Understanding Cross-country Differences in Health Status and Expenditures: Health prices matter

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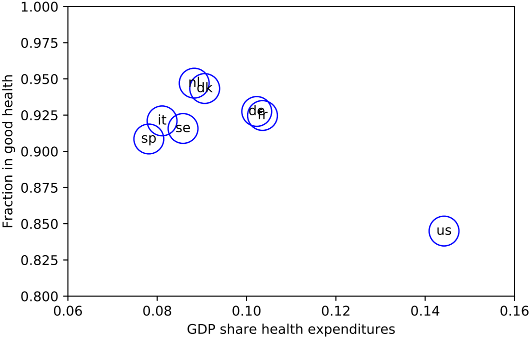
Motivation : well-known stylized facts

- Large differences in how much countries spend on health
- Differences in health outcomes
- The US is an outlier : $\begin{cases} \text{They spend more on health} \\ \text{Health outcomes lower} \end{cases}$



Our contribution

- **Objective**
  To measure the **size**, the **impact** and the **welfare costs** of health price differences across OECD countries
- **Method**
  A structural approach because health prices are not observable
- **Theory :**
  - Heterogeneous-agent GE model à la Aiyagari (1994)
  - with a health production function as in Grossman (1972)
  - Introduction of health prices as a key mechanism that shapes health outcomes and health expenditures

What we do

- **Structural estimation** using a sample of 8 countries g

$$g \in \{DE, DK, FR, IT, NL, SE, SP, US\}$$

- Health price relative to the U.S. : Health price gaps
- After controlling for key country-specific features

  $\rightarrow$ TFP gaps relative to the US (Macro)

  $\rightarrow$ Others differences (Micro) :

  - health risks (health production function),
  - income risks,
  - health insurance (co-insurance rate)

What we deduce

- **Counterfactual analysis :** to compute the U.S. equilibrium if the health price is equal to the average European price.
  - $\rightarrow$ from the estimation of the price differences to an original measure of there impacts on health expenditures, health status and health inequalities.

- **Welfare analysis :** to compute the **extra cost of living induced by high health prices**
  - $\rightarrow$ from the WTP to an original extension of the Lifetime cost-of-living index to dynamic-stochastic models.

Plan

- Stylized facts : how to explain differences in health expenditures ? Why do health price differences matter ?
- Model presentation
- Model estimation
- Model implications :
  - counterfactuals
  - welfare analysis

1. Decomposition of Growth in Health Expenditures

Empirical evidence 1970-2007

- Classical view : Differences in GDP growth and population aging can explained cross-country differences in health expenditures.
- We show that these explanatory variables can only account for **a fraction** of the differences
- Estimate the regression (country g, year t)

$$\log(pm_{g,t}) = a\log(y_{g,t}) + b\log(p65^{+}_{g,t}) + c_g + \eta_t + e_{g,t}$$

  - health expenditures per capita $pm_{g,t}$
  - real GDP per capita $y_{g,t}$
  - the 65+ population share $p65^{+}_{g,t}$
- For each country, we can decompose growth into a component due to economic growth, population aging and a residual

1. Growth Accounting

LT growth rates (%)	DE	DK	FR	NL	SE	SP	US	Europe Av.
GDP growth	1.1	1.6	1.7	1.7	1.6	1.9	1.8	1.5
Pop. Aging	0.7	0.4	0.5	0.6	0.4	1.0	0.4	0.7
Residual	1.0	0.1	1.4	0.5	0.2	1.5	1.9	1.1

From $\log(pm_{g,t}) = a\log(y_{g,t}) + b\log(p65^{+}_{g,t}) + c_g + \eta_t + e_{g,t}$. We obtain estimates $\widehat{a} = 0.90$ and $\widehat{b} = 0.70$.

1970-2007

- Economic growth $\approx$ 1.1 to 1.9 percentage points long-term annual growth in health expenditures for each country
- Population aging contributes much less and the contribution is similar across countries
- The residual component varies the most across countries and for which the U.S. has the highest growth

2. Excess Health Inflation : Explaining the Residual

- We look at data on inflation in health prices π_m
  - BLS, Eurostat, 1996-2007
- We compute health inflation π_m minus CPI inflation π :
  - excess health inflation
- We compute counterfactual health expenditure
  - $s = \frac{pm}{y}$ in data
  - counterfactual $\hat{s} = \frac{\bar{p}m}{y} = p_{1996}\frac{m}{y}$ under the assumption of zero health inflation
  - compare s to $\hat{s}$ to infer the contribution of excess health inflation to growth in health expenditures

2. Inflation in Health Prices and GDP Share of Health Expenditures

(%)	DE	DK	FR	IT	NL	SE	SP	US	Europe Av.
health $\overline{\pi}_m$	2.45	1.29	1.81	2.33	2.98	2.40	1.31	3.62	2.10
overall $\overline{\pi}$	1.36	1.80	1.55	2.059	2.06	1.48	2.63	2.31	1.81
$\overline{\pi}_m - \overline{\pi}$	1.08	-0.50	0.25	0.274	0.92	0.92	-1.31	1.31	0.28
$s = p\frac{m}{y}$	10.62	9.34	10.62	8.25	9.24	9.03	8.12	15.03	9.55
$\widehat{s} = p_{1996}\frac{m}{y}$	9.37	10.02	10.43	7.82	8.13	8.25	9.24	12.41	9.16
$\frac{s-\widehat{s}}{\widehat{s}}$	13.39	-6.81	1.83	5.50	13.68	9.46	-12.14	21.10	4.22

- Suggestive evidence that health prices matter
- Limitation : this is inflation, not relative prices across countries

Price and Efficiency | Use and Supply of Health Care | R&D Activities and Outcomes

3. Impact on Health Differences : Prevalence of Various Health Conditions (SHARE & HRS 2004)

	hyper-tension	diab.	lung	heart	stroke	total cond.	ADLs	Life exp.(50)
DE	0.339	0.105	0.043	0.092	0.035	0.613	0.069	31.14
DK	0.281	0.069	0.060	0.065	0.040	0.516	0.070	30.15
FR	0.256	0.089	0.049	0.105	0.025	0.524	0.073	32.56
IT	0.359	0.115	0.064	0.087	0.026	0.651	0.076	32.66
NL	0.240	0.077	0.061	0.092	0.035	0.506	0.052	31.22
SE	0.264	0.081	0.027	0.114	0.031	0.517	0.056	32.11
SP	0.290	0.124	0.045	0.078	0.018	0.556	0.070	32.26
EU	0.310	0.104	0.050	0.092	0.028	0.584	0.070	31.96
US	0.440	0.149	0.070	0.159	0.046	0.865	0.112	30.65
Δ	0.130	0.045	0.020	0.067	0.018	0.281	0.042	-1.31
(%)	41.9	43.8	40.9	73.3	62.1	48.1	59.2	-4.1

In relative terms, the prevalence of various health conditions is 40.9 to 73.3% higher in the U.S. than in Europe.

Putting the Pieces Together

Consider a static model for households ($g \in \{US, EU\}$) ▸ health risk

- For each income level $y_{g,i}$, $\forall i = 1, \dots, 4$ (quartiles),

$$\max_{m_{g,i}} \left\{ \frac{(y_{g,i} - p_g m_{g,i})^{1-\sigma}}{1-\sigma} + \phi \left[1 - \exp(-\alpha_{1,g} - \alpha_0 m_{g,i})\right] \right\}$$

$$m_{g,i} \quad \Leftarrow \quad p_g (y_{g,i} - p_g m_{g,i})^{-\sigma} = \alpha_0 \phi \exp(-\alpha_{1,g} - \alpha_0 m_{g,i})$$

- We get the following mapping to aggregate moments :

$$\begin{aligned}
s_g \equiv \frac{p_g m_g}{y_g} &= \frac{1}{4} \sum_i m_{g,i}(\phi, \alpha_0, \alpha_{1,g}) \\
\overline{\pi}_g &= \frac{1}{4} \sum_i (1 - \exp(-\alpha_{1,g} - \alpha_0 m_{g,i}(\phi, \alpha_0, \alpha_{1,g}))) \\
\frac{\overline{\pi}_{g,4}}{\overline{\pi}_{g,1}} &= \frac{1 - \exp(-\alpha_{1,g} - \alpha_0 m_{g,4}(\phi, \alpha_0, \alpha_{1,g}))}{1 - \exp(-\alpha_{1,g} - \alpha_0 m_{g,1}(\phi, \alpha_0, \alpha_{1,g}))}.
\end{aligned}$$

Putting the Pieces Together

- Consider 4 income quartiles in each country $\{y_{g,i}\}_{i=1}^{4}$
- y_{US} normalized to unity, $y_{EU} = 0.78 y_{US}$
- We set $\sigma = 2$, a value used by Hall and Jones (2007)
- **For the U.S.** where p is normalized to unity

$$\left\{s, \overline{\pi}, \frac{\overline{\pi}_4}{\overline{\pi}_1}\right\}_{US} = \{0.15, 0.89, 1.27\} \Rightarrow \{\phi, \alpha_0, \alpha_{1,US}\} = \{2.95, 7.19, 1.47\}$$

- **For Europe**, given $\{\phi, \alpha_0\}$

$$\{s, \overline{\pi}\}_{EU} = \{0.09, 0.93\} \quad \Rightarrow \quad \{p_{EU}, \alpha_{1,EU}\} = \{0.54, 1.86\}$$

- **Results :**
  - $p_{EU} < p_{US}$ **Higher price in the US**
  - $\alpha_{1,US} < \alpha_{1,EU}$ **More risky behaviors in the US**
  - $\frac{\overline{\pi}_{4,EU}}{\overline{\pi}_{1,EU}} = 1.13 < \frac{\overline{\pi}_{4,US}}{\overline{\pi}_{1,US}} = 1.27$ **Larger inequalities in the US**

Model : Preferences

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

- Agents have infinite lifetime horizon
- 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.
- Agents of all countries share the same preferences (σ, ϕ, β)

Model : Health "Production"

- The probability of being in good health next period is

$$\pi(h' = 1 | h, m) = \max\left\{0, 1 - e^{-(\alpha_0 m + \alpha_{1h})}\right\}$$

- m use of medical services
- α_0 return of health services on health outcome
- α_{1h} next period probability of good health depends on current health status h
- We expect $\alpha_{11} > \alpha_{10}$: advantage of being in good health
- α_{1h} are **country specific** to account for differences across countries of risky behaviors.
- α_0 is common to all countries : each new treatment is integrated by individuals in the same way all over the world

Model : Resource Constraint

- Wealth dynamics :

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

- Borrowing constraint, $a' \geq 0$.
- country specific parameters/variables
  - Earnings risk e follows AR(1) with parameters (ρ_e, σ_e)
  - Health insurance : τ and co-insurance μ
  - Price of health services (estimated and country-specific) : p
- The interest rate r, the wage per unit of human capital w and tax rate τ are determined at the general equilibrium.

Model : Consumer Problem

The consumer solves :

$$
\begin{aligned}
V(a,h,e) &= \max_{m,c}\left\{\frac{c^{1-\sigma}}{1-\sigma}+\phi h\right.\\
&\qquad \left.+\beta\sum_{e'}\sum_{h'}\widetilde{\pi}(e'|e)\pi(h'|h,m)V(a',h',e')\right\}
\end{aligned}
$$

$$
\text{s.t.}\quad\left\{\begin{array}{rcl}
a' &=& a(1+r)+we(1-\tau)-c-\mu p m\\
a' &\geq& 0\\
\pi(h'|h,m) &=& \max\{0,1-e^{-(\alpha_0 m+\alpha_{1h})}\}\\
\widetilde{\pi}:\quad e' &=& \rho_e e+\sigma_e\epsilon \qquad \epsilon\sim N(0,1)
\end{array}\right.
$$

Model : Health service market

Microfoundations for differences in health prices

- Agents on the health market are
  - Physicians $\rightarrow$ information rent
  - providers of medical services $\rightarrow$ Cournot competition
  - payers (or insurers) $\rightarrow$ perfect competition

$$\underbrace{b_h \rightarrow b = zb_h}_{\text{Physicians}} \rightarrow \underbrace{p_p b \rightarrow p_r m_r(i)}_{\text{Providers}} \rightarrow \underbrace{p_r m_r(i) \rightarrow p m_r(i)}_{\text{Payers}}$$

- 3 sources of inefficiency :
  - Information frictions $\Leftrightarrow$ The quality of the health service is not perfectly observed by patients (Arrow (1963))
  - Imperfect competition among providers of medical services
  - Administrative costs
- Profits induced by rents are used to pay fixed costs and entry costs : no dividend is paid to households

Model : Inefficiency on health services market

Assuming linear production functions on health market,

$$p = \underbrace{\frac{1}{\zeta}}_{\text{information rents}} \times \underbrace{\frac{1}{1 - 1/P}}_{\text{imperfect competition}} \times \underbrace{\frac{1}{(1-\iota)}}_{\text{admin. costs}} \times \underbrace{\frac{1}{z}}_{\text{marginal cost}}$$

- $\zeta \in (0,1)$: probability to detect a shirking medical care provider
- P : number of providers of medical services
- $\iota \in (0,1)$: administrative cost
- z : TFP of the health sector (thus $\frac{1}{z}$ is the marginal cost)

$\{1/P; \zeta; \iota; z\}$ are country specific

$\Rightarrow$ **health price is country specific**

Model : Production of Goods

- Production Y is CRS using aggregate capital K and labor N as inputs :

$$Y = AK^{\alpha}N^{1-\alpha}$$

- Capital depreciation rate is δ_k
- Input prices are determined on competitive markets (r and w).
- A captures technological progress incorporated in production sector (TFP).
- $\{A, \delta_k, \alpha\}$ are **country-specific**.

Solving the model

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

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

(e.) τ adjusts the health insurance budget ▸ Health insurance budget

(f.) 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 $\sum_e \sum_h \sum_a pm(a, h, e)\lambda(a, h, e) =$ Health Supply

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

Estimating the model

- 8 countries : $= \{DE, DK, FR, IT, NL, SE, SP, US\}$
- Calibrating auxiliary parameters using external information :
  - common to all countries : β
  - country-specific : co-insurance rate μ, income risk (ρ_e, σ_e), technology $(\alpha,\ \delta_k)$ ▸ Auxiliary
- Method of Simulated Moments : find parameter values to minimize distance between moments from model and data
  - We normalize $A_{US} = 1$ and $p_{US} = 1$
- Empirical strategy : 2-step procedure
  - US data
  - European data

Moments of Simulated Moments

- The vector of estimated parameters is :

$$\begin{aligned}\Theta_{US} &= \{\sigma, \phi, \alpha_0, \alpha_{10,US}, \alpha_{11,US}\}\\ \Theta_{g\neq US} &= \{\alpha_{10,g}, \alpha_{11,g}, A_g, p_g | \sigma, \phi, \alpha_0\}\end{aligned}$$

- Θ is such that :

$$\min_{\Theta_{g\neq US}} \left(\left[m_S(\Theta_{g\neq US}) - m_{\text{data},g\neq US} \right]' W_{g\neq US} \left[m_S(\Theta_{g\neq US}) - m_{\text{data},g\neq US} \right] \right)$$

$$s.t.\;\; \Theta_{US} = \text{argmax} \left(\left[m_S(\Theta_{US}) - m_{\text{data},US} \right]' W_{US} \left[m_S(\Theta_{US}) - m_{\text{data},US} \right] \right)$$

The constraint provides Θ_{US} and thus $\{\sigma, \phi, \alpha_0\}$ taken as given for the estimation of $\Theta_{g\neq US}$.

- W_g is a diagonal matrix with elements equal to the inverse of the variance of each moment.
  - To compute these variances, we use the bootstrap method for moments involving microdata, and time-series variation for aggregate moments.

Moments m_{data}

Identifying moments m_{data} for each country g

$$\begin{aligned} m_{\text{data},US} &= \left\{C/Y, s, \tilde{\pi}_{1|0}, \tilde{\pi}_{1|1}, \overline{\pi}_2, \overline{\pi}_3, \overline{\pi}_4\right\} \\ m_{\text{data},g\neq US} &= \left\{\tilde{Y}, s, \tilde{\pi}_{1|0}, \tilde{\pi}_{1|1}, \overline{\pi}_2, \overline{\pi}_3, \overline{\pi}_4\right\} \end{aligned}$$

- Ratio of consumption to GDP (C/Y) : Penn World Tables
- Relative GDP per capita to the US $(\tilde{Y}_g)$: OECD
- Share of health spending in GDP $(s = \frac{pm}{Y})$: OECD
- Transition rate from bad to good health $\tilde{\pi}_{1|0}$ and good to good health $\tilde{\pi}_{1|1}$: SHARE-2004/2006 and HRS-2004/2006.
- Health-income gradient $\overline{\pi}$: Fraction of individuals in good health by net income quartiles, SHARE 2004 and HRS 2004

▸ Moments

Estimation results : Common Parameters

σ	ϕ	α_0
2.105	0.397	0.161
(0.048)	(0.006)	(0.009)

- ϕ : individuals are on average willing to accept a loss of 1% of their permanent consumption to increase their probability of being in good health by 1 percentage point
  De Nardi et al (2018) : 3%
- Elasticity of *pm* to the co-insurance μ : our model -0.27
  RAND Health Insurance Experiment : -0.2 to -0.3
- Income elasticity of *pm* : 0.5
  Acemoglu et al (2013) : 0.55 (std=0.230) to 0.8 (std=0.155)

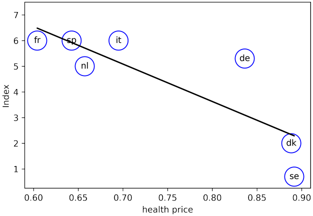
Estimation results : Country-specific Parameters

	US	DE	DK	FR	IT	NL	SE	SP
α_{10}	-0.988	-1.282	-1.602	-1.099	-0.831	-1.390	-1.394	0.002
	(0.069)	(0.069)	(0.025)	(0.009)	(0.004)	(0.003)	(0.047)	(0.061)
α_{11}	3.511	4.029	4.273	3.786	3.917	3.992	4.311	3.434
	(0.035)	(0.035)	(0.007)	(0.020)	(0.027)	(0.004)	(0.053)	(0.024)
$\frac{p}{p_{US}}$	1	0.836	0.888	0.604	0.695	0.657	0.891	0.642
	-	(0.072)	(0.011)	(0.006)	(0.019)	(0.111)	(0.007)	(0.105)
$\frac{A}{A_{US}}$	1	1.011	1.260	0.922	0.613	0.989	0.795	0.795
	-	(0.011)	(0.006)	(0.023)	(0.010)	(0.024)	(0.023)	(0.044)

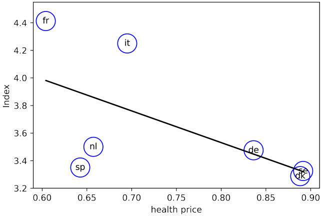
The US health price is 25% higher than the European average health price

▸ Model Fit ▸ Model Fit on un-targeted moment

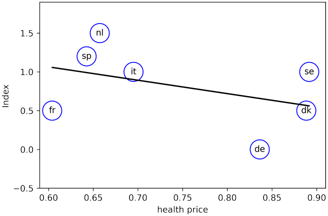
Correlation between Price Estimates and Proxies for Distortions ▸ more



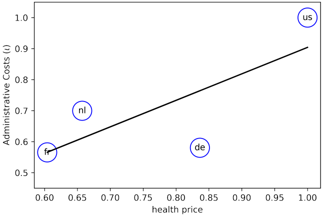
(a) Competition



(b) Regulation

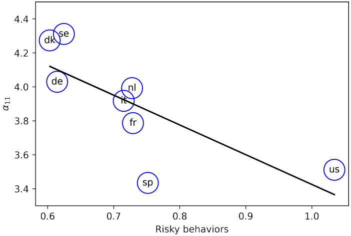


(c) Incentive for quality

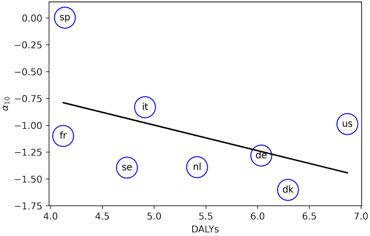


(d) Administrative costs

Health Behaviors and Country-Specific Effects on Transitions to Good Health ▸ more



(e) From good to good health



(f) From bad to good health

(e) Health Behaviors : sum of the prevalence of individuals with at least one of the risky behavior (obesity, smoking, absence of physical activity and drug consumption). Source : HRS, Share, Global Burden of Disease Collaborative Network.

(f) Disability Adjusted Life Years (DALYs) measure the sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability induced by selected risky behaviors. Source : Global Burden of Disease Collaborative Network.

Robustness : 2 extensions of the model

- Those in worse health earn less (Model 1)
  $a' = (1+r)a + (1-\tau)we\Gamma(h) - c - \mu pm$
- co-insurance rate depends on household earnings (Model 2)
  $a' = (1+r)a + (1-\tau)we - c - \mu(e)pm$

Estimation results

- the ranking of countries remain the same
- US still pay the price for health services

Model extensions

Counterfactual : Decomposition of the Differences between U.S and Europe

	GDP share of health expenditure		
	US	Europe	$\Delta = US - EU$
Baseline	14.013	9.004	5.009
Price	11.034	9.471	1.562
TFP	15.684	9.490	6.193
Health risks	9.707	9.866	-0.159

- "Price" : model predictions when $p_{US} = p_{EU}$ and $p_{g \neq US} = p_{EU}$
- 68% fall in the gap in **health expenditures** due to price convergence

Counterfactual : Decomposition of the Differences between U.S and Europe

	Fraction in good health		
	US	Europe	$\Delta = US - EU$
Baseline	89.654	95.563	-5.908
Price	92.570	95.297	-2.726
TFP	88.703	95.802	-7.098
Health risks	93.763	94.618	-0.854

- "Price" : model predictions when $p_{US} = p_{EU}$ and $p_{g \neq US} = p_{EU}$
- 54% fall in the gap in **good health** due to price convergence

Counterfactual : Decomposition of the Differences between U.S and Europe

	Health gradient $\overline{\pi}_4$		
	US	Europe	$\Delta = US - EU$
Baseline	1.275	1.059	0.216
Price	1.182	1.075	0.107
TFP	1.299	1.056	0.243
Health risks	1.160	1.084	0.075

- "Price" : model predictions when $p_{US} = p_{EU}$ and $p_{g \neq US} = p_{EU}$
- $\overline{\pi}_4$ is the relative probability to be in good health in the fourth income quartile (Income-health gradient)
- 50% fall in the gap in **health inequalities** due to price convergence

Welfare analysis

- **Results :** Disparity in health prices matters
  - The US are paying the price
  - TFP differences do not matter
- **Why shall we care ?**
  - Health price wedges have large impact on **welfare**.
  - We develop a new measure of the welfare costs, measuring directly the **"extra cost of living"**.

$$\underbrace{\frac{\text{Expenditures}|p_{US}}{\text{Expenditures}|p_{EU}}}_{\text{Laspeyres index}} \rightarrow \underbrace{\frac{\text{Lifetime Expenditures}|\{p_{US}, V(a+\mathcal{P}, s|p_{US})\}}{\text{Lifetime Expenditures}|\{p_{EU}, V(a, s|p_{EU})\}}}_{\text{Lifetime index}}$$

where the willingness to pay $\mathcal{P}$ is defined for each agent (a, s) by $V(a+\mathcal{P}, s|p_{US}) = V(a, s|p_{EU})$ Welfare

Welfare : Lifetime cost-of-living

		e_0	e_4	e_9	Aggregate
GE	Bad health	100.413	101.785	103.307	102.019
	Good health	100.876	101.905	103.071	
PE	Bad health	100.076	100.617	100.776	100.454
	Good health	100.221	100.452	100.542	

- PE : The extra-cost of living is 0.45%
- GE : The extra-cost of living is 2%
- Laspeyres is index 0.87%

WTP graphs

Conclusion

- We use a GE framework to uncover sources of differences in health and health expenditures between the U.S. and Europe.
- We find that
  - US health prices are 25% higher than in Europe
  - High prices are related to inefficiencies in the health sector
  - Disparity in health prices matters :

  $\Rightarrow$ If $p_{US} = p_{EU}$, then the gaps are reduced by

  $$\begin{cases} \text{68\% for health expenditures} \\ \text{54\% for individuals in good health} \\ \text{50\% for health inequalities} \end{cases}$$

  - Moderate welfare consequences of health prices differences

  $\Rightarrow$ The US bear an extra lifetime cost of living of 2%

Appendix

Price and Efficiency Differences Across Countries (2013 dollars)

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	US	DE	DK	FR	IT	NL	SE	SP
Prices								
Angiogram	914			264				125
relative US	1			0.288				0.136
Bypass surgery	73420			22344		14061		17437
relative US	1			0.304		0.191		0.275
Drug price index	1	0.34		0.268	0.285	0.272	0.306	0.275
relative US								
Hospital spending per discharge	18788	5251	11468	5348		13909	9953	
relative US	1	0.28	0.61	0.28		0.74	0.53	
Efficiency								
Case-fatality rate after AMI (%)	6.66	5.5	9.85	7.05	7.25	9.5	6.3	10.3
relative US	1	0.82	1.47	1.05	1.08	1.42	0.94	1.54

Supply and Utilization of Health Care Services

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	DE	DK	FR	IT	NL	SE	SP	US
Supply								
Hospital beds (a)*	8.54	3.89	7.25	4.09	4.50	3.00	3.35	3.24
Magnetic scanner (b)*	13.62	0.18	1.63	5.49	0.40	-	1.93	9.03
Resonance imaging (b)*	13.09	-	1.02	4.59	0.40	3.52	-	12.02
Radiotherapy equipment (b)*	-	12.6	-	6.4	7.20	-	4.4	11.3
Nurses (a)*	11.18	9.62	8.08	6.25	11.40	10.52	4.65	10.67
Doctors (a)*	3.43	3.30	3.30	3.68	2.71	3.44	3.42	2.39
Utilization								
Doctors' consultations (c)*	8.25	4.42	6.95	6.33	5.72	2.86	8.23	3.94
Waiting time specialists (d)*	72	-	51	-	75	54	-	76
Waiting time doc/nurse (e)*	76	-	57	-	63	58	-	48
Hospital discharge rate (b)*	21.96	15.92	17.58	15.41	10.40	15.97	10.65	12.94
Length hospital stay (f)*	8.93	3.63	5.82	6.76	7.14	6.29	6.71	5.60

(a) per 1,000 inhabitants. (b) per 1,000,000 inhabitants. (c) per capita. (d) Waiting time for a doctor specialist appointment of less than 4 weeks (%). (e) Waiting time for a doctor or a nurse appointment on the same day or the next day when sick or needed care (%). (f) Days. OECD Data : * 2000-2010, $\star$ 2001-2014.

R&D Activities and Outcomes ▸ Back to slides

	DE	DK	FR	IT	NL	SE	SP	US
Medical R&D in GDP $(a)^{\bullet}$	0.39	0.85	0.42	0.10	0.23	0.61	0.13	0.61
Medical patents $(b)^{\diamond}$	1989	201	817	454	404	325	156	7313
Share of medical patents $(c)^{\diamond}$	9.47	24.13	11.05	12.55	15.79	15.67	17.29	20.05

(a) GDP share (%) of R&D of business sector in "Pharmaceuticals" and "Medical, precision instruments". OECD Analytical Business Enterprise Research and Development database (ANBERD). (b) Numbers of patents in medical and pharmaceutical domains. (c) Share (%) of patents in medical and pharmaceutical domains in the country total patents. OECD Data : $^{\bullet}$ 2005-2006, $^{\diamond}$ 1990-2016.

Putting the Pieces Together

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The exponential form, $\overline{\pi}_g(m_{g,i}) = 1 - \exp(-\alpha_{1,g} - \alpha_0 m_{g,i})$, fits well the US data (Medical Expenditure Survey).
For $g = US$ and $i = 1, ..., 10$ (deciles) :

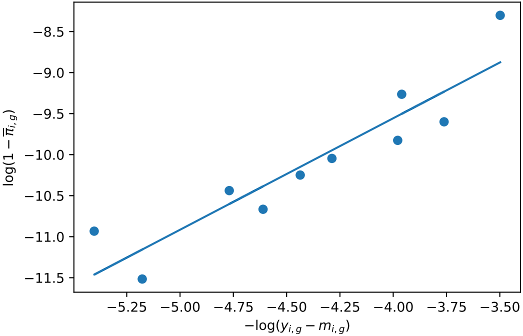

Figure – **Exponential Production Function and Data.** We test the linearity by including a square term in $\log(1 - \overline{\pi}_{i,g})$. The t-statistic is 0.246

Model : Health insurance system

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- The government provides health insurance.
- Health insurance reimburses medical expenditures using proportional taxes on labor income :

$$\tau w N = (1-\mu) p \sum_e \sum_h \sum_a m(a,h,e)\lambda(a,h,e)$$

  where $\lambda(a,h,e)$ is the stationary distribution of individuals across individual states (a,h,e).
- Given the co-insurance rate μ, the tax rate τ must finance expenditures.
- The SS parameters are country specific.

Auxiliary Parameters : step 1

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The observable heterogeneity among countries is introduced to purge the wedge measures from well known differences.

- Income Risk : micro data on income, PSID - ECHP Estimates
- Co-insurance rates μ : OECD Health Data Estimates
- Production of goods : country-specific shares of capital (α) and the depreciation rates (δ_k), Penn World Table (Feenstra et al. 2015) Estimates

Earnings risk

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	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
$\frac{\sigma_e^2}{1-\rho_e^2}$	0.26	0.0956	0.2367	0.275	0.181	0.0956	0.2776	0.493

Table – **Covariance Structure of Income Process** : Parameter estimates by minimum distance as outlined in text. ρ_e refers to the persistence of permanent shocks, σ_e^2 the variance of permanent shocks and σ_u^2 the variance of transitory shocks (assumed measurement error in model and set to zero).

Production functions and depreciation rates

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	DE	DK	FR	IT	NL	SE	SP	US
μ	0.127	0.149	0.088	0.237	0.097	0.162	0.228	0.136
α	0.372	0.360	0.379	0.470	0.393	0.461	0.373	0.384
δ_k	0.039	0.043	0.04	0.039	0.041	0.046	0.037	0.048

α refers to the expenditure share of capital. δ_k refers to the depreciation rate on capital.

Out-of-Pocket μ

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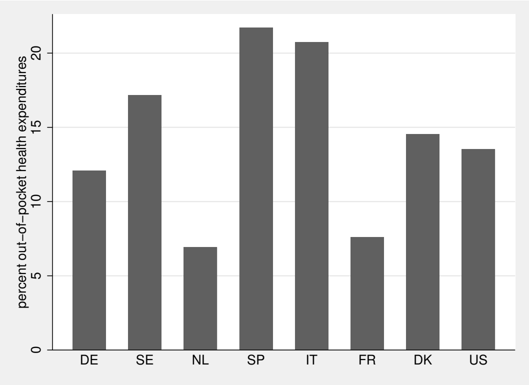

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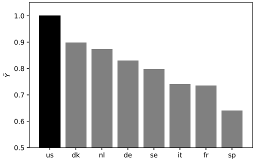
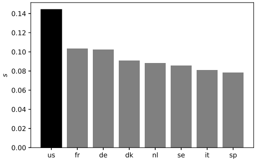
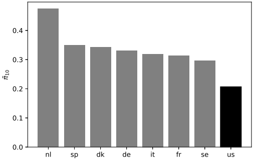


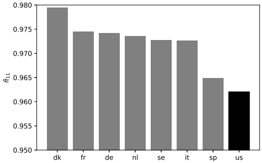
(a) Relative GDP per capita



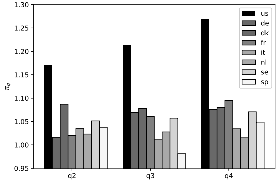
(b) GDP share of health expenditures



(c) Transition from Bad to Good Health



(d) Transition from Good to Good Health



(e) Health-Income Gradient

Fit

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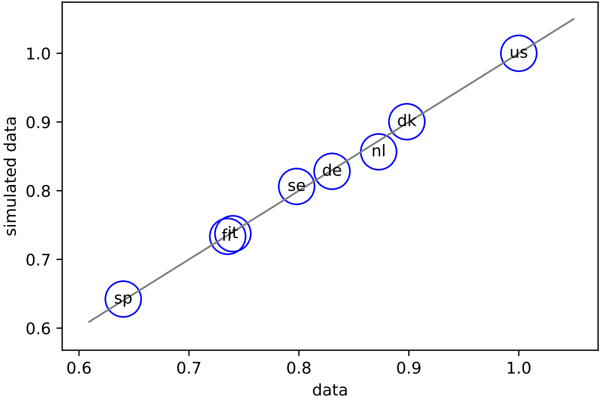

Figure – Relative GDP per capita $\tilde{Y}$

Fit

▸ back to Main

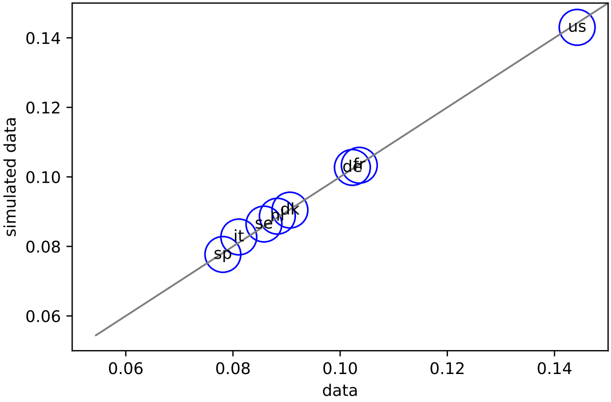

Figure – GDP share of health exp. $s = \frac{pm}{Y}$

Fit

▸ back to Main

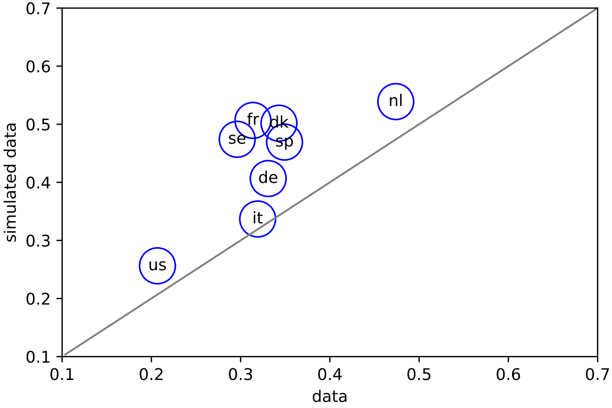

Figure – Transition bad to good health $\tilde{p}_{10}$

Fit

▸ back to Main

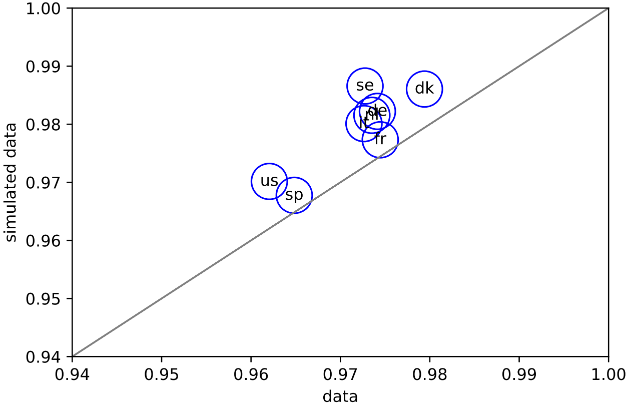

Figure – Transition goog to good health $\tilde{p}_{11}$

Fit

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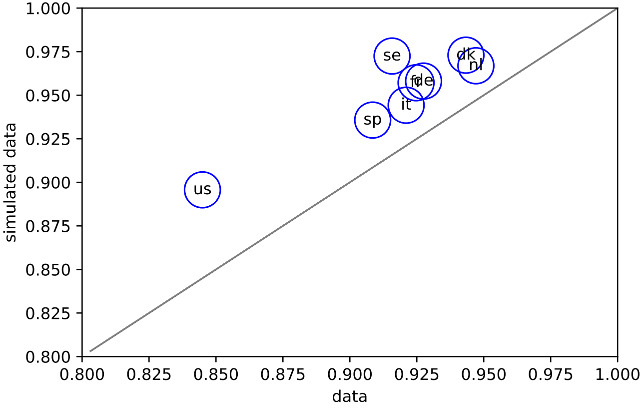

Figure – Fraction in good health $\tilde{p}_1$]

Fit

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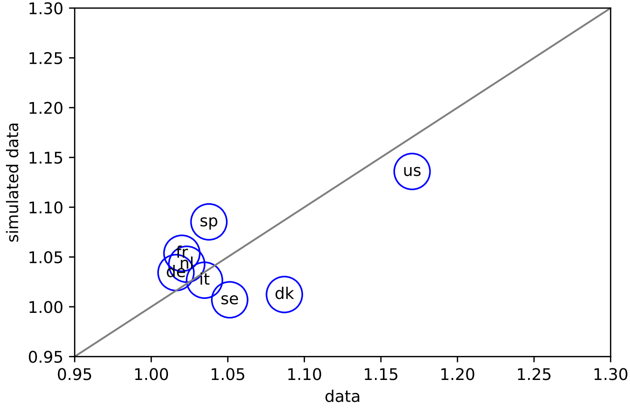

Figure – Income-health gradient $\overline{p}_2$

Fit

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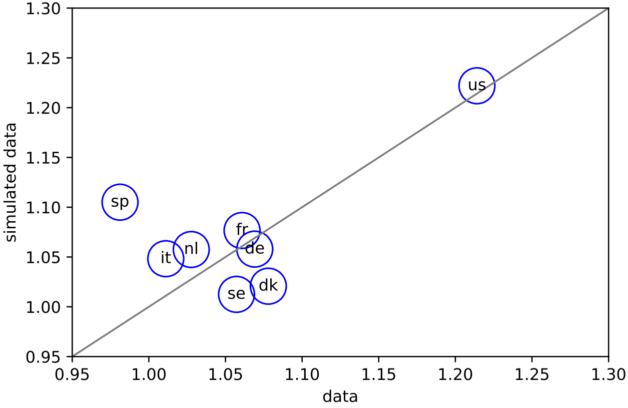

Figure – Income-health gradient $\overline{p}_3$]

Fit

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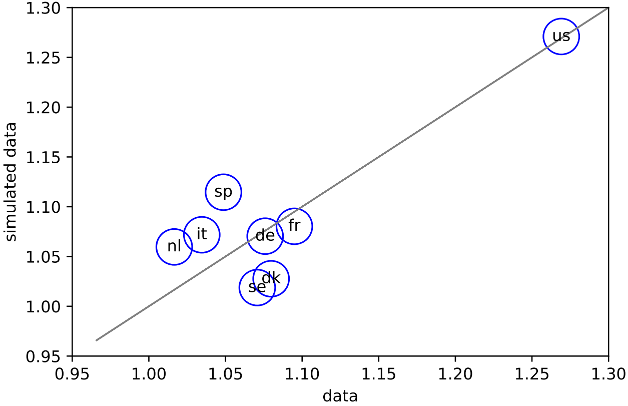

Figure – Income-health gradient $\overline{p}_4$

Fit on un-targeted moment

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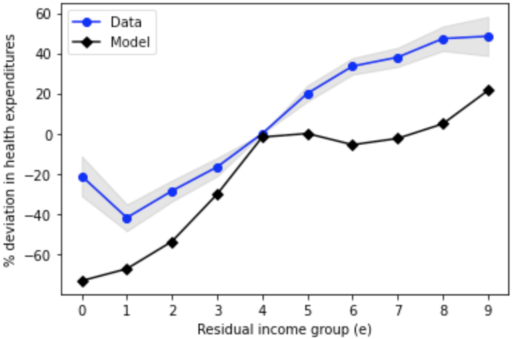

Figure – **Total Health Expenditures as a Function of Income in MEPS**. Sample age 25-84, 1996-2008. The figure shows the ratio of average out-of-pocket health expenditures to average total health expenditures by income group relative to group 5 (middle income group). The income group are obtained by regressing log household income on age dummies and then creating 10 equally spaced groups. The model outcomes are derived from the steady-state distribution of agents and the decision rule for medical consumption.

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	Common parameters			U.S. specific	
	σ	ϕ	α_0	α_{10}	α_{11}
Baseline	2.105	0.397	0.161	-0.988	3.511
	(0.048)	(0.006)	(0.009)	(0.069)	(0.035)
Model 1	2.122	0.367	0.190	-0.980	3.597
Model 2	2.097	0.377	0.146	-0.990	3.604

Table – **Parameters Based on U.S. Data.** Estimates by method of simulated moments. Standard errors in parenthesis. Baseline : benchmark. Model 1 : productivity reduced when individual is in bad health (-20%). Model 2 : Out-of-pocket increasing with household's income.

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		US	DE	DK	FR	IT	NL	SE	SP
α_{10}	Ref.	-0.988	-1.282	-1.602	-1.099	-0.831	-1.390	-1.394	0.002
		(0.069)	(0.069)	(0.025)	(0.009)	(0.004)	(0.003)	(0.047)	(0.061)
	M1	-0.980	-1.286	-1.545	-1.218	-0.677	-1.301	-1.398	-0.316
α_{11}	Ref.	3.511	4.029	4.273	3.786	3.917	3.992	4.311	3.434
		(0.035)	(0.035)	(0.007)	(0.020)	(0.027)	(0.004)	(0.053)	(0.024)
	M1	3.597	4.012	4.403	3.809	3.943	4.012	4.399	3.573
$\frac{p}{p_{US}}$	Ref.	1	0.836	0.888	0.604	0.695	0.657	0.891	0.642
		-	(0.072)	(0.011)	(0.006)	(0.019)	(0.111)	(0.007)	(0.105)
	M1	1	0.821	0.941	0.592	0.750	0.649	0.899	0.633
$\frac{A}{A_{US}}$	Ref.	1	1.011	1.260	0.922	0.613	0.989	0.795	0.795
		-	(0.011)	(0.006)	(0.023)	(0.010)	(0.024)	(0.023)	(0.044)
	M1	1	1.009	1.271	0.921	0.630	0.992	0.799	0.916

Table – **Country-Specific Parameters.** Estimated by method of simulated moments. Standard errors in parenthesis. Baseline (Ref.) : benchmark. Model 1 (M1) : productivity reduced when individual is in bad health (-20%).

Health supply

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- **Provider competition :** degree of patient choice for physicians, specialists and hospitals, i.e. the choice among providers.
- **Regulation :** (i) workforce supply legislation (existence of quotas for medical students and for location), (ii) hospital supply legislation (regulation for opening, bed supply, services, high-cost equipment in hospitals), (iii) regulation of price for physician services (degree of flexibility for physicians' fees), (iv) regulation of price for hospital services (degree of flexibility for setting hospital service prices), (v) regulation of pharmaceutical price (degree of flexibility that companies have to set their prices), (vi) regulation of prices charged to third-party (regulation of fees paid to providers by third-party payers), (vii) incentives for higher volume in physician payment mechanisms (salary arrangements, capitation or fee-for-service), (viii) incentives for higher volume in hospital payment mechanisms (payment mechanisms to hospitals based on lineitem budgets, the volume of procedures, bundle of services, e.g. diagnosis-related groups).
- **Incentives for quality :** (i) incentives for health care quality (patient outcomes and satisfaction), (ii) guidelines/protocol adherence incentives (including financial), and (iii) sanctions for physicians and/or specialists and/or hospitals.
- **Administrative Costs :** OECD administrative cost includes private insurers ("health administration and health insurance : private") as well as public health providers ("General government administration of health, including social security").

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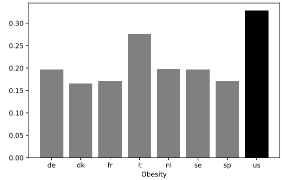
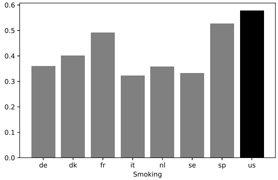
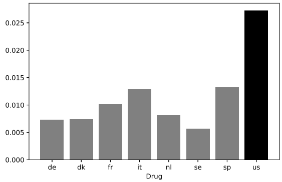


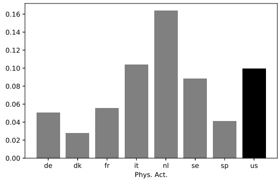
(a) Obesity : BMI>30



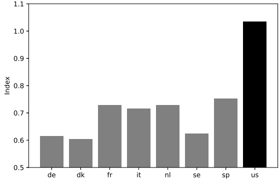
(b) Smoking : ever or currently smoke



(c) Drug use disorders



(d) No physical activity



(e) Index of Risky Health Behaviors

Figure – **Risky Health Behaviors.** (a) to (d) : Fraction of the population exposed. (e) : Index

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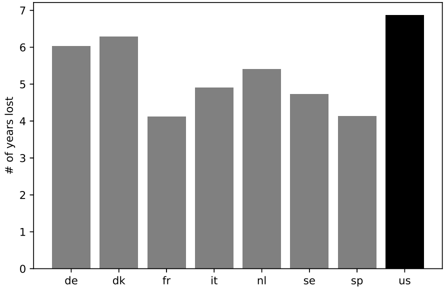
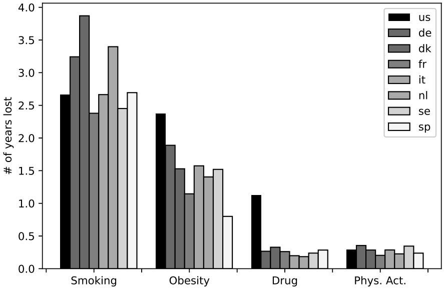


(a) Total DALYs for the 4 risks



(b) DALYs per risky behaviors

Figure – **DALYs : total and by risky behaviors.**

The number of years lost each year per individual (x) is obtained by dividing the raw data by the population of each country. Thus, an individual dying at 70 could have lived up to $70/(1-x)$ years if he did not have a particular risky behavior, which made him lose $70/(1-x) - 70$ years of life.

Welfare

Back to main slides

- Measuring the welfare impact of price distortions
  - **The willingness to pay** ($\mathcal{P}(a, s)$) : how much money is it necessary to transfer to the agent living in the economy with high health price (p^{high}) in order she reaches the same welfare than if she lives in the economy with low health price (p^{low}) ?

$$V(a + \mathcal{P}(a, s), s | p^{high}) = V(a, s | p^{low})$$

Welfare

Back to main slides

- Measuring the welfare impact of price distortions
  - **The willingness to pay** ($\mathcal{P}(a, s)$) : how much money is it necessary to transfer to the agent living in the economy with high health price (p^{high}) in order she reaches the same welfare than if she lives in the economy with low health price (p^{low}) ?

$$V(a + \mathcal{P}(a, s), s | p^{high}) = V(a, s | p^{low})$$

  - **Cost of living :** Conditional on reaching the same welfare in each scenarii, how expensive is it to live in an economy with high health price versus in an economy with low health price ?

$$I_{LT}(a, s) = \frac{\text{Lifetime Expenditures} \mid \{p^{high}, V(a + \mathcal{P}, s | p^{high})\}}{\text{Lifetime Expenditures} \mid \{p^{low}, V(a, s | p^{low})\}}$$

Welfare

Back to main slides

- Measuring the welfare impact of price distortions
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- Link : it is necessary to compute WTP to deduce I_{LT}

Welfare : from the WTP to the "cost of living"

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Cost of living :

- Ratio of expenditure functions under two price regimes, given that both economies yield the same utility level
- **Laspeyres index.** Under the two price regimes (p_{US} vs. p_{EU}), the cost of living approximated by :

$$I_L = \frac{\text{Expenditures}|p_{US}}{\text{Expenditures}|p_{EU}} \times 100 = \frac{\bar{c}_{US} + \mu p_{US}\bar{m}_{US}}{\bar{c}_{US} + \mu p_{EU}\bar{m}_{US}} \times 100 = 100.36\%$$

- Same utility level **iff** static choices and no-substitution effects (Identical basket of goods $\{\bar{c}_{US}, \bar{m}_{US}\}$).
- **Limitations :** representative agent in static and deterministic model (impossible to distinguish GE vs. PE)
- **Solution :** Our measure of the Lifetime cost of living I_{LT}.

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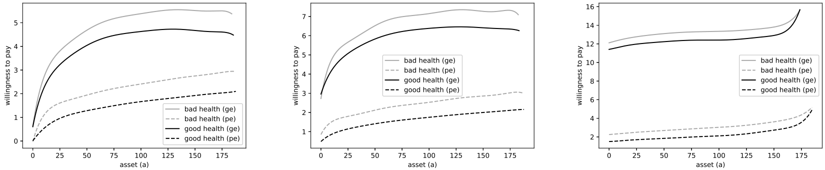

(a) Low-income (b) Middle-income (c) High-income

Figure – **Compensation for Higher Prices in the U.S..** We report the compensation required for maintaining welfare fixed at higher price. We do this for three types of agents : low-income ($e = 0$), middle-income ($e = 4$) and high-income ($e = 9$). For each agent, we compute the willingness-to-pay as a function of health status ($h = 0$ for bad health and $h = 1$ for good health) and asset level a. The willingness-to-pay is reported in consumption units in partial equilibrium (dotted line) and general equilibrium (solid line).

Difficult to measure the price of health

Lorenzini et al (2017). OECD.

- Price collection for non-market goods and services such as health
- Output-based method : Given that output prices for health and hospital products are not readily observable in open and competitive market transactions, "quasi prices" are imputed to approximate what a market price might have been, if there were a market.
- The input-based method, traditionally applied in PPP comparisons of non-market products, such as health services, consists of comparing the prices of inputs in the production process of non-market services. Example : compare the wage rate of a surgeon in different countries.