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Translog Variable Cost Function Estimates for Philippine Hospitals

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Abstract

This paper presents the parameter estimates of a translog variable cost function for 65 Philippine hospitals and discusses certain inferences that can be drawn from these estimates. It means to highlight three points. First, it shows how a translog cost function, which has many parameters, can be estimated with a relatively small regression sample (typical of hospital data sets in developing countries) by applying a system estimation method (FIML) on the cost function and its input demand equations. Second, using a specification that allows the intercepts of the cost function and the factor share equations to be different between private and public hospital, the paper finds that private hospitals are apparently not more technically efficient than public hospitals. Third, the optimal bed size (at which minimum efficient scale is achieved) is inferred to be about 80 beds—way below those in developed countries, perhaps because of the generally lower quality of hospitals in developing countries.

1. Introduction

This paper reports the parameter estimates of a translog variable cost function for Philippine hospitals. As a contribution to the hospital cost literature from a developing country, it is meant to highlight three points. First, the paper serves as an illustrative case of how—given a relatively small sample (which is not an uncommon trait of hospital cost data sets from developing countries)—it is possible to get around the *degrees of freedom problem* posed by the many parameters that have to be estimated in a translog specification. The solution adopted here is to apply a system estimation method, namely, full-information maximum likelihood (FIML), on the cost function and its share equations. Second, the study explores the relative efficiencies of public and private hospitals to determine whether there is a technical basis for the efficiency-quality dilemma supposedly faced by health policy makers in many developing countries. Succinctly put, this problem deals with whether hospitals should be privatized on the grounds of technical and administrative efficiency or whether a system of public hospitals ought to be maintained in order for the government to retain some control over service quality. Using a specification that allows the intercepts of the cost function and the share equations to be different across hospital ownership, the paper finds that there are no statistically significant differences between these intercepts, indicating that at least for the hospitals in the regression sample private hospitals are apparently not more technically efficient than public hospitals. Third, in this study, the optimal bed size is found to be about 80 beds. Although this is way below that found in developed countries (see, for example, Berki (1972)), it is suggested that this is possibly because, in low quality environments such as are found in many developing countries, the minimum efficient scale occurs at relatively small *plant sizes*.

The plan for the rest of this paper is as follows: The next section provides a brief exposition of the empirical considerations involved in the estimation of a translog variable cost function and discusses some of the statistical inferences that are usually drawn from such estimates in the hospital cost literature. Section three then supplies some background

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information on the data set and the cost function variables. The results and interpretation of the regression are provided in section four. Finally, the paper concludes with a short discussion of the significance and implications of the findings.

2. The translog variable cost function: specification and inferences

2.1 Empirical specification

Given I variable inputs, T fixed factors, and N outputs, a variable cost function with a transcendental logarithmic (translog) specification has the form:

$$\begin{aligned}\ln c^{v*} = \alpha_0 &+ \sum_{i=1}^{I} \alpha_i \ln w_i^* + \sum_{n=1}^{N} \beta_n \ln y_n^* + \sum_{t=1}^{T} \gamma_t \ln k_t^* \\ &+ \frac{1}{2}\sum_{i=1}^{I}\sum_{j=1}^{I} \alpha_{ij} \ln w_i^* \ln w_j^* + \frac{1}{2}\sum_{n=1}^{N}\sum_{m=1}^{N} \beta_{nm} \ln y_n^* \ln y_m^* + \frac{1}{2}\sum_{t=1}^{T}\sum_{s=1}^{T} \gamma_{ts} \ln k_t^* \ln k_s^* \\ &+ \sum_{i=1}^{I}\sum_{n=1}^{N} \rho_{in} \ln w_i^* \ln y_n^* + \sum_{i=1}^{I}\sum_{t=1}^{T} \delta_{it} \ln w_i^* \ln k_t^* + \sum_{n=1}^{N}\sum_{t=1}^{T} \theta_{nt} \ln y_n^* \ln k_t^*,\end{aligned} \tag{1}$$

where $\ln c^{v*}$, $\ln w_i^*$ for $i = 1, \ldots, I$, $\ln y_n^*$ for $n = 1, \ldots, N$, and $\ln k_t^*$ for $t = 1, \ldots, T$, are, respectively, the natural logarithms of mean-scaled values of variable costs, input prices, output levels, and fixed factors.

Parenthetically, it may be noted that when the coefficients of the second-order terms, α_{ij}, β_{nm}, γ_{ts}, ρ_{in}, δ_{it}, θ_{nt}, are all equal to zero, the translog variable cost function reduces to a Cobb-Douglas form.

For equation (1) to be a proper cost function, however, it must be linearly homogeneous and concave in factor prices, convex in outputs, and nondecreasing and continuous in both outputs and factor prices. In econometric estimations of translog cost functions, the convention has been to impose restrictions on certain parameters to ensure that the equality conditions—namely, continuity in both factor prices and outputs and linear homogeneity in factor prices—are satisfied and to check that the estimated model complies with the inequality conditions implied by monotonicity in both outputs and prices, concavity in prices, and convexity in outputs.

These equality conditions take the forms of the following symmetry restrictions to ensure continuity in factor prices and output levels,

$$\alpha_{ij} = \alpha_{ji} \quad \text{for all } i \text{ and } j \text{ and} \quad \beta_{nm} = \beta_{mn} \quad \text{for all } n \text{ and } m, \tag{2}$$

and the following linear homogeneity restrictions,

$$\begin{aligned}&\sum_{i=1}^{I} \alpha_i = 1, \\ &\sum_{j=1}^{I} \alpha_{ij} = 0 \qquad \text{for } i = 1, 2, \ldots, I, \\ &\sum_{i=1}^{I} \rho_{in} = 0 \qquad \text{for } n = 1, 2, \ldots, N, \text{ and} \\ &\sum_{i=1}^{I} \delta_{it} = 0 \qquad \text{for } t = 1, 2, \ldots, T.\end{aligned} \tag{3}$$

As for the inequality restrictions, monotonicity in factor prices requires that at the means of the sample,

$$s_i = \alpha_i \geq 0 \qquad \text{for } i = 1, 2, \ldots, I \tag{4}$$

where $s_i = w_i^* x_i / c^{v*}$ is the share of the ith input in variable costs, whereas monotonicity in outputs requires that at the sample means,

$$\frac{\partial \ln c^v}{\partial \ln y_n} = \beta_j \geq 0 \qquad \text{for } n = 1, 2, \ldots, N. \tag{5}$$

Necessary and sufficient conditions for concavity in factor prices require that

$$H_{ww}^* = \begin{bmatrix} \alpha_{11} - \alpha_1 + \alpha_1^2 & & & \\ \alpha_{12} + \alpha_1 \alpha_2 & \alpha_{22} - \alpha_2 + \alpha_2^2 & & \\ \vdots & \vdots & \ddots & \\ \alpha_{1I} + \alpha_1 \alpha_I & \alpha_{2I} + \alpha_2 \alpha_I & \cdots & \alpha_{II} - \alpha_I + \alpha_I^2 \end{bmatrix} \leq \mathbf{0}. \tag{6}$$

Or, in words, the matrix H_{ww}^*, whose elements are positive monotonic transforms of the cross-price derivatives of the conditional demand functions at the sample means, must be negative semi-definite.

Analogously, necessary and sufficient conditions for convexity in outputs require that the matrix of positive monotonic transforms of the Hessian matrix of second-order partial derivatives of the cost functions with respect to outputs be positive semi-definite. That is,

$$H_{yy}^* = \begin{bmatrix} \beta_{11} - \beta_1 + \beta_1^2 & & & \\ \beta_{12} + \beta_1 \beta_2 & \beta_{22} - \beta_2 + \beta_2^2 & & \\ \vdots & \vdots & \ddots & \\ \beta_{1N} + \beta_1 \beta_N & \beta_{2N} + \beta_2 \beta_N & \cdots & \beta_{NN} - \beta_N + \beta_N^2 \end{bmatrix} \geq \mathbf{0}. \tag{7}$$

2.2 Estimation

The translog variable cost function (1) is converted into a regression equation by appending to it an additive stochastic disturbance term ε. The sequence of random variables $\{\varepsilon_\ell\}$, $\ell = 1, \ldots, L$ (where L stands for the size of the regression sample), is usually assumed to be (identically) normally and independently distributed (NID) with mean zero and variance σ_ε^2. Ordinary least squares (OLS) can be applied on this regression equation to estimate the parameters of the translog variable cost function. Additional information may be obtained from the data, however, which can result in efficiency gains in estimation as well as circumvent the degrees of freedom problem posed by having to estimate a large number of parameters when the sample size is small. This takes the form of the input share equations, which are derived using Shephard's lemma:

$$\frac{\partial \ln c^{v*}}{\partial \ln w_i^*} = s_i = \alpha_i + \sum_{j=1}^{I} \alpha_{ij} \ln w_j^* + \sum_{n=1}^{N} \rho_{in} \ln y_n^* + \sum_{t=1}^{T} \delta_{it} \ln k_t^* \qquad \text{for } i = 1, 2, \ldots, I. \tag{8}$$

Adding to each share equation s_i a disturbance term $\nu_{i\ell}$ for $i = 1, 2, \ldots, I$ and $\ell = 1, 2, \ldots, L$ with the following distributional assumptions

$$\begin{bmatrix} \varepsilon_\ell \\ \nu_{1\ell} \\ \vdots \\ \nu_{I\ell} \end{bmatrix} \sim \mathrm{NID}(\mathbf{0}, \mathbf{\Sigma})$$

where

$$\Sigma = \begin{bmatrix} \sigma_\varepsilon^2 & & & \\ \sigma_{1\varepsilon} & \sigma_1^2 & & \\ \vdots & \vdots & \ddots & \\ \sigma_{I\varepsilon} & \sigma_{1I} & \cdots & \sigma_I^2 \end{bmatrix}$$

results in a model with a seemingly unrelated regression (SUR) structure.

With the equality restrictions (equations (2) and (3)) imposed on its parameters, the translog variable cost function and any set of $I-1$ share equations may be estimated as a system of equations using full-information maximum likelihood.[1]

2.3 *Inferences on the structure of costs and production*

In the hospital cost function literature, three aspects of costs and production have received some emphasis. These include economies (or diseconomies) of scale and scope and whether or not fixed inputs are employed according to their long-run cost-minimizing levels.

Economies of scale are the cost function analog of the elasticity of scale. They are meant to answer the question, would unit costs increase, decrease, or stay constant as hospital operations expand? For multiple output firms, the most commonly used concept of economies of scale is the ray or overall economies of scale, which measure the relative increase in total costs of increasing all outputs of the firm by the same proportion.[2] When the evaluation is done on a translog variable cost function, the index of ray scale economies may be given as

$$\epsilon = \frac{1-\left(\sum_{t=1}^{T}\gamma_t + \sum_{t=1}^{T}\gamma_{tt}\ln k_t^{*\prime} + \frac{1}{2}\sum_{t=1}^{T-1}\sum_{s=t+1}^{T}\gamma_{ts}\ln k_s^{*\prime}\right)}{\sum_{n=1}^{N}\beta_n} \tag{9}$$

where the evaluation is done at the sample means and $k_t^{*\prime}$ is the mean-scaled long-run optimal level of the tth fixed input.

Using the ray scale index, economies (diseconomies) of scale are said to exist if $\epsilon > 1$ ($\epsilon < 1$). Hence, based on considerations about economic efficiency alone, a policy implication that may be drawn from measures of economies of scale is that each hospital should expand (contract) operations, when scale economies (diseconomies) exist.

A concept specific to multiple product firms, economies (diseconomies) of scope are said to exist if the costs of jointly producing different outputs are less (greater) than if outputs are produced separately. In a translog variable cost function, scope economies exist if

$$\beta_{nm} + \beta_n\beta_m < 0 \qquad \text{for } n \neq m. \tag{10}$$

The policy implication of scope economies is straightforward. Hospital departments(*e.g.*, obstetrics and pediatrics or surgery and emergency care) or output categories that are cheaper to produce jointly should be available in one hospital. Hospital departments that are more expensive to maintain jointly should be offered in different, specialized hospitals.

Given the widespread concern on the escalation of medical care costs, one other issue that has received some attention in the hospital cost literature is whether or not hospitals

[1] One share equation has to be thrown away to avoid singularity in the error terms since the intercept of the share equations sum to unity. Because of the invariance property of full-information maximum likelihood, it does not matter which share equation is deleted.

[2] Cowing, Holtmann, and Powers (1983) note that a problem with this concept is that when the firm's scale of operations expand, outputs along the same ray may no longer be in the firm's least cost path.

employ fixed inputs according to their long-run cost-minimizing levels.[3] Wagstaff and Barnum (1992) note a fine point on this issue: The problem is not whether outputs should be expanded to fully utilize the fixed inputs, which is a question concerning economies of scale, but whether optimal amounts of the fixed inputs are employed *given the output levels of hospitals*. In other words, the question is whether hospitals are allocatively efficient in their use of the fixed factors.

How to correctly investigate this issue, however, has been the subject of a debate related to the question of which cost function is the more appropriate one to estimate. In their survey of the hospital cost function literature, Cowing, Holtmann, and Powers (1983) recommended using the variable cost function, particularly when the estimation is performed on cross-section data. They argued that it is improbable that in the short-run all hospitals would be employing all inputs at their long-run cost-minimizing levels. Thus, when they explored whether hospitals overemploy fixed factors, Cowing and Holtmann (1983) proposed checking whether $\partial c^v/\partial k$ in a variable cost function specification is not statistically different from $-w_k$: If $-\partial c^v/\partial k < w_k$ $(-\partial c^v/\partial k > w_k)$, *i.e.*, the savings in variable costs on the margin due to the employment of an additional unit of capital turn out to be less than (greater than) the marginal cost of capital, then fixed input k may be said to be overemployed (underemployed).

Wagstaff and Barnum (1992), however, object to a variable cost function specification, pointing out that it is difficult to cleanse total cost data of all fixed costs. They claim that this is possibly the reason why $\partial c^v/\partial k$ is positive and statistically significant in Cowing and Holtmann's study: For given input prices and a combination of output levels, the employment of variable factors and their costs should decrease as a hospital acquires and employs more of the fixed factors—unless variable costs are not rid of all fixed costs. Consequently, Wagstaff and Barnum suggest using the total cost equation

$$\begin{aligned} c &= \mathbf{w}^v \cdot \mathbf{x}^v + \mathbf{w}^k \cdot \mathbf{k} \\ &= c^v(\mathbf{w}^v, \mathbf{y}, \mathbf{k}) + \mathbf{w}^k \cdot \mathbf{k}, \end{aligned} \tag{11}$$

where the fixed factors enter the specification twice—as arguments of the variable cost function c^v and as components of fixed costs $\mathbf{w}^k \cdot \mathbf{k}$. Then, to determine whether hospitals use fixed inputs at their cost-minimizing levels, statistical tests can be performed on whether the estimated coefficients of the fixed inputs $\hat{\mathbf{w}}^k$ are significantly different from zero. Specifically, if $\hat{\mathbf{w}}^k = \mathbf{0}$, then $\partial c/\partial k_t = \partial c^v(\mathbf{w}^v, \mathbf{y}, \mathbf{k})/\partial k_t = 0$, which implies that the amounts of the fixed assets employed are consistent with their long-run cost-minimizing levels. But if $\hat{\mathbf{w}}^k > \mathbf{0}$ $(\hat{\mathbf{w}}^k < \mathbf{0})$, then $\partial c/\partial k_t = 0 > \partial c^v(\mathbf{w}^v, \mathbf{y}, \mathbf{k})/\partial k_t$ $(\partial c/\partial k_t = 0 < \partial c^v(\mathbf{w}^v, \mathbf{y}, \mathbf{k})/\partial k_t)$, which implies that hospitals underemploy (overemploy) fixed inputs.

A problem with the Barnum and Wagstaff specification, though, is that it may be subject to serious collinearity problems, particularly when data on the fixed factors are badly measured since they enter twice in the cost equation. It is for this reason that a variable cost function specification is used in this study.[4]

[3] In other studies, this line of inquiry has been directed at whether or not hospitals have too much capital equipment or too many doctors on their medical staffs—not surprisingly, the two factors which are often blamed for the increasing costs of hospital care.

[4] See footnote 6.

3. Data set and variables

The data set used in this paper came from the Hospital Administrators Survey of the Baseline Studies for Health Care Financing Reform Project. *Baseline Studies* was a research initiative that was jointly undertaken by the Department of Health (DOH) and the Philippine Institute for Development Studies (PIDS) under a grant from the World Bank. Its primary aim was to formulate a consistent set of policies intended to reform the country's health care financing system.

Under *Baseline Studies*, five surveys were commissioned to collect information on various aspects of the Philippine health sector. These included surveys of (a) households, of (b) patients and (c) medical practitioners in free-standing and hospital-based clinics, and of (d) patients and (e) administrators of hospitals. Conducted between 1991 and 1992, the surveys covered four regions of the country: Region II was selected to represent a middle-income area, Region VII to represent a high-income area, Region X to represent a middle-income area, and the National Capital Region (NCR) to represent a highly urbanized area. In each of the regions with the exception of NCR, one high- and one low-income province were also selected. Cagayan and Quirino were picked as the high- and low-income provinces of Region II. Cebu, as the high-income province, and Bohol, as the low-income province, were chosen for Region VII. And Misamis Oriental (high-income) and Surigao del Norte (low-income) were made to represent Region X.[5]

Spanning these seven provinces, the survey of hospital administrators initially selected some 188 hospitals on the basis of a stratified random sampling scheme with hospital ownership as the stratifying variable. But of these, only 159 hospital administrators or their representatives allowed themselves to be interviewed. Due to gaps in information provided by these respondents, the size of the sample was further reduced to 65 observations. These hospitals constitute the regression sample of this study.

Tables 1 and 3 provide short definitions and some descriptive statistics of the variables contained in the data set—for the sample as a whole and for the public and private hospital sub-samples. As shown in Table 1, about a third of the hospitals in the sample are located in Metro Manila, hospitals located in Cebu and Bohol provinces each comprise about a fifth of the sample, and the rest are located in Cagayan, Misamis Oriental, Quirino, and Surigao del Norte. Close to one half of the hospitals in the sample are secondary hospitals, a quarter are primary hospitals, and 30% are tertiary (non-teaching or teaching) hospitals. Privately-owned hospitals comprise about 46% of the sample.

In this study, variable costs are defined as the sum of a hospital's expenditures on labor services as well as on drugs and medical supplies. Other expenses, including those for depreciation, interest, rents, water and electricity, transportation and communication, and repairs and maintenance—most of which went unreported—are regarded as (quasi-)fixed costs. Annual wages are calculated for four categories of labor inputs—medical residents, nurses, other medical personnel, and non-medical personnel—as the total annual gross compensation of the staff divided by the number of full-time personnel in that labor category. Information necessary to construct a service-weighted price index of drugs and medical supplies dispensed was unavailable. In its stead was used the value of drugs and medical supplies per patient, which is defined as the ratio of annual expenditures on drugs and medical supplies to the total number of patients served.

The measures of hospital outputs are the number of in-patient discharges and the number of out-patient consultations. Although finer distinctions in in-patient services would have been desirable (to explore scope economies more satisfactorily, for example), the data were riddled by missing observations when in-patient discharges were disaggregated by hospital

[5] For more detailed information on these surveys, see Mendoza (1992) and TRENDS (1993).

department or when the number of in-patient days was used as the measure of in-patient output.

The number of hospital beds is the indicator used to proxy for fixed inputs. Given the heterogeneity of fixed factors, this variable is likely to be measured with error. Unfortunately, no other measure yielded as large a sample as bed capacity.[6]

4. Regression results

The regression results of the translog variable cost function for the hospitals in the sample are presented in Table 4. The specification of this function follows that of equation (1) with $I = 5$, $N = 2$, $T = 1$, and $L = 65$—except for two additional features. First, dummy variables are included in the set of regressors to account for cost variations due to hospital type, hospital ownership, and the location of hospitals. Second, the dummy variable for hospital ownership is interacted with the natural logarithm of input prices to allow for intercept differences between public and private hospitals in the cost share equations.[7]

To improve the precision of the parameter estimates, the translog variable cost function itself and four of the five share equations were specified as a system of equations and estimated using full-information maximum likelihood (FIML) procedures (in 386TSP Version 4.2B). One share equation had to be omitted from the equation system to avoid singularity in the error terms; this was the cost share of drugs and medical supplies. Following standard practice in translog cost function estimations, the equality conditions for continuity in both outputs and input prices (equation (2)) as well as linear homogeneity in input prices (equation (3)) were imposed as prior restrictions.

4.1 Inequality restrictions

In general, the regression results seem sound. They meet the inequality conditions for the translog variable cost function: The coefficients of the natural logarithm of input prices (α_i for $i = 1,\ldots,5$) are all estimated to be positive and highly significant, and the coefficients of the natural logarithm of the outputs (β_n for $n = 1,2$) are at least non-negative, in effect satisfying the conditions for monotonicity in factor prices and outputs as stipulated in equations (4) and (5). Concavity in input prices and convexity in outputs are also met. The matrix H_{ww} is (weakly) negative semidefinite with principal minors: $h_1^w = -0.022$ and $h_2^w = \cdots = h_5^w = 0$, while the matrix H_{yy} is (weakly) positive semidefinite with principal minors: $h_1^y = 0.151$ and $h_2^y = 0$.[8]

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[6] In the regression runs, when the number of medical specialists was specified as a second measure of fixed inputs, serious collinearity problems were encountered, resulting in the failure of maximum likelihood algorithms to converge.

[7] I am grateful to Paul Gertler for suggesting this specification, which in effect restricts the other coefficients of the cost function to be equal between private and public hospitals but still allows the data to be pooled across hospital ownership. The alternative strategy of estimating separate cost functions by type of ownership yielded poor results for private hospitals, perhaps because, given measurement errors in the variables, the sample size (30 hospitals) was too small.

[8] Wald tests conducted for each principal minor indicate that only h_1^w and h_1^y are different from zero at 10% level of significance.

4.2 *Cost shares, cost elasticities of outputs, and the Cobb-Douglas form*

Turning to the interpretation of the individual parameters, recall that the input price coefficients α_is are the intercepts of the cost share equations (equation (8)). Since the variables in the translog variable cost function are mean-scaled, however, when the share equations are evaluated at the sample means of the regressors, the coefficient estimates also represent the cost shares of the various input categories. As such, the α_is ought to take on estimated values that lie in the unit interval—which they do in the results. Among the variable inputs, drugs and medical supplies have the highest estimated cost share (48.5%), although labor services as a whole account for about 51.5% of variable costs. Surprisingly, the cost shares of the various personnel categories are relatively even, on average accounting for 10 to 14 percent of variable costs.

In the case of the output coefficients, β_1 and β_2, their estimates can be interpreted as the output elasticities of variable costs (which are monotonic transforms of marginal costs) when the evaluation is performed at the sample means of the variables. In this light, the lack of statistical significance of $\hat{\beta}_1$ and the significant but small magnitude of $\hat{\beta}_2$ can be taken to mean that variable costs are relatively unresponsive to small increases in outputs. What $\hat{\beta}_2 = 0.536$ implies, for instance, is that if the number of out-patient visits to hospitals doubles (holding other regressors fixed), variable costs, on average, would increase only by about 54%. In terms of the more customary cost curves, this result suggests that on average the hospitals in the sample are operating at the decreasing portion of their average variable cost curves.

Does the estimated cost function have a Cobb-Douglas form? Recall that the translog variable cost function degenerates to a Cobb-Douglas function when the coefficients of the second-order terms, α_{ij}, β_{nm}, γ_{tt}, ρ_{in}, δ_{it}, and θ_{nt} (for $i, j = 1, \ldots, 5$; $n, m = 1, 2$; and $t = 1$), are found to be jointly not significantly different from zero. Using the Wald test to test this composite hypothesis yields a test statistic of $\chi^2_{28} = 608.231$. Hence, the hypothesis that the estimated cost function is no different from a Cobb-Douglas cost function is to be rejected for any given significance level.

4.3 *Does hospital ownership matter?*

As mentioned above, the specification of the variable cost function accounted for cost variations due to hospital ownership in two ways. First, a dummy variable on whether a hospital is government- or privately-owned was included to account for intercept shifts in variable costs. Second, this dummy variable was interacted with the natural logarithm of input prices to allow for intercept shifts in the cost shares of the variable inputs.

Neither the coefficient of the hospital ownership dummy nor those of the interactions between the dummy variable and input prices turn out to be significantly different from zero, however. What this suggests is that there may be no systematic differences in the cost structures of private and government hospitals.

4.4 *Does hospital type or location matter?*

In addition to the dummy variable on hospital ownership, nine other dummy variables were included as regressors of the variable cost function to capture intercept shifts arising from differences in hospital type and provincial location.[9] But of these dummy variables, only a hospital's being located in Bohol turned out to be significantly different from zero. Thus, on average, there are no significant differences in the intercepts of the variable cost

[9] Secondary hospitals, public hospitals, and hospitals located in Metro Manila were selected as the omitted categories.

functions of secondary hospitals versus other types of hospitals and of hospitals located in Manila versus those located in other provinces with the exception of Bohol. In the case hospitals located in Bohol, their variable cost functions, on average, turn out to be lower than those of Manila hospitals.

4.5 Are there economies (diseconomies) of scale?

Would average variable costs decline, increase, or keep pace with outputs if hospitals were to expand the scale of their operations (while maintaining the relative proportions of their outputs)? As discussed in Section 2, this question is answered using the index of ray scale economies ϵ at the long-run optimal level of the fixed input. For $T = 1$ and $N = 2$, the ray scale index may be expressed as:

$$\epsilon = \frac{1 - (\hat{\gamma}_1 + \hat{\gamma}_{11} \ln k_1^{*\prime})}{\sum_{n=1}^{2} \hat{\beta}_n}$$

or in terms of the estimated parameters

$$\epsilon = \frac{1 - (0.424 + 0.257 \ln k^{*\prime})}{0.059 + 0.536}$$

Thus, the value of ϵ depends on the value of $k^{*\prime}$, the mean-scaled long-run optimal number of hospital beds, which unfortunately is not known. Since $k^{*\prime}$ is the only variable with an unknown value on the right hand side of ϵ, however, the value of k', the long-run optimal number of hospital beds (*i.e.*, the numerator of $k^{*\prime}$) can be solved for $\epsilon = 1$ to derive relative ranges of economies or diseconomies of scale. Using the sample mean of hospital beds (87.2), it can be calculated that

$$\epsilon \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} 1 \qquad \text{when} \qquad k' \begin{Bmatrix} < \\ = \\ > \end{Bmatrix} 81.0.$$

In other words, if the long-run optimal size of hospitals in the regression sample is about eighty beds, then doubling the scale of hospital operations would correspondingly double their unit variable costs. If the long-run optimal number of beds turns out to be much less than eighty beds, then doubling outputs would increase variable costs, but by less than the increase in outputs. Finally, if $k' >> 80$, average variable costs of hospitals in the sample would more than double if demand for their services doubled.

While this optimal bed size is far below those reported in the literature (see Berki (1972), for instance), it may well be that with hospitals of generally low-quality, long-run per unit costs quickly reach their lowest point at relatively low levels of output. Thus, from this result, it may be inferred that, perhaps, ray scale economies exist for primary and secondary hospitals, but ray scale diseconomies may exist for tertiary hospitals.

4.6 Are there economies (diseconomies) of scope?

Should hospitals offer both in-patient and out-patient care? The index of scope economies given in equation (10) is calculated to be -0.003, but by the Wald test is found to be insignificantly different from zero ($\chi_1^2 = 0.004$). Thus, it is apparently not cheaper, although neither is it more expensive, for hospitals in the sample to offer both in-patient and out-patient services jointly.

4.7 Do hospitals have too much bed capacity?

As discussed in Section 2, the issue of whether there is too much capital stock in the hospital system *given the levels of outputs of hospitals* is usually investigated by comparing the value of $-\partial c^v/\partial k$ with the optimal return on investment in the fixed factor. The hypothesis on this issue is that $\partial c^v/\partial k < 0$ (or, equivalently, $\partial \ln c^{v*}/\partial \ln k = \gamma < 0$), since along the same isoquant (*i.e.*, holding outputs fixed), the utilization of variable inputs must decrease as amounts of the fixed factor are incremented.

Table 4 reports a statistically significant $\hat{\gamma} = 0.424$. Cowing and Holtmann (1983), who got a similar result, interpret this to mean that hospitals are overcapitalized. But Wagstaff and Barnum (1992) disagree. Noting that it is $\partial c/\partial k > 0$ (the partial derivative of *total costs* with respect to capital stock) that indicates overcapitalization, they argue that $\partial c^v/\partial k > 0$ is instead evidence that variable costs have not been totally rid of fixed costs.

Here, still another interpretation is suggested (at least for cross-section data). Note that the output measures used in the regression do not control for treatment procedures. As new capital equipment becomes available in hospitals, however, it may well be that doctors change their treatment protocols in favor of using the new machines. If so, even variable costs would be positively affected by increasing the hospitals' stock of capital.[10] In other words, it is possible that when a hospital purchases new equipment, it does not only increase the hospital's capital stock, it also changes the hospital's technology. As a result, new isoquants prevail, and to produce the same output levels, even variable costs increase.

In the context of variable cost function estimation using a cross-section sample of hospitals, the explanation just proffered may be reflected in $\partial c^v/\partial k$ if the proxy measure of capital stock, *e.g.*, bed capacity, is positively correlated with (unobserved) sophistication of capital equipment. For then, the (omitted variable) effect of technology on variable cost would be captured by the indicator of fixed inputs. Hence, whether or not Philippine hospitals are overcapitalized cannot be adequately answered by the variable cost function that was estimated in this study, since differences in technology and treatment protocols were unaccounted for.

[10] Formally, let q be some index of quality (*e.g.*, diagnostic accuracy) which has a positive influence on the employment of variable inputs x_v (*e.g.*, the services of medical technologists) and is itself increasing in fixed factors k (*e.g.*, more expensive machines). Then,

$$\frac{\partial c^v}{\partial k} = w_v\left(\frac{\partial x_v}{\partial k} + \frac{\partial x_v}{\partial q}\frac{\partial q}{\partial k}\right),$$

where $\partial x_v/\partial k$ is the direct effect of k on the employment of variable inputs and $(\partial x_v/\partial q)(\partial q/\partial k)$ is the effect through quality. It is therefore possible for fixed factors to have a net positive effect on variable costs: their impact on variable costs through quality just has to be stronger than their direct effect.

5. Conclusion

This paper presented and interpreted the parameter estimates of a translog variable cost function that was estimated using a cross-section sample of 65 Philippine hospitals of various types, ownership, and provincial location. To explore the technical efficiency of private relative to government hospitals (given the small sample size), the specification that was adopted restricted the coefficients of the second-order terms of the translog function to be the same between public and private hospitals, but allowed the intercepts of both the cost function and the share equations to vary by hospital ownership. The regression results show that these coefficients of the private hospital dummy variable tend to be insignificantly different from zero, in effect indicating that there may not be systematic differences in the cost and production structure of private and public hospitals. How are this and other inferences to be taken?

Note from Table 1 that, relative to the estimation requirements, the size of the regression sample at 61 observations is quite small. This imposes rather severe constraints on the estimation exercise. Ideally, given that in an econometric estimation of a cost function all the firms that constitute the regression sample are assumed to have the same structure of costs and production, regressions ought to be performed on hospitals that are as much alike as possible (*e.g.*, in terms of size and ownership), so that the same case mixes, technology, and behavioral modes would prevail in the sample. Performing regression runs on subsamples of hospitals in the data set, however, would have cut deeply into the degrees of freedom and the precision of the parameter estimates.

In addition, it ought to be realized that, relative to their theoretical constructs, the cost function variables in the data set are measured with error. For instance, variable costs do not include outlays for quasi-fixed inputs such as utilities and for a miscellany of other items. The annual wage of a typical member of each labor category is derived as the wage bill of that category of labor divided by the number of full-time staff. The value of drugs and medical supply is really the ratio of expenditures on those items (including inventories) to the number of both in-patient discharges and out-patient visits. The measures of outputs themselves do not take account of illness severity, case mix, and aggregation (across hospital departments) issues. And the number of beds is a poor proxy of the capital stock of hospitals (but one that maximized sample size).

Nonetheless, the regression results generally seem reasonable. The variable cost function that was estimated conforms to the (unimposed) theoretical requirements of a cost function: Statistical tests reveal it to be monotonically nondecreasing in input prices and outputs, concave in factor prices, and convex in outputs. Key coefficient estimates, such as the cost share of inputs $\hat{\alpha}_i$ and the output elasticity of variable costs $\hat{\beta}_n$, have the expected signs with magnitudes that are within the range required by theory. What this suggests is that there may be enough of a common cost structure shared by hospitals of different sizes, geographical location, and management styles, so that the estimation exercise is not totally invalidated.

Unexpected results can also be explained. For instance, why $\hat{\beta}_1$, the coefficient estimate of the natural logarithm of in-patient discharges, is not statistically significant and why the output elasticities for in-patient services of primary, secondary, and public hospitals are negative in the simulation results may be attributed to the poor measurement of the output variable. Relative to its theoretical construct (which is intended to measure in-patient service delivery), in-patient discharges assigns a uniform weight to patients even if they are afflicted with different types as well as severity of illness and even though they may be using hospital resources at different levels of intensity. With such errors-in-variable, it is well-known that the coefficient estimate tend to be biased toward zero.

Why the estimate of γ_1, the coefficient of the natural logarithm of the number of beds, is positive and significant has been previously explained as a probable consequence of the different rates at which hospitals are adopting new technology as they expand operations. In other words, hospital investments may not be affecting the scale alone, such as when more machines are purchased or when more beds or rooms are provided, but may also have an impact on the quality of capital equipment, such as when the new machines allow more accurate diagnoses or earlier detection of illnesses. Since the case mix of hospitals (or the range as well as the seriousness of illnesses handled) and differences in treatment protocols of hospitals were not adequately controlled for, it is hard to tell whether the escalation of hospital variable costs arising from expansions of capital stock is due to overcapitalization or to technological improvements.

What policy implications may be drawn from the regression results? The most important message is that policy makers and hospital administrators need to rationalize the structure of hospital costs and operations. Hospital costs *must* be related to performance. As it is, the regression results show that supply-side factors, such as labor services and medical supplies, are what drive hospital costs. Services offered by hospitals apparently have little or no impact on costs. It may not even be cheaper to maintain out-patient and in-patient departments jointly in one hospital. As for the production structure of hospitals, policy makers need to address whether or not it is reasonable on administrative and medical grounds that (a) expenditures on drugs and medical supplies should take up about half of hospital variable costs, (b) tertiary hospitals are apparently operating at output levels where long-run unit costs are likely to rise if hospital operations are expanded, while primary and secondary hospitals are likely to reduce unit costs if their operations are doubled, and (c) there are apparently no systematic differences in the production structures of private and public hospitals.

Two reform initiatives in the Philippine health sector make studies on the structure of hospital costs imperative. Under the devolution of health services delivery, public hospitals need to prove to local government units their economic viability as well as responsiveness to the health needs of their catchment areas. With national health insurance impending, an increasingly important concern for the Philippine Health Insurance Corporation that is to oversee the insurance scheme is that curative health care costs, particularly of private hospitals, do not escalate unless there is at least a corresponding increase in value for the services offered. Both initiatives need a detailed understanding of the nature of hospital costs and production, such as those provided by structural cost function estimates.

Table 1
Descriptive Statistics of Variables for All Hospitals

Variables	Description	Mean	Standard Deviation	Minimum	Maximum
Total Cost	Total Cost of Operations (in Thousand Pesos)	19,284.90	41,668.30	311.33	249,421.00
Variable Cost	Total Cost less Fixed Cost (in Thousand Pesos)	9,973.25	20,451.00	241.33	131,608.00
Wage of Medical Residents	Average Annual Stipend of Full-Time Medical Residents	69,867.22	47,719.80	680.40	318,532.50
Wage of Nurses	Average Annual Wage of Full-Time Nurses	39,273.73	16,757.13	712.88	139,495.78
Wage of Other Medical Personnel	Average Annual Wage of Full-Time Other Medical Personnel	33,757.19	16,786.86	10,233.82	145,446.66
Wage of Non-Medical Personnel	Average Annual Wage of Full-Time Non-Medical Personnel	30,691.53	9,989.12	9,767.59	58,048.80
Value of Drugs and Medical Supplies	Annual Expenditures on Drugs and Medical Supplies Per Patient	102.54	121.26	0.63	746.79
Total In-Patient Discharges	Annual Number of In-Patient Discharges	3,976.57	4,955.00	276	24,608
Total Out-Patient Visits	Annual Number of Out- Patient Consultations	41,487.38	120,924.05	759	934,794
Number of Beds	Total Number of Hospital Beds	87.20	149.04	8	1,044
Manila	1 if located in Metro Manila, 0 otherwise	0.3385	0.4769	0	1
Bohol	1 if located in Bohol, 0 otherwise	0.1846	0.3910	0	1
Cagayan	1 if located in Cagayan, 0 otherwise	0.1077	0.3124	0	1
Cebu	1 if located in Cebu, 0 otherwise	0.2000	0.4031	0	1
Misamis Oriental	1 if located in Misamis Oriental, 0 otherwise	0.0462	0.2115	0	1
Quirino	1 if located in Quirino, 0 otherwise	0.0462	0.2115	0	1
Surigao del Norte	1 if located in Surigao del Norte, 0 otherwise	0.0769	0.2685	0	1
Privately Owned Hospital	1 if a privately owned hospital, 0 otherwise	0.4615	0.5024	0	1
Primary Hospital	1 if a primary hospital, 0 otherwise	0.2462	0.4341	0	1
Secondary Hospital	1 if a secondary hospital, 0 otherwise	0.4615	0.5024	0	1
Tertiary Non-Teaching Hospital	1 if a tertiary non-teaching hospital, 0 otherwise	0.2000	0.4031	0	1
Tertiary Teaching Hospital	1 if a tertiary teaching hospital, 0 otherwise	0.0923	0.2917	0	1

Number of Observations = 65

Table 2
Descriptive Statistics of Variables for Public Hospitals

Variables	Description	Mean	Standard Deviation	Minimum	Maximum
Total Cost	Total Cost of Operations (in Thousand Pesos)	21,337.30	48,656.30	311.33	249,421.00
Variable Cost	Total Cost less Fixed Cost (in Thousand Pesos)	9,165.47	22,757.80	241.33	131,608.00
Wage of Medical Residents	Average Annual Stipend of Full-Time Medical Residents	73,458.57	43,548.02	680.40	280,088.00
Wage of Nurses	Average Annual Wage of Full-Time Nurses	40,924.85	10,793.05	712.88	67,064.00
Wage of Other Medical Personnel	Average Annual Wage of Full-Time Other Medical Personnel	33,536.42	8,142.06	10,233.82	63,532.14
Wage of Non-Medical Personnel	Average Annual Wage of Full-Time Non-Medical Personnel	30,944.44	7,963.73	9,767.59	43,815.43
Value of Drugs and Medical Supplies	Annual Expenditures on Drugs and Medical Supplies Per Patient	82.07	63.78	0.63	263.55
Total In-Patient Discharges	Annual Number of In-Patient Discharges	3,722.63	5,424.72	454	24,608
Total Out-Patient Visits	Annual Number of Out- Patient Consultations	53,619.03	160,346.06	786	934,794
Number of Beds	Total Number of Hospital Beds	98.34	189.67	10	1,044
Manila	1 if located in Metro Manila, 0 otherwise	0.1429	0.3550	0	1
Bohol	1 if located in Bohol, 0 otherwise	0.1714	0.3824	0	1
Cagayan	1 if located in Cagayan, 0 otherwise	0.1714	0.3824	0	1
Cebu	1 if located in Cebu, 0 otherwise	0.2286	0.4260	0	1
Misamis Oriental	1 if located in Misamis Oriental, 0 otherwise	0.0571	0.2355	0	1
Quirino	1 if located in Quirino, 0 otherwise	0.0857	0.2840	0	1
Surigao del Norte	1 if located in Surigao del Norte, 0 otherwise	0.1429	0.3550	0	1
Primary Hospital	1 if a primary hospital, 0 otherwise	0.3429	0.4816	0	1
Secondary Hospital	1 if a secondary hospital, 0 otherwise	0.4000	0.4971	0	1
Tertiary Non-Teaching Hospital	1 if a tertiary non-teaching hospital, 0 otherwise	0.2286	0.4260	0	1
Tertiary Teaching Hospital	1 if a tertiary teaching hospital, 0 otherwise	0.0286	0.1690	0	1

Number of Observations = 35

Table 3
Descriptive Statistics of Variables for Private Hospitals

Variables	Description	Mean	Standard Deviation	Minimum	Maximum
Total Cost	Total Cost of Operations (in Thousand Pesos)	16,890.40	32,327.80	476.00	113,546.00
Variable Cost	Total Cost less Fixed Cost (in Thousand Pesos)	10,915.70	17,722.90	396.95	58,008.60
Wage of Medical Residents	Average Annual Stipend of Full-Time Medical Residents	65,677.32	52,615.32	23,600.00	318,532.50
Wage of Nurses	Average Annual Wage of Full-Time Nurses	37,347.42	21,817.33	11,700.00	139,495.78
Wage of Other Medical Personnel	Average Annual Wage of Full-Time Other Medical Personnel	34,014.75	23,324.89	10,800.00	145,446.66
Wage of Non-Medical Personnel	Average Annual Wage of Full-Time Non-Medical Personnel	30,396.47	12,070.08	12,654.55	58,048.80
Value of Drugs and Medical Supplies	Annual Expenditures on Drugs and Medical Supplies Per Patient	126.42	163.05	1.72	746.79
Total In-Patient Discharges	Annual Number of In-Patient Discharges	4,272.83	4,417.44	276	16,768
Total Out-Patient Visits	Annual Number of Out- Patient Consultations	27,333.80	41,737.23	759	191,198
Number of Beds	Total Number of Hospital Beds	74.20	80.76	8	329
Manila	1 if located in Metro Manila, 0 otherwise	0.5667	0.5040	0	1
Bohol	1 if located in Bohol, 0 otherwise	0.2000	0.4068	0	1
Cagayan	1 if located in Cagayan, 0 otherwise	0.0333	0.1826	0	1
Cebu	1 if located in Cebu, 0 otherwise	0.1667	0.3791	0	1
Misamis Oriental	1 if located in Misamis Oriental, 0 otherwise	0.0333	0.1826	0	1
Quirino	1 if located in Quirino, 0 otherwise	0.0000	0.0000	0	0
Surigao del Norte	1 if located in Surigao del Norte, 0 otherwise	0.0000	0.0000	0	0
Primary Hospital	1 if a primary hospital, 0 otherwise	0.1333	0.3458	0	1
Secondary Hospital	1 if a secondary hospital, 0 otherwise	0.5333	0.5074	0	1
Tertiary Non-Teaching Hospital	1 if a tertiary non-teaching hospital, 0 otherwise	0.1667	0.3791	0	1
Tertiary Teaching Hospital	1 if a tertiary teaching hospital, 0 otherwise	0.1667	0.3791	0	1

Number of Observations = 30

Table 4
Translog Hospital Variable Cost Function

Variables	Parameters	Coefficient Estimates	Student's t-Statistics
Constant	α_0	-0.19153	-2.144 *
Bohol		-0.17689	-2.200 *
Cagayan		-0.04847	-0.546
Cebu		-0.11203	-1.684
Misamis Oriental		-0.14392	-1.285
Quirino		-0.13491	-1.242
Surigao del Norte		-0.16126	-1.731
Primary Hospital		0.01148	0.152
Tertiary Non-Teaching Hospital		0.09291	1.080
Tertiary Teaching Hospital		0.13192	1.193
Private Hospital		0.05732	1.004
ln(*Wage of Medical Residents*)	α_1	0.13383	11.906 **
ln(*Wage of Nurses*)	α_2	0.14234	15.749 **
ln(*Wage of Other Medical Personnel*)	α_3	0.10335	11.433 **
ln(*Wage of Non-Medical Personnel*)	α_4	0.13554	12.693 **
ln(*Value of Drugs and Medical Supplies*)	α_5	0.48493	31.378 **
Private Hospital × ln(*Wage of Medical Residents*)	α_1'	-0.00636	-0.461
Private Hospital × ln(*Wage of Nurses*)	α_2'	0.00594	0.541
Private Hospital × ln(*Wage of Other Medical Personnel*)	α_3'	0.01527	1.431
Private Hospital × ln(*Wage of Non-Medical Personnel*)	α_4'	0.00128	0.098
Private Hospital × ln(*Value of Drugs and Medical Supplies*)	α_5'	-0.01613	-0.759

Variables	Parameters	Coefficient Estimates	Student t-Stati
ln(*Total In-Patient Discharges*)	β_1	0.05858	1.356
ln(*Total Out-Patient Visits*)	β_2	0.53596	8.125 **
ln(*Number of Beds*)	γ_1	0.42449	5.268 **
[ln(*Wage of Medical Residents*)]^2	α_{11}	0.09375	7.715 **
[ln(*Wage of Nurses*)]^2	α_{22}	0.09172	6.2[illegible]1 **
[ln(*Wage of Other Medical Personnel*)]^2	α_{33}	0.05568	3.915 **
[ln(*Wage of Non-Medical Personnel*)]^2	α_{44}	0.08153	6.219 **
[ln(*Value of Drugs and Medical Supplies*)]^2	α_{55}	0.16526	19.161 **
[ln(*Total In-Patient Discharges*)]^2	β_{11}	0.20578	2.682 **
[ln(*Total Out-Patient Visits*)]^2	β_{22}	0.16133	3.185 **
[ln(*Number of Beds*)]^2	γ_{11}	0.25694	2.103 *
ln(*Wage of Medical Residents*) × ln(*Wage of Nurses*)	α_{12}	-0.03944	-3.609 **
ln(*Wage of Medical Residents*) × ln(*Wage of Other MedicalPersonnel*)	α_{13}	-0.01410	-1.583
ln(*Wage of Medical Residents*) × ln(*Wage of Non-Medical Personnel*)	α_{14}	-0.01292	-1.4[illegible]9
ln(*Wage of Medical Residents*) × ln(*Value of Drugs and Medical Supplies*)	α_{15}	-0.02728	-5.107 **
ln(*Wage of Nurses*) × ln(*Wage of Other Medical Personnel*)	α_{23}	0.00886	0.852
ln(*Wage of Nurses*) × ln(*Wage of Non-Medical Personnel*)	α_{24}	-0.01532	-1.550
ln(*Wage of Nurses*) × ln(*Value of Drugs and Medical Supplies*)	α_{25}	-0.04581	-10.262 **
ln(*Wage of Other Medical Personnel*) × ln(*Wage of Non-Medical Personnel*)	α_{34}	-0.00577	-0.501
ln(*Wage of Other Medical Personnel*) × ln(*Value of Drugs and Medical Supplies*)	α_{35}	-0.04466	-10.045 **
ln(*Wage of Non-Medical Personnel*)×ln(*Value of Drugs and Medical Supplies*)	α_{45}	-0.04751	-9.05[illegible] **

Variables	Parameters	Coefficient Estimates	Student's t-Statistics
ln(*Total In-Patient Discharges*) × ln(*Total Out-Patient Visits*)	β_{12}	-0.03601	-0.651
ln(*Total In-Patient Discharges*) × ln(*Wage of Medical Residents*)	ρ_{11}	-0.02185	-1.852
ln(*Total In-Patient Discharges*) × ln(*Wage of Nurses*)	ρ_{12}	0.00742	0.802
ln(*Total In-Patient Discharges*) × ln(*Wage of Other Medical Personnel*)	ρ_{13}	0.00812	0.905
ln(*Total In-Patient Discharges*) × ln(*Wage of Non-Medical Personnel*)	ρ_{14}	-0.01380	-1.248
ln(*Total In-Patient Discharges*) × ln(*Value of Drugs and Medical Supplies*)	ρ_{15}	0.02011	1.056
ln(*Total Out-Patient Visits*) × ln(*Wage of Medical Residents*)	ρ_{21}	-0.00901	-0.999
ln(*Total Out-Patient Visits*) × ln(*Wage of Nurses*)	ρ_{22}	-0.01310	-1.813
ln(*Total Out-Patient Visits*) × ln(*Wage of Other Medical Personnel*)	ρ_{23}	-0.02577	-3.699 **
ln(*Total Out-Patient Visits*) × ln(*Wage of Non-Medical Personnel*)	ρ_{24}	-0.03908	-4.563 **
ln(*Total Out-Patient Visits*) × ln(*Value of Drugs and Medical Supplies*)	ρ_{25}	0.08696	6.275 **
ln(*Wage of Medical Residents*) × ln(*Number of Beds*)	δ_{11}	0.04765	3.849 **
ln(*Wage of Nurses*) × ln(*Number of Beds*)	δ_{12}	0.02676	2.661 **
ln(*Wage of Other Medical Personnel*) × ln(*Number of Beds*)	δ_{13}	0.00409	0.425
ln(*Wage of Non-Medical Personnel*) × ln(*Number of Beds*)	δ_{14}	0.04019	3.424 **
ln(*Value of Drugs and Medical Supplies*) × ln(*Number of Beds*)	δ_{15}	-0.11868	-6.256 **
ln(*Total In-Patient Discharges*) × ln(*Number of Beds*)	θ_{11}	-0.04816	-0.930
ln(*Total Out-Patient Visits*) × ln(*Number of Beds*)	θ_{12}	-0.14152	-2.185 *
R^2			0.985
Log-likelihood Function			452.803
Number of Observations			65

* —significant at 95% confidence interval.
** —significant at 99% confidence interval.

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