Effects of Community Characteristics on Young Physicians' Decisions Regarding Rural Practice

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Synopsis

The supply of physicians has increased rapidly during the past decade. To examine the impact of this expanding supply on the geographic distribution of physicians in rural areas, we examined the location patterns of 1974–78 medical school graduates practicing in 1983 in rural areas. Of 2,112 rural counties, 58 percent gained at least one 1974–78 graduate; 31 percent of the least populous rural counties gained physicians; and 92 percent of most populous counties gained physicians. When Health Manpower Shortage Areas were examined separately, it was found that only 45 percent of the HMSAs that consisted of an entire county gained a young physician compared with 61 percent of non-HMSA counties.

Characteristics of counties that gained a young physician were compared with characteristics of counties that did not attract a young physician. Results of the multivariate analysis indicated that the probability that a county would attract a young physician is positively related to population, the supply of physicians, the proportion of white collar employment, and the presence of a college. Higher levels of farm population are associated with a lower probability that a county would attract a young physician. These findings suggest that diffusion of young physicians into rural areas is occurring as the supply of physicians increases. However, young physicians are attracted to communities with particular characteristics. Those counties with fewer attractive characteristics may continue to have difficulty gaining physicians to serve their communities.

DURING THE 1980s IT HAS BECOME evident that the rapid expansion of the supply of young physicians nationally has increased the availability of physicians in rural areas. In a 1982 study, Newhouse and colleagues examined the changing geographic distribution of physicians between 1970 and 1979 and concluded that, as the supply of physicians has increased, competitive forces have encouraged the diffusion of physicians into rural areas (*1*). The implications of this diffusion of physicians for the future geographic distribution of physicians among counties were explored in a recent report (*2*) prepared by the Office of Data Analysis and Management (ODAM) of the Health Resources and Services Administration (HRSA). The results reported by the ODAM researchers are consistent with earlier geographic diffusion studies; that is, that the total number of patient care physicians under 35 years of age has increased in rural counties in the past decade. These researchers concluded that, in coming years, the diffusion of primary care physicians will reduce the overall number of areas with shortages; however, many areas are unattractive to physicians, and they will continue to have a shortage of physicians. This latter finding is particularly important for future policy planning since it suggests that some communities will continue to find it difficult to attract new physicians despite the increasing supply.

To examine this issue, the Health Resources and Services Administration, part of the Public Health Service, in 1983 initiated a study of factors influencing the location choices of young physicians in nonmetropolitan areas. The purpose of this study was to identify the characteristics of rural areas that are associated with higher and

Variables used in multivariate community characteristics analysis

	Dependent variables
ANYDOC	= 1, if any young physician located in the county; 0, otherwise
NONNHSC	= 1, if any young nonalumnus of the National Health Service Corps (NHSC) located in the county; 0, otherwise
NHSCLOC	= 1, if any young NHSC alumnus located in the county; 0, otherwise
	Explanatory variables
AMA2	= 1, if the county has 10,000–24,999 population and is not in a Standard Metropolitan Statistical Area (SMSA); 0, otherwise
AMA3	= 1, if the county has 25,000–49,999 population and is not in an SMSA; 0 otherwise
PPSQM75	= County population per square mile in 1975
EDUCATE	= County expenditures on public education per capita
COLLEGE	= 1, if there is a 2-year or 4-year college in the county; 0, otherwise
URBAN	= 1, if the county is contiguous to an SMSA; 0, otherwise
INCRATE	= Percentage increase in per capita income in county, 1975–80
WC80	= Percentage of population with white collar employment, 1980
FARMPOP	= Percentage of population residing on farms, 1980
PERPOVF	= Percentage of population with incomes below the poverty level, 1980
WORKRES	= Percentage of the employed population who work in the county of residence
HOSPITAL	= 1, if there is a hospital in the county; 0, otherwise
MDPOP	= Physicians-to-100,000 population ratio in county
HMSA1	= 1, if the county is a wholly designated HMSA; 0, otherwise
HMSA2	= 1, if the county is a partly designated HMSA; 0, otherwise

lower probabilities of attracting a young physician. Results of this study can be used by HRSA in identifying areas least likely to gain private practice physicians and, therefore, with the greatest need for a National Health Service Corps-assigned physician. Physicians who received financial support for their medical education through the National Health Service Corps scholarship program are obligated to serve for a specified period in a Health Manpower Shortage Area (HMSA). HMSA counties are so designated based upon a set of criteria including the primary care physician-to-population ratio and other indicators of need. Entire counties or parts of counties may be designated as a HMSA.

To examine the association between community characteristics and the probability of attracting a young physician, data on the characteristics of the 2,112 nonmetropolitan counties in the United States and on the rural location choices of 1974–78 medical graduates were analyzed using descriptive and multivariate techniques. In this paper, the data and methodology for the analyses are described, and findings of the study are reported and discussed. Complete study findings are available from HRSA (*3,4*).

Data and Methodology

While it is evident that urban areas are more attractive to most physicians than are rural areas, there is a wide spectrum of community characteristics which make specific rural communities more or less attractive to physicians. These characteristics of nonmetropolitan communities may be classified into several categories:

- health resources characteristics
- socioeconomic characteristics
- recreational, cultural, and climatic characteristics.

Much of the research which has been conducted on physicians' decisions to locate in rural areas has been attitudinal; physician respondents rank the characteristics of a community by level of influence on their decision or simply indicate whether the characteristic was or was not an influence on their decision. A few studies have included specific characteristics of an area as variables in explanatory models; however, the absence of data to measure many community characteristics of interest, prior to development of the Area Resource File by HRSA's Bureau of Health Professions, severely restricted these approaches. The findings of earlier studies of rural location choices (*3,4*) guided our selection of variables for use in the analysis of community characteristics associated with young physicians' location patterns. These

Community characteristics identified as influencing the location decisions of physicians (Area Resource File[1] is the source of data except where another source is noted with [2])

Characteristics

Educational quality
Expenditures per capita for public education[2]
Number of colleges and universities in county

Health resources
Number of nursing schools
Number of full-time physician assistants and nurse practitioners
Number of short term general and community hospitals
Number of short term general and community hospital beds
Neonatal intensive care unit beds
Medical-surgery intensive care unit beds
Number of physicians (MDs and DOs) providing direct patient care services in county
Number of primary care physicians (MDs and DOs) providing direct patient care services in county
County MD and DO physician-to-population ratios
County primary care MD and DO physician-to-population ratios

Economic factors
County per capita income
County per household income
Percent growth in per capita income
County unemployment rate
Percent of population living on farms
Percent households below the poverty level
Percent persons below the poverty level
Occupied housing units[2]
Occupied housing units without plumbing[2]
Number AFDC recipients
Percent construction workers
Percent white collar workers
Percent manufacturing workers
Civilian labor force[2]
Local government expenditures for health and hospitals[2]
Per capita farm income[2]
Number of farms[2]
Percent farmland[2]
Number employed and residing in county[2]

Population characteristics
Total population, 1980
Population growth rate, 1970–80
Population per square mile
Racial distribution:
  Percent white
  Percent black
  Percent Spanish descent
  Percent other
Median school years, persons 25 years and older

Climate and recreational opportunities
January temperature
July temperature
January precipitation
July precipitation
Elevation feet
Number of contiguous urban counties

Health status of population
Total births
Infant mortality rate
Total deaths
Number of deaths due to infection and parasitic diseases
Number of deaths due to ischemic heart disease and other cardiovascular disease
Number of deaths due to influenza and pneumonia
Incidence of measles
Incidence of mumps
Incidence of rubella
Fertility rate

Crime
Number of murders
Number of rapes
Number of burglaries

Health care utilization
Hospital inpatient days
Hospital outpatient days
Hospital emergency room visits
Surgical operations

[1] The Area Resource File, developed and maintained by the Bureau of Health Professions, Health Resources and Services Administration, is a county-level data set containing extensive data on population, health resources and services, and socioeconomic characteristics of each U.S. county.

[2] City and County Data Book, U.S. Department of Commerce (*6*).

variables and their sources are summarized in the box on page 319.

Counties were grouped by the presence or absence of a 1974–78 medical school graduate in primary care practice. This grouping was done using data provided by the American Medical Association and American Osteopathic Association on the nonmetropolitan locations of all 1974 through 1978 graduates of U.S. medical schools who are practicing in primary care specialties.

The descriptive analysis compares the mean values of the characteristics of counties which, by 1984, had

- gained a 1974–78 medical school graduate or
- failed to gain a 1974–78 medical school graduate.

A two-tailed t-test was used to identify significant differences in these mean values between the two groups.

For those counties which gained young physicians, we created several categories according to the number of physicians they attracted:

- counties which attracted 1 or 2 physicians
- counties which attracted 3 or 4 physicians
- counties which attracted more than 6 physicians

We also examined the distribution of counties by number of physicians attracted, by census region (*5*), and by population size.

The descriptive analysis permitted the identification of a reduced set of variables which were included in the multivariate analysis of community characteristics. The variables which were examined in the multivariate analysis are listed on page 318. All explanatory variables were constructed from data in the Bureau of Health Professions' Area Resource File or the City and County Data Book File (*6*). The dependent variables were constructed using the data provided by the American Medical Association and the American Osteopathic Association which have been described previously.

Since our primary interest was in determining the relationship between specific characteristics of communities and the probability that a county will attract young physicians, we used the LOGIT procedure offered by SAS (*7*) for the multivariate analysis. The qualitative dependent variable is assigned the value of 1 for counties that attracted young physicians and 0 for counties that failed to gain a young physician. Use of LOGIT analysis for the community characteristics analysis yields coefficients that can be examined for sign and significance of each variable as a factor influencing the probability that a county will have gained a young physician. In addition, each variable can be evaluated separately using the logistic transformation to determine the effect of that variable on the conditional probability that a county will attract a young physician. These conditional probabilities have potential use in developing a system for classifying rural counties by probability of gaining a young physician.

Although these data could also be used to analyze the relationship between the characteristics of communities and the number of young physicians choosing to locate, we chose not to analyze the latter dependent variable. Previous studies (*8*) have shown that the strongest predictor of the number of health professionals locating in a particular area is population. Instead of examining this less informative issue, we have focused on identifying the characteristics which distinguish between those communities that attract young physicians and those that do not.

Findings: Descriptive Analysis

The 1974 through 1978 cohort of medical school graduates who were in a primary care practice in a nonmetropolitan area in 1983 includes 3,058 MDs and DOs (doctors of osteopathy). Table 1 summarizes the distributional patterns observed:

- for all nonmetropolitan counties
- by census region
- by county population categories
- by HMSA status.

Table 1 shows both the number and percent of all counties falling into each group. Fifty-eight percent of nonmetropolitan counties had gained at least one young physician by 1983; 43 percent failed to attract any young physician in our cohort. Of counties that attracted physicians, 64 percent attracted only one or two. Counties that attracted three to six young physicians were relatively few—32 percent; only 4 percent of all nonmetropolitan counties attracted seven or more young physicians.

When the data were examined by census region, clear patterns emerged. The Northeast Census Region counties were most likely (92 percent) to have gained a physician and, in addition, gained more physicians per county than other areas—64 percent attracted three or more young physicians.

Table 1. Distribution of counties which did and did not gain young physicians, by region, county population, and county HMSA status

Physician supply	All nonmetropolitan counties	Region				County population			HMSA status		
		Northeast	North Central	South	West	Under 10,000	10,000 -25,000	More than 25,000	Non-HMSA	Whole-HMSA	Part-HMSA
Failed to gain:											
Percent	42.0	8.0	45.0	43.0	39.0	69.0	38.0	8.0	39.0	55.0	22.0
Number	893	5	359	415	114	513	341	39	346	459	88
Gained physicians:											
Percent	58.0	92.0	55.0	57.0	61.0	31.0	62.0	92.0	61.0	45.0	78.0
Number	1,219	55	436	553	175	227	568	424	432	378	309
Number physicians gained:											
1–2	64.0	36.0	68.0	70.0	46.0	89.0	71.0	42.0	61.0	78.0	53.0
3–4	22.0	27.0	20.0	20.0	31.0	10.0	21.0	30.0	25.0	16.0	25.0
5–6	10.0	26.0	8.0	8.0	13.0	1.0	6.0	19.0	10.0	5.0	13.0
7 or more	4.0	11.0	4.0	2.0	10.0	0.0	2.0	9.0	4.0	1.0	9.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total counties	2,112	60	795	968	289	740	909	463	878	837	397

NOTE: HMSA indicates health manpower shortage area.

In absolute numbers, however, the Northeast represents only a few physicians' location choices since there are only 60 counties in the Northeast which have less than 50,000 population and are not part of an SMSA.

The West Region ranked second in the proportion of counties gaining young physicians; 61 percent of counties gained physicians and, of these 289 counties, 54 percent gained three or more. Again, since the West accounts for only 14 percent of all rural counties, the high proportion of counties gaining physicians does not imply large absolute numbers. The South and North Central Regions account for 84 percent of all rural counties in the United States. Only 57 percent of 968 southern counties and 55 percent of 795 North Central Region counties gained a physician. In both regions, by far the majority of counties gained only one or two young physicians; 88 percent of gaining counties in the North Central Region and 90 percent of gaining counties in the South obtain four or fewer physicians.

Examining the distribution of young physicians by the size of the county's population yielded findings that were expected: counties with greater population are more likely to be attractive to physicians and to gain a larger number per county. Only 31 percent of the 740 counties with less than 10,000 population gained *any* young physician; of these counties, 89 percent gained only one or two, and only 1 percent gained five or more physicians. When we examined counties with 10,000 to 25,000 population and those with 25,000 to 50,000 population, a strong population-related pattern was clear:

- 62 percent of 909 counties of 10,000 to 25,000 population attracted a physician
- 92 percent of 463 counties with 25,000 to 50,000 population attracted a physician

While only 8 percent of counties of 10,000 to 25,000 population attracted five or more young physicians, 28 percent of the most populous counties attracted this many.

To examine the issue of differences in distributional patterns by specialty and year of graduation,

Table 2. Distribution of young physicians by specialty, year of graduation, and population of county

Physician category	Percent locating		
	Counties with under 10,000	Counties with 10,000–25,000	Counties with more than 25,000
Specialty			
General practice	11.7	44.0	44.3
Family practice	19.3	44.7	36.0
Internal medicine	6.3	33.3	60.4
Pediatrics	3.3	31.4	65.3
Year of graduation			
1974	10.2	43.4	46.4
1975	11.9	38.8	49.3
1976	9.7	38.4	51.9
1977	9.5	39.0	51.5
1978	10.2	42.7	47.1

Table 3. Mean characteristics of counties which did and did not gain physicians—all young physicians and non-NHSC young physicians

Characteristics	All young physicians		Non-NHSC young physicians	
	Gained	Failed to gain	Gained	Failed to gain
Number of counties	1,219.00	893.00	1,121.00	991.00
Population				
Population	[1]22,029.00	[1]10,721.00	[1]22,711.00	[1]11,068.00
Annual population growth rate, 1975–80 (percent)	[1]15.60	[1]11.52	[1]15.50	[1]12.05
Percent white	88.50	88.73	88.94	88.22
Percent black	8.66	8.00	8.30	8.48
Percent Hispanic	[1]3.25	[1]4.74	[1]3.16	[1]4.69
Median school years	[1]11.46	[1]11.27	[1]11.49	[1]11.26
Population per square mile	[1]35.10	[1]19.90	[1]35.94	[1]20.45
Cultural				
Number of colleges and universities	[1].19	[1].04	[1].19	[1].04
Per capita educational expenditures (dollars)	[1]312.30	[1]332.64	[1]310.94	[1]332.16
Number of urban contiguous counties	[1].86	[1].68	[1].86	[1].70
Economic				
Per capita income (dollars)	[1]5,422.00	[1]5,274.00	[1]5,462.00	[1]5,242.00
Household income (dollars)	[1]11,381.00	[1]11,034.00	[1]11,464.00	[1]10,975.00
Growth rate of per capita income (percent)	60.15	59.49	60.20	59.50
Unemployment rate (percent)	[1]10.78	[1]9.56	[1]10.70	[1]9.70
Labor force participation rate (percent)	46.19	45.63	[1]46.36	[1]45.51
Percent labor force construction	7.42	7.48	7.39	7.52
Percent labor force white collar	[1]39.22	[1]34.93	[1]39.49	[1]35.05
Percent labor force manufacturing	[1]21.10	[1]17.53	[1]21.02	[1]17.98
Percent working in State and county of residence	[1]79.63	[1]75.81	[1]80.38	[1]75.34
Percent working in State, not county of residence	[1]17.60	[1]21.34	[1]16.94	[1]21.71
Percent not working in State of residence	2.78	2.73	2.68	2.85
Percent agricultural	[1]9.90	[1]16.10	[1]9.87	[1]15.55
Per capita farmer income (dollars)	6,262.00	5,739.00	5,761.00	6,360.00
Number of farms	[1]733.00	[1]533.00	[1]747.00	[1]556.00
Farmland as percent of total land	[1]5.70	[1]6.60	[1]5.71	[1]6.50
Occupied housing units per capita	.35	.35	.35	.35
Percent of families below poverty line	[1]13.16	[1]15.19	[1]12.93	[1]15.25
Percent persons below poverty line	[1]16.65	[1]18.79	[1]16.41	[1]18.35
Percent households lacking complete plumbing	5.01	5.34	[1]4.86	[1]5.48
Percent population receiving AFDC	[1]3.37	[1]3.03	3.27	3.17
Health resources				
Mean number of registered nurse schools	[1].12	[1].01	[1].13	[1].02
Mean number of full-time-equivalent registered nurses per 100,000 population	[1]181.00	[1]123.00	[1]186.00	[1]123.00
Mean number of physician extenders per 100,000 population	4.62	4.10	4.59	4.19
Mean number of hospitals	[1]2.48	[1]1.53	[1]2.58	[1]1.51
Mean number of hospital beds	[1]199.00	[1]82.40	[1]209.00	[1]82.00
Number of hospital beds per 100,000 population	[1]932.80	[1]832.70	[1]967.90	[1]802.95
Number of neonatal ICU beds per 100,000 population	[1].24	[1].02	[1].26	[1].02
Local per capita expenditures for health (dollars)	[1]4.42	[1]8.56	[1]4.32	[1]8.26
Total mean number of MDs	[1]16.50	[1]4.55	[1]17.45	[1]4.66
Mean number of primary care MDs	[1]8.41	[1]3.10	[1]8.83	[1]3.13
Total mean number of DOs	1.02	.75	[1].95	[1].62
Mean number of primary care DOs	[1].88	[1].66	[1].81	[1].57
MDs per 100,000 population	[1]69.38	[1]38.21	[1]72.25	[1]38.05
Primary care MDs per 100,000 population	[1]38.06	[1]28.14	[1]39.39	[1]27.62
DOs per 100,000 population	[1]4.48	[1]5.54	[1]4.23	[1]5.63
Primary care DOs per 100,000 population	[1]3.84	[1]5.06	[1]3.73	[1]5.07
Total number of MD interns and residents per county	[1].43	[1].11	[1].46	[1].11
Environment				
January temperature (degrees F)	31.60	32.50	[1]31.50	[1]32.61
July temperature (degrees F)	[1]75.50	[1]76.50	[1]75.41	[1]76.51
January precipitation (inches)	[1]2.53	[1]2.13	[1]2.53	[1]2.17
July precipitation (inches)	3.65	3.53	3.63	3.56
Elevation (feet)	[1]1,343.00	[1]1,588.00	[1]1,350.00	[1]1,555.00

Continued

Table 3. Mean characteristics of counties which did and did not gain physicians—all young physicians and non-NHSC young physicians—Continued

Characteristics	All young physicians		Non-NHSC young physicians	
	Gained	Failed to gain	Gained	Failed to gain
Health status				
Fertility rate (per 100,000 women of childbearing age)	[1]7.70	[1]8.10	[1]7.70	[1]8.10
Percent of births to teenage women	8.53	8.65	8.45	8.72
Infant mortality rate (per 100,000 live births)	156.00	157.50	155.13	158.30
Deaths per 100,000 population	[1]991.00	[1]1,041.00	[1]989.00	[1]1,038.00
Deaths per 100,000 from infective-parasitic diseases	7.01	6.42	7.03	6.53
Deaths per 100,000 from influenza-pneumonia	26.20	26.50	26.72	26.25
Deaths per 100,000 from cardiovascular conditions	[1]513.10	[1]547.70	[1]512.20	[1]544.60
Incidence of measles per 100,000 population	[1]7.25	[1]4.38	[1]7.53	[1]4.34
Incidence of mumps per 100,000 population	7.59	7.85	7.73	7.67
Incidence of rubella per 100,000 population	5.40	3.46	5.64	3.37
Health utilization				
Inpatient hospital visits per 100,000 population	[1]110,680.00	[1]84,529.00	[1]115,094.00	[1]82,123.00
Outpatient hospital visits per 100,000 population	[1]70,626.00	[1]40,146.00	[1]72,885.00	[1]40,607.00
Emergency hospital visits per 100,000 population	[1]27,531.00	[1]16,649.00	[1]28,505.00	[1]16,623.00
Inpatient surgical operations per 100,000 population	[1]1,041.00	[1]254.60	[1]1,010.00	[1]254.60
Total surgical operations per 100,000 population	[1]4,698.00	[1]2,365.00	[1]4,932.00	[1]2,331.50
Crime				
Number of murders per 100,000 population	4.98	4.94	5.04	4.87
Number of rapes per 100,000 population	[1]7.21	[1]6.00	[1]7.32	[1]6.00
Number of burglaries per 100,000 population	[1]588.10	[1]427.10	[1]588.10	[1]443.00

[1] Difference is significant at the $P < .05$ level, using a two-tailed t-test.
NOTE: NHSC indicates National Health Service Corps; AFDC, Aid to Families with Dependent Children; DO, doctors of osteopathy; ICU, intensive care unit.

table 2 was constructed. Evidence on the location patterns of young physicians, as the supply of physicians increases, suggests that in recent years physicians have begun to go to more rural areas and that this effect is more pronounced for generalist physicians than for specialists.

As would be expected, family practitioners, and to a lesser extent general practitioners, were most likely to be located in the most rural communities; only 6 percent of internists and 3 percent of pediatricians in our cohort were in counties with less than 10,000 population. Family practitioners were least likely to be in the largest nonmetropolitan counties, where 65 percent of pediatricians and 60 percent of internists were located.

When we examined distributional patterns by year of graduation, it appears that graduates of the earlier and latest classes were most likely to choose to locate in communities with less than 10,000 population. For counties with 10,000 to 25,000 population, the pattern is similar to that observed in least populous counties. However, for the most populous counties in our study, there was a decline in the proportion of 1978 physicians attracted.

The means of characteristics of counties which attracted or failed to attract young physicians are shown in table 3. Significant differences in the means of characteristics of counties which did and did not attract young physicians are indicated with a footnote. There were significant differences in the characteristics of these counties:

- Attractive counties were more populous, had higher population growth rates, had a better educated population, and a greater population density.
- Attractive counties were more likely to have colleges and universities and to be contiguous to urban counties. Contrary to prior expectations, however, per capita expenditures for education were somewhat lower in attractive counties.
- With respect to economic variables, income levels were higher in attractive counties, and the work force was more heavily concentrated in white collar and manufacturing activities; there were fewer farmers and a smaller percentage of land in farmland. Attractive counties also tended to have higher unemployment rates and a higher proportion of the population receiving payments under the Aid to Families with Dependent Children Program.
- Health resources were more available in attractive counties than in counties which failed to

Table 4. Results of logit analysis: all young physicians and by National Health Service Corps service status (maximum likelihood estimates)

Explanatory variable	1 Gain - not gain any young physician: Log odds of gaining	2 Any young physician: ($\delta P \div \delta X_j$)*	3 Gain - not gain nonalumni: Log odds of gaining	4 Nonalumni: ($\delta P \div \delta X_j$)*	5 Gain - not gain NHSC alumni: Log odds of gaining	6 NHSC alumni: ($\delta P \div \delta X_j$)*
CONSTANT	[1] -3.255	...	[1] -3.955	...	[1] -3.471	...
AMA2	[2].926	.225	[1].946	.232	[1].999	.079
AMA3	[1]2.097	.428	[1]2.017	.447	[1]1.465	.143
PPSQ75	[2].007	.054	[2].009	.069	-0.006	-.019
EDUCATE	.000	.005	-.000	-.009	[1].002	.021
COLLEGE	[2].595	.126	.313	.075	[2].474	.052
URBAN	.056	.013	.089	.022	-.015	-.001
INCRATE	-.003	-.007	-.002	-.006	-.006	-.006
WC80	[2].024	.056	[2].025	.062	.012	.011
FARMPOP	[1] -.023	-.054	[2] -.018	-.043	[1] -.047	-.041
PERPOVF	-.005	-.011	-.008	-.019	-.013	.012
WORKRES	.009	.020	[1].015	.037	-.003	-.003
HOSPITAL	.135	.031	[2].356	.088	[2] -.459	-.049
MDPOP	[1].018	.167	[1].018	.172	.001	.006
HMSA1	[1].439	.104	.100	.025	[1]1.389	.128
HMSA2	[1].876	.193	[1].639	.162	[1]1.225	.105
R^2	.198		.217		.093	
Conditional probability (P)**		.644	...	.574	...	.107

[1] Significant at the P < .10 level.
[2] Significant at the P < .05 level.
* ($\delta P \div \delta X_j$) is the change in the conditional probability of locating associated with a change in the value of variable X_j.
** P is the conditional probability obtained by evaluating the entire model at the sample mean. The equation used to compute P is $1 \div (1 + e^{-t})$, $t = \Sigma \alpha_j X_j + \alpha_o$ where α_j = coefficient, X_j = mean value, α_o constant, and j = number of explanatory variables.

attract young physicians. However, per capita expenditures for health were lower in attractive counties.

- With respect to environment, attractive counties were cooler, had more winter precipitation, and were at lower elevations.
- Health status variables did not present a consistent profile; attractive counties had fewer births and deaths per capita, and a higher incidence of measles cases.
- Per capita use of medical care resources was consistently higher in attractive counties. This finding may reflect the greater supply of health resources in these counties, or it may indicate high levels of demand for care.
- Although there was a positive relationship between crime rates and attractiveness of the county, it is likely that this apparent relationship is the result of correlation of crime rates with other variables identified as attractive to physicians (for example population).

Overall, the results of the comparison of characteristics of communities which attracted and failed to attract young physicians were consistent with prior expectations.

Findings: Multivariate Analysis

The findings of the descriptive analysis provided evidence that there are characteristics of counties which are more, or less, attractive to young physicians. However, although the descriptive analysis identified factors which appeared to be positively or negatively associated with young physicians' location choices, it did not measure the magnitude of the effect, nor did it consider the interrelationships of the variables which are associated with location choices. The purpose of the multivariate analysis of the impact of community characteristics on location choices was to measure the magnitude and significance of the association of selected variables on the probability that a specific county will gain a young physician.

Results of the analysis of the effect of community characteristics on the probability that a 1974–78 medical school graduate in primary care practice would locate in a rural community with a particular set of characteristics are shown in table

Table 5. Estimated probabilities of attracting a physician for counties[1], by HMSA status, population density, and presence of a hospital

County population	Whole HMSA county		Non-HMSA county		Part-HMSA county	
	High population density	Low population density	High population density	Low population density	High population density	Low population density
	Category 1, no hospital					
Population less than 10,000	.45	.40	.35	.30	.56	.50
Population 10,000–25,000.....	.68	.62	.57	.52	.76	.72
Population more than 25,000 ...	.87	.84	.81	.78	.91	.89
	Category 2, hospital present					
Population less than 10,000	.49	.43	.38	.33	.60	.54
Population 10,000–25,000.....	.71	.65	.61	.55	.79	.75
Population more than 25,000 ...	.89	.86	.83	.80	.92	.90

[1] For all variables in the model, other than the specific variables in the different cohorts, the mean values were used to evaluate the expression:

$$P = 1 \div (1 + e^{-t})$$

where: $t = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + \ldots$ and P is the estimated probability for each cohort. See reference *10* for discussion of methods to calculate probabilities for cohorts.

Table 6. Estimated probabilities of attracting a physician for counties[1] by HMSA status, population, population density, and physician-to-population ratio level

County population	Whole HMSA county		Non-HMSA county		Part-HMSA county	
	High population density	Low population density	High population density	Low population density	High population density	Low population density
	Category 1, low physician-to-population ratio					
Population less than 10,000	.39	.33	.29	.24	.49	.44
Population 10,000–25,000.....	.61	.56	.51	.45	.71	.66
Population more than 25,000 ...	.84	.80	.77	.72	.89	.86
	Category 2, high physician-to-population ratio					
Population less than 10,000	.57	.51	.46	.40	.67	.61
Population 10,000–25,000.....	.77	.72	.68	.63	.84	.80
Population more than 25,000 ...	.91	.89	.87	.84	.94	.93

[1] For all variables in the model, other than the specific variables in the different cohorts, the mean values were used to evaluate the expression:

$$P = 1 \div (1 + e^{-t})$$

where: $t = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + \ldots$ and P is the estimated probability for each cohort. See reference *10* for discussion of methods to calculate probabilities for cohorts.

4. Overall, the estimated model is consistent with prior expectations. Although the R^2 values are relatively low, the estimated coefficients of many of the explanatory variables are statistically significant at the .05 level or above.

In column 1, the model has been estimated for the dependent variable ANYDOC (that is, coded 1, if any young physician located in that county; 0, if otherwise), and the coefficients are estimates of the impact of the explanatory variables on the log odds that a community will gain any young physicians. From these coefficients, the conditional probabilities of gaining any young physician have been calculated and are shown in column 2.

The population size variables, AMA2 and AMA3, are significant and contribute the greatest amount to the overall probability that a community will gain a young physician. This finding is consistent with findings of many earlier studies which show that population dominates cross-sectional location studies. As the population of a county moves from 10,000 to 25,000, the probability of gaining a young physician increases by 24 percent; when population increases from 25,000 to

'Counties with greater population are more likely to be attractive to physicians and to gain a larger number per county.'

50,000, this probability increases by another 46 percent. Other significant explanatory variables in the ANYDOC estimation follow:

- HMSA2 (indicating counties which are part-HMSAs) is, as expected, a positive and significant variable in explaining the probability that a county gains a young physician; designation as a part-HMSA increases the probability that a county will gain a young physician by 19 percent.
- COLLEGE, the presence of a college or university, increases the probability of gaining a young physician by 12 percent.
- WC80, the proportion of the employed population in white collar jobs, increases the probability of gaining a young physician by 6 percent.
- FARMPOP, the proportion of the population on farms, decreases the probability of gaining a young physician by 5.5 percent.
- MDPOP, the ratio of physicians to 100,000 population in the county, increases the probability of gaining a young physician by 16 percent when it changes from 40 per 100,000 to 80 per 100,000.

Evaluating the entire model at the sample mean, we obtain a mean conditional probability, $\overline{P}$, of .64; an estimated 64 percent of nonmetropolitan counties will gain at least one young physician. The R^2 of the model is 0.19.

One of the strengths of a multivariate probability model is that the estimated coefficients can be used to calculate the probability of the occurrence of a particular event (for example, gaining any young physician) for subgroups in the study, while controlling for the influence of other factors in the model. Tables 5 and 6 present the estimated probability that a county will attract any young physician for selected combinations of characteristics of counties. For each of the three population groups, the effects of HMSA status, population density, and presence or absence of a hospital are examined in table 5. In table 6, for the three population groups, the effects of HMSA status, population density, and low versus high physician to population ratios are examined.

The important feature to note in tables 5 and 6 is that the probability that a county will attract any young physician varies considerably for selected combinations of community characteristics:

- From a low of 30 percent in non-HMSA counties of less than 10,000 population, with low population density per square mile, and no hospital, to a high of 92 percent in part-HMSA counties of more than 25,000 population with high population density per square mile and a hospital.
- From a low of 24 percent in non-HMSA counties with less than 10,000 population, low population density, and relatively few physicians, to a high of 94 percent in part-HMSA counties with population more than 25,000, high population density, and a high physician to population ratio.
- The effect of increasing the physician-population ratio from "low" to "high" is to increase the probability that a HMSA county of less than 10,000 population will gain a young physician from 39 percent to 57 percent; however, hospital availability only adds 4 percent to the probability for a similar set of communities.
- Overall, the effect of increasing the availability of hospital and physician resources is greatest for the least populous counties and is relatively smaller for the most populous counties.

The purpose of the comparisons shown in tables 5 and 6 is primarily to demonstrate how this model could be used to estimate the probability that a specific county, with a given set of characteristics, will attract a young physician. The estimated model could be applied, for example, to identify those counties that are most likely to attract a physician and to identify those counties least likely to gain any young physician. Identification of these groups of counties could be potentially useful to the process of government policy formulation.

Summary and Discussion

The analytic findings presented in this paper concentrate on two issues:

- distributional patterns of young physicians in nonmetropolitan areas
- characteristics of nonmetropolitan communities in which young physicians did and did not locate.

Summary. We examined distributional patterns in the location choices of 1974 to 1978 medical

school graduates. Findings of this analysis indicate that

- Of 2,112 nonmetropolitan counties with population under 50,000, 58 percent gained at least one 1974 to 1978 graduate.
- Counties in the Northeast Census Region were most likely to have gained a young physician.
- When counties are classed by population, it is observed that
  - —31 percent of counties with less than 10,000 population gained a physician
  - —62 percent of counties of 10,000 to 25,000 population gained a physician
  - —92 percent of counties with 25,000 to 50,000 population gained a physician.
- Although 78 percent of part-HMSAs and 61 percent of non-HMSAs gained a physician, only 45 percent of whole-county HMSAs gained a physician.
- The diffusion hypothesis is supported, though weakly, by the distributional patterns of the cohort of 1974 through 1978 graduates; graduates in later years appear slightly more likely to locate in less populous areas.

When the characteristics of counties which gained and failed to gain young physicians are compared, the findings indicate that

- Counties in which young physicians located are more populous, have higher population growth rates, have smaller Hispanic populations, have a better educated population, and a greater population density.
- These counties are more likely to have colleges and universities and be contiguous to urban counties. In counties with more than 10,000 population, higher per capita expenditures for education are observed in counties that are attractive to young physicians.
- With respect to economic variables, higher income levels are observed in gaining counties, and the work force is more heavily concentrated in white collar and manufacturing activities; there are fewer farmers and a small percentage of land is in farmland. Gaining counties also tend to have higher unemployment rates and a higher proportion of the population receiving payments in the Aid to Families with Dependent Children Program.
- Health resources are more available in counties which were attractive to young physicians. However, per capita public expenditures for health are lower in these counties.
- With respect to environment, counties in which young physicians located are cooler, have more winter precipitation, and are at lower elevations. These findings may be related to distributional patterns by census region.
- Health status variables do not present a consistent profile; counties which gained young physicians have fewer births and deaths per capita and a higher incidence of measles cases.
- Use of health services per capita is consistently higher in gaining counties. This finding may reflect the greater supply of health resources in these counties, or it may indicate high levels of demand for care.

Overall, the results of the comparison of characteristics of communities in which young physicians did and did not locate are consistent with prior expectations. Results of the multivariate analysis suggest that counties are more likely to be attractive to young physicians, in general, when they have

- Greater population. As population of a county increases from 10,000 to 25,000, the probability of attracting young physicians increases by 24 percent; when population increases from 25,000 to 50,000, this probability increases by another 46 percent.
- More physicians. As the ratio of physicians-to-population increases from 40 per 100,000 to 80 per 100,000, the probability that the county will gain a young physician increases by 16 percent.
- A college. Counties which have a 2- or 4-year college have a 12 percent higher probability of gaining a young physician.
- White collar employment. An increase in the proportion of the employed population in white collar jobs, from 30 percent to 40 percent, increases the probability of attracting a young physician by 6 percent.
- Less farm population. As the proportion of the population on farms increases from 10 percent to 20 percent, the probability of attracting any young physician decreases by 5.5 percent.

Discussion. The supply of physicians has increased dramatically during the past decade and is expected to grow by an additional 35 to 40 percent by 1990. As a result, competitive pressures on young physicians may be expected to affect their decisions on location, and shifts in these patterns may occur. Early evidence that this is occurring has been presented for the 1970–79 period by

Newhouse and coworkers (*1*). They found that, as the supply of physicians grew during the 1970s, physicians went to smaller communities. In their 23-State sample, by 1979, nearly every community with 2,500 or more population had access to physicians. The diffusion effect has implications for primary care physicians, who could be regarded as being "pushed" out of more desirable areas by the competitive pressure generated by specialists who can provide specialized services in addition to primary care. Newhouse and coworkers concluded (*1*):

> The data strongly suggest that competitive forces play a major role in determining where physicians choose to practice. As the pool of physicians expands during the 1980s, a wide range of services will become increasingly available to populations outside metropolitan areas.

A related study by Schwartz and coworkers (*9*) examined the diffusion of board-certified physicians into communities with 10,000 to 20,000 population and concluded that diffusion of board-certified physicians to less populous areas has also occurred as the supply of board-certified physicians has increased.

Our study extends the early findings of Newhouse and coworkers (*1*) and Schwartz and coworkers (*9*) to examine the factors beyond population size that determine whether a community of a certain population size, with specific characteristics, is more or less likely to attract a young physician. Although the unit of analysis in our study is the county, rather than the town, it may be that in rural areas the market area that young physicians consider is considerably larger than the single community—particularly for the smaller towns studied by the Newhouse team.

Our findings generally are consistent with prior expectations, although the evidence presented on the relative effects of some community characteristics are surprising. Although population size dominates the factors influencing the probability that a county will attract a physician, other factors explain which community of a given population size will gain a young physician when competitive forces are resulting in diffusion of the supply of physicians to rural areas.

Results of this study provide information useful to the government and private organizations concerned about improving access to health services in rural areas. Although 58 percent of nonmetropolitan counties gained one or more young physicians, 42 percent did not. Nearly 60 percent of counties that did not gain a physician had populations under 10,000. Some of these most rural areas already may have a physician or may be contiguous to areas with an adequate physician supply, but others may continue to be inadequately served and have little likelihood of attracting a permanent physician.

References

1. Newhouse, J. P., Williams, A. P., Bennett, B. W., and Schwartz, W. B.: How have location patterns of physicians affected the availability of medical services? No. R-2872, the RAND Corporation, Santa Monica, CA, May 1982.
2. U.S. Department of Health and Human Services: Diffusion and the changing geographic distribution of primary care physicians. ODAM Report No. 4-83, Bureau of Health Professions, Health Resources and Services Administration, Public Health Service, Rockville, MD, June 1982.
3. Langwell, K., Czajka, J., Nelson, S., Lenk, E., and Berman, K.: Young physicians in rural areas: the impact of service in the National Health Service Corps. Vol. I. County characteristics. ODAM Report No. 3-86, Health Resources and Services Administration, Public Health Service, Rockville, MD, 1986.
4. Langwell, K., Czajka, J., Nelson, S., Lenk, E., and Berman, K.: Young physicians in rural areas: the impact of service in the National Health Service Corps. Vol. II. Survey of factors influencing the location decision and practice patterns. ODAM Report 3-86, Health Resources and Services Administration, Public Health Service, Rockville, MD, 1986.
5. U.S. Bureau of the Census: Statistical abstract of the United States, 1986. Ed. 106, U.S. Government Printing Office, Washington, DC, 1985.
6. U.S. Bureau of the Census: County and city data book, 1977 (A statistical abstract supplement). U.S. Government Printing Office, Washington, DC, 1978.
7. SAS Institute, Inc.: SAS user's guide: basics, version 5 edition. Cary, NC, 1985.
8. Langwell, K., Keane, M., and Nelson, S. L.: The market for vision care: analyses of the geographic distribution and practice patterns of ophthalmologists and optometrists. ODAM Report No. 2-86, Bureau of Health Professions, Health Resources and Services Administration, Public Health Service, Rockville, MD, 1986.
9. Schwartz, W. B., Newhouse, J. P., Bennett, B. W., and Williams, A. P.: The changing geographic distribution of board-certified physicians: facts, theory, and implications. No. R-2673, RAND Corporation, Santa Monica, CA, October 1980.
10. Theil, H.: Statistical decomposition analysis in the social and administrative services. University of Chicago Press, Chicago, IL, 1972.