

Productivity Analysis in Health Care

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Outline of Talk

- Nature of the Health System as a Production Function: where do economic theory and empirical analysis intersect at the Health System Level?
- Efficiency Based Methods: applications in health organizations and physician offices
- Inefficiency Measurement Based Methods: diversity of methods, how to make a real process improvement difference

Production Technology: Outputs y Producing Inputs x (Lovell, 1993)

- Represented by Input Set:
 - $L(y) = \{x: (y, x) \text{ is feasible}\}$
- Has for every y an Isoquant:
 - Isoq. $L(y) = \{x: x \text{ in } L(y), \lambda x \text{ not in } L(y), \lambda \text{ in } [0, 1)\}$
- And Efficient Subset:
 - Eff. $L(y) = \{x: x \text{ in } L(y), x' \text{ not in } L(y), x' \leq x\}$
- Structure Best Described in Terms of Distance Functions: Multidimensional distance from any productive activity to boundary of production possibilities
 - Duality then allows production/cost/revenue/profit etc.

What Are the Elements of a Production Function/Technology?

- Inputs (Labor, Capital, other Resources?)
 - Consideration of all Possible Combinations
- Outputs (Multiple or Single?)
 - Maximum Output Attainable from Input Possibilities
- Quality of Service (Varying Substantially?)
- Substitutability or Complementarity of Inputs (Right Mix of Inputs? Essential Inputs?)
- Scale and Scope Economies (Production or Consumer View of Product Relationships?)
- Allocative, Economic, and Technical Efficiency (What is/are the Relevant Measure/Measures?)

What are the Health System Issues that are Distinctive in Production?

- Inputs: Financial Resources Rather than Specific Inputs Usually are Used at Health System Level
- Outputs: Measurement of Health Status is Key(!)
- Quality of Service: Does Vary Substantially, Data Generating Process Still Not Understood
- Substitutability/Complementarity: Not Usually Considered, but IS Key to Resource Allocation
- Scale and Scope Economies: Scope Economies for Producer/Consumer Not Well Understood
- Allocative/Economic/Technical Efficiency →

Allocative Efficiency

- In Current Health Practice, Allocative Efficiency Usually is Assessed via Economic Evaluations at a Micro-Level in Evaluating Health Services
 - Incremental Cost Effectiveness Ratios and Acceptability Curves (e.g.)
- Relative Disconnect Exists Between Research on Health System Evaluation for Allocative Efficiency and Production Function Evaluation of the Health System as a Whole, Which May Be Distinct from Services We Call Health Services
- Economies of Scale/Scope are Important

Economic Efficiency

- Determination of Economic Efficiency Given Technical Efficiency Trades Off Input Prices
- Relative Input Prices for Health Services Vary Dramatically and Frequently are Subject to Non-Market Influences
- Which Inputs are Complementary and thus “Essential” to Producing Particular Outcomes?

Fare, Grosskopf, Lindgren, and Poullier Definition of Health System Technical Efficiency

- Technical efficiency in health care at the level of country performance has been defined as catching up to what can be done under current technology while technological change or shifts in the attainable technology encompasses both process innovation and product innovation

Measurement of Health System Production Functions

- General Problem of Aggregation Bias
- Other Measurement Error Problems also Abound – Drawing Conclusions from Flawed Data, even “Best Available”, May Still Be Extremely Problematic
- Role of Estimating Inefficiency
- Precisely Defined Outcomes at the Patient Level Highlight Uncertainty of Costs/Inputs
- Precisely Defined Costs/Inputs Highlight Uncertainty of Patient Level Outcomes of Delivered Health Services using those Inputs

What are the Key Questions?

- Think about the Levels of the Production Function From Individual Patient Encounters to Population Health – What Issues are Relevant to the Key Questions?
- Do Complicated Methods Serve the Purposes or Do they Limit Applicability??
- If the Real Problem is Measurement, then What Do We Measure and How Do We Measure It???
- Are Technical Change Realities and Opportunities Dominated by Process or Product Innovation????

Efficiency Based Measures

- Cost Functions
 - Use of hybrid flexible functional forms
 - Measuring scale/scope economies and quality
- Production Functions
 - Difficulties estimating complementarities between inputs (e.g. hospitals need both physicians and nurses, not substitutable)
 - Simultaneous equation methods estimate the production technology as a labor requirements system with inputs as LHS vars.

Efficiency Methods in HC Orgs.

- Hospitals or nursing homes most common
- Continuing difficulties distinguishing quality of care differences from case-mix differences and unobserved heterogeneity
 - Gertler and Waldman (1992, nursing homes), Carey (1997, hospital panel data), Carey and Burgess (1999, hospital quality with lagged quality as instruments in panel data)
- Measuring economies of scale and scope
 - Wilson and Carey (2004, hospital panel data using non-parametric/discrete kernel estimation) maximize functional flexibility that is required for success

Efficiency Methods for MDs

- In most countries MDs operate at least partly independently, evaluated separately
- Measuring all labor inputs in health care services, assigning them properly to output contributions, and measuring complementarity/substitutability tends to be a difficult empirical task
- Output specification varies from simple to complex (e.g. visits, billings to RVUs or panel sizes for primary care)

Efficiency Methods for MDs, cont.

- RVUs link production measures across specialties and seem to reflect effort well (Lasker and Marquis, NEJM, 1999)
- While capitation in primary care has been a concept for some time, relatively little work on productivity by panel size
- Thurston and Libby (ReStat, 2002) capture physician practice productivity very well using Diewert's Generalized Linear Production Function and q -complementarity between inputs
 - Thurston and Libby find all other labor inputs are q -complements to physicians in production

Inefficiency Measurement Based Methods

- Key role of the Newhouse (1994) critique, also applies to efficiency based methods in large part
- Key problem in my view:
 - Policymakers want to understand waste or inefficiency at the individual provider level
 - But providers (hospitals, nursing homes, physician groups, etc.) produce heterogeneous outputs (!!)
- Researchers too often attack this with ever more complex technical solutions to data/modeling problems w/o considering other perspectives

Newhouse (1994) Critique Points

- Unmeasured Inputs
- Need for Better Case-Mix Controls
- Strong and Non-Testable Assumptions in the Estimation Methodologies
- Omitted or Improper Outputs
- Fundamental Problem of Aggregation
 - Heisenberg Uncertainty Principle of Productivity Analysis (Inputs vs. Outputs)

Inefficiency Methodologies

- See Hollingsworth (HCMS, 2003) for detail
- Parametric Frontier Methods
 - Most similar to efficiency-based methods, since they just add one-sided error terms
- Non-Parametric Frontier Methods
 - Data Envelopment Analysis (DEA), Free Disposal Hull (FDH) etc. use Linear Programming methods
- Integrated Frontier Methods
 - Using multiple methods and then looking for consistency (useful in general) has not worked well
 - Newer methods combine stochastic and non-stochastic concepts in mixed methods (complex!)

Parametric Frontier Methods

- Two Excellent Studies that Build Well from Theory/Conceptual Frameworks to Analysis:
 - Gaynor and Pauly (JPE, 1990) on MD practices
 - DeFelice and Bradford (HE, 1997) relate inefficiency to organizational structure
- Most Promisingly: Focus on SMALLER Units of Analysis (why hospitals, when services or patients may generate interpretable results??)
- Models seldom sensitive to one-sided error term specification (Kumbhakar and Lovell, 2000)
- Greene (2002) software can be used to estimate most models easily

Non-Parametric and Integrated Frontier Methods

- Nature of deterministic methods requires careful attention to conceptual frameworks and research questions to get results
- Also looking at smaller units and FDH methods, or directional distance functions or slacks can yield more interpretable and useful analyses
- Statistically integrated methods (e.g. Simar and Wilson, 2000) can test hypotheses regarding model design and structure
- Hollingsworth (Economic Journal, 2004) reviews existing software packages

Explaining Inefficiency and Process Improvement Recommendations

- Second stage regression and other techniques for doing this almost always severely flawed, despite appealing idea
- Data generating process could be seen as truncation, but not as censoring
- More importantly, any estimates of inefficiency are serially correlated in complex ways, difficult to model
- Best advice is not to do this, but approach process improvement recommendations more directly from the data, with heavy caveats

What are the Key Questions Revisited?

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