Scale economies in college and university student health centers: An econometric analysis

MaryAnn Brady
University of Nevada, Las Vegas

Follow this and additional works at: https://digitalscholarship.unlv.edu/rtds

Repository Citation
https://digitalscholarship.unlv.edu/rtds/162

This Thesis is brought to you for free and open access by Digital Scholarship@UNLV. It has been accepted for inclusion in UNLV Retrospective Theses & Dissertations by an authorized administrator of Digital Scholarship@UNLV. For more information, please contact digitalscholarship@unlv.edu.
INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.
Scale economies in college and university student health centers:
An econometric analysis

Brady, MaryAnn, M.A.
University of Nevada, Las Vegas, 1992
SCALE ECONOMIES IN COLLEGE AND UNIVERSITY
STUDENT HEALTH CENTERS: AN ECONOMETRIC ANALYSIS

By
MaryAnn Brady

A thesis submitted in partial fulfillment
of the requirements for the degree of

Master of Arts
in
Economics

Department of Economics
University of Nevada, Las Vegas
May 1992
APPROVAL

The thesis of MaryAnn Brady for the Degree of Master of Arts in Economics is approved.

Chairperson, Dr. Djete Assane

Examining Committee Member, Dr. Thomas M. Carroll

Examining Committee Member, Dr. Lewis Karstensson

Graduate Faculty Representative, Dr. Ann Mayo

Graduate Dean, Dr. Ronald W. Smith

University of Nevada
Las Vegas, Nevada
May 1992
ABSTRACT

This study estimates economies of scale for the provision of health care in college and university student health centers. Services at student health centers are available for approximately 10 million of the students enrolled in 1,500 institutions of higher learning in the United States. Estimated cost of these services is greater than $1 billion annually. A translog cost function is employed to analyze data from a random sample of 80 American College Health Association member institutions across the country. The results indicate that there are economies of scale in the production of student health care at levels of output up to the vicinity of 85 to 92 student visits on average per day, and diseconomies of scale thereafter.
TABLE OF CONTENTS

LIST OF TABLES ........................................... v
ACKNOWLEDGEMENTS ....................................... vi

I. INTRODUCTION ......................................... 1
II. STUDENT HEALTH CENTERS ............................... 3
III. LITERATURE REVIEW ................................... 6
IV. THE MODEL ............................................. 11
V. THE DATA ................................................ 19
VI. ESTIMATION PROCEDURE AND RESULTS ................. 26
VII. SUMMARY AND CONCLUSIONS ........................... 33

APPENDICES
A. HEALTH CENTER SURVEY QUESTIONNAIRE ............... 36
B. COLLEGES AND UNIVERSITIES IN THE STUDY .............. 44
C. INPUT PRICE VARIABLE EQUATIONS ....................... 46
D. SCALE ECONOMIES ESTIMATES BY HEALTH CENTER ...... 48

BIBLIOGRAPHY ............................................... 50
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Selected Characteristics of Institutions in the Study</td>
<td>20</td>
</tr>
<tr>
<td>2. Selected Characteristics of Health Centers in the Study</td>
<td>22</td>
</tr>
<tr>
<td>3. Descriptive Statistics for Variables in the Cost Function</td>
<td>24</td>
</tr>
<tr>
<td>4. Estimated Cost Function Parameters</td>
<td>27</td>
</tr>
<tr>
<td>5. Estimated Elasticities</td>
<td>29</td>
</tr>
<tr>
<td>6. Estimated Scale Economies by Size of Average Daily Caseload (Y)</td>
<td>31</td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to the Chair of my Thesis Committee, Professor Djeto Assane, without whose tutelage this project could not have been accomplished. Dr. Assane in his gentle, caring way led me along this difficult path, believing in my ability to succeed; thereby, strengthening my belief in myself.

To the other members of my Committee, Professors Lewis Karstensson, Thomas Carroll, and Ann Mayo, I extend a heartfelt thank you. Dr. Karstensson has been my teacher and friend throughout my studenthood at the University of Nevada, Las Vegas. His encouragement and support contributed greatly to the completion of this study. Dr. Carroll's guidance during my graduate program helped me to keep my goal in sight, and his wonderful sense of humor lifted my spirits in the inevitable moments of discouragement. I am grateful for his interest in my work. Dr. Mayo has been an inspiration to me, and her helpful comments have served to enhance the quality of my work.

I am indebted to Lori Winchell, the Director of the UNLV Student Health Center, and her staff for their
assistance in data collection, and their interest in this project.

Finally, I wish to thank my family, fellow graduate students, and other friends for their patience, understanding, and encouragement.
Economists, like doctors, are seeking to extend life and relieve misery. In the case of doctors, the premature mortality and the misery is due to disease. In the case of economists, it is due to scarcity. Health economics stands at the interface between those two important fields of human endeavour. . . .

In such a rapidly developing field it is difficult to know just when to offer your wares to the public for appraisal and comment, but the enormous interest in public policy suggests that anyone with something useful to contribute should not hold back.*

Alan Williams (1987)

I. INTRODUCTION

The health and health education of university and college students is an important element in the quality of student life and education. Institutions of higher learning which proclaim academic excellence as their mission consider mental and physical wellness as a necessity in achieving this goal. Providing such care and education to a student community is the function of the university or college student health center. Recent estimates suggest that approximately 1,500 of the 3,400 institutions of higher education in the United States have

student health services providing health care to 10 million students at an annual cost of $1 billion (Patrick 1988, 3301). The American College Health Association (ACHA) listed 737 of the nation's post-secondary schools among its membership in 1989 (American College Health Association 1990, 68-91). This study explores the relationship between inputs and output in student health centers with emphasis on the costs of production and the nature of scale economies. Specifically, the purpose of this investigation is to estimate, by means of a translog cost function, scale economies in a random sample of 80 ACHA-member student health centers. The results of this study will cast light on economic efficiency in the use of scarce resources in the student health center segment of the health care industry.

This thesis is organized as follows. First, the nature of the student health center is discussed. Second, selected studies concerned with the problem of estimating scale economies are reviewed. Third, the model employed in this investigation is presented. Fourth, the data used in this analysis are described. Fifth, the estimation procedure and results are discussed. Finally, a conclusion is presented.
II. STUDENT HEALTH CENTERS

The college or university student health center is a unique setting in the health care delivery system. It is a facility whose purpose is to serve one specific subset of the population of a community, namely the college or university student body. The first American institution of higher education to offer health services to its students was Amherst College in Massachusetts. Following this first appearance in the 1860s, the University of California at Berkeley in 1906 developed the first medical service in the United States which offered comprehensive care to college students. The ACHA was formed in 1917 by physicians serving college students (Roemer 1981, 128).

Health problems encountered by student health services require a range of programs to meet the students' needs (Fingar 1989, 143). Services offered typically include clinical care, health education, nutrition counseling, and, occasionally, psychological counseling, and dental care. Health care providers in this setting include physicians, nurse practitioners, registered nurses, and licensed vocational nurses. In many cases, the center director is a nurse practitioner or a registered nurse; whereas, in the
traditional clinic setting physicians direct the operations of the facility. Depending on the size of the health center, the staff may encompass other medical personnel, such as pharmacists, laboratory technologists, and radiation technologists.¹

For analytical purposes it would be convenient to identify the market structure to which the student health center is best classified; however, this can be a difficult undertaking. According to Feldstein, demand for and supply of hospital, or inpatient, services have dominated research in health economics. Also, analyzing elements of the health care industry in the context of traditional market behavior is complicated by the predominant number of nonprofit institutions and the multifarious nature of the demand for health services (Feldstein 1974, 380). The relatively sparse empirical information available on the economics of ambulatory care allows only a limited comparison of student health center characteristics to similar types of health care delivery systems.

Primarily the student health center is a provider of ambulatory, or outpatient, care rather than inpatient care. Various types of ambulatory health services exist in the United States each having developed to fulfill specific

¹These observations are based on the data gathered by the survey conducted for this study.
social needs (Roemer 1981, 29). Comparable to student health centers in services provided are public health clinics and health maintenance organizations. Funding for these health service providers differs from that of the student health center in that public health clinics are funded by state and federal government, and health maintenance organizations are financed through an insurance fund to which an enrolled population contributes. In contrast, student health care programs receive their funding from various sources, including student health fees, institutional allocations, and patient charges. In many institutions student health fees and student health insurance are mandatory for admission. Patrick estimates that, overall, students enrolled in postsecondary academic institutions make 20 to 25 million visits to student health centers each year and that 45.5 percent of the cost of care is borne by the institution (Patrick 1988, 3304).
III. LITERATURE REVIEW

Although investigation into returns to scale and scale economies in other health care settings can be found in the available literature, to the best of our knowledge, there are no previous studies related to the economics of college and university student health centers. However, rapid acceleration in the costs of care in the nursing home industry led researchers to examine the nature of the production process in this subset of the health care institutions. The studies of interest estimate cost functions to determine whether economies of scale exist in the nursing home industry.

Previous studies appear to fall into two classifications: first generation cost function estimation which employs an additive functional form, and second generation cost function estimation which uses the translog functional form. The analysis of the nursing home industry in the state of Ohio by Caswell and Cleverley is an example of a first generation study (Caswell and Cleverley 1983).² A second generation analysis is seen in McKay's

²Another first generation type study is Lee and Birnbaum 1983.
investigation of the Texas nursing home industry (McKay 1988).

The Ohio study investigated economies of scale in a sample of 1,382 nursing homes. Ordinary least squares regression techniques were used to estimate three cost functions, with cost measured as cost per patient day. The quadratic functions expressed the dependent variables as average total cost, average direct cost, and average indirect cost, respectively (Caswell and Cleverley 1983, 363). Direct costs are a measure of expenses having the greatest impact on patient care and more variability than indirect, or overhead expenses. The independent variables in each model included the size of the care facility, measured in number of beds, and the size, or number of beds, squared. Relative to the question of economies of scale, the size squared variable introduced a quadratic term into the model to produce the theoretical U-shaped cost curve (Pindyck and Rubinfeld 1989, 231-232). Other right-hand variables were related to type of ownership, occupancy rate, status of Medicaid reimbursement, and level of care. The data were disaggregated into three levels of care: skilled nursing care, intermediate care, and a combination category made up of skilled and intermediate care. Separate regressions were run for all institutions contained in the sample (n = 1,382), skilled nursing
facilities (n = 490), intermediate care homes (n = 767), and establishments offering both levels of care (n = 125).

Findings in the all homes, average indirect cost regression were contradictory to theory; namely, a positive sign on the size variable and a negative sign on the size squared coefficient implied an inverted U-shaped cost curve. Only the coefficient on size was significant. The size coefficients in the other two cost models were insignificant. The skilled nursing facility cost regressions revealed significant coefficients on the size variables implying the theory-dictated U-shaped cost curve. Although economies of scale were found, the authors concluded that the reduction in costs (20 cents per day) was of little consequence in policy formation.

Results of the intermediate care level regressions exhibited insignificant size coefficients, and although combination home findings showed significant coefficients on the size variables, the signs were "wrong" suggesting an inverted U-shaped cost curve.

The authors found no distinct pattern of economies of scale; hence, they determined their investigation to be inconclusive with no clear evidence of a cost benefit to larger plant size.

The examination of economies of scale in the nursing home industry in Texas by McKay falls into our second
generation cost function classification. McKay asserts that studies such as that by Caswell and Cleverley are inadequate in examining the statistical determinants of nursing home costs because the cost function employed is based on variables other than levels of output and the prices of inputs. She further emphasizes that economies of scale are properly measured by varying output levels while holding input prices constant, which certainly cannot be done if the model does not include input prices. Finally, McKay criticizes the use of an additive quadratic functional form for estimation purposes because it does not fulfill the regularity conditions of a cost function (Varian 1984, 44).

McKay's study estimates a translog cost function, a more flexible functional form than that of Caswell and Cleverley. Her data consisted of 82 for-profit facilities providing care at the intermediate level. The nursing home model developed relates patient-days of nursing home care as a function of nursing hours, aide hours, building and equipment, and other services (administrative services, food services and housekeeping). In her analysis McKay estimates two cost functions: the first assumes that all nursing homes provide the same quality of care, the second controls for quality differences across homes. Quality is measured as the number of nursing hours per patient day.
Input prices were derived and output levels established using the available cost and quantity information.

McKay's findings suggest the presence of economies of scale in the nursing home production process, with a 10 percent increase in output resulting in an increase of approximately 9 percent in total cost and a decrease of close to 1 percent in average cost. The results were essentially the same for both the constant quality and the quality adjusted cost functions. According to McKay, the disparity in findings between the first and second generation cost functions is related to the use of a model imposing unnecessary restrictions, vis-a-vis the employment of a more flexible functional form, and the failure to capture information relative to input price variables (McKay 1988, 70-72). This study will follow McKay's method of analysis.
IV. THE MODEL

This study views the student health center as a producer of health care transforming three factors of production -- medical staff, capital and various other services -- into an output measured by the average number of students evaluated and tested daily.

The introduction of duality theory to economic analysis allows a production process to be evaluated by means of either a production or a cost function (Diewert 1971). Duality provides a linkage between production and cost which enables the researcher to solve for derived demand equations for inputs to production using different techniques, but obtaining the same results. The solution to the production problem, thus, can be approached by employing a production function and maximizing the production function, subject to a cost constraint, by means of the Lagrangian method or by utilizing a cost function, meeting particular conditions, and solving for the cost

---

3This method usually limits the analysis to the one or two input case where the Lagrangian results in a three equation system readily solvable by means of substitution. A greater number of inputs leads to a more complex system of equations wherein solving by substitution or the Hessian determinant is a laborious process.
share equations by means of Shephard's Lemma⁴. The factor
demand equations and the share equations give exactly the
same information (Diewert 1971, 483). A legitimate cost
function is one that is, with respect to input prices,
(1) non-decreasing, (2) homogeneous of degree one,
(3) concave, and (4) continuous (Varian 1984, 44).

The search for a technologically efficient combination
of inputs can be difficult because of the paucity of
information available relative to the various inputs. The
dual relationship between a production function and a cost
function enables the analyst to look to the market for
observable prices of factors of production and levels of
output without necessarily facing the task of measuring
input factors.

The functional form of choice in this analysis is the
translog cost function (Christensen, Jorgensen and Lau
1973). This functional form belongs to a family of forms
known as flexible functional form (Chambers 1988, 160).
The relative ease of data collection makes the translog
cost function a more efficient approach to production and
cost analysis. Moreover, there are no a priori
restrictions placed on factor substitution elasticities,

⁴The partial derivative of the cost function with
respect to each input price yields the cost-minimizing
demand for that input. This derivative property is
known as Shephard's Lemma (Diewert 1987, 692).
cross-price elasticities are attainable, and scale
economies can be observed at varying levels of output.

The cost function for college and university health
centers is written as:

\[ C = C (P_H, P_K, P_S, Y) \quad (1) \]

where \( C \) is total cost, \( P_H, P_K, \) and \( P_S \) are prices of inputs,
medical staff (M), capital (K), and other services (S),
respectively. \( Y \) denotes output measured as average daily
caseload.

The specification for the translog cost function is:

\[
\ln C = a_0 + a_Y \ln Y + \frac{1}{2} \beta_{YY} (\ln Y)^2 + \sum_{i=1}^{n} a_i \ln P_i + \\
\frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \beta_{ij} \ln P_i \ln P_j + \sum_{i=1}^{n} \beta_{ii} \ln Y \ln P_i 
\]

(2)

where \( \beta_{ij} = \beta_{ji} \), inputs \( i, j = M, K, \) and \( S, \) and \( P_i \) = the
price of the \( i \)th input. In order to correspond to a
well-behaved production function, a cost function must be
homogeneous of degree one in input prices; that is, for a
fixed level of output, a 1 percent increase in all input
prices would result in a 1 percent increase in total cost.
The homogeneity requirement necessitates the following
restrictions in the parameters:

\[ \sum_{i=1}^{n} \alpha_i = 1 \]

\[ \sum_{i=1}^{n} \beta_{yi} = 0 \]

and

\[ \sum_{i=1}^{n} \beta_{ij} = \sum_{j=1}^{n} \beta_{ji} = \sum_{i=1}^{n} \sum_{j=1}^{n} \beta_{ij} = 0 \]

An efficient method for identifying the input factor derived demand equations is to apply Shephard's Lemma to the cost function. The partial differentiation of the cost function with respect to factor prices yields:

\[ \frac{\partial \ln C}{\partial \ln P_i} = \frac{P_i X_i}{C} = \frac{P_i}{C} \frac{\partial C}{\partial P_i} = S_i, \quad i = M, K, S \quad (3) \]

where \( S_i \) is the cost share equation of the \( i \)th factor input. In terms of the translog function:

\[ S_i = \alpha_i + \sum_{j=1}^{n} \beta_{ij} \ln P_j + \beta_{yi} \ln Y \quad (4) \]
Derivation of the elasticities of substitution is accomplished by (Uzawa 1962):

\[ \sigma_{ij} = \frac{\beta_{ij} + S_i S_j}{S_i S_j}, \quad i, j = M, K, S; \quad i \neq j \]

and

\[ \sigma_{ii} = \frac{\beta_{ii} + S_i^2 - S_i}{S_i^2}, \quad i = M, K, S \]

Price elasticities are computed as:

\[ \varepsilon_{ij} = \frac{\beta_{ij} + S_i S_j}{S_i}, \quad i, j = M, K, S; \quad i \neq j \]

and

\[ \varepsilon_{ii} = \frac{\beta_{ii} + S_i^2 - S_i}{S_i}, \quad i = M, K, S \]

Because \( S_i \) and \( S_j \) are variables, the estimated elasticities of substitution will vary over observations. A common approach is to compute the various elasticities at the means of the data (Christensen and Greene 1976, 528).

The extent of scale economies in a production process can be described as the proportional increase in cost resulting from a small proportional increase in the level of output. A convenient approach to ascertaining the
nature of returns to scale utilizing the results of Shephard's Lemma given by equations (3) and (4) is:

\[ SCE = 1 - \frac{\partial \ln C}{\partial \ln Y} \]

\[ SCE = 1 - (\alpha_y + \beta_{yy} \ln Y + \sum_{i=1}^{n} \beta_{ij} \ln P_i) \quad (5) \]

where:

- \( SCE > 0 \) = Increasing returns to scale;
- \( SCE = 0 \) = Constant returns to scale; and
- \( SCE < 0 \) = Decreasing returns to scale.

The relationship between scale economies and average cost (AC) can be shown by (McKay 1988, 63):

\[ \frac{\partial \ln AC}{\partial \ln Y} = \frac{\partial \ln C}{\partial \ln Y} - 1 = -SCE \]

Increasing returns to scale implies decreasing average cost, constant returns to scale yields constant average cost, and decreasing returns to scale results in increasing
average cost, producing the theoretical long run average cost curve.

The following system of equations was estimated:

\[
\ln\left(\frac{C}{P_S}\right) = a_o + \alpha_T \ln Y + \frac{1}{2} \beta_{YY} (\ln Y)^2 + \alpha_K \ln \left(\frac{P_M}{P_S}\right) + \alpha_K \ln \left(\frac{P_K}{P_S}\right) + \frac{1}{2} \beta_{MM} \left[\ln\left(\frac{P_M}{P_S}\right)\right]^2 + \frac{1}{2} \beta_{KK} \left[\ln\left(\frac{P_K}{P_S}\right)\right]^2 + \frac{1}{2} \beta_{MK} \ln \left(\frac{P_M}{P_S}\right) (\ln \left(\frac{P_K}{P_S}\right)) + \beta_{YY} \ln Y \ln \left(\frac{P_M}{P_S}\right) + \beta_{YY} \ln Y \ln \left(\frac{P_K}{P_S}\right)
\]

\[S_M = a_M + \beta_{MM} \ln \left(\frac{P_M}{P_S}\right) + \beta_{MK} \ln \left(\frac{P_K}{P_S}\right) + \beta_{YY} \ln Y \quad (7)\]

\[S_K = a_K + \beta_{MK} \ln \left(\frac{P_M}{P_S}\right) + \beta_{MM} \ln \left(\frac{P_K}{P_S}\right) + \beta_{YY} \ln Y \quad (8)\]

It was necessary to include the cost function in the system in order to obtain the values of \(\alpha_T\) and \(\beta_{YY}\) for the purpose of determining the nature of economies of scale (Christensen and Greene 1976, 662).

In order to implement this multivariate system, additive disturbances are appended to each of the share equations and the cost function (Christensen and Greene 1976, 662). It is assumed that the resulting vector of
disturbance terms is normally distributed with a mean of zero and a constant covariance matrix. Because we cannot rule out the possibility that the error terms over the system are mutually correlated (that is, some unknown disturbance may have an influence on the production process across all health centers), Zellner's seemingly unrelated regression method is the estimation procedure of choice (Kmenta 1991, 636).

Because the cost shares must sum to unity, estimation of the system of seemingly unrelated equations results in a singular covariance matrix of disturbance terms; hence, the share equation for other services ($S_g$) is dropped from the system. Barten has shown that Zellner's procedure, with one equation excluded, results in maximum likelihood estimates which are invariant as to which of the equations is chosen for elimination (Barten 1969). Extending Barten in an operational direction, Kmenta and Gilbert establish that iteration of the Zellner procedure until convergence results in maximum likelihood estimates (Kmenta and Gilbert 1968). Parameters of the cost function not explicitly included in the system of equations are found by means of the homogeneity and symmetry conditions (Berndt 1991, 472-473).
V. THE DATA

The data were obtained by means of a 16-item questionnaire which was mailed in August 1991 to 250 student health centers across the country. The questionnaire appears in Appendix A. The sample was randomly selected from among the 646 colleges and universities listed as "Institutional Members" of the ACHA in 1988 (American College Health Association 1990). Questionnaires were returned by 100 schools of which 80 provided usable data. This study focuses on responses to questions pertaining to annual budget, average daily caseload, levels of staffing, number of functional examination rooms, and the various types of services provided.

The 80 colleges and universities are listed in Appendix B. Selected characteristics of this sample of institutions are given in Table 1. The mean student enrollment is 9,686 students with a standard deviation of 9,368 students. Eighty-two percent of the sample institutions are four-year schools; the remaining eighteen percent are two-year community colleges. Sixty-five percent are public schools while thirty-five percent are
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Enrollment</td>
<td>9,686.24</td>
<td>9,367.79</td>
</tr>
<tr>
<td>Four-Year School</td>
<td>.8250</td>
<td>.3824</td>
</tr>
<tr>
<td>Public School</td>
<td>.6500</td>
<td>.4800</td>
</tr>
<tr>
<td>Medical School on Campus</td>
<td>.1500</td>
<td>.3593</td>
</tr>
</tbody>
</table>

*The latter three characteristics are dummy variables having the following definitions, respectively: Four-year school = 1, two-year school = 0; public school = 1, private school = 0; medical school on campus = 1, no medical school on campus = 0.*
private schools. Finally, fifteen percent of the sample schools have medical schools on campus.

Selected characteristics of the student health centers in the sample are given in Table 2. These data suggest that the average student health center is open for operation 52 hours per week, is a facility with 6 examination rooms, and services a daily caseload of 82 patients. The data with respect to services provided indicate that 97 percent of the health centers offer clinical care, 40 percent provide mental health care, 95 percent afford health education, and 6 percent render dental care services. Furthermore, we see that 55 percent of the health centers are nurse-directed facilities, 30 percent are centers directed by a physician, with the remaining 15 percent being directed by others, largely nonmedical college or university administrators. The observations on staff, expressed in full time equivalent (FTE) terms, suggest that the typical health center employs the services of 1.86 physicians, 1.21 nurse practitioners, 2.86 registered nurses, 0.79 licensed vocational nurses, 0.76 mental health personnel, 0.79 health educators, and 0.04 dentists. Finally, the funding data reveal that the average health center has a mean level of funding of approximately $750,000 per year; however, the more representative median annual budget turns out to be in the
## TABLE 2
SELECTED CHARACTERISTICS OF THE HEALTH CENTERS IN THE STUDY
(N = 80)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of operation per week</td>
<td>52.26</td>
<td>29.34</td>
</tr>
<tr>
<td>Number of examination rooms</td>
<td>6.00</td>
<td>7.10</td>
</tr>
<tr>
<td>Average daily caseload</td>
<td>82.43</td>
<td>89.35</td>
</tr>
<tr>
<td>Services provided:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical care (%)</td>
<td>.9750</td>
<td>.1571</td>
</tr>
<tr>
<td>Mental health care (%)</td>
<td>.4000</td>
<td>.4930</td>
</tr>
<tr>
<td>Health education (%)</td>
<td>.9500</td>
<td>.2193</td>
</tr>
<tr>
<td>Dental care (%)</td>
<td>.0625</td>
<td>.2436</td>
</tr>
<tr>
<td>Director:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physician (%)</td>
<td>.3000</td>
<td>.4611</td>
</tr>
<tr>
<td>Nurse (%)</td>
<td>.5500</td>
<td>.5006</td>
</tr>
<tr>
<td>Other (%)</td>
<td>.1500</td>
<td>.3593</td>
</tr>
<tr>
<td>Staff:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physicians (FTE)</td>
<td>1.86</td>
<td>3.34</td>
</tr>
<tr>
<td>Nurse practitioners (FTE)</td>
<td>1.21</td>
<td>1.92</td>
</tr>
<tr>
<td>Registered nurses (FTE)</td>
<td>2.86</td>
<td>3.18</td>
</tr>
<tr>
<td>Licensed vocational nurses (FTE)</td>
<td>0.79</td>
<td>2.47</td>
</tr>
<tr>
<td>Mental health personnel (FTE)</td>
<td>0.76</td>
<td>1.73</td>
</tr>
<tr>
<td>Health educator (FTE)</td>
<td>0.79</td>
<td>2.38</td>
</tr>
<tr>
<td>Dentists (FTE)</td>
<td>0.04</td>
<td>0.19</td>
</tr>
<tr>
<td>Funding levels and sources:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual budget ($, mean)</td>
<td>746,709.61</td>
<td>1,178,730.10</td>
</tr>
<tr>
<td>Annual budget ($, median)</td>
<td>174,404.00</td>
<td></td>
</tr>
<tr>
<td>Institutional allocation (%)</td>
<td>.5176</td>
<td>.4769</td>
</tr>
<tr>
<td>Student health fee (%)</td>
<td>.3986</td>
<td>.4392</td>
</tr>
<tr>
<td>Patient charges (%)</td>
<td>.0745</td>
<td>.1281</td>
</tr>
<tr>
<td>Other sources (%)</td>
<td>.0093</td>
<td>.0307</td>
</tr>
<tr>
<td>Annual student health fee ($)</td>
<td>95.40</td>
<td>77.65</td>
</tr>
</tbody>
</table>

*aBased on 39 health centers having a student health fee; the other 41 centers have no explicit student health fee.
vacinity of $175,000. The health center, on average, receives 52 percent of its budget from an institutional allocation, 40 percent from a student health fee (averaging $95.40 per year), 7 percent from patient charges, and 1 percent from other sources. The standard deviations on these characteristics are indicative of the variation in the properties over the sample of health centers.

Students experiencing illness, physical and/or emotional, seek assistance at student health centers for evaluation and treatment. The type and level of care required to meet the needs of the student is determined by the nature of the problem.\(^5\) Output in the case of this type of health care process, can be viewed as the number of patients treated.\(^6\) Because staff (labor), the size of the facility (capital), and the various other services (measured as medical services other than the hands-on care provided by physicians and nurses, administrative services and supplies), are unquestionable factors in the process of providing adequate health care, this analysis considers such factors as production inputs. These variables are listed in Table 3. An explanation of

\(^5\)The author is a Registered Nurse with experience as a staff member at the University of Nevada, Las Vegas Student Health Center.

\(^6\)A discussion of the problems associated with appropriate measures of output in health care can be found in Bailey 1970, 258.
### Table 3

**Descriptive Statistics for Variables in the Cost Function**  
(N = 80)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost (C)</td>
<td>$932,864.98</td>
<td>1,357,396.70</td>
</tr>
<tr>
<td>Cost Shares:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Staff (Sₘ)</td>
<td>.344</td>
<td>.1051</td>
</tr>
<tr>
<td>Physical Plant (Sₓ)</td>
<td>.332</td>
<td>.1544</td>
</tr>
<tr>
<td>Other Services (Sₒ)</td>
<td>.324</td>
<td>.1665</td>
</tr>
<tr>
<td>Output, Average Daily Caseload (Y)</td>
<td>82.43</td>
<td>89.35</td>
</tr>
<tr>
<td>Input Prices:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Staff (Pₘ)</td>
<td>$20.31</td>
<td>8.96</td>
</tr>
<tr>
<td>Physical Plant (Pₓ)</td>
<td>$21.97</td>
<td>4.25</td>
</tr>
<tr>
<td>Other Services (Pₒ)</td>
<td>$11.87</td>
<td>15.76</td>
</tr>
</tbody>
</table>
the determination of the input price variables is presented in Appendix C. Two sources of information extraneous to the data set were consulted. In the case of missing salary information, the American College Health Association, 1990/1991 Salary Survey Report was employed (American College Health Association 1990), and a measure of the price of the capital input was acquired from the Appraisal Institute's, Market Share, a real estate statistical bulletin (Appraisal Institute 1991).

The means and standard deviations of the sample data for total cost, cost share, output, and the input price variables are also shown in Table 3. The observed mean total cost is approximately $933,000 with a standard deviation of about $1,357,000. The cost share attributable to medical staff is 34.4 percent; that associated with physical plant is 33.2 percent; and that accounted for by other services is 32.4 percent. Average daily caseload, our measure of output, is again observed to be around 82 patients. Finally, the medical staff input commands a price of $20.31 per hour; the physical plant, or facility, input has a price of $21.97 per square foot per month; and the other services input is found to have a price of $11.87 per patient visit. Again, the standard deviations reveal the variation in these variables.
VI. ESTIMATION PROCEDURE AND RESULTS

Joint estimation of the cost function and the cost share equations as a multivariate regression system was accomplished by means of the iterative seemingly unrelated regression procedure in MicroTSP (Lilien 1990). The estimated cost function parameters appear in Table 4. It is necessary to check the estimated cost function to ensure that the conditions of monotonicity and concavity in input prices are met. Positive fitted cost shares imply monotonicity. The fitted cost shares are positive when calculated at the mean values of the exogenous variables, and are positive for each observation in the sample. The own partial elasticities of substitution have negative values and the matrix of partial elasticities of substitution is negative semidefinite when \( S_h, S_k, \) and \( S_s \) have values calculated at the mean of the exogenous variables; hence, both the necessary and sufficient

---

Cost functions are assumed to be monotonic and concave in input prices (Varian 1984, 44). Monotonicity exists if the fitted cost shares are positive. A necessary condition for concavity is negative signs on the own partial elasticities of substitution, and a sufficient condition is that the matrix of partial elasticities of substitution exhibit negative semidefiniteness (McKay 1988, 68).
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter Estimate</th>
<th>Asymptotic Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha_0 )</td>
<td>7.31917</td>
<td>0.29035</td>
</tr>
<tr>
<td>( \alpha_Y )</td>
<td>0.46839</td>
<td>0.14634</td>
</tr>
<tr>
<td>( \beta_{YX} )</td>
<td>0.12139</td>
<td>0.03678</td>
</tr>
<tr>
<td>( \alpha_M )</td>
<td>0.08819</td>
<td>0.04356</td>
</tr>
<tr>
<td>( \alpha_K )</td>
<td>0.41925</td>
<td>0.04469</td>
</tr>
<tr>
<td>( \alpha_S )</td>
<td>0.49256</td>
<td>0.03649</td>
</tr>
<tr>
<td>( \beta_{MM} )</td>
<td>0.10970</td>
<td>0.01681</td>
</tr>
<tr>
<td>( \beta_{MK} )</td>
<td>-0.02661</td>
<td>0.01271</td>
</tr>
<tr>
<td>( \beta_{MS} )</td>
<td>-0.08309</td>
<td>0.00755</td>
</tr>
<tr>
<td>( \beta_{XX} )</td>
<td>0.11511</td>
<td>0.01456</td>
</tr>
<tr>
<td>( \beta_{XS} )</td>
<td>-0.08850</td>
<td>0.00005</td>
</tr>
<tr>
<td>( \beta_{SS} )</td>
<td>0.17159</td>
<td>0.00580</td>
</tr>
<tr>
<td>( \beta_{YM} )</td>
<td>0.04189</td>
<td>0.00989</td>
</tr>
<tr>
<td>( \beta_{YX} )</td>
<td>-0.05151</td>
<td>0.01007</td>
</tr>
<tr>
<td>( \beta_{YS} )</td>
<td>0.00962</td>
<td>0.00859</td>
</tr>
</tbody>
</table>
conditions for concavity are met at these values.

**Elasticities of Substitution and Price Elasticities**

The translog cost function provides information on elasticities of substitution and cross-price elasticities which are not available when a less generalized method of estimation is employed. Table 5 presents a summary of these measures of factor substitution possibilities and factor price relationships. All inputs are substitutable with the highest degree of substitutability seen in medical staff and capital. There is no complementarity among the inputs examined in this model, which is substantiated by the positive values of the cross-price elasticities.

Researchers interested in analyzing the optimal combination of production factors are afforded more information through the use of the more flexible functional forms with fewer empirical a priori restrictions.

**Scale Economies**

Turning now to the central matter of inquiry in this study, we examine the nature of scale economies. The degree of scale economies, \( \text{SCE} = 1 - \frac{\partial \ln C}{\partial \ln Y} \), when calculated for each student health center diminishes from .384 to -.266 with diseconomies setting in at an average daily caseload in the neighborhood of 85 to 92 patients. These findings appear in Appendix D.
### TABLE 5

**ESTIMATED ELASTICITIES**

*(N = 80)*

<table>
<thead>
<tr>
<th>Elasticity</th>
<th>M-K</th>
<th>M-S</th>
<th>K-S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substitution</td>
<td>0.7590</td>
<td>0.2326</td>
<td>0.1911</td>
</tr>
<tr>
<td>Cross Price</td>
<td>0.2476</td>
<td>0.0898</td>
<td>0.0641</td>
</tr>
<tr>
<td>Own Price</td>
<td>-0.3375</td>
<td>-0.3212</td>
<td>-0.1409</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Approaching the matter from a somewhat different angle, we partition the sample of student health centers into five groups according to output, permitting scale economies to vary with output levels (Christensen and Greene 1976, 666). SCE is computed at the median daily caseload in each group. The results are presented in Table 6. Scale economies diminish as health centers increase in size with diseconomies of scale manifest at average daily caseloads greater than 100.  

Finally, the degree of scale economies measured at the mean values of the independent variables is 0.069. The elasticity of cost relative to output, $\frac{\partial \ln C}{\partial \ln Y} = 1 - \text{SCE}$, is 0.931, and the elasticity of average cost with respect to output, $\frac{\partial \ln AC}{\partial \ln Y} = -\text{SCE}$, is equal to -0.069. This finding suggests that, when calculated at the mean values of the independent variables, a 10 percent increase in output leads to a 9.3 percent increase in total cost and a 0.69 percent decrease in average cost.

This pattern of economies and diseconomies of scale does not appear to be an isolated finding in the research.

---

The price variable for medical staff (PM) was computed deleting physicians from the equation to rule out the possibility of upward pressure on price due to higher physician salaries. The system of equations was reestimated incorporating the change. SCE was computed for each observation in the sample. Because there was no substantive difference in the findings, the original price variable for medical staff was retained.
TABLE 6

ESTIMATED SCALE ECONOMIES
BY SIZE OF AVERAGE DAILY CASELOAD
(N = 80)

<table>
<thead>
<tr>
<th>Size Class</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caseload Range</td>
<td>0-25</td>
<td>26-50</td>
<td>51-75</td>
<td>76-100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Number of Centers</td>
<td>20</td>
<td>19</td>
<td>15</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Median Caseload</td>
<td>18</td>
<td>35</td>
<td>60</td>
<td>87</td>
<td>175</td>
</tr>
<tr>
<td>SCE</td>
<td>.193</td>
<td>.118</td>
<td>.052</td>
<td>.007</td>
<td>-.078</td>
</tr>
</tbody>
</table>

*A negative sign on SCE first appears at an average daily caseload of 85 patients. See Appendix D for more detail.*
pertaining to the outpatient sector of the health care industry. In *Health Maintenance Organizations: Dimensions of Performance*, Luft discusses scale economies in the provision of ambulatory care and states that, "The empirical literature is split between studies that find economies of scale and those that find diseconomies. In fact, both appear to occur — the economist's traditional U-shaped cost curve." (Luft 1981, 163) He also cites an unpublished study of health maintenance organizations by Bothwell and Cooley which reports that if economies of scale are realized they occur at relatively small patient enrollment levels (Luft 1981, 157).
VII. SUMMARY AND CONCLUSIONS

In this study, a translog cost function was utilized to estimate scale economies in a sample of college and university student health centers across the United States. Although economies of scale have been investigated in other segments of the health care industry, evidence of economic analysis of student health centers was not uncovered in a search of the literature preparatory to this study. However, given the size and scope of the student health enterprise, examination of its production and cost characteristics is warranted.

The results of this study indicate that there are economies of scale in the production of student health at levels of output up to the vicinity of 85 to 92 student visits on average per day, and diseconomies of scale thereafter.

These findings are not contradictory to those of previous studies in ambulatory care economics. However, further research is needed. Possible considerations for future projects might be to examine (1) the possible effects of quality of care on scale economies, and (2) the relationship between scale economies and economies of scope.
with the health center considered as a multiproduct firm. Considering the increasingly high costs of medical care, ever present competition for limited resources in academic institutions, and the millions of students enrolled in those academic institutions relying on the services of student health centers, additional research is imperative in order to assist decision makers in selecting the most efficient methods of health care production to meet the needs of student communities.
Dear Health Center Director:

Student health centers serve an important role. Unfortunately, these services are not always supported at a desired level.

Your college or university health center is among a small number of randomly selected ACHA-member centers asked to participate in a comparative study of student health facilities.

Please help us by completing and returning the enclosed questionnaire as soon as possible. You can be assured of complete confidentiality. Individual center responses will not be divulged. Only summary findings will be published.

I would be most happy to answer any questions you might have. Please write or call. Our telephone number is (702) 739-3370.

Thank you for your assistance.

Sincerely,

Lori Winchell, Director
Student Health Center
APPENDIX A (CONTINUED)

STUDENT HEALTH CENTER

COLLEGE/UNIVERSITY STUDENT HEALTH CENTER COMPARISON SURVEY

This national survey is one we are doing to gather comparison data on ACHA-member student health centers. Please answer all the questions.

If you wish to comment on any questions or qualify your answers, please feel free to use the space in the margins. Your comments will be read and taken into account.

Thank you for your help.
APPENDIX A (CONTINUED)

Part 1: College or University Information:

1. Type of educational institution: (Please check one)
   ___ Two-year junior or community college
   ___ Four-year college or university

2. Term system: (Please check one)
   ___ Semester system
   ___ Quarter system
   ___ Other system: specify: ___________________

3. Nature of institution: (Please check one)
   ___ Public
   ___ Private

4. Does your educational institution have a medical school?
   ___ Yes
   ___ No

5. Total student enrollment (Fall 1991):
   Headcount number: ____________
   Full-time equivalent number: ____________

6. Total students residing on campus:
   Number: ____________
Part 2: Health Center Information: Please supply the following information for the current academic year.

7. What is the average daily case load for your health center?
   Patients per day: ____________

8. How many hours per week is your health center open?
   Hours per week: ____________

9. Type of services your health center provides: (Please check all that apply)
   ___ Clinical care
   ___ Mental health care
   ___ Health education
   ___ Dental care
   ___ Other; Specify: __________________________

10. How many functioning examination rooms are there in your center?
    Number of rooms: ____________
APPENDIX A (CONTINUED)

11. What is the level of staffing in your center for each of the following in terms of full time equivalent (FTE) employees?
   Note: 40 hours per week = 1.0 FTE employee.
   ________ Director or administrator
   ________ Physician (MD or DO)
   ________ Nurse practitioner or physician assistant
   ________ Registered nurse
   ________ Licensed vocational nurse or nurse assistant
   ________ Dentist
   ________ Nutritionist
   ________ Mental health staff
   ________ Health educator
   ________ Pharmacist
   ________ Medical records clerk
   ________ Receptionist
   ________ Laboratory technician
   ________ Radiology technician

12. The Director of your health center is: (Please check one)
   ______ A physician
   ______ A nurse
   ______ Other: specify: ______________________________
13. What is the total budget for your health center for the 1991-92 academic year?
   Total budget in dollars: ____________

14. What are the sources of the health center funds in percentage terms?
   ___ % allocated by institution
   ___ % from student health fee
   ___ % from patient charges
   ___ % from other sources; specify: ____________________

15. What is the amount of your student health fee per year if you have one?
   Fee in dollars: ____________

16. What percentages of your budget for the 1991-92 academic year are allocated to the following?
   ___ % physician salaries
   ___ % nursing salaries
   ___ % other medical staff salaries
   ___ % support staff salaries (administration and clerical staff salaries)
   ___ % medical facility and equipment purchases
   ___ % medical supplies
   ___ % clerical supplies and equipment
   ___ % other; specify: ____________________
Part 3: Identification Information: Please print the following identifying information.

17. Name of Institution: ____________________________
18. Health Center Director: __________________________
19. Health Center Phone: (___) ___ - ________

THANK YOU!

Mailing Instructions

This survey booklet may be mailed directly without an envelope. The return address and necessary postage is on the back cover of this booklet. Should you wish to seal the booklet for confidentiality, please use tape.

Note: No Postage is Required.
APPENDIX B
COLLEGES AND UNIVERSITIES IN THIS STUDY

The following is a list of colleges and universities having student health centers included in this study.

1. Aquinas College (MI)
2. Arizona Western College (AZ)
3. Asbury College (KY)
4. Bellview Community College (WA)
5. Bentley College (MA)
6. Bowling Green State University (OH)
7. Brandeis University (MA)
8. Brown University (RI)
9. California Luthern University (CA)
10. Calvin College and Seminary (MI)
11. Centenary College (NJ)
12. City College of San Francisco (CA)
13. Community College of Allegheny County (PA)
14. Community College of the Finger Lakes (NY)
15. Dominican College of San Rafael (CA)
16. Drew University (NJ)
17. Duquesne University (PA)
18. Eastern New Mexico University (NM)
19. Gloucester County College (NJ)
20. Hampden-Sydney College (VA)
21. Hocking Technical College (OH)
22. Hollins College (VA)
23. Hood College (MD)
24. Iona College (NY)
25. Kansas State University (KS)
26. LaSalle University (PA)
27. Lincoln Land Community College (IL)
28. Medical College of Wisconsin (WI)
29. Middlesex County College (NJ)
30. Montana State University (MT)
31. Montreat-Anderson College (NC)
32. Moorhead State University (MN)
33. Morehead State University (KY)
34. Mount Mary College (WI)
35. North Carolina Central University (NC)
36. Northeastern Illinois University (IL)
37. North Hennepin Community College (MN)
38. Old Dominion University (VA)
39. Oregon Health Sciences University (OR)
40. Owens Technical College (OH)
41. Pasadena City College (CA)
42. Philadelphia College of Textiles and Science (PA)
43. Ramapo College of New Jersey (NJ)
44. St. Cloud State University (MN)
45. St. Johns College, New Mexico (NM)
46. Salem State College (MA)
47. San Jose State University (CA)
48. South Carolina State College (SC)
49. South Dakota State University (SD)
50. Southwest Texas State University (TX)
51. SUNY, Plattsburg (NY)
52. Texas Tech University (TX)
53. The Claremont Colleges (CA)
54. Trinity University (TX)
55. Triton College (IL)
56. University of California, Irvine (CA)
57. University of Central Florida (FL)
58. University of Central Oklahoma (OK)
59. University of Colorado (CO)
60. University of Hawaii (HI)
61. University of Massachusetts, Boston (MA)
62. University of Minnesota, Duluth (MI)
63. University of New Haven (CT)
64. University of Northern Colorado (CO)
65. University of North Florida (FL)
66. University of Texas (TX)
67. University of the Arts (PA)
68. University of Toledo (OH)
69. University of Tulsa (OK)
70. University of Virginia (VA)
71. University of Washington (WA)
72. University of Wisconsin, Green Bay (WI)
73. University of Wisconsin, LaCrosse (WI)
74. University of Wisconsin, Parkside (WI)
75. Valparaiso University (IN)
76. Virginia Commonwealth University (VA)
77. Washington State University (WA)
78. Western Carolina University (NC)
79. Wheeling Jesuit College (WV)
80. Winona State University (MN)
Central to the translog cost function are the input price variables. Given here are the TSP generated input price variable definitions together with the original variables used to construct them.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_m$</td>
<td>$\left( \frac{((PPHY+PNUR)/100) \times BUDT}{((SPHY+SNPR+SREN+SLVN) \times 40) \times 52} \right)$</td>
</tr>
<tr>
<td>Note: $P_m$ is the price of medical staff (physicians and nurses) expressed in dollars per hour of health center operation, assuming a 40 hour work week and a 52 week year.</td>
<td></td>
</tr>
<tr>
<td>$P_k$</td>
<td>$\text{RENT}$</td>
</tr>
<tr>
<td>Note: $P_k$ is the price of capital (health center plant) expressed in dollars per square foot per month.</td>
<td></td>
</tr>
<tr>
<td>$P_s$</td>
<td>$\left( \frac{((PMED+PSUP+PPUR+PMES+PCSE+POTH)/100) \times BUDT}{312} \right)/\text{ADCL}$</td>
</tr>
<tr>
<td>Note: $P_s$ is the price of other services expressed in dollars per patient visit per operating day, assuming a 312 day operating year at a rate of 6 days per week in a 52 week year.</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C (CONTINUED)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>M = ((SPHY+SNPR+SREN+SLVN)*40)*52</td>
<td>Note: M is the quantity of medical staff (physicians and nurses) expressed in hours per year, assuming a 40 hour work week and a 52 week year.</td>
</tr>
<tr>
<td>K = XRMS*126</td>
<td>Note: K is the quantity of capital (size of the health center plant) expressed in square feet of examination rooms, assuming a standard examination room of 126 square feet.</td>
</tr>
<tr>
<td>S = ADCL*312</td>
<td>Note: S is average daily caseload expressed in patient visits per operating year.</td>
</tr>
</tbody>
</table>

**Original Variables**

- **ADCL**: Average daily caseload, patient visits.
- **BUDT**: Total health center budget, dollars per year.
- **RENT**: Monthly office rent, dollars per square foot.
- **XRMS**: Health center examination rooms, number.
- **SPHY**: Physicians on staff, fte.
- **SNPR**: Nurse practitioners on staff, fte.
- **SREN**: Registered nurses on staff, fte.
- **SLVN**: Licensed vocational nurses on staff, fte.
- **PPHY**: Physician salaries, percent of budget.
- **PNUR**: Nurse salaries, percent of budget.
- **PMED**: Other medical staff salaries, percent of budget.
- **PSUP**: Support staff salaries, percent of budget.
- **PPUR**: Facility/equipment purchases, percent of budget.
- **PMES**: Medical supplies, percent of budget.
- **PSCE**: Clerical supplies, percent of budget.
- **POTH**: Other expenditures, percent of budget.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
## APPENDIX D

### SCALE ECONOMIES ESTIMATES BY HEALTH CENTER

<table>
<thead>
<tr>
<th>Health Center</th>
<th>Average Daily Caseload</th>
<th>SCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>5.00</td>
<td>0.3841</td>
</tr>
<tr>
<td>2.</td>
<td>10.00</td>
<td>0.2924</td>
</tr>
<tr>
<td>3.</td>
<td>10.00</td>
<td>0.3051</td>
</tr>
<tr>
<td>4.</td>
<td>10.00</td>
<td>0.2832</td>
</tr>
<tr>
<td>5.</td>
<td>12.00</td>
<td>0.2878</td>
</tr>
<tr>
<td>6.</td>
<td>14.00</td>
<td>0.2441</td>
</tr>
<tr>
<td>7.</td>
<td>14.00</td>
<td>0.2042</td>
</tr>
<tr>
<td>8.</td>
<td>15.00</td>
<td>0.2797</td>
</tr>
<tr>
<td>9.</td>
<td>16.00</td>
<td>0.2115</td>
</tr>
<tr>
<td>10.</td>
<td>18.00</td>
<td>0.1852</td>
</tr>
<tr>
<td>11.</td>
<td>18.00</td>
<td>0.2003</td>
</tr>
<tr>
<td>12.</td>
<td>18.00</td>
<td>0.2309</td>
</tr>
<tr>
<td>13.</td>
<td>20.00</td>
<td>0.2228</td>
</tr>
<tr>
<td>14.</td>
<td>20.00</td>
<td>0.1973</td>
</tr>
<tr>
<td>15.</td>
<td>20.00</td>
<td>0.1224</td>
</tr>
<tr>
<td>16.</td>
<td>20.00</td>
<td>0.2135</td>
</tr>
<tr>
<td>17.</td>
<td>20.00</td>
<td>0.2104</td>
</tr>
<tr>
<td>18.</td>
<td>22.00</td>
<td>0.2090</td>
</tr>
<tr>
<td>19.</td>
<td>24.00</td>
<td>0.1712</td>
</tr>
<tr>
<td>20.</td>
<td>24.00</td>
<td>0.1423</td>
</tr>
<tr>
<td>21.</td>
<td>25.50</td>
<td>0.1177</td>
</tr>
<tr>
<td>22.</td>
<td>28.00</td>
<td>0.1244</td>
</tr>
<tr>
<td>23.</td>
<td>30.00</td>
<td>0.1620</td>
</tr>
<tr>
<td>24.</td>
<td>30.00</td>
<td>0.1696</td>
</tr>
<tr>
<td>25.</td>
<td>30.00</td>
<td>0.1802</td>
</tr>
<tr>
<td>26.</td>
<td>30.00</td>
<td>0.1043</td>
</tr>
<tr>
<td>27.</td>
<td>32.00</td>
<td>0.1074</td>
</tr>
<tr>
<td>28.</td>
<td>32.00</td>
<td>0.1237</td>
</tr>
<tr>
<td>29.</td>
<td>35.00</td>
<td>0.1265</td>
</tr>
<tr>
<td>30.</td>
<td>35.00</td>
<td>0.0939</td>
</tr>
<tr>
<td>31.</td>
<td>35.00</td>
<td>0.1239</td>
</tr>
<tr>
<td>32.</td>
<td>37.00</td>
<td>0.1352</td>
</tr>
<tr>
<td>33.</td>
<td>37.00</td>
<td>0.1463</td>
</tr>
<tr>
<td>34.</td>
<td>40.00</td>
<td>0.1067</td>
</tr>
<tr>
<td>35.</td>
<td>40.00</td>
<td>0.1280</td>
</tr>
<tr>
<td>36.</td>
<td>44.00</td>
<td>0.1209</td>
</tr>
<tr>
<td>Health Center</td>
<td>Average Daily Caseload</td>
<td>SCE</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>37.</td>
<td>45.00</td>
<td>0.1185</td>
</tr>
<tr>
<td>38.</td>
<td>50.00</td>
<td>0.0633</td>
</tr>
<tr>
<td>39.</td>
<td>50.00</td>
<td>0.0683</td>
</tr>
<tr>
<td>40.</td>
<td>53.00</td>
<td>0.0499</td>
</tr>
<tr>
<td>41.</td>
<td>55.00</td>
<td>0.0671</td>
</tr>
<tr>
<td>42.</td>
<td>55.00</td>
<td>0.0902</td>
</tr>
<tr>
<td>43.</td>
<td>55.00</td>
<td>0.0400</td>
</tr>
<tr>
<td>44.</td>
<td>60.00</td>
<td>0.0693</td>
</tr>
<tr>
<td>45.</td>
<td>60.00</td>
<td>0.0287</td>
</tr>
<tr>
<td>46.</td>
<td>60.00</td>
<td>0.0628</td>
</tr>
<tr>
<td>47.</td>
<td>60.00</td>
<td>0.1253</td>
</tr>
<tr>
<td>48.</td>
<td>60.00</td>
<td>0.0503</td>
</tr>
<tr>
<td>49.</td>
<td>62.00</td>
<td>0.1384</td>
</tr>
<tr>
<td>50.</td>
<td>68.00</td>
<td>0.0307</td>
</tr>
<tr>
<td>51.</td>
<td>70.00</td>
<td>0.0591</td>
</tr>
<tr>
<td>52.</td>
<td>71.00</td>
<td>0.0259</td>
</tr>
<tr>
<td>53.</td>
<td>75.00</td>
<td>0.0143</td>
</tr>
<tr>
<td>54.</td>
<td>75.00</td>
<td>0.0123</td>
</tr>
<tr>
<td>55.</td>
<td>80.00</td>
<td>0.0183</td>
</tr>
<tr>
<td>56.</td>
<td>85.00</td>
<td>-0.0012</td>
</tr>
<tr>
<td>57.</td>
<td>87.00</td>
<td>-0.0134</td>
</tr>
<tr>
<td>58.</td>
<td>87.00</td>
<td>0.0398</td>
</tr>
<tr>
<td>59.</td>
<td>92.00</td>
<td>-0.0283</td>
</tr>
<tr>
<td>60.</td>
<td>100.00</td>
<td>-0.0329</td>
</tr>
<tr>
<td>61.</td>
<td>100.00</td>
<td>-0.0275</td>
</tr>
<tr>
<td>62.</td>
<td>120.00</td>
<td>-0.0217</td>
</tr>
<tr>
<td>63.</td>
<td>120.00</td>
<td>-0.0154</td>
</tr>
<tr>
<td>64.</td>
<td>125.00</td>
<td>-0.0506</td>
</tr>
<tr>
<td>65.</td>
<td>130.00</td>
<td>-0.0316</td>
</tr>
<tr>
<td>66.</td>
<td>140.00</td>
<td>-0.0696</td>
</tr>
<tr>
<td>67.</td>
<td>150.00</td>
<td>-0.0911</td>
</tr>
<tr>
<td>68.</td>
<td>160.00</td>
<td>-0.0915</td>
</tr>
<tr>
<td>69.</td>
<td>168.00</td>
<td>-0.1027</td>
</tr>
<tr>
<td>70.</td>
<td>173.00</td>
<td>-0.0838</td>
</tr>
<tr>
<td>71.</td>
<td>175.00</td>
<td>-0.0884</td>
</tr>
<tr>
<td>72.</td>
<td>190.00</td>
<td>-0.1292</td>
</tr>
<tr>
<td>73.</td>
<td>200.00</td>
<td>-0.1156</td>
</tr>
<tr>
<td>74.</td>
<td>200.00</td>
<td>-0.1014</td>
</tr>
<tr>
<td>75.</td>
<td>220.00</td>
<td>-0.1389</td>
</tr>
<tr>
<td>76.</td>
<td>225.00</td>
<td>-0.1417</td>
</tr>
<tr>
<td>77.</td>
<td>313.00</td>
<td>-0.1652</td>
</tr>
<tr>
<td>78.</td>
<td>350.00</td>
<td>-0.1870</td>
</tr>
<tr>
<td>79.</td>
<td>350.00</td>
<td>-0.1978</td>
</tr>
<tr>
<td>80.</td>
<td>500.00</td>
<td>-0.2660</td>
</tr>
</tbody>
</table>
BIBLIOGRAPHY


Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.


