Paying the Price: Accounting for Health and Expenditure Differences across Countries

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Motivation

- Large differences in how much countries spend and health outcomes

Motivation

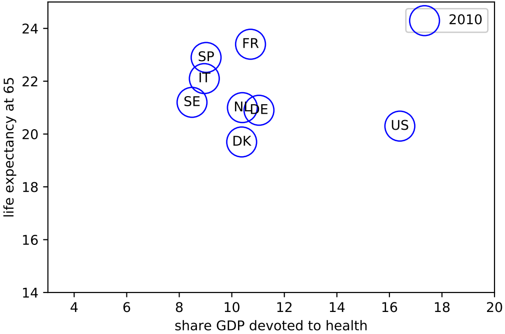

FIGURE – OECD Health Data 2010

Motivation

- Evidence that prices for the same services are very different across countries (**health price wedge**)
  - Anderson et al. (2003), Cutler and Ly (2011), Hornstein and Santos (2018)
- Quantity differences result, among other factors, from income differences (**efficiency wedge**)
  - Newhouse (1992), Gerdtham and Jonsonn (2002), Hall and Jones (2007)

This paper

- General equilibrium model that accounts for various sources of differences in health and health expenditures
- Estimation of structural parameters over 8 countries
- Counterfactual simulations to account for sources of differences
- Welfare consequences : willingness to pay and ideal price index

Price Differences

- There is no comparable international health price index.
- Evidence from Cutler and Ly (2011), Anderson et al. (2003) and IFHP (2013)

	Diagnostics Angiogram	Drugs Gleevec (Cancer)	Scan Abdomen	Surgery Bypass surgery
US	914$ (1)	6,214$ (1)	750$ (1)	73,420$ (1)
DE	—	—	319$ (0.425)	—-
FR	264$ (0.288)	—	248$ (0.330)	22,344$ (0.304)
NL	—	3,321$ (0.534)	258$ (0.344)	14,061$ (0.191)
SP	125$ (0.136)	3,348$ (0.538)	161$ (0.214)	17,437$ (0.237)

TABLE – Comparison of Prices (IFHP, 2013)

More data

Do Price Difference Reflect Quality Differences ?

	Colon	Cervical	Breast	Leukemia
DK	61.6	69.5	86.1	94.0
FR	63.7	65.0	86.7	88.6
DE	64.8	65.2	86.0	91.1
IT	64.1	66.8	86.0	87.8
NL	63.0	67.5	86.6	90.4
SP	63.3	64.5	85.4	84.7
SE	64.9	68.3	88.8	89.0
US	64.9	62.6	90.2	89.5

TABLE – 5-year cancer survival rates 2010-2014, OECD Health Data

Health Price Wedge

Why do health service prices can be so different across countries ?
At least two potential sources of inefficiency :

- Administrative costs : ι
- Information frictions between medical service suppliers and medical intermediaries for the households :
  - ζ probability to detect a shirking provider and z is the TFP of the health sector

$$\text{Incentive contract} \qquad p = \frac{1}{\zeta}\frac{1}{1-\iota}\frac{1}{z} \equiv \underbrace{(1+\mu)}_{\text{Health price wedge}} \frac{1}{z}$$

- But p is not an observable.

Prices and Quantity

Can we deduce easily price from observable ?

- In a simple setting, we observe

$$\{s, h\} = \left\{ \frac{pm}{y}, f(m) \right\}$$

- If we know the function $f()$:

$$p = \frac{sy}{f^{-1}(h)}$$

- ... but we cannot estimate $f()$ without knowledge of p, given that we cannot observe m, but only pm.

$\Rightarrow$ We need for a equilibrium model that reveals the price of health services, and thus the health price wedge.

Preferences

A general equilibrium model à la Aiyagari (1994) including a health production function as in Grossman (1972).

- health h takes 2 values : $h = 1$ good health, $h = 0$ bad health
- utility is additive in consumption c and health h :

$$u(c, h) = \frac{c^{1-\sigma}}{1-\sigma} + \phi h.$$

with utility benefit $\phi > 0$ of good health.

Health Production

The probability of being in good health next period is

$$p(h' = 1|h, m) = 1 - e^{-(\alpha_0 m + \alpha_{1h} + \eta r_b)}$$

- α_0 captures the returns of health services on health production of the agent
- α_{1h} captures competitive advantage to be in good health when agent is previously in good health, then $\alpha_{11} > \alpha_{10}$
- r_b captures differences in health behaviors (here obesity).

Resource Constraint

- Wealth dynamics :

$$a' = a(1+r) + we(1-\tau) - c - \mu p m$$

- Borrowing constraint, $a' \geq 0$.
- Health Insurance : tax rate τ and co-insurance μ
- Price of health services : p including the health price wedge
- Earnings risk e follows AR(1) with parameters (ρ_e, σ_e)

Consumer Problem

The consumer solves :

$$
\begin{aligned}
V(a,h,e) \;&=\; \max_{m,c}\left\{\frac{c^{1-\sigma}}{1-\sigma}+\phi h \right.\\
&\qquad \left. +\beta\sum_{e'}\sum_{h'} p(e'|e)p(h'|h,m)V(a',h',e')\right\}\\
\text{s.t.} &\qquad \left\{\begin{array}{lcl} a' & = & a(1+r)+we(1-\tau)-c-\mu pm \\ a' & \geq & 0 \end{array}\right.
\end{aligned}
$$

Production of Goods

- Production Y is CRS using aggregate capital K and labor N as inputs :
$$Y = AK^{\alpha}N^{1-\alpha}$$
- A captures technological progress (TFP).
The measure of the TFP includes the efficiency wedge
- Prices determined on competitive markets (r and w).

General Equilibrium

Empirical strategy

We use a two-step strategy for $g = 1, ..., G$ countries :

- Step 1 : Calibration of parameters and estimations of exogenous income risks : Auxiliary parameters using external information
- Step 2 : Estimation of other parameters using a method of simulated moments approach (MSM)

Auxiliary Parameters : step 1

- Countries $= \{DE, DK, FR, IT, NL, SE, SP, US\}$
- Income Risk : micro data on income : PSID - ECHP ▸ Estimates
- Risky Health Behaviors, r_b : HRS and SHARE ▸ Estimates
- Co-insurance rates μ : OECD Health Data ▸ Estimates
- Other Parameters : country-specific shares of capital (α) and the depreciation rates (δ_k) : Penn World Table (Feenstra et al. 2015) ▸ Estimates

Method of Simulated Moments : step 2

- The vector of parameters to estimate is :

$$\Theta = \{\beta, \sigma, \phi, \alpha_0, \alpha_1, \psi, \eta, \{A_g\}_{g \neq US}, \{p_g\}_{g \neq US}\}$$

- The MSM estimator $\hat{\Theta}$ is the solution to the problem

$$\min_{\Theta} [m_S(\Theta) - m_{\text{data}}]' W_N [m_S(\Theta) - m_{\text{data}}]$$

- Weighting : diagonal matrix with elements equal to the inverse of the variance of each moment.
- We follow the method proposed by Chernozhukov and Hong (2003) : Metropolis-Hastings using the MSM objective function.
- Confidence intervals using the posterior distribution of parameters

Moments m_{data} : step 2

Identifying moments m_{data} for each country g

$$m_g = \left\{ K_g/Y_g, \tilde{Y}_g, s_g, \tilde{p}_{1|0}(X_g,1), \tilde{p}_{1|1}(X_g,1), \overline{p}_2(X_g,1), \overline{p}_3(X_g,1), \overline{p}_4(X_g,1) \right\}$$

- Relative GDP per capita to the US ($\tilde{Y}_g$) : OCDE,
- Ratio of capital to GDP (K/Y) : Penn World Tables
- Share of health spending in GDP ($s = \frac{pm}{Y}$) : OECD
- Transition rate from bad to bad health and good to good health : SHARE-2004/2006 and HRS-2004/2006. We correct these raw measures for the well-known country-specific bias in the self-reported health. Estimates
- Fraction of individuals in good health by net wealth quartiles (health gradient) : SHARE 2004 and HRS 2004 Estimates

Structural Parameters

	Common Parameters		
Parameter	Estimates	Low CI(95%)	High CI (95%)
σ	3.158	3.115	3.179
β	0.832	0.831	0.833
ϕ	0.079	0.069	0.088
α_0	2.088	2.032	2.233
α_{10}	0.291	0.254	0.354
α_{11}	2.059	1.931	2.124
η	-0.073	-0.089	-0.043

TABLE – Estimated Parameters : preferences and health production function

▸ fit

Structural Parameters

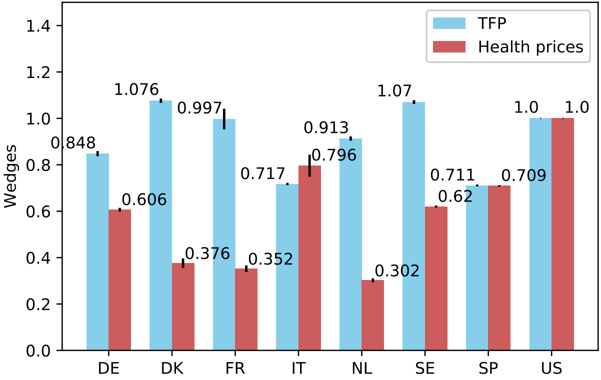

FIGURE – Estimated Parameters : wedges

R&D R&D

Sizes of Wedges and Impacts of Wedges

For $\{s, p(H=1)\}$, we decompose our results as follows :

$$\underbrace{\frac{dy}{y}}_{\substack{\text{Endogenous}\\ \text{response}}} = \underbrace{\varepsilon_{y|x}}_{\substack{\text{Model}\\ \text{mechanism}}} \times \underbrace{\frac{dx}{x}}_{\substack{\text{Exogenous}\\ \text{change}}}$$

Variable y	Exogenous change $x \in \{p, A\}$		Model mechanism $\varepsilon_{y\|x}$	Endogenous response $\frac{dy}{y}$
s	$\frac{dp}{p}$ = -0.76	GE	0.56	-0.42
		PE	0.68	-0.51
$p(H=1)$		GE	-0.065	0.05
		PE	-0.04	0.03
s	$\frac{dA}{A}$ =-0.074	GE	0.53	-0.04
		PE	1.56	-0.11
$p(H=1)$		GE	0.25	-0.0185
		PE	0.41	-0.03

Counterfactuals : Benchmark

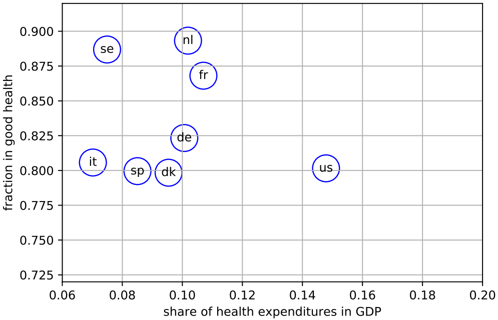

FIGURE – Benchmark Relationship

Counterfactuals : Average European price in the US – GE

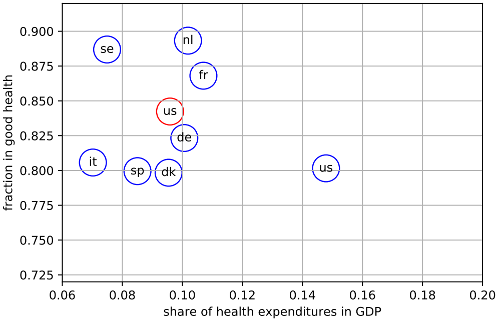

FIGURE – US with average price of European countries – GE

Counterfactuals : Average European price in the US – PE

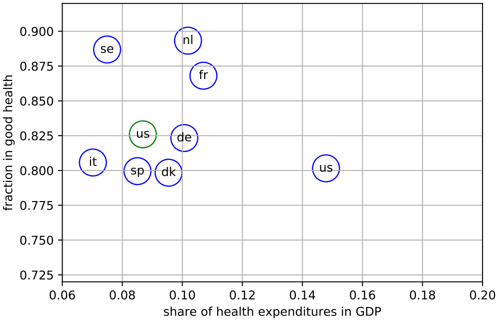

FIGURE – US with average price of European countries – PE

Counterfactuals : Average European TFP in the US – GE

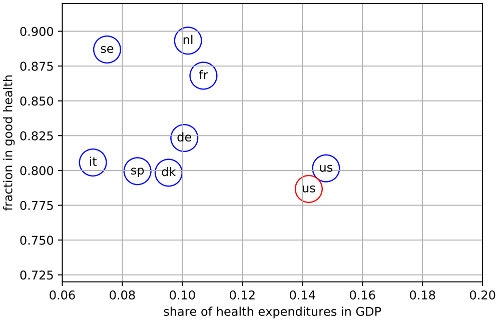

FIGURE – US with average TFP of European countries – GE

Counterfactuals : Average European TFP in the US – PE

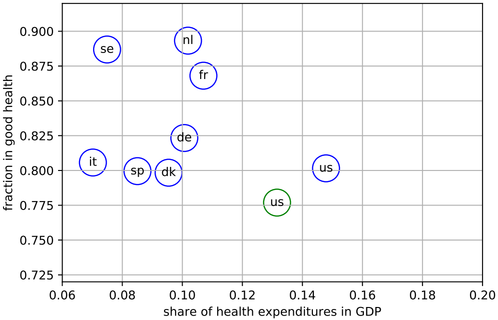

FIGURE – US with average TFP of European countries – PE

Counterfactuals : Benchmark

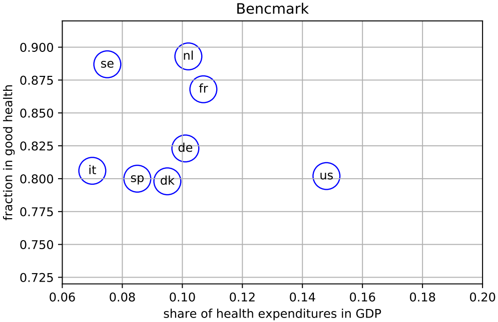

FIGURE – Benchmark Relationship

Counterfactuals : US price in European countries – GE

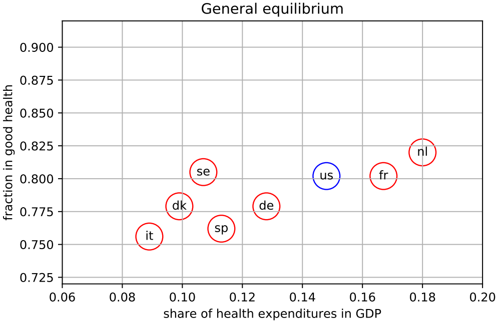

FIGURE – All countries with US price level – GE

Counterfactuals : US price in European countries – PE

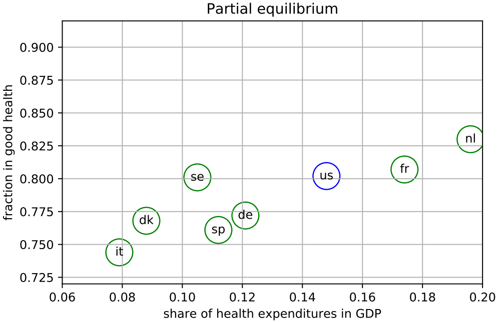

FIGURE – All countries with US price level – PE

The willingness to pay (WTP) for a US agent access to the European health care system

- Let $\mathcal{P}(a, h, e)$ be the WTP for a (a, h, e)-type US agent access to p_{EU} :

$$\begin{aligned} \underbrace{V(a,h,e|p_{US},A_{US},\Omega_{US})}_{\downarrow \text{ the compensation}} &\leq V(a,h,e|p_{EU},A_{US},\Omega_{US}) \\ V(a+\mathcal{P}(a,h,e),h,e|p_{US},A_{US},\Omega_{US}) &= V(a,h,e|p_{EU},A_{US},\Omega_{US}) \end{aligned}$$

- We control for the US-specific characteristics $\{A_{US}, \Omega_{US}\}$
- $\mathcal{P}(a, h, e)$ is computed by comparing the value function of a US agent with the value function of this agent if the price, for her, will be the European price.

WTP to access at p_{EU} in units of wages : $\mathcal{P}(a,h,e)/we$

	$e=0$	$e=4$	$e=9$	Macro
$p(H=0)$	0.836	0.401	0.325	0.515
$p(H=1)$	0.940	0.521	0.346	

TABLE – Willingness to pay by agent groups : $\frac{\sum_a \lambda(a,h,e)\mathcal{P}(a,h,e)}{\sum_a \lambda(a,h,e)we}$

- $\frac{\mathcal{P}(a,h=1,e)}{we} < \frac{\mathcal{P}(a,h=0,e)}{we}, \forall a, e$
- But agents in poor health are poorer

$\Rightarrow \mathbb{E}_a \frac{\mathcal{P}(a,h=1,e)}{we} > \mathbb{E}_a \frac{\mathcal{P}(a,h=0,e)}{we}, \forall e$

The WTP by agent groups. Inequalities

The transfer paid by an US agent to have the same value than if she lives with the EU technology : $\mathcal{T}(a,h,e)/we$

	$e=0$	$e=4$	$e=9$	Macro
$p(H=0)$	-1.684	-0.723	-0.444	-0.879
$p(H=0)\vert_{p_{EU}}$	0.836	0.401	0.325	
$p(H=1)$	-1.973	-0.891	-0.482	0.515
$p(H=1)\vert_{p_{EU}}$	0.940	0.521	0.346	

TABLE – Transfer paid by agent groups : $\frac{\sum_a \lambda(a,h,e)\mathcal{T}(a,h,e)}{\sum_a \lambda(a,h,e)we}$

Ideal price index : basics

- We define the cost of living in the US as follow :

$$\mathcal{C}(\overline{u}, p_{US}) = \min_{c,m} \{c + \mu p_{US} m \;\mid\; \overline{u} = u(c, m)\}$$

- The cost of living in the US is given by

$$\frac{c_{US} + \mu p_{EU} m_{US}}{c_{US} + \mu p_{US} m_{US}} \equiv I_P \leq I_K = \frac{\mathcal{C}(\overline{u}, p_{EU})}{\mathcal{C}(\overline{u}, p_{US})} \leq I_L \equiv \frac{c_{EU} + \mu p_{EU} m_{EU}}{c_{EU} + \mu p_{US} m_{EU}}$$

  This Konus's index measures the monetary gains to switch to EU prices, keeping constant the utility level.
  In a static model, it is bounded by the Laspeyres and the Paasche indexes, based on observable variables.

Ideal price index in our dynamic and stochastic model

- Using $\mathcal{P}(a, h, e)$, we compute the basket that the household must have to reach the same value than an household living in an economy with the EU prices.
- We then deduce the ideal price index :

$$I_K(a, h, e) = \frac{c(a, h, e|p_{EU}) + \mu p_{EU} m(a, h, e|p_{EU})}{c(a + \mathcal{P}(a, h, e), h, e|p_{US}) + \mu p_{US} m(a + \mathcal{P}(a, h, e), h, e|p_{US})}$$

- This index is not bounded by Laspeyres/Paasche indexes because the "control" for the utility level is done through the value function, and thus integrate intertemporal impact of permanent change in heath price.

Ideal price index I_K

	$1 - I_K$	
	$p(H=0)$	$p(H=1)$
$e=0$	1.9	1.7
$e=4$	1.7	1.4
$e=9$	4.2	5.7
Macro	2	

TABLE – Cost of living (%) in the US ($P_{US} \rightarrow P_{EU}$)

- With I_K, the cost of living is reduced by 1.7% (5.7%) for the low (high) paid agents in good health and 1.9% (5.2%) if they are in bad health.

Conclusions

- We use a general equilibrium framework to uncover sources of differences in health and health expenditures between the U.S. and Europe.
- We find that price differences are substantial while health expenditures are highly productive.
- The WTP for a US agent access to the EU health price is equal to a half a month's salary in average. Behind this number hides great inequalities, and composition effects that we reveal.
- The welfare losses associated to price differences are lower than those associated to TFP gaps...but only twice as small, whereas health accounts for only 15% of GDP !
- Using a structural model, the ideal price index can be revealed : the structural over-cost of living in the US is 2% in average, with significant inequalities : the wealthy agents can paid an extra cost of 6% for their consumption basket.

Price Differences

	US	NL	DK	SE	FR	DE
$	18,142	13,244	11,112	9,870	5,2014	5,072
US=1	1	0.73	0.61	0.54	0.28	0.27

Source : OECD Health Data 2011

TABLE – Hospital Spending per Discharge (2009) : US vs. European Countries

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General Equilibrium ▸ Back to slides

(a.) Factor inputs, tax revenues, and transfers are obtained aggregating over households :

$$K = \sum_e \sum_h \sum_a a\lambda(a,h,e), \quad N = \sum_j e_j N_j$$

(b). Given K and N, marginal productivities give r and w.

(c.) Given r, w, τ, households solve their decision problem.

(d.) Tax rate τ adjusts the health insurance budget constraint.

(e.) The goods market clears :

$$Y = \delta_k K + \sum_e \sum_h \sum_a [c(a,h,e) + pm(a,h,e)]\lambda(a,h,e)$$

where $\sum_e \sum_h \sum_a pm(a,h,e)\lambda(a,h,e) = \text{Health Supply}$

(f.) The price of health services is $p = \frac{1}{\zeta(1-\iota)z}$ (No profit).

(g.) The measure of households $\lambda(a,h,e)$ is stationary.

Earnings risk ▸ Back to slides

	Country							
	DE	*DK*	*FR*	*IT*	*NL*	*SE*	*SP*	*US*
ρ_e	0.9436	0.9182	0.9588	0.9433	0.9697	0.9182	0.9798	0.959
σ_e^2	0.0285	0.0150	0.0191	0.0303	0.0108	0.0150	0.0111	0.0396
σ_u^2	0.0967	0.0751	0.1143	0.0806	0.1192	0.0751	0.1364	0.1257
ς	0.3567	0.1707	0.3510	0.3556	0.3002	0.1707	0.4140	0.6187

TABLE – Estimates of Income Process

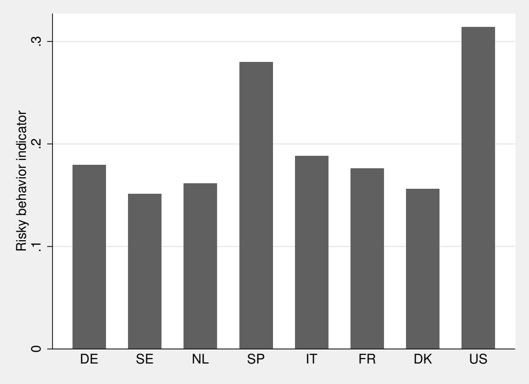
Production functions and depreciation rates

▸ Back to slides

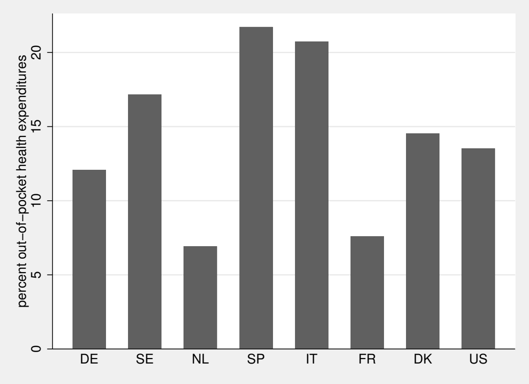
TABLE – Calibration

	Country							
	DE	*DK*	*FR*	*IT*	*NL*	*SE*	*SP*	*US*
α	0.373	0.338	0.373	0.456	0.383	0.353	0.348	0.358
δ	0.037	0.041	0.035	0.041	0.038	0.048	0.034	0.040

Risky health behaviors r_b ▸ Back to slides



Out-of-Pocket μ ▸ Back to slides



Adjusting the Health Data

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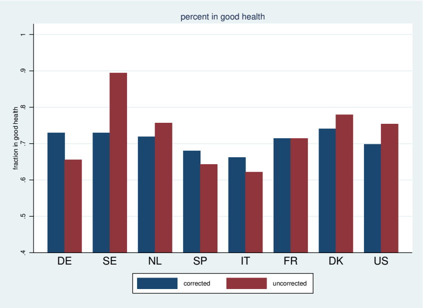
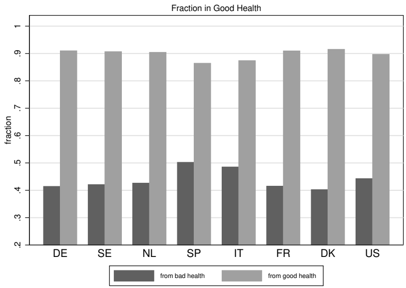
- Estimate a logit for self-reported health on objective health indicators and country fixed-effects.
- Predict based on the parameters of that logit setting the country fixed effects to zero.



(a) Measure of correction



(b) Transitions $b \to g$, $g \to g$

Adjusted the Health gradient

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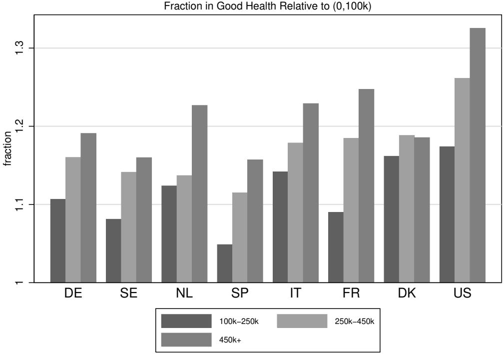

Fit

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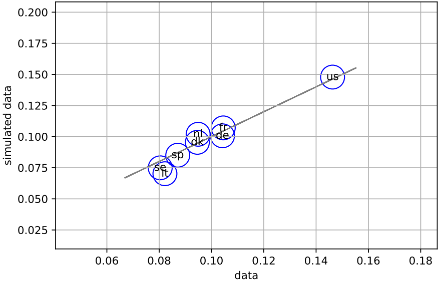

FIGURE – Data vs. Fit : Share of Health Expenditure in GDP

Fit ▸ Back to slides

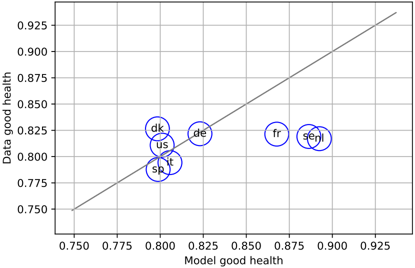

FIGURE – Data vs. Fit : Fraction Good Health

Fit

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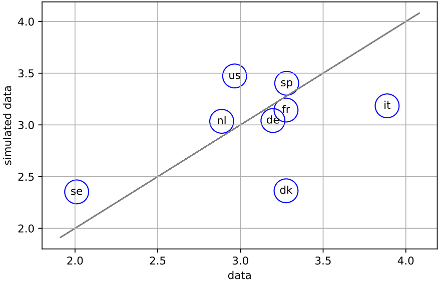

FIGURE – Data vs. Fit : Capital-GDP Ratio

Fit ▸ Back to slides

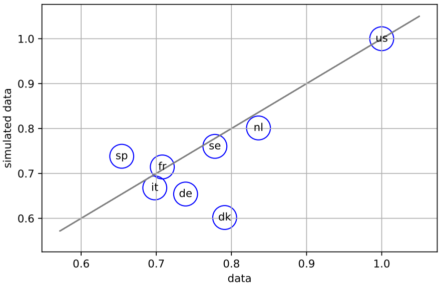

FIGURE – Data vs. Fit : Output Gap

Fit ▸ Back to slides

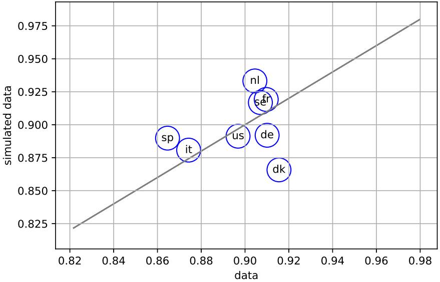

FIGURE – Data vs. Fit : From good to good

Fit

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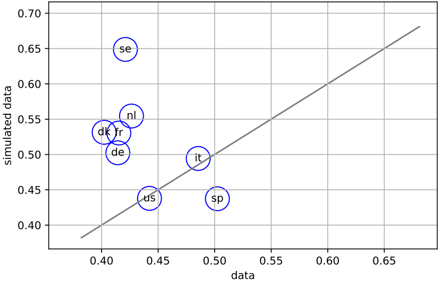

Figure – Data vs. Fit : From bad to good

Fit

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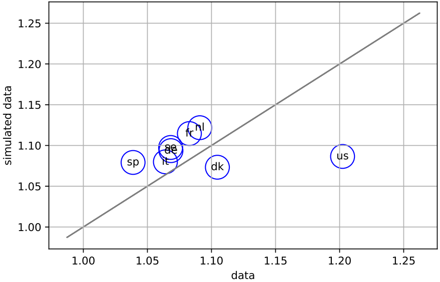

FIGURE – Data vs. Fit : Health-Wealth Gradient $Q2/Q1$

Fit

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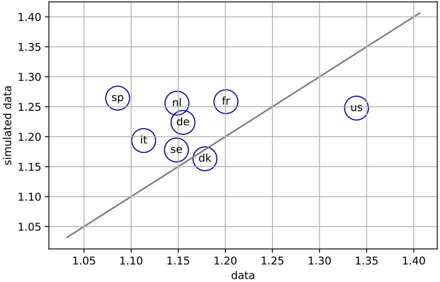

FIGURE – Data vs. Fit : Health-Wealth Gradient $Q3/Q1$

Fit

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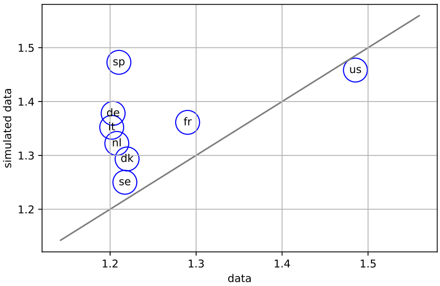

Figure – Data vs. Fit : Health-Wealth Gradient $Q4/Q1$

Does the high health price in the US reflect larger investments in R&D used all over the world ? ▸ Back to slides

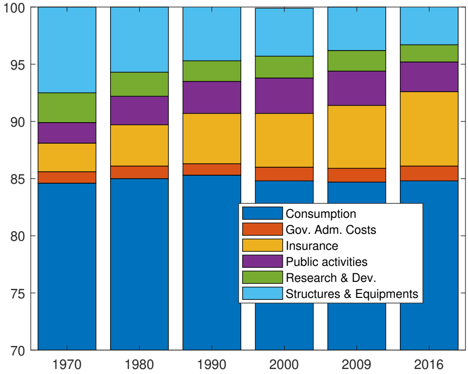

FIGURE – The use of health expenditures : by activity

⇒ The share of R&D decline in the expenditures

- ... but some costs of R&D are in the prices of drugs

Does the high health price in the US reflect larger investments in R&D used all over the world ? Back to slides

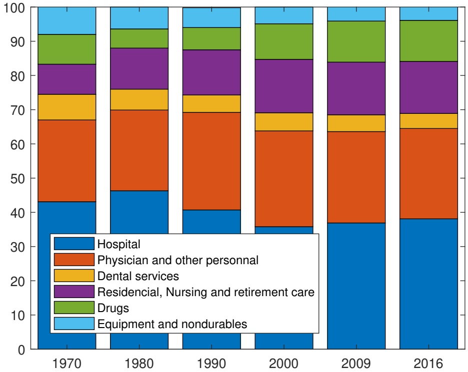

FIGURE – The use of health expenditures : by services

- The share of R&D drugs does increase in the expenditures

$\Rightarrow$ High price in the US are not supported by large R&D costs.

p_{EU} for a US agent : $\mathcal{P}(a,h,e)/we$

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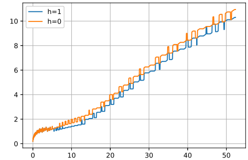
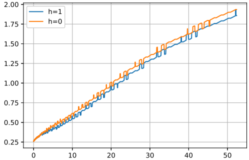
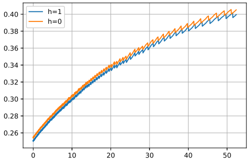


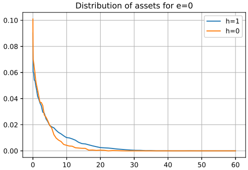
(a) $\frac{\mathcal{P}(a,h,e{=}0)}{w(e{=}0)}$



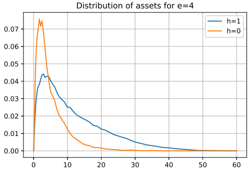
(b) $\frac{\mathcal{P}(a,h,e{=}4)}{w(e{=}4)}$



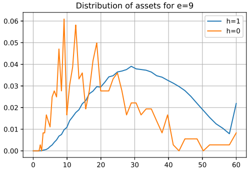
(c) $\frac{\mathcal{P}(a,h,e{=}9)}{w(e{=}9)}$



(d) $\lambda(a,h,e=0)$



(e) $\lambda(a,h,e=4)$



(f) $\lambda(a,h,e=9)$

Ideal price index : intertemporal and stochasstic

- We define the cost of living in the US as follow :

$$\mathcal{C}(a,h,e|\overline{V},p_{US}) = \min_{\{c,m\}} \left\{ \begin{array}{l} c(a,h,e) + \mu p_{US} m(a,h,e) \\ + \left(\frac{1}{1+r}\right) \sum_{e'} \sum_{h'} \mathcal{C}(a',h',e'|\overline{V},p_{US}) \end{array} \right| \overline{V} = V(a,h,e)$$

- If we control by the utility level (reference=EU), then $\overline{u} = u(c_{EU}, m_{EU}) = \{\max_{c,m} u(c,m) \;\mid\; c + p_{EU} m = y\}$.
- With $p_{US} > p_{EU}$, $u(c_{US}, m_{US}) = v(p_{US}, y) < v(p_{EU}, y)$, $\Rightarrow$ a monetary transfer *tr* is needed to reach $v(p_{US}, y + tr) = v(p_{EU}, y)$, $\Rightarrow u(\widetilde{c}_{US}, \widetilde{m}_{US}) = u(c_{EU}, m_{EU})$.
- Therefore, the cost of living in the US is given by

$$\frac{c_{US} + p_{EU} m_{US}}{c_{US} + p_{US} m_{US}} \equiv I_P \leq I_K = \frac{\mathcal{C}(\overline{u}, p_{EU})}{\mathcal{C}(\overline{u}, p_{US})} \leq I_L \equiv \frac{c_{EU} + p_{EU} m_{EU}}{c_{EU} + p_{US} m_{EU}}$$

This Konus's index measures the monetary gains to switch to EU prices, keeping constant the utility level.
In a static model, it is bounded by the Laspeyres and the Paasche indexes, based on observable variables.