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The Market for Optometric Services in the United States in the 1960s

ABSTRACT: In this paper a market model for optometric services is estimated across states, using data for the mid-1960s. Several of the hypotheses that have been offered to explain the demand for and supply of physician services are also relevant to the market for optometric services and are re-examined in this research. In the discussion of the empirical results, emphasis is placed on the differences between urban and rural areas in the per capita supply of optometric services. The results indicate that because of a combination of lower market prices in rural areas and a backward-bending labor supply curve, the relative scarcity in the supply of optometric services in rural areas is not nearly as great as the relative scarcity of optometrists.

My purpose here is to analyze the market for optometric services in the United States. Although gross expenditures for those services are only a small part of total health care expenditures,[1] those without a specialized interest in eye care

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may also be concerned with the findings here because many of the hypotheses offered to explain the workings of the market for physician services are also relevant to the delivery of optometric services and are re-examined in this research. Some of the questions considered within the framework of the model for optometric services developed in this paper are: What factors influence the locational 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? What role do price and income play in determining the demand for optometric services? What is the influence of price on the workloads of optometrists?

This paper is divided into five sections. In the first three, a market model for optometric services is specified and discussed. Estimates of the model are presented in section 4, and the implications of this research are considered in section 5.

[1] 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 study consists of an identity, a demand equation, and two equations which together describe the supply of optometric services.[2] The supply side is investigated by examining the workload and locational decisions of the optometrist. The four endogenous variables in the model (marked by asterisks) are per capita quantity of optometric services demanded, price, 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) $Q_d \equiv Opto^* \cdot Work^*$

where

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 nonwhite
Ed = percent of the population with one to three 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 1968 graduates of optometry schools
Work = average annual output supplied by optometrists

[2] THE DATA

The model is estimated across states. Data limitations require that sources for the mid-1960s be combined. The quantity measure of the per capita consumption of optometric services by state 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 (HEW 1973b). The average output figure is derived from the 1964 American Optometric Association (AOA) Survey of Optometrists. In that survey, nationwide data were collected from over 4,000 optometrists on the wholesale value of their 1964 purchases of lenses, temples, and frames and on the annual number of visual examinations provided. These output measures were 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.[3]

The 1964 average output of optometrists by state was determined by averaging the output indexes of optometrists who responded to the AOA survey. (States in which fewer than forty optometrists responded to the survey were excluded from the data base. Thirty-two states had forty or more respondents.) The average output figures were 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 thirty-two states.

Data sources for the remaining variables included in the model are presented as each equation is discussed in detail.

[3] EQUATION SPECIFICATIONS

[3.1] The Demand for Optometric Services

A well-specified demand equation includes product price, income of potential consumers, prices of substitutes, and complements and taste variables. Equation 1 falls somewhat short of this ideal. The price variable was derived from the 1964 AOA survey of optometrists. It was 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 was the number of units of output produced.

The prices of the competing eye care services offered by ophthalmologists and opticians could not be included in the demand equation because the data were not available. However, some idea of the substitutability of the services of competing eye professionals for those of the optometrist may be gained by entering the number of ophthalmalogists and opticians per 100,000 population into the demand equation.

A dummy variable, which equals 1.0 for those states that did not restrict the advertising of optometric services, was included in the demand equation. Advertising would be expected to reduce the costs of these services to consumers. Search costs are reduced because the price and terms of sale as well as information on the supplier's identity, location, and reliability are often provided. Benham (1972) has shown that advertising also lowers the price paid by consumers for eyeglasses because it stimulates price competition among sellers. When price is held constant, the effect of advertising would be to shift the demand curve for optometric services to the right because the information costs faced by consumers would be lowered and optometrists might be able to compete more effectively with ophthalmologists for patients seeking eye examinations and corrective lenses. As a condition of their license, ophthalmologists, like all other physicians, cannot advertise.

To determine which states did not restrict advertising, I used Benham's classification of states according to their restrictions on the advertising of eyeglasses. Benham constructed the series by examining state laws, interviewing optometrists and members of state optometry boards, and searching newspapers for eyeglass advertisements.

Several socioeconomic variables have been included in the demand equation. The age distribution variable—percent of the population sixty-five and over—was included in the demand relation because the need for and utilization of corrective lenses increases dramatically with age: about 90 percent of adults have eyeglasses by age sixty.[4] Consequently, the older the population the optometrist serves, the greater should be the demand for his services.

Percent nonwhite was included as an independent variable because of evidence that blacks have stronger vision than whites. For example, at age fifty, about 90 percent of black men have uncorrected distance vision of 20/30 or better as compared to less than 75 percent of the white men of the same age (National Center 1963). The race variable is entered into the demand equation to test whether interstate differences in racial composition actually translate into differences in the demand for optometric services.

Income and education may also play a role in determining the demand for optometric services. Use of corrective lenses is positively correlated with family income and level of education of the family head. Fifty percent of the population in families with income over $5,000 had corrective lenses in 1965-1966, as compared to 44 percent in families with income below $5,000. Fifty-four percent of the population in families whose head had thirteen or more years of education owned corrective lenses in 1965-1966; the corresponding figure for families whose head had less than thirteen years of schooling was 46 percent (National Center 1967; the figures are age adjusted). 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. To determine the separate effects of income and education on the demand for optometric services, state per capita income and the percent of the state population with one to three years of college were included in the demand equation.

Although use of corrective lenses increases with income and education, it is not clear a priori that the partial effects of each factor on the demand for optometric services will be positive. The reason is that the higher the income and education of individuals, the more likely they are 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-June 1966 obtained their optical prescription from an ophthalmologist; the corresponding figure for those with family income of $5,000 and over was 36 percent. Similarly, 28 percent of individuals in families whose head had twelve years of schooling or less obtained their optical prescription from an ophthalmologist; the corresponding figure in families whose head had at least thirteen years of schooling was 48 percent (National Center 1967).

All the socioeconomic variables were collected from the 1970 census.

[3.2] The Supply of Optometric Services

The determinants of the supply of optometric services were examined by estimating two equations, one for location and one for average workload.

The Location of Optometrists Price was included in the location equation and was 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 those cultural, educational, and other environmental advantages of a state that are correlated with per capita income.

The number of 1968 graduating students in optometry schools was 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 this should be the case is that optometry schools would seem more likely to draw entering students from their own states than from other places, since home-state students are often given preferential treatment when they apply for admission and often face lower tuition costs.[5]

A national board dummy variable was included in the location equation as a proxy for the stringency of state licensing requirements. This variable equals 1.0 for those states that did not accept the national board examinations in 1968. Nationwide, the national board examination was accepted in lieu of the written portion of the state examination in twenty-six states in 1968.[6] The failure rates on individual state licensing examinations would 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 more stringent licensing requirements.

There is evidence that the licensing arrangements of some professions have been used to restrict labor mobility between states. Holen (1965, p. 494) 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." She found that failure rates among candidates for license tended to be high in states where lawyers or dentists enjoyed high incomes. This was not true in the case of physicians; restrictions on their interstate mobility are few because of reciprocity agreements and the use of national boards. Maurizi (1974) 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.

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 the negatively sloped portion.

[4] EMPIRICAL RESULTS

[4.1] The Demand for Optometric Services

The second-stage estimates of the demand equations are presented in Table 1.[7] All variables are in natural logs except for the advertising dummy. The per capita income coefficients (elasticities) vary from 0.34 to 0.59 in the demand equations. This range is high relative to the income elasticities of demand estimated for physician services by Fuchs and Kramer.[8] A relatively higher income elasticity of demand for optometric services is not unexpected. A

TABLE 1 Demand for Optometric Services: Second Stage of Two-Stage Least Squares Estimates[a] (figures in parentheses are t statistics)

	Percent Nonwhite	Percent 65 and Over	Per Capita Income	Ophthalmologists per 100,000 Population	Opticians per 100,000 Population	Price[b]	Education	Advertise 1 = Yes 0 = No	Constant
1.	−0.14	0.53	0.55		−0.23	−1.00	0.26		7.78
	(−4.15)	(2.7)	(2.28)		(−3.30)	(−2.12)	(1.58)		(3.68)
2.	−0.15	0.51	0.59		−0.24	−1.54	0.36	−0.07	6.31
	(−3.29)	(2.22)	(1.81)		(−2.50)	(−0.56)	(0.69)	(−0.18)	(2.02)
3.	−0.15	0.50	0.34			−0.48			9.21
	(−3.68)	(2.13)	(1.50)			(−0.89)			(3.50)
4.	−0.15	0.55	0.49		−0.21		0.09	0.13	11.75
	(−3.87)	(2.45)	(1.78)		(−2.67)		(0.50)	(1.80)	(6.12)
5.	−0.15	0.56	0.48		−0.20	0.34		0.17	13.45
	(−3.68)	(2.32)	(1.41)		(−2.15)	(0.23)		(0.91)	(1.81)
6.	−0.15	0.55	0.48	−0.09	−0.19	0.78		0.22	15.72
	(−2.90)	(1.77)	(1.10)	(−0.11)	(−0.95)	(0.18)		(0.5)	(0.72)

[a]All variables are in natural logs except the advertising dummy. $N = 32$.
[b]Endogenous variable.

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 0.5. The income elasticity of demand for optometric services would understate the income elasticity for eye health services if the tendency to secure optical prescriptions and corrective lenses from ophthalmologists and opticians rather than optometrists increased with income.[9]

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 in a one-tailed test at the 3 percent level 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 1.0.

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 and 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 turn to ophthalmologists and opticians rather than optometrists for optical prescriptions and corrective lenses increases with education. The hypothesis itself seems reasonable: as education increases, so does emphasis on good health and, probably, interest in reading, for which corrective lenses are usually required by middle age.

The price coefficient varies from −0.48 to −1.54 in regressions 1, 2, and 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 use of corrective lenses with age. The age elasticity is approximately 0.5. Percent nonwhite is negatively related to demand for optometric services. The negative association can be explained in part by the better vision of blacks. Perhaps an equally important explanation, however, is that blacks probably have higher transportation and search costs than whites. Many blacks live in urban ghettos or rural areas in the South where optometric care is relatively scarce.

As anticipated in section 3.1, the regression results provide no decisive evidence on the extent to which the services of ophthalmologists and opticians are substituted for those of the optometrist. 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 variables for the two competing eye professionals 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.[10]

The "better performance" of the optician variable may indicate that opticians offer services that are more competitive with those of optometrists than do ophthalmologists. This interpretation is consistent with the fact that dispensing eyeglasses is the chief service provided by optometrists. According to the output measure used in this study, the dispensing of corrective lenses constitutes 76 percent of optometric output, and visual exams account for the remaining 24 percent.[11] The coefficient of the optician variable is stable at about -0.20 in all the estimated demand equations.

[4.2] The Location of Optometrists

The second-stage estimates of the location equation are

$$\underset{}{Opto} = \underset{(1.86)}{6.44} + \underset{(1.51)}{1.01P^*} + \underset{(1.86)}{0.58Y} + \underset{(1.61)}{0.002Grads} - \underset{(1.71)}{0.15\ License}$$

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

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 in those states with more restrictive licensing requirements, the per capita stock of optometrists has been constrained to a level 15 percent lower than in states not so classified.

The graduating optometry student coefficient shows that optometrists have at least a slight propensity to remain in the state where they receive their professional education. The elasticity of *Opto* with respect to *Grads* inherent in the regression results is very low, approximately 0.03. A low elasticity is to be expected because only nine states have optometry schools in the United States. Therefore, a significant number of optometrists must establish their practice in a state other than the one where they received their professional training, or optometrists would be much less evenly distributed around the country than they actually are. The elasticity must also be low because in any one year the total number of optometric graduates is small in relation to the number of optometrists already in practice.

The attraction of optometrists to states with high per capita income, holding price constant, indicates that a significant role in their locational decision is played by environmental factors that are correlated with per capita income. This finding and the role of price in the locational decision are discussed below.

[4.3] The Workload of Optometrists

The second-stage estimates of the workload equation are

$$\ln Work = \underset{(2.15)}{3.22} - \underset{(-3.43)}{1.05} \ln P^*$$

The t statistics are in parentheses. The obvious explanation of the negative price coefficient is that optometrists are on the backward-bending portion of a labor supply curve. Taken together, the negative unitary elasticity of workload with respect to price and the positive unitary elasticity of the per capita number of optometrists with respect to price imply that the in-state supply of optometric services is not sensitive to variation in price.

[5] Implications of the Research

The uneven distribution of primary health professionals in the United States between urban and rural areas has been a source of concern to health economists for the past decade.[12] In 1971, for example, the mean number of physicians per 100,000 population was 93.5 in rural states, and 125.8 in urban ones.[13] Optometrists, like physicians, are more heavily concentrated in urban areas: 9.7 active optometrists per 100,000 in urban states as compared to 7.8 in rural ones. A similar disparity between urban and rural states exists in ophthalmological manpower. There are 4.8 active ophthalmologists per 100,000 population in urban states and 3.6 per 100,000 in rural ones. Opticians are also concentrated in urban states, with 7.0 active practitioners per 100,000 population and 4.2 per 100,000 in rural ones (HEW 1972, HEW 1973a).

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. Estimation of the location equation (subsection 4.2) revealed that price, per capita income, and the stringency of state licensing requirements were the most important determinants of the location of optometrists. In the following tabulation, the means of these variables are presented for the urban and rural states included in the cross section; as before, states classified as urban have 55 percent or more of their population in urban areas:

	Urban States	Rural States
Price	$7.69	$7.29
Per capita income	$4,068	$3,251
National board dummy	0.63	0.53
No. of observations	19	13

Taken together, the regression results and the data shown indicate that differences in the price of output and in the environmental and cultural qualities of a state that correlate with per capita income are the chief reasons for 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 more than the mean number in the thirteen rural states (8.45 per 100,000). 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 percent. 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. However, the per capita income coefficient in the location equation suggests that the 25 percent higher income level in urban states attracted 15 percent more optometrists than would have been the case if the income levels of rural and urban states were the same. Apparently, then, the explanation for the uneven distribution of optometrists lies in "life style" differences between the two types of area—in the environmental and cultural attributes of a state that are correlated with per capita income.

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 (1973, p. 31) were as high as 0.5 and were statistically significant with price also included as one of the other independent variables. The stock of physicians in urban states is 34 percent greater than in rural ones. More than one-third of this urban-rural difference can be accounted for by differences in life-style opportunities, given the per capita income differential of about 25 percent and assuming that the upper range of Fuchs and Kramer's estimated per capita income coefficients in their location equation are relevant.

The relative scarcity of optometrists 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 that services offered by the average optometrist declined in response to increases in price. As indicated in the tabulation above, the price of optometric services in urban states is 5.5 percent higher than in rural states. 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 appears to be accounted 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 Kramer (1973) and by Feldstein (1970) which support the hypothesis that physicians reduce their supply in response to an increase in fees.[14] This may be a partial explanation of why residents of rural areas are not in relatively poorer health than urbanites. The relative scarcity in the supply of physician services in rural areas may not be nearly as great as the relative scarcity of physicians.

NOTES

1. In 1969, expenditures on optometric services totaled about $800 million. This is the most recent year for which a reliable estimate can be made (Coate 1977).
2. This model is very similar to the market model for physician services estimated in Fuchs and Kramer (1973).
3. This procedure is described thoroughly in Coate (article 4, below).
4. Near vision generally deteriorates quite rapidly after age thirty-five, with 90 percent of adults between the ages of forty-five and fifty-four having visual acuity of less than 14/14 (National Center 1963). The same pattern holds true for distance vision, although the rate of deterioration with age is not as great.
5. The data souce for the number of graduates from individual optometry schools is Pennel and Delong (1970).
6. This information was collected from unpublished data of the Optometric Center of New York.
7. The regressions are unweighted. Plots of the residuals did not indicate heteroscedasticity.
8. The income elasticities in what Fuchs and Kramer (1973, p. 33) call their more successful estimates of the demand for physician services range from 0.04 to 0.20.
9. One problem with this interpretation that is relevant to all the regressions except 3 is that either the number of ophthalmologists or of 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 increased their workloads. In regression 3 the numbers of ophthalmologists and optometrists are allowed to vary, and this qualification does not apply.
10. 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 1.0 (in absolute value). These results are not presented in Table 1.
11. 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 only medical services and do not dispense corrective lenses. About 22 percent of practicing ophthalmologists employ opticians or optical fitters (HEW 1973a).
12. See, for example. Fein (1967, pp. 74-75). More recently Lave et al. (1975, p. 22) concluded: "A major unresolved problem is the provision of [physician] services to rural areas distant from major cities." Yett and Sloan (1974, p. 125) also argue that "physicians are in noticeably short supply in low-income districts and rural areas in general."
13. States classified as urban have 55 percent or more of their population in urban areas. In computing the urban and rural state means, the state per capita number of physicians was

weighted by the state population. The 1971 per capita number of physicians by state was taken from AMA (1973).

14. The per capita income coefficients in the location equations of Fuchs and Kramer (1973, p. 31) were generally unstable because of multicollinearity.

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