Developing a composite index of spatial accessibility across different healthcare providers: a German example

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Motivation

- analyses of spatial accessibility often restricted to single healthcare sectors/providers
- focusing on a single healthcare sector allows only partial analyses
- aim: to derive a composite index of healthcare accessibility
- methodological approach:
  - concept of regional multiple deprivation to combine different healthcare sectors
  - Improved Gravity Model (IGM) to measure geographic access
- data sources
  - physician numbers: `versorgungsatlas.de`
  - population numbers: `regionalstatistik.de`
  - hospital beds: `regionalstatistik.de`
  - travel times between districts: kindly provided by BBSR

Healthcare domains I

- combine similar healthcare providers into healthcare domains
- group by regional unit of capacity planning
- capacity planning directive (Bedarfsplanungsrichtlinie) §§ 11–13 for ambulatory care
- hospitals planned at state level
- no similar scheme available
- suggestion: derive inpatient domains similar to outpatient domains

Healthcare domains II

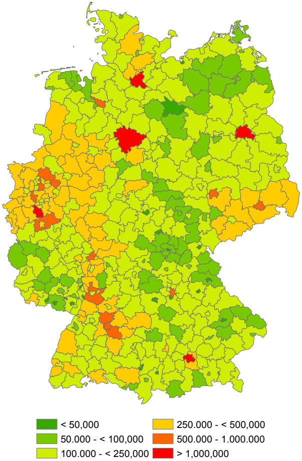
d	domain	includes e.g.	regional level	weight w_d
1	ambulatory GP	GPs, internists providing GP care	small area level	30%
2	ambulatory SP	eye doctors, women's doctors, ENTs, ...	district level	15%
3	ambulatory specilized SP	cardiologists, pulmonary specialists, anesthesists, ...	administrative regions	5%
4	inpatient general care	inpatient general care beds (internal medicine, surgery, orthopedics)	state level	25%
5	inpatient spec. care	inpatient specialized care beds (e.g. geriatrics, eye clinics, ...)	state level	25%

- weights: chosen by area unit of planning
- the **larger** the area unit on which population to provider ratios must be met, the **smaller** the weight
- ambulatory and inpatient domains weighted 50/50

First, measure accessibility separately for each type of care

- geographic accessibility: Improved Gravity Model (IGM)
- free choice of physicians ⇒ each person is a potential user of each healthcare provider
- patients may travel between areas to use health services
- probability of use decreases with increasing travel times

population numbers in districts



2-Stage computation of the Improved Gravity Model (IGM)

1. compute supply per potential user S_i^* for region i including population in adjacent areas

$$S_i^* = \frac{S_i}{\sum_j \frac{P_j}{t_{ij}^{1.5}}} = \frac{\text{supply (total number of physicians or hospital beds)}}{\text{potential demand (distance-weighted sum of population)}}$$

2. compute the accessibility score α_i for region i as the distance-weighted sum of supply per potential user

$$\alpha_i = \sum_j t_{ij}^{-1.5} S_j^* = \sum_j t_{ij}^{-1.5} * \frac{S_j}{\sum_k t_{ij}^{-1.5} P_k}$$

- where

P_i: population in region i
S_i: supply in region i
t_{ij}: travel time in minutes by car between regions with $t_{ii} = 1$

Then summarize healthcare accessibilities to scores

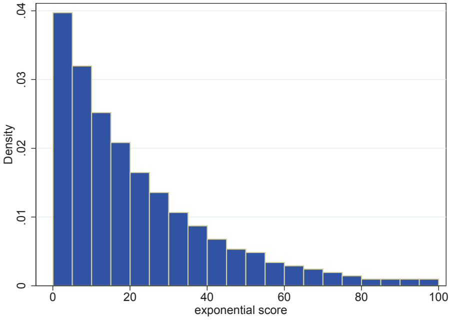
- combine accessibility scores α into univariate score for each domain d
- domain score = weighted average of accessibilities
- weights obtained through explorative factor analysis
- rank districts i by combined accessibility scores in descending order

$\rho_{di} = \frac{1}{n}$ for district with highest combined accessibility score

$\rho_{di} = 1$ for district with lowest combined accessibility score

Exponential transformation of domain ranks ρ_{di}

- low accessibility in one domain should not easily be canceled out
- domain scores δ_{di}: exponentially transformed ranks rescaled to $(0; 100)$
- only the worst-off decile $(\rho_{di} > 0.9)$ receives scores $\delta_{di} > 50$



histogram of transformed domain ranks δ_{di}

$$\delta_{di} = -23 \ \ln \left\{ 1 - \rho_{di} \left(1 - \exp \left\{ -\frac{100}{23} \right\} \right) \right\}$$

Summarize domain scores δ_{di} to an index of accessibility

$$\mathcal{I}_i = \sum_d w_d \delta_{di}$$

The index of healthcare accessibility $\mathcal{I}_i$ is the weighted sum of the exponentially transformed domain scores.

Healthcare accessibility in Germany

- lower accessibility mostly in rural areas
- higher accessibility in more urban districts
- $\approx$ 13% population in the 83 districts with lowest accessibility
  $\rightarrow$ mostly rural districts
- $\approx$ 32% population in the 82 districts with highest accessibility
  $\rightarrow$ mostly urban districts

domain	weight w_d
ambulatory GP	30%
ambulatory SP	15%
specialized ambulatory SP	5%
inpatient general care	25%
inpatient specialized care	25%

results are available from the author on request

Discussion

- accessibility correlates with population numbers
- unequal distribution of accessibility persists when using a holistic measure
- rural districts surrounding urban districts receive low accessibility scores but urban district is corresponding center $\rightarrow$ result of German administrative area boundaries
- interpret carefully: $\mathcal{A}$ is a purely ordinal measure
  - best-off quintile may still be underserved
  - worst-off quintile may still be overserved
  - both seem rather unlikely

Discussion II

A set of normative choices must be made

- how to value distance
- which domains are more/less important
- which services are similar enough to form a domain
- altering domain weights had only little impact
- more obvious changes when altering geographic model
- having those choices also makes the index adaptable

THANK YOU FOR YOUR ATTENTION