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Locational Choices of Medical Doctors: A U.S. County-Level Analysis

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Access to and availability of health care are fundamental measures of economic development and well-being. In this paper we focus on the availability of health care over space, rather than the more complex issue of access or entitlement to health care.[1] Although the number of physicians in both rural and non-rural areas of the U.S. has recently been increasing, there are more than twice as many doctors per capita in urban as compared to rural areas (see also Frenzen). Concern about the availability of doctors in rural areas has been implicitly or explicitly expressed recently by authors such as Kindig and Ricketts; Kindig, Schmelzer and Hong; Hicks and Glenn; Hines and Rutrough; Rowland and Lyons; Cowper and Kushman; Obidiegwu and Alwang; Conte et al., as well as others.[2]

Reasons that have been advanced for the smaller relative number of doctors in rural areas include "isolation from professional colleagues and lack of educational opportunities, work conditions [and] social and cultural conditions," including amenities and a "more favourable income-leisure trade-off in urban areas" (Adams, p. 48, citing Dupont and Flor, Anderson and Rosenberg, and Landry, Berlinguet and Levy),[3] along with numerous other reasons related to recent changes in the practice of medicine (an excellent discussion is contained in Crandall, Dwyer and Duncan).[4] A case study of factors influencing the retention of doctors in a rural Florida community is contained in Conte, Imershein and Magill. Some states, such as Kentucky, are studying economic incentives which would induce young doctors to spend one or more years in rural areas upon graduation from medical school. Other states, such as West Virginia and North Dakota, are recruiting trained doctors from foreign countries to take up residency in rural areas.

In this paper we attempt to identify and model factors associated with medical doctors' county-level location decisions. Our goal is to determine whether public policy levers and private incentives exist which can be manipulated to increase the availability of doctors in rural areas. After developing a formal model of medical doctors' location decisions, we use 1989 county-level data on numbers of doctors from the Area Resource File (ARF) to estimate econometric equations at the county-level for the entire U.S. predicting the number of doctors per capita. The data on medical doctors are complemented with ARF data on causes-of-death in 1989, data from the 1990 U.S. Census of Population, and the USDA's rural-urban adjacency or continuum (Beale) code, as well as various state-level variables.

Modeling Doctors' Location Choices

Medical doctors' location choices are modeled as resulting from utility maximization subject to a full-income constraint. More specifically, suppose doctors maximize utility U over a composite of goods (Z) and amenities (A):

$$(1) \qquad \max.\ U = U(Z, A)$$

Doctors choose a county, c_i*, $i \in \mathrm{N}$, in which to locate by comparing utility gained in different counties (U_i), until they identify the county ($c_i = c_i$*) yielding positive net utility over all other counties:

$$prob(c_i^* = 1) = f(U_i - U_j) > 0, \ \forall\ i \neq j.$$

The model is operationalized using county-level characteristics which proxy for amenities such as leisure activities and rural vs. urban status of the county:

$$(2) \quad A = A(\Omega, \mathbf{B})$$

where Ω includes state-level measures of environmental quality and policies as well as educational spending per pupil and availability of recreational facilities[5] as amenities, and public spending on welfare as a disamenity. In addition, we include educational attainment of the county population as a proxy for other cultural and social amenities available in the county. This is based on the premise that counties with a more highly educated populace are more likely to offer precisely the types of amenities that medical doctors are also likely to demand. **B** represents ten Beale codes for the rural-to-urban continuum, as described in more detail below. Doctors' disposable income (y^o) is determined by the demand for their services and taxes:

$$(3) \quad y^o = y^o(\alpha, \delta, \xi, d, \gamma),$$

where α measures the percent of population 65 years and older, which requires greater medical attention, *cet. par.* ($y_\alpha^o > 0$); δ is a vector of death rates per capita from different causes listed below, with $y_\delta^o > 0$;[6] ξ is per capita personal income in the county, which reflects demand for medical services and which is also likely to be correlated with salaries of doctors ($y_\xi^o > 0$);[7] d measures population density, with $y_d^o > 0$ to reflect agglomeration economies; and

and γ measures government fiscal policy, with $y_\gamma^o < 0$ for various taxes described in more detail below. In general terms, the model is estimated as,

$$(4) \qquad l_i = l_i(\Omega_i, \mathbf{B}_i, \alpha_i, \delta_i, \xi_i, d_i, \gamma_i) + \epsilon_i,$$

where l_i measures the number of doctors per capita. The distributions of l_i and ϵ_i are discussed in more detail in the next section.

Data and Econometric Models

Variables used in the regression are reported in Table 1 along with their detailed definitions and summary statistics. The number of doctors per 10,000 population ranges from zero in 147 counties to 197.3 in Montour county, Pennsylvania, while the maximum total number of doctors in any county is 23,363 (Los Angelos county, California).[8] As suggested in Figure 1, considerable diversity exists in the per capita distribution of doctors across the U.S. One useful categorization of counties according to their urban/rural status is the Beale code (Hady and Ross), which ranges from "0" for central counties of metro areas with a population of one million or more to "9" for rural counties in which there are no places with more than 2,500 people and which are not adjacent to metro areas (Table 1 and Figure 2). The average number of doctors per 10,000 population in 1989 varied noticeably across these Beale codes, with central metro counties having the highest number of doctors per capita, and the most rural counties exhibiting the lowest numbers (Figure 3). These numbers are likely to reflect the fact that medical specialists locate in highly populated areas of the country.

The data on the number of doctors per county are censored in the sense that 147 or 5.04% of all counties do not have any doctors. Table 3 shows summary statistics of the variables used in the regression stratified by the number of doctors per capita. While the percentage of counties without doctors is relatively small, it is large enough to warrant econometric estimation by methods other than OLS. In particular, this means that the doctors' location problem should be cast within a probabilisitic framework whereby a distinction is made statistically between the probability that a given county has doctors, and the number of doctors per capita, conditional on the county having one or more doctors. It is conceivable that different variables affect the probability that a given county has doctors as opposed to the number of doctors, particularly if a threshold has to be overcome before a county can attract doctors.

The range of models estimated to fully explore the doctors' location problem includes OLS, Tobit, probit, sample selection and truncated models. It is well-known that OLS yields biased coefficient estimates in censored samples, and that the Tobit method is appropriate in such situations (e.g., Greene or Maddala). However, the Tobit method fails to exploit all of the information contained in censored samples, which provides the motivation for using the additional methods. In particular, an assumption is made in the Tobit model that a given variable affects both the likelihood that a given counties has doctors, and the number of doctors per capita. By estimating the probit, sample selection and truncated models separately, it is possible to distinguish among different forces (if any) affecting the first as opposed to the second phenomenon.

The sample selection model is based on a two-stage regression originally proposed by Heckman. In the first stage, results of a probit regression on x_1 with coefficients β_1 are used to calculate the inverse Mill's ratio,

$$\hat{\lambda}_i = \frac{\phi(\hat{\beta}_1 x_{1i})}{\Phi(\hat{\beta}_1 x_{1i})}$$

where ϕ is the marginal and Φ the cumulative standard normal distribution, and the dependent variable has value one for the ith county if that county has at least one doctor, and zero otherwise. In the second stage, λ_i is entered into an OLS regression on variables x_{2i} with parameters β_2, in which the number of doctors per capita is the dependent variable. Inclusion of λ_i controls for the possibility that forces determining whether or not a county has doctors are *systematic*, which would lead to sample selection bias if only non-zero observations were included. It is possible that x_1 (x_2) is a subset of x_2 (x_1), $x_1 \neq x_2$ or $x_1 = x_2$. We assume the latter to be the case here. The truncated estimation method is based on the assumption that the dependent variable is truncated (as opposed to censored) at zero, so that no information is used from the counties without doctors. The estimator is based on the well-known result that, for a continuous random variable y with density function $g(y)$, which is truncated at t,

$$g(y \mid y > t) = \frac{g(y)}{prob[y > t]}.$$

The estimation involves maximizing the likelihood function (Greene, p. 723),

$$\ln\mathscr{L} = -\frac{n}{2}(\ln(2\pi)+\ln\sigma^2)-\frac{1}{2\sigma^2}\sum_i (l_i-\beta_2 x_{2i})^2-\sum_i \ln\left[1-\Phi\left[\frac{-\beta_2 x_{2i}}{\sigma}\right]\right].$$

Results

Results for five regression models are presented in Table 3. The OLS and Tobit coefficient estimates are generally similar, although some noteworthy differences exist (see McDonald and Moffitt for calculations of marginal effects in the Tobit model). For example, per capita income is statistically significant in the OLS but not in the Tobit model, while the opposite is true for Beale code 1. Among the amenity variables, the number of golf courses, educational attainment of college graduates and environmental policies[8] have expected signs and are statistically significant. Better environmental conditions, however, do not appear to attract doctors into a county, *cet. par.* Higher spending on education per pupil, at the state level, has a positive effect, but it is not statistically different from zero in these models. Surprisingly, greater public spending on welfare programs per capita is associated with larger rather than fewer numbers of doctors per capita. Greater spending on such programs leaves fewer dollars for other public amenities that doctors might desire (parks, roads, etc.), *cet. par.*, so that this result is unexpected.[9]

The number of doctors per capita is significantly higher in seven of the ten Beale codes shown (in eight for the Tobit model), relative to the most rural counties, which represent the excluded category (code 9). However, according to the OLS model, there is no significant difference between Beale codes "1," "8" and "9," suggesting that fringe counties of metropolitan areas with a population on one million or more have problems similar to those faced by rural areas in terms of attracting doctors. At the same time it is interesting to note that, according to these estimates, central metro counties with populations of one million or more do not have problems attracting doctors, all else equal.

Among the variables hypothesized to affect the demand for medical doctors' services, it is surprising that the share of population aged 65 years or older has a negative effect on the number of doctors per capita. This is unexpected, since the elderly population is generally believed to require more medical services. A possible explanation for this finding is that we are controlling for higher incidence of diseases in the elderly with the vector on causes-of-death, so that this particular variable is picking up some other influence that has been excluded from the regression. Higher death rates from any of the causes shown are associated with more doctors per capita, as expected, although the coefficient estimates for liver cirrhosis and influenza and pneumonia are not statistically different from zero. Per capita income and population density both have positive effects on the number of doctors, as hypothesized earlier. Table 3 also suggests that doctors are sensitive to property, sales and income taxes in making their location decisions (although not significantly in the latter case).

The probit equation shows factors which affect the probability that a county has medical doctors. While the results should be interpreted cautiously owing to the small number of counties without doctors, it is noteworthy that some variables affecting the number of doctors in the OLS and Tobit equations are not significant in this equation. Also, the Beale code "8" and educational spending have statistically significant coefficient estimates in the probit equation, which was not the case in the OLS and Tobit models. The sign on liver cirrhosis and deaths from other causes are also negative in this equation (although not statistically significant). This may suggest that counties with high crime rates due, for example, to gang violence and related social problems including alcoholism, have difficulty attracting doctors.

The selection and truncated models by and large show results similar to those obtained in the Tobit and OLS models, although there are important subtle differences. A parameter estimate in these equations shows the effect of the underlying variable on the number of doctors per capita, conditional on the fact that the county has doctors. Among the noteworthy results is that educational spending, the Beale codes 1 and 8, and income taxes are statistically significant in the truncated but not the selection model, while the opposite is true for other cardiovascular diseases. The selection parameter (λ) is statistically significant at the 10 percent level.

The results for Beale code 8 and per capita income show the importance of disaggregating the Tobit parameter as was done here. More specifically, the probit model shows that counties with Beale code 8 and higher per capita incomes are *more* likely to have doctors relative to counties with code 9 and less income per capita, respectively. However, the truncated model shows that these variables have the *opposite* effect on the number of doctors, conditional on doctors having located in the county: The estimate for code 8 is negative, while that for income is positive. Thus we have the case where a given variable has an effect in one direction on the probability that a county has doctors, and an effect in the opposite direction in terms of the number of doctors in a county, conditional on the county having doctors. In the case of income per capita, doctors are less likely to locate in higher-income counties, but once a county has attracted doctors, higher per capita incomes are associated with a larger number of doctors per capita, *cet. par.* Similarly, counties with

Beale code 8 are more likely to attract doctors than counties with code 9, but those code 8 counties with doctors have fewer doctors per capita relative to counties with code 9.

Summary and Conclusion

Our results suggest that a limited set of economic incentives is available to state and county governments to increase the local supply of doctors per capita. In particular, recreational facilities such as golf courses can play an important role in recruiting doctors. State fiscal policies appear to significantly influence doctors' location decisions, although we will be able to make more definitive statements only after using county-level tax data, as we intend to do in the future. Population density appears to be one of the most significant factors attracting doctors, and if rural areas continue to lose population, the number of doctors per capita will decline more than proportionally. Surprisingly, increasing the share of retirees in a community (as measured by the percent of population 65 years and older), which has been proposed by some writers as a promising economic development alternative, will not lead to greater availability of doctors per capita according to our results.

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Appendix

Data Sources

1. The number of doctors and causes of death data were obtained from the Area Resource File (Bureau of Health Professions). The doctors data are on total active non-federal M.D.'s, the original source of which is the American Medical Association's (AMA) Physicians Master File. The reporting period for the data is January 1 through December 31, 1989.

2. The data on number of golf courses in each county is from the 1988-89 County Business Patterns CD-Rom from the U.S. Department of Commerce.

3. Environmental conditions and policies data consist of state-level rankings, whereby a higher rank indicates less favorable environmental conditions or policies that are less protective of the environment. Both indices consist of a wide variety of measures (see Hall and Kerr for more details).

4. Educational and welfare spending data as well as all state and local tax data are from U.S. Data on Demand, Inc. (1992).

5. The percent college-educated population, per capita income, percent of population over 65 and population are from the U.S. Census Bureau (May 1993), and reflect 1989 U.S. Census data. The land area variable was obtained from U.S. Bureau of Census (June 1992).

Notes

1. At the same time, it should be noted that availability of health care may not be independent of access (i.e., ability to pay for care).

2. Hines and Rutrough find that both farm and non-farm elderly residents of nonmetro areas visit doctors less frequently than do residents of metro areas. They attribute the discrepancy to a lack of doctors in rural areas, not a difference in medical needs.

3. While these observations are based on experience in rural Canada, they are likely to be equally valid in the rural U.S.

4. In this regard it is noteworthy that the American Medical Association not too long ago selected a doctor practicing in rural Utah as its "Doctor of the Year."

5. We use the number of golf course per county as a proxy.

6. Including this vector also serves as a control for doctors by specialty, which is important since the dependent variable is measured as all non-federal physicians with a medical degree.

7. Since we do not include salaries of doctors in the location equation, we are estimating a quasi-reduced form. Doctors' salaries would be endogenous, reflecting demand and supply conditions, whereas personal income per capita is exogenous.

8. The second and third largest number of doctors per capita is found in Olmstead county, Minnesota (168.1) and Albemarle county, Virginia (150.8); the second and third largest concentration of doctors in found in Cook county, Illinois (15,195) and New York county, New York (13,941 doctors).

9. A larger index value means policies are less favorable toward the environment.

10. Alternatively, this may reflect greater effective demand for medical services, *cet. par.*

Table 1: Description of Variables and Summary Statistics

Variable	Description	Mean	Std dev	Min	Max
DOCPCAP	Number of doctors per 10,000 population, 1989	9.55	10.48	0.00	197.30
GOLF	Number of golf courses in the county, 1989	5.06	12.01	0	232.0
ENVCON	Environmental conditions (state ranking; 1987-89)	4784.0	596.2	3343	5739
ENVPOL	Environmental policies (state ranking; 1987-89)	2284.8	591.7	764	3230
EDSPEND	State and local general expenditures for education per capita, 1988-89	1,031.1	135.7	815.5	1,574.0
WELFARE	State and local general expenditures for public welfare per capita, 1988-89	317.9	115.6	176.9	795.0
COLL90	Adult population with college degree, 1989 (%)	13.39	6.44	3.69	53.42
BEALE 0	Central county of metro area with 1 million population or more	0.017	0.128	0	1
BEALE 1	Fringe county of metro area with 1 million population or more	0.056	0.230	0	1
BEALE 2	Counties in metro areas with 250,000 to 1,000,000 million population	0.094	0.292	0	1
BEALE 3	Counties in metro areas with less than 250,000 population	0.064	0.245	0	1
BEALE 4	Urban population of 20,000 or more, adjacent to metro area	0.044	0.206	0	1
BEALE 5	Urban population of 20,000 or more, not adjacent to metro area	0.048	0.214	0	1
BEALE 6	Urban population of 2,500-19,999, adjacent to metro area	0.180	0.384	0	1
BEALE 7	Urban population of 2,500-19,999, not adjacent to metro area	0.244	0.430	0	1
BEALE 8	Rural (no place with more than 2,500 population), adjacent to metro area	0.074	0.262	0	1
BEALE 9	Rural (no place with more than 2,500 population), not adjacent to metro area	0.178	0.382	0	1
PERCOV65	Population aged 65 or higher, 1989 (%)	14.95	4.35	1.47	33.96
BEAPC	Death rate from bronchitis, emphysema and asthma, 1988 (per 1,000)	4.073	2.465	0	35.84
CLIPC	Death rate from cirrhosis of liver, 1988 (per 1,000)	0.92	1.05	0	17.97
DFOCPC	Death rate from other causes, 1988 (per 1,000)	15.37	6.60	0	102.20
IHDPC	Death rate from ischemic heart disease, 1988 (per 1,000)	24.40	10.27	0	94.75
IPDPC	Death rate from infectious and parasitic diseases, 1988 (per 1,000)	1.43	1.28	0	13.24
IPNPC	Death rate from influenza and pneumonia, 1988 (per 1,000)	4.02	2.91	0	37.83
MVAPC	Death rate from motor vehicle accidents, 1988 (per 1,000)	2.82	2.00	0	24.92
NEOPC	Death rate from malignant neoplasms, 1988 (per 1,000)	21.87	7.03	0	74.43
OCDPC	Death rate from other cardiovascular disease, 1988 (per 1,000)	23.18	9.82	0	84.56
OECPC	Death rate from other external causes, 1988 (per 1,000)	4.60	2.79	0	45.66
INC89	Per capita personal income, 1989 ($)	14,294	3,327	4,961	36,450
POPDEN	Population density (1989 population per square mile)	0.199	1.608	0.00016	67.62
PROPTAX	State and local property taxes per capita, 1988-89	501.4	194.0	148.0	1,058.0
SALETAX	State and local general sales taxes per capita, 1988-89	412.6	129.0	0	930.6
INCMTAX	State and local income taxes per capita, 1988-89	394.5	234.5	0	1,127.0

Data sources: see Appendix

Table 2: Summary Statistics by Doctors/Capita Quintiles

	DOCPCA	DOC89	COLL90	METRO	INC89	PERCOV	AREAPC
DOCPCAP5	23.9	747.9	20.6	0.58	16949	13.3	33.6
	16.8	1668.5	8.1	0.49	4047	3.9	137.0
DOCPCAP4	11.0	79.2	14.5	0.26	14456	14.6	65.8
	1.4	122.2	5.5	0.44	2694	4.5	166.0
DOCPCAP3	7.4	26.8	12.1	0.16	13829	15.3	89.2
	0.7	35.1	4.3	0.36	2779	4.5	202.7
DOCPCAP2	5.2	11.3	10.8	0.11	13385	15.6	88.3
	0.6	10.4	3.7	0.31	2618	4.2	180.5
DOCPCAP1	2.9	5.0	9.5	0.11	12614	15.3	73.0
	0.9	5.0	3.1	0.31	2526	4.1	113.7
DOCPCAP0	0.0	0.0	11.3	0.00	14950	17.1	638.4
	0.0	0.0	4.1	0.00	4098	4.8	808.8

	BEALE 0	BEALE 1	BEALE 2	BEALE 3	BEALE 4	BEALE 5	BEALE 6	BEALE 7	BEALE 8
DOCPCAP5	0.08	0.10	0.21	0.18	0.05	0.13	0.05	0.14	0.01
	0.27	0.29	0.41	0.39	0.22	0.33	0.22	0.35	0.07
DOCPCAP4	0.00	0.08	0.09	0.08	0.12	0.09	0.14	0.28	0.03
	0.06	0.28	0.29	0.27	0.32	0.28	0.35	0.45	0.16
DOCPCAP3	0.00	0.06	0.07	0.02	0.05	0.03	0.22	0.35	0.04
	0.06	0.24	0.26	0.15	0.22	0.17	0.41	0.48	0.19
DOCPCAP2	0.00	0.03	0.06	0.02	0.01	0.01	0.29	0.31	0.08
	0.00	0.18	0.24	0.12	0.09	0.07	0.46	0.46	0.27
DOCPCAP1	0.00	0.02	0.05	0.03	0.00	0.00	0.24	0.20	0.20
	0.00	0.15	0.23	0.18	0.04	0.06	0.43	0.40	0.40
DOCPCAP0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.14
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.35

	BEAPC	CLIPC	DFOCPC	IHDPC	IPDPC	IPNPC	MVAPC	NEOPC	OCDPC	OECPC
DOCPCAP5	3.9	1.0	14.3	21.4	1.6	3.5	2.2	20.7	20.3	4.2
	1.7	0.6	5.3	8.9	1.4	1.9	1.8	6.8	7.9	2.0
DOCPCAP4	4.1	0.9	14.7	23.7	1.4	3.8	2.6	21.4	22.0	4.3
	2.1	0.9	5.5	9.3	1.0	2.4	1.5	6.6	9.0	2.1
DOCPCAP3	4.1	0.8	15.4	25.0	1.4	4.3	2.9	21.9	24.0	4.6
	2.3	0.8	5.8	10.1	1.2	3.0	1.7	6.8	10.0	2.4
DOCPCAP2	4.1	0.9	16.1	26.0	1.3	4.2	3.2	22.7	24.4	4.7
	2.3	0.9	6.7	10.3	1.1	2.9	2.0	6.7	9.3	2.5
DOCPCAP1	4.2	0.8	15.8	25.7	1.5	4.2	3.2	22.5	24.8	4.8
	2.4	1.0	6.3	10.3	1.4	3.0	2.1	6.8	10.2	2.5
DOCPCAP0	4.4	1.2	17.6	24.5	1.1	4.6	2.6	22.2	24.7	5.7
	5.7	2.8	14.1	15.7	2.0	5.8	3.9	10.6	14.9	7.4

e:\qpw\docsum.wq1

Table 3: Regression Results for Factors Affecting the Location of Medical Doctors docloc2.tab

[Dependent variable = no. of doctors/capita; asymptotic *t*-statistics are in parentheses]

Variable	OLS	Tobit	Probit	Selection	Truncated
Constant	−9.590***	−11.716***	−2.757**	−10.604***	−64.623***
	3.26	3.84	2.15	3.35	6.63
Golf courses (no.)	0.097***	0.098***	0.174**	0.088***	0.075**
	5.82	5.74	2.18	5.25	2.26
Environmental conditions (index)	0.00019	0.00035	0.000004	0.0002	−0.0007
	0.60	1.10	0.03	0.67	0.66
Environmental policies (index)	−0.0011***	−0.0014***	0.00017	−0.0012***	−0.0022*
	2.61	3.09	0.78	2.67	1.75
Educational spending ($/capita)	0.0016	0.0022	0.0014*	0.0012	0.0092*
	0.98	1.27	1.86	0.68	1.82
Welfare spending ($/capita)	0.0048**	0.0047**	0.0002	0.0059***	0.021***
	2.12	2.03	0.19	2.55	2.97
College graduates (% of adults)	0.775***	0.814***	0.066***	0.795***	1.674***
	22.79	22.99	3.49	21.82	16.04
BEALE 0 (d.v.=0,1)	7.341***	8.536***	−6.053	6.855***	21.261***
	4.86	5.49	0.15	4.23	5.96
BEALE 1	0.0763	1.497*	2.972	−0.369	6.145**
	0.09	1.69	0.02	0.35	2.14
BEALE 2	5.054***	6.343***	3.364	4.679***	19.089***
	7.52	9.08	0.03	5.26	7.86
BEALE 3	8.255***	9.493***	3.704	7.881***	25.062***
	11.47	12.73	0.02	8.56	10.09
BEALE 4	3.381***	4.605***	3.922	3.068***	15.172***
	4.28	5.64	0.01	3.16	5.68
BEALE 5	7.379***	8.623***	4.616	6.992***	24.143***
	9.72	10.98	0.01	7.31	9.53
BEALE 6	2.439***	3.690***	5.185	2.202***	8.391***
	4.84	7.01	0.02	2.89	3.96
BEALE 7	2.700***	3.957***	2.006***	2.394***	9.585***
	5.98	8.36	5.97	3.26	4.99
BEALE 8	0.060	0.820	0.341**	−0.155	−9.470***
	0.09	1.24	2.15	0.21	2.78
Over 65-year olds (% × 100)	−30.123***	−31.68***	−0.0030	−34.327***	−42.692**
	4.97	4.99	0.00	5.33	2.24
Bronchitis, emphysema & asthma	0.174***	0.205***	0.021	0.208***	0.745***
	2.79	3.10	1.49	2.82	2.84
Cirrhosis of liver	0.112	0.085	−0.033	0.414**	0.969*
	0.81	0.57	1.01	2.41	1.62
Deaths from other causes	0.106***	0.100***	−0.009	0.147***	0.424***
	4.11	3.65	1.46	4.84	4.07
Ischemic heart disease	0.086***	0.094***	0.0097*	0.086***	0.151**
	4.49	4.65	1.75	4.06	2.21
Infectious & parasitic disease	0.672***	0.731***	0.0395	0.689***	1.734***
	5.65	5.89	1.24	5.36	4.15
Influenza & pneumonia	0.053	0.061	0.0016	0.047	0.137
	0.95	1.05	0.13	0.76	0.62
Motor vehicle accidents	0.143**	0.202***	0.042**	0.113	0.216
	1.92	2.56	2.32	1.34	0.69
Malignant neoplasms	0.140***	0.156***	0.013*	0.144***	0.275***
	4.94	5.21	1.83	4.51	2.52
Other cardiovascular disease	0.059***	0.065***	0.0028	0.056***	0.085
	2.99	3.16	0.52	2.60	1.14
Other external causes of death	0.123**	0.113**	−0.00085	0.222***	0.672***
	2.29	1.93	0.07	3.25	2.75
Income/capita in 1989 ($'000)	0.163**	0.093	−0.053***	0.222***	0.737***
	2.50	1.36	2.59	3.05	3.62
Population density (miles^{-2})	0.559***	0.554***	39.836***	0.523***	0.034
	5.44	5.25	4.85	5.04	0.17
Property taxes ($/capita)	−0.0058***	−0.0064***	−0.00023	−0.0058***	−0.016***
	4.33	4.58	0.38	4.16	3.91
Sales taxes ($/capita)	−0.0041***	−0.004***	0.00064	−0.0047***	−0.016***
	2.94	2.81	1.12	3.25	3.80
Income taxes ($/capita)	−0.0011	−0.0010	0.00058	−0.0017	−0.0066*
	0.95	0.78	1.09	1.33	1.78
σ or λ		7.995***		2.864*	13.27***
		75.98		1.65	30.23
Adjusted R-square	44.9				

Significance levels: *=10%, **=5%, ***=1% or lower; sample size = 3,062, except in selection and truncated models (see text).

Figure 1: Doctors Per Capita, the U.S., 1989

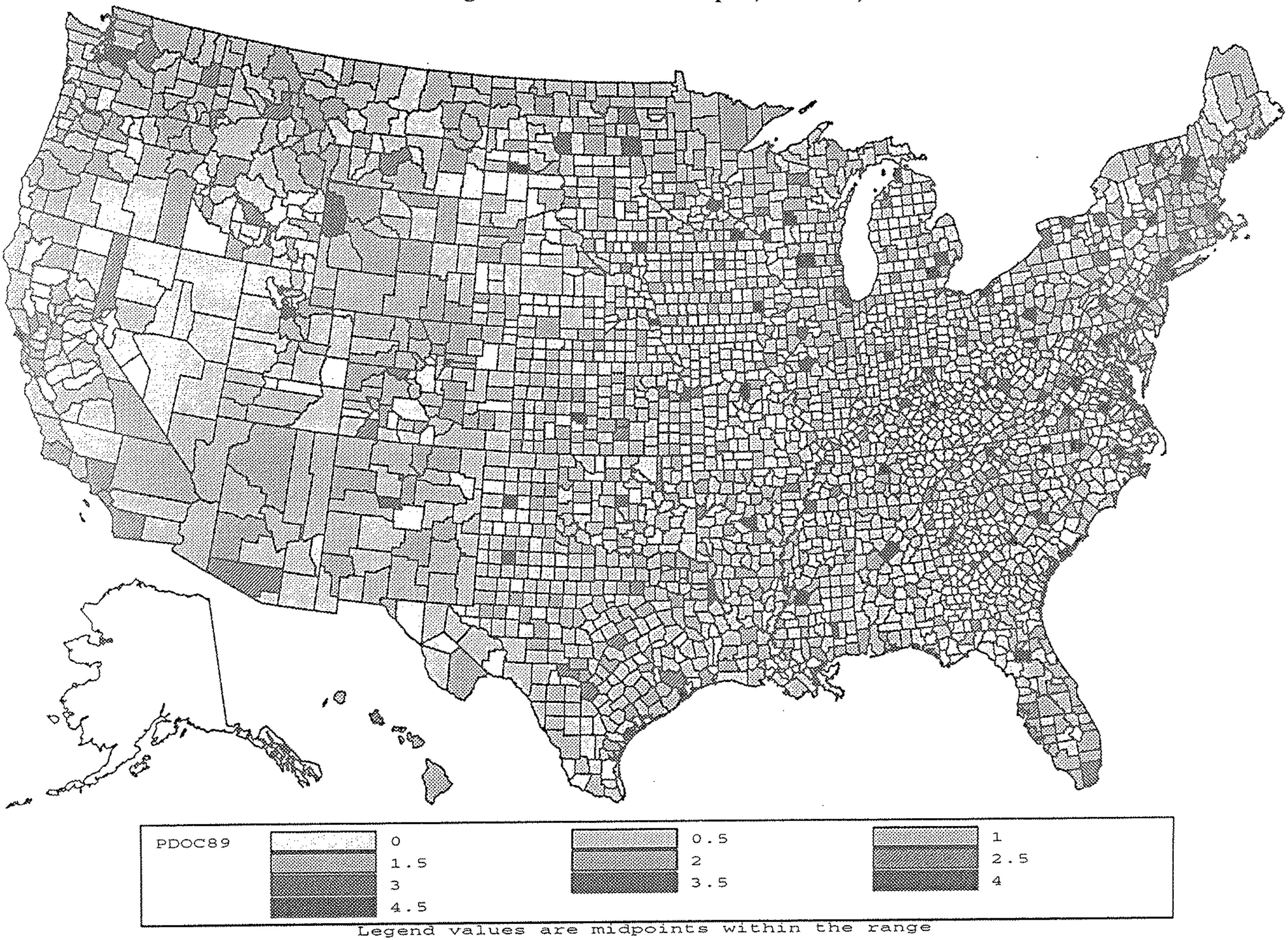
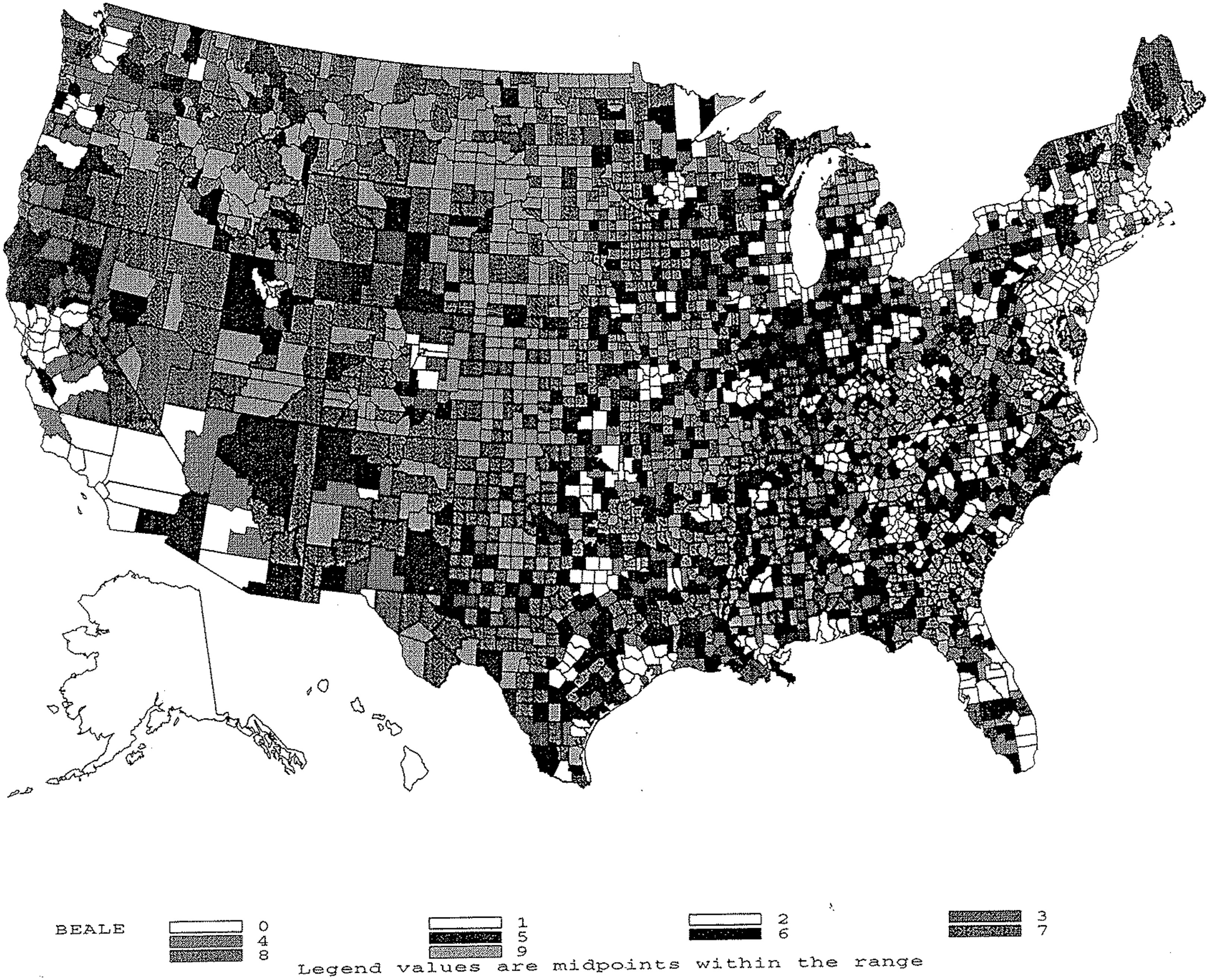


Figure 2: Beale Code for U.S. Counties



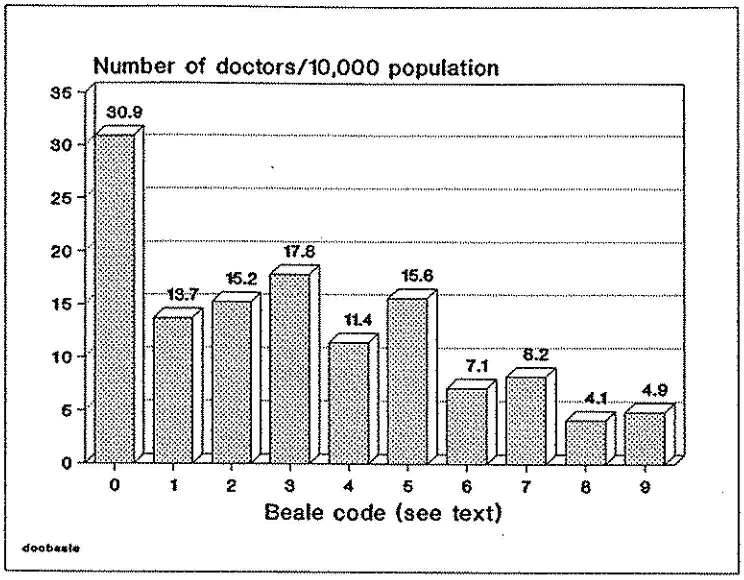


Figure 3: Doctors Per Capita by Beale Code, the U.S., 1989