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ABSTRACT

A demand-supply model, consistent with earlier status consistency models, for the distribution of private physicians within a city is presented, and the effect of the race of the potential client population is examined. The results indicate a substantial effect of race on physicians' locations net of the other variables in the model, although this effect can be eliminated if aggregate areal income is very high. The data suggest a threshold value in physicians' locational response to income. As the data are cross-sectional, the results must be interpreted with caution; however, the size of the regression coefficients offers little support for proposals that seek to redistribute physicians by means of financial incentives.

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RACE AND URBAN MEDICINE

p. 20 l. 6 should read
cent increases the number of physicians by only 0.029![15]

p. 20 l. 9 should read
incomes, but it is noteworthy that the effect of raising incomes is virtually the

p. 31 Table 5 should be corrected to read as follows:

TABLE 5

Increase in Number of Physicians Produced by a Unit Increase in Independent Variables of Revised Model
Chicago, 1960

	All Physicians	General Practitioners	Specialists
Population (in 000s)	.277	.209	.072
Pct. Commercial Area	.103	.082	.029
No. of Hospitals	1.344	.616	.739
CBD	6.853	2.674	9.292
Pct. 25 yrs. old or older	.058	.038	.020
Pct. H.S. Grad. Plus	.023	.019	.013
Pct. $10,000 Plus	.029	.017	.015
Black	-.227	-.248	-.040

Park's observation that spatial relations reflect social relations is as applicable to the relations between social institutions and individuals as to the relations among individuals (Park, 1952:177). As Hughes noted, the resolution of status problems created by the auxiliary status characteristics of an institution frequently will involve the social segregation of potential clients from its services (Hughes, 1945:35). Medical practice in a city is illustrative. The spatial distribution of physicians within a city may be seen as the result of attempts by physicians to secure desirable practices consistent with their status preferences and the status characteristics of potential clients.

The problem has been earlier addressed by Lieberson (1958) with regard to the extent to which physicians of a particular ethnicity locate themselves among their own ethnic group. However, this paper takes a different approach to the general question. It sets forth a model of the supply of and demand for physicians' services within a city and in this context examines the effect of the race of the potential client population on the supply.

Prior research on physician distributions has been almost entirely restricted to areal units of county size or larger and focused on the economic factor as the chief determinant. Rimlinger and Steele (1963) demonstrated a correlation between per capita income and physician-population ratios for counties grouped by degree of urbanization. Similarly, Benham et al. (1968) showed that the distribution of physicians across states correlated above .90 (multiple r) with population, per capita income, and physician income.

In a more elaborate study Marden (1966) examined the distribution of general practitioners and specialists across metropolitan areas using age as a measure of the need for care, education as a measure of the ability to pay for it, percent nonwhite as a measure of the learned predisposition for it, and number of hospital beds as a measure of the availability of supporting facilities, and found that these four variables, together with population, could account for 59 to 96 percent of the variance, the amount depending upon the size category of the metropolitan areas within which the analysis was performed. Garner (1970), in an extension of Marden's work for metropolitan areas with populations of more than one million, devised several measures of need, learned predisposition, ability to pay, supportive facilities, and alternative sources of care, and found that they explained substantial proportions of the variance of the distribution of several specialty groups. However, net of SMSA population, they added no significant amount to the explained variance. Weiss (1964) also extended Marden's work, demonstrating that the number and complexity of medical support facilities (hospitals, clinics, schools, etc.) was substantially related to the number of physicians.

Studies of distributions within cities have also emphasized the economic factor. In a study of Buffalo, Rochester, and Syracuse, Terris and Monk (1956) showed not only that the economic status of an area was related to its physician-population ratio but that, with the exception of specialists, the effect of the economic factor increased over time. Similarly, a Chicago Board of Health study (1966) found that the physician-population ratio for the 24 community areas designated as poor was half that for the rest of the city. Finally, in two studies, the Lieberson piece mentioned earlier and a study of physician movements in Chicago by Rees (1967), income appears only implicitly. In Lieberson's work physicians' desire to maximize their incomes would appear to lie behind their tendency to locate among their own ethnic group. And the same desire undoubtedly partly lies behind Rees' finding that physicians have moved their offices to follow the suburbanization of the high income population.

The question raised here is whether controlling for constraints on supply and the three components of the demand for physicians' services--ability to pay for, disposition for, and need for them--physicians are less likely to be found in black than in white areas of the city. If they are, we shall interpret that fact as an indication of the desire of white physicians to avoid black areas because of negative valuations placed upon the auxiliary status characteristics of the residents. Independently of this issue, the model is the most comprehensive attempt to date to account for the distribution of physicians within a city.

We shall present what may be termed an economic model for physicians' locations. But it is quite consonant with a status consistency argument since physicians who locate themselves so as to maximize their incomes usually will be locating themselves in areas which have status characteristics consistent with their own. Simply put, the highly educated, highly rewarded physicians will seek highly educated, highly rewarded potential patient populations. Thus Lieberson's arguments follow from an economic model, albeit not a simple one. The fact that some physicians tend to locate among their own ethnic groups means simply that, in a competitive situation, they seek to take advantage of whatever preferences members of their ethnic groups have for giving their business to members of the same group. Their behavior is not less economic for doing so. We shall assume that physicians seek locations in order to maximize their incomes and that they will charge what the traffic will bear.[1]

THEORETICAL FRAMEWORK

1. Factors Affecting Demand for Physicians' Services

Ability to pay. That ability to pay should affect the demand for physicians' services seems intuitively reasonable and is documented by National Health Survey data which show that use of physicians increases with income (U.S. National Center for Health Statistics, 1965:Table 7). Accordingly, physicians can be expected to locate in high income areas, although such locations should be more important for specialists as they are used most heavily by high income populations (USNCHS, 1964: Table 5). Not only are high income populations better able to afford the additional cost of specialists, but they also are more likely to use them as their primary physicians (USNCHS, 1968:Table 18).

Cultural predisposition. Cultural predispositions have been long cited to explain use of physicians in particular and health knowledge, attitudes, and behavior in general. Theoretically, the concept has generally referred to the extent to which a person's culture defines health as susceptible to scientific control, but operationally its meaning is less clear. For some, it has referred to cultural differences between social classes (e.g., Koos, 1954); for others it has meant differences in ethnicity (Saunders, 1954; Paul, 1955; Zborowski, 1956; Croog, 1961; Suchman, 1964), ethnic parochialism (Suchman, 1964; 1965), religion (King, 1962), or education (Feldman, 1966).

But there is growing evidence that education can explain most (though not all) of the differences attributed to the other measures of cultural predisposition. Suchman (1965) found that the relationships between a measure of ethnic variations in health orientations and several health behaviors (including use of physicians) disappeared when an index of socioeconomic status based on education was controlled. Feldman (1966:109) and Samora et al. (1962) found that when education is controlled, most of the differences in health knowledge due to income or occupation disappear; but when occupation or income is controlled, the differences by education remain. The sometimes forgotten point of these findings is that formal education creates a common culture--one which places a high value on medical care.

Thus physicians' response to demand created by cultural predispositions is probably mostly engendered by education, and it can be expected that, other things equal, the higher the educational level of an area, the greater the number of physicians serving it. Moreover, since use of specialists implies greater sophistication and knowledge about medical care, specialists can be expected to locate more responsively to a population's educational level than general practitioners.

Need. However else individuals may vary in terms of need for medical care, all find their need for it increases with age. As they age, their health is less likely to be protected by others, their resilience lessens, and their defenses decline; they need increasing care, and they use it increasingly (USNCHS, 1966). Since physicians learn these facts in their training and observe them in their practices, they can be expected to influence where practices will be established. While there are doubtless other dimensions of need which affect physicians' locations, none are so visible or so universal.

Population size. Other things equal, the number of physicians a fixed area will be able to support will increase with the size of its population. The above three demand factors describe how, given populations of equal size, physicians will distribute themselves with regard to population composition. However, as populations increase in size, the absolute magnitudes of the demand factors also increase; consequently they can support more physicians.

2. Factors Affecting the Supply of Physicians

Availability of office space. Although it is a factor so obvious as to be neglected, the relative availability of suitable office space across a city will affect where physicians locate. Other things equal, some areas, by virtue of their devotion to residential or industrial uses, will lack physicians, while other areas, with large commercial sections, will have them in heavy concentrations. Commercial sections offer the physician space and the kind of traffic helpful in establishing and maintaining a successful practice.

Availability of hospital services. There are two opposing arguments for the effect of hospitals on physicians' locations. The first asserts that the supportive facilities of hospitals attract physicians; the second says that the outpatient clinics and emergency rooms of hospitals compete with private physicians, causing them to locate at distance. The first argument follows from the fact that most physicians require the use of hospital facilities, and many spend a substantial fraction of their working hours within them. Consequently, to the extent that physicians depend upon hospitals, it can be expected that they will locate close to them so as to reduce unproductive travel time. In gross terms, this means that specialists are more likely to locate near hospitals than are general practitioners, since the former's dependence upon them is typically greater. Indeed, some spend almost all their working time there, obtaining patients through referrals from physicians throughout the city.

In contrast, the second argument derives from the assertion that physicians cannot compete with the free and low cost outpatient hospital services. However, there is little to support this position. While it is true that use of outpatient facilities increases as income decreases, it cannot be argued, as is sometimes done, that low income people prefer clinics. Indeed, the data support the opposite conclusion: people prefer private physicians and will use them to the extent they can afford them. For example, Kosa (cited in Roth, 1969:221) found that the percentage of clinic patients with repeat visits varies inversely with income. Similarly, USNCHS data show that use of clinics decreases as income increases (USNCHS, 1965:Table B). And some part of the hospital usage among low income blacks is also caused by the referrals of black general practitioners who fear competition from black specialists (Reitzes, 1958).

Accessibility to supporting population base. Other things equal, all physicians require a population base of some minimum size to support their practices. But a general practitioner, who sees the widest range of complaints, needs a far smaller population base than a specialist, who sees fewer complaints and those which are relatively rare in the population. Since the area of a city most accessible to the largest population is usually its central business district (CBD), specialists can be expected to locate there (Terris and Monk, 1956).

The effect of race. Physicians' attitudes toward black patients appear never to have been systematically studied, but few would doubt the existence of considerable prejudice. This feeling is bolstered by studies of physicians' attitudes toward the poor. Fredericks et al. (1969) found that over 40 percent of a random sample of U.S. physicians surveyed by mail thought that "[a] dissolute way of life is the cause of many diseases among the poor." Roth (1969:226-28) summarized his studies of physicians' attitudes toward the poor by saying that they thought them dirty, smelly, unreliable with respect to directions and appointments, observing poor health practices, and generally living in unhealthy conditions. Fredericks et al. (1969) reported that less than 20 percent of their sample thought that every physician should serve two years in a poor area before "settling down." Clearly, the general implication is that a practice among the poor is to be avoided. If racial prejudice is added to these views, physicians' reactions can be expected to become even more intense. Consequently, we expect physicians to avoid black areas, other things being equal.

In summary, the discussion above outlines a basic model for the distribution of physicians within cities comprised of eight factors, four affecting demand and four affecting supply. Put another way, the model consists of population, four population composition factors, and three ecological factors. Since some of these factors are expected to operate differently on specialists than on general practitioners, separate specifications of the model will be given for the two types of physicians.

THE DATA

We shall examine the model in terms of the spatial distribution of physicians in Chicago in 1960. The basic areal unit or market area for a physician in the analysis is the census tract, although larger units are also considered. The data for tracts are the most comprehensive available for subareas of cities, and the measures of the population factors are drawn from the published tract statistics (U.S. Bureau of the Census, 1962).[2] The measure of market area income will be the percent of tract families with $6000 or more annual income. The measure of market area education will be the percent of the tract's population, 25 years old or older, with at least a high school education.[3] The age of the population will be represented by the percent 25 years old or older.[4] A tract is coded black if at least 90 percent of its population is black; otherwise it is coded white.[5] Market area population is given as tract population.

Data on the location of hospitals were obtained from the directory of the American Hospital Association (1960).[6] The availability of accessible office space is indexed by the percent of a tract's area devoted to commercial use as computed from the Chicago Land Use Map (Chicago

Plan Commission, 1961). The Chicago CBD consists of the tracts comprising Chicago's Loop area (Kitagawa and Taeuber, 1963).

Finally, the information on physicians and their office locations was drawn from the Directory of the American Medical Association (1961). Data were gathered on all physicians in Chicago who were in private practice and under the age of 70. By restricting the study to physicians in private practice, we eliminate interns, residents, and all physicians employed full-time by governmental agencies, hospitals, educational institutions, and private companies. Few among them make relevant locational decisions that significantly affect the delivery of direct, public medical care. By arbitrarily retiring physicians at the age of 70, we seek to limit the analysis to those in full-time practice. These restrictions reduced the population of physicians from 6735 to 4208, and all further references are to this smaller figure.

Because the nature of medical practice differs for general practitioners and specialists, we examine their distributions separately as well as jointly. We shall define general practitioners as all those who define themselves as general practitioners plus those who call themselves internists, obstetrician-gynecologists, and pediatricians.[7] Although the latter three types of physicians seek identification as specialists, the decline in the number of general practitioners, the increasing restrictions placed upon their use of hospitals, and the growing patient preference for the expertise indicated by specialization increasingly have required these specialists to take on the functions of general practitioners. All other specialists are classified as specialists. In terms of this classification, 2451 physicians were general practitioners and 1757 were specialists in 1960. All the physicians' distributions across census tracts are skewed to the right; consequently they are analyzed in log form.[8]

Means and standard deviations for all variables (except the CBD and race dummy variables) are given in Table 1 for all tracts and for white and black tracts separately. The six tracts comprising the CBD are included in the figures for all tracts but are excluded from the data for white tracts in order to avoid exaggerating the differences in the average numbers of physicians: 945 physicians are located in the CBD.

But despite this adjustment, substantial differences in the numbers of physicians exist between white and black tracts. On average, there are over three times as many physicians of all types, more than two and

Table 1 About Here

one-half times as many general practitioners, and five times as many specialists in white as in black tracts. Nor is there evidence of a compensating difference in the number of hospitals, since black tracts average one-third as many as white tracts. In ratio to population, the figures in Table 1 amount to one hospital for every 51,000 whites and one hospital for every 125,000 blacks. Thus blacks would appear to lack access to the major alternatives to private physicians--hospital clinics and emergency rooms--as well as to the physicians themselves. Moreover, the data probably overstate blacks' access to hospital care since the county (the responsible agency) paid for the care of the indigent only at its own hospital, and many hospitals continue to discriminate against blacks (Reitzes, 1958:104-112; Morrill and Earickson, 1969).[9]

But black tracts also show less demand for physicians in terms of measures in Table 1. They are younger, less well educated, and substantially poorer than white tracts. Thus it is possible that the differences in the number of physicians can be accounted for by differences in the levels of demand and available hospitals.

FINDINGS

If this is the case, then the racial composition of a tract should have no effect on the distribution of physicians net of the other variables. But the partial regression coefficients for the equation for all physicians given in the first column of Table 2 contain a substantial negative effect for race, as predicted, indicating that the compositional differences of Table 1 are not an adequate explanation. At the same time,

Table 2 About Here

comparison of the coefficients for race in the second and third columns reveals the race effect is almost entirely on general practitioners. The race coefficient for specialists is less than half its size for general practitioners and only slightly larger than its standard error. The explanation for this finding appears to lie in the extremely high degree to which specialists are clustered. Forty-six percent are located in six tracts, one of which is both black and the site of a major medical center. It is the existence of this tract which diminishes the otherwise substantial effect of race.

More generally, comparison of the coefficients for general practitioners and specialists reveals partial support for the predicted differences between them and other differences which, while not anticipated, are quite consistent with those predicted. There is no evidence of the expected differences in the effects of income and education; in fact the income effect has the wrong sign and is unstable. (This is somewhat surprising but not unaccountable, and it will be explored further below.) However, as predicted, the concentration of specialists in the CBD is documented by a CBD coefficient for them three times as large as for general practitioners, and specialists' greater reliance on hospitals is shown by a hospital effect one-third larger for them than for general practitioners. Consistent with these differences, general practitioners are more affected by local populations and commercial space. The population coefficient for general practitioners is twice that for specialists, and the coefficient for commercial space is two and one-half times greater for general practitioners than for specialists.

In relative terms, the demand factors appear to have a good deal more effect than those which facilitate supply. In all three equations, the standardized coefficients indicate that the most important variables are those which refer to population size and composition: tract population, age, and education.

What remains unexplained in Table 2 is the negative income effect which, although small and unstable, is consistent across the physician groups. Such a finding is not intuitively plausible, since it implies that as market area income rises, the number of doctors declines. A reanalysis of the data using a higher income variable, percent above $7000, produced only a stronger negative effect.

A test for what may be termed "shape effects" was therefore performed using a procedure analogous to the examination of curvilinearity with dummy variables. In an ordinary dummy variable test for curvilinearity, a variable is divided into a set of mutually exclusive variables and an observation is described by one of these. The nature of the curvilinearity is then estimated from the pattern of the coefficients across the entire set. However, in aggregate data such as for tracts, an individual level variable will have a distribution within as well as across the aggregates, and thus one cannot define ordinary dichotomous dummy variables. However, it is possible to assess the effect of the shape of the distribution of a variable by dividing it into a set of variables, each representing the proportion of disaggregated observations within specified boundary values. For example, the income variable can be divided into a variable for the percent of families with incomes below $3000, a variable for the percent with incomes between $3000 and $5999, and so on. Theoretically and generally empirically, an aggregate can have a nonzero value for every variable in the set. Taken together, they characterize the shape of the distribution within an aggregate, and over all aggregates, they describe an unweighted sum of the within-aggregate distributions.

As applied to the present case, the procedure involved dividing the income distribution into seven categories for which seven variables were created. Of these, six were entered into the equations for shape effects reported in Table 3. The remaining variable, the percent of families with incomes below $3000, was omitted as it is an exact function of the remaining incomes variables, and its inclusion would render the variance-covariance matrix singular.

Table 3 About Here

Inspection of the coefficients for these variables reveals negative effects except for the highest income variable, the percent of families with incomes of at least $10,000. Thus it would appear that, net of the other variables, physicians are attracted only by unimodal income distributions with a mode at least $3300 or 149 percent greater than the city median family income or $4000 or 160 percent greater than the national median family income. Moreover, since the income effects are measured as deviations from the omitted lowest income category, the fact that there is an increase in the absolute value of the raw coefficients from $3000 to $8999 suggests that families living in middle income areas may have slightly less access to physicians than families in low income areas.

The coefficients also explain the negative effect of income in Table 2. Although most families have incomes between $6000 and $9999, Table 3 shows that tract income distributions with a mode within this range are negatively related to physicians' locations. Since by definition, the variable, percent of families with incomes of at least $6000, has such a mode, it generates negative coefficients.

These findings suggest that to obtain a positive income effect in the basic model it would be necessary to raise the threshold of the income variable to $10,000. This was done, and Table 4 documents that the effects of income are positive and, relative to the other variables, substantial.

Table 4 About Here

However, of greater interest is the fact that the new income variable substantially changes the impact of the other measures of population composition. The most important of these changes is the indication that if tract family income is raised high enough, the negative effect of race on physicians' locations can be eliminated. Roughly speaking, the coefficients for the racial variable in Table 4 are one-half or less their size in Table 2; in two of the three cases, they are less than their standard errors. Although the reductions are less marked, the effects of education and age are also reduced by the new income measure. The reduction is substantially greater for education than for age and results in the replacement of the former by the latter as the population composition variable with the strongest effect on physicians' locations.

In contrast, the new income measure increases the effects of the three ecological variables. Commercial area replaces education as the second most important predictor of all physicians and general practitioners, and CBD supplants education as the most important predictor of specialists. Since the new income variable is less highly correlated with both the commercial area and CBD measures, it appears that the shifts are at least in part due to a confounding of commercial activity with income in the initial model.[10]

DISCUSSION

1. Alternative Definitions of Medical Market Areas

Interpretation of these findings assumes acceptance of the census tract as an appropriate definition of a physician's market area. Yet the choice of the tract was essentially arbitrary, although it is given some plausibility by the fact that the average tract could generate about \$195,000 in revenue for physicians in 1960.[11] In any event, suitable published data for areal units smaller than tracts do not exist. Moreover, there is more reason to believe that market areas might be larger than tracts; it can be argued that some tracts simply will not have populations sufficiently large, wealthy, educated, or needy to attract physicians, and thus the latter will have to serve larger areas. But the difficulty lies in determining an appropriate size for these market areas.

One way of approaching this problem is to characterize tracts in terms of their proximity to populations with a high demand for physicians' services. For example, a measure of the access of tract T_1 to the population in another tract can be computed by dividing the population in the other tract by the linear distance between T_1 and that tract. Summed over all tracts T_2 through T_N we have a measure of the "population potential" of T_1 which can be expressed as

$$\text{Pot } (T_1) = \sum_{i=2}^{N} \frac{P_i}{D_i} .$$

Every tract will have a potential, and potentials can be defined for specific kinds of populations (e.g., the black population) as well as for population size.

Three potential measures were created for this analysis: a simple population potential, a potential for the population with at least a high school education, and a potential for the population with at least \$10,000 annual income. These variables were then separately added to the equations for the revised model to see if they provided any additional explanatory power. They did not; in every instance they account for less than one-hundredth of 1 percent of the variance.[12]

But these potential measures can be criticized in that the use of linear distance in the denominator implies that tracts far from a reference tract are given the same weight as those near it. It seems more reasonable to assume that the closer tracts should be weighted more heavily. Consequently, the potentials were recomputed using the square of distance and the equations were reestimated. But, once again, the potential measures added no explanatory power.

Thus there is no evidence of market areas larger than tracts other than those already indicated by the CBD and hospital variables. It is possible that if market areas were defined in terms of transportation time and cost instead of distance, different results might have been obtained. But it is unlikely: distance and transportation time and cost are usually sufficiently correlated to lead one to expect more substantial results than those observed here if the latter factors were the actual determinants of market size (Meyer et al., 1965).

Consequently, in view of the dependence of general practitioners on local populations noted earlier, it would seem that census tracts are a reasonable approximation to their market areas. In contrast, specialists seem divisible into two groups: those who locate in the CBD or hospital tracts and serve a citywide market and those who locate in outlying tracts and serve local populations. As Reitzes (1958) has pointed out in the case of black specialists, some of these local specialists are probably specialists in name only.

2. Summary and Implications

The data largely support the initial theoretic expectations. Physicians do avoid practice in black areas, although the avoiders are chiefly general practitioners and the desire to avoid can be overcome if aggregate areal income is raised to an extremely high level.[13] Moreover, while a control for the number of hospitals eliminates the differential between black and white areas in the number of specialists, it should be remembered that in ratio to population black areas have fewer hospitals.

Clear differences distinguished the equations for specialists and general practitioners. The effects of the hospital and CBD variables were far greater for specialists than for general practitioners, while the opposite was true for the local population and commercial area variables. These differences were also observable in the standardized coefficients: the most important predictor of specialists was a CBD location; the most important predictor of general practitioners was local population.

However, the most unanticipated results were the negative coefficients for the income variables with cutting points below $10,000. These findings suggest that concern about the poor's access to physicians might well be broadened to include middle income groups.[14] Clearly, physicians prefer to locate among their own status group. That they can afford to express their status preferences in this way is only one more piece of evidence that demand for physicians' services exceeds the supply of them.

Despite requisite caveats to be mentioned subsequently, these findings have arresting implications for proposed federal programs which seek to financially induce physicians to practice in low income and black areas by raising residents' incomes. It is evident that any such programs would have to be extremely expensive if they are to have any substantial impact. A rough idea of the cost may be obtained from Table 5, which gives the increase in the actual number of physicians

Table 5 About Here

produced by a one-unit increase in the independent variables. Raising the percentage of families with incomes of at least $10,000 by 1 percent increases the number of physicians by only 0.012![15] Obviously the table indicates a lag between population shifts and physician relocations and over-time data are necessary to reveal the full impact of raising incomes, but it is noteworthy that the effect of raising incomes is the smallest in the table.

But such financial inducements are only the latest in the series of incentives that have been offered to physicians to locate in particular areas. In the past, the construction of offices, clinics, and hospitals has been tried with mixed success. And the data in Table 5 suggest that such incentive systems may not be the most effective or efficient way to put physicians in needed areas.

Current proposals to create health maintenance organizations (HMOs) which would include poverty program participants paid for by the federal government on a capitation basis may be more successful insofar as they would require the HMOs to locate reasonably close to the poor. That is, if income security is important to physicians, then the HMOs may be able to attract them into areas now lacking them. At the same time, there is little cause for optimism, since the current shortage of physicians implies both little need to be concerned about income security and great latitude in the choice of locations. Under these conditions, the findings of this paper indicate physicians will prefer to locate in high status areas, although it must be noted that the data do not speak directly to the possible effects of income security. On balance, we suspect that it may take direct legislative action to put physicians in areas where they are needed.

To be sure, although there is no reason to believe that Chicago is atypical, these findings describe only one city in cross-section, and their generalizability is thereby limited.[16] Future reports will extend the model to a sample of cities and over time.

NOTES

[1]It can be argued that physicians locate their offices near their homes and with an eye to access to good schools for their children, cultural opportunities, and other amenities. This is said to imply locations in the high status areas for noneconomic reasons. While it is probably true that some physicians use these criteria in choosing their locations, it is less clear that the criteria are without a strong economic component. First, access to good schools and other amenities involve costs and physicians must balance these costs against the potential revenue to be obtained in different locations. Second, the desire to have access to amenities indicates a work-leisure preference which is easier operationalized in high status areas. In such areas physicians can see fewer patients and charge higher fees to obtain the same income as physicians in low income areas who must see more patients at lower fees. In any event, the argument leads to the same predictions as the model proposed here.

[2]The 935 Chicago Census tracts were combined into 809 comparable from 1940-60; following this, the 17 noncentral business district tracts with populations under 200 were eliminated. They represented nonresidential and noncommercial land uses and lacked data on social variables.

[3]In 1960 Chicago's median family income was $6738; median years of school completed was 10.

[4]We recognize that more precise measures could be obtained; the choice of this measure was dictated by the exigencies of the available data.

[5]Chicago's index of segregation (dissimilarity index) was 89.8 in 1960, indicating that that 89.8 percent of the black population would require relocation if each tract's population contained the same proportion of blacks.

[6]The number of hospitals per tract is used in preference to the number of hospital beds as the former's zero-order correlation with the dependent variables is slightly higher.

[7]The American Medical Association's classification of physicians into specialties is based solely on physicians' reports as to the character of their practice.

[8]The actual transformation was $\log_e (x + 1)$, since some tracts had no physicians.

[9]Since 1960, Medicare and Medicaid have made blacks somewhat more acceptable, although administrative and statutory difficulties with the latter program have lessened its potential effectiveness.

(Notes cont'd)

[10]The zero-order correlation between the proportion of families with at least $6000 income and commercial space is -.188; the correlation between the proportion of families with at least $10,000 income and commercial space is -.204.

[11]The revenue figure was estimated by multiplying average tract population (4524) by $43, the average per capita expenditure for physicians' services in 1962 (USNCHS, 1964:48).

[12]Copies of the regressions involving these and the subsequent potential measures are available upon request to the senior author.

[13]Another way to consider how the supply and demand factors reduce the difference in the numbers of physicians in black and white tracts is in percentage terms. If we add 1.0 to the mean number of all physicians in black and white tracts in Table 1 (for comparability to the regressions--since they involve the log of x + 1), subtract the black mean from the white, and divide the difference by the white mean, we find that black tracts have 60 percent fewer physicians on average. To find the percentage differences due to race net of the other variables in the initial and revised models of Tables 2 and 4, respectively, we take the antilogs of the raw coefficients for race and subtract them from 100 percent. This reveals that in the initial model that, net of the remaining variables, race produces an 18 percent difference between black and white tracts in the number of physicians; that is, 42 percent of the original 60 percent difference is accounted for by the other variables in the model. In the revised model, the net difference between the black and white tracts is further reduced to 8 percent.

[14]The suggestion also receives support from the fact that the zero-order correlations between the number of physicians (log form) and the percentage of families with incomes under $3000 is -0.149, while the correlation between the physician variable and percentage of families with incomes between $3000 and $6000 is -0.282.

[15]Some economists have argued that education should be considered a measure of what Milton Friedman has called "permanent" or average long term income. They would sum the education and income effects, interpreting the income variable as a measure of transitory income. While this argument has some validity on the individual level, it is questionable on the aggregate level since one would expect the transitory components of the income variable to average out in the aggregate.

[16]However, tests comparing the cumulative relative frequencies of the residuals with the cumulative probabilities of the standard normal distribution showed that the residuals did not significantly differ from a normal distribution. This is a necessary, but not sufficient, condition for the completeness of the model.

TABLE 1

Means and Standard Deviations for the Numbers of Physicians and Predictor Variables for All Tracts and White and Black Tracts Separately Chicago, 1960

	All Tracts	White Tracts	Black Tracts
No. of Physicians[a]	5.31 (25.99)	5.87 (15.99)	1.69 (2.50)
No. of G.P.s	3.09 (9.12)	2.98 (5.25)	1.16 (1.84)
No. of Specialists	2.22 (17.51)	2.89 (12.79)	.53 (1.00)
Population	4524 (3595)	4591 (3682)	4332 (3021)
Pct. Commercial Area	6.89 (5.85)	6.57 (5.01)	7.59 (7.33)
No. of Hospitals	.08 (.30)	.09 (.32)	.03 (.18)
Pct. 25 yrs. old or older	60.07 (9.28)	61.03 (8.31)	53.24 (10.18)
Pct. H.S. Grad. Plus	31.80 (14.18)	32.80 (14.10)	24.76 (11.20)
Pct. $6000 Plus	54.88 (18.23)	58.83 (15.68)	32.09 (13.87)
N =	792[b]	671[c]	115

[a]See text for definition of physician variables.

[b]The 935 Chicago census tracts were combined into 809 comparable from 1940-60; the 17 non-CBD tracts with populations under 200 were eliminated. They represented nonresidential and noncommerical land uses and lacked data on social variables.

[c]The six CBD tracts are excluded from the base.

TABLE 2

Summary of Analyses of Predictive Model for Physician Distributions Chicago, 1960

	All Physicians[a]	General Practitioners	Specialists
	A. Coefficients in Raw Form		
Constant	-1.314 (.203)[b]	-1.114 (.186)	-1.009 (.165)
Population (in 000s)	.093 (.008)	.086 (.007)	.044 (.006)
Pct. Commercial Area	.031 (.005)	.031 (.005)	.013 (.004)
No. of Hospitals	.338 (.093)	.197 (.086)	.324 (.075)
CBD	1.034 (.345)	.617 (.317)	1.711 (.279)
Pct. 25 yrs. old or older	.023 (.004)	.019 (.004)	.016 (.003)
Pct. H. S. Grad. Plus	.016 (.003)	.013 (.002)	.013 (.002)
Pct. $6000 Plus	-.002 (.002)	-.002 (.002)	-.003 (.002)
Black	-.196 (.092)	-.202 (.084)	-.084 (.074)

TABLE 2 continued

	All Physicians[a]	General Practitioners	Specialists
B. Coefficients in Standard Form			
Population (in 000s)	.338	.352	.209
Pct. Commercial Area	.187	.204	.102
No. of Hospitals	.103	.068	.130
CBD	.091	.061	.197
Pct. 25 yrs. old or older	.219	.199	.194
Pct. H.S. Grad. Plus	.234	.214	.254
Pct. $6000 Plus	-.046	-.046	-.063
Black	-.070	-.081	-.039
$\bar{R}^2$ [c]	.391	.357	.319
N	792	792	792

[a]Physician variables were normalized by taking $\log_e (x + 1)$.

[b]Standard errors of coefficients are given in parentheses.

[c]R^2 corrected for degrees of freedom.

TABLE 3

Summary of Analyses of "Shape Effects" Equations for Physician Distributions
Chicago, 1960

	All Physicians[a]	General Practitioners	Specialists
	A. Coefficients in Raw Form		
Constant	-.637 (.295)[b]	-.664 (.273)	-.428
Population (in 000s)	.092 (.008)	.085 (.007)	.043 (.006)
Pct. Commercial Area	.032 (.005)	.031 (.005)	.014 (.004)
No. of Hospitals	.331 (.092)	.192 (.085)	.317 (.074)
CBD	.956 (.365)	.582 (.337)	1.646 (.293)
Pct. 25 yrs. old or older	.025 (.003)	.020 (.004)	.017 (.003)
Pct. H.S. Grad. Plus	.008 (.003)	.007 (.003)	.006 (.002)
Black	-.247 (.092)	-.241 (.085)	-.129 (.074)
Pct. $3000-$5999	-.006 (.004)	-.004 (.003)	-.005 (.003)
Pct. $6000-$6999	-.014 (.008)	-.013 (.008)	-.015 (.007)
Pct. $7000-$7999	-.017 (.009)	-.013 (.008)	-.010 (.007)
Pct. $8000-$8999	-.021 (.010)	-.013 (.009)	-.025 (.008)

TABLE 3 continued

	All Physicians[a]	General Practitioners	Specialists
	A. Coefficients in Raw Form		
Pct. \$9000-\$9999	-.009 (.005)	-.007 (.005)	-.007 (.003)
Pct. \$10,000 Plus	.007 (.004)	.005 (.004)	.007 (.003)
	B. Coefficients in Standard Form		
Population (in 000s)	.335	.349	.206
Pct. Commercial Area	.191	.208	.109
No. of Hospitals	.101	.066	.127
CBD	.084	.058	.190
Pct. 25 yrs. old or older	.234	.211	.209
Pct. H.S. Grad. Plus	.114	.114	.108
Black	-.088	-.097	-.060
Pct. \$3000-\$5999	-.078	-.055	-.078
Pct. \$6000-\$6999	-.059	-.060	-.082
Pct. \$7000-\$7999	-.066	-.056	-.052
Pct. \$8000-\$8999	-.072	-.048	-.110
Pct. \$9000-\$9999	-.051	-.048	-.051
Pct. \$10,000 Plus	.088	.070	.115
$\bar{R}^2$[c]	.409	.367	.346
N	792	792	792

[a]Physician variables are normalized by taking $\log_e (x + 1)$.

[b]Standard errors are given in parentheses.

[c]R^2 corrected for degrees of freedom.

TABLE 4

Summary of Analyses of Revised Predictive Model for Physician Distributions
Chicago, 1960

	All Physicians[a]	General Practitioners	Specialists
A. Coefficients in Raw Form			
Constant	-1.270 (.201)[b]	-1.115 (.185)	-.977 (.162)
Population (in 000s)	.092 (.008)	.085 (.007)	.042 (.006)
Pct. Commercial Area	.035 (.005)	.034 (.005)	.017 (.005)
No. of Hospitals	.383 (.092)	.232 (.085)	.366 (.074)
CBD	1.218 (.343)	.758 (.316)	1.881 (.278)
Pct. 25 yrs. old or older	.020 (.004)	.016 (.003)	.012 (.003)
Pct. H.S. Grad. Plus	.008 (.003)	.008 (.003)	.008 (.002)
Pct. $10,000 Plus	.010 (.003)	.007 (.003)	.009 (.003)
Black	-.082 (.084)	-.111 (.077)	-.024 (.068)

TABLE 4 continued

	All Physicians[a]	General Practitioners	Specialists
	B. Coefficients in Standard Form		
Population (in 000s)	.334	.349	.203
Pct. Commercial Area	.270	.224	.130
No. of Hospitals	.117	.080	.146
CBD	.107	.075	.217
Pct. 25 yrs. old or older	.186	.170	.154
Pct. H.S. Grad. Plus	.142	.137	.144
Pct. $10,000 Plus	.131	.105	.151
Black	-.029	-.045	-.011
$\bar{R}^2$	.397	.360	.326
N	792	792	792

[a]Physician variables are normalized by taking $\log_e (x + 1)$.

[b]Standard errors are given in parentheses.

[c]R^2 corrected for degrees of freedom.

TABLE 5

Increase in Numbers of Physicians Produced by a Unit Increase in Independent Variables of Revised Model Chicago, 1960

	All Physicians	General Practitioners	Specialists
Population (in 000s)	.143	.123	.040
Pct. Commercial Area	.052	.053	.011
No. of Hospitals	.536	.264	.302
CBD	2.411	1.128	5.666
Pct. 25 yrs. old or older	.067	.053	.021
Pct. H.S. Grad. Plus	.013	.013	.013
Pct. $10,000 Plus	.012	.011	.012
Black	-.084	-.119	-.030

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