A Utility-Theoretic Approach to Measuring Changes in US Rural Residents' Access to Hospital Services from 1980 to 1999

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1. Introduction

Questions of access to hospital services figure centrally in rural-health policy debates, yet few analyses exist that measure the importance of changes in hospital access in rural areas of the US. Of the studies that measure changes in access to hospital services over time in the literature, none use economic theory as the framework for the analysis. This paper proposes an economic approach based upon revealed preferences to measuring access to hospital services and quantifies the value of changes in hospital access over the period 1980 to 1999 for residents in rural counties in the US.

The ability to quantify the value of access to hospital services is essential if efficiency concerns about the level and targeting of rural health spending are to be addressed. For instance, the Medicare Payment Advisory Commission (MedPAC) and the General Accounting Office (GAO) have recently raised questions about the Critical Access Hospital Program and its eligibility standards. The CAH Program allows hospitals that meet its bed size and length of stay requirements (predominantly small rural hospitals) to receive cost-based reimbursement. The rationale for the program is that it provides small rural communities with access to an essential health care resource. But what is the value of the access to these services? How can policy analysts know whether or not we are spending too much or too little on these facilities?

This paper argues that the appropriate economic measure to answer these sorts of value of access questions is a measure of utility (a welfare index) that arises from a structural demand model for rural health services. The welfare index is derived from the coefficients of a nested-logit model of hospital choice of rural residents. The discrete-choice travel-cost model of rural hospital demand is estimated with survey data (1989 and 1991) from the University of Minnesota's Evaluation of the Hospital-Based Rural Health Care Program. The estimated coefficients form an indirect utility function index, which is applied to data on rural residents and hospitals (AHA Annual Survey) in the United States. For each rural county in the US a representative individual is constructed with identical demographic information but with access to hospitals that varies because of variations in hospital markets. Welfare measures are constructed for the years 1980 and 1999 for rural residents in all the rural counties of the US. On average the lowest levels of hospital access are found in the counties of the Western US, while Eastern US counties have better access to hospitals in comparison. The changes in hospital-consumer welfare indicate that over the period 1980 to 1999, access to hospital services has declined for many rural US residents.

This methodology can be applied to measuring other quality of life issues that communities face beyond the health-care arena. For instance, a similar travel-cost approach can create measures of access to shopping and entertainment outlets. Economic maps can be created to help communicate the resulting measures to policy makers. In addition, since the hospital-access index is a Hicksian welfare measure we can analyze its distribution across rural America using measures like the Gini Coefficient and the quantiles. These analyses can help make the targeting of public programs that aim to improve the access to health care services (such as the National Health Service Corps and health clinic subsidies) more efficient, by identifying the areas where the greatest need exists. Similarly, this approach lends itself to evaluations of programs such as the Critical Access Hospital program, and the resulting access indices can be used to value these public programs and examine whether the benefits that rural residents receive outweigh the costs of implementing the programs.

2. **Previous Approaches to Measuring Access to Hospital Services**

Both policy makers and health care researchers have framed access to services primarily in terms of distance to the nearest facility. For instance, health care researchers generally measure access to health care for rural people in terms of distance to a provider. Newhouse, et al. (1982, page 2396) report "there are virtually no towns with a population of 2,500 or more that do not have ready geographic access to a physician." Similarly, Williams, et al. (1983) estimated the driving distance of rural residents from sixteen Northeast, North Central and High Plains, and Southeast states to different types of physicians. Their geographical analysis showed that 80 percent of the rural residents were within ten miles traveling distance to some physician. 98 percent of the rural residents lived within 25 miles driving distance (Williams, et al., 1983).

Likewise, rural health researchers examining access to hospitals have emphasized distance and driving time as a measure of access. One such study that documents the nature of rural residents' access to hospitals is Bosanac, et al. (1976). This research examined the travel times to the nearest hospital for West Virginia's rural residents and showed that 20 percent of the state's rural residents lived beyond the 30-minute travel time standard for hospital care. When all the state's residents are considered, 10 percent of the population is found to live beyond the 30-minute travel time standard. The authors raise the question of whether access should be improved through transportation (road) improvements or hospital construction and improvements.

Public policies intended to ameliorate rural access to health care difficulties are also built upon distance measures. The CAH Program, for instance, uses a standard of 35 miles to the next nearest hospital for a given rural hospital to be eligible as a CAH. The basic distance standard has the strengths of simplicity and transparency, but it does not lend itself to direct use in economic evaluation and it does not provide a measure of value.

3. **Methods**

To measure the impact of changes in access services on the welfare of rural US residents, this study looks at what the change in the value of a utility index for a hypothetical residents located each county centroid in the 48 contiguous states. The utility index is based upon the coefficients of a previously estimated nested logit model of the demand for rural hospital services that was discussed and reported in McNamara (1998) and McNamara (1999). The demand model coefficients are combined with data on the set of hospitals in 1980 and the available hospitals in 1999 in order to calculate the value of a rural resident's utility derived from the set of available hospitals. The value of these welfare indices provide a utility-based measurement of the change in hospital access faced by US rural residents over the time period 1980 to 1999.

3.1 Data

The primary data for this study comes from the Bureau of Health Professions Area Resource File (ARF) for the year 1999 (US DHHS, 1999). The ARF is a database on US counties that includes a rich set of information related to health care services and public health indicators. For this study, the ARF provided county locations (population-weighted county centroids) that were used. In all, complete data on 3,069 US counties in the lower 48 states was obtained from the ARF database, and 2,241 of these counties are classified as rural.

Data on hospitals in the United States was obtained from the American Hospital Association (1980, 1999). The AHA Annual Survey provides information on all different types of hospitals and their associated facilities, services, staffing patterns, reimbursement structures, etc. The nested logit model of demand applied here only considers general surgical and community hospitals, and specialty hospitals such as children's hospitals or psychiatric hospitals were dropped from the data sets. The primary information of interest to this study from the AHA survey data is the location and set of attributes associated with each hospital in the lower 48 states. Locations were provided in the form of latitudes and longitudes for zip codes. These location centroids were combined with the county locations to calculate the sets of hospitals within a 200-mile distance radius. The choice sets for the demand model use the first 30 rural and first 30 urban hospitals within that distance radius.

3.2 Welfare Index and Nested Logit Demand Model

The nested logit model of demand for rural hospital services is reported in McNamara (1999) and further details on data and study background can be found in McNamara (1998). The nested logit model is estimated on data that was collected as part of a University of Minnesota study of rural hospital networks (Moscovice, et al., 1995). That study conducted a survey of rural residents and collected individual social, health, locational and economic information from more than 2000 rural households in 1989 and 1992 from communities in 30 states. The data was collected to "evaluate the effect of rural hospital participation in networks on the attitudes and behavior of rural residents" (Moscovice, et al., 1995, p. 188). Their study showed that network participation “did not appear to influence resident attitudes or behavior to any significant degree” (Moscovice et al., 1995, p. 198). As a source of data on rural residents and their use of hospital services, this survey is unique in that it provides hospitalization information with rich social and economic information about the consumer.

The nested logit model coefficients are reported in Table 1. The variables included in the nested logit model are (at the hospital level) travel cost, hospital beds, number of board certified physicians, and (at the individual level) age, shopping patterns, illness severity, and income.

As is common in the recreational demand literature to value changes in water quality, the nested logit model here is applied to value a change in the level of hospital services available to rural US consumers. Following the method suggested by Hanemann (1982) for the case of a discrete choice model with an income effect, this study calculates the value of the change in access by finding what level of income transfer would make the consumer indifferent between two consumption bundles. To estimate this compensating variation (CV) amount, a numerical search method is employed. Estimates of this CV were calculated to find the amount of income transfer necessary to make residents indifferent between their current access (1999) and their previous hospital access. A positive amount means that the resident values his or her current (1999) set of hospital alternatives more highly than his or her 1980 hospital alternatives, and an income transfer would be required to make the consumer indifferent between the two consumption bundles. Note that the CV amounts reported in Tables 2 and 3 are for hospital consumers. In order to interpret these estimated CV amounts for a general population, a scaling factor of the likelihood of a given resident seeking hospital care would need to be added. On average, roughly 10 percent or less of the US adult population has an inpatient hospital stay in a given year, so the relevant scaling factor would be roughly in the range of 0.07 to 0.1.

4. **Results**

The welfare indices were calculated for each county in the United States in the case of a hypothetical 65 year-old woman, with an annual income of $30,000 per year. Table 2 and 3 report the results for Inclusive Value terms (welfare indices) for the 20 rural counties with the poorest access to hospital services in 1980 and the 20 rural counties with the best access to hospital services in 1980. In addition to the 1980 inclusive value terms, Tables 2 and 3 also report inclusive value terms for 1999 and the calculate CV amount. The CV amount is the income transfer necessary to make the 1999 consumer indifferent between his or her current set of hospital alternatives and the set of alternatives for his or her area in 1980.

Overall, rural counties saw a decrease in access to hospital services over the period 1980 to 1999. In 1980, the average rural county Inclusive Value term was 1.2763, while in 1999 it is calculated to be 1.2292. The average Compensating Variation necessary to make the hypothetical 1999 rural hospital service consumer indifferent between her current set of hospital alternatives and the 1980 alternatives is about $5,000.

As Table 2 and Figure 1 indicate, the rural counties in 1980 with the poorest access to hospitals are nearly all in the West, mostly in the Mountain states of California, Wyoming, Montana, Nevada, and Idaho. It should be no surprise that these counties with low population densities and huge areas with few hospitals would rank low on an index of access. Note, however, that many of the counties that are in the lowest 20 in 1980 experienced increases in their hospital access over the period 1980 to 1999, as seen through the higher inclusive value terms for 1999 and the negative amounts in the CV column (implying that the consumer would have to reduce his or her income in 1999 in order to be indifferent between hospital access in 1999 and in 1980).

The rural counties with the best access to hospitals are found primarily in the South and in the East, including Arkansas, Ohio, Indiana, Mississippi, and Tennessee. Note that these rural counties all display (Table 3) much higher levels of the inclusive value index when compared to the counties with the lowest levels of access. Moreover, note from Figure 1 and 2 the strong geographical pattern of the distribution of access to hospital services. Better access is found mostly in the East and in areas near major metropolitan areas. Lower levels of access are found in the Great Plains and in the West. Isolated regions in Northern Maine, Northern Michigan and Northern Minnesota also display low levels of hospital access.

To see how access compares between rural and urban counties, the values for the index were compared. The average rural county in 1999 had an Inclusive Value measure of access of 1.229, while the average large urban county had an Inclusive Value measure of 1.261. Smaller urban counties fared better, with the smallest urban county group having an average Inclusive Value term of 1.506 and the next largest group having an average value of 1.349. However, the ability of the model to span across both urban and rural areas is in question, since it was estimated only upon data from rural residents. That limitation being noted, it is likely that this measure understates the difference in access between urban and rural areas, since we almost never see an urban resident travel to a rural hospital for treatment (unless on vacation or traveling), while we commonly observe outmigration of rural hospital consumers.

Has the distribution of access in rural US counties become more unequal over the period 1980 to 1999? In 1980 the Gini coefficient for the Inclusive Value term for all rural counties was 0.1356. Recall that the Gini coefficient for income in the US is in the range of .34 to .42 depending on what definition of income and household is applied. Thus, access to hospital services is much more inequally distributed compared to income. In 1999, the rural Inclusive Value Gini coefficient was 0.1308, indicating an increase in inequality over the period 1980 to 1999. For urban areas, the opposite effect was observed, with a slight decrease in the urban Inclusive Value index over that period.

Another dimension of access that can be investigated with the Inclusive Value term is whether or not access differences vary more across people or across geographic areas. Note the differences of about 2 or 3 units on the Inclusive Value scale for the values reported in Tables 2 and 3. Further Inclusive Value terms were estimated for women with slightly different characteristics than the hypothetical 65 year-old woman mentioned above. For an 85 year-old woman, the Inclusive Term in 1980 averaged 1.0645 and decreased to 1.0207 in 1999. These values are significantly below the average Inclusive Values for the 65 year-old woman. Younger women also have lower Inclusive Value terms, probably because they are less likely to outmigrate to urban hospitals. And, as expected lower income women have lower Inclusive Value terms and higher income women have higher Inclusive Value terms. In 1980, a rural 65 year-old woman with an income of $60,000 per year had an average Inclusive Value term of 1.4938. To sum up, on average rural residents have seen decreases in their access to hospital services as measured by the Inclusive Value index of hospital access over the period 1980 to 1999.

5. **Conclusions or Is The Inclusive Value Approach Ready For Rural Health Policy Use?**

This paper has demonstrated that a valuation approach based upon the observed demand for hospital services can offer rankings and measurements of value that are useful in analyzing changes in access to hospital services. The welfare maps presented in Figures 1, 2, and 3 are probably what most rural health observers would expect to see. Moreover, the estimate of a decrease in access to hospital services over the period 1980 to 1999 is a conclusion similar to what some rural health observers have been reporting as they describe hospital closures in rural areas. What this method does is provide a link to the theory of value and a method of measurement of welfare changes.

Of course, this method faces some limitations. There is a need for further validation and testing of rural hospital demand models. Are the estimated coefficients and estimated valuations provided by the model confirmed by new studies?

While there is need for further refinement and work on econometric estimation, the approach itself raises some basic questions for rural health policy. Is equality of access an acheivable or even desireable goal? The very low welfare values found for some rural West counties raise the possibility that there are limits to the ability of policy to reduce access disparities. Clearly, there are points where reducing access disparities will prove to be extremely costly and alternative public health uses of these public funds would lead to greater returns.

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Table 1. Nested Logit Model of a Rural Resident's Hospital Choice

Variable	Coef.	S.E.	t-stat
Lower Level (Conditional)			
DNear	1.3824	0.5221	2.648
DNear*Shop Local	0.6795	0.3993	1.702
Travel Cost	-0.0556	0.0114	-4.886
DUrban*Travel Cost	0.0128	0.0119	1.078
Bedsize	0.0062	0.0006	10.109
Physicians	0.0012	0.0029	0.414
DUrban*Physicians	-0.0034	0.0030	-1.116
Upper Level (Marginal)			
DUrban	-1.5016	0.5221	-2.874
Urban*Age	0.0115	0.0067	1.714
DUrban*Elderly	-0.8002	0.3238	-2.471
DUrban*Income	0.0148	0.0064	2.299
DUrban*Life Threat.	0.7531	0.2338	3.221
Inclusive Value	0.2540	0.0860	2.952
Observations=934 Pseudo R^2=0.3875			
Source: McNamara, 1999.			

Table 2 Rural Counties Ranked By Access in 1980 -- The Lowest 20 Counties

County Name	State	Inclusive Value 1980	Inclusive Value 1999	CV -- 1999 to 1980 Access
Humboldt County	CA	-0.65968	-0.43518	-38.6
Trinity County	CA	-0.33953	-0.20523	-19.0
Mariposa County	CA	-0.25682	-0.29210	5.8
Lincoln County	NV	0.02200	0.70528	-299.0
Esmeralda County	NV	0.05024	0.11542	-11.1
Alger County	MI	0.20232	0.10040	33.5
Tuolumne County	CA	0.22822	0.23198	-0.6
Teton County	WY	0.25365	0.30844	-17.8
San Juan County	UT	0.27375	0.17207	18.1
DeBaca County	NM	0.28032	0.35148	-16.7
Clark County	ID	0.32440	0.38665	-14.9
Lassen County	CA	0.32734	0.26573	6.5
Petroleum County	MT	0.36330	0.40661	-9.7
Garfield County	UT	0.36568	0.29407	10.9
Prairie County	MT	0.37198	0.33692	11.0
Billings County	ND	0.37587	0.28716	36.4
Humboldt County	NV	0.38133	0.43189	-12.7
Custer County	ID	0.38605	0.42535	-10.4
Tehama County	CA	0.39077	0.27102	15.1
Elko County	NV	0.39337	0.40257	-2.8

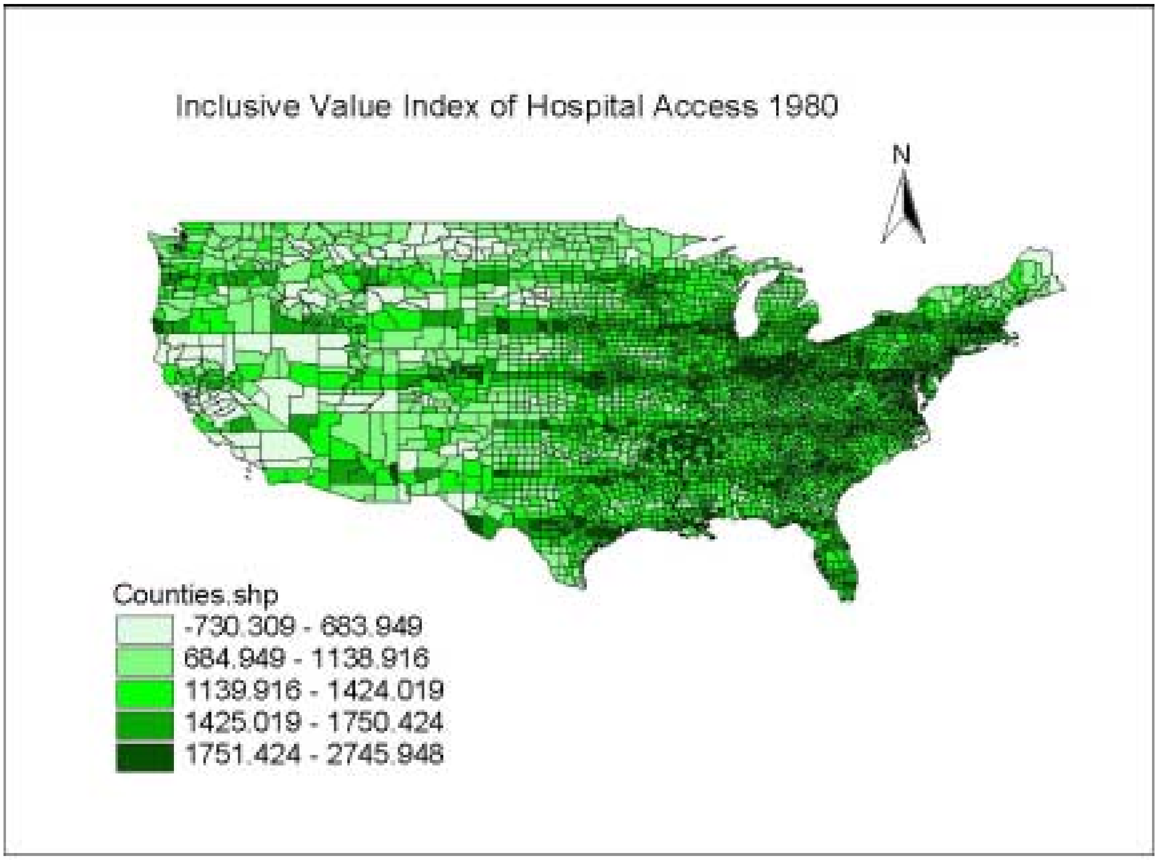
Note: CV amounts are in 000s.

Table 3 Rural Counties Ranked By Access in 1980 -- The Highest 20 Counties

County Name	State	Inclusive Value 1980	Inclusive Value 1999	CV -- 1999 to 1980 Access
Poinsett County	AR	1.654694	2.458041	71.3
Preble County	OH	1.528001	2.382625	87.7
Fayette County	OH	1.478256	2.368281	89.6
Macon County	AL	1.197105	2.357742	114.9
Lee County	AR	1.677708	2.335877	57.9
Wayne County	IN	1.812405	2.297652	47.9
Benton County	MS	1.494814	2.288439	73.4
Garland County	AR	1.378359	2.28004	102.4
Jackson County	AR	1.598462	2.274401	68.2
Lafayette County	MS	1.262616	2.265384	122.7
Union County	IN	1.727601	2.254826	53
McNairy County	TN	1.426256	2.214468	80.7
Logan County	OH	1.376557	2.204642	86.2
Coahoma County	MS	1.212379	2.204629	123.7
Darke County	OH	1.428661	2.169996	76.8
Lee County	MS	1.917785	2.163108	52.5
Wabaunsee County	KS	1.636621	2.144941	49.5
Warren County	IN	1.677627	2.120424	46.7
Jay County	IN	1.345836	2.114093	82.6

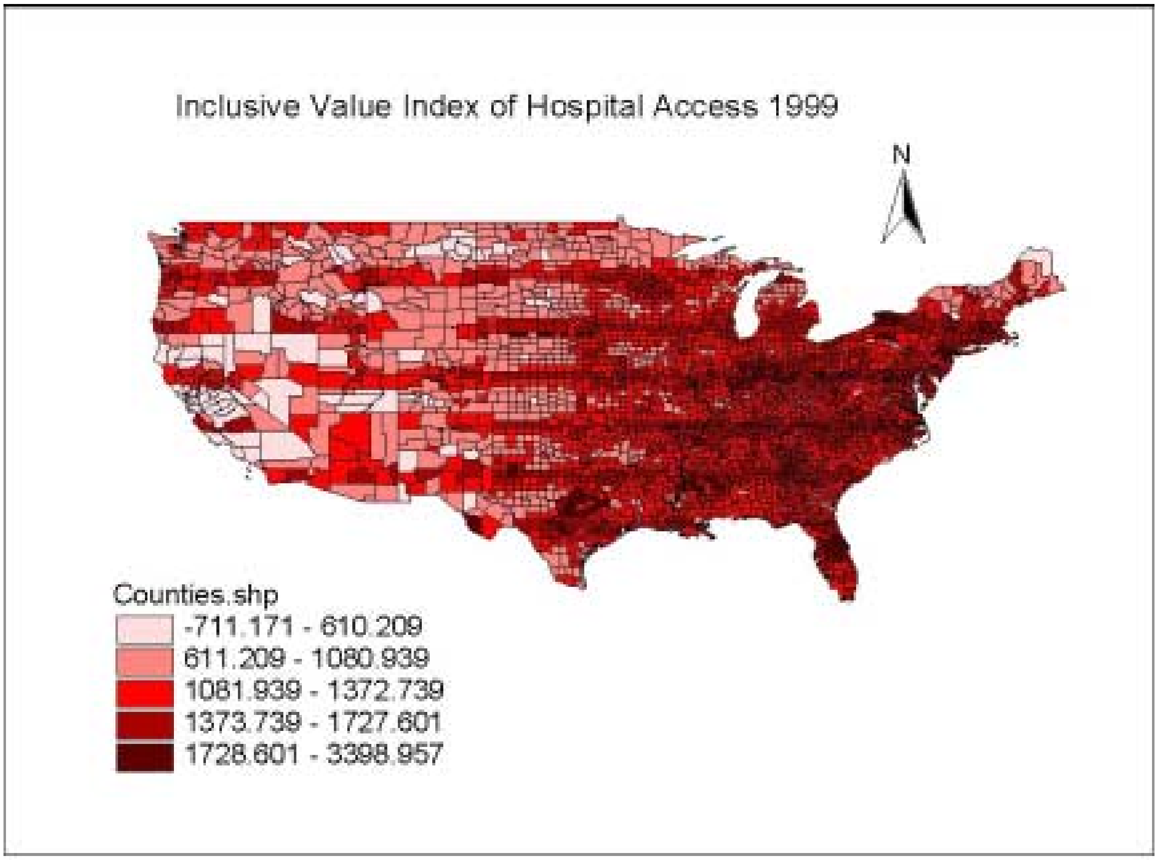
Note: CV amounts are in 000s.

Figure 1 Hospital Access in 1980



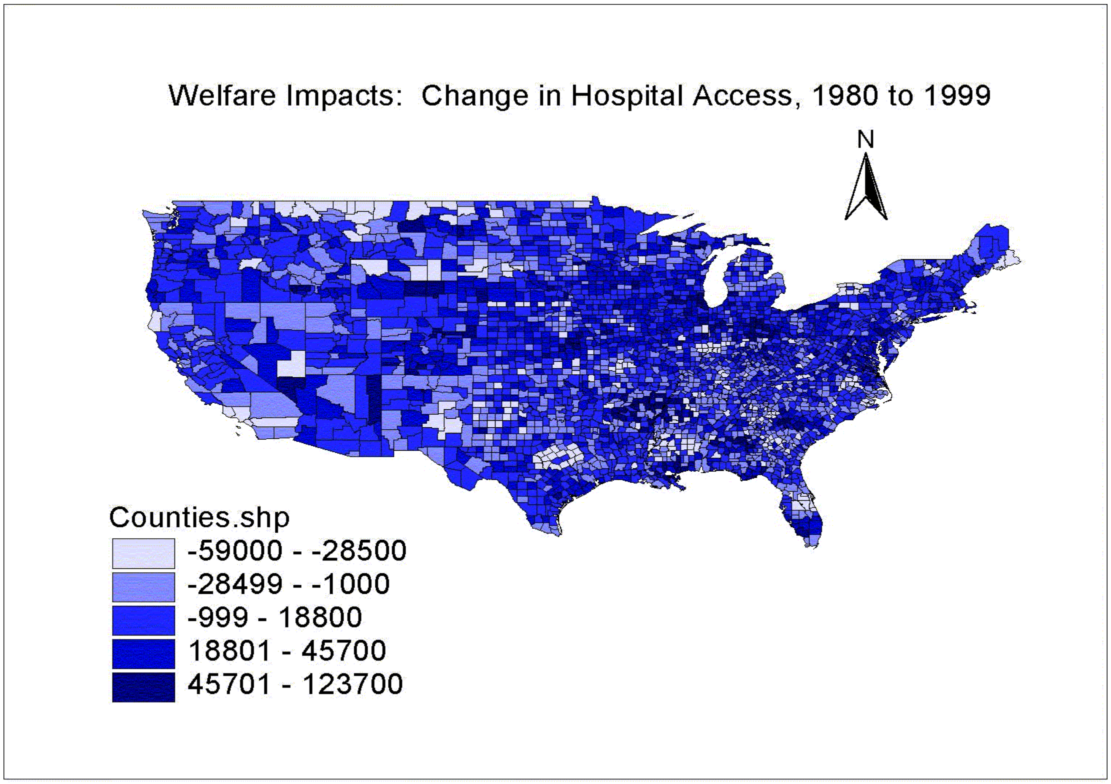
Note: Light green areas denote counties with lower levels of access to hospital care.

Figure 2 Hospital Access in 1999



Note: Light red and pink areas denote counties with lower levels of access to hospital care.

Figure 3 Welfare Impacts of Change in Hospital Access, 1980 to 1999



Note: Welfare impacts are defined here as the amount of income required to make a resident indifferent between his or her current hospital alternatives (1999) and the hospital alternative he or she would have faced in 1980. A negative amount implies that the consumer would prefer (be willing to pay) to face the 1980 hospital alternatives in his or her area. A positive amount implies that the person would require an income transfer to remain indifferent between the hospital alternatives he or she faces now and would have faced in 1980.