Health effects of OOP

Jan Boone

Work in Progress

Outline

Introduction

Health insurance

- healthcare costs increase in all developed countries
- insurance can cause moral hazard
- oop payments is one way to mitigate this
- if a deductible increase reduces expenditure, we view this as welfare enhancing
- what if oop cause people to postpone *valuable* treatments?
- can we identify this effect across countries?

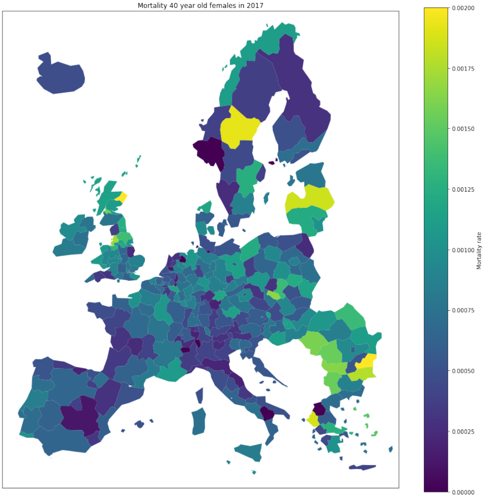
Health effects

- postponing/forgoing valuable care has health effects
- measuring health effects is not easy
- we use mortality per NUTS 2 region/year/age/gender in European countries
- time varying NUTS 1 fixed effects

Insurance generosity

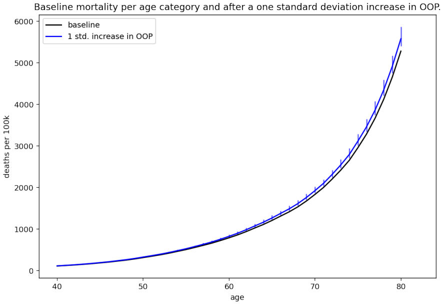
- comparing insurance generosity across countries is not straightforward
- how to compare a system with high deductible but low coinsurance rate or many treatments exempted from oop with a low deductible system?
- we use variable `OOP`: % oop in total health expenditure in a country
- high oop is especially problematic for people on low income
- they could forgo treatment if it is expensive
- if this mechanism exists: higher mortality in regions where `OOP` $\times$ `Poverty` is high

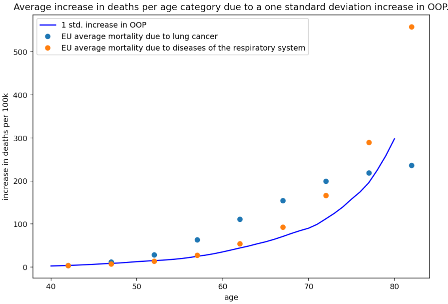
NUTS 2 regions in Europe



Summary: effect of increase in OOP on mortality in poor regions

Mortality effects of one standard deviation increase in OOP in a region with poverty two standard deviations above the mean.





Literature: individual level data

- recent literature on relation oop and mortality
- US individual level data
- e.g. Miller et al. (2021) on Medicaid eligibility expansion:
  - introduced in different states at different times
- Chandra et al. (2021) Medicare part D prescription drug coverage
  - enrollment month
- behavioral hazard: Baicker et al. (2015)

This paper

- European regional data
- more broad brush: cannot capture effect of 1% increase in deductible
- compare health insurance systems that are more/less generous
- more variation in OOP than with Dutch individual level data
- European health insurance more homogeneous across regions in a country

Two equations to estimate

Number of deaths

- per age, gender, year, nuts 2 region
- k deaths out of n population: $\binom{n}{k} m^k (1-m)^{n-k}$

$$h_{2atg} = \mu_{1tg}\beta_a + \mu_{ag} + \beta_{poverty,a} Poverty_{2t} + \beta_{educ,a} Educ_{2tg} + \beta_{unmet,a} Unmet_{2t} + \beta_{lagged\_log\_odds} h_{2a-1t-1g}$$

$$m_{2atg} = \frac{e^{h_{2atg}}}{1 + e^{h_{2atg}}}$$

Too expensive

- one motivation for unmet medical needs is that treatment was too expensive
- fraction of people in a region indicating that they postponed/forgone treatment because it was too expensive:

$$\begin{aligned} TooExp_{2t} = {} & b_{0,c} + b_{oop} HealthExpend_{ct} OOP_{ct} \\ & + b_{interaction} HealthExpend_{ct} OOP_{ct} Poverty_{2t} \end{aligned}$$

Model

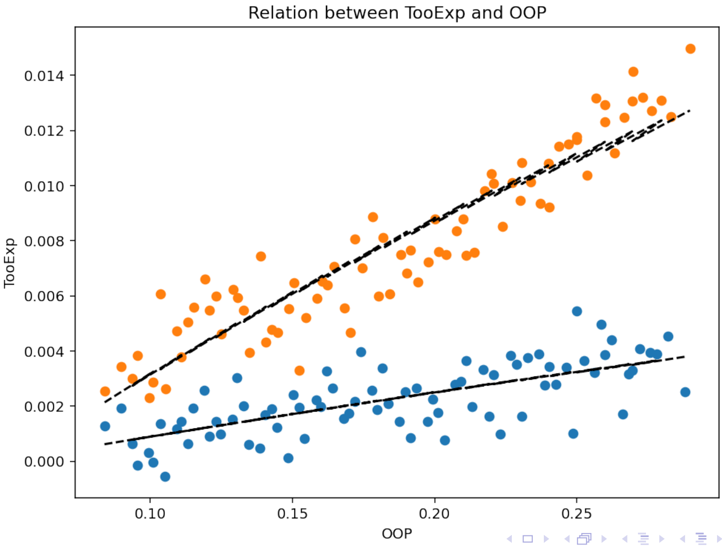
Ingredients

- fraction α low income l; $1-\alpha$ high income h
- probability falling ill: $\pi^l > \pi^h$
- coinsurance ξ; deductible D
- health effects: $1 > \sigma_x > \sigma_0 \geq 0$
- get treatment if: $\nu\sigma_x u(y^j - oop) > \sigma_0 u(y^j)$
- other factors affecting treatment decision: $G(\nu)$
- probability treatment: $1 - G\left(\frac{\sigma_0}{\sigma_x}\frac{u(y^j)}{u(y^j - oop)}\right)$

Model outcomes

- mortality $m_{at} = \frac{e^{h_{at}}}{1+e^{h_{at}}}$ where health:
- h_{at} = fixed effects $+ \gamma h_{a-1t-1}$ − expected health
- expected health depends on poverty, unmet medical needs
- too expensive: $G\left(\frac{\sigma_0}{\sigma_x}\frac{u(y^j)}{u(y^j - oop)}\right) - G\left(\frac{\sigma_0}{\sigma_x}\right)$
- OOP $\approx \frac{\zeta\xi x_0 + (1-\zeta)D}{\zeta x_0 + (1-\zeta)x_1}$
- as we vary ξ, D we generate a relation between `OOP` and `TooExp`

Relation OOP and TooExp



Data

Eurostat data: 2009-2019; ages 2-85

Table: Summary statistics main variables

	count	mean	std	dim.
population	514212.00	10051.42	9441.60	nuts 2, age, g
deaths	514212.00	71.14	134.86	nuts 2, age, g
poverty	212820.00	17.13	7.92	nuts 2
too exp.	113700.00	2.14	3.21	nuts 2
unmet	113700.00	5.02	3.87	nuts 2
out-of-pocket	411980.00	18.75	7.54	country
low educ.	504216.00	24.11	13.67	nuts 2, g
expend. per head	452072.00	3129.58	1646.01	country

Missing values

- we have missing values
- but cannot afford to drop them
- variables based on sums are normally distributed
- we standardize variables: mean 0.0 and standard deviation 1.0
- when value is missing, we draw a value from this distribution
- allows us to estimate the relevant effects
- keep the uncertainty in the posterior distributions

Estimation

Estimation technique

- Bayesian analysis: are we 95% sure that the following chain of effects is present:
  - higher oop leads to higher unmet needs in areas with high poverty
  - which then leads to higher mortality
- we approximate the posterior distribution using Automatic Differentiation Variational Inference (ADVI)
- Gaussian Processes for coefficients that depend on age: $\beta(a)$ is more closely correlated with $\beta(a+1)$ then with $\beta(a+20)$
- squared exponential kernel

Results

Fit

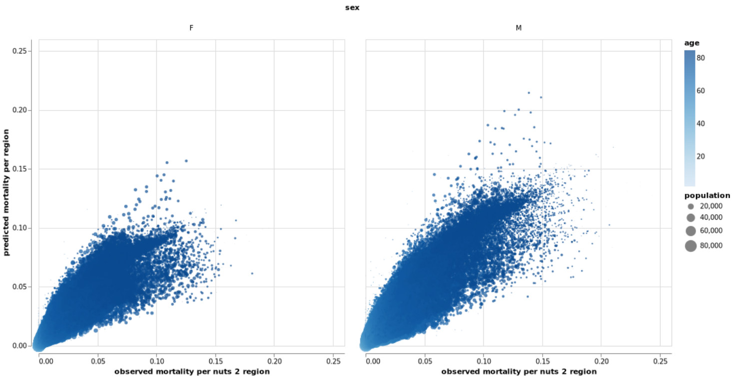


Figure: Fit of estimated and observed mortality across all observations.

Coefficients

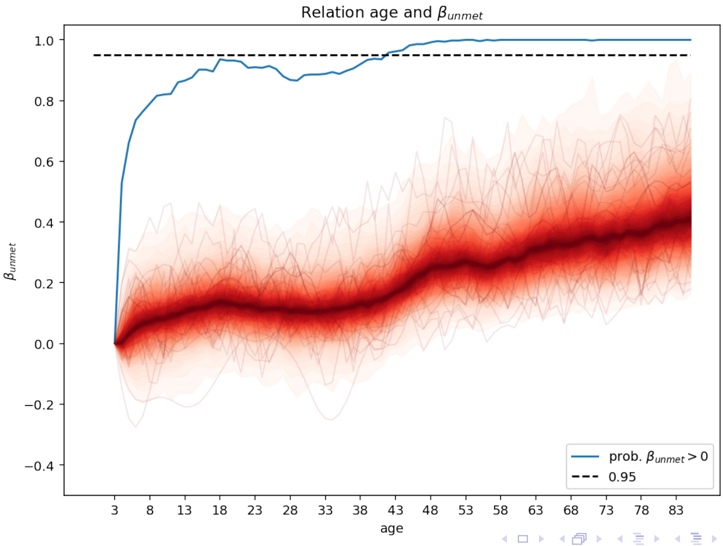
$$
\begin{aligned}
TooExp_{2t} = b_{0,c} &+ b_{oop} HealthExpend_{ct} OOP_{ct} \\
&+ b_{interaction} HealthExpend_{ct} OOP_{ct} Poverty_{2t}
\end{aligned}
$$

$$
\begin{aligned}
h_{2atg} = \mu_{1tg}\beta_a + \mu_{ag} + \beta_{poverty,a} Poverty_{2t} + \beta_{educ,a} Educ_{2tg} \\
+ \beta_{unmet,a} Unmet_{2t} + \beta_{lagged\_log\_odds} h_{2a-1t-1g}
\end{aligned}
$$

Table: Summary statictics for estimated coefficients

variable	mean	sd	hdi_3%	hdi_97%
$\beta_{lagged\_log\_odds}$	-0.032	0.232	-0.464	0.402
b_{oop}	0.018	0.005	0.009	0.029
$b_{interaction}$	0.017	0.003	0.012	0.022

GP for β_{unmet}



Main result: in a poor region

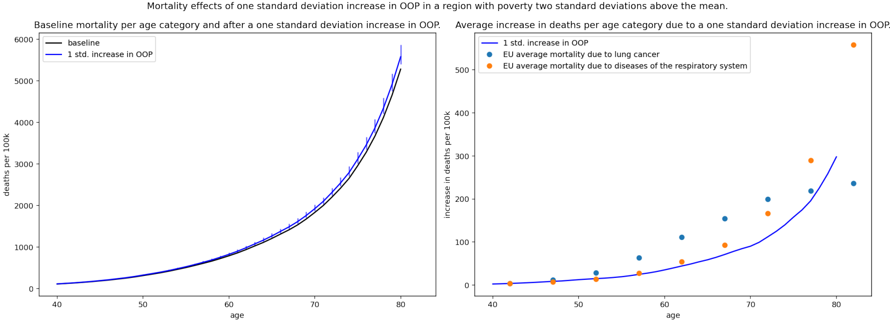


Figure: One std. increase in OOP: From Dutch to Finish system; Finland to Switzerland; Switzerland to Greece

Robustness analysis

- include voluntary health insurance payments in OOP measure
- material deprivation as poverty measure
- separate effect of TooExp and other unment needs on mortality

Conclusions

Bayesian analysis

- we find the following:
  - consider a country with high OOP
  - people in a region with high poverty rate
  - are more likely to report unmet medical needs because treatment was too expensive
  - unmet medical needs increase mortality
- for people above age 45 living in a poor region we are at least 95% sure that an increase in oop increases mortality
- the increase in mortality due to a std. increase in OOP is comparable to mortality due to lung cancer in the EU for the ages above 45

Policy implications

- increasing oop leads to more costs than just risk aversion
- in poor areas, increase in mortality is comparable to lung cancer
- doing without oop is not an option:
  - means tested oop
  - let copayments vary with cost effectiveness of treatments