Healthcare exceptionalism in a non-market system: hospitals performance, labor supply, and allocation in Denmark

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PRELIMINARY, PLEASE DO NOT CITE WITHOUT AUTHORS’ PERMISSION
This paper

1. How does health affect labor supply?
   - we link Danish hospital records to labor market data
   - observe how individuals’ earnings change before and after hospital admission
   - hospital admission = in- and outpatient episodes of care

2. Intermediate goal: measure quality of treatment by exploit labor market response to health shock
   - higher quality of care ⇒ less harmful labor market consequences

3. Final goal: evaluate the degree of “Dynamic Allocation” in non-market system
   - Chandra et al (AER 2016) show that better hospitals grow more over time in US and argue it is due by “market forces”
General Idea

Labor market outcome $y_{i,t}$ is a function of observables $X_{i,t}$ and unobservables: non-health related $\lambda_{i,t}$ and health status $h_{i,t}$

$$y_{i,t} = f (X_{i,t}, \lambda_{i,t}, h_{i,t})$$

- evolution of health status is a function of previous health status and current health shock $s_{i,t}$

$$h_{i,t} = g(h_{i,t-1}) + s_{i,t}$$

Health shock $s_{i,t}$ is characterized by

- its nature, e.g. the disease $d_{i,t}$
- treatment and quality of health care provider $q_{j,t}$

$$s_{i,t} = s(d_{i,t}, q_{j,t})$$

We do not observe neither health status $h$ nor health shocks:

- can we still say something about $q_{j,t}$?
Health Care in Denmark

- Population of 5.7 Million
- Free health care, public hospitals
- Few big hospitals - many merges during last 20 years
Data

1. Universe of Danish hospital records from 1994-2013
   - hospital ID, department ID, department specialty
   - patient type (in- or out-patient)
   - Start-date, end-date, # of bed days
   - 4-digit ICD-10 diagnoses
   - Conducted treatments, operations, examinations and tests

2. Labor market outcomes of Danish population from 1980-2013
   - Everybody - not just patients
   - Yearly earnings, transfers and hours worked (for some workers)
   - Occupation (4 digit ISCO class)
   - Address (Municipality)
   - Highest obtained education, gender, age, marital status

For each Dane, we know his-her work history and all interactions with the hospital system

   - Use 15% random subsample of individuals
“Admission”

We consider each record in the National Patient Register as one admission

- any in-patient hospital admission or visit at ambulatory hospital
- registration process is determined by committee – identical rules across all hospitals
- a record is created whenever
  - patient type changes between in- and outpatient
  - contact type changes between control, treatment, examination
  - significant change in diagnosis (e.g. new disease)

We exclude

- screening and examination records
- pregnancy/childbirth related records
Number of admissions per year

- little data problem in late 2000’s
Admissions and Labor Supply

Let $e_{i,t} = 1$ iff individual $i$ is admitted for the first time to any hospital for a specific condition in year $t$

- We run the event-study regression:

$$Y_{i,t} = \sum_{\tau=t-5}^{t+5} \beta_{\tau} \cdot e_{i,\tau} + FE_{age,gender,t} + \eta_{i,t}$$

Notice:

- $Y_{i,t}$ is yearly earnings or hours worked
- we consider one condition at time
- control group = people with same age
- all figures are conditional on survival
- we focus here on first moments, but effect on variance might be equally important
Earnings: Acute myocardial infarction

- in 2010 Danish Crown ($\approx 6$ for 1 USD)
- mean $\approx 270k$ DNK
Hours Worked: Acute myocardial infarction

mean ≈ 1360
Probability of death: Acute myocardial infarction

Linear Prob Model
Earnings: Diseases of the circulatory system
Hours Worked: Diseases of the circulatory system
Earnings: Diseases of the nervous system
Hours Worked: Diseases of the nervous system
Earnings: Mental and behavioural disorders
Hours Worked: Mental and behavioural disorders
Probability of death: Mental and behavioural disorders
What did we learn?

1. patients are not randomly selected (e.g. lower earnings)
   - use data richness to control for (observable) heterogeneity

2. labor market outcomes around admission:
   - for acute conditions (e.g. AMI) → admission represents an actual “shock”
   - for other conditions, admission arrives after long-term decline in earnings
     - conditions present prior to contact with hospital
     - labor outcome shocks affect health
     - correlated co-morbidities

→ lit use acute conditions (or injuries) to perform diff-in-diff and estimate economic effect of health shocks
   - we don’t want to limit the analysis to few specific diagnoses
A measure of quality

Our goal is to relate the quality of care to the evolution of post-admission labor market outcomes

1. compute the distance between patients’ realized outcome and some counterfactual
2. estimate the size of this difference as a function of which hospital the patient is admitted, conditional on the diagnosis and past medical story

pre-admissions dynamics (trends) are not problematic as long as they are homogeneous across providers for a given diagnosis
Earnings Dynamic

Estimate shock to income $\epsilon_{i,t}$, from the AR(1) process

$$y_{i,t} = \rho(\text{educ}_{i,t}, \text{age}_{i,t}) \cdot y_{i,t-1} + \beta X_{i,t} + \epsilon_{i,t}$$  \hspace{1cm} (1)

where

- $y_{i,t}$ is log earnings of individual $i$ in year $t$
- the autocorrelation coefficients $\rho$ is allowed to vary with age and education
  - $\approx .7$ when held constant
- controls $X_{i,t}$ include
  - age$\times$education FE (heterogeneous age-income profile?)
  - occupation$\times$year FE (sector shocks?)
  - municipality$\times$year FE (geographical shocks?)
- estimated separately for male and female
- only individuals with positive earnings
  - exercise can be repeated for the extensive margin or other outcomes
Hospital admissions and negative earnings shocks

For each individual $i$ and year $t$ we estimate

$$\hat{\epsilon}_{i,t} = \sum_{n=1}^{10} \beta_n \cdot 1 [NAdm_{i,t} = n] + \eta_{i,t}$$

where:

- $NAdm_{i,t}$ are number of hospitalizations of individual $i$ in year $t$ and $1 [\cdot]$ is indicator function
Health shocks have persistent effect on earnings

For each individual $i$, year $t$ and lag $\tau$ we estimate

$$\hat{\epsilon}_{i,t} = \sum_{\tau = t-5}^{t+5} \beta_\tau \cdot NAdm_{i,\tau} + \eta_{i,t}$$

Results (remind, average $\rho$ is .7):
AMI

Focusing on first AMI episode, again

\[ \hat{\epsilon}_{i,t} = \sum_{\tau=t-5}^{t+5} \beta_{\tau} \cdot e_{i,\tau} + \eta_{i,t} \]

Results (remind, average \( \rho \) is .7):
Diseases of the nervous system

\[ \hat{\epsilon}_{i,t} = \sum_{\tau=t-5}^{t+5} \beta_{\tau} \cdot e_{i,\tau} + \eta_{i,t} \]

Results (remind, average \( \rho \) is .7):
Hospital heterogeneity

One obs $a$ is a hospital admission of individual $i(a)$ in year $t(a)$ with main diagnosis $d(a)$ in hospital $h(a)$,

- we measure hospital quality $q_h$ as a FE from regression:

$$
\hat{\epsilon}_{i(a), t(a)} = \gamma d(a) + q_h(a) + \beta X_{i(a), t(a)} + \eta_a
$$

**discussion:**

- one individual can have multiple hospitalizations in same year
  - we build set of controls $X_{i(a), t(a)}$ to proxy for severity of other conditions
  - implicitly assuming health shocks can be controlled for in a linear fashion
- selection on unobserved severity
  - we perform both OLS and IV estimates of $q_h$
  - use patient municipality as an instrument - criticized by Doyle et al (2015)
Estimated hospital quality

We interpret $q_h$ as hospital quality
- the better the healthcare, the less detrimental are health shocks to income

Estimate the model for 4 4-years periods from 1995 to 2012 (we exclude 2007 and 2008)
- we include only hospitals with at least 1,000 in the subsample
  - smaller hospitals put together and used as reference category
- ANOVA tests confirm hospital FEs statistically significant
- we normalize $q_{h,t}$ so that they unit variance
- OLS and IV are correlated $\approx 0.3$
- OLS correlated across periods: autocorrelation $\approx 0.3$
Application: “Dynamic Allocation”


- critique: their quality measures are defined over few conditions

We perform similar exercise:

1. for each hospital $h$ and period $t$ we compute growth rate as

$$
\Delta_{h,t} = 2 \frac{N_{h,t} - N_{h,t-1}}{(N_{h,t} + N_{h,t-1})}
$$

where $N_{h,t}$ is the number of total admissions

2. we estimate

$$
\Delta_{h,t+1} = \beta \cdot \widehat{q}_{h,t} + \gamma_t + \eta_{i,t}
$$

and

$$
\Delta_{h,t+1} = \beta \cdot \widehat{q}_{h,t} + \gamma_t + \lambda_h + \eta_{i,t}
$$
Results

Higher quality hospitals grow more:
- “dynamic allocation” without markets

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<tr>
<td>$\Delta_{h,t+1}$</td>
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<td>$\hat{q}_{h,t}^{OLS}$</td>
<td>0.0596</td>
<td>0.130**</td>
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<td>[0.0500]</td>
<td>[0.0590]</td>
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<tr>
<td>$\hat{q}_{h,t}^{IV}$</td>
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<td>0.0124</td>
<td>0.0954**</td>
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<td></td>
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<td>[0.0484 ]</td>
<td>[0.0462]</td>
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<tr>
<td>Year FEs</td>
<td>×</td>
<td>×</td>
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<td>×</td>
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<tr>
<td>Hospital FEs</td>
<td>×</td>
<td></td>
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<td>×</td>
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<tr>
<td>Obs</td>
<td>302</td>
<td>271</td>
<td>302</td>
<td>271</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.340</td>
<td>0.726</td>
<td>0.340</td>
<td>0.726</td>
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Z-score

Higher quality hospitals grow more:

- we estimate hospital quality as \( z - score \) by summing information on present \((\epsilon_{i,t})\) and future \((\epsilon_{i,t+1})\) income shocks

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<thead>
<tr>
<th>( \Delta h_{t+1} )</th>
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<tbody>
<tr>
<td>( \hat{z}_{h,t}^{OLS} )</td>
<td>0.0143</td>
<td>0.0555**</td>
<td>[0.0218]</td>
<td>[0.0268]</td>
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<tr>
<td>( \hat{z}_{h,t}^{IV} )</td>
<td></td>
<td>0.0461**</td>
<td>0.0215</td>
<td>[0.0153]</td>
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Year FEs \( \times \) \( \times \) \( \times \) \( \times \) \( \times \)
Hospital FEs \( \times \) \( \times \)
Obs 302 271 302 271
\( R^2 \) 0.337 0.725 0.356 0.721
Appendix
Controls

1. consider patient-years with only one hospitalization and run

\[ \hat{\epsilon}_{i,t} = \gamma_{d'} + \eta_{i,t} \]

2. take estimated FEs \( \hat{\gamma}_{d'} \) as proxy for disease \( d' \) severity (only diseases with at least 250 observed hospitalizations)

3. then, given all diagnoses \( d'' \) experienced by patient \( i \) in year \( t \) build the vector

\[ X_{i,t} = [\min(\hat{\gamma}_{d''}), \sum(\hat{\gamma}_{d''}), P_{i,t}] \]

where \( P_{i,t} \) is a polynomial in the number of admissions