Economic Impact of Hospital Closure on Rural Communities in Three Southern States: Georgia, Tennessee, and Texas. A Quasi-Experimental Approach.

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The Hill-Burton program which started in 1946 provided financing for constructing hospitals in small communities. The major goal of the program was to increase resident's access to medical care. The secondary goal was income distribution, which promotes development in general. The program was effectively applied for 20 years. As a result of it, the supply of hospitals in rural areas increased. Twenty five years later, in 1971, approximately 40% of the 10,748 projects that received funds which resulted in an addition of 6,594 hospital beds nationally were located in communities with a population lower than 10,000, while 60% were located in communities with a population lower than 25,000 (Christianson et al., 1981).

In contradiction with the goals of the Hill-Burton program, during the last two decades a large number of hospitals closed in rural communities all across the United States. Between 1988 and 1997, for example, 243 rural hospitals closed their doors across the country (Pearson et al., 2003). Among the main factors explaining such behavior are rural out-migration, changes in Medicare payment methodologies, and chronic operating losses.

Have the rural communities been economically affected as a result of the hospital closures? Some researchers have studied this problem. However, the results have been contradictory. Hart et al. (1991) examined the opinions of mayors of towns experiencing hospital closure between 1980 and 1988. They used a survey that included both closed and open ended questions concerning the effects of the hospital closure. The mayors were asked to cite the negative aspects of the closure. The economic effects were cited more often (63.4 percent) than increased travel distance (60.4 percent) or access to health services and decline in health status (56.4 percent). Using I/O analysis, Christianson and

Faulkner in their 1981 article “The Contribution of Rural Local Hospitals to Local Economies” found that the hospital as a single institution contributed more in salaries to rural communities, on average, than did many other major sectors of the rural economies. Their study and other studies (Doeksen et al., 1997) found that rural hospitals are often the only entities that attract new residents and businesses into these communities. Hospitals are considered the locus of rural health systems and most of the health care personnel of the community are either employed by or supported by the local hospital. Probst et al. (1999) analyzed the economic impact of hospital closure on small rural communities in the 1980’s using a quasi-experimental approach. They did not find a statistically significant difference in income trends in the closure counties relative to comparison counties. Closure counties exhibit a flattening of income growth in the closure year and the two years following versus consistent growth registered by comparison counties. Differences, however, are not statistically significant. Pearson et al. (2003) used a pre-test/post-test model to analyze the economic health of the local communities in Texas and found that the results did not show that hospital closure had a significant short or long term harm on the economies of the 24 rural counties studied.

Objective

The overall objective of this research is to analyze the economic impact of rural hospital closures on rural communities in Georgia, Tennessee, and Texas by using a quasi-experimental control group method. In particular, the results will indicate whether rural communities that suffered hospital closures were affected in economic terms relative to those that did not suffer such a closure.

Methodology

Quasi-Experimental Control Group Method

The main advantage of experimental research is the fact that it allows to use randomization. By applying a particular policy or treatment to a randomly selected group it is possible to avoid the biases between groups (Campbell and Stanley, 1963). However, in the context of regional economic policy it is not possible to use the selection of random groups in which case one or more of them are subjected to the treatment or policy under study. The control group is selected after the treatment has happened so that it permits isolating the treatment effect.

In the case of regional economic policy evaluation the use of quasi-experimental methods might be more appropriate. The quasi-experimental method or technique has most aspects of an experiment –a treatment, an outcome measure, and a control group whose experiences serve as a baseline against which the effects of treatment can be measured.

Quasi-experimental control group methods have been used as a measurement technique to analyze economic and spatial structural change. As Isserman et al. (1982) explain, the essence of such methods is the careful identification of a control group- a set of places whose economic development enables measurement of what would have happened in the place under study without the phenomenon or policy being studied. The control areas are selected on the basis of their similarity to the treated region in the period before the policy or treatment was implemented.

Some of the advantages of the quasi-experimental approach (Isserman and Merrifield, 1982) are the following:

1. The method controls for events that occur simultaneously to the regional policy, such as recent changes in national economic cycles and inflation.
2. Unlike economic base or input-output analysis, the quasi-experimental approach may be applied to cases where the structure of the economy is radically transformed. This method identifies structural changes.
3. Whereas such changes may invalidate pre-impact economic base multipliers and input-output coefficients, this method requires no assumptions about fixed structural relationships nor any complex, time-consuming adjustment mechanisms to approximate structural change.

Instead, what it is required is the conviction that the control group is wisely chosen.

The quasi-experimental design proposed might be thought of a combination of the non-equivalent untreated control group design and the interrupted time-series design (Campbell and Stanley, 1963). The main idea of this method is to match policy treated counties with untreated counties that have similar economic and spatial characteristics.

The resulting design is diagrammed below:

O_1	O_2	O_3	O_4	O_5	X	O_6	O_7	O_8	O_9	O_{10}
O_1	O_2	O_3	O_4	O_5		O_6	O_7	O_8	O_9	O_{10}

In the ‘non equivalent group design’ proposed by Campbell and Stanley (1963), the treatment or policy group (or region) is compared or matched to an untreated group in the period before the treatment happened, if they show statistical similarity before the treatment is applied, then the criterion for a control group is met. These groups will be tested again after the treatment or policy is applied to check for differences between the treated and the untreated (or control regions). These differences will be the impact of applying the policy/treatment. The economic performance of the untreated or control group will be the criteria for what would have happened to the treated group if no policy or treatment was applied.

For the purpose of this study, the following definitions (Department of Health and Human Services, 1993) will be used:

Rural Hospital: a facility located in a rural area that provides general, short-term, acute medical and surgical inpatient services.

Closed Hospital: one that stopped providing general, short-term, and acute inpatient services during the period of analysis. If a hospital merged with or was sold to another hospital and the physical plant closed for inpatient acute care, it was considered a closure. If a hospital both closed and reopened in the same year, it was not considered a closure. If a hospital closed, reopened, and then closed again during the years in the study, it will be counted as a closure only once.

Selection and Behavioral Variables

As explained by Rephann (1993), assume a population of n regions, and each region i (i=1, …, n) has a 1xp vector of variables $[X_{i1}\ X_{i2}\ \ldots X_{ip}]$ or vector X_i. These variables also called selection variables will be used with the purpose of selecting a control group.

Also, each of the regions has a t x r matrix of variables (where r is the variable and t is the year) or matrix $Y_{i:}$

$$Y_i = \begin{matrix} Y_{i11} & Y_{i21} & \dots & Y_{ir1} \\ Y_{i12} & Y_{i22} & \dots & Y_{ir2} \\ & & & \\ Y_{i1t} & Y_{i2t} & & Y_{irt} \end{matrix}$$

The Y variables are known as behavioral variables and will be used to examine policy effects.

A region or county that receives treatment or in this case hospital closure will be called a treatment region T where T = 1,… f and will be represented by the selection vector X_T and behavior matrix Y_T.

Time Periods

It will be necessary to distinguish different time periods:

(1) The selection period

(2) The treatment period

(1) The selection period

The selection period is the period before the policy is administered. It is composed of the calibration period and the selection-test period.

Calibration period

This period is used to identify the control group. The variables that describe conditions and growth rates within this period (selection variables) are the basis for selecting the control counties.

Selection-test period

It is in the selection-test period when a statistical pre-test is performed which permits an explicit evaluation of the validity of the control group. By doing this it is possible to evaluate the ability of the control to trace out accurately the growth path of the treated county. This period starts at the end of the selection period and it ends just before the treatment begins. Because no treatment occurred during the selection test period, the counterfactual traced out by the control group during that period should be identical to the actual.

(2) Treatment period

The treatment period is the period after the policy is administered. A treatment effect is identified if the actual and the counterfactual diverge during this period and their difference is statistically significant.

Pairwise Matching

The "pairwise matching method" is one type of quasi-experimental control group design. It compares a group of policy treated regions to a matched group or untreated group. When particular control counties are the best match for more than one treatment region, rules must be specified for assigning them to only one region.

This method assumes that the mean of the paired behavioral growth rates follow an approximately normal distribution, and therefore, uses a test statistic that exhibits a student's t distribution.

Selecting Control Groups

The more similar the treated and untreated groups or regions are the more effective the control group becomes. Therefore, it is extremely important to carefully select the control regions in this type of analysis. The quasi-experimental approach requires the conviction that the control group is wisely chosen.

In order to select a control group it is important to follow two steps (Rephann, 1993 and Ray 1999):

The first step is deciding what variables are important in defining and identifying similar places. The decision on the variables will depend on the type of research and on the availability of data.

The purpose of this research is to analyze the impact of rural hospital closures on the economic development of the affected counties. However, it is important to consider that factors other than the closure may have affected the economic development of the closure counties. In order to know what would have happened in the absence of the hospital closure in the closure counties, a group of control counties will be selected. These counties will match each of the counties on the basis of similar economic structures, special structure, and growth patterns.

Ideally, the non-policy control variables selected for quasi-experimental policy analysis should follow from some regional economic theory. One approach for selecting control variables suggested in the regional literature is the “disequilibrium-adjustment models” (Rephann, 1993). Disequilibrium models focus on growth. Growth rate differences are explained by disparities in the conditions at which different regions begin a period.

The list of variables used to match counties is the following:

Previous growth variables

Total Income Growth Rate

Total Population Growth Rate

Spatial Structure

Total Population

Population density

Distance to the nearest metropolitan statistical area (MSA)

Net migration rate

Economic Structure

Per Capita Income

Farming Earnings

Manufacturing Earnings

Combined earnings from the wholesale, retail and service sectors

Health service earnings

Number of beds per 1000 inhabitants

Number of doctors

The second step is to choose a selection method for sorting and selecting a control region (s) for each treatment region.

Selecting a control region/county

Optimal Matching

This method relies on an iterative optimization algorithm to obtain the best set of matches. It searches for the set of control matches which minimizes the distance of the matches (taken as a group) from the treatment observations.

If the purpose is go find the best control group possible, preferring the set of matches that produces the minimum summed Mahalanobis distance from each treated to its matched untreated county would be the best.

$d(x_T,x_i) = (x_T-x_i)'\sum^{-1}(x_T-x_i)$,

where $d(x_T,x_i)$ is the distance between the vector of selection variables for treated county and county i, and $\sum$ is the variance-covariance matrix of the variables for the potential twins. The Mahalanobis metric implicitly scales and weighs the variables by a factor determined from the variability of data. For example, if a variable has high variance, ceteris paribus, the variable will contribute less to the dissimilarity between the treatment region and a control candidate than if the variable has a low variance. The Mahalanobis metric is forgiving on those high-variance dimensions for which it is difficult to find close observations

The Mahalanobis metric has several advantages, among those it reduces researcher subjectivity and it does not alter the distributional characteristics of the data. In the absence of knowledge about the importance of different covariates in affecting outcomes, as in the case of regional development research, it may be preferred to discretion.

Statistical Testing

Statistical tests are used both to evaluate the suitability of the control groups and to assess the economic effects of hospital closures in rural communities.

The optimal matching procedure suggests that the matched counties for each of the models are a reasonable control group for the treated counties. However, a more rigorous statistical evaluation will establish if this is true. The control group will indicate what would have happened to the treated counties in the absence of treatment. If the control group shows that is a good proxy for the hypothetical treated county growth before the closure year then it should also be a good proxy for the treated growth rates after the treatment. The best situation would be to find no statistically significant difference between the growth rates of the treated counties and their twins before the treatment began.

Both Univariate and Global significance testing are used in a multivariate setting such as this one. The Univariate Significance refers to statistically significant difference between the policy treated counties and their control groups on growth rates of individual (behavioral) variables. The pairwise matching method will assume that the mean of the pairwise growth rate differences is distributed approximately normally and use a conventional t test for univariate statistical significance.

It is a t-test of the mean growth rate difference of the matched pairs,

Ho: $D_{jt}^{TC} = r_{jt}^{T} - r_{jt}^{C} = 0$

Where,

D is the growth rate difference,

T is the treated (closure) group,

C is the no-closure control group,

r_j = is growth rate j,

j is one of the behavioral variables,

and t is the test year.

According to Rephann (1993: 148), “the appropriate test in this case would be a standard difference of means test. This test is less efficient than testing on paired growth differences because it throws away information about pairwise association”. The test statistic which is based on the mean differences is the following:

$t_{jt}=\delta_{mjt}/(s_{djt}/\sqrt{f})$

where,

δ_m is the mean of growth rate differences

s_d is the standard deviation of the growth rate differences

f = number of treatment regions

The behavioral variables used in this research are the following:

Per capita Personal Income

Total population

Unemployment rate

Combined earnings of manufacturing, wholesale, retail and health service sectors

This list is a subset of the list included in the Regional Information System of the Bureau of Economic Analysis (BEA) serve to measure county performance.

<u>Global significance</u> calculated to study the overall fitness of the twins. It refers to growth differences for the vector of growth rates taken as a whole. If no statistical significant

differences are revealed, it means the matches are good. The simplifying assumptions in this case are the independence of growth rates over time and among variables.

The statistic used in testing here is the Hotelling T^2 test statistic which is a multivariate extension of the univariate t-test. It will provide an overall test of growth rate similarity to assess the good choice of the control groups in the pre-test stage.

Following Johnson et al. (1982),

Ho: $\mu = \mu_o$

H1: $\mu \neq \mu_o$

$$T^2 = n\,(x-\mu_o)' S^{-1} (x-\mu_o)$$

Where,

$x = (1/n) * \sum_{j=1}^{n} x_j$

x is a p*1 matrix, where p is the number of variables

n = number of treated (and paired untreated) counties

$S = (1/(n-1)) * \sum_{j=1}^{n} (x_j - x)(x_j - x)'$

S is a p*p matrix

$$\mu_o = \begin{matrix} \mu_{1o} \\ \mu_{2o} \\ . \\ . \\ . \\ \mu_{po} \end{matrix}$$

μ_o is the matrix of mean variables of the control counties. It is a p*1 matrix.

T^2 is distributed $(n-1)p/(n-p)\ F_{p,n-p}$

Where $F_{p,n-p}$ denotes a random variable with an F distribution with p and n-p degrees of freedom.

The best would be to find no statistical significant differences between the growth rates of the closure counties and the selected control group before the closure happened.

The Impact

The mean growth differences in the post treatment period are the primary measure of the program effects.

For each year after the closure year, the growth rate from the closure year to the last year of the study will be calculated for each treated county and its twin, for each variable. A Univariate t-test of the mean growth rate differences similar to the one to be performed in the pre-test period will be performed, in this case it will be estimated for each consecutive year from the closure year to the last date analyzed.

Rural Hospitals Closed in the Period 1998-2000

According to the Department of Health and Human Services 167 hospitals closed across the United States between 1998 and 2000. Fifty eight of those hospitals were closed in rural areas. This number represented around 1.2 percent of all hospitals in the United States. The rural hospitals closed in these three years had an average of 51 beds, smaller than the national average of 68 beds.

To analyze the impact of rural hospital closure the first step was to see what states experienced at least two hospital closures in the period 1998 to 2000. The second step was to choose states that were relatively close geographically. The states of Georgia, Tennessee, and Texas were chosen for those reasons.

Ten hospitals were closed in the states of Texas, Tennessee, and Georgia in the period analyzed in areas considered rural according to the Department of Health and Human Services. However, two of them were eliminated because they were located in counties not considered rural according to the urban influence codes as defined by Economic Research Service of USDA.

The following table summarizes the closures occurred in the years 1998, 1999, and 2000. The information (data) of the counties where these hospitals were located was the one used to analyze the economic impact of the hospital closure.

Year	Hospital Name	City	County	State
1998	Johnson County Hospital	Mountain City	Johnson	Tennessee
1998	Lakes Regional Medical Center	Jasper	Jasper	Texas
1999	Ridgecrest Hospital	Clayton	Rabun	Georgia
1999	Cumberland River Hospital South	Gainesboro	Jackson	Tennessee
1999	East Texas Medical Center-Rusk	Rusk	Cherokee	Texas
1999	Starlite Village Hospital	Center Point	Kerr	Texas
2000	Bulloch Memorial Hospital	Statesboro	Bulloch	Georgia
2000	Brook's Hospital Inc.	Atlanta	Cass	Texas

Results

Time Periods

The selection period

(a) Calibration period: The five year period before the selection-test period started. Therefore, for the rural counties that suffered hospital closure in 1998 the calibration period went from 1987 to 1992, for the rural counties that suffered hospital closure in 1999 the calibration period went from 1988 to 1993, and for the rural counties that suffered hospital closure in 2000 the calibration period went from 1989 to 1994.

(b) Selection-test period: Five years before the hospital closed. Therefore, for the rural counties that suffered hospital closure in 1998 the selection-test period went from 1992 to 1997, for the rural counties that suffered hospital closure in 1999 the selection-test period went from 1993 to 1998, and for the rural counties that suffered hospital closure in 2000 the selection-test period went from 1994 to 1999.

The treatment period

The treatment period stretches from the year of closure to three years after closure. Therefore, for the rural counties that suffered hospital closure in 1998 the treatment period went from 1998-2001, for the rural counties that suffered hospital closure in 1999 the treatment period went from 1999-2002, and for the rural counties that suffered hospital closure in 2000 the treatment period went from 2000-2003.

Results of Optimal Matching

The counties considered as possible matches had to meet the criteria of both being rural and of having a number of beds different than zero, which gave an indication of hospital presence in the county. The number of counties considered in this research was 69 for the state of Georgia, 49 for the state of Tennessee, and 133 for the state of Texas. Therefore, the total of number of counties which could be possible matches for the closure counties was 250, this is, 251 counties except the closure county in each case.

The SAS results of applying the Mahalanobis distance are included in the following tables:

Year of Closure	**State**	**County**	**Match within State**	**Mahalanobis distance**
1998	Tennessee	Johnson	Bledsoe	47.23
1998	Texas	Jasper	Shelby	8.76
1999	Georgia	Rabun	Putnam	13.55
1999	Tennessee	Jackson	Franklin	30.46
1999	Texas	Cherokee	Howard	10.8
1999	Texas	Kerr	Howard	29.28
2000	Georgia	Bulloch	Coffee	29.46
2000	Texas	Cass	Limestone	6.12

Year of Closure	**State**	**County**	**Match within Region**	**Mahalanobis distance**
1998	Tennessee	Johnson	Dimmit (Texas)	27.58
1998	Texas	Jasper	Monroe (Tennessee)	4.1
1999	Georgia	Rabun	Candler (Georgia)	7.54
1999	Tennessee	Jackson	Franklin (Texas)	10.09
1999	Texas	Cherokee	Navarro (Texas)	11.82
1999	Texas	Kerr	Howard (Texas)	20.68
2000	Georgia	Bulloch	Coffee (Georgia)	15.47
2000	Texas	Cass	Cooke (Texas)	3.07

Because the Mahalanobis distance was much lower in all the cases except for one when considering counties of the three states as possible matches, the analysis was made with the matches within the region instead of the matches within the same state of the hospital closure.

Results of Statistical Testing

Univariate Test

(Please refer to table No. 1 in the attachment section)

During the testing period, the average growth rates of the closure counties were higher for three of the four variables considered: per capita personal income, total population, and personal income in the closure counties than the average growth rates of the matched counties. In the case of health services share however, the shares of the matched counties was higher than the shares of the closed counties. All these results were not significant at the 99% confidence level.

Global Test

The Hotelling T square test was applied to test if the matches obtained applying optimal matching (Mahalanobis distance) were good at the 99% confidence level. The variables used to perform the test were the following: per capita personal income, total population, personal income, and health share. The results indicated that the matches are good.

Results of Impact

(Please refer to table No. 2 in the attachment section of the paper)

Univariate Test

The Univariate test was performed to analyze if there was an economic impact in the counties that suffered hospital closure. The variables used for this test were the following: per capita personal income, personal income, unemployment rate, and health services share. The analysis was made for the first three years after hospital closure.

In the first year after closure all the variables considered were higher in the case of the matched counties than in the closure counties. In the second year after closure the average growth rates of per capita income growth and the unemployment rate were higher in the closed counties than in the matched counties and the average growth rates of personal income and the health services share were lower in the closed counties than in the matched counties. Finally, for the third year after closure, all the variables considered were lower in the closure counties than in their matched counties.

None of these results however, were significant at the 99% confidence level.

Attachments

Table No. 1

Results of Univariate Test

Testing period	Mean			T value
	Closure Counties	Control Counties	Difference	
Per capita Personal Income	4.80	4.21	0.59	0.90
Total Population	1.98	1.69	0.28	0.59
Personal Income	6.87	5.96	0.91	1.09
Health Services Share	4.56	4.73	-0.16	-0.23

Table No. 2

Economic Impact

Variables	Closure Counties	Control Counties	Difference	T value
One year after closure				
Percapita Personal Income	3.10	4.06	-0.96	-0.93
Personal Income	4.16	4.41	-0.25	-0.17
Unemployment Rate	6.24	6.26	-0.02	-0.01
Health Services Share	4.03	4.18	-0.16	-0.22
Two years after closure				
Percapita Personal Income	4.28	3.76	0.52	0.29
Personal Income	4.89	5.39	-0.50	-0.26
Unemployment Rate	5.79	5.53	0.26	0.34
Health Services Share	4.40	4.44	-0.04	-0.05
Three years after closure				
Percapita Personal Income	1.05	3.07	-2.02	-1.00
Personal Income	1.80	4.60	-2.80	-1.53
Unemployment Rate	6.10	6.18	-0.08	-0.09
Health Services Share	4.62	4.96	-0.34	-0.30

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