Harberger, "Monopoly and Resource Allocation," American Economic Review Proceedings, 1954.

5. For a view on the role of the public sector in a free market economy, see Richard A. Musgrave, The Theory of Public Finance (New York, McGraw-Hill, 1959), chapters 1-3.

6. The emphasis on efficiency, and the relative inattention paid to distribution has been stressed by the New Left in its critique of modern economics. See Michael Zweig, "A New Left Critique of Economics," D. Mermelstein, ed., Economics - Mainstream Readings and Radical Critiques (New York, Random House, 1970).

7. For example, see Milton Friedman, Capitalism and Freedom (Chicago, University of Chicago Press, 1962), chapter 6, and Musgrave, op. cit., among many others.

8. For some examples of external benefits of education, see Burton Weisbrod, "External Effects of Investment in Education," Journal of Political Economy, 1962.

9. Friedman, op. cit.

10. For a discussion of the return to investment in human capital, see Gary S. Becker, Human Capital (New York, National Bureau of Economic Research, 1964).

11. See W. L. Hanson, B. A. Weisbrod, and W. J. Scanlon, "Schooling and Earnings of Low Achievers," American Economic Review, June 1970.

12. The extent to which intelligence differences as measured by standardized tests result from genetic factors or environment is a matter of some dispute, but it is clear that the combination of inheritance and a "deprived" environment leads to lower academic performance. See Coleman, op. cit. For a discussion of the relative roles of heredity and environment, see A. Jensen, "How Much Can We Boost IQ and Scholastic Achievement," Harvard Educational Review, Winter 1969 and critical articles by Bereiter, Cronbach, Crow, Hunt and McVicker, and Kagan, Harvard Educational Review, Spring 1969.

13. The Coleman Report discussed inequality of educational opportunity in terms of inequality of outputs. Bowles has argued that the educational system neither can nor should alone bear the responsibility for reaching equal opportunity in those terms. See Coleman, op. cit., and Samuel Bowles, "Towards Equality of Educational Opportunity," Harvard Educational Review, Winter 1968.

14. For a discussion of how the existence of many communities supplying different mixes of public services approaches the optimum allocation features of a private market, see Charles M. Tiebout, "A Pure Theory of Local Expenditures," Journal of Political Economy, Volume 64, (October 1956).

15. See Christopher Green, Negative Taxes and the Poverty Problem (Washington, D.C., Brookings Institution, 1967). Also see Thomas I. Ribich, Education and Poverty (Washington, D.C., Brookings Institution, 1968).

16. Artificial barriers can be of two types: 1) housing segregation that prevents blacks from residing in communities which provide the desired level of educational services, and 2) inputs, in particular white teachers, who are reluctant to be employed in communities with many black students.

17. For example, Thurow defines "human capital" discrimination as the difference between the amount invested in whites and the amount invested in blacks. See Lester C. Thurow, Poverty and Discrimination (Washington, D.C., The Brookings Institution, 1969).

18. See the Kerner Report, op. cit.

19. James R. Coleman, op. cit.

20. In a recent study, evidence is presented which shows that black student achievement is increased more than white student achievement by equal increases in school inputs. See Eric Hanushek, "The Education of Negroes and Whites," unpublished Ph.D. dissertation, Massachusetts Institute of Technology.

21. Kerner Report, op. cit.

22. The Massachusetts State aid formula is based, among other things, on the local community's effort. See chapter 4 for a fuller discussion of state aid in Massachusetts.

23. Patricia C. Sexton, Education and Income (New York, Viking Press, 1961), and Patricia C. Sexton, "City Schools," The Annals of the American Academy of Political and Social Science, March 1964.

24. Martin T. Katzman, "Distribution and Production in a Big City School System," Yale Economic Essays, Spring 1968.

25. See studies referred to by Levin in Henry Levin, Recruiting Teachers for Large City Schools (Brookings Mimeo, 1968, to be published by Charles E. Merrill).

26. A further way in which blacks within a large system may suffer is if the needs of black, inner-city students are different than other students within the system, i.e. the educational production functions are different for blacks and whites. If the central administration is only attuned to white needs, then resources within the black schools, although not quantitatively different than resources within the white schools, are in fact systematically misallocated. For a discussion of the responsiveness of central city administrators to needs of ghetto residents, see Henry M. Levin, ed., Community Control of Schools (Washington, D.C., The Brookings Institution, 1970), Peter Schrag, Village School Downtown (Boston, Beacon Press, 1967), and Jonathan Kozol, Death At An Early Age (Boston, Houghton Mifflin Co., 1967).

27. Gary S. Becker, The Economics of Discrimination (Chicago, University of Chicago Press, 1957).

28. Ibid., p. 7, n.

29. Anne O. Kreuger, "The Economics of Discrimination," Journal of Political Economy, 1963, and Lester C. Thurow, op. cit.

30. The exact condition is $F_{KW} = F_{KN}(1+1/e_d)$, where F_{KW}=return to capital in white sector, F_{KN}= return to capital in black sector, and e_d = elasticity of demand for capital in black sector. See Kreuger, op. cit.

31. In a net sense, including the non-pecuniary "gain" from discrimination, whites of course must gain. The question is whether the teachers' loss in monetary income exceeds the students' gains in quality of education.

Chapter 2

1. For a fuller explanation, see Lawrence R. Klein, An Introduction to Econometrics (Englewood Cliffs, N.J., Prentice-Hall, 1962).

2. Edmund S. Phelps, "The New Microeconomics in Employment and Inflation Theory" in Phelps et al., Microeconomic Foundations of Employment and Inflation Theory (New York, W. W. Norton & Co., 1970).

3. Hedonic indexes have also been used in studies of the market for automobiles and housing. See Zvi Griliches, "Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change," in Arnold Zellner, ed., Readings in Economic Statistics and Econometrics (Boston, Little, Brown & Co., 1968) and Jerome Rothenberg, "A Dynamic Model of the Metropolitan Area Housing Market" (unpublished).

4. The most important results of those studies are reviewed in chapter 4.

5. If there is efficient allocation of resources internally, then $MP_i/P_i = MP_j/P_j$, where MP_i = the marginal contribution to a student's test score of the i^{th} teacher characteristic, and P_i = the partial contribution to teacher's salary of the i^{th} characteristic. It has been shown that MP/P is much greater for teacher verbal score than for teacher experience. See Henry Levin, "A Cost-Effectiveness Analysis of Teacher Selection," Journal of Human Resources, Winter 1970

6. Data on teacher salaries and teacher characteristics in Massachusetts, for individual school systems, was supplied to the author by the Massachusetts State Department of Education Research Center.

7. See J. Johnson, Econometric Methods (New York, McGraw-Hill, 1965).

8. For a full discussion of the problem of mis-specification resulting from left-out variables and derivation of the relevant formulas, see Zvi Griliches, "Specification Bias in Estimates of Production Functions," Journal of Farm Economics, February 1957.

9. The Association for School College and University Staffing published an annual booklet on teaching opportunities, in which some school systems advertise. The only school systems in the Boston Metropolitan Area to advertise in this source were Newton and Wayland, both upper-income suburbs. The above says nothing about possible communication through other media or contacts. See Teaching Opportunities For You (Hershey, Pa., ASCUS Communication and Services Center Inc., 1969).

10. Henry Levin, Recruiting Teachers For Large City Schools (Brookings mimeo, 1968, to be published by Charles E. Merrill).

11. See J. Johnston, op. cit., pp. 207-211, for a discussion of the problem of heteroscedasticity.

12. A justification for the assumption that variance is proportional to 1/N is presented in Appendix I.

13. Massachusetts Department of Commerce and Development, Town Monographs, published annually. Much of the included data is from the U.S. Census.

14. Massachusetts Department of Welfare, Aid to Families With Dependent Children in Massachusetts, 1968.

15. Boston Safe Deposit Company, Financial Statistics of Massachusetts, 1968.

16. Data for the Corazzini survey was supplied by the Massachusetts Council on Higher Education.

17. For example, Boston is not the most densely populated town in the SMSA, trailing both Cambridge and Somerville. See Town Monographs.

18. Means and variances of variables used in the study are shown in Appendix I.

19. The initials METCO stand for Metropolitan Council for Educational Opportunity. For a history of the METCO program, see Peter Schrag, Village School Downtown (Boston, Beacon Press, 1967).

Chapter 3

1. Because of the possibility of specification bias, a smaller critical t-value was used than is customary, to minimize the probability of rejecting a variable whose coefficient is biased downward. This increases the possibility of accepting a false hypothesis. It can be seen from the results that the t-statistic exceeds 2 in almost all cases in which a variable is included.

2. In 1968-69 total expenditures for public education were \$949,338,000 of which \$575,483,000 were listed under instruction costs. See Division of Research and Development, Massachusetts Department of Education, Facts About Education in Massachusetts (Bureau of Public Information, Mass. Department of Education, publication No. 272).

3. A poverty "discrimination coefficient" would be defined to mean that low income individuals would have to pay a higher price for the same quality service than those of middle and upper incomes. In Tables 3.2 and 3.6, the coefficient of POVTY is positive only because of the inclusion of the term $(POVTY)^2$, which has a negative coefficient. When either POVTY or $(POVTY)^2$ alone is used, the coefficient is negative.

4. See Appendix II.

5. This point has been suggested to me by Arthur J. Corazzini, Leila Sussman, and Burleigh Wellington, director of Tufts teacher placement service.

6. Data on SAT scores of entering college freshman were supplied to Dr. Arthur Corazzini by the Massachusetts Council on Higher Education.

7. Mean highest level of educational attainment on the Massachusetts Department of Education rating code is 9.71 for all secondary teachers in Massachusetts, 9.29 for elementary teachers. "9" is a bachelor's degree; "10" is a bachelor's degree plus 30 hours or more; "11" a master's degree.

8. Henry Levin, Recruiting Teachers for Large City Schools (Brookings mimeo, 1968).

9. The $700 to $1900 figure was derived using the same reasoning as that explained for the interpretation of the coefficient of STGOS, above.

10. The premium paid to a female was found statistically significant at the 10 percent level in only one of five possible regressions, and in that regression was estimated to be $97.

11. Possible reasons for this are discussed in Appendix I.

12. Fear of crime, whether or not justified by the facts, appears to explain other forms of market discrimination, also. A recent article in a local paper documents the fact that taxi drivers refuse to pick up blacks and refuse to drive to the black sections of Boston through interviews with the drivers themselves. Most say that the prospective fare doesn't compensate for the fear of attack. See Paul Solman, "Why Cabbies Won't Pick Up Blacks," Boston After Dark, November 10, 1970.
From the standpoint of the black wishing to use a cab, the question of whether or not the drivers' beliefs are "incorrect" is irrelevant. The market consequence is the same.

Chapter 4

1. For a good review of the state of research as of the summer of 1968, see Samuel Bowles, "Towards An Educational Production Function," (National Bureau of Economic Research, mimeo, 1968).

2. See Ibid. Also, see Samuel Bowles and Henry Levin, "More On Multicollinearity and the Effectiveness of Schools," Journal of Human Resources, Summer 1968; also, "The Determinants of Scholastic Achievement - An Appraisal of Some Recent Evidence," Journal of Human Resources, Winter 1968; Jesse Burkhead, Thomas Fox, and John W. Holland, Input and Output in Large City Schools (Syracuse University Press, 1967); James S. Coleman et al., Equality of Educational Opportunity (Washington, D.C., U. S.

Government Printing Office, 1966); Eric Hanushek, "The Education of Negroes and Whites," unpublished doctoral dissertation, Massachusetts Institute of Technology; John F. Kain and Eric Hanushek, On the Value of Equality of Educational Opportunity As A Guide to Public Policy, Program on Regional and Urban Economics, Discussion Paper No. 36, Harvard University, May 1968; Martin T. Katzman, "Production and Distribution In a Big City School System," Yale Economic Essays, Spring 1968; Herbert J. Kiesling, "Measuring a Local Government Service: A Study of School Districts in New York State," Review of Economics and Statistics, August 1967.

3. See W. L. Hansen, B. A. Weisbrod, and W. J. Scanlon, "Schooling and Earnings of Low Achievers," American Economic Review, June 1970.

4. Samuel Bowles, op. cit.

5. In some cases, such inputs have been measured. Bowles uses a measure of a student's control over his environment. See Ibid.

6. See Katzman, op. cit.

7. For a discussion of simultaneous-equations bias in estimating production functions, see Zvi Griliches, "Specification Bias in Estimates of Production Functions," Journal of Farm Economics, 1957.

8. James S. Coleman et al., op. cit. Bowles, Levin and Hanushek have used EEO data in their studies.

9. For criticisms of the EEO Survey, see Bowles and Levin, op. cit., and Hanushek and Kain, op. cit.

10. Henry Levin, "A New Model of School Effectiveness," unpublished, 1970.

11. Henry Levin, "A Cost-Effectiveness Analysis of Teacher Analysis of Teacher Selection," Journal of Human Resources, Winter 1970

12. Martin T. Katzman, op. cit.

13. See chapter 3.

14. This does not imply that school systems with more non-whites actually receive more inputs than other systems, since percent students non-white is negatively correlated with the median income of the town.

15. See Tables 4.8 and 4.9. POPDEN would be a "taste" variable if people who choose to reside in more densely populated communities also place a higher value on public education.

16. Peter Schrag, Village School Downtown (Boston, Beacon Press, 1967).

17. The school aid formula, including the basic formula of equation (4.2) along with limitations, was supplied to the author by the Massachusetts State Department of Education Research Center.

18. Martin T. Katzman, op. cit.

19. Katzman's inputs include measures of class size, percent teachers permanent, percent teachers with M.A. degree, and teacher experience. Thus, his input measures are similar to the ones used in this essay, both in terms of what is included, and in terms of the exclusion of variables such as teacher verbal score and quality of institution from which the teacher received a degree.

20. This statement is not equivalent to saying that individual black students receive the same teacher input as individual whites.

Chapter 5

1. Gary S. Becker, The Economics of Discrimination (Chicago, University of Chicago Press, 1957).

Appendix I

1. In writing this section I have relied heavily on Zvi Griliches' unpublished lecture notes. For other sources on weighted regressions see J. Johnston, Econometric Methods (New York, McGraw-Hill 1965), and N. R. Draper and H. Smith, Applied Regression Analysis (New York, John Wiley & Sons, 1966).

Appendix II

1. For a discussion of variable selection procedures, see N. R. Draper and H. Smith, op. cit.

APPENDIX I

A. Heteroscedasticity and Weighted Regressions[1]

In ordinary multiple regressions, the estimator $b = (X'X)^{-1}X'Y$ is best linear unbiased under the assumptions that 1) the disturbance terms are uncorrelated with the independent variables ($X\mu=0$), and 2) the disturbances are of constant variance for all observations and are uncorrelated with each other ($\mu_i\mu_j= 0$, $i \neq j$, $\mu_i\mu_j=\sigma^2$ for $i=j$). The latter statement is equivalent to saying that the variance-covariance matrix of the residuals can be written:

$$V = \sigma^2 I, \text{ where I is the identity matrix.}$$

If in fact $V \neq \sigma^2 I$, the estimator b, though still unbiased is no longer *efficient*, and the estimate of the variance-covariance matrix of the coefficients is biased. A best linear-unbiased estimator would then be given by the generalized least-squares estimator:

$$b^* = (X'V^{-1}X)^{-1}X'V^{-1}y$$

where V is the variance-covariance matrix of the residuals. It is possible to use a simple least squares regression program to estimate b*, by transforming the original least-square model, $Y = XB + \mu$, into one for which the standard least-squares assumption about the variance-covariance matrix holds again. Since V is positive-definite matrix, there exists a matrix H such that

$$HVH' = I \text{ and } H'H = V^{-1}.$$

Then, by transforming the original model by premultiplying all variables by H, we have

$$HY = HXB + H\mu$$

Ordinary least-squares estimates of the above equation will be the same as generalized least-squares estimates of the equation $Y = XB + \mu$.

In cross-section econometric analysis, it is generally reasonable to assume that the covariance of the residuals are zero, but often it is believed that the variance of μ is not the same for each observation. Since we cannot in fact observe the "true" variance-covariance matrix, it is necessary to make reasonable assumptions about it. Under certain circumstances it is believed that heteroscedasticity, the condition where the variance of the disturbance term is a function of the nature of the observation i, is likely to exist.

One such circumstance is the case where all observations are group means, the group are of unequal size, and individual observations are not available. This case is a description of what in fact occurs in estimating equation 2.1. The school systems are of varying size and the observations on teacher characteristics are mean observations for the entire system. If we assume that the variance of the residual for each individual teacher would be the same, (and equal to σ^2), and that the within group variances are the same, then the variance of the group mean is equal to σ^2/n, where n is the size of the group. (For size, the variable used was population of the town).

In this case, the matrix V is equal to:

$$V = \sigma^2 \begin{bmatrix} 1/N_1 & 0 & 0 & 0 & 0 \\ 0 & 1/N_2 & \cdots & & \\ \cdot & & & & \\ \cdot & & & & \\ 0 & 0 & \cdots & & 1/N_T \end{bmatrix}$$

and it can be easily shown that H is equal to:

$$H = \begin{bmatrix} N_1 & 0 & \cdots & 0 \\ 0 & N_2 & \cdots & 0 \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ 0 & & & N_T \end{bmatrix}$$

Thus, assuming that the source of heteroscedasticity is the difference between the variance of the error term for observations of group means resulting from differences in the size of the group for which the observation was computed, weighting each observation by the square root of the size of the group, and applying ordinary least squares to the transformed observations, will yield best-linear unbiased estimators.

The problem with using the above weighting scheme in estimation of the quality-supply function for teachers in the Boston SMSA is that it is not clear that it is reasonable to assume that the within-system variances are the same for all systems. In particular, the city of Boston is much less uniform internally than many of the suburbs. For this reason, it is not entirely clear that the standard weighting scheme used above will yield more efficient estimators than ordinary least squares applied to the individual observations. A simple test for heteroscedasticity performed in an earlier version of this paper showed no evidence that the size of the residual, computed using ordinary least squares, was correlated in either direction with the size of the observation.

B. Expanded Description of The Sample

In the next few pages, an expanded description of the samples of data used in estimating the quality-supply function for teachers in the state of Massachusetts is presented.

Tables A1.1 and A1.2 list means, variances, and coefficients of variation for all variables used in the Boston S.M.S.A. sample and the statewide sample.

Some points regarding construction of the variables, and how some of the special data problems were handled are worth mentioning.

i) Much of the available data, as can be seen from Tables 2.1 and 2.2, are for different years. Thus, we are regressing mean teacher salary in 1968-69 on teacher and student characteristic variables for 1968-69 and population characteristics, some which refer to the year 1960. Since census data is not collected annually, and alternative sources were not available for much valuable information, there is little that can be done about the problem. If the characteristics of the various towns and cities did not change much, relative to each other, then there is no problem in using data from different years. Some evidence that the relative change wasn't great is that a) the median income and percent of employed professional, technical and kindred variables both had very high t-values in many of the regressions despite the fact that they were being correlated with 1968-69 variables, and b) the two non-white variables, though collected for different years, nine years apart, were still almost perfectly correlated with each other. The variable POPGRO, a measure of the rate of population expansion of a town between 1930 and 1965, was still used as a check on the possible effect of different relative rates of growth. The coefficient of POPGRO was significant only in one set of regressions.

ii) The towns chosen to be included in the final sample were all towns with separate secondary school systems. Those towns in the state which share in regional secondary systems were eliminated from the sample, because of the difficulty in knowing which data to use for the corresponding census variables. There are 180 such towns in the state, 66 in the Boston S.M.S.A. Only 137 towns were used in the statewide sample. The reason for the elimination of the extra 43 was the incompleteness of the data in many of the individual town monographs. If the monograph did not include data on the racial characteristics and job characteristics of the population, the town was eliminated from the sample.

For the included towns, some of the observations for the variables STMALE, SSTRAT, APPC, ETMALE, ETCERT, IRITAL, SSVSAT, and SSMSAT were missing. It was decided to use estimates of these observations, since discarding the entire observation would have resulted in the loss of much information. The estimates were calculated as follows: 1) The

Table A1.1

Means, Variances and Coefficient of Variation
Variables in Boston S.M.S.A. Sample

Variable Name	Mean	Variance	Coefficient of Variation
STSAL	7935.35	447464.0	0.084
STYPS	8.60197	7.32994	0.315
STED	9.99682	0.114741	0.34
STMALE	49.0279	52.9388	0.148
STGOS	28.3923	106.911	0.364
ETSAL	7626.94	306371	0.073
ETYPS	9.60257	7.22649	0.280
ETED	9.55257	0.168005	0.044
ETMALE	12.2433	32.2084	0.464
ETGOS	24.4824	141.113	0.485210
ETCERT	88.1126	164.519	0.146
ASNW	1.87667	16.8480	2.187
PROFTK	16.9697	26.9054	0.306
ADPC	0.457727	0.309	1.215
POPFOR	36.4913	59.0995	0.211
IRITAL	10.7768	31.4943	0.521
MEDINC	7422.03	1353.80	0.182
VALPRP	6846.11	3583360	0.276
POPDEN	4077.80	20353500.0	1.10635
CITY	0.0151515	0.0151515	8.124
POPNW	0.660454	1.85223	2.061
POIGRO	247.508	27675.0	0 672
SSTRAT	22.8485	5.532	0.103
ESTRAT	25.9060	4.02613	0.077
POVTY	8.41060	3.41616	0.406173
RUSS	2.21364	16.2080	1.81869
DISEOS	12.3333	35.8564	0.486
SISS	1143.35	197113	0.388
SSVSAT	474.864	533.473	0.048
SSMSAT	507.818	726.582	0.053

Table A1.2

Means, Variance and Coefficients of Variation
Variables in Statewide Sample

Variable Name	Mean	Variance	Coefficient of Variation
STSAL	7535.82	460314	0.090
STYPS	8.27598	7.23323	0.325
STED	9.78562	0.172703	0.042
STMALE	52.0307	68.7526	0.159
STGOS	29.2423	110.500	0.359
ETSAL	7356.63	304639	0.075
ETYPS	9.82109	7.65316	0.282
ETED	9.09533	0.264245	0.057
ETMALE	11.3020	31.6426	0.498
ETGOS	23.4325	129.597	0.486
ETCERT	88.2634	188.530	0.156
ASNW	1.88051	14.4732	2.023
PROFTK	13.6601	29.3638	0.397
ADPC	0.502	0.242	0.980
POPFOR	36.7087	55.1176	0.202
IRITAL	8.949	31.4763	0.627
MEDINC	6712.35	1603740	0.189
VALPRP	6868.84	5278550	0.379
POPDEN	2517.79	12846700	1.424
CITY	0.0948905	0.0865178	3.100
POPNW	0.691241	1.85169	1.969
POPGRO	208.271	18864.2	0.659
SSTRAT	23.1431	7.04327	0.115
ESTRAT	26.6073	5.90992	0.091
BOSTON	0.00729927	0.00729927	11.704
SMSA	0.459854	0.250215	1.088

missing variable was regressed on STSAL. if a secondary teacher variable, ETSAL, if an elementary teacher variable, and MEDINC if a socioeconomic variable. A sub-sample including only those observations for which all data was available was used for these regressions. If the t-value in the regression was greater than two, the missing observation was predicted from the regression; otherwise the mean value of the missing variable was used for all observations for which it had been missing. In no case were more than 8 observations missing for any included variable.

None of the teacher characteristic variables, except percent male, and none of the racial data was missing from any included observation before the above adjustments.

Table A1.3 lists the towns in the Boston SMSA sample. Table A1.4 lists the towns in the statewide sample.

The variables used in the regressions were constructed as described in Tables 2.1 and 2.2, except for SPSS. SPSS is a weighted average of students per secondary school, constructed from data on the size of individual junior high and high schools. The weights are students per secondary school. If the student-teacher ratio is the same in each school within a system, the variable can be interpreted as the average size of school faced by each teacher.

$$SPSS = \frac{Xi^2}{Xi}$$

where Xi = students in each secondary school.

Table A1.3

Towns in SMSA Sample

Arlington	Natick
Ashland	Needham
Bedford	Newton
Belmont	North Reading
Beverly	Norwood
Boston	Norwell
Braintree	Peabody
Brookline	Quincy
Burlington	Randolph
Cambridge	Reading
Canton	Revere
Chelsea	Rockland
Cohasset	Salem
Danvers	Saugus
Dedham	Scituate
Duxbury	Sharon
Everett	Somerville
Framingham	Stoneham
Hanover	Swampscott
Hingham	Wakefield
Holbrook	Walpole
Hull	Waltham
Lexington	Watertown
Lynn	Wayland
Lynnfield	Wellesley
Malden	Wenham
Manchester	Weston
Marblehead	Westwood
Medfield	Weymouth
Medford	Wilmington
Melrose	Winchester
Millis	Winthrop
Milton	Woburn

Table A1.4

Towns in Statewide Sample

Andover	Lawrence	Reading
Arlington	Lee	Revere
Ashland	Leicester	Rockland
Attleboro	Lenox	Rockport
Auburn	Leominster	Salem
Avon	Lexington	Saugus
Ayer	Longmeadow	Scituate
Barnstable	Lowell	Seekonk
Bedford	Ludlow	Sharon
Bellingham	Lynn	Shrewsbury
Belmont	Lynnfield	Somerset
Beverly	Malden	Somerville
Billerica	Manchester	Southbridge
Blackstone	Marblehead	Spencer
Boston	Marshfield	Springfield
Braintree	Medfield	Stoneham
Brookline	Medford	Stoughton
Burlington	Melrose	Sutton
Cambridge	Methuen	Swampscott
Canton	Middleborough	Swansea
Chelmsford	Milford	Taunton
Chelsea	Millbury	Tewksbury
Chicopee	Millis	Wakefield
Clinton	Milton	Walpole
Cohasset	Montague	Waltham
Danvers	Natick	Ware
Dedham	New Bedford	Warren
Dracut	Newburyport	Wayland
Duxbury	Newton	Wellesley
East Bridgewater	North Adams	Wenham
Easton	Northampton	Westborough
Everett	North Andover	West Boylston
Fall River	North Attleborough	West Bridgewater
Falmouth	Northbridge	Westfield
Fitchburg	North Brookfield	Weston
Foxborough	North Reading	Westport
Framingham	Norwell	West Springfield
Franklin	Norwood	Westwood
Gardner	Oxford	Weymouth
Greenfield	Palmer	Wilmington
Haverhill	Peabody	Winchendon
Hingham	Pittsfield	Winchester
Holbrook	Provincetown	Winthrop
Holyoke	Quincy	Woburn
Hopkinton	Randolph	Worcester
Hudson		
Hull		

APPENDIX II

In this appendix, some regression results from alternate specifications of the equations used in chapter 3 are presented.

The final variables used in all the regressions in chapter 3 were selected by the stepwise regression procedure. Stepwise regression is justified when there is no a priori reason to conclude that one independent variable ought to belong in an equation rather than another. In the regressions of chapter 3, many independent variables, particularly among the socioeconomic indicators, were tested which essentially represent similar phenomena. Several different measures of racial composition and of the incidence of poverty were tried, as well as a number of measures of a community's ability to pay. There was no inherent reason to believe one to be a more relevant variable than another.

The stepwise regression procedure is performed as follows:[1]

1) Regress mean salary (dependent variable) on all the independent variables, independently choosing the one with the highest R-square to enter the equation.

2) Regress the dependent variable on the originally selected variables plus all other variables added to it separately. Choose as the second independent variable to enter the regression the one which adds the most to the R-Square.

3) Keep repeating step 2) until none of the variables being added have a t-value equal to or greater than 1.7.

4) If any of the included variables has a t-value less than 1.7, when a new variable, with a higher t-value is added, drop the old variable from the regression.

The rules listed above were departed from in two ways. One, all the teacher characteristic variables were added before any socioeconomic variables were tried. Second, when data from a new source became available, that variable was added midway in the selection procedure to the list of variables being introduced on each round.

All final regressions listed in chapter 3 only include variables with t-statistics at least equal to 1.7. An attempt was made to add all of the non-included variables to each final regression; none were statistically significant.

All variables were entered linearly, except for a few which it was believed might possibly be non-linear. As explained in chapter 3, a square root term was used for the teacher experience variable. Square terms were entered for the variables POVTY, POPNW, ASNW, ADPC, on the hypothesis that perhaps the compensating salary differential required might be increasing more than proportionately with the percent students non-white, or with the percent of families below the poverty line. Except for two regressions including the variable POVTY, the linear term in all cases fit better than the square term.

In chapter 3, it was explained that multicollinearity between the percent students non-white and a dummy variable for the city of Boston made it difficult to know whether race, or some other attribute unique to the central city, was behind the discrimination coefficient. Table A2.1 shows the results of three alternative specifications for the secondary teachers equation for the Boston SMSA.

Table A2.2 shows the effect of adding the two central city dummy variables, BOSTON, a dummy for the city of Boston, and CITY, a dummy for the central city of any Metropolitan area, to the regression equation for secondary teachers in the statewide sample. When the non-white variable is excluded, a "central city" coefficient remains for the city of Boston, but the sign attached to the coefficient of CITY is not significantly different from zero. There is no indication that a central city per se requires a higher teacher salary. Second, when the non-white student variable ASNW is included, adding a central-city dummy does not contribute significantly to the regression, no matter which variable is used, and the coefficient of ASNW remains positive and statistically significant (although slightly smaller when BOSTON is added).

In estimation of the Tufts sample, multicollinearity was much more serious than in estimation of the SMSA sample, thus clouding the interpretation of the results. Table A2.3 shows the simple correlation matrix of the variables ASNW, POPNW, CITY and ADPC. Table A2.4 presents quality-supply estimates for the sample of Tufts teachers with the four above-mentioned variables entered separately.

It can be seen from Table A2.4 that each of the four variables, when added to the regression, contribute significantly to the variance in teacher salary. The "non-white student" coefficient may be interpreted also as a "poverty-avoidance" coefficient and a "central city" coefficient. The variables ASNW, POPNW, and ADPC are so closely correlated that random noise may in fact be responsible for the individual signs of the coeffi ients in Tables 3.12-3.15. The size of the non-white coefficient measured in Table A2.4 is $32.00 per teacher per additional percent students non-white, a slightly higher coefficient than the one estimated from the SMSA and statewide samples.

Table A2.1

Alternate Specifications for Secondary Teacher Regression

Dependent Variable: STSAL

Coefficients (t-statistics in parenthesis)			
Independent Variable	ASNW added	CITY added	Both added
STED	813.977 (6.32)	803.713 (6.23)	807.262 (6.25)
STMALE	18.4317 (4.07)	18.3424 (4.05)	18.3787 (4.05)
$(STYPS)^{1/2}$	741.944 (9.69)	789.015 (10.60)	761.905 (9.53)
MEDINC	0.149329 (4.61)	0.147077 (4.55)	0.149517 (4.61)
ASNW	24.0197 (3.13)	. . . .	13.3506 (0.93)
CITY	. . . .	758.512 (3.11)	401.420 (0.88)
Constant	-4407.73	-4386.80	-4383.27
R-Square	.8839	.8838	.8854
F-statistic	91.3856	91.2326	76.0086
N	66	66	66

Table A2.2

Alternate Specifications for Secondary Teacher Regression

Dependent Variable: STSAL

Sample: State of Massachusetts

Coefficients (t-statistics in parenthesis)

Independent Variable	ASNW added	CITY added	BOSTON added
STYPS	-204.007	-175.265	-164.722
	(2.42)	(2.00)	(1.92)
STED	435.193	464.941	454.962
	(5.26)	(5.39)	(5.40)
$(STYPS)^{1/2}$	1915.41	1779.69	1726.94
	(3.96)	(3.52)	(3.50)
SMSA	267.985	294.084	260.839
	(4.37)	(4.50)	(4.14)
MEDINC	0.155772	0.136855	0.144610
	(5.55)	(4.73)	(5.11)
ASNW	26.1907	. . . .	. . . .
	(3.67)		
CITY	. . . .	88.1197	. . . .
		(0.89)	
BOSTON	. . . .		845.784
			(2.72)
Constant	-1690.46	-1678.26	-1552.69
R-Square	.8156	.7978	.8075
F-Statistic	95.8343	85.4757	90.8973
N	137	137	137

Table A2.2 (cont'd)

Independent Variable	Coefficients (t-statistics in parenthesis) ASNW and CITY added	ASNW and BOSTON added
STYPS	-205.231 (2.43)	-197.043 (2.32)
STED	434.786 (5.24)	436.001 (5.25)
$(STYPS)^{1/2}$	1928.54 (3.97)	1879.53 (3.85)
SMSA	260.347 (4.11)	263.585 (4.26)
MEDINC	0.155162 (5.50)	0.155924 (5.54)
ASNW	27.7278 (3.57)	22.5517 (2.47)
CITY	-52.6829 (0.51)	. . . .
BOSTON	. . . .	249.032 (0.64)
Constant	-1703.91	-1648.12
R-Square	.8160	.8162
F-statistic	81.7169	81.8293
N	137	137

Table A2.3

Simple Correlation Between Selected Variables
Tufts Sample

	ASNW	POPNW	ADPC	CITY
ASNW	1.00	0.99	0.94	0.95
POPNW	0.99	1.00	0.95	0.94
ADPC	0.94	0.95	1.00	0.93
CITY	0.95	0.94	0.93	1.00

Table A2.4

Quality-Supply Estimates: Tufts Sample
Under Alternate Specifications
Dependent Variable: SALARY

Independent Variable	ASNW added	POPNW added	CITY added	ADPC added
MASTER	427.535 (7.49)	419.625 (7.13)	428.077 (7.02)	417.750 (6.64)
SPEC	-218.780 (2.45)	-208.201 (2.26)	-193.611 (2.03)	-197.689 (2.00)
SEX	-156.405 (2.52)	-154.180 (2.41)	-142.547 (2.15)	-146.439 (2.12)
POPDEN	0.0200617 (2.86)	0.0247793 (3.47)	0.0339769 (4.88)	0.0258047 (2.98)
MEDINC	0.268659 (12.37)	0.277649 (12.24)	0.266943 (11.45)	0.285352 (11.28)
ASNW	32.0835 (8.58)	. . . .	. . . .	. . . .
POPNW	. . . .	93.9469 (7.54)	. . . .	. . . .
CITY	. . . .	. . . .	666.501 (6.30)	. . . .
ADPC	. . . .	. . . .	. . . .	226.962 (4.97)
Constant	5403.31	5325.77	5423.66	5255.54
R-Square	.6470	.6238	.5971	.5700
F-Statistic	61.0848	55.2723	49.3918	44.1891
N	207	207	207	207