Assessing technical efficiency of healthcare services and programs

Traditional methods and new approaches

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1. Measuring Technical Efficiency

A brief review (Dutta)
The health systems concern with technical efficiency

**Measure technical efficiency (TE) to improve resource use**

*Input-oriented*: minimize resource use to meet a required health demand

*Output-oriented*: maximize health level using a given level of resource use

**Typical challenges to measuring TE for public health systems**

- Health program or system level production processes complex
- Challenges in defining all outputs and inputs
- Selecting an appropriate policy- or decision-making unit

*Adapted from:* Kalirajan and Shand, 1999.
History of TE measurement

1957
Deterministic approaches pioneered (Farrell).

1977
Stochastic frontier production function estimation published by Aigner, Lovell and Schmidt and Meeusen and Van den Broeck

1978
Data Envelopment Analysis first introduced (Charnes et al.). Varian incorporated stochastic characteristics in 1985.

1994
Bayesian approach (van den Broeck et al.)

Now: New tools and approaches for global public health?

Where TE analysis for public health systems usually begins...

If we can analyze the production process for the health area, we could begin examining TE.

Two ways:
- **Non-parametric approaches** (e.g., Data Envelopment Analysis, applying visualization as in Figure 1)
- **Parametric approaches** (e.g., Stochastic Frontier Analysis)

**Figures 1**

- **CRS** = constant returns to scale
- **VRS** = variable returns to scale
- **NIRS** = non-increasing returns to scale

1. Applying DEA to health system level analysis

**Strengths**

- Since *no production function* needs to be specified it can fit the difficulty in estimating one for health systems
- Can consider multiple inputs and outputs at the same time
- Analytical procedures widely available (e.g., Stata dea)
- Has been used to model TE of health systems (e.g., Cylus et al., 2017)

**Weaknesses**

- Efficiency scores across different health system studies cannot be compared
- Data availability forces basic DEA models
- Most studies do not include quality variables as covariates
- Limited impact of DEA results on decision-making
- **Use for evaluation of health system changes?**  We provide an example of how we did this

**Source:** Kohl et al., 2019; Cylus et al., 2017.
2. Other possibilities for TE analysis of public health systems

Can process measures be improved?

- Increase scope of TE analysis with a mix of indicators capturing different parts of the health system or program. Combine them with weights
- Methodological challenge: how best to develop these weights?
- Decision-making utility: can process measures lead to real policy change?

We present two examples of potential real-world fixes.

Adapted from: Cylus et al., 2017.
2. Is Indonesia’s National Health Insurance Associated with Greater Hospital Efficiency?

Using DEA and Private Hospital Survey Data (Ross)
Background and Rationale

• National Health Insurance (JKN)-contracted hospitals are paid per admission, visit, or procedure through Indonesia Case-Based Groups (INA-CBGs).

• Under INA-CBGs, given few national treatment guidelines, providers have flexibility to optimize facility resources for treatment procedures, interventions, and drug administration.

What has been the private hospital response; has hospital use of resources improved since JKN initiation? Has technical efficiency changed?

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Costs covered by</th>
<th>Proportion of total hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>Wages: Government through national or local budgetary transfers</td>
<td>Federal: 10%</td>
</tr>
<tr>
<td></td>
<td>Capital expenditure: Mixed: JKN, national or local transfers, user fees</td>
<td>Local: 26%</td>
</tr>
<tr>
<td>Private non-profit</td>
<td>Wages: Mixed: JKN transfers from philanthropic or faith-based organizations, user fees, private health insurance</td>
<td>22%</td>
</tr>
<tr>
<td>Private for-profit</td>
<td>Wages: Mixed: JKN transfers from corporate reserves (network hospitals only), user fees, private health insurance</td>
<td>42%</td>
</tr>
</tbody>
</table>

Source: MOH, 2018
Methodology - 1

1. Data Envelopment Analysis (DEA) to assess the change in physical inputs and outputs (technical efficiency) used pre- (2013) and post-JKN initiation (2016)

- Non-parametric, linear programming to measure proportional change in multiple inputs and outputs without data distribution assumptions
- 4 models, each output-oriented with variable returns to scale
- For each decision-making unit, \( i = 1, \ldots, N \), calculate a bias corrected efficiency score

\[
\hat{\theta}_{i}^{bc} = \hat{\theta}_{i} - \left( \frac{1}{B} \sum_{b=1}^{B} \hat{\theta}_{i}^{b} - \hat{\theta}_{i} \right)
\]

Technical efficiency: the state in which every resource is optimally allocated, minimizing waste and misuse

Source: Badunenko and Tauchmann, 2018.
Difference-in-Difference truncated regression models to understand whether BPJS-K (payer agency) contract status influenced observed change in DEA efficiency score between study years

- Used Simar and Wilson (2007) methodology for inverted (Farrell) efficiency scores
- For each department type, $i$, in time $T$:

$\hat{\theta}_{iT}^{bc} \text{efficiency}_{iT} = \beta_0 + \beta_1 \text{Contracting}_i + \beta_2 \text{Time}_T + \beta_3 \text{Contracting}_i \text{Time}_T + \beta_4 Z_{iT} + u_i + \varepsilon_{iT}$
Data Used

Data Sources

Data collected from 73 private hospitals across 11 provinces

Operational data collected from hospital records of 2013 and 2016

Variables Included

Inputs
- Number of wards/clinics
- Number of beds
- Index of human resources

Outputs
- Inpatient days
- Inpatient surgical services provided
- Outpatient services provided

Covariates
- Geographic group
- Residence, urban
- Population density
- Hospital classification
- Hospital ownership
Facilities contracted with JKN showed larger increases in capacity, but this increase was not related to JKN.
(b) How have output variables changed over time?

Among JKN Contracted Hospitals
Inpatient days: 51%
OPD services: 35%
Surgical services: 67%

Among non-JKN Contracted Hospitals
Inpatient days: -43%
OPD services: -14%
Surgical services: -14%
(c) Has private hospital efficiency changed since JKN initiation?

Average Efficiency Scores (2013, 2016)

<table>
<thead>
<tr>
<th>Department</th>
<th>2013</th>
<th>2016</th>
<th>2013</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient Department</td>
<td>-4.7%</td>
<td>12%</td>
<td>-3.4%</td>
<td>12%</td>
</tr>
<tr>
<td>Outpatient Department</td>
<td>14%</td>
<td>27%</td>
<td>14%</td>
<td>27%</td>
</tr>
</tbody>
</table>

Non-BPJS-K-Contracted

BPJS-K-Contracted
(d) Does JKN contract status affect changes in efficiency?

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Inpatient Department Efficiency</th>
<th>Outpatient Department Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>JKN-contracted</td>
<td>-1.002</td>
<td>-0.042</td>
</tr>
<tr>
<td>Year: 2016</td>
<td>-2.434*</td>
<td>0.503</td>
</tr>
<tr>
<td>Interaction: JKN-contracted and year</td>
<td>3.455**</td>
<td>-0.096</td>
</tr>
<tr>
<td>Geographic group: Java (reference = Sumatera)</td>
<td>3.512***</td>
<td>-0.01</td>
</tr>
<tr>
<td>Geographic group: others (reference = Sumatera)</td>
<td>-0.094</td>
<td>-0.274</td>
</tr>
<tr>
<td>Residence: urban</td>
<td>0.837</td>
<td>-0.758**</td>
</tr>
<tr>
<td>Population density</td>
<td>0.000***</td>
<td>0.000</td>
</tr>
<tr>
<td>Hospital classification: Type C</td>
<td>1.732**</td>
<td>-0.397**</td>
</tr>
<tr>
<td>Hospital classification: Type D</td>
<td>-2.153*</td>
<td>-1.185***</td>
</tr>
<tr>
<td>Hospital ownership: for-profit</td>
<td>-2.920***</td>
<td>-0.734***</td>
</tr>
</tbody>
</table>

* p < 0.05; ** p < 0.01; *** p < 0.001
Limitations

- Sample of surveyed hospitals does not include Class A hospitals
- Limited sample size; we cannot generalize these findings to the entire private sector
- Not causal inference; we cannot directly attribute efficiency changes to JKN or contracting with JKN
- Without costs or prices we cannot assess allocative or total efficiency of private hospitals

A Family Planning and Technical Efficiency Assessment Tool (Barker Cantelmo)
Why do family planning (FP) programs need to maximize efficiency?

Unpredictable and plateauing donor government funding for FP…

…with limited fiscal space for FP in developing countries
Why existing approaches are insufficient

**Allocative efficiency models that consider family planning:**

DEA approaches measure TE by health facility, but we need to understand inefficiencies across multiple levels of the FP program.

**Technical efficiency models for policymakers do not exist:**

Existing FP efficiency studies are limited and mostly focus on efficiency gains from task-shifting/sharing and integrating FP with other services.
New tool to assess FP program technical efficiency

HP+ will pilot the Excel-based tool in two countries in 2020

1. Diagnose inefficiencies

Deconstructed efficiency scores for up to 26 FP program components

2. Identify root causes

Identify up to 5 root causes for each inefficient program component

3. Evaluate potential solutions

Country develops action plan for solutions deemed most effective and feasible to implement

Engage key FP stakeholders including government, service providers, and CSOs
Step 1: Diagnose Inefficiencies

- Compute inefficiency scores based on input-output ratios for each of the 26 family planning program components
  - Tool includes multiple options for input and output indicators based on country context and data availability
  - Some indicators are composite indicators
- Criteria applied to determine whether ratio is indicative of inefficiency
  - Comparison to other countries
  - Comparison to other ratios within country application
  - Stand-alone interpretation
## Step 1: Diagnose Inefficiencies

### Service Delivery
- FP-HIV integration
- Adolescent-friendly services
- Postpartum FP
- Availability of commodities
- In-service training for providers

### Demand Creation
- Voucher programs
- Health insurance
- Interpersonal communication

### Program Management
- Policy commitment
- Private sector engagement
- Decentralization
- Budget formulation
- Budget execution

### Supportive supervision
- Task-shifting or task-sharing
- Health workforce distribution
- Facility use
- Distribution of service points

### Mass media communication
- Male engagement
- Social marketing

### Donor coordination
- Commodity procurement
- Commodity security
- Stewardship
- Information use
Step 1: Diagnose Inefficiencies

**Adolescent-friendly services**

**Potential inputs**

A. % of health workers trained to provide adolescent and/or youth-friendly services

B. % of facilities that provide adolescent and/or youth-friendly services

**Potential outputs**

C. % of FP users ages 15-24 who accessed FP from a facility providing adolescent and/or youth-friendly services

D. Unmet need for FP among women ages 15-24

*Interpretation of ratio depends on the specific input and output selected*

- If A or B/C > 1, may indicate inefficiency
- For A or B/D, the higher the score, the better due to widespread implementation of services and low unmet need among targeted population
Step 2: Analyze Root Causes

For those FP components deemed inefficient, **root causes are identified** through focus group discussions (FGDs) with key FP stakeholders.

The tool provides several root causes for each FP component as a starting point for FGDs; these should be customized to fit the unique conditions of each country.

<table>
<thead>
<tr>
<th>Illustrative Inefficient Component</th>
<th>Illustrative Root Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adolescent-friendly services</td>
<td>Legal and policy barriers</td>
</tr>
<tr>
<td></td>
<td>Commodity stockouts</td>
</tr>
<tr>
<td></td>
<td>Provider bias/stigma</td>
</tr>
<tr>
<td></td>
<td>Facility space constraints</td>
</tr>
</tbody>
</table>
Step 3: Identify and Evaluate Inefficiency Solutions

- Solutions for each root cause – across FP components deemed inefficient – are identified in consultation with stakeholders.

- Each solution is evaluated based on four criteria to support prioritization:
  1. Does the family planning program have control over implementing this solution?
  2. How long will it take to implement the solution?
  3. What is the estimated additional cost to implement the solution?
  4. What is the perceived effectiveness of the solution?

- Stakeholders agree to weights for the four criteria at the beginning of the exercise.
Strengths and limitations of the proposed new TE tool

**Strengths**

- Able to assess efficiency of specific FP program components across all levels
- Customizable to country context and data availability
- Uses specific inputs and outputs
- Key policymakers and program managers engaged throughout process

**Limitations**

- Ratio scores do not account for covariates
- Some ratios are more difficult to interpret
- Does not assign overall TE score for the FP program
- Requires detailed data inputs, and countries may not have accurate/complete data
4. New Tools and Approaches for Assessing Technical Efficiency

Using Selected Data to Assess Efficiency and Advocate for Increased Health Funding in Kenyan Counties

(Khaoya)
Why do we care about TE in health care spending in Kenyan counties

A legal requirement

- Article 104(1)(K) of Public Financial Management (PFM) Act, 2012 provides for county treasury to monitor the county government’s entities to ensure compliance with this Act and effective management of their funds, efficiency and transparency, and proper accountability for expenditure of funds.

Plateau in budgetary allocation to health in counties (~27% of budget) hence the need for prudent management of allocated resources to achieve the same level or better outcomes.

- Improvement in TE is an avenue of application of PFM principles which can increase resources to health
HP+ approach and interventions to support TE in Kenyan counties

Approaches

1. **Capacity building** with a focus on programme-based budgeting (PBB) (linking inputs to outputs)

2. **Evidence generation** to inform TE
   - Ratio analysis discussed with counties to inform action plans (expenditure, workload, and bed ratios)
Existing approaches not readily applicable to a systemwide measurement of efficiency

Our approach for evidence generation:

- **Ratio analysis**: uses descriptive techniques to obtain the level of performance of a given health providing unit (county)
  - **Cost or expenditure ratios**
    - Expenditure/outpatient visit
    - Expenditure/inpatient admission
    - Expenditure/bed/day
  - **Workload ratios**
    - Doctor/patient ratio
    - Nurse/patient ratio
  - **Bed ratios**
    - Average length of stay (ALOS)
    - Bed occupancy rate
Specific actions to improve TE in Kenyan counties

1. Capacity building on PBB
HP+ developed a PBB curriculum whose focus is to improve efficiency in public financial management.

HP+ has built capacity on PBB in seven counties to develop budgets/annual workplans which are PBB-compliant in line with PFM Act, 2012.

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### Programme Logic

**Definition**

A collection of related activities working towards a common purpose.

**Health Dept Example**

Preventive Health

**Objective**

Reduce prevalence of common diseases by 30% through pre-emptive community health interventions and appropriate educational outreach.

### Sub-programme

**Definition**

A group of projects/activities under the same operational or development priority policy objective.

**Health Dept Example**

Community Health

**Outcome(s)**

- Reduce prevalence of malaria by 15% or 475,000 over five years based on a historic baseline average;
- Target for budget year = 95,000 fewer hospital admissions directly attributable to programme interventions.

### Output(Services)

**Definition**

These are all the services that are delivered to parties external to the ministry or department. Services delivered to a client within the same ministry are not outputs but support services.

**Health Dept Example**

Malaria Eradication

**Output(Services)**

Malaria Eradication Service

- Distribute 20,000 treated nets distributed to 9500 households this year;
- Larvae eradication - Treatment of breeding grounds;
- Public Education on preventive measures;
- Prophylactic Medicine;
- Early detection and response service

### Activity(ies)

**Definition**

Activities are work processes in the production of the Output.

**Health Dept Example**

Distribution of 20,000 Mosquito Nets to 9500 Homes

**Activity(ies)**

- Distribute 20,000 treated nets distributed to 9500 households this year;
- Larvae eradication - Treatment of breeding grounds;
- Public Education on preventive measures;
- Prophylactic Medicine;
- Early detection and response service

### Inputs

1) Health workers & Clinicians
2) Offices
3) Vehicles and fuel supply
4) Equipment e.g sprayers, office equipment, mobile phones,
5) Admin support staff
6) Procure medicines and treated nets etc.

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**Linking inputs to outputs**
2. Evidence generation to inform policies on technical efficiency
Ratio analysis for fiscal year 2018/19

<table>
<thead>
<tr>
<th></th>
<th>Kilifi</th>
<th>Kitui</th>
<th>Kisumu</th>
<th>Mombasa</th>
<th>Migori</th>
<th>Nakuru</th>
<th>Turkana</th>
</tr>
</thead>
<tbody>
<tr>
<td>CGHE/outpatient visit (USD)</td>
<td>11.7</td>
<td>10.7</td>
<td>13.9</td>
<td>25.6</td>
<td>11.5</td>
<td>16.0</td>
<td>19.6</td>
</tr>
<tr>
<td>CGHE/inpatient visit (USD)</td>
<td>837.2</td>
<td>1202.0</td>
<td>649.5</td>
<td>833.8</td>
<td>554.4</td>
<td>696.9</td>
<td>1512.5</td>
</tr>
<tr>
<td>CGHE/inpatient occupied bed day (USD)</td>
<td>193.0</td>
<td>114.0</td>
<td>129.6</td>
<td>142.0</td>
<td>225.8</td>
<td>139.8</td>
<td>414.3</td>
</tr>
<tr>
<td>Personnel emoluments/outpatient visit (USD)</td>
<td>6.6</td>
<td>6.1</td>
<td>11.1</td>
<td>17.8</td>
<td>7.5</td>
<td>9.0</td>
<td>12.6</td>
</tr>
<tr>
<td>Personnel emoluments/inpatient visit (USD)</td>
<td>472.4</td>
<td>680.9</td>
<td>519.4</td>
<td>579.1</td>
<td>360.2</td>
<td>393.9</td>
<td>968.5</td>
</tr>
<tr>
<td>Personnel Emoluments/Inpatient occupied bed day (USD)</td>
<td>108.9</td>
<td>64.6</td>
<td>103.6</td>
<td>98.7</td>
<td>146.7</td>
<td>79.0</td>
<td>265.3</td>
</tr>
<tr>
<td>ALOS in # of days</td>
<td>6.5</td>
<td>8</td>
<td>5.3</td>
<td>9.2</td>
<td>2.1</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

CGHE = County Government Health Expenditure

Mean conversion rate of Ksh to US$ = 101.155022709163
General decrease in health expenditure per service output, 2016/17 -- 2018/19
Improvement in health labour efficiency across counties

Personnel Expenditure/Outpatient Visits

Personnel Expenditure/inpatient Admissions
Result: Counties used efficiency analysis to inform their policy decisions

- County teams appreciated need for accurate data
  - Action plan to improve data quality
  - Human resources for health audit (identify ghost workers)

- Replaced retiring specialized doctors with contract doctors (case of Mombasa County)
  - Most counties reducing proportion of recurrent expenditure allocated to PE
Health Policy Plus (HP+) is a five-year cooperative agreement funded by the U.S. Agency for International Development under Agreement No. AID-OAA-A-15-00051, beginning August 28, 2015. The project’s HIV activities are supported by the U.S. President’s Emergency Plan for AIDS Relief (PEPFAR). HP+ is implemented by Palladium, in collaboration with Avenir Health, Futures Group Global Outreach, Plan International USA, Population Reference Bureau, RTI International, ThinkWell, and the White Ribbon Alliance for Safe Motherhood.

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