The Economic Value of Eliminating Diseases

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Research Questions

1. What are the economic consequences of a given disease?
   - Mortality
   - Participation or disability
   - Wage (productivity) growth
   - Medical expenditures
   - Entering into a nursing home

2. How much a given individual is willing to pay to eliminate a given disease?

3. Does the answer to the previous questions depend on who the individual is?
   - Low vs. high income
   - Young vs. old
   - Female vs. male

Answers are key for understanding demand for insurance products and policy analysis

What We Do

1. Treat bad health as a multidimensional risk, ...
   - use administrative data on the whole Dutch population
   - for 334 distinct medical diagnoses in 12 medical specialties
   - to estimate the effect of bad health on several dimensions (mortality, disability, medical expenditures, wages, entering into a nursing home)
   - per gender, age, and income group.
2. Measure the incidence of each disease.
3. Obtain willingness to pay for curing a given disease using a life-cycle model.

Literature & Our Contribution

- Effect of health on savings and insurance: DeNardi et al. (2010), Koijen et al. (2016), DeNardi et al. (2017)
  - We consider health at the disease level, and our counterfactual is changing health because we estimate causal effects.
- Heterogeneous effects of a diagnosis: Heinesen and Kolodziejczyk (2013), García-Gómez et al. (2013), Lundborg et al. (2015)
  - We consider the impact in terms of welfare by using a comprehensive set of diseases and a life-cycle model.
- Cost of illness: see Larg and Moss (2011) for a review.
  - We consider a comprehensive set of diseases, a life-cycle model, and socioeconomic heterogeneity.

Administrative Data from Statistics Netherlands

- **Medical expenses**: covered by mandatory basic health insurance
- **Diagnoses by medical specialists** (2013-2017): spell-type data on inpatient and outpatient care with medical diagnosis codes (Dutch Healthcare Authority)
- **Labor market**: gross earnings and payroll taxes
- **Income groups**: we classify people into income groups using the fixed effect estimate of a linear regression of wages on an age polynomial by gender.

Empirical Design - Event Study

- Aim to identify the average treatment effect of health shock on:
  - {Medical expenditures, Employment, Labor earnings, Nursing home use}

- Sub-samples: 334 diagnoses $\times$ {Male, Female} $\times$ 3 age groups $\times$ 3 income groups

- E_i: year of diagnosis; t: calendar year; $K_{i,t} = t - E_i$: years since diagnosis; c: birth cohort; i: individual

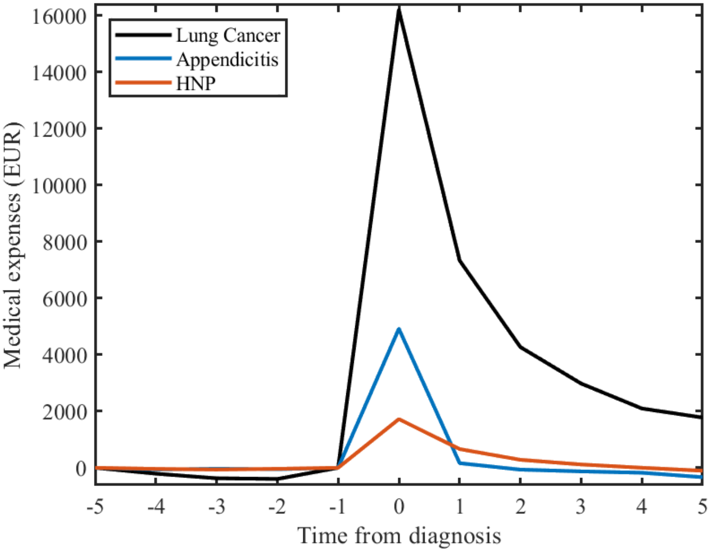
$$Y_{i,t} = \alpha_i + \delta_{c(i),t} + \sum_{k=-4,k\neq-1}^{5} \gamma_k \mathbb{1}\{K_{i,t} = k\} + \epsilon_{i,t},$$

- Mortality: We use an OLS regression including all diseases in the previous period

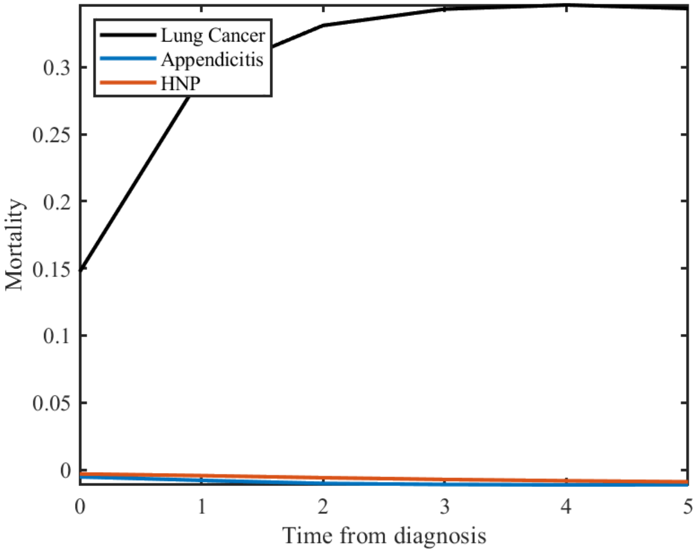
Three diseases as a running example

- Lung Cancer: abnormal cell growth that starts in the lungs.
- Hernia (HNP): Injury to the cushioning and connective tissue between vertebrae
- Appendicitis: Inflammation of the appendix

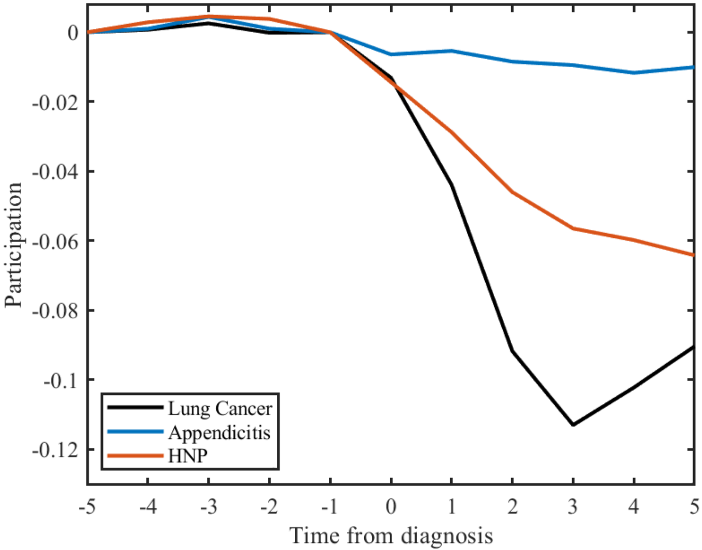
Effect on medical expenses



Effect on mortality



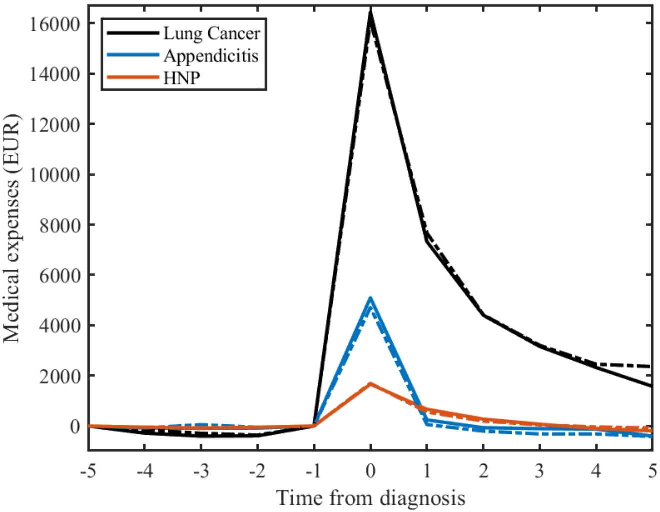
Effect on participation



Risks are not spanned by one factor

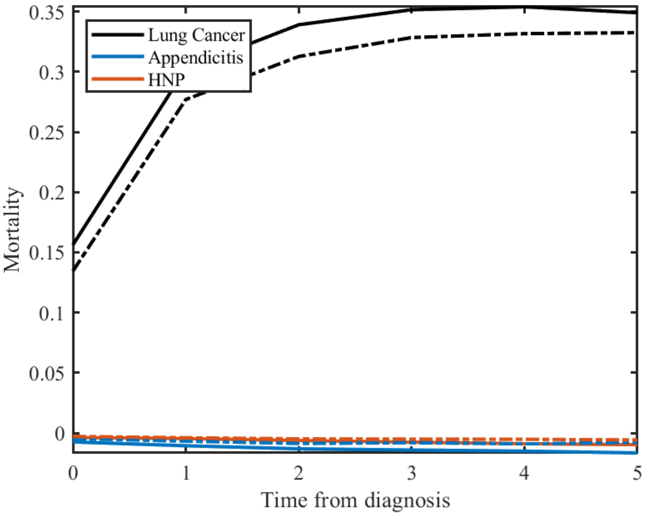
- Usually, we consider health as a single risk factor. E.g. bad, medium, good health.
- We show there are:
  - Diseases with medium medical costs but no mortality or labor effects (Appendicitis).
  - Diseases with low medical costs and mortality but high labor effects (HNP).
  - Diseases with high medical costs, mortality, and labor effects (Lung cancer).
- Understanding each risk is important to design insurance.
- If the exposure to each risk differs across the population (e.g. low vs high income), a simple risk factor might hide redistributional effects.

Effect on medical expenses



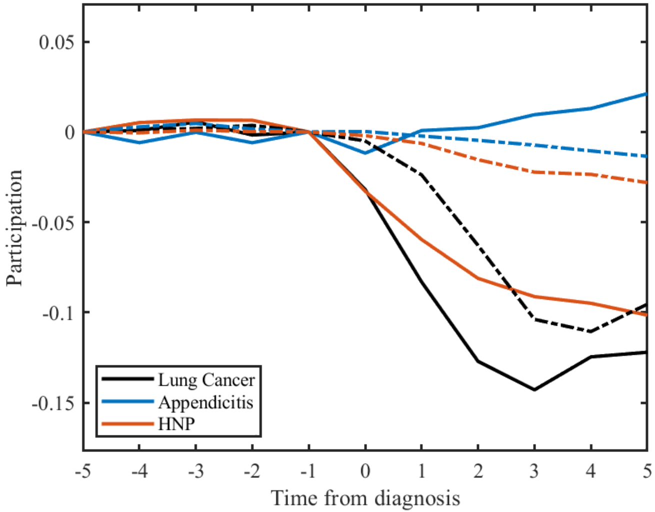
Solid: Low income   Dashed: High income

Effect on mortality



Solid: Low income   Dashed: High income

Effect on participation



Solid: Low income   Dashed: High income

Model set-up

Individual i belonging to socieconomic group s maximizes current and future utility flows:

$$u(c_{it}) = \bar{u} + \frac{c_{it}^{1-\rho}}{1-\rho}, \tag{1}$$

and obtain utility v from bequests when they pass away:

$$v(a_{it}) = \theta \frac{(R\frac{a_{it+1}}{\theta} + \bar{a})^{1-\rho}}{1-\rho}. \tag{2}$$

Assets of individuals outside a nursing home follow:

$$a_{it+1} = a_{it}R + y_{it} - \tau_y(y_{it}) - c_{it} - premium - min(m_{it}, ded), \tag{3}$$

where $y_{it} = \max\{d_{it}\tilde{y}_t^s, \underline{y}\}$ for working individuals and y_R^s for retired individuals.

Counterfactual

- Implementation:
  - We set the probability of a given disease to 0.
  - Then, we compute the maximum annual increase in premium that an individual can face without losing welfare (willingness to pay).
  - Finally, we consider the whole premium goes to the government to obtain the government surplus per individual.
- Interpretation willingness-to-pay: The annual amount an individual is willing to pay to reduce all the effects of the disease to 0 (e.g. vaccine).
- Interpretation government surplus: The maximum amount per born individual that the government can spend in medical research for that disease without lowering welfare.

Three diseases example

- We consider four states: diagnosed with appendicitis, lung cancer, HNP, or none of these.
- We assume the labor effect is permanent.
- The mortality and medical expenses effects last for one period.
- We calibrate incidence depending on the observed probability of each diagnosis.

Willingness to pay

	Lung Cancer	Appendicitis	HNP
	Female		
Lowest PI	340	7	155
Medium PI	564	7	126
Highest PI	7,940	115	1,509
	Male		
Lowest PI	476	6	190
Medium PI	3,475	49	518
Highest PI	15,294	149	1,733
	Government surplus		
	258,657	11,833	46,540

Conclusions and applications

1. Estimate the causal effects of 334 diagnoses on mortality and morbidity
2. Health risk has more than one dimension and varies across income groups
3. Quantify the willingness to pay to eliminate health risks

Ongoing work on applications: benefits of HPV vaccination, colon cancer screening, obesity

Our Dataset Covers 334 Diagnoses from 12 Medical Specialties

- Start with $\sim$ 2500 Dutch diagnosis codes ('Diagnosis Treatment Combinations', DTC), e.g., 'small cell lung cancer'
- Exclude: rehabilitation, clinical genetics, anesthesiology, radiotherapy, and radiology (follow-up care/diagnosis); pregnancy-related care and plastic surgery
- Classify the remaining 1761 codes into 334 diagnosis groups based on the 'ICD-10 - DTC' correspondence table of the Dutch Healthcare Authority
- Health shock: focus on the first diagnosis of a given group in the sample period

Generalization: All and income

Year	Medical expenses (EUR) $t = 0$	Excess Mortality (%) $t = 3$	Labor participation (%) $t = 3$	Disability (%) $t = 3$	Log earnings (%) $t = 3$	Nursing home (%) $t = 3$
All						
Mean	5385	0.04	-0.04	0.04	-0.02	0.02
5%;95%	[401;18300]	[-0.02;0.23]	[-0.15;0.00]	[0.00;0.15]	[-0.06;0.01]	[0.00;0.07]
% Sign.	99%	54%	66%	74%	49%	79%
By permanent income tercile						
Low	**5436**	0.04	**-0.05**	0.05	-0.03	0.02
Medium	**5391**	0.04	**-0.05**	0.04	-0.02	0.03
High	**5322**	0.04	**-0.03**	0.03	-0.02	0.02

5th and 95th percentiles within square brackets

Generalization: Gender and age

Year	Medical expenses (EUR) $t = 0$	Excess Mortality (%) $t = 3$	Labor participation (%) $t = 3$	Disability (%) $t = 3$	Log earnings (%) $t = 3$	Nursing home (%) $t = 3$
By gender						
Male	5838	0.04	-0.04	0.04	-0.02	0.02
Female	5036	0.04	-0.04	0.04	-0.02	0.03
By age at diagnosis						
25-45	4798	0.02	-0.03	0.02	-0.01	
45-65	5753	0.03	-0.05	0.05	-0.02	
65+	5761	0.04				

5th and 95th percentiles within square brackets

Calibration

Parameter	Value	Interpretation	Source/Note
ρ	5	Risk aversion parameter	Kvaerner (2022)
r	2.44%	Return on savings	Kvaerner (2022)
β	$\frac{1}{1+r}$	Discount rate	Kvaerner (2022)
$\overline{a}$	EUR 20,000	Bequest threshold	Kvaerner (2022)
θ	83.3	Bequest intensity	Kvaerner (2022)
SVL $(\overline{u})$	2 million ($\overline{u} \approx 1.3 \times 10^{-17}$)	Utility flow for being alive	DeNardi et al. (2017)
$\underline{y}$	EUR 12,700	Minimum income	Social minimum (2015)
$\overline{E}_{NH}$	EUR 43,545	Total cost of nursing home care	Statistics Netherlands
c_{NH}	EUR 30,481	Consumption in the nursing home	70% of E_{NH}
λ_{dis}	0.7	Dis. insurance replacement rate	WGA wage-related benefit
τ_a	0.3	Tax on assets	Tax rate in Box 3
$premium_t$	EUR 1164	Health insurance premium	Avg. premium (2015)
ded	EUR 375	Health insurance deductible	2015 minimum deductible

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