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THE MARKET FOR OPTOMETRIC SERVICES IN THE UNITED STATES

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The purpose of this paper is to analyze the market for optometric services in the United States. This is done primarily by specifying and estimating a market model for optometric services. Within the context of the model many of the more interesting questions relating to the practice of optometry can be considered. Some of these are: What factors influence the location decision of the optometrist? What effect does advertising have on the demand for optometric services? To what extent is the interstate mobility of optometrists inhibited by restrictive licensing arrangements? To what degree are the services of ophthalmologists and opticians substituted for those of the optometrist? What role do price and income play in determining the demand for optometric services?

This paper is divided into seven sections. In the following section an overview of the practice of optometry is presented. This is succeeded by an examination of the distribution of eye health professionals in the United States. In sections 3-5 a market model for optometric services is specified and discussed. Next, estimates of the model are presented. Finally, the implications of this research are considered.

1. The Practice of Optometry: An Overview

The primary health services provided by optometrists are the examination of the eye and the prescription and provision of lenses to correct refractive error. Optometrists also adjust and repair eyeglasses. The mean gross income of the 16,000 self-employed optometrists in the United States from their professional practices is approximately $50 thousand, implying that upwards of $800 million are spent annually on the services of self-employed optometrists.[1] Optometrists are engaged primarily in solo practice. About 17 percent of self-employed optometrists are in partnerships or group practices.[2] Most optometrists are general practitioners. Only about 3.5 percent of optometrists specialize in contact lenses, vision training, industrial vision or other fields.[3]

Besides optometrists, two other eye professions are involved in the delivery of eye care services in the United States. The ophthalmologist diagnoses eye disease, administers medical treatment, performs surgical operations, and prescribes eyeglasses to correct refractive error. The primary role of the optician is the fitting and dispensing of eyeglasses according to prescription. There are approximately 8,600 active ophthalmologists and about 11,000 active opticians in the United States.[4]

2. The Distribution of Eye Health Professionals in the United States

The uneven distribution of primary health professionals in the United States has long been a source of concern to health economists. In 1971, for example, the mean number of physicians per 100,000 population in rural states was 93.5, as compared to 125.8 in urban states.[5] Optometrists, like physicians, are more heavily concentrated in urban areas. There are 9.7 active optometrists per 100,000 in urban states as compared to 7.8 in rural states. A similar disparity exists in ophthalmology manpower between urban and rural states. There are 4.8 active ophthalmologists per 100,000 population in urban states and 3.6 per 100,000 in rural states. Opticians are also concentrated in urban states, with 7.0 active practitioners per 100,000 population, as compared to 4.2 per 100,000 in rural states.[6]

Because rural practitioners are also fewer spacially, their relative scarcity is magnified. In addition, rural practitioners are probably older than their urban counterparts, and thus could be less productive.[7] It should be noted, however, that despite the differentials that exist in medical manpower between urban and rural states, there is no evidence that the residents of those states where the supply of medical services is low are in poorer health as a result.[8]

Because of the concern over the "maldistribution" of health professionals, an important emphasis of this research is an examination of the location decision of the optometrist. The market model discussed in the following section is specified so that the location decision of the optometrist comprises one of the structural equations.

3. Specification of the Model

A fully specified model of the market for optometric services must describe both the demand for and supply of optometric services. The model estimated in this paper consists of a demand equation, two equations which together describe the supply of optometric services and one identity.[9] The supply side is investigated by examining the workload and location decisions of the optometrist. Four variables in the model are endogenous. These are the per capita quantity of optometric services demanded, price, the per capita number of optometrists and the workload of the optometrist. The model is presented below.

1. Q_d^* = Q_d (P*, Y, Age, NW, Ed, Advert, Oph, Opti)

2. Opto* = Opto (P*, License, Y, Grads)

3. Work* = Work (P*)

4. Q_d ≡ Opto · Work

*Designates endogenous variable.

Q_d	=	quantity of optometric services demanded per 100,000 population
P	=	price
Y	=	per capita income
Age	=	percent of the population 65 and over
NW	=	percent of the population non-white
Ed	=	percent of the population with 1-3 years of college
Oph	=	ophthalmologists per 100,000 population
Opti	=	opticians per 100,000 population
Opto	=	optometrists per 100,000 population
Advert	=	advertising restriction dummy, 1 = no state restrictions on advertising
License	=	national board licensing dummy 1 = national boards not accepted
Grads	=	number of graduating optometrists from optometry schools
Work	=	average annual output supplied by optometrists

4. The Data

The model is estimated across states by combining several data sources from the mid-1960's. Two of these sources are used to compute the quantity measure of the per capita consumption of optometric services by state. This measure is calculated by multiplying the annual average output of optometrists in each state by the number of practicing optometrists per 100,000 population. The latter figure is taken from the 1968 National Vision and Eye Care Manpower Survey of the National Center for Health Statistics.[10] The average output figure is derived from data collected in the 1964 American Optometric Association Survey of Optometrists. In this national survey data were collected from over 4,000 optometrists on the wholesale value of lenses, temples, and frames purchased by the optometrist in 1964 and on the annual number of visual examinations provided. These output measures can be converted into a single output index by deflating the wholesale value of eyeglasses to physical units and then combining the number of eyeglasses and eye examinations provided into a single measure by using the respective prices as weights.[11]

The 1964 average output of optometrists by state is determined by averaging the output indexes of those optometrists who responded to the AOA survey. Those states where less than forty optometrists responded to the AOA survey were excluded from the data base. Thirty-two states had forty or more respondents. These average output figures are then multiplied by the number of practicing optometrists per 100,000 population in 1968 in order to compute the quantity measure of the consumption of optometric services per 100,000 population for each of the 32 states.

Any bias in this measure resulting from the combining of the data sources from two different years should not be large since any changes in the state per capita stocks of optometrists over the four-year period would be small.

The data sources for the remaining variables included in the model are revealed as each equation is discussed in detail.

5. Discussion of Equation Specifications

5.1 The Demand for Optometric Services

A well-specified demand equation includes price of the product, the income of potential consumers, the prices of substitutes and complements and taste variables. Equation 1 falls somewhat short of this ideal. The price variable is derived from the 1964 AOA survey of optometrists. It is computed for each state by taking a weighted average of the gross annual income per unit of output of the responding optometrists, where the weight is the units of output produced.

The prices of the competing eye care services offered by ophthalmologists and opticians cannot be included in the demand equation because the data are not available. However, it may be possible to gain some idea of the substitutability of the services of competing eye professionals for those of the optometrist by entering the number of ophthalmologists and opticians per 100,000 population into the demand equation. A problem with this approach is that the relationship between the number of practitioners and the price of their services is not clear. On the one hand, an above average number of practitioners might depress price to a below average level; on the other hand, higher than average prices could serve to attract a higher than average number of practitioners.

A dummy variable is included in the demand equation which takes on a value of one for those states that did not restrict the advertising of optometric services. The advertising of optometric services should reduce the cost of these services to consumers. Search costs are reduced because the price and terms of sale as well as information on the suppliers identity, location and reliability are often provided. Lee Benham has shown that advertising also lowers the price paid by consumers for eyeglasses because it stimulates price competition among sellers.[12] Holding price constant, the effect of advertising should be to shift the demand curve for optometric services to the right because it lowers the information costs faced by consumers and may also enable optometrists to more effectively compete with ophthalmologists for patients seeking visual examinations and corrective lenses. Ophthalmologists, like all physicians, cannot advertise as a condition of license.

Those states not restricting advertising were determined from Lee Benham's classification of states in accordance with the restrictions placed on the advertising of eyeglasses. Benham constructed the series by examining state laws, by interviewing optometrists and members of state optometry boards, and by searching newspapers for eyeglass advertisements.

Several socioeconomic variables have been specified in the demand equation. The age distribution variable, percent of the population 65 and over, was included in the demand relation because the need for and utilization of corrective lenses increases dramatically with age. Near vision generally deteriorates quite rapidly after the age of 35, with 90 percent of adults between the ages of 45 and 54 having visual acuity of less than 14/14.[13] The same pattern holds for distance vision, although the rate of deterioration with age is not as great. With this background, it is not surprising to find that the utilization of corrective lenses increases markedly with age. About 90 percent of adults have eyeglasses by the age of 60.[14] Consequently, the older the population the optometrist serves, the greater should be the demand for his services.

The race variable, percent non-white, is included as an independent variable because of evidence that blacks have stronger vision than whites. For example, at the age of 50, about 90 percent of Negro males have uncorrected distance vision of 20/30 or better as compared to less than 75 percent of the white male population of the same age.[15] To test whether inter-state differences in racial composition actually translate into differences in the demand for optometric services, the percent of the population that is non-white is entered into the demand equation.

Income and education may also play a role in determining the demand for optometric services. The utilization of corrective lenses is positively correlated with family income and the education of the family head. Fifty percent of the population in families with income in excess of $5,000 had corrective lenses in 1965-66, as compared to 44 percent of the members of families with income less than $5,000. Fifty-four percent of the population in families where the head had 13 or more years of education owned corrective lenses in 1965-66, while 46 percent of the members of families where the head had less than 13 years of schooling had corrective lenses.[16] It is not evident from these figures whether the income effect results from the higher educational levels associated with higher income individuals, or whether the educational effect actually reflects a positive income elasticity for corrective lenses. In order to separate out the effects of income and education on the demand for optometric services, the state per capita income and the percent of the state population with 1-3 years of college are entered into the demand equation.

Although the utilization of corrective lenses increases with income and education it is not clear, a priori, that the partial effects of income and education on the demand for optometric services would be positive. This is because the higher the income and education of an individual, the more likely he is to use the services of an ophthalmologist instead of an optometrist to obtain an optical prescription. Twenty-five percent of those individuals with family income under $5,000 who had an eye examination and purchased eyeglasses during the two years preceding July 1965 to June 1966 used an ophthalmologist as a source of their optical prescription, while the same figure for those with family income of $5,000 and over was 36 percent. Similarly, 28 percent of those individuals whose family head had twelve years of schooling or less used an ophthalmologist as the source of their optical prescription while the comparable figure was 48 percent for those individuals whose family head had thirteen years of schooling and over.[17]

All of the socioeconomic variables were collected from the 1970 census.

5.2 The Supply of Optometric Services

The determinants of the supply of optometric services are examined by the estimation of a location equation and an average workload equation.

5.2a The Location of Optometrists

Price is included in the location equation and is expected to be positively associated with the number of optometrists per 100,000 population. With price held constant, the per capita income variable in the location equation must be interpreted as a proxy for the cultural, educational and other environmental advantages of a state which are correlated with per capita income.

The number of graduating students in optometry schools is entered into the equation to test whether graduating optometrists have a propensity to remain in the state where they receive their professional education. One reason why this should be the case is that optometry schools would seem more likely to draw entering students from their own states. This is because home state students are often given preferential treatment when considered for admission and often face lower tuition costs.[18]

To serve as a proxy for the stringency of state licensing requirements a national board dummy variable is included in the location equation. This variable takes on a value of one for those states which did not accept the national board examination in 1968. The national board examination was accepted in lieu of the written portion of the state licensing examination in 26 states in 1968.[19] The failing rates on individual state licensing examinations would probably be a more appropriate barrier to entry variable, but such data are not available. Implicit in the use of the national board dummy is the assumption that those states which do not accept the national board examinations also have the most stringent licensing requirements. Although state licensing requirements are established for the expressed purpose of ensuring that high standards of optometric care are practiced, many economists have argued that licensing is used by members of a profession in order to limit the number of competing practitioners. It is interesting to note that in most cases it is the professions that have demanded that their members be licensed. Consumers, who supposedly need to be protected from malpractice, have been less concerned about professional licensure.

There is evidence that the licensing arrangements of some professions have been used to restrict labor mobility between states. Holen found that interstate mobility in law and dentistry was low relative to medicine because of the "structure of licensing arrangements ... (and) because of the exclusionary practices of various state licensing boards."[20] She found that those states in which lawyers or dentists enjoyed high incomes also tended to have high failure rates among candidates for license. This was not true for the case of physicians, where restrictions on interstate mobility are small because of reciprocity agreements and the use of national boards. Maurizi has presented regression results that support the hypothesis that state licensing boards adjust the pass rate on licensing examinations in order to protect the incomes of those already licensed.[21]

5.2b The Workloads of Optometrists

Price is the only variable in the workload equation. Optometrists are expected to take on greater workloads the higher their per unit reward for doing so, unless their supply curves are backward bending and the average optometrist operates on that portion that is negatively sloped.

6. Empirical Results

6.1 The Demand for Optometric Services

The second stage estimates of the demand equations are presented in Table 1.[22] All variables are in logs with the exception of the advertising dummy. The per capita income coefficients (elasticities) vary from .34 to .59 in the demand equations. This range is high relative to the income elasticities of demand estimated for physician services by Fuchs and Kramer.[23] A relatively higher income elasticity of demand for optometric services is not unexpected. A good portion of optometric services, such as tinted glasses, more expensive, stylish frames and extra glasses, would seem to fall into the "luxury" category. In fact, the income elasticity of eye health services could be substantially greater than .5. The income elasticity of demand for optometric services would understate the income elasticity for eye health services if the tendency

TABLE 1

The Demand for Optometric Services: Second Stage of Two Stage Least Squares

	Percent Non-White	Percent 65 and Over	Per Capita Income	Ophthal-mologists Per 100,000 Population	Opticians Per 100,000 Population	Price	Education	Advertise 1 = Yes 0 = No	Constant
1.	-.14 (-4.[illegible])	.53 (2.7)	.55 (2.28)		-.23 (-3.30)	-1.00 (-2.12)	.26 (1.58)		7.78 (3.68)
2.	-.15 (-3.29)	.51 (2.22)	.59 (1.81)		-.24 (-2.50)	-1.54 (-.56)	.36 (.69)	-.07 (-.18)	6.31 (2.02)
3.	-.15 (-3.48)	.50 (2.13)	.34 (1.50)			-.48 (-.89)			9.21 (3.50)
4.	-.15 (-3.47)	.55 (2.45)	.49 (1.78)		-.21 (-2.67)		.09 (.50)	.13 (1.80)	11.75 (6.12)
5.	-.15 (-3.48)	.56 (2.32)	.48 (1.41)		-.20 (-2.15)	.34 (.23)		.17 (.91)	13.45 (1.81)
6.	-.15 (-2.90)	.55 (1.77)	.48 (1.10)	-.09 (-.11)	-.19 (-.95)	.78 (.18)		.22 (.5)	15.72 (.72)

All variables in natural logs except the advertising dummy. t statistics in parentheses.

N = 32.

to utilize the services of ophthalmologists and opticians rather than optometrists to secure optical prescriptions and corrective lenses increased with income.[24]

The interpretation of the coefficients of the advertising dummy and the education and price variables is hazardous because of multicollinearity. The advertising dummy varies markedly in the estimated demand equations. In regression 4, with the price variable excluded, the advertising dummy coefficient is significant at the 3 percent confidence level[25] and indicates that the demand for optometric services is 13 percent greater in those states where advertising is not restricted. However, with price included in the demand equation the t values of the advertising dummy fall to below one.

The education variable is positively related to the quantity of optometric services demanded and approaches statistical significance in equation 1, where the advertising dummy does not appear. In regressions 2, 4, education is included with the advertising dummy and is statistically insignificant. An insignificant education coefficient would lend support to the hypothesis that the tendency to utilize the services of ophthalmologists and opticians rather than optometrists to secure optical prescriptions and corrective lenses increases with education. This conclusion follows if it is accepted that the taste for corrective lenses increases with education. This assumption seems reasonable. The more educated place a greater emphasis on good health and probably have a greater interest in reading, an activity that requires the use of corrective lenses in most cases by middle age.

The price coefficient varies from -.48 to -1.54 in regressions 1-3, but becomes positive in regressions 5 and 6 when the education and advertising variables are excluded from the estimated demand equations.

The coefficients and statistical significance of the race and age variables remain fairly stable in the estimated regression equations. The positive association between the demand for optometric services and the percent of the population 65 and over is an expected result given the increased utilization of corrective lenses with age. The age elasticity is approximately .5. The percent of the population that is non-white is negatively related to the quantity of optometric services demanded. The negative association can be explained in part by the stronger vision possessed by Negroes. Perhaps an equally important explanation, however, is the higher price of securing optometric services that Negroes probably confront because of higher transportation and search costs. Many Negroes live in urban ghettos or rural areas in the South where optometric care is relatively scarce.

The regression results provide no decisive evidence on the extent to which the services of ophthalmologists and opticians are substituted for optometric services. This is true because of the inconclusive regression estimates as well as the considerations discussed above (see pp. 6-7). The optician variable is highly significant and negatively related to the demand for optometric services when the ophthalmologist variable does not appear in the demand equation. When the two competing eye professional variables are entered together, however, the optician variable is significant at only the 30 percent confidence level. The ophthalmologist variable is always statistically insignificant, even when the optician variable is excluded from the demand models.[26]

The "better performance" of the optician variable may indicate that opticians offer services that are more competitive with those of the optometrist than is true for the eye care services provided by ophthalmologists. This interpretation is consistent with the fact that the dispensing portion of the optometrist's practice comprises the major portion of services supplied. According to the output measure used in this study, the dispensing of corrective lenses comprises 76 percent of optometric output and visual exams the remaining 24 percent.[27] The coefficient of the optician variable is stable at about -.20 in all the estimated demand equations.

6.2 The Location of Optometrists

The second stage estimates of the location equation are

$$\text{Output} = \underset{(1.86)}{6.44} + \underset{(1.51)}{1.01}\ \text{Price} + \underset{(1.86)}{.58}\ \text{Per Capita Income}$$

$$+ \underset{(1.61)}{.002}\ \text{Graduating Optometry Students}$$

$$- \underset{(1.71)}{.15}\ \text{National Board Dummy.}$$

All variables are in logs except the number of graduating optometry students and the national board dummy. The t-statistics are in parentheses.

Optometrists appear to be quite sensitive to price in making their location decision. This price coefficient of 1.01 is in the upper range of the price elasticities for the per capita supply of physicians reported by Fuchs and Kramer. Optometrists may be more sensitive to interstate variations in price because they are more likely to migrate (interstate) than physicians. This conclusion is based on the assumption that migration in both these professions is undertaken predominately by recent graduates of the professional schools. The established practices of older practitioners should make them reluctant to migrate. Recent graduates of optometry schools should be more prone to migrate than their physician counterparts because of the much smaller number of optometry schools. There existed only ten optometry schools in nine states in 1968, while medical schools were located in nearly every state. The national board dummy coefficient indicates that state licensing examinations are an effective means of restricting entry, given the assumption that states which do not accept the national boards in optometry have the more stringent licensing requirements. The dummy coefficient indicates that states with more restrictive licensing requirements have 15 percent fewer optometrists per 100,000 population, holding other variables equal, than those states with less restrictive licensing arrangements. To put this another way, consumers in those states with restrictive licensing requirements could have a substantially larger stock of optometrists from which to choose if these entry restrictions were eased.

The graduating optometry student coefficient demonstrates that optometrists have at least a slight propensity to remain in the state where they receive their professional education. The elasticity of the number of optometrists per 100,000 population with respect to the number of graduating optometrists inherent in the regression results is very small, approximately .03. A small elasticity is to be expected because only nine states have optometry schools in the United States, so a significant amount of outmigration must take place by optometrists from the state where they receive their professional training, or optometrists would be much less evenly distributed around the country than they presently are. The elasticity must also be small because the total number of graduates from optometry schools in any one year is small in relation to the stock of practicing optometrists.

The attraction of optometrists to high per capita income states, holding price constant, indicates that environmental factors which are correlated with per capita income play a significant role in their location decision. This finding is discussed in more detail in Section 7.

6.3 The Workloads of Optometrists

The simple regression of the log of average workloads on the log of price yields:

$$\text{Log average workload} = \underset{(2.15)}{3.22} - \underset{(-3.43)}{1.05} \text{ log price.}$$

The t-statistics are in parenthesis. The obvious explanation of the negative price coefficient is that optometrists are on the backward bending portion of a labor supply curve. The price coefficient shows that an instate price increase of 10 percent should reduce the average workloads of optometrists by about 10 percent. The supply of optometric services within the state would remain about the same, however. The regression results for the location equation indicate that the per capita number of optometrists would increase by approximately 10 percent as a result of a 10 percent price increase.

7. Implications of the Research

At the outset of this paper a brief discussion was provided of the concern of many health economists over the uneven distribution of health professionals, particularly between urban and rural areas. Optometrists, as well as physicians, were seen to be relatively scarce in rural areas.

The estimation of the market model for optometric services in this study provides some insight into the reasons for the uneven distribution of health manpower. The estimation of the equation describing the location decision of optometrists revealed that price, per capita income and the stringency of state licensing requirements were the most important determinants of the location of optometrists. In Table 2 the means of these variables are presented for the urban and rural states included in the cross section. The regression results and the data in Table 2 together indicate that differences in the price of output and in the environmental and cultural qualities of a state that correlate with per capita income primarily explain the uneven distribution of optometric manpower between urban and rural states. Differences in the stringency of state licensing requirements, as represented by the national board dummy, work in favor of rural states in terms of the location of optometric manpower.

The mean number of optometrists per 100,000 population in the nineteen urban states is 9.71. This is 15 percent greater than the mean number of 8.45 optometrists per 100,000 population in the thirteen rural states. The price coefficient in the estimated location equation indicates that if the price of output in rural states increased to the urban state mean, or by 5.5 percent, the mean number of optometrists per 100,000 would increase by the same percentage. The price effect, therefore, does not account for the major portion of the discrepancy in the per capita number of optometrists between urban and rural states. Apparently, the environmental and cultural attributes

TABLE 2

Sample Means of Location Decision Variables for Optometrists, Urban and Rural States

Variable Name	Mean: Urban States[a]	Mean: Rural States
Price	$7.69	$7.29
Per-capita income	$4,068	$3,251
National Board Dummy	.63	.53
N	19	13

[a]States in the urban category have 55 percent or more of their population in urban areas.

of a state that correlate with per capita income primarily explain the optometrist's preference for urban over rural areas. The per capita income coefficient in the location equation suggests that the 25 percent higher income level in urban states has attracted 15 percent more optometrists than would have been the case if urban state incomes were at the rural state level. It is this "life style" differential, then, that appears to be mainly responsible for the uneven distribution of optometrists between urban and rural areas.

The same effect could be very important in explaining the urban-rural discrepancy in the location of physicians. The per-capita income coefficients in the physician location equation estimated by Fuchs and Kramer were as high as .5 and statistically significant with price also included as one of the other independent variables.[28] The stock of physicians in urban states is 34 percent greater than in rural states.[29] More than one-third of this urban-rural state disparity in the per capita number of physicians can be accounted for by the differences in life-style opportunities, given the per-capita income differential of about 25 percent and assuming the upper range of Fuchs and Kramer's estimated per-capita income coefficients from their location equation are relevant.

The relative scarcity of optometrist's in rural areas does not translate unimpeded into a similar differential in the supply of optometric services. The estimated price coefficient in the workload equation showed the average optometrist to offer <u>less</u> services in response to increases in price. The price of optometric services in urban states is 5.5 percent higher than in rural states (see Table 2). According to the price coefficient in the workload equation, average workloads in urban states should correspondingly be about 5.5 percent less. About one-third of the differential in per capita optometric manpower between urban and rural states, therefore, is made up for in terms of the total supply of optometric services by higher workloads taken on by rural optometrists because of lower market prices.

The same argument could also be relevant to the supply of physician services in urban and rural areas. Regression results have been presented by Fuchs and Framer and by Feldstein which support the hypothesis that physicians reduce supply in response to an increase in fees.[30] This may be a partial explanation of why residents of rural areas are not in poor health relative to urban residents. The relative scarcity in the supply of physician services in rural areas may not be nearly as great as the relative scarcity of physicians.

Footnotes

[1]In 1968 there were 18,299 optometrists in active practice. Self-employed optometrists totaled 16,218. (National Center for Health Statistics, Optometrists Employed in Health Services, United States, 1968, Department of HEW Publication No. (HSM) 73-1803, Vital Health Statistics - Series 14, No. 8.) In 1969, the mean annual gross income of practicing optometrists was $46 thousand. (Fred Chipman, "AOA 1969 Economic Survey, Part IV," Journal of the American Optometric Association, Vol. 41, No. 6, June 1970, p. 551.)

[2]National Center for Health Statistics, Optometrists Employed in Health Services, p. 14.

[3]"A Survey of Optometrists," Journal of the American Optometric Association, Vol. 40, No. 12, December 1969, p. 1195.

[4]Opticians Employed in Health Services, United States, 1969, Department of HEW Publication No. (HSM) 72-1052, Vital Health Statistics - Series 14, No. 3, pp. 8-9.

Ophthalmology Manpower: Characteristics of Clinical Practice, United States, 1968, Department of HEW Publication No. (HMS) 73-1802, Vital Health Statistics - Series 14, No. 7.

[5]States classified as urban have 55 percent or more of their population in urban areas. The state per capita numbers of physicians were weighted by state population in computing the urban and rural states means.

The 1971 per capita number of physicians by state was taken from Distribution of Physicians in the U.S., 1971, Center for Health Services, Research and Development, AMA, Chicago, 1973.

[6]The considerations presented in footnote 5 apply here as well. The per capita number of eye professionals by state was taken from Optometrists Employed in Health Services, op. cit.; Opticians Employed in Health Services, op. cit.; and Ophthalmology Manpower, op. cit.

[7]Fein argues that many rural physicians have reached an age where the increased need for leisure time has offset the productivity gains associated with work experience. See Rashi Fein, The Doctor Shortage, The Brookings Institute, Washington, D.C., 1967, pp. 74-75.

[8]Victor Fuchs and Marcia Kramer, The Determinants of the Expenditures for Physician Services in the United States, 1948-68, National Bureau of Economic Research, Occasional Paper 117 and DHEW publication HSM 73-3013, 1972.

[9]This model is very similar to the market model for physician services estimated by Fuchs and Kramer, op. cit.

[10]Optometrists Employed in Health Services, United States, 1968, Department of Health, Education and Welfare Publication No. (HSM) 73-1803, Vital Health Statistics - Series 14, No. 8.

[11]This procedure is described thoroughly in Douglas Coate, "The Optimal Employment of Inputs in Fee for Service, for Profit Health Practices: the Case of Optometrists," NBER Working Paper, October 1975.

[12]See Lee Benham, "The Effect of Advertising on the Price of Eyeglasses," Journal of Law and Economics, October 1972, pp. 337-353.

[13]____________, "Binocular Visual Acuity of Adults, U.S., 1960-62, National Center for Health Statistics, Series 11, No. 3.

[14]____________, Characteristics of Persons with Corrective Lenses, 1965-66, National Center for Health Statistics, Series 10, No. 53.

[15]____________, Binocular Visual Acuity of Adults, op. cit.

[16]____________, Characteristics of Persons with Corrective Lenses, op. cit. These figures are age adjusted.

[17]Ibid.

[18]The data source for the number of graduates from individual optometry schools is M.Y. Pennel and M.B. Delong, "Optometric Education and Manpower," Journal of the American Optometric Association, Vol. 41, No. 1, November 1970.

[19]This information was collected from unpublished data of the Optometric Center of New York.

[20]Arlene S. Holen, "The Effects of Professional Licensing Arrangements on Interstate Labor Mobility and Resource Allocation," Journal of Political Economy, 73, October 1965.

[21]Alex Maurizi, "Occupational Licensing and the Public Interest," Journal of Political Economy, Vol. 82, No. 2, March/April 1974.

[22]The regressions are unweighted. Residual plots did not indicate heteroscedasticity.

[23]The income elasticities in what Fuchs and Kramer call their more successful estimates of the demand for physician services range from .04 to .20. Fuchs and Kramer, op. cit., p. 33

[24]One problem with this interpretation that is relevant to regressions 1-2, 4-6 is that either the number of ophthalmologists or opticians or both are being controlled for. Within the constraints of these models, therefore, increases in income could result in a movement by consumers from optometrists to ophthalmologists or opticians only if the latter eye professionals increased their workloads. In regression 3 the numbers of ophthalmologists and optometrists are allowed to vary and this qualification does not apply.

[25]In a one-tailed test.

[26]When the ophthalmologist variable is included in the demand equation without the optician variable, the coefficient is negative but the t-statistic is less than one (in absolute value). These results are not presented in Table 1.

[27]The mean number of visual exams supplied by optometrists by state averaged 1,063. The mean number of eyeglasses provided by state in visual exam units averaged 3,310. It should not be assumed, however, that ophthalmologists supply exclusively medical services and do not dispense corrective lenses. About 22 percent of practicing ophthalmologists employ opticians or optical fitters. (Ophthalmology Manpower, op. cit.)

[28] Fuchs and Kramer, op. cit., p. 31. The per capita income coefficients in their location equations were generally unstable because of multicollinearity.

[29] See page 2.

[30] Fuchs and Kramer, op. cit.; and Martin Feldstein, "The Rising Price of Physicians' Services," Review of Economics and Statistics, No. 52, May 1970, pp. 121-33.