Financial Health Economics

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Outline

Three Questions

1. Do we spend enough/too much/just enough on health care?

   Health expenditures have been rising from 7.1% of GDP to 15.7% of GDP in the United States

   Hall and Jones (2007, QJE): Luxury-good explanation using a deterministic model without medical R&D

2. Do we spend enough/too much/just enough on medical R&D?

   Murphy and Topel (2006, JPE): Puzzle of “missing R&D.” Given the productivity of medical R&D, one would expect we spend more using a deterministic model

3. Why are health care stock returns so high?

   Will show: additional 4% excess return on health stocks above “usual” equity premium.

Three answers

In reverse order:

1. The excess health equity premium is a risk-adjusted reward for bearing government intervention risk. More than half of it is a “risk premium”, the rest a “disaster premium”.

2. Health R&D investments are thus risky, and need to earn this excess return. Without government intervention risk, R&D would currently be more than twice as high.

3. As a consequence, medical progress has been held back. Without government intervention risk, health spending would be higher by 4% of GDP. Long-run: health spending share is 38%.

Three approaches

1. Examine health equity returns, using CAPM and Fama-French. Document 4% excess health investment premium.
2. Examine 10k filings and draw downs. Examine Clinton heath care reform attempt, Obama health care reform. Argue: the premium is government intervention risk.
3. Provide a long-run general equilibrium model with many distortions and risk of government intervention disaster. Calibrate and solve to obtain quantitative answers to questions. (Additional: complement with simple models, arguing it must be government intervention risk).

Health Care Data

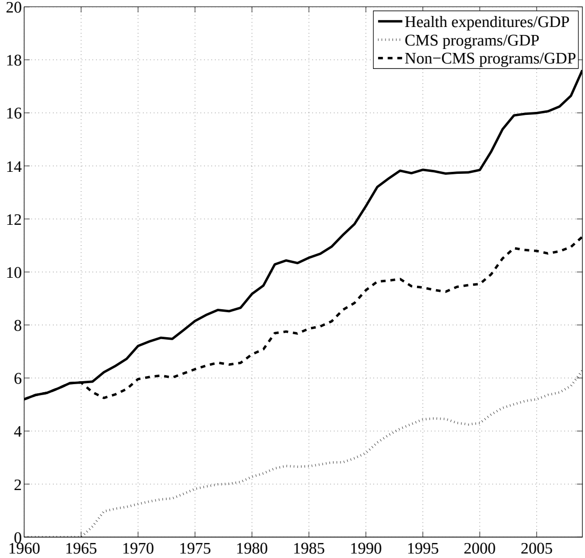
- US health care spending

  National Health Expenditure Accounts from the Centers for Medicare and Medicaid Services

- International data on health expenditures to GDP and the data on pharmaceutical expenditures

  OECD Health Data 2010

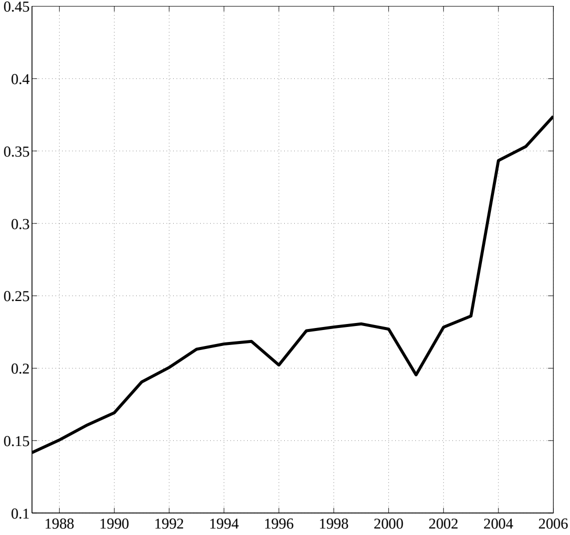
Health Care Spending Shares in the United States



Health Care Spending Shares in the OECD Countries

	Health exp. (% GDP)		Pharma (% health exp.)	
Country	1971	2007	1971	2007
Australia	4.8	8.5	14.8	14.3
Belgium	4.0	10.0	28.3	15.0
Canada	7.2	10.1	-	17.2
Germany	6.5	10.4	15.5	15.1
Japan	4.7	8.1	-	20.1
Spain	4.0	8.4	-	21.0
Sweden	7.1	9.1	6.9	13.4
United Kingdom	4.5	8.4	14.8	12.2
United States	7.3	15.7	11.5	12.0
Average	5.6	9.5	14.1	13.9
Median	5.2	9.1	14.2	13.5

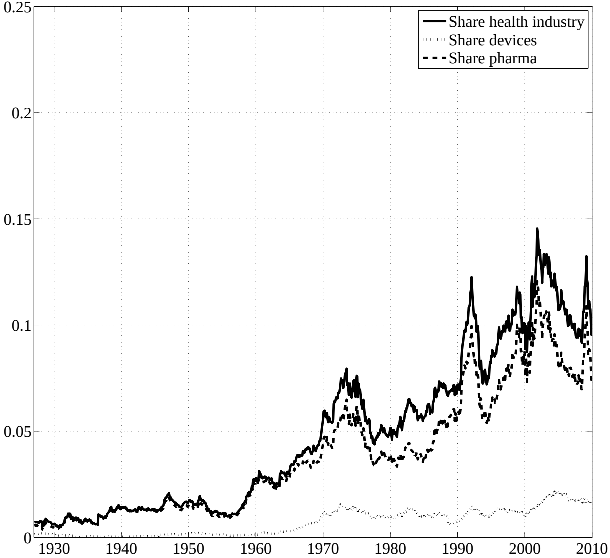
Medical R&D Spending Share in the United States



Financial Markets Data

- Standard data from Ken French
- Divide universe of Amex/NYSE/Nasdaq stocks into
  - Consumer goods
  - Manufacturing
  - Technology
  - Health care
  - Other
- Three subcategories of health care
  - Drugs
  - Devices
  - Services (starting in the seventies)
- Sample periods
  - 1927-2010
  - 1946-2010
  - 1961-2010

Market Cap Shares Health Care Sector



Benchmarking Returns in the Health Care Sector

To analyze returns, we study the returns on all industries relative to factor models

$$r_t - r_{ft} = \alpha + \beta' F_t + \varepsilon_t$$

Factor choices (F_t)

- CAPM: Market
- 3-factor Fama and French (1992) model: Market, Size (*SMB*), and Value (*HML*) factors

The Medical Innovation Premium

Alphas based on annual returns from 1961 - 2012

	Cons	Manu	HiTec	Health	Other	Devices	Drugs
CAPM	1.81	1.66	-0.83	3.31	0.22	3.71	3.70
T-statistic	1.40	1.54	-0.54	1.61	0.17	1.40	1.78
Fama and French	-0.13	1.04	1.67	5.01	-2.66	6.44	5.37
T-statistic	-0.09	0.84	0.86	2.44	-2.75	2.05	2.63
No. of observations	52	52	52	52	52	52	52

Reconciling the Asset Pricing Evidence

- We show in the paper that shocks to
  - Health care productivity ("stochastic Murphy-Topel")
  - Longevity ("stochastic Hall-Jones")

  generate a negative instead of a positive alpha

  $\Rightarrow$ Profits rise when consumption declines

- Mechanism that generates a positive correlation: Government intervention risk

  $\Rightarrow$ US health care companies face the risk that the US government adopts the European model and restricts markups

Empirical Evidence Supporting the Main Mechanism

In general, it is challenging to conclusively show that a risk premium is due to a certain risk (e.g., the size and value premium, momentum, . . .)

Three pieces of supportive evidence

1. Risk factors identified from textual analysis of 10-K filings
2. Drawdowns of the health care sector
3. The cross-section of announcement returns and health factor betas around Clinton-care reforms

Empirical Evidence: 10-K Filings

- All 10-K Filings contain a section "Risk Factors" in which companies list the "most significant factors" that affect the company
- We take the largest 50 health and non-health care companies
- Build a dictionary of government related words, which are not specific to the health care sector

  E.g., "regulatory" and not "FDA"

  ⇒ See Table 2 for the full dictionary

Empirical Evidence: 10-K Filings

Panel A: Main dictionary without health care-specific terms

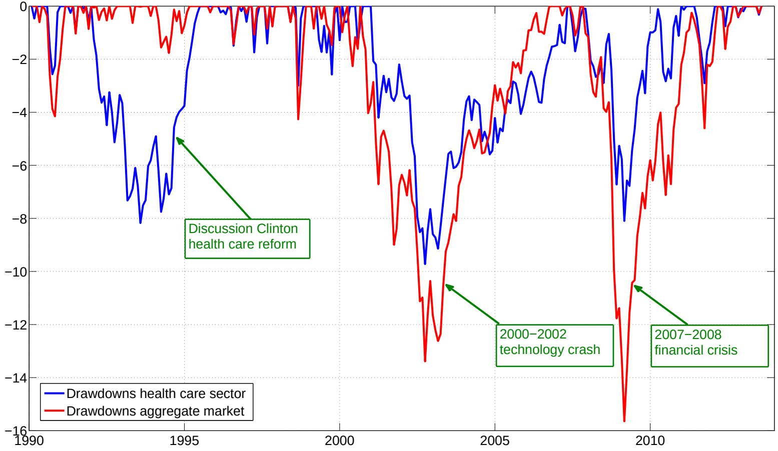
	Average word count	Average fraction of words
Health care sector	138.98	1.51%
Non-health care sector	76.58	1.23%
S.e. of difference in means	15.06	0.10%
T-statistic	4.14	2.78

Panel B: Dictionary including health care-specific terms

	Average word count	Average fraction of words
Health care sector	180.60	1.89%
Non-health care sector	78.86	1.27%
S.e. of difference in means	19.68	0.13%
T-statistic	5.17	4.96

Empirical Evidence: Drawdowns

Drawdowns to measure risk: $D_t = \sum_{s=1}^{t} r_s - \max_{u=1,\ldots,t} \sum_{s=1}^{u} r_s$



Empirical Evidence: Clinton Health Care Reform

Date	Description of event
1/19/92	Clinton issues health care reform proposals before New Hamps. primary
2/18/92	Clinton unexpectedly finishes second in the New Hampshire primary
3/10/92	Clinton does well in the Super Tuesday primaries
4/7/92	Clinton wins NY primary and turns favorite to win the Dem. nomination
6/4/92	Republicans in the House of Rep. offer their health care reform proposal
9/24/92	Clinton speaks at Merck on health care reform
11/3/92	Clinton wins presidential election
1/25/93	Clinton names Hillary Clinton to head his Health Care Task Force
2/12/93	Clinton says drug prices are too high
9/11/93	NY Times describes probable regulations based on a leaked copy of plan
9/22/93	Clinton officially announces his health care reform plan

Abnormal returns during 11 events: -24%

Uses 10-day event window and CAPM as the benchmark model

Empirical Evidence: Clinton Health Care Reform

We link the exposure to the health care factor, which earns the medical innovation premium, to the announcement returns

$$CAR_i = \delta_0 + \delta_1 \frac{\beta_i^{HC}}{\sigma\left(\beta_i^{HC}\right)} + u_i$$

Intercept (δ_0)	-0.21
t-statistics	-8.28
Slope coefficient (δ_1)	-7.7%
t-statistic	-2.66
R-squared	4.0%
Number of firms	327
Average number of years used to estimate health care betas	20.8

Households

- Time: $t = 0, 1, \ldots$.
- Two types of infinitely lived households:
  - "Consumers:" $i \in [0, 1]$
  - "Entrepreneurs:" $i \in (1, 1 + \kappa]$ for some $\kappa > 0$
- Preferences
  - Consumers:

$$U = E\left[\sum_{t=0}^{\infty} \beta^t \frac{\left(c_{nt}^{\xi} h_t^{1-\xi}\right)^{1-\eta}}{1-\eta}\right], \tag{1}$$

  - Entrepreneurs:

$$U_t = V\left(c_{et}, E[\Upsilon(U_{t+1})]\right) \tag{2}$$

  In paper: Endogenize the preferences of the entrepreneurs
- Endowment of consumers:
  - One unit of time per period, supplied as labor. Productivity: γ^t
  - Base level of health: $\underline{h}\gamma^t$

Technologies

- Consumption (L_{ct}: labor devoted to producing consumption):

$$c_{nt} + \kappa c_{et} = \gamma^t L_{ct} \tag{3}$$

- Health: with a continuum $j \in [0,1]$ of medical care types,

$$\begin{aligned} h_t &= \underline{h}\gamma^t + m_t \\ m_t &= \left(\int_0^1 m_{jt}^{1/\phi} dj \right)^{\phi}, \end{aligned}$$

- Medical care production:

$$m_{jt} \equiv \int_0^1 m_{ijt} di = q_{jt} \gamma^t L_{mjt},$$

- Evolution of quality, per R&D,

$$q_{j,t+1} = \left(q_{jt}^{\nu} + d_{jt}^{\nu} \right)^{1/\nu}, \text{ where } d_{jt} = \gamma^t L_{djt}$$

- Feasibility: $L_{ct} + \int L_{mjt} dj + \int L_{djt} dj = 1$

Decentralization

- Government
- Firms
- Households and their budget constraints

We impose symmetry throughout:

$$p_{jt} \equiv p_t,\ m_{jt} \equiv m_t,\ d_{jt} \equiv d_t,\ q_{jt} \equiv q_t$$

Government

The government intervenes in three ways

- Subsidize R&D: Firms pay fraction $1-\chi$
- Subsidize medical care: Households pay fraction $1-\sigma$
- Regulate markups: $p_t \leq \zeta/q_t$
  - Monopolistic competition: $p_t = \phi/q_t$
  - Source of aggregate risk: Start from $\zeta \geq \phi$ ("$z_t = 0$')
    With probability ω iid across time, government imposes $0 \leq \zeta < \phi$ forever after ("$z_t = 1$").

Government budget constraint:

$$\sigma p_t m_t di + \chi d_t = \tau_t + \kappa \tau_{t,e} \tag{4}$$

Incidence of taxation:

$$\begin{aligned} \sigma p_t m_t &= \tau_t \\ \chi d_t &= \kappa \tau_{t,e} \end{aligned}$$

Firms

- They live for two periods
  - Do R&D d_t in t to obtain patent
  - Sell m_{t+1} in monopolistic competition
- Firms maximize firm value v_t:

$$v_t = \max_{d_t} E_t \left(M_{t+1} \pi_{t+1} \right) - (1-\chi) d_t$$

- M_{t+1}: market stochastic discount factor
- Profits: π_{t+1} per monopolistic competition. Price p_{t+1} per unit
- R&D: useful beyond $t+1$. Externality

Budget Constraints

- Consumers:

$$c_{nt} + (1-\sigma)\, p_t m_t + \tau_t = \gamma^t \tag{5}$$

- Entrepreneurs: pay for R&D to create and hold new firms. "Marginal investor".

$$c_{et} + \tau_{t,e} + (1-\chi)\frac{1}{\kappa} d_t = \frac{1}{\kappa}\pi_t \tag{6}$$

Analysis and Solution Approach

- Highly nonlinear
- Assumptions made to avoid complicated numerical techniques
- Monopolistic competition and government regulation:

$$p_t = \mu_t / q_t, \tag{7}$$

where

$$\mu_t = \begin{cases} \phi & \text{if } z_{t+1} = 0, \\ \zeta & \text{if } z_{t+1} = 1 \end{cases} \tag{8}$$

- Entrepreneurs: κ tiny, dividend income much larger than wage income. Thus

$$\kappa c_{t,e} = \pi_t - d_t \tag{9}$$

- Impose SDF per $\overline{M} > \underline{M}$ with $(1-\omega)\overline{M} + \omega \underline{M} = 1$:

$$M_{t+1} = \begin{cases} \bar{R}^{-1}\overline{M} & , \quad \text{if new regul. at } t+1 \\ \bar{R}^{-1}\underline{M} & , \quad \text{if unregul. in } t \text{ and } t+1 \\ \bar{R}^{-1} & , \quad \text{if regul. in } t \text{ and } t+1 \end{cases}$$

Key Implications

- Medical spending share increases only due to medical R&D, which lowers prices
- $\varphi_t = p_t m_t / \gamma^t$: share of gross labor income spent by households on medical care
- Share evolution:

$$\varphi_t = \frac{p_t m_t}{\gamma^t} = \frac{1-\xi}{1-\sigma\xi} - \frac{1-\sigma}{1-\sigma\xi}\xi \underline{h} p_t \tag{10}$$

- The long-run share equals $(1-\xi)/(1-\sigma\xi)$
- Optimal R&D: with R_{t+1} as return to health care firms,

$$1-\chi = \frac{1}{q_t^{\nu} d_t^{1-\nu} + d_t} \frac{1}{\phi - 1} \frac{E_t[\pi_{t+1}]}{E_t[R_{t+1}]}$$

Discouragement of R&D with high risk premium, i.e. high $E_t[R_{t+1}]$

Calibration

- Parameters: t counts decades.

$$\Theta = \left\{\gamma, \underline{h}, \nu, q_0, \underline{M}, \overline{M}, \phi, \xi, \zeta, \chi, \beta\right\}. \tag{11}$$

- $\bar{M}$ and η: no impact on med. spending, no need for calibration.
- Approximation: $y_t = (1+\kappa)\gamma^t + \pi_t \approx (1+\kappa)\gamma^t$. Facts:
  - Output growth: 3% p.a.. Thus $\gamma = 1.35$.
  - Markup: 200%, thus $\phi = 3$. (Caves-Whinston-Hurwitz: generics=20%, so $\phi = 5$)
  - If government intervention: assume markup $= 0$, $\zeta = 1$.
  - $\bar{R}$: 4% p.a.
  - Expected ret. of health care firms: $\bar{R}\underline{M}^{-1}$. Per α: $\underline{M} = 0.63$.
  - R&D share in 1990 and 2010. Health share in 1960 and 2010. Numerically solve for parameters $\underline{h}, \nu, q_0, \xi$ to deliver these.
  - Per "Medicare/Medicaid": medical subsidy $\sigma = 0.5$
  - $\chi = 0.5$ (Jones, 2011)
  - Intervention risk: assumed. We choose $\omega = 10\%$ (per decade). Sensitivity: $\omega = 20\%$.

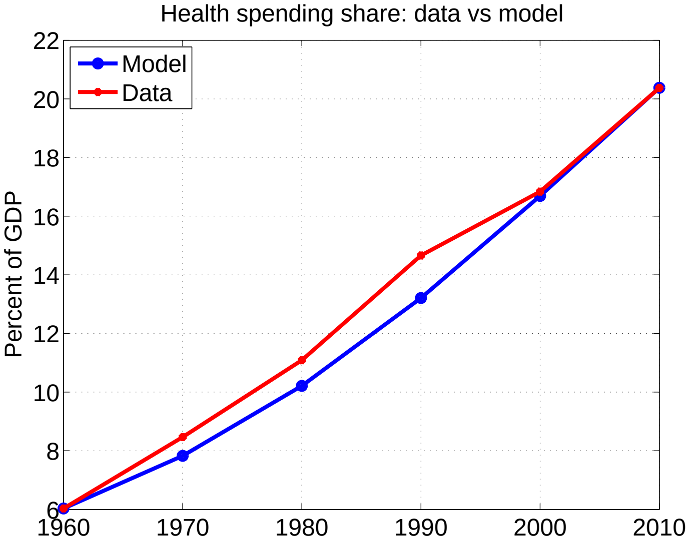
Back-of-the-envelope

- Excess premium is 4
- $\omega = 0.1$: "disaster risk" is 1% p.a..
- So, "risk premium on disaster" is 3% p.a..
- Prob("no intervention in 60 years") = 53%
- If $\omega = 0.2$: "disaster risk" is 2% p.a., risk premium is 2%.
- Prob("no intervention in 60 years") = 26%
- $\omega > 0.2$: implausible. Thus, more than half of the premium is "risk premium against disaster" rather than "disaster premium".

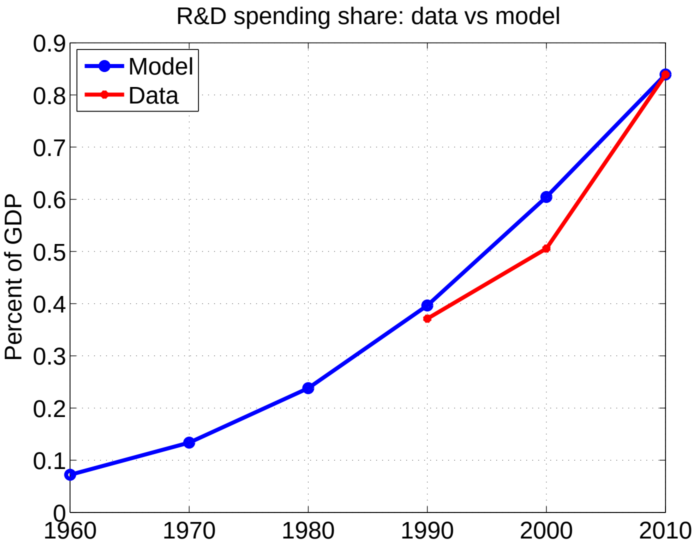
Parameters

Parameter	Description	
γ	10-yr growth	1.35
ϕ	Markup	3
ζ	Constrained markup	1
χ	R&D subsidy	50%
σ	Medical care subsidy	50%
R	10-yr benchmark return	1.48
Q	10-yr return on health R&D, if no interv.	2.37
q_0	Initial level of medical knowledge	4.74
ν	Curvature R&D production function	0.42
$\underline{h}$	Health endowment	0.80
ξ	Weight non-health consumption in U	0.77
$\underline{X}$	Price of government risk, if $\omega = 10\%$:	0.69
$\underline{X}$	Price of government risk, if $\omega = 20\%$:	0.78

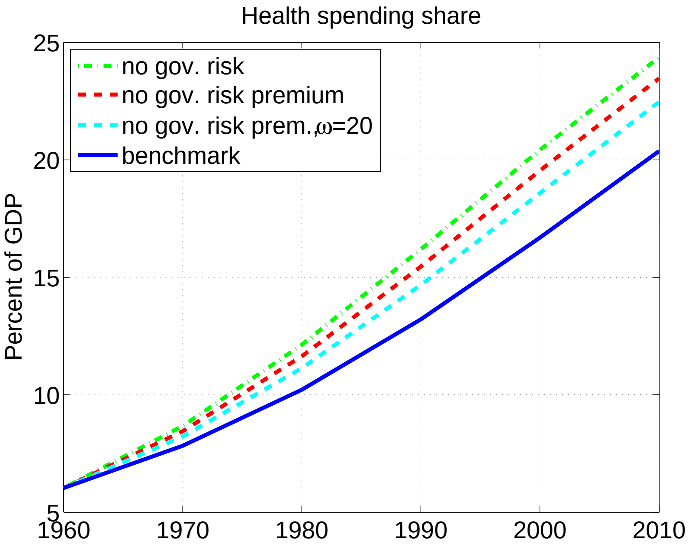
Health Share: Model Versus Data



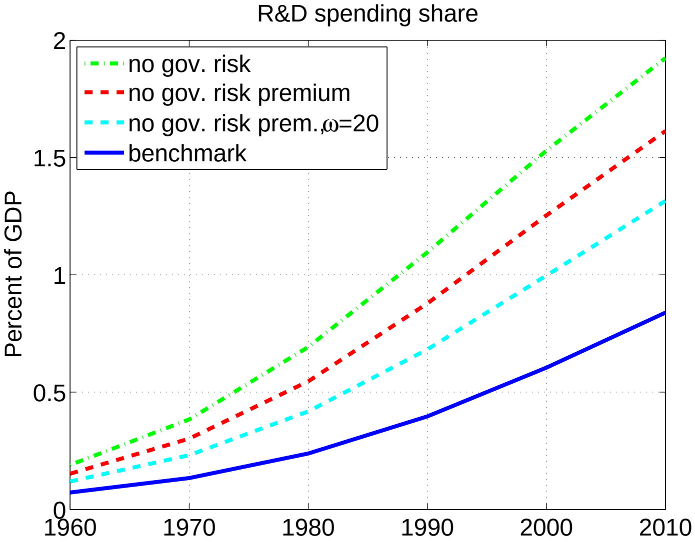
R&D Share: Model Versus Data



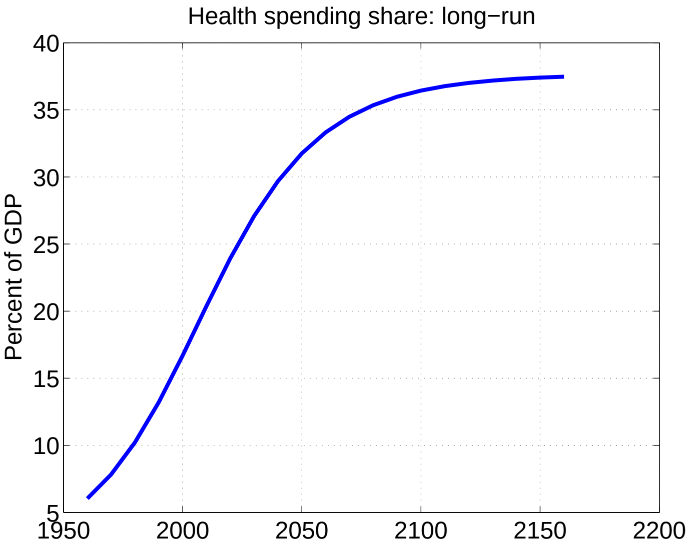
Health Share: Counterfactual



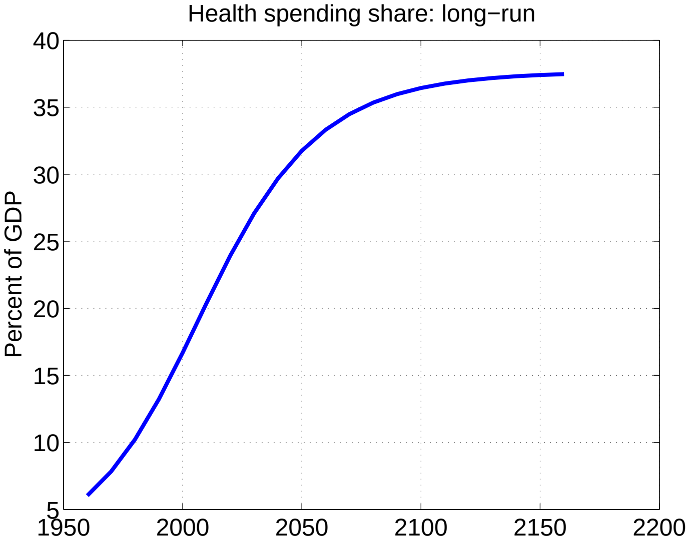
R&D Shares: Counterfactual



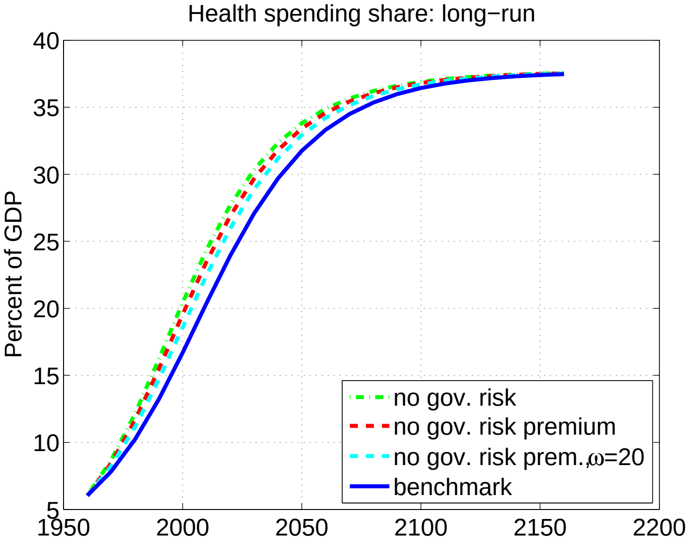
Long-run Health Share



Long-run R&D Share



Long-run Health Share: Counterfactual



Conclusions

- Medical innovation premium (α) of 4-6% for health care firms

  $\Rightarrow$ Must correspond to health-care relevant aggregate risk

- Litmus test for theories

- Our favorite explanation is government intervention risk:
  - Monopoly profits are motor for R&D
  - Risk that profits will be erased

Punchline

Government intervention risk leads to excess equity returns in the health sector. Because of it, more than half of medical R&D and 4% of GDP spending on health is "missing".

Asset Pricing

$$1 = E_t[M_{t+1}R_{t+1}] = E_t\left[\frac{\partial U/\partial c_{t+1}}{\partial U/\partial c_t} R_{t+1}\right]$$

R_{t+1} for health industry: unexpectedly high, when profits are unexpectedly high.

Key insight:

Positive health industry alphas

$=>$

when health industry profits π_{t+1} are high,

$\partial U/\partial c_{t+1}$ is low,

and thus consumption c_{t+1} is high.

Caveat for "thus": that may depend on other arguments of U.

Budget constraints, markups, profits, subsidies

Some theory, "stripped down":

- Health: h. Productivity ("Quality", 1/marg.costs): q. Price: p. Markup: ϕ. Profits: π. Income: y. Cons.: c. Subsidy: σ. Taxes: τ.
- Profits (linear production function):

$$p = \frac{\phi}{q} \text{ and } \pi = (\phi - 1)\frac{h}{q}$$

- Household budget constraint:

$$y + \pi = c + (1 - \sigma)ph + \tau$$

- Government budget constraint:

$$\sigma ph = \tau$$

- Together:

$$\boxed{\begin{gathered} c = y - h/q = y - \pi/(\phi - 1) \\ \pi = (\phi - 1)h/q \end{gathered}}$$

Approaches That Do Not Work

$$\boxed{\begin{array}{c} c = y - h/q = y - \pi/(\phi - 1) \\ \pi = (\phi - 1)h/q \end{array}}$$

π, h, c: endogenous.

y, ϕ, q: parameters or constant.

- Medical progress and longevity: $q \uparrow$, thus $h \uparrow$.
- Preference shock for h, with c and h separable or complements.
- Subsidy shock. $\sigma \uparrow$.

Hard to get them to work:

- Suppose $\pi \uparrow$. Then $c \downarrow$.
- Suppose $\pi \downarrow$. Then $c \uparrow$.
- Negative correlation, not positive correlation.

Approaches That Might Work

$$\boxed{\begin{array}{c} c = y - h/q = y - \pi/(\phi - 1) \\ \pi = (\phi - 1)h/q \end{array}}$$

π, h, c, y, ϕ, q: possibly all endogenous.

1. Medical progress and productivity: $q \uparrow$, thus $y \uparrow$, $\pi \uparrow$ and $c \uparrow$.
2. Preference shock for h, with c and h (strong) substitutes: $h \uparrow$, thus $\pi \uparrow$ and $c \downarrow$, but nonetheless $u_c(c, h) \downarrow$.
3. Government regulation on ϕ: $\phi \downarrow$, thus $\pi \downarrow$, $h \uparrow$ and $c \downarrow$.

We pursue the third approach. We also need to explain:

- Share for "health" rising over time. $R\&D$ rising over time.
- Share for "health" not rising with higher individual income ("cross-section").