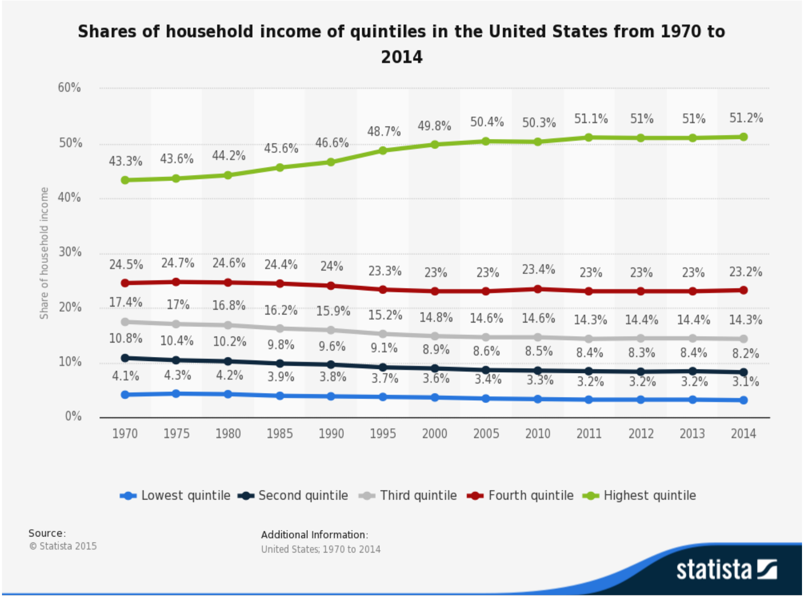
Health Production

University of Alabama

August 30, 2016


Shares of household income of quintiles in the United States from 1970 to 2014
Share of household income
60%
50%
40%
30%
20%
10%
0%
1970
1975
1980
1985
1990
1995
2000
2005
2010
2011
2012
2013
2014
43.3%
43.6%
44.2%
45.6%
46.6%
48.7%
49.8%
50.4%
50.3%
51.1%
51%
51%
51.2%
24.5%
24.7%
24.6%
24.4%
24%
23.3%
23%
23%
23.4%
23%
23%
23%
23.2%
17.4%
17%
16.8%
16.2%
15.9%
15.2%
14.8%
14.6%
14.6%
14.3%
14.4%
14.4%
14.3%
10.8%
10.4%
10.2%
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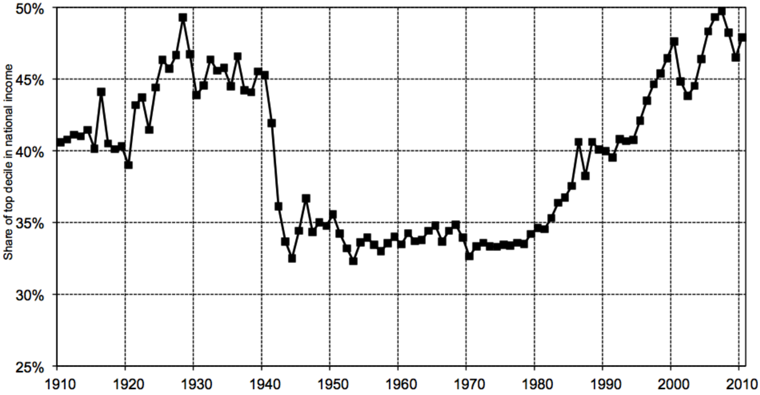
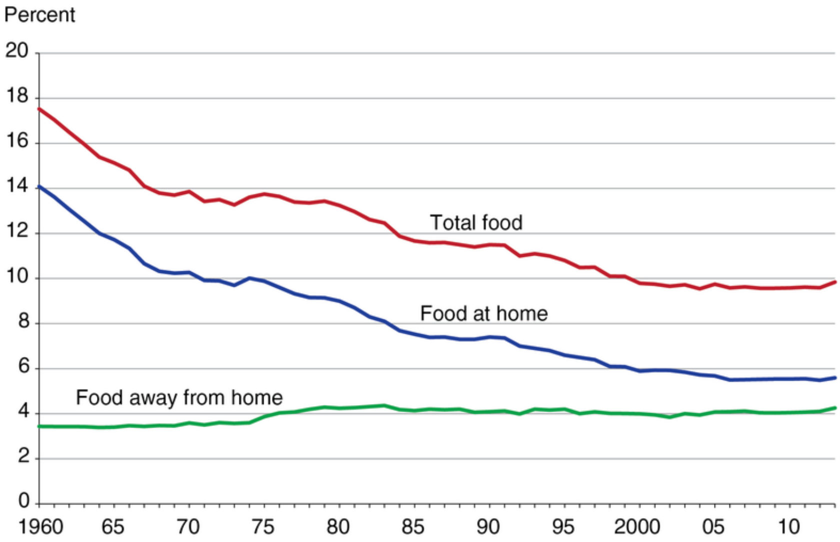
8.3%
8.4%
8.2%
4.1%
4.3%
4.2%
3.9%
3.8%
3.7%
3.6%
3.4%
3.3%
3.2%
3.2%
3.2%
3.1%
Lowest quintile
Second quintile
Third quintile
Fourth quintile
Highest quintile
Source:
© Statista 2015
Additional Information:
United States; 1970 to 2014
statista

Figure I.1. Income inequality in the United States, 1910-2010



The top decile share in U.S. national income dropped from 45-50% in the 1910s-1920s to less than 35% in the 1950s (this is the fall documented by Kuznets); it then rose from less than 35% in the 1970s to 45-50% in the 2000s-2010s. Sources and series: see piketty.pse.ens.fr/capital21c.

Per capita disposable income spent on food in the United States, 1960-2013



Source: USDA, Economic Research Service, Food Expenditure Series, table 7.

Last Class

- Welfare Economics
- Equity-Efficiency Tradeoff
- The First and Second Fundamental Theorems of Welfare Economics
- How Health Care is different than the standard perfectly competitive market (Arrow, 1963)
- Hence, with the market for health care, the fundamental theorems don't necessarily apply

The Production Function

- The production function relates inputs (i.e. factors of production) with outputs (i.e. goods, services, or whatever we are producing).
- The production function is simply a mathematical representation of the "production process" of a firm or agent.
- Consider a very commonly used production functional form: The Cobb-Douglas Production Function:

$$f(K, L) = K^{\alpha} L^{\beta}$$

where K and L represent capital and labor inputs of the firm, respectively, and α and β represent output elasticities measuring the responsiveness of output to changes in capital and labor, respectively.

Can you calculate the marginal product of capital/labor?

The Production Function

$$f(K, L) = K^{\alpha} L^{\beta}$$

Can you preserve the general Cobb-Douglas functional form and prove returns to scale?

With the standard Cobb-Douglas form, we can easily determine whether a firm exhibits increasing, decreasing, or constant returns to scale:

- if $\alpha + \beta = 1$, we have CRS
- if $\alpha + \beta > 1$, we have IRS
- if $\alpha + \beta < 1$, we have DRS

The Production Function

Example:

$$f(K, L) = K^{\alpha} L^{\beta}$$

Can you assume values of α and β and show whether a function exhibits increasing, decreasing, or constant returns to scale?

1. Suppose $\alpha = 0.9$ and $\beta = 0.1$
2. Suppose $\alpha = 0.5$ and $\beta = 0.4$
3. Suppose $\alpha = 0.6$ and $\beta = 0.8$

The Production Function

Returns to scale is related to a concept called *functional homogeneity*.

- If a functions exhibits *constant returns to scale*, we say that the function is *homogeneous of degree 1*

This is not more than a fancy way to describe returns to scale.

This assumption is typically made in theoretical economic models in an effort to provide a realistic painting of the long run production process.

The Production Function

Though the Cobb-Douglas functional form is the most commonly used in economics, there are others:

Linear Production Function:

$$f(K, L) = K + L$$

This production function shows a situation in which the inputs to production, K and L, are perfectly substitutable.

An example of this may be a robot substituting to take to place of a human, perhaps in the production of education.

L-Shaped or "Leontief" Production Function:

$$f(K, L) = min\{K, L\}$$

This production function exhibits a situation in which the inputs to production, K and L, are perfectly complementary.

An example of this may be cab drivers and cars in the production of cab rides.

The Production Function

Standard assumptions of the production function

1. Inputs are finite and non-negative
2. "No free lunch", i.e. in order to get some output, a firm must use some amount of inputs
3. Monotonicity, i.e. increasing inputs does not decrease output
4. Continuous and twice-differentiable
5. Quasi-Concavity, i.e. $\frac{\partial f()}{\partial Inputs} \geq 0$ and $\frac{\partial^2 f()}{\partial Inputs^2} \leq 0$

Assumption 5 implies diminishing marginal productivity.

Can we Model Health Production?

Can we abstract away from the production process of a firm, and consider either an individual agent's or society's Production Function of Health?

What will be the output of this production process?

And the inputs?

Health Production Framework

Suppose that a society, or an individual, has a health production function that has all the standard assumptions. For now, assume the health production process is given by:

$$HS(Medical\ Care, Lifestyle, Genetics, Environment, Luck)$$

where HS indicates Health Status, i.e. our output in the production process, Medical Care represents consumption of medical inputs such as visits to the doctor or consumption of prescription drugs, Lifestyle represents our choices in daily life, Genetics and Environment represent our biological factors and the extent to which externalities affect us, and Luck represents all stochastic events that may occur in life.

Health Production Framework

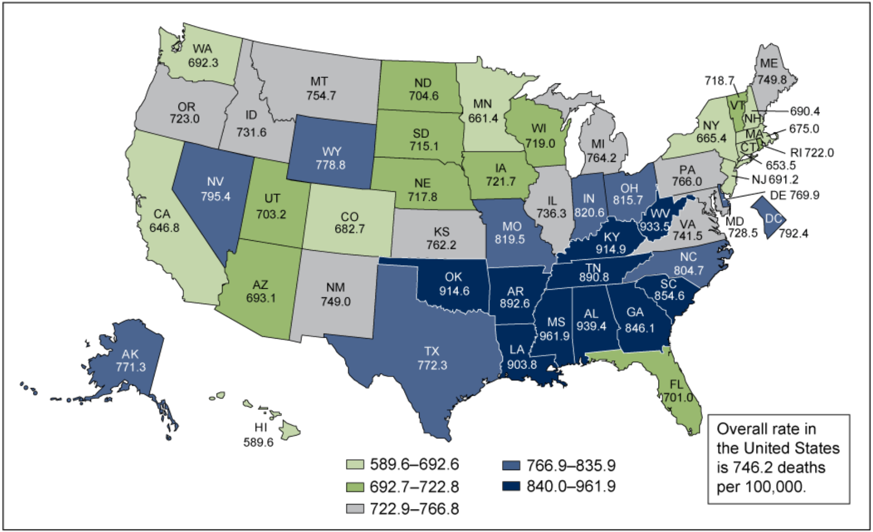
Which of the possible health inputs do you think are most important?

$$HS(Medical\ Care, Lifestyle, Genetics, Environment, Luck)$$

There is no clear answer to this question:

- We would like to think that medical care improves our health, however this is not always the case. Consider iatrogenic disease, i.e. provider-caused disease.
- Lifestyle clearly plays a role: consider the book by Victor Fuchs titled *Who Shall Live?*
  - Fuchs compared people from Nevada and Utah, two states with about the same levels of income and medical care
  - Fuchs asserted that the death rates per 100,000 in the population of Nevada were much higher than those of Utah primarily due to lifestyle factors.

Figure 3. Age-adjusted death rates per state and the District of Columbia: United States, preliminary 2010



SOURCE: National Vital Statistics System, Mortality.

Health Production Framework

Which of the possible health inputs do you think are most important?

$$HS(Medical\ Care, Lifestyle, Genetics, Environment, Luck)$$

- Genetics is certainly important, consider that many studies find that taller people live longer. However, this is likely not independent of lifestyle and environment (Endogeneity).
- Many contribute the improved mortality rates across time to environmental factors, i.e. cleaner water, development of pasteurized milk, improvements in knowledge of the spread of disease, etc.
- Like many things in life, luck certainly plays a role.

A Simplified Version

In order to model health production, we might benefit from narrowing our focus to Medical Care inputs.

For simplicity, let us reduce all health inputs into one variable and call it Health Care, Then

$$HS(Health\ Care)$$

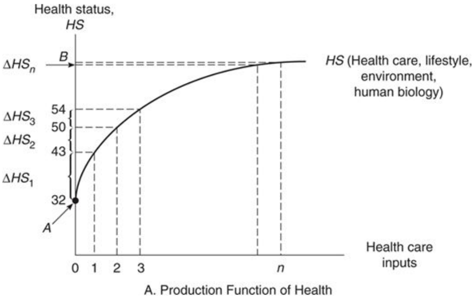
Flat-of-the-Curve Medicine

"Flat-of-the-Curve Medicine" refers to the phenomenon that health care costs continue to rise, yet health outcomes do not improve.

Total Product

- Health status increases as more and more health care inputs are added to the production process.

Figure 5-1 Production of Health A

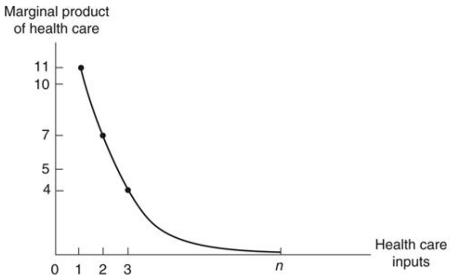


Flat-of-the-Curve Medicine

Marginal Product

- Diminishing marginal product – as more and more health care inputs are added to the production process, the increments in heath status diminish.

Figure 5-1 Production of Health B



B. Marginal Product of Health Care

Are we at the “Flat-of-the-Curve?”

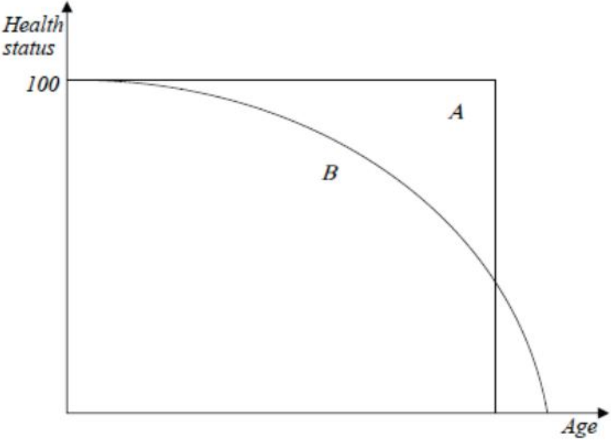
- If we ARE at the flat of the curve, then governments and citizens should theoretically allocate resources away from health care and perhaps into areas of higher marginal productivity.
- According to Schoder and Zweifel (2011) we are not at the flat-of-the-curve if we take into account levels of risk aversion.
- According to Whaley (2016), even if at the flat-of-the-curve, additional spending may not be wasteful.
- Perhaps consuming more Health Care gives us peace of mind.
- Moreover, perhaps by consuming health care we are able to decrease the variance of adverse health outcomes.

Schoder and Zweifel (2011)

- Study the question of whether Health Care inputs are related to an increase in the expected value of health status.
- If health inputs do lead to an increase in health status, this is an argument against the “flat-of-the-curve” argument.
- Analyze data from 24 OECD countries
- Using Fixed Effects methods, they estimate the effects of Health Care Expenditure on Variability of Age at Death (VAD)

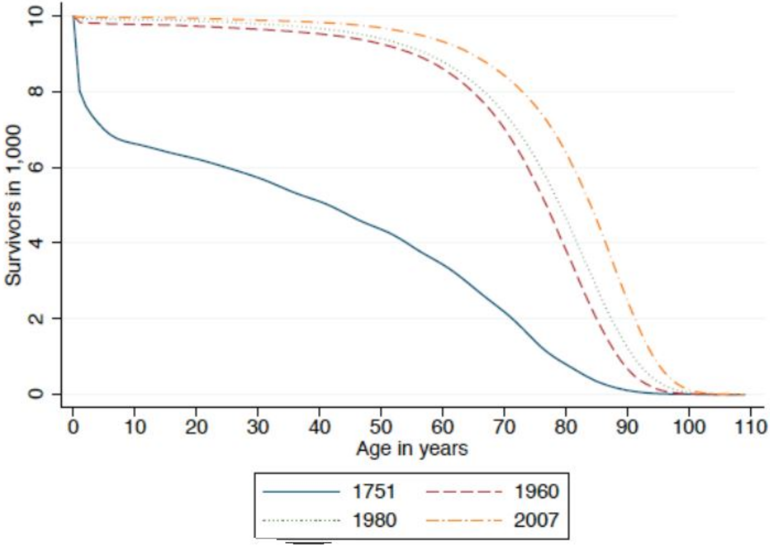
Schoder and Zweifel (2011)

Figure 1: Ranking of two health profiles



Schoder and Zweifel (2011)

Figure 3: Survival curves for Sweden



Schoder and Zweifel (2011)

What is Variability at Age of Death (VAD)?

VAD is a measure a country's deviation about the mean age of death.

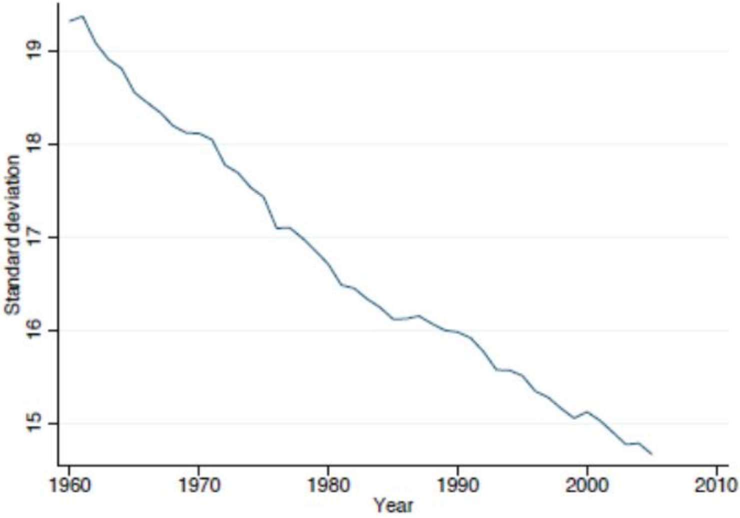
$$VAD = \sqrt{\sum_{x=0}^{\omega} f_x (x - \mu)^2}$$

where x is a random variable, μ is the average age at death of a given nation, ω is the maximum achievable age of a society, and f_x is some probability density function.

Don't get bogged down by the math, this is just a measure of the dispersion of a country's death age, i.e. how many people are dying at an age that is different than the average. If VAD is large, people are dying more often at ages drastically different than the mean. If VAD is small, people tend to live to the mean death age more frequently.

Schoder and Zweifel (2011)

Figure 2: Standard deviation of age at death averaged over OECD countries, 1960-2005



Schoder and Zweifel (2011)

Model specification for variability of age at death VAD:

$$VAD_{it} = \beta_1 HCE_{it-5} + \beta_2 HCE^2_{it-5} + \beta_3 GDP_{it} + \beta_4 GDP^2_{it} +$$

$$\beta_5 ALC_{it-10} + \beta_6 ALC^2_{it-10} + c_i + \gamma_t + u_{it}$$

where all variables are in logs, VAD is variability of age at death, HCE is per capita health care expenditure, GDP is per capita gross domestic product, ALC is annual consumption of alcohol in liters per person, c is a country-specific fixed effect, γ is a time fixed effect, and u is a normally distributed N(0,σ^2) vector of unobservables .

Schoder and Zweifel (2011)

	Coef.	sd z	P>z
VAD			
HCE_{-5}	-0.072	-3.09	0.002
HCE^2_{-5}	0.005	2.65	0.008
GDP	-0.066	-1.99	0.046
GDP^2	0.004	0.94	0.345
ALC_{-10}	0.049	1.29	0.198
ALC^2_{-10}	0.017	1.87	0.061
constant	3.435	11.47	0.000

A 10% increase in Health Care Expenditure in the 5-year prior period leads to a $10(-0.072 + 2 * 0.005 * lnHCE_{-5}) = 0.42\%$ reduction in the variation of age at death

Schoder and Zweifel (2011)

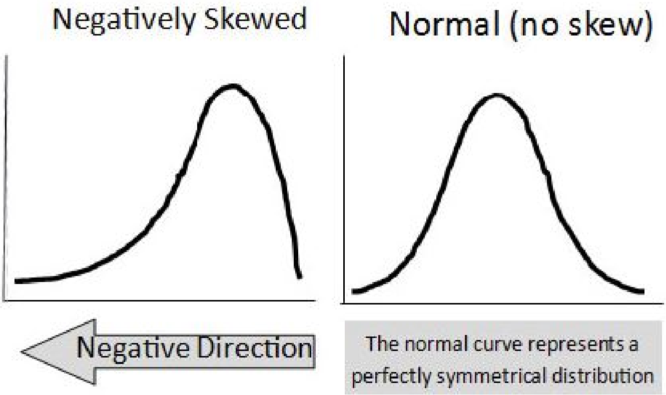
So according to this study, we are not yet at flat-of-the-curve.

Another recent study finds evidence that we are at the flat-of-the-curve, however additional health care spending may not be completely wasteful (Whaley, 2016).

Whaley (2016)

- Perhaps spending at the flat-of-the-curve reduces some of the uncertainty of adverse health outcomes.
- Models health production as a stochastic process.
- Analyzes the impact of medical care on different moments of the health distribution, i.e. on the mean, variance, and skewness of the health outcomes.
- Demonstrates higher-order benefits of health care spending.
- Medical care utilization significantly lowers the variance of health outcomes and negatively skews the distribution of mortality rates.

Whaley (2016)


Negatively Skewed
Normal (no skew)
Negative Direction
The normal curve represents a
perfectly symmetrical distribution

Next Class

- The Demand for Health (Chapter 7 FGS)
- Grossman (1972)
- Wagstaff (1986)