RACE AND URBAN MEDICINE:

A REPLICATION AND EXTENSION

David Elesh and Joanne Lazarz

RACE AND URBAN MEDICINE:

A REPLICATION AND EXTENSION

David Elesh

and

Joanne Lazarz

The research reported here is supported by funds granted to the Institute for Research on Poverty at the University of Wisconsin by the Office of Economic Opportunity pursuant to the provisions of the Economic Opportunity Act of 1964. The conclusions are the sole responsibility of the authors.

March 1972

ABSTRACT

This paper replicates and extends a demand-supply model for the distribution of private physicians within a city. Contrary to the earlier study in which this model was used, no significant main effect attributable to the racial characteristics of the potential patient population was found; but a significant interaction between race and a variable not in the earlier model was discovered. Consistent with the earlier model, the coefficients for the demand variables were statistically significant but small, and a threshold value was found for physicians' locational response to income. An explanation for these findings is given in terms of physicians' locational response to a market for their services, long characterized by excess demand; it is argued that under such conditions, physicians will attempt to locate so as to reduce their unproductive travel time while maintaining their accessibility to populations capable of supporting them.

RACE AND URBAN MEDICINE:

A REPLICATION AND EXTENSION

Ecologists, economists, and geographers have long been concerned with the relationship between the spatial distributions of service institutions and population and environmental factors (Hawley, 1941; Hoover, 1948; Berry, 1967). Recently, special attention has been paid to the distribution of health services--particularly the distribution of private physicians. The importance of this problem has been noted in a recent special issue of The Annals of the American Academy of Political and Social Science on "The Nation's Health" in which the editors cited the lack of physicians in the inner cities and rural areas as one of the five most important deficiencies of the health care delivery system (Berki and Heston, 1972:ix). Its significance is further attested to by the fact that although researchers may disagree over whether there is a shortage of physicians, there appears to be no disagreement that they are seriously maldistributed (Fein, 1967; Hansen, 1964).

As noted, a substantial part of the distribution problem is seen as occurring within urban areas. The purpose of this paper is to further the analysis of the distribution of physicians within urban areas by replicating and extending a theoretical model developed by Elesh (Elesh and Schollaert, 1972). The model takes the supply or spatial distribution of physicians to be a function of the demand for their services and environmental factors which facilitate or limit the supply; within this context, the model 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. Taking a more strictly empiricist approach, Joroff and Navarro (1971) used the Automatic Interaction Detector program to examine the relationship between ten community characteristics in 299 Standard Metropolitan Statistical Areas and 27 physician-population ratios created from a classification of types of practice and specialties. Although their findings that population age, education, and medical environment were significant predictors of the ratios are consistent with other research, it is difficult to say that the same results would have been observed had a theoretical model been postulated.

In an analysis of the distribution of physicians across states, counties, and zipcode zones, Hambleton (1970) proposed a model in which physicians located as a function of net physician income and leisure opportunities. However, it is extremely difficult to assess his results inasmuch as his operationalization of the model appears to suffer from considerable distance between concepts and indicators and multicollinearity among some of his independent variables.

In a more careful 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 avialability of supporting facilities. He 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 changes in the distribution of general practitioners, internists, and pediatricians from 1940-61 in the Boston Metropolitan area, Robertson (1970) found that the general practitioner-population ratio in high status areas decreased while the internist- and pediatrician-population ratios increased slightly; the author attributed the decline in high status areas to an increasing tendency for general practitioners to move their offices to professional buildings. In contrast, 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 effect of income appears implicitly. Lieberson's (1958) finding that physicians of a particular ethnicity tend to locate among their own ethnic group, surely has an economic component in that physicians are taking advantage of whatever preferences members of their ethnic groups have for giving their business to members of the same group. Also economic considerations probably lie, at least partly, behind Rees's (1967) finding that physicians have moved their offices to follow the suburbanization of the high income population.

The most recent and most comprehensive analysis of intra-city patterns of physician distribution is Elesh and Schollaert's (1972) study of the office locations of Chicago general practitioners and specialists in 1960 with particular reference to the effects of the race of the potential patient population. While their model was an economic one based on measures of the supply of and demand for physician services, they argued that it was consistent with explanations of location (such as Lieberson's) in terms of attempts by physicians to treat patients whom they consider to be of a "desirable" social status. In other words, the economist's assumption of a desire to maximize income and the status consistency concept actually lead to similar expectations regarding locational choices. Other things being equal, income maximization should occur where the physician can earn the most money with the least amount of effort, which is, of course, where demand is high and the market population is financially well off. And, generally speaking, this means locating where potential patients have social statuses quite similar to their own.

The results generally supported theoretical expectations. Race proved to have a substantial negative effect on physicians' locations when other status variables and ecological factors were controlled for. But areal income had no effect on the distribution of physicians unless it was extremely high; in other words, the data indicated a "threshold effect" for income. And at such high income levels, the negative effect of race disappeared.

This paper, as stated above, will replicate the Elesh and Schollaert analysis by applying their model to Detroit, another large northern metropolitan area, a sizable portion of which is black and/or poor. It also will extend their analysis by the addition of a new variable to the model which helps to clarify the influence of the ecological factors. Similar results will be viewed as further substantiation of their conclusions; differences will be interpreted either as indicating needs for refinement of the model or the measures it employs or as expressing unique local patterns.

THE MODEL

As Hoover (1964) points out, locational decisions are made after carefully weighing the desirability and advantages of alternative choices. From the standpoint of spatial economic and ecological theory, it is assumed that individual decision units will prefer sites that will provide relatively higher rates of return. In the case of private practice physicians, this means locating where they (1) perceive effective demand to be greatest, and (2) find environmental advantages in the way of supportive facilities, office space, and accessibility.

The concept of effective demand encompasses not only a population's real health care needs, but also qualifying or conditional factors which have an impact on locational decisions (e.g., their ability to pay for care and predisposition to seek it). The model incorporates measures of these aspects of demand along with the indicators of environmental attractiveness mentioned above to account for the intra-city distribution of all physicians, and for general practitioners and specialists separately.

Demand Indicators

Regardless of other considerations, need for medical care is related to age. Since statistics reveal that physician usage is highest for individuals under the age of five and over the age of sixty-five, the proportion of an area's population falling into those two groups has most often been employed as a measure of age-related need. However, the interpretation of this variable in terms of a population's age structure is somewhat ambiguous, and therefore Elesh and Schollaert chose to use the percentage of the population over the age of twenty-five, since after the age of five the average number of physician visits per year increases with age (U.S. National Center for Health Statistics, 1965:13). This variable is also used here.

It follows from the income maximization assumption that a private practice physician's perception of need for his services includes a concern about the patients' ability to pay for them. Since it is known that fees are frequently based on patients' financial status, physicians could be expected to locate in higher income areas, where they not only would be able to earn more working fewer hours, but would have less difficulty in collection as well. The fact that rates of physician usage increase with income should also attract doctors to such areas (U.S. National Center for Health Statistics, 1965:13), particularly specialists since the association between visits to specialists and income is stronger than that for general practitioners (Richardson, 1969:38). The initial model employs the variable "percent of families with annual incomes greater than $6000" to represent ability to pay.

Another aspect of demand is the predisposition of individuals to use health care services. While variations have often been attributed to "cultural" differences (e.g., in social class, ethnic or racial backgrounds, etc.), as Elesh and Schollaert document (1972:5), a significant portion of this variation can be explained by differences in education. Such can be attributed to the fact that higher educational levels result in increased awareness of the benefits of preventive care and in the early recognition of symptoms and problems as needing professional attention. Specialists would be expected to respond more strongly to such considerations than general practitioners since their use requires a higher degree of such awareness. The percent of an area's population over the age of 25 who have at least a high school education is used as an indicator of predisposition to use physicians' services.

Aside from the compositional effects discussed above, the absolute population size of an area should influence doctors' decisions to locate there. 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.

Environmental Factors

All physicians, though some more so than others, are dependent on the services provided by supportive facilities, primarily hospitals. To the extent that his work requires laboratory and other technical analyses, the use of special equipment and the hospitalization of patients, a doctor could be expected to locate his office in the vicinity of the hospital(s) to which he has admitting privileges and at which he spends a good deal of time. Specialists rely more heavily on the support of such institutions than general practitioners and consequently could be expected to locate nearer to them.

As Elesh and Schollaert mention, there is an opposing argument which states that private practice physicians consciously avoid locating near hospitals in order to escape the competition of outpatient clinics and emergency room services. There is, however, little evidence in the literature for this argument. It is true that hospitals are frequently found in older, inner city neighborhoods where the surrounding population is of a rather low socio-economic level. And it is a fact that populations with incomes under $3000 are twice as likely to see a doctor in a clinic or emergency room as those with higher incomes (U.S. National Center for Health Statistics, 1965:Table 12). Certainly, the effective demand for private doctors in such areas would be low while rates of clinic and emergency room usage would be high. But this would not necessarily indicate that the people preferred the latter and were willingly substituting them for private services. Indeed, there is evidence that the poor would prefer to visit a private physician, and in fact, do so when they are in a position to make the choice (Roth, 1969:221; U.S. National Center for Health Statistics, 1965:Table B).

Two variables are used to measure the importance of supportive facilities: the first is the number of hospitals located within a given tract; the second is the number of hospitals in tracts adjacent to a physician's tract. While the adjacent hospital variable was not included in the Chicago analysis, it was felt that it might prove to be quite useful as an indicator of geographic proximity both since hospitals are frequently found near the edge of tracts, and since in the inner city, especially, the land area of a tract is often fairly small.

Another environmental consideration involves the very basic question of just how much office space an area can make available to physicians.

Tracts which are devoted primarily to residential, industrial, recreational, and institutional uses would not be as likely to contain structures capable of providing suitable office accommodations as those which have a greater proportion of their land in commercial use. Thus, we employ the variable "percent of a tract in commercial land use" as an indicator of the attraction which available office space has for physicians.

But the commercial land use variable serves another purpose as well--that is, as a measure of accessiblity to market areas. Businesses, particularly retail establishments, generally situate in easy-access, high traffic-volume locations in an attempt to maximize sales. Physicians could be viewed as responding similarly--especially specialists who are dependent on a wider market area than are general practitioners. The point of greatest access, and therefore a thriving center of activity, is usually a city's Central Business District (CBD). When such is the case, one would expect it to attract a significant number of those physicians who serve an entire metropolitan area. For example, in 1960 the Chicago loop contained 945 private practice physicians, two thirds of whom were specialists (Elesh and Schollaert, 1972 :11). However, as cities experience decentralization of both population and business, the importance of their CBD's decreases relative to that of strip commercial and outlying center developments. To the extent that such decentralization has occurred, we would expect the CBD variable to be less important for physician location than the commercial area variable which should be larger because it would be acting as an indicator of access as well as of available office space. In comparing results for the two cities, we would expect the relative strengths of the CBD variables to be consistent with the relative vitality of the cities' central areas.

Given the status consistency explanation of location discussed above and the fact that the vast majority of physicians are not only white but of a middle or upper class background, we would expect that, even controlling for all of our other variables, the racial composition of an area would have an impact on the number of physicians located there. More specifically, heavily black tracts (defined as at least 90 percent black) are not expected to be attractive to physicians. The existence of racial prejudice and discrimination by the medical profession has often been discussed and implied through references to the poor, though it has not been rigorously documented. For example, Roth (1969:227) reports that even aside from ability to pay, members of a "recognizable poverty subculture" are often considered the least desirable sort of patients, a "less pleasurable way to practice medicine", and are thus likely to lack access to private physicians. National statistics reveal that for each age-income category the average number of physician visits per year is substantially lower for nonwhites than for whites (U.S. National Center for Health Statistics, 1968:Table 7).

To summarize, the hypothesized partial relationships between the dependent (physician) variables and the independent (ecological and demand) variables are as follows:

1. Need: The number of physicians in a tract is positively associated with the percentage of the tract population 25 years of age or older.

2. Ability to pay:
   a. The number of physicians in a tract is positively associated with the percent of families in the tract with an annual income of $6000 or more.

   b. The relationship is stronger for specialists than for general practitioners.

3. Predisposition: a. The number of physicians in a tract is positively associated with the percent of the population over 25 years of age who have completed at least a high school education.

   b. The relationship is stronger for specialists than for general practitioners.

4. Market size: a. The number of physicians in a tract will increase as the absolute size of the tract population increases.

   b. The relationship is stronger for general practitioners than for specialists.

5. Market access: a. Being a CBD tract is positively associated with the number of physicians in a tract.

   b. The relationship should be stronger for specialists than for general practitioners.

6. Office space: The number of physicians in a tract is positively associated with the percentage of its land in commercial use.

7. Supportive facilities: a. The number of physicians in a tract is positively associated with the presence of hospitals in that tract.

   b. The number of physicians in a tract is positively associated with the presence of hospitals in tracts adjacent to that tract.

   c. These relationships are stronger for specialists than for general practitioners.

8. Racial composition: A tract's being at least 90 percent black is negatively associated with the presence of physicians in that tract.

9. Within each equation the demographic (demand) variables will assume a greater importance for general practitioner's than for specialists, while the ecological (supply influencing) variables will better predict specialists' locations than general practitioners.

DATA AND METHODOLOGY

Since the objective of this analysis is replication of the Elesh and Schollaert study, similar data sources have been used. Census tracts provide the basic areal units of analysis on the assumption that a tract is a relevant market area for physicians. (See Elesh and Schollaert for a full justification of this assumption.) While the Chicago study was confined to the central city proper, data were collected for almost the entire urbanized area of Detroit, thus including both some suburban areas and the two villages, Hamtramck and Highland Park, which are physically surrounded by the central city.[1] The main rationale for defining boundaries in this way lies in the history of urban development in the area. Detroit is somewhat atypical of large central cities in that its present city limits are virtually the same as they were in 1926. While other cities annexed new land as their populations grew and decentralized, the city of Detroit did not expand to include peripheral developments. Thus it was felt that by including many of the older, closer suburbs in the analysis, we would be working with a physical area more comparable to that of other cities to which the model might be applied. The original intention was to test the validity of this argument by presenting findings separately for the urbanized area and for the central city alone. But since preliminary evaluation of equations based only on the central city revealed very little substantive difference from results based on the urbanized area, it was felt that to present both would be redundant and rather tedious. Therefore, only the urbanized area models will be discussed.

Demographic variables, reflecting the characteristics of tract populations, were obtained from the 1960 Census of Population and Housing. (U.S. Bureau of the Census, 1962) Hospital location was determined from the 1960 directory of the American Hospital Association (1960). Institutions were included if they (1) treated primarily short term, as opposed to chronic or convalescent, cases and (2) were classified as general, maternity, eye-ear-nose-throat, or children's hospitals (i.e., those offering most widely demanded types of services). Data on commercial land use were provided by the Southeastern Michigan Council of Governments which had conducted a transportation and land use study in 1958.[2] Central Business District boundaries were, with some modification, as designated by the 1958 Census of Business.[3]

Data on the personal characteristics and office locations of physicians were coded from the 1961 directory of the American Medical Association (1961). Information was collected for all physicians listed as practicing in Detroit, Hamtramck, Highland Park, or any of the included suburban areas. However, only private practice physicians age 70 or under were used in the analysis. This restriction effectively excluded those who were interns or residents, who worked as full-time hospital staff, medical school faculty or researchers, or who were either retired or for some other reason not actively engaged in full-time private practice in 1960. In other words, this meant eliminating any physician who did not make an individual locational decision and/or was not available to serve the general public. The remaining physicians were categorized as either specialists or general practitioners. Following Elesh and Schollaert, we included within the category of general practitioners those doctors who classified themselves as specialists in internal medicine, obstetrics-gynecology and pediatrics--on the grounds that they are increasingly being called upon to render the sorts of services formerly provided by general practitioners alone.

The models have been estimated using least squares multiple linear regression; coefficients for each equation are presented in both raw and standardized form. Initial inspection of the data revealed that the physician distributions across tracts were highly skewed to the right, with a sizable number of tracts containing no doctors at all. To compensate for this, the dependent variables were transformed by adding "one" to the number of physicians in each tract, and then normalizing the distributions by taking the natural log of that sum. A relationship is considered statistically significant if the t-value for a partial regression coefficient is greater than or equal to 1.65, since all hypotheses are directional.

FINDINGS

There was, in 1960, a total of 3854 physicians with offices in the urbanized area of Detroit, 1393 of whom were eliminated from the analysis on the basis of the criteria previously discussed. Of the remaining 2461, 1068 (43.4 percent) were specialists and 1393 (56.6 percent) were general practitioners. The physicians comprising the latter category can be more specifically classified as follows: 681 general practitioners, 322 internists, 245 obstetrician-gynecologists and 145 pediatricians. Because an objective of this study is an understanding of how racial composition of areas affects the distribution of these physicians, descriptive statistics were computed for black and white tracts separately as well as for the city as a whole. Panel A of Table 1 presents means and standard

TABLE 1

Means and Standard Deviations for Independent and Dependent Variables

	A. Detroit, 1960			B. Chicago, 1960		
	All Tracts	White Tracts[a]	Black Tracts	All Tracts	White Tracts[a]	Black Tracts
Population (in 000's)	6167 (6103)[b]	6470 (6330)	3668 (1999)	4524 (3595)	4591 (3682)	4332 (3021)
Pct. Commercial Area	7.93 (6.82)	7.46 (5.30)	8.22 (4.23)	6.89 (5.85)	6.57 (5.01)	7.59 (7.33)
No. of Hospitals	.12 (.42)	.12 (.43)	.12 (.39)	.08 (.30)	.09 (.32)	.03 (.18)
No. of Adj. Hospitals	.79 (1.43)	.70 (.13)	1.53 (2.37)	.54 (.84)	.57 (.86)	.39 (.66)
Pct. 25 Yrs. or Older	58.87 (7.67)	58.81 (6.84)	55.96 (6.62)	60.07 (9.28)	61.03 (8.31)	53.24 (10.18)
Pct. H.S. Grad Plus	33.95 (16.39)	35.28 (16.42)	20.81 (9.14)	31.80 (14.18)	32.80 (14.10)	24.76 (11.20)
Pct. $6000 Plus	48.48 (20.59)	51.55 (19.09)	22.36 (9.81)	54.88 (18.32)	58.83 (15.68)	32.09 (13.87)
Pct. $10,000 Plus	17.29 (14.41)	18.67 (14.50)	5.17 (3.66)	18.52 (12.41)	20.35 (12.16)	7.96 (5.99)
All Physicians	5.30 (14.30)	5.09 (10.18)	1.53 (1.89)	5.31 (25.99)	5.87 (15.99)	1.69 (2.50)
General Practitioners	3.00 (5.84)	3.02 (5.18)	1.23 (1.54)	3.09 (9.12)	2.98 (5.25)	1.16 (1.84)
Specialists	2.30 (9.07)	2.07 (5.46)	.30 (.56)	2.22 (17.51)	2.89 (12.79)	.53 (1.00)
N	464	417	43	792	671	115

[a] CBD tracts omitted
[b] Standard deviations in parentheses

deviations for the Detroit variables; Panel B reproduces Chicago statistics for comparative purposes.

Inspection of the demand-related variables indicates at least part of the reason for black tracts having an average number of physicians only one third that of white areas: their means for education, income and populations size are substantially lower and their population is somewhat smaller than in white parts of the city. But while effective demand would thus seem to be lower, they do not, on the surface at least, appear to suffer from environmental disadvantages as well. In fact, black tracts have a slightly higher proportion of their land in commercial uses, and, on the average, more than twice as many hospitals in tracts adjacent to them. However, the fact that significant differentials in the mean numbers of physicians per tract do exist (particularly for specialists where the black mean is only 0.3 compared with 2.07) seems to indicate either that the demand variables are sufficiently low to negate any environmental attractiveness or that some other factor such as racial discrimination is operating, or perhaps, both.

One major difference between the two cities can be noted from Table 1. In Chicago, blacks appear, relative to whites, to lack access to hospitals as well as to private practice physicians, whereas in Detroit the situation is reversed--blacks have substantially greater access to hospitals than do whites. Recognizing that simple geographic proximity does not necessarily mean actual utilization of the institutions, the data nonetheless indicate the potential availability of care through outpatient clinics and emergency room services, if not through formal admission. Viewed in terms of ratios of hospitals to population, the inter-city differences become clearer: while figures for white tracts are fairly comparable (one hospital for every 54,000 white tract residents in Detroit and one for every 51,000 in Chicago), Detroit blacks are considerably better off with one hospital for every 31,500 persons as compared to one for every 125,000 in Chicago (Elesh and Schollaert, 1971:11). If hospitals in adjacent tracts are included as well, the black-white differential in Detroit becomes even greater, with black tracts having one hospital in or next to them for every 2,160 residents, as opposed to one for every 7,936 whites. The intercity differences can be partially explained by the fact that as Chicago neighborhoods have become heavily black, hospitals located within them have tended to relocate in more "desirable" parts of the city, whereas in Detroit most have remained, some opening their doors to the surrounding population, others continuing, however, to rely mainly on white middle class clientele. (Reitzes, 1958:111).

The results of the initial predictive model (see Table 2) generally support all but three of the predicted relationships. Among the measures of demand, the coefficients for tract population size and age are, as predicted, greater for general practitioners than for specialists. The dependence of the former on local population concentrations is evidenced by a coefficient almost two and one-half times larger than that for specialists. General practitioners' responsiveness to the age

TABLE 2

Summary of Analyses of Initial Predictive Model for Physician Distributions
Detroit, 1960

	All Physicians[a]	General Practitioners	Specialists
	A. Coefficients in Raw Form		
Constant	-2.233 (.335)[b]	-2.105 (.297)	-1.468 (.290)
Population (in 000's)	.063 (.007)	.063 (.006)	.026 (.005)
Pct. Commercial Area	.031 (.008)	.022 (.007)	.034 (.007)
No. of Hospitals	.568 (.085)	.387 (.075)	.559 (.073)
CBD	-.239* (.512)	-.484* (.455)	.203* (.444)
Pct. 25 Yrs or Older	.032 (.006)	.030 (.005)	.015 (.005)
Pct. H.S. Grad Plus	.023 (.004)	.013 (.003)	.022 (.003)
Pct. $6000 Plus	.000* (.003)	.003* (.003)	-.002* (.003)
Black	.098* (.132)	.203* (.118)	-.055* (.115)

TABLE 2 (continued)

	All Physicians	General Practitioners	Specialists
	B. Coefficients in Standard Form		
Population (in 000's)	.374	.440	.186
Pct. Commercial Area	.206	.172	.275
No. of Hospitals	.233	.186	.280
CBD	-.022	-.051	.022
Pct. 25 Yrs or Older	.240	.265	.135
Pct. H.S. Grad Plus	.359	.247	.435
Pct. $6000 Plus	.005	.072	-.046
Black	.028	.067	-.019
$\bar{R}^2$ [c]	.494	.453	.433
N	464	464	464

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

[b]Standard deviations in parentheses.

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

*P >.05, one-tailed test.

of local population is indicated by the fact that it has twice the effect on them as on specialists. On the other hand, the coefficient for education is almost twice as large for specialists as for general practitioners. Similarly, the location of hospitals has a greater effect on specialists' locations than on general practitioners'; and the coefficients for commercial area with three equations were both positive and substantial.

The three departures from theoretical expectations lie in the coefficients for the race, income, and CBD variables, although the income result is consistent with Chicago findings and thus not especially surprising. While the effect of income was predicted to be significant and positive, it was not found to be so in any of the three equations. And although prior findings, especially those of Elesh and Schollaert, lead to the expectation of substantial negative race coefficients, none were found, suggesting that if blacks in Detroit have inadequate access to private physicians it is probably due to their social and economic characteristics and environmental context. But perhaps of greatest interest is the lack of a significant postive CBD coefficient in any physician equation. Although this result was not predicted, it is consistent with the decline in vitality which Detroit's central area has experienced. Extensive freeway construction has isolated it, breaking physical continuity and structure. Central functions such as commercial activities and services geared to middle and upper income needs have rapidly followed the suburbanizing population. Some have relocated along major radial traffic arteries, others have jumped to more peripheral center-type developments. Central location is not only, as predicted, less important for general practitioners, but is actually a negative factor. In comparison with the eight other largest U.S. cities the Detroit CBD has experienced the greatest losses in employment and retail sales (Doxiadis, 1966:150). Doxiadis, in his recent analysis of the Detroit urban region, summarized the situation: "Generally speaking the nearer one gets to what is called the center of activities, the less activities there are. The closer one comes to the area where one would normally expect life of high intensity and quality, the lower it actually is." (Doxiadis, 1966:149).

In terms of the relative importance of demographic versus ecological variables for the two physician categories, the predicted relationships hold. Comparison of the standardized coefficients reveals the three prime determinants of location to be, in order, population size, age, and education for general practitioners, and education, hospitals, and commercial area for specialists. These findings are identical to Chicago results with one exception: in Chicago, "CBD" rather than "commercial area" is the third strongest factor in specialist location. This, again, is interpreted not as an inconsistency, but as evidence for the claim that both variables are to some extent measuring the same site quality (i.e., access), the difference between the two cities being attributable to the greater decentralization of business and service activities in Detroit.

In order to test the hypothesis that tracts adjacent to tracts containing hospitals are attractive to physicians, particularly to specialists, the adjacent hospital variable was added to the initial equation. It has, as Table 3 indicates, very little effect on the model for general practitioners, simply decreasing most of the other coefficients slightly, with its own coefficient being the smallest of the significant variables. That locating near hospitals is of greater importance to specialists is evidenced by fairly substantial decreases in the values of the coefficients in the specialist equation, with the adjacent hospital variable supplanting commercial area as the third most important in relative terms. And while the R^2 increases only slightly for the "All" and "G.P." models, it jumps from 0.433 to 0.470 for specialists.[4] It is also interesting to note that the CBD coefficient becomes significant when adding a control for adjacent hospitals--indicating that the effect of CBD had been obscured by an association with adjacent hospitals. It appears, then, that including this variable is a useful modification of the original model. That it helps to further clarify relationships and increase overall explanation in the case of specialists but alters general practitioner coefficients only slightly is consistent with predictions. Thus, all equations presented subsequently will contain the "adj. hospitals" variable, even though they will not remain strictly comparable to Chicago models.

As mentioned above, the lack of significant association between the dependent and income variables was consistent with what Elesh and Schollaert found in Chicago. Suspecting that the explanation would prove to be similar as well, the same test was run to observe more specifically the relationships between the physician variables and the shape of the within-tract income distributions. (For a complete explanation of the test see Elesh and Schollaert.) Briefly, a new model was constructed which consisted of all the variables in the original equation

TABLE 3

Summary of Analyses of Initial Predictive Model, Version 2, for Physician Distributions Detroit, 1960

	All Physicians[a]	General Practitioners	Specialists
	A. Coefficients in Raw Form		
Constant	-2.000 (.336)[b]	-1.961 (.301)	-1.155 (.285)
Population (in 000's)	.058 (.007)	.060 (.006)	.019 (.006)
Pct. Commercial Area	.025 (.008)	.019 (.007)	.026 (.006)
No. of Hospitals	.530 (.084)	.364 (.075)	.508 (.071)
No. of Adj. Hospitals	.098 (.027)	.061 (.024)	.132 (.023)
CBD	.174* (.518)	-.229* (.464)	.758 (.440)
Pct. 25 Yrs or Older	.027 (.006)	.027 (.006)	.009 (.005)
Pct. H.S. Grad Plus	.021 (.004)	.012 (.003)	.020 (.003)
Pct. $6000 Plus	.003* (.003)	.005* (.003)	.002* (.003)
Black	.038* (.132)	.166* (.177)	-.135* (.112)

TABLE 3 (continued)

	All Physicians	General Practitioners	Specialists
B. Coefficients in Standard Form			
Population (in 000's)	.345	.419	.139
Pct. Commercial Area	.169	.145	.214
No. of Hospitals	.218	.175	.255
No. of Adj. Hospitals	.137	.099	.255
CBD	.016	-.024	.083
Pct. 25 Yrs or Older	.203	.239	.079
Pct. H.S. Grad Plus	.328	.225	.383
Pct. $6000 Plus	.059	.111	.043
Black	.011	.055	-.047
$\bar{R}^{2\,c}$	.507	.459	.470
N	464	464	464

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

[b]Standard deviations in parentheses.

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

*P > .05, one-tailed test.

(including adjacent hospitals) except the percent of families with incomes of $6,000 or more. In place of the latter were substituted six variables, each representing a segment of the income distribution (see Table 4). The category for incomes under $3,000 was omitted since it was, of course, simply a function of the other six (i.e., 100 percent minus the sum of the six segments equals the percent under $3,000). Results for general practitioners indicate no consistent relationship between the dependent variable and the income segments, although at the "$10,000 plus" level the coefficient though small is positive and significant. While a similar pattern obtains for specialists, the effect of the last income term is considerably stronger. As part B of Table 4 shows, it becomes, in fact, the strongest variable in the equation with a standardized coefficient of 0.304 as compared to the next largest value of 0.244 for hospitals.

These results are similar in nature to those found in Chicago, although the Detroit coefficients for the "$10,000 plus" variable are about twice as large.[5] The interpretation suggested by the small, often negative, coefficients for the first five income terms is that to the extent that income, controlling for all other factors, affects the location of physician offices, the middle income population is no better off than the poor. Only at the point of $10,000 and above does income seem to offer a substantial attraction, and then mainly for specialists.

Table 5 indicates the results of re-estimating the original model, substituting (as suggested by the findings of the shape-effects equation) the percent of families with incomes of $10,000 or more for the $6,000

TABLE 4

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

	All Physicians[a]	General Practitioners	Specialists
	A. Coefficients in Raw Form		
Constant	-1.696 (.443)[b]	-1.890 (.399)	-.754 (.369)
Population (in 000's)	.064 (.007)	.063 (.007)	.028 (.006)
Pct. Commercial Area	.025 (.008)	.019 (.007)	.027 (.006)
No. of Hospitals	.516 (.084)	.358 (.076)	.486 (.070)
No. of Adj. Hospitals	.096 (.027)	.061 (.025)	.129 (.023)
CBD	.245* (.517)	-.180* (.466)	.834* (.430)
Pct. 25 Yrs or Older	.026 (.006)	.027 (.006)	.007 (.005)
Pct. H.S. Grad Plus	.013 (.005)	.009 (.004)	.009 (.004)
Black	-.014* (.134)	.146* (.121)	-.211 (.111)
Pct. $3000-$5999	-.000* (.006)	.001* (.006)	-.001* (.005)
Pct. $6000-$6999	-.001* (.013)	.004* (.012)	.004* (.011)
Pct. $7000-$7999	-.012* (.015)	-.004* (.014)	-.015* (.013)
Pct. $8000-$8999	.016* (.018)	.012* (.016)	-.003* (.015)
Pct. $9000-$9999	-.020* (.021)	-.012* (.019)	-.021* (.017)
Pct. $10,000 Plus	.013 (.006)	.010 (.006)	.018 (.005)

TABLE 4 (continued)

	All Physicians	General Practitioners	Specialists
B. Coefficients in Standard Form			
Population (in 000's)	.380	.438	.204
Pct. Commercial Area	.168	.145	.219
No. of Hospitals	.212	.172	.244
No. of Adj. Hospitals	.134	.010	.220
CBD	.022	-.019	.092
Pct. 25 Yrs or Older	.196	.233	.066
Pct. H.S. Grad Plus	.212	.167	.183
Black	-.004	.048	-.073
Pct. $3000-$5999	-.004	.015	-.008
Pct. $6000-$6999	-.004	.017	.018
Pct. $7000-$7999	-.040	-.018	-.065
Pct. $8000-$8999	.052	.073	-.012
Pct. $9000-$9999	-.053	-.039	-.069
Pct. $10,000 Plus	.186	.165	.304
$\bar{R}^{2}$ [c]	.512	.457	.495
N	464	464	464

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

[b]Standard deviations in parentheses.

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

*P > .05, one-tailed test.

term. Comparing the general practitioner column of Table 5 with that in Table 3, we can see that changes in the general practitioner coefficients, if any, are slight. While the income variable is now significant and positive, its standardized coefficient remains quite small. Thus even increasing the income term to $10,000 does not alter the fact that population size, age, and education are the most important determinants of general practitioners' location.

Specialists, on the other hand, are expected to be more responsive to income levels and are: their raw income coefficient shifts from 0.002 in the $6,000 model to 0.019 in this one, while the standardized coefficient jumps from 0.043 to 0.325 indicating that it has become the strongest independent variable in terms of relative explanatory power. But aside from the attraction of high income, their primary response is still to environmental considerations as evidenced by the importance of the commercial area (access and office space) and the two hospital (supportive facilities) variables, and the fact that in this equation age becomes insignificant. It appears that part of the effect of education, the most important variable in the initial model, was through its association with high income, so when the latter is controlled for, as it is in this equation, the relevance of education to physician location is greatly diminished and the ecological variables together with income assume the foremost explanatory role.

In summary, then, the Elesh and Schollaert model, supplemented by the adjacent hospital variable, was found to be a valid and useful tool for predicting the intra-city distribution of physicians. Indeed, the predicted relationships regarding the individual variables were, for the most part,

TABLE 5

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

	All Physicians[a]	General Practitioners	Specialists
A. Coefficients in Raw Form			
Constant	-1.769 (.343)[b]	1.806 (.309)	-.846 (.287)
Population (in 000's)	.062 (.007)	.064 (.006)	.023 (.006)
Pct. Commercial Area	.027 (.007)	.018 (.007)	.029 (.006)
No. of Hospitals	.528 (.082)	.350 (.074)	.514 (.069)
No. of Adj. Hospitals	.099 (.026)	.056 (.024)	.138 (.022)
CBD	.277* (.507)	-.261* (.456)	.975 (.424)
Pct. 25 Yrs or Older	.026 (.006)	.027 (.005)	.006* (.005)
Pct. H.S. Grad Plus	.013 (.005)	.009 (.004)	.007 (.004)
Pct. $10,000 Plus	.014 (.005)	.009 (.005)	.019 (.004)
Black	.028* (.123)	.120* (.111)	-.118* (.103)

TABLE 5 (continued)

	All Physicians	General Practitioners	Specialists
	B. Coefficients in Standard Form		
Population (in 000's)	.366	.447	.164
Pct. Commercial Area	.177	.141	.235
No. of Hospitals	.217	.168	.258
No. of Adj. Hospitals	.139	.092	.235
CBD	.025	-.028	.107
Pct. 25 Yrs or Older	.191	.239	.051
Pct. H.S. Grad Plus	.203	.176	.138
Pct. $10,000 Plus	.194	.141	.325
Black	.008	.040	-.041
R^{2c}	.515	.461	.493
N	464	464	464

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

[b]Standard deviations in parentheses.

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

*P >.05, one-tailed test.

stronger than those found in this original test, and the proportion of the total variance explained reached 45 to 50 percent in Detroit as compared to 35-40 percent in Chicago. The behavior of the two measures which did yield different results--the CBD and race variables--can be explained in terms of differences in the structures of the two cities. Detroit's central area has experienced the effects of more extensive decentralization, making it a less attractive location for physicians' offices. The almost total absence of significant coefficients for racial composition should, perhaps, be interpreted within the context of the less segregated racial structure of Detroit. Because Detroit's blacks are less segregated--having a tract-based segregation index of 79.9 as compared to a value of 89.9 for Chicago (Taeuber and Taeuber, 1964:61)--Detroit's physicians have a higher probability of locating on the edge of a black tract their patients, however, may be entirely or largely drown from adjacent white areas.

But despite the fact that no negative effect of race itself was found, there still existed the possiblity of interactions between it and other independent variables in the model. In order to test for any such hidden relationships, five interaction terms were added to the predictive model.[6] Of these, only one--race and adjacent hospitals--yielded statistically significant coefficients. This variable was then added to the original nine in the revised predictive equations to create the final form of the model. The sizable negative coefficients for the interaction term (see Table 6) proved to significantly increase the model's explanatory power, though more strongly so for specialists than for general practitioners.[7] This suggests that while physicians are

TABLE 6

Summary of Analyses of Final Predictive Model for Physician Distributions
Detroit, 1960

	All Physicians[a]	General Practitioners	Specialists
	A. Coefficients in Raw Form		
Constant	-1.655 (.342)[b]	-1.735 (.310)	-.701 (.282)
Population (in 000's)	.061 (.007)	.064 (.006)	.021 (.005)
Pct. Commercial Area	.026 (.007)	.018 (.007)	.028 (.006)
No. of Hospitals	.526 (.082)	.349 (.074)	.511 (.067)
No. of Adj. Hospitals	.146 (.030)	.085 (.027)	.197 (.025)
CBD	.333* (.503)	-.227* (.455)	1.046 (.415)
Pct. 25 Yrs or Older	.024 (.006)	.026 (.005)	.003* (.005)
Pct. H.S. Grad Plus	.012 (.004)	.009 (.004)	.006* (.004)
Pct. $10,000 Plus	.015 (.005)	.010 (.004)	.021 (.004)
Black	.241 (.141)	.253 (.127)	.152* (.116)
Race-Adj. Interaction	-.165 (.054)	-.102 (.049)	-.209 (.045)

TABLE 6 (continued)

	All Physicians	General Practitioners	Specialists
	B. Coefficients in Standard Form		
Population (in 000's)	.360	.442	.154
Pct. Commercial Area	.174	.139	.230
No. of Hospitals	.216	.168	.256
No. of Adj. Hospitals	.204	.139	.336
CBD	.030	-.024	.115
Pct. 25 Yrs or Older	.176	.228	.027
Pct. H.S. Grad Plus	.184	.162	.109
Pct. $10,000 Plus	.214	.156	.357
Black	.068	.083	.053
Black-Adj. Interaction	-.136	-.099	-.211
R^{2} [c]	.523	.465	.515
N	464	464	464

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

[b]Standard deviations in parentheses.

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

*P > .05, one-tailed test.

attracted to tracts near those containing hospitals, other things being equal, they do not choose tracts where the population is over 90 percent black.

CONCLUSIONS

The effects of race on the distribution of physicians in Detroit can be summarized as follows: when other factors affecting the supply of and demand for physicians are controlled, race has no main effect on the locations of physicians. In view of the large differences in Table 1 between white and black tracts in their mean numbers of physicians, this finding is quite striking. It becomes even more so if we consider the result 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 $\log_e$ of X + 1), subtract the black mean from the white, and divide the difference by the white mean, we find that black tracts have 59 percent fewer physicians on average. To find the percentage difference due to race net of the other variables in the initial model (Table 2), we take the antilog of the raw coefficient for race and subtract it from 100 percent. This procedure reveals that in the initial model, controlling for the remaining variables, black tracts will have 10 percent more physicians on average than white tracts. However, the size of the standard error relative to the race coefficient indicates that the latter is unstable, and it is therefore more reasonable to conclude that, controlling for demand and supply factors. There is simply no difference between black and white tracts in their average numbers of physicians. On the other hand, there is a negative effect for the interaction between the race and adjacent hospital variables, indicating that physicians locating near hospitals tend to stay out of black tracts.

In contrast to these results, Elesh and Schollaert (1972) found that in Chicago black tracts had 18 percent fewer physicians than white tracts despite controls for demand and supply factors as in the model of Table 2 (if the difference between black and white tracts is examined without controls, black tracts average 60 percent fewer physicians). Moreover, there was no significant interaction between the race and adjacent hospital variables in the Chicago data. Although the available data do not permit a definitive resolution of these differences between the two sets of results, we suspect that at least one reason is the aforementioned lower level of racial segregation in Detroit. Since Detroit is less segregated, physicians with offices on the edges of black areas may be better able to maintain white, or largely white, practices than would be the case in Chicago with its more concentrated and segregated black settlements. It follows from this argument that although black areas in Detroit appear to have better access to physicians than black areas in Chicago, net of supply and demand considerations, it is not <u>necessarily</u> true that they are served by the physicians to whom they seem to have access.

Perhaps as interesting as the results for race on the effects of areal income, while there is a large literature dealing with the inadequate access of the poor--particularly, the black poor--to medical care, the data presented here suggest that many urban nonpoor citizens have a similar lack of access to physicians. It is not until the threshold of the areal income variable is set at $10,000 that income begins to attract physicians significantly. It has been suggested that physicians will be attracted to areas if areal demand is higher, and therefore increases in the income and health consciousness levels of local populations are needed. Our data, however, offer little support for this contention. Table 7 shows just how much change in absolute number of physicians would result from incrementing any of the independent variables in our final model by one unit. Quite obviously, the results would be trivial.

Unfortunately, very few of the factors which we have found to influence the location of private physicians are realistically subject to manipulation or control. And, as Table 7 shows, even those which can be influenced to some extent cannot be altered sufficiently to result in any major changes in the distribution of physicians. Since many of the proposals to induce physicians to locate in particular areas involve direct or indirect financial subsidies through payments to the populations of those areas, it is worth noting that the effect of increasing the percentage of families with $10,000 or more income is the second smallest in the model. This result is essentially identical to that found by Elesh and Schollaert in the Chicago data.

Such a result is somewhat surprising but not entirely inexplicable. Following Elesh and Schollaert, we suggest that the explanation lies in the nature of a market for physicians' services in which demand has long exceeded supply. Although there has been some dispute over the validity of the latter statement (Hansen, 1964), the evidence for the existence of excess demand can be found in its effect on prices. According to conventional economic theory, if the demand for a particular good or service exceeds the supply of that good or service, its price

TABLE 7

Changes in Numbers of Physicians Produced by a One Unit Change in any of the Independent Variables of the Final Model (including adjacent hospitals and the interaction term) Detroit, 1960

	All Physicians	General Practitioners	Specialists
Population in (000's)	.206	.167	.039
Pct. Commercial Area	.086	.046	.052
No. of Hospitals	2.265	1.054	1.220
No. of Adjacent Hospitals	.515	.224	.398
CBD	1.293	-.513	3.377
Pct. 25 Yrs or Older	.080	.066	.006
Pct. H.S. Grad Plus	.040	.023	.011
Pct. $10,000 Plus	.050	.025	.049
Black	.892	.727	.300
Race-Adjacent Hospitals	-.498	-.245	-.345

will be driven up relative to the prices of other goods and services, other things equal. This phenomenon can be observed in Table 8 which compares the annual percentage rates of change of the Consumer Price Index (CPI) for physicians' fees with the CPI for all items from 1950-1968. It is easily seen that, throughout this period, the fee index has risen faster than the index for all items. Moreover, Table 8 actually understates the increases in fees because the "customary fees" on which the CPI is based have historically lagged behind average fees and because physicians increasingly are billing separately for laboratory tests and vaccinations (Klarman, 1970:13-14).

Yet physicians have not raised their fees as much as they might have if they had wished to clear the market of excess demand. Rather, they have attempted to keep their fees down by reorganizing their practices in order to see more patients per day. One of the most significant changes was the reduction of home visits. In 1948, physicians saw an average of 4.5 patients per day at home (Richardson, 1949:64); in 1963, the number had dropped to three per week (Medical Economics, 1963:94).[8] The effect of this reorganization on physicians' fees can be seen in the following, somewhat overly simple, example. Let us suppose that a physician in 1950 charged $4 for an office visit and $5 for a home visit. Let us further suppose that he allocates $4.50 of the $5 price to cover his estimate of the cost he incures in traveling to and from the patient's home, excluding his estimate of income he might have made had he seen patients in his office during that time. Now suppose that six months later under the pressure of increased demand, he eliminates house calls in order

TABLE 8

Annual Percentage Rates of Change in The Consumer Price Indices for Physicians' Fees and All Items, 1950-1968

	Fees	All Items	Difference
1950-55	3.4	2.2	1.2
1955-60	3.3	2.0	1.3
1960-65	2.8	1.3	1.5
1965-68	6.3	3.5	2.8

Source: Herbert E. Klarman et al., 1970: Table 11. Years begin on July 1 and end on June 30.

to see more patients per day and raises the price for an office visit to \$4.50 (not necessarily simultaneously).[9] By refusing to make house calls, he has, in effect, transferred his \$.50 travel cost to the patient as a nonpecuniary cost which, however, has the effect of raising the real price of a consultation to \$5.00. (Thus we have a good part of the reason why physicians' incomes have risen faster than their fees.)

Since physicians can require patients to come to them (and increasingly are) because of the excess demand, it should be clear that they need not locate responsibly to the income and other demand factors. Rather, operating rationally, they should locate in areas where their unproductive travel time would be at a minimum. Typically, this will imply locations near hospitals, since they must visit patients there, or in areas such as commerical districts a major arterials with ready access to large potential patient populations. Thus the small sizes of the demand coefficients found here and in the Elesh and Schollaert study are a function of the nature of the market for physicians' services. For these coefficients to be appreciably larger, the supply of services would have to be far closer to the demand for them than it is. In a market characterized by excess demand, physicians can locate practically where they choose without financial hardship.[10]

However, the existence of excess demand does not necessarily imply that the solution to the distribution problem is to produce more physicians. While the production of greater numbers of physicians is one way to increase the supply of services, it is not clear that it is the most effective or efficient alternative. It should be remembered that physicians can and do create some of the demand for their services and may be willing to use this power to avoid locating in what they take to be undesirable areas. More research is needed on findings such as the relationship between the incidence of surgical procedures in an area and the number of physicians who do those procedures (Lewis, 1969; Bunker, 1970), and the implications of such "overdoctoring" for improving the distribution of physicians.

It also must be remembered that the finding of an inadequate supply of services is partly a function of the current organization of practice.[11] Whether the supply would remain insufficient if medical practice was restructured is unknown. It would be useful to have projections of supply based on a variety of different conceptions of medical practice. Such projections would of course require some definition of the quality of care a medical practice structure would be expected to deliver--say, for example, in terms of a basic range of services which all structures might be expected to make available and accessible regardless of patients' incomes. Some of these reorganizations might involve the creation of multi-doctor clinics in which physician productivity is know to be higher; others might involve the greater use of paramedical personnel for tasks now performed by physicians. But here again, increases in the supply of services may lead to "overdoctoring" as physicians, for noneconomic reasons, seek to avoid certain areas.

Nonetheless, solution of the maldistribution problem requires that the supply of physicians' services equal at least the patient-initiated demand for them. Given this equality, it is possible, within a market framework, to induce physicians by financial means to locate in areas which they now avoid for both economic and non-economic reasons. (Note that making physicians' services a free good will not solve the distribution problem, since, in the absence of financial inducements, non-economic factors will continue to cause them to avoid certain areas.) Alternatively, if it is decided that physicians' services should not be distributed in a market framework, the problem could be solved by assigning physicians to specific areas.

NOTES

[1]Data were collected for all of the tracts within the central city of Detroit, plus all contiguous tracts which were either part of an incorporate civil division or for the most part surrounded by incorporated areas thus more likely to be urban than rural in character. Because this analysis is part of a larger research effort which will include a longitudinal analysis of Detroit area physicians, it was necessary to combine certain of the tracts in order to construct geographic units which would be comparable from 1940 through 1960.

[2]Commercial uses included all retail, wholesale, office, service, hotel/motel, and indoor recreational functions classified as privately owned. (Southeast Michigan Council of Governments, Detroit Regional Transportation and Land Use Study Report: "A Profile of Developed Land: 1965 Land Use," p. 2).

[3]The Census Bureau designated six tracts as the Central Business District of Detroit but two of them were eliminated in constructing the CBD variable for the equations. In order to achieve geographic comparability of tracts over time (see note 1) data for those two were combined with that of three others outside of the CBD area as it was defined by the Census Bureau. Faced with the choice of either eliminating the two CBD tracts from our definition or including the three other tracts which did not meet the criteria of a Central Business District, we chose to do the former. Since no physicians were located in either of the two exclusions, no distortion of the nubmer of physician offices located in the actual CBD resulted. On the other hand, incorporating the additional three would have meant including an extra 27 physicians whose offices were not in the real CBD area.

[4]F-tests revealed that adding the adjacent hospital variable resulted in a significant increase in the size of the multiple R^2's for all models at the .05 level and for the "all" and "specialists" models at the .01 level.

$$\text{where } F_{(b,n-a-b-1)} = \frac{R^2 Y\cdot AB - R^2 Y\cdot A \;/\; b}{1 - R^2 Y\cdot AB \;/\; n-a-b-1}$$

[5]Even when the Detroit equation was run without the adjacent hospitals variable, the "$10,000 plus" coefficients were almost one and one-half times as large as those for Chicago.

[6]The interaction terms were created by multiplying the value of the race dummy variable for a tract (where "0" was white and "1" was black) by the values of each of the other 5 independent variables for that tract. Those interactions tested were: race-percent age 25 or over; race-percent high school education or more; race-number of hospitals; race-number of adjacent hospitals.

[7] F-tests revealed that adding the race-adjacent hospitals interaction to the model resulted in increases in the multiple R^2's which were statistically significant in all three equations at the .05 level and in the "all physicians" and "specialists" equations at the .01 level.

[8] Actually, the 1948 and 1963 figures are not strictly comparable, since the 1963 figure is a median rather than a mean. Given the size of the decline in home visits, however, this discrepancy cannot be considered significant.

[9] Even if the physician kept his fee for an office visit at $4, he would probably make more money because he probably underestimated the true value of the income foregone in making house calls in order not to have too great a differential between the prices of office and home visits. Physicians could have shifted demand from home to office visits by increasing the price of the former relative to the latter but few physicians took this route, perhaps because they suspected that a very high price for home visits would have alienated their paitients more than the elimination of home visits.

[10] This statement is made notwithstanding the fact for some specialties in some areas, the supply of services probably exceeds the patient-initiated demands (as contrasted with demand created by physicians) for them.

[11] It is also, of course, a function of the prices at which alternative sources of care such as homeopathy and chiropractic are offered.

BIBLIOGRAPHY

American Hospital Association.
1960 "Listing of Hospitals." Hospitals 34 (August):103-109.

American Medical Association.
1961 The American Medical Directory. Twenty-first edition. Chicago: American Medical Association.

Benham, Lee, Alex Maurizi and Melvin Reder.
1968 "Migration, Location and Remuneration of Medical Personel: Physicians and Dentists." Review of Economics and Statistics 50 (August):332-347.

Berki, Sylvester E., and Alan W. Heston.
1972 Introduction to "The Nation's Health: Some Issues," The Annals of the American Academy of Political and Social Science 399 (January):ix-xiv.

Berry, Brian J. L.
1967 Geography of Market Centers and Retail Distribution. Englewood Cliffs, N. J.: Prentice-Hall, Inc.

Bunker, John P.
1970 "Surgical Manpower." New England Journal of Medicine. 282 (January):135-143.

Census Tract Coding Guide for Detroit SMSA.
1964 Fourth Edition. Detroit Regional Census Advisory Committee. Wayne State University, Department of Urban Planning.

Chicago Board of Health.
1966 Preliminary Report on Patterns of Medical and Health Care in Poverty Areas of Chicago and Proposed Health Programs for the Medically Indigent. Chicago: Chicago Board of Health.

Doxiadis, Constantinos.
1966 Emergence and Growth of an Urban Region: The Developing Urban Detroit Area. Detroit: Detroit Edison Co.

Elesh, David and Paul T. Schollaert.
1972 "Race and Urban Medicine: Factors Affecting the Distribution of Physicians in Chicago." Journal of Health and Social Behavior (in press).

Fein, Rashi.
1967 The Doctor Shortage: An Economic Diagnosis. Washington, D.C.: Brookings Institution.

Garner, Barbara F.
1970 "An Ecological Analysis of Physician Distribution in Greater American Metropolises." Unpublished Master's thesis, University of Washington, Seattle.

Hambleton, John W.
1970 "Determinants of Geographic Differences on the Supply of Physician Services." Unpublished Doctoral dissertation, Department of Economics, University of Wisconsin.

Hansen, W. Lee.
1964 "'Shortages' and Investment in Health Manpower" in The Economics of Health and Medical Care. Ann Arbor: University of Michigan Press, pp. 74-91.

Hawley, Amos F.
1941 "An Ecological Study of Urban Service Institutions." American Sociological Review 6 (October):629-639.

Hoover, Edgar M.
1964 "Spatial Economics: The Partial Equilibrium Approach." Center for Regional Economic Studies. Occasional Paper No. 2.

Joroff, Sheila and Vincente Navarro.
1971 "Medical Manpower: A Multivariate Analysis of the Distribution of Physicians in Urban United States." Medical Care 71 (September-October):428-438.

Klarman, Herbert E., et al.
1970 Sources of Increase in Selected Medical Care Expenditures, 1929-1969. Washington, D.C.: Social Security Administration. Office of Research and Statistics. Staff Paper No. 4.

Lewis, Charles E.
1969 "Variation in the Incidence of Surgery." New England Journal of Medicine 281 (October):880-884.

Lieberson, Stanley.
1958 "Ethnic Groups and the Practice of Medicine." American Sociological Review 23 (October):542-549.

Marden, Parker G.
1966 "A Demographic and Ecological Analysis of the Distribution of Physicians in Metropolitan America, 1960." American Journal of Sociology 72 (November):290-300.

Medical Economics.
1963 "Patient Visits Per Week." (December):92-95.

Reitzes, Dietrich.
1958 Negroes and Medicine. Cambridge: Harvard University Press.

Richardson, William Alan.
1949 "Your Patient Load Level." Medical Economics (February):63-67.

Richardson, William C.
1969 "Poverty, Illness and Use of Health Services in the U.S." Hospitals 43 (July):34-40.

Rimlinger, Gaston V. and Henry B. Steele.
1963 "An Economic Interpretation of the Spatial Distribution of Physicians in the U.S." Southern Economic Journal 30 (July): 1-12.

Robertson, Leon S.
1970 "On the Intraurban Ecology of Primary Care Physicians." Social Science and Medicine 4:227-238.

Roth, Julius A.
1969 "The Treatment of the Sick," in John Kosa, et al., Poverty and Health. Cambridge: Harvard University Press, pp. 214-243.

Taeuber, Karl E. and Alma F.
1965 Negroes in Cities; Residential, Segregation and Neighborhood Change. Chicago: Aldine Publishing Co.

Terris, Milton, and Mary M. Monk
1964 "Recent trends in the distribution of physicians in upstate New York," in Medical Care in Transition. Washington, D.C.: U.S. Public Health Service, U.S. Government Printing Office, pp. 323-329.

U.S. Bureau of the Census.
1961 U.S. Census of Business: 1958. Vol. VII, Central Business District Report, Detroit, Michigan, Area--BC58--CBD24. Washington, D.C.: U.S. Government Printing Office.

U.S. Bureau of the Census.
1962 U.S. Census of Population and Housing: 1960, Final Report PHC(1)-26. Washington, D.C.: U.S. Government Printing Office.

U.S. National Center for Health Statistics.
1965 Volume of Physician Visits by Place of Visit and Type of Service. Series 10, Number 18. Washington, D.C.: U.S. Government Printing Office.

U.S. National Center for Health Statistics.
1968 Volume of Physician Visits by Place of Visit and Type of Service. Series 10, Number 49. Washington, D.C.: U.S. Government Printing Office.

Weiss, James E.
1968 "The Effect of Medical Centers on the Distribution of Physicians in the U.S." Unpublished Doctoral dissertation, University of Michigan, Ann Arbor.