THE VALUE OF HEALTH: 1970-1990

David M. Cutler and Elizabeth Richardson*

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David M. Cutler
Department of Economics
Harvard University
Cambridge, MA 02138
Phone: (617) 496-5216
FAX: (617) 495-8570
e-mail: **dcutler@fas.harvard.edu**

Elizabeth Richardson
NBER
1050 Massachusetts Avenue
Cambridge, MA 02138
Phone: (617) 588-0359
FAX: (617) 868-2742
e-mail: **erichard@nber.org**

Given a choice between spending more money on medical care or on other consumption goods, which should society choose? Should the National Institutes of Health devote a larger part of its research budget to AIDS or to cancer? Has the increased inequality of income in the United States led to worse health among the poor? Answering these questions is fundamental to understanding the medical sector and to forming sound public policy. But knowledge about the value of health is limited. At both a conceptual and empirical level, there are few integrated treatments of population health. In this paper and related work (Cutler and Richardson, 1997), we estimate the health of the United States population, and examine how it has changed over the past several decades.

I. Methodology

"Health" is a multi-attribute concept, encompassing both physical and mental components. The first requirement in measuring health is to find a way to combine these different dimensions. We assume that a person's quality of life in any year (denoted H_t) can be scaled on a 0 to 1 basis, where 0 is death and 1 is perfect health. Living with a given disease falls between 0 and 1. We can then add up the expected

number of quality-adjusted life years a person has remaining, to form a measure of expected quality-adjusted life years, or QALYs. A QALY has a unit of years in perfect health; if we multiply the number of QALYs by the value of a year in perfect health (denoted *V*), we have a measure of the value of health. Following Michael Grossman's (1972) pioneering work, we term this measure "health capital". Algebraically, health capital is defined as:

$$\textbf{(1)} \qquad Health\ Capital_t = V \cdot \sum_{k=0}^{\infty} \frac{E_t[H_{t+k}]}{(1+r)^k}$$

where *r* is the real discount rate. Health capital is analogous to the more common measure of human capital in the economics literature.

Measuring health capital empirically requires assuming values for *V* and *r*. Both of these are longstanding issues in economics. A consensus estimate from the literature (W. Kip Viscusi, 1993; George Tolley, Donald Kenkel, and Robert Fabian, 1994) is that a life is worth about $3 million to $7 million, or that a life year is worth about $75,000 to $150,000. We use an intermediate value of $100,000 for a year of life. The economics literature (Edward M. Gramlich, 1990) also suggests a real discount rate of about 3 percent, which we employ.

Measuring quality of life is more difficult. We start with the probability that the person is alive or dead in each year in the future. Estimates of survival probabilities conditional on reaching any age are published in standard life tables.[1] Life expectancy has increased over time, from 47 years at birth in 1900, to 71 years in 1970, to 75 years in 1990. Increased survival implies increasing health over time.

We then adjust these survival rates by the prevalence of disease at every age. We measure disease prevalence using the annual National Health Interview Surveys (NHIS). The NHIS asks about a variety of acute and chronic conditions. After reviewing the NHIS documentation and other sources of data, we identified 10 conditions that we believe to be consistently reported between 1970 and 1990. The conditions

and their prevalence (adjusted for the changing age and sex mix of the population) in 1970 and 1990 are shown in the first columns of Table 1. The prevalence of most of these conditions is increasing over time. Between 1970 and 1990, for example, the four most common conditions -- orthopedic problems, arthritis, cardiovascular disease, and hearing problems – all increased in prevalence, by up to 50 percent. This increase in disease prevalence is in opposite direction to the longevity improvement.

Finally, we need to attach quality of life weights to each condition. Quality of life differs across conditions and over time; the fact that more buildings have ramps and elevators, for example, raises quality of life for those with mobility problems. The most common method for estimating quality weights is through surveys (George W. Torrance, 1986). For example, people might be asked how many years of perfect health they would trade off for a given number of years with a particular condition (termed the "time-tradeoff" method). The answer to this question gives an implicit quality adjustment for the disease. In practice, however, there is no consensus in the literature about the disutility associated with various conditions or the change in these disutilities over time.

We therefore follow an alternative approach to quality measurement. The Health Interview Survey asks people to rate their health as either excellent, very good, good, fair, or poor.[2] We assume that a person's underlying health, h^*_I, is related to their demographics and health conditions (X_i) as:

$$h_i^* = X_i\beta + \epsilon_i \qquad \textbf{(2)}$$

If we assume that peoples' self-reported health reflects their underlying health state, we can estimate the β coefficients using the self-report data. In particular, if ϵ is normally distributed, equation (2) can be estimated as an ordered probit model for self-reported health. The β's then give the reduction in quality of life associated with each condition.[3]

The last columns of Table 1 show the quality of life weight for each condition in 1970 and 1990. The estimates generally accord with intuition: quality of life is lowest for cancer, cardiovascular disease,

and diabetes, and highest for minor vision and hearing problems. Importantly, quality of life for each condition is improving over time. Whether because of medical care or other factors, people consistently report themselves in less worse health than they did in the past. The reduced prevalence of disease over time implies improved health.

Combining our estimates of the share of people who are alive, the prevalence of people with particular conditions, and the quality of life for people with those conditions, we can estimate quality of life as:

$$\textbf{(3)} \qquad H_{t+k} = Pr[Alive\ at\ t+k] \cdot \left(\sum_{d} Pr[Condition\ d\ at\ t+k] \cdot [QALY\ for\ d\ at\ t+k] \right)$$

where *d* is the range of conditions a person may have.

II. Trends in Health

Table 2 presents estimates of health capital in 1970, 1980, and 1990. Health capital is large. For a newborn in 1990, health capital over their lifetime is about $2.5 million; for a person aged 65, remaining health capital is about $750,000. By comparison, if a person earns $30,000 per year from ages 20 through 65, the present discounted value of lifetime earnings (as of age 0) is less than $450,000. Of course, there is no requirement that people be able to afford the value they place on their health.[4]

Perhaps more importantly, health has improved over time. For newborns, health capital increased by $95,000 between 1970 and 1990, while health capital for the elderly increased by $169,000. The greater increase in health capital for the elderly than for the young is a result of differential changes in mortality by age. The lion's share of mortality reduction between 1970 and 1990 was a result of fewer deaths from cardiovascular disease. Since cardiovascular disease is more prominent late in life than early in life, the present value of these gains is greater for the elderly than for the young.

Are these changes in health large or small? One way to gauge them is to compare the increase in

health capital with the increase in medical spending over this time period. While not all of the increase in health capital results from improved medical care, if we find that the increase in health capital is smaller than the increase in medical spending, that would be a strong indication that medical spending over this time period was not, on net, worth it. Using cross-section data on medical spending in 1970 and 1987, we estimate that expected medical costs increased by $19,000 for infants (in 1987 dollars), and by $34,000 for people aged 65. The increase in health capital is greater than the increase in medical spending; thus, the return to medical care could be very high.

The next rows of Table 2 show health capital by race and sex. We show health capital just for newborns. Changes in health capital by race mirror changes in labor market earnings by race. In the 1970s, black men's health improved relative to white men; the same is true of earnings. But this situation reversed in the 1980s. In that decade, health capital for black males rose by much less than for white males. This is also true of earnings.

Changes in health capital by gender are less reflective of changes in labor market returns by gender. Health capital for men and women is about the same at birth, and is much greater for women at older ages, where earnings are much lower for women than for men. Further, health capital for the two groups changed about the same over this period. Earnings for women, in contrast, increased much more rapidly than did earnings for men in the 1980s. Understanding why changes in health capital by gender look so different from changes in economic returns by gender is an important topic of future research.

Measuring changes in health capital by income or education is more difficult than for race and gender, in large part because mortality is rarely classified by economic status. The lower panel of Table 3 shows estimates of health capital by income, measured by poverty status. Health capital is higher for people with family income above poverty level. A newborn in a family with income above poverty level has about $124,000 more health capital than one in a family with income below poverty level; while a 65 year old above poverty level has about $21,000 more health capital than a 65 year old with lower income.

The increase in health capital from 1970 to 1990 was about the same for both income groups. However, the gap in health for persons over 65 narrowed over this period, with elderly below the poverty level realizing larger gains in health capital than elderly above the poverty level.

III. Conclusions

The United States population is healthier than it used to be. We estimate that health improved by $100,000 to $200,000 per person between 1970 and 1990. This increase in health is greater for the elderly than for the young. It is also greater than the increase in medical spending over this time period, although medical spending certainly did not cause all of the improved health. Health changes for blacks mirror labor market changes for that group, but we do not find improvements for women relative to men. The gap in health inequality by income has declined for people over 65.

Perhaps most important, our measure of health capital will allow us to more systematically examine the value of the medical care system. We know a great deal about the resources we put into the medical system -- people, dollars, technology, and the like – but very little about what we get out. Our methodology provides a mechanism for estimating what return we get for our medical care dollars.

References

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Table 1: Disease Incidence and Quality of Life

	Prevalence		QALY Weight	
Condition	1970	1990	1970	1990
Amputee	6.1	6.0	0.87	0.89
Arthritis[a]	111.8	127.8	0.69	0.79
Blindness	8.6	2.0	0.73	0.87
Other vision	48.0	30.2	0.84	0.93
Cancer[b]	11.1	18.7	0.70	0.70
Cardiovascular disease[a]	64.7	99.3	0.57	0.71
Diabetes[a]	45.9	54.3	0.65	0.66
Hearing	80.9	91.2	0.91	0.93
Orthopedic[a]	102.1	135.0	0.70	0.88
Paralysis[a]	7.4	7.1	0.62	0.68

Note: Prevalence is adjusted for the change in the age- and sex-mix of the population.
[a] There are also interactions for these QALY estimates which are not reported.
[b] QALY estimate is based on review of literature rather than model estimate.

Table 2: Health Capital

Measure	Health Capital (thousands of dollars) 1970	1980	1990	Change 1970-90
By Age				
0	$2,350	$2,395	$2,444	$95
65	590	700	759	169
By Race and Sex, Age 0				
Men				
White	$2,364	$2,404	$2,471	$108
Black	2,255	2,348	2,377	132
Women				
White	2,348	2,387	2,437	89
Black	2,226	2,305	2,361	135
By Income				
Age 0				
Below poverty level	$2,240	$2,285	$2,296	$57
Above poverty level	2,361	2,365	2,420	54
Age 65				
Below poverty level	567	706	735	168
Above poverty level	611	707	756	145

Note: The value of a year in perfect health is assumed to be $100,000, and the real discount rate is assumed to be 3 percent.

FOOTNOTES

* Cutler: Department of Economics, Harvard University, Cambridge, MA 02138, and National Bureau of Economic Research; Richardson: Department of Health Care Policy, Harvard University, 180 Longwood Avenue, Boston, MA 02115. We are grateful to Victor Fuchs, Theodore Keeler, and Doug Staiger for helpful comments.

1. Note that this measure is not perfect. Period life tables assume that people currently alive will have age-specific mortality in the future equal to current mortality at those ages. Any improvements in mortality that can be forecast are thus omitted from the life table. There are no better alternatives to the period life table, however, so we use these data.

2. Prior to 1982, very good was omitted.

3. For a more detailed discussion of this issue, see Cutler and Richardson (1997).

4. This is particularly true since estimates of the value of life, or of a life year, generally consider the value of small changes in mortality, so that wealth constraints are minimized.