Productivity and Quality in Health Care: Evidence from the Dialysis Industry

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Health Care Expenditures are Rising

- Health care expenditures are rising faster than income in most developed countries.
- Policy makers are looking for mechanisms to slow the increase in health care costs by incentivizing productivity.
  - Medicare Prospective Payment System (PPS): Pay for medical care on the basis of diagnosis, not on cost of treatment provided.
  - In the private sector, HMOs operate in a similar manner.
  - Proponents of increased competition argue that medical services will compete on price and eliminate "wasteful procedures."

Our Questions:

What could go wrong?

- Being an experience good, it can be difficult for consumers or regulators to observe quality of care.
- If we give providers incentives to be more "productive", will they respond by lowering quality?

Empirical question 1: Is it costly for medical personnel to exert effort to increase quality?
Empirical question 2: Do they adjust the effort on the basis of incentives?

Basic Approach

- Focus on the US Dialysis Industry
  - Relatively homogeneous service with clear measure of output quantities.
  - Clear capital and labor measures.
  - Stand-alone facilities, so no cross-subsidization issues as in hospitals.
  - Prices set by Medicare, independent of quality of care.
- Consistently estimate a production function augmented to include quality effort.
- Estimate quality policy functions controlling for center productivity.

Challenges

- Quality (and input choices) are endogenous.
  - Adapt Olley-Pakes (OP) and Ackerberg, Caves, Frazer (ACF) models for use in dialysis industry.
- Quality is not directly observed.
  - Proxy for quality effort with outcome measure (infection rate) and correct for measurement error by using a second outcome measure as an instrument.

Preview of Results

Quality is Costly:

- Holding quality and capital fixed, raising output 1.2 percent would require a 5 percent increase in labor inputs. Hiring one additional part time worker for average staff levels.

Firms with stronger profit incentive offer lower quality:

- Non-Profit Centers have infection rates 1.3 percentage points (more than 10 percent) lower than for-profit centers.

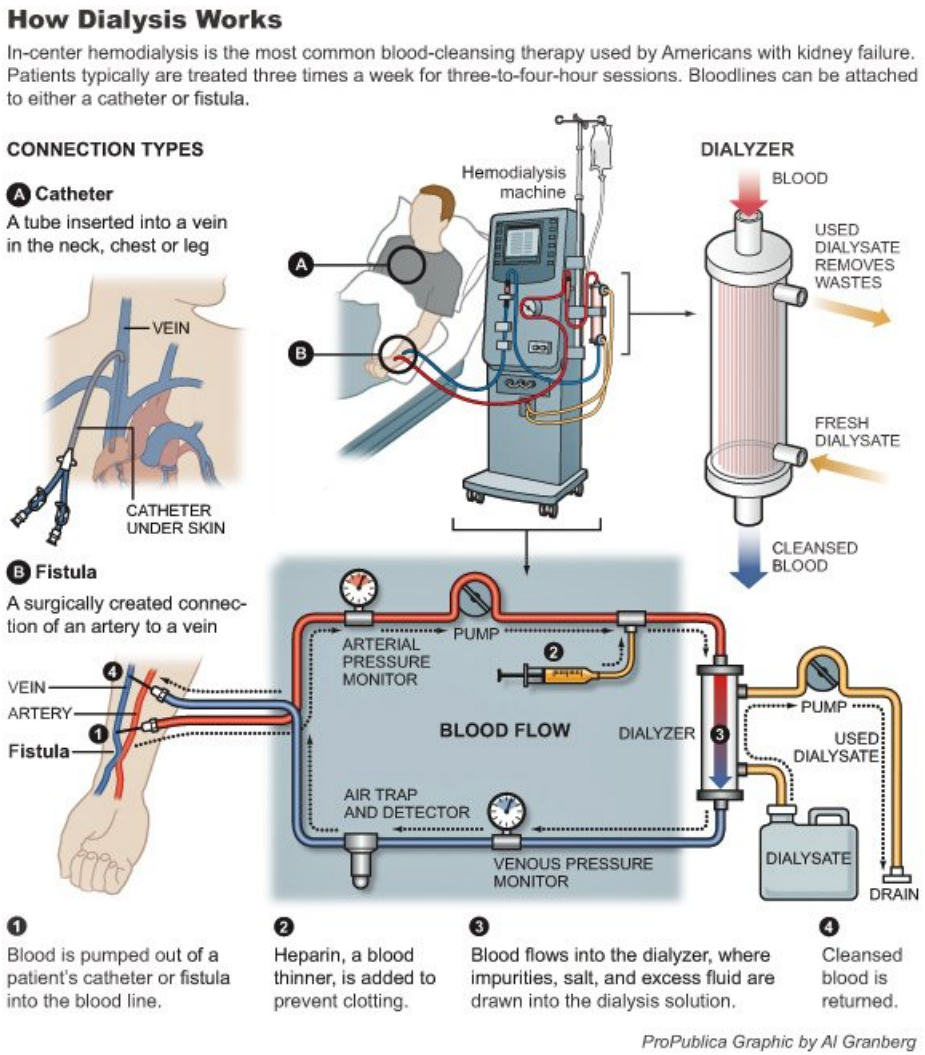
Competition does not seem to incentivize higher quality:

- Centers in monopoly markets do not have lower quality.

Related Work

- Production Function Estimation: Olley and Pakes (1996), Levinsohn and Petrin (2003) Ackerberg, Caves, and Fraizer (2006); Gandhi, Navarro and Rivers (2011) and many others...
- Dialysis Provision:
  - Ramanarayanan and Snyder (2011) — examine whether dialysis centers respond to "worse than expected" ratings using a regression discontinuity design.
  - Dai (2012) — Examines product differentiation between hemodialysis and (in-home) and peritoneal dialysis and the impact of the 2008 adjustment in medicare reimbursement rates.
  - Cutler, Dafny, and Ody (2012) — Use mergers to estimate impact competition on quality, find little effect.

Dialysis Procedure



Data

Medicare (CMS) prepares annual report on every dialysis provider in the US we have collected data on the reports from 2004-2009.

- Location, name, and ownership information.
- Inputs: number of nurses and technicians and number of stations.
- Outputs: Patient-hours served (accounting for death, transplant, new patients and transfers).
- Quality Outcomes:
  - Hospitalization rate for septic infection.
  - Death rate at center, and expected death rate calculated with individual patient characteristics.

Production Function

We assume a Cobb-Douglas production function,

$$Y_{it} = A_{it}(q_{it})K_{it}^{\beta_k} L_{it}^{\beta_\ell},$$

where for center i in year t,

- Y_{it} is patient-years of service provided.
- K_{it} is the number of stations available in the center.
- L_{it} is full-time equivalent nurses and technicians on staff.
- $A(q_{it})$ is a Hicks-neutral technology shifter which depends on "quality target" for septic infection rate.

Production Function

Let,

$$A(q_{it}) = e^{\alpha_0 + \alpha_q q_{it} + \omega_{it} + \epsilon_{it}},$$

Where,

- α_q is the impact of quality targets on production.
- ω_{it} is the firm productivity which is observed by the firm at t.
- ϵ_{it} is unanticipated productivity or measurement error.

Taking logs we arrive at,

$$y_{it} = \alpha_0 + \alpha_q q_{it} + \beta_k k_{it} + \beta_\ell \ell_{it} + \omega_{it} + \epsilon_{it}$$

Endogeneity

$$y_{it} = \alpha_0 + \alpha_q q_{it} + \beta_k k_{it} + \beta_\ell \ell_{it} + \omega_{it} + \epsilon_{it}$$

- We face the usual endogeneity problem: centers observe ω_{it} when choosing inputs and quality target.
- Olley-Pakes approach: use investment as a proxy to develop a control function for productivity.
- However, we can't use investment because net investment is zero 90% of the time.
- Instead we'll use net hiring, because of license and training requirements, delay in hiring fits the industry.

Measuring Quality

$$y_{it} = \alpha_0 + \alpha_q q_{it} + \beta_k k_{it} + \beta_\ell \ell_{it} + \omega_{it} + \epsilon_{it}$$

- Quality effort is not directly observed.
- We proxy for quality effort by using the rate of hospitalization for septic infection.
- Since proxy is noisy, use rate of deaths to expected deaths as an instrument.
- Our approach gives similar results whether or not we use instruments.

The Quality Proxy

- Beyond quality effort, the infection rate is affected by patient characteristics in the center.
- While Medicare constructs "expected deaths" from individual patient charachteristics, they do not do so for infections.
- Instead we use center aggregates, z_{it}:
  - Average Age, Percent Female
  - Percent with AV Fistula
  - Average number of comorbidities
  - Duration of ESRD, Average hemoglobin levels
- We then use the residual of:

$$i_{it} = z_{it}'\delta - q_{it}$$

as our proxy for quality.

Policy Shifters

We allow firm policies to depend on observable characteristics, x_{it} that do not directly affect production.

- **For-Profit Status:** Non-profit firms may prefer higher quality because they are maximizing something other than profits.
- **Competition:** Centers in competitive markets may want to provide higher quality of service.

So we have the policy functions:

$$q_{it} = q(k_{it}, \ell_{it}, x_{it}, \omega_{i,t-b}) \qquad h_{it} = h(k_{it}, \ell_{it}, x_{it}, \omega_{i,t})$$

Results

Start by comparing our model with simpler approaches:

- OLS: Assume choices are uncorollated with productivity (ignore endogeneity).
- Fixed Effects: Assume center productivity is fixed over time.

If quality provision is positively corrolated with productivity, we would expect that both OLS and FE estimates of α_q would be biased upwards.

Table: Production Function Estimates.

	OLS	FE	Model
Quality Effort, α_q	-0.0028	-0.0018	-0.0124
	(0.0007)	(0.0004)	(0.0042)
Capital, β_k	0.4607	0.1788	0.5134
	(0.0209)	(0.0514)	(0.0468)
Labor, β_ℓ	0.6723	0.1855	0.2453
	(0.0149)	(0.0119)	(0.0319)

Results on Quality-Quantity Tradeoff

- Lowering quality target (raising targeted septic infection rate) by 1 percentage point can increase output by 1.2 percent.
  - Serving roughly one additional patient (a two percent increase in output for the average center) holding inputs & productivity fixed would raise center's infection rate 1.6 points.
- Same increase in output could be achieved by raising labor input 5 percent.
  - Serving one additional patient holding capital, quality, & productivity fixed would require one additional nurse (roughly a 10 percent increase in staffing).

Incentives to offer high quality

Of course, there may be non-linear effects; as a robustness check, we use the partially linear specification:

$$q_{it} = \gamma_{c(it)} + \delta_{fp(it)} + \mu(k_{it}, \ell_{it}, \hat{\omega}_{it}) + \nu_{it},$$

- $\gamma_{c(it)}$ is a dummy for whether firm faces 0,1,2, or 3 or more firms in its home market (hospital service area).
- $\delta_{fp(it)}$ is a dummy for whether firm is for-profit.
- μ is a non-parametric function of capital, labor, and productivity estimate.
- Can also subsume for profit status and competition levels into μ.

Table: Partially Linear Quality Regressions.

	III	IV	V
For Profit	-1.5390	-1.5444	
	(0.2030)	(0.2111)	
Monopolist	0.4824		0.4725
	(0.2196)		(0.2222)
Duopolist	-0.2977		-0.2926
	(0.1843)		(0.1855)
Triopolist	-0.4678		-0.4431
	(0.2234)		(0.2224)
Nonparametric Control for:			
Productivity	Yes	Yes	Yes
Capital	Yes	Yes	Yes
Labor	Yes	Yes	Yes
For-Profit Status	No	No	Yes
Competition	No	Yes	No

Conclusion

- We find a significant quality-quantity tradeoff in the industry—firms can raise output by reducing quality.
- Firms with different profit incentives choose quality levels differently.
- Competition does not seem to play a strong role in firms' quality policies.
- We suspect these findings apply across many settings: