Technical efficiency and economies of diversification in health care

Diego Prior and Magda Solà

Dpt. Economia de la Empresa, Universitat Autònoma de Barcelona, E-08193 Bellaterra (Barcelona), Spain

Received June 1999; accepted May 2000

In national health services, where there is a tendency towards a lack of resources and a continuous increase in demand, it is necessary to implement decisions that promote efficiency. In this paper we focus on potential diversification economies as a strategy to increase efficiency levels.

We evaluate the change in efficiency in Catalan hospitals between 1987 and 1992, and analyse the presence of possible diversification economies in each hospital. We use Data Envelopment Analysis, which does not need information on either input or output prices.

The results are that the majority of hospitals could increase their efficiency and reduce their costs by diversification to the output-mix offered. Potential productivity gains are between 29% and 46%.

Keywords: technical efficiency, hospital management, economies of diversification

1. Introduction

When organisations consume an excess of inputs in the production of outputs, the production process is technically inefficient, since the costs exceed their potential levels. There are other parallel sources of inefficiency: operating with a scale of production that is not optimal (scale inefficiencies) or with an inappropriate mix of products and services (scope inefficiencies). This paper seeks to evaluate technical efficiency and potential scale and scope economies in the health care service.

A clear and precise interpretation of scope appears in Panzar and Willig [14] and can be explained intuitively: there are economies of scope when the cost of producing \( N \) products in one firm is lower than producing such \( N \) products in \( N \) different uni-product firms.

When production technology requires considerable fixed costs, and when the demand for individual products is insufficient for the complete utilisation of the installed capacity, the joint utilisation of resources generates scope economies in multi-product processes. In a broader perspective, the dilemma that we seek to resolve lies in verifying whether there are economically justifiable reasons that support processes of diversification, or, whether the advantages of specialisation predominate. In relation to health care, there appear to be advantages of diversification in the following cases: First, in cases with high fixed costs and insufficient product demand to utilise fully the fixed resources. Second, when there is physical capital with significant adjustment costs and time required to dismantle or significantly alter their level. Third, in reducing the risk faced by inflexible organisations specialised in the production of a limited number of goods and services. Finally, in minimising the transaction costs of consumers, given the knowledge they acquire about the main characteristics of output or services.

On the other hand, depending on the specific treatment required, advantages of specialisation could appear promoted by the presence of a high level of labour productivity due to skills in determined tasks or by the lower requirements of coordination and monitoring activities.

Thus, in health service organisations it might be possible that the advantages of diversification appear clearly by joining some specific treatments, but not necessarily in other combinations. On the other hand, to detect the presence of diversification economies, the existence of determined “output-mix” (i.e., a balanced output-mix could be better than a biased “output-mix” towards a specific service) may be required. The main objective of this paper is to use DEA to detect the presence of diversification economies.

This paper begins by describing the concept of diversification economies and the most important features and limitations of previous methods used to analyse it (section 2). Subsequently, in section 3 we propose a new theoretical two-stage evaluation process in order to quantify whether or not there are potential diversification economies when analysing a sample of both general and specialised Catalan hospitals. Section 4 presents the discussion and the descriptive statistics of the data used. The results are presented in section 5. Section 6 concludes.

2. Previous research in the evaluation of diversification economies

Panzar and Willig [14] based their definition of the concept of economies of scope on the reductions in costs made possible by combining several production plants that manufacture different outputs. Economies of scope exist when...
the cost of producing two outputs separately is greater than the total cost of their joint production. That is to say,
\[ c_{s_1}(y_{1,1}, 0) + c_{s_2}(0, y_{2,2}) > c_d(y_{1,1}, y_{2,2}). \]

The concept that we use, diversification economies, is very similar, but presents a more flexible definition:
\[ c_{s_1}(y_{1,1}, y_{1,2}) + c_{s_2}(y_{2,1}, y_{2,2}) > c_d(y_{1,1} + y_{2,1}, y_{1,2} + y_{2,2}) \]

that is, we have two specialised units \( s_1 \) and \( s_2 \) producing specific outputs \((y_{1,1} \text{ and } y_{2,2})\) and some quantities of other output \((y_{1,2} \text{ and } y_{2,1})\). There are economies (diseconomies) of diversification if the total cost of producing separately \((c_{s_1} \text{ plus } c_{s_2})\) is higher (lower) than the total cost of producing the same amount of output in only one diversified unit \( c_d \).

The proposal of Panzar and Willig, analysing the manufacturing sector, required the use of cost functions. Following this, Ullman and Holtman [17] applied the concept to health services, attempting to verify the presence of scope economies in intermediate and specialised health care, but they conclude by rejecting its presence. Later, Dor [6], having defined hospitals as multi-output units, studied a sample of North American hospitals, analysing the services provided to patients covered by Medicare and Medicaid programmes, together with private patients. Dor concludes that the hospital remuneration system involved a non-desired situation with important and unexploited economies of scope.

From the point of view of the methodological approach, there have been some adaptations of non-parametric DEA frontier methodology to detect the presence of economies of scope – Färe [7], Kittelsen and Forsund [11], Magnussen [12] and Fried et al. [9]. While based on the theory of duality, all are formulated from analysis of the set of factor requirements without using cost functions; nevertheless, the translation of efficiency coefficients in terms of potential savings in costs is direct.

Färe, and Kittelsen and Forsund attempt to establish whether there are improvements in efficiency when production plants, operating separately but belonging to the same firm or organisation, are combined.

Magnussen finds that the average efficiency of hospitals that have a low percentage of general medical cases is higher than that of those with a high percentage. In the same way, when the hospitals are analysed separately, taking account of the length of overnight stays, he finds that the average efficiency is higher in those hospitals where there are prolonged overnight stays. Magnussen relates this to the presence of diseconomies of scope in general medicine and to economies of scope in those hospitals where the average length of stay is longer. However, this approach is flawed because it does not distinguish between scope economies and the technical inefficiency promoted for other environmental, managerial or technical factors.

Fried, Schmidt and Yaisawarng test for scope economies in nursing homes. Their aim is to verify whether there is a source of cost saving in the joint provision of intermediate and specialised nursing care. The results suggest that, in general, there are excessive costs associated with the joint provision of intermediate and specialised nursing care (diseconomies of scope). It is possible, however, to merge specialised facilities to gain the benefits of scope economies. This approach has a clear shortcoming: in order to simulate the costs of providing a diversified level of care in separate facilities, artificial nursing homes are created by randomly combining non-diversified frontier units, and the size of the new hybrid units could have a determinant effect on their level of efficiency as a result of scale diseconomies.

This paper extends these analyses. With reference to Färe, and Kittelsen and Forsund, we are interested in the formalisation of a theoretical process in quantifying the economies (or diseconomies) of diversification, and not only in comparing the results obtained. In contrast with Magnussen, we separate technical efficiency from diversification economies. Finally, in connection with Fried et al., we do not need to create a sample of composite artificial, and this can reduce the problems related to the size of the units that are compared (diseconomies of scale).

### 3. The two-stage DEA proposed model

The DEA model was initially presented in the seminal paper of Charnes, Cooper and Rhodes [4]. After some improvements, the very well known dual version of the linear programming model (BCC model, corresponding to the envelopment version in radial input orientation and variable returns to scale) is the following:

\[
\begin{align*}
\text{Min } & \alpha_j \\
\sum_{i=1}^{I} z_i \cdot y_{m,i} & \geq y_{m,j}, \quad m = 1, \ldots, M, \\
\sum_{i=1}^{I} z_i \cdot x_{n,i} & \leq \alpha_j \cdot x_{n,j}, \quad n = 1, \ldots, N, \\
z_i & = 1, \quad i = 1, \ldots, I,
\end{align*}
\]

where
\( y_{m,j} \): quantity of output \( m \) obtained by unit \( j \),
\( x_{n,j} \): quantity of input \( n \) consumed by unit \( j \),
\( I \): total number of units,
\( M \): total number of outputs,
\( N \): total number of inputs,
\( z_i \): coefficient of intensity that determines the weights with which the observation “i” is used in determining the frontier corresponding to unit \( j \),
\( \alpha_j \): radial coefficient of technical efficiency corresponding to unit \( j \).

In the standard application of program (1), inside the \( I \) units we do not introduce in advance any restriction