Efficiency in Attaining Good Resident Outcomes in the Nursing Home Industry

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Research Questions

- Why do nursing homes allocate inputs the way that they do?
- What is an efficient allocation of resources to attain good resident outcomes?
- Are inputs allocated to most efficiently attain outputs, i.e., good resident outcomes?

Importance of the Problem

- The nation spends 7% of all national health expenditures on nursing home care -- $92.2 billion (2000).
- Nursing home expenditures account for 7.1% of the state's 2000 FY spending ($28.0 billion). Up from 6.8% in 1999.
- State of Ohio spent an estimated $4.8 billion on all types of long-term care for persons with disabilities – about 17.3% of the state's 1999 expenditures
- Roughly 50% of the LTC dollars go to institutional settings
- 1930 baby dearth to "2030 Problem"

Solutions

- Create a LTC financing system that works
  - Medicaid is single largest payer, is institutionally biased, administratively cumbersome, and relatively inflexible
- Build a viable and affordable community-based care system
- Invest in healthy aging

Governors: "Show me the Money!"

- NGA and Bush's "New Freedom Initiative" are exploring additional flexibility in Medicaid requirements and federal approval for state flexibility in market-based, value-purchasing driven strategies, e.g., competitive rate-setting processes and selective contracting
- In the meantime, "Doing more with less"
  - "Rightsize" the NH industry – "match capacity with demand"
  - Increase efficiency
  - Make it easier for family members to be the "provider of choice."

Research Goal

- Inform policy makers about the level of resources required by efficient nursing homes to transform inputs (staffing and capital) into outputs (quality care).

NH's and Inefficient Allocation of Resources

- Excess supply to meet demand
  - Nationally, though the number of elderly has increased, the supply of nursing home beds per 1,000 people 75 declined from 127 in 1987 to 117 in 1996 - a 7.9% decrease in the supply of NH beds.
  - Overall occupancy rate declined from 92.3% in 1987 to 88.8% in 1996
- Medicaid PPS reimbursement policy
- Management at the NH level -- high staff turnover/low retention, poor training

This study focuses on

- Medicaid reimbursement issues using one state
- Management of resources at the nursing home level to produce quality
- Opportunity for natural experiment due to Medicare shift to PPS in July 1998 for the majority of providers – should see some change in their management of resources

Measuring Efficiency

- Rooted in industry and especially manufacturing
- Farrell (1957) first proposed estimating a fully efficient firm's production function using sample data and a non-parametric piece-wise-linear technology or a parametric function, such as the Cobb-Douglas form
- Aigner and Chu (1968) considered the estimation of a parametric frontier production function of Cobb-Douglas form using data on a sample of firms.

$$(\ln y_i = x_i\beta - u_i)$$

- Where $\ln(y_i)$ is the logarithm of the scalar output for the *i*-th firm
- x_i is a *(K+1)* row vector, whose 1st element is "1" and the remaining elements are logarithms of the K-input quantities used by the *i-th* firm
- $\beta = (\beta_0, \beta_1, \ldots, \beta_k)'$ is a *(K+1)* column vector of unknown parameters to be estimated; and
- u_i is a non-negative random variable, associated with TI in production of firms in the industry involved

- The ratio of the observed output for the *i-th* firm, relative to the potential output, defined by the frontier function, given the input vector, x_i, is used to define the technical efficiency of the *i-th* firm. TE_i =

$$\frac{y_i}{\exp(x_i\beta)} = \frac{\exp(x_i\beta - u_i)}{\exp(x_i\beta)} = \exp(-u_i)$$

- Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977) independently proposed the stochastic frontier production function in which an additional random error *u* was added to the non-negative random error variable w_i.

$$\ln(y_i) = x_i\beta + w_i - u_i$$

•Charnes, Cooper, and Rhodes (1978) formalized the non-parametric ideas calling them DEA

•Rooted in linear programming

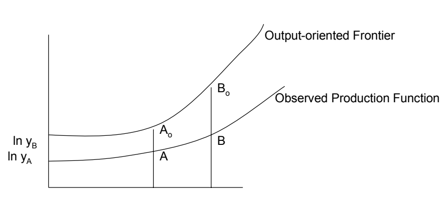
$$\min_{\theta,\lambda},$$
$$\text{st} \quad -y + Y\lambda \geq 0,$$
$$\theta x_i - X\lambda \geq 0,$$
$$\lambda \geq 0,$$

Where θ is a scalar between 0 and 1 denoting TE and λ is a N*1 vector of constants. The LP problem must be solved N times, once for each firm in the sample.

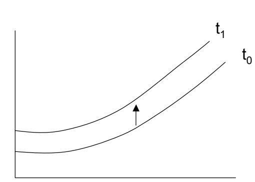
Productivity and Efficiency

- Productivity = outputs/inputs
- We are interested in total factor productivity versus labor productivity or other partial measures of productivity
- Efficiency is in relationship to a frontier

- A production frontier captures the current state of technology in an industry. Firms in the industry are either operating on the frontier (and are therefore **technically efficient**), or below that frontier (and technically inefficient).

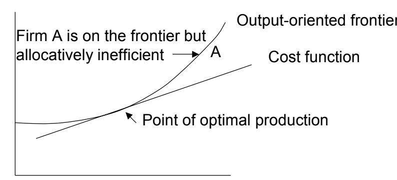


– Productivity improvements can be achieved by giving them new tools to accomplish tasks in a more timely fashion or reorganizing the work flow to improve productivity. This is called **technical change** and is represented by an upward shift in the frontier.



– Productivity improvements can also be achieved by training workers to ensure that existing technology is used more efficiently. This is called **technological progress** or **efficiency improvement** and is represented by movement from below the frontier towards the frontier.

– Dual to the production frontier is the cost function. Costs are a function of input prices, output, and *allocative inefficiency.* Allocative inefficiency refers to deviations from the cost frontier tangent to the production frontier.



Estimating Frontiers

- Two methods, stochastic frontier estimation (SFE) and data envelopment analysis allow applied researchers to estimate production, cost, as well as revenue and profit frontiers.
- Using DEA, all deviations from the frontiers are assumed to be inefficiency.
- Using SFE, we decompose deviations into two components, inefficiency and statistical noise.

- Distance function ratios calculate inefficiencies in DEA – in SFE, distance function ratios are comprised of error term and inefficiency term…statistically calculate the inefficiency term after making assumption re: error distribution.

- In SFE, the technical inefficiency effects are assumed to be a function of a set of explanatory variables, the z_{it}s and an unknown vector of coefficients, δ.

$$U_i = z_i\delta + W_i$$

where the random variable, W_i, is defined by the truncation of the normal distribution with mean zero and variance σ^2, such that the point of truncation is $-z_i\delta$.

Advantages of DEA & SFE

- Both allow us to incorporate different assumptions regarding returns to scale, depending on the industry
- Both allow us to estimate the direction of the inefficiencies, e.g., inefficiencies are the result of input-, output-, or both.
  - Output-oriented inefficiency assumes that firms in this industry could be producing more output from the inputs.

Disadvantages

- Vulnerable to validity problems
  - the closer or further our assumptions regarding inefficiencies are from the frontier, the more or less valid any results based on the assumption
- Not theoretically driven
  - In SFE, inefficiency is assumed to be part of the deviation from the traditionally determined production function. There is no theory to support this.

- DEA results are determined by peers and inefficiency scores can change depending on who’s included in the analysis

Policy Applications

- Widely applied in a variety of economic and policy applications
  - Banking, agricultural, health, energy, eduction, and regulation economics.
- Provides another metric for relative performance, esp. those at the bottom and high-performers – identifies problem providers as well as best practice providers.

- Covariates in the models can highlight contributors to efficiency/inefficiency
- Will give us insights into the substitutability of various inputs and inefficiencies in allocation of inputs, esp. capital

Research Proposal

- Phase I
  - Identify determinants of variations in inputs
- Phase II
  - Using outcome indicators, identify relationship of inputs to outcomes
  - Explore application of SFE/DEA production frontier approaches to the data

Data

- Ohio Medicaid nursing facility cost reports for 1996-1999 (4 years)
  - Total hours by nursing facility for each job classification
  - Unit prices for each labor input
  - Total costs for non-labor variable costs
  - Depreciation and interest expense on capital
- NH-specific Quality Indices from MDS

Methodology

- **2 Major Inputs**
  - Labor by category (RNs, LPNs, STNAs, Administration, Indirect, Ancillary services)
  - Capital by category (plant maintenance, number of beds, utility expenses, depreciation, interest)
- **1, Factor Sets, or 15 Outputs**
  - **10** Clinical Outcome Indicators, 4 functional change indicators, 1 process indicator

Covariates

- **Market Level**
  - Competetiveness index
  - Per-capita bed supply for persons 85+
  - Median income
- **Facility Level**
  - Medicare
  - For-profit
  - Chain-affiliated
  - Religious

  - Hospital-based (Y/N)
  - Size of facility (scale)
  - Education level of administrator
  - Occupancy rate
  - Payer mix
- **Residency characteristics**
  - Average case mix

- **Revenue to Expense data**
  - Revenues/Expenses by cost center
  - Revenues – expenses
  - Quick ratio
  - Acid-test ratio
- **Reimbursement System Variables**
  - Above/below ceiling
  - Amount of efficiency incentive (indirect & capital)

Feedback

Equations

$DC_{ijt} = f\ (R_{it}, p_{ijt}, DC_{i(j-1)t}, CC_{iht}, RE_{it}, M_{it}, F_{it})$

$IC_{igt} = f\ (R_{it}, p_{ij}t, CC_{iht}, RE_{it}, M_{it}, F_{it})$

$CC_{iht} = f(R_{it}, RE_{it}, M_{it}, F_{it})$

$Qit = f(DC_{ijt}, CC_{iht} \mid R_{it}\ RE_{it}, M_{it}, F_{it})$

Methods

Potential of Medicare PPS Implementation and implications for design