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PART THREE National Health Insurance

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Mortality, Disability, and the Normative Economics of Medicare

ABSTRACT

Medicare subsidizes the purchase of health services by elderly persons. This paper supposes that several insurance alternatives may be compared, or experience monitored, using a social welfare function that recognizes gains from risk spreading, cash transfers, and improved health status. A particular measure of welfare gain, an "equivalent transfer," is derived and applied to the Medicare experience.

Econometric analysis suggests that, owing to Medicare, some improvement in mortality and disability is evident in 1969. Whether these health improvements are "large" is a question for statistical hypothesis testing, but also it is a tractable question of parameter values in the equivalent transfer formula.

1. INTRODUCTION

Medicare is one of several conceivable programs for improving the opportunity for elderly persons to spread individual monetary risk.

Each elderly person, under Medicare, is partially reimbursed for certain expenses in what may be called a system of matching grants conditional on validation by physicians and other health professionals. A matching grant, instead of a more neutral cash transfer, is a natural instrument of policy by a central authority wishing to partly overrule individually perceived values.[1]

This paper formulates the assessment of Medicare and some limited alternatives by a central authority. Individual risk preference and individual valuation of cash transfers are to be honored, but the improvement of health status is taken to be a matter for outside valuation.[2] The relevance of such a formulation for applied welfare analysis will be briefly discussed in this section. Then in Section 2 a particular measure of welfare gain, an "equivalent transfer," is derived. The application of this measure to monitoring the early results of Medicare is sketched. The next two sections of the paper apply econometric models for estimating improvements associated with Medicare in mortality and disability.

The problem for statistical inference is the adequate specification and testing of stochastic disturbance properties of age-specific rates. Each age-specific mortality rate should not be treated as an independent time series, since over time different individuals are observed, with different histories appearing elsewhere in the data. A related shortcoming is inherent in the cohort approach of epidemiology—technology is dated in time, affecting different cohorts at different ages. These two observations motivate the statistical tests in Section 3. Mortality rates for ages in five-year intervals, and for years at five-year intervals ending in 1969, suggest a significant improvement for elderly white males associated with Medicare. The result for older white women is less clear. Disability rates for both elderly men and elderly women over the period 1959-1971 show meaningful improvements relative to younger persons.[3] Whether health gains are substantial is a question for statistical hypothesis testing and also a tractable question of parameter values in the equivalent transfer formula.

The volumes of expert testimony and position papers during the early 1960s indicate that the purchase of additional medical care for the elderly was regarded as a key social goal.[4] Such a goal is furthered more by Medicare than by either of the two following insurance alternatives: (1) A floor on disposable income for nonhealth consumption, implemented by a subsidy with a means test; (2) A system of cash indemnities that "compensates" for health impairment without encouraging the purchase of particular services.

It is possible to criticize either of the insurance alternatives on the grounds of practicality or human dignity. In addition, neither of these alternatives offer the potential leverage of a reimbursement program for promoting efficient supplier behavior. Finally, the case for reimbursement contracts can be advanced directly, without prejudging whether experience indicates such contracts to be cost effective. The premise is that the high cost to a consumer of keeping well informed about health leads to overly long delays in seeking medical attention.

2. A NORMATIVE MODEL FOR QUANTITATIVE ASSESSMENT OF MEDICARE

The central features of Medicare to be treated here are (1) a transfer of resources to the elderly; (2) a presumably better spreading of monetary risk among the elderly; (3) presumably better average levels of health for the elderly. The purpose of this section is to derive a measure of welfare change that combines information on the above three phenomena. The measure may be called an "equivalent transfer" and may be used to compare hypothetical programs or to monitor the welfare change of a given program. The equivalent transfer is derived with a particular social welfare function.

Economists use a social welfare function (SWF) to specify exactly the information and ethical prescriptions that seem to be relevant for a decision by some absolute authority. The SWF may be completely irrelevant for understanding or participating in the political process of voting. The economic content of voting is limited to the self-interest of each and every person who votes. A program like Medicare has an effect on persons who do not vote.[5] More important, Medicare seems appropriate for the SWF approach if costs of information about the efficacy of medical care are drastically lower for a central planning authority.[6] The use of a SWF does not prejudge whether, as a result, a reimbursement program would be found inferior to cash indemnity insurance.

If we ignore program features that involve redistributing or comparing the preferences of different individuals, the SWF applies to a representative individual. Analyses containing this limitation have become conventional in the context of intertemporal and life-cycle phenomena.

The representative individual is here assumed to be required to save out of his current income while young, building up a sum of money, G. At a critical age, the saving ends and the individual receives an annuity together with a reimbursement contract for the purchase of medical services. At this critical age, the future consumption of other goods and services per period is determined by the following variables:

y = annuity income, plus actuarial value of the government reimbursement per year
z = out-of-pocket ("direct") expense on covered medical services, a random variable
π = premium charges per year for health insurance plus the actuarial value of government reimbursement
c = consumption of goods and services other than medical care.

From the above, assuming no borrowing or lending,

$$c = y - \pi - z \tag{1}$$

and c is a random variable.[7] The number of future periods that the individual will enjoy, and his health status while alive, are obvious concerns to him. In this analysis, however, a planning authority will be assumed to partially overrule individual valuation of medical services and health.

Define T to be an average health status variable perceived by the planning authority and assume that $u(c)$ is a function that displays the individual's degree of risk aversion.

The function $T \cdot E[u(c)]$, which is a product of expectations, will be taken as the social perception of individual welfare at the critical age. This objective function is assumed to be unique except for origin and scale. It preserves the degree of risk aversion displayed by u. The variable T may be interpreted as the effective number of periods in which $E[u(c)]$ is enjoyed.[8] This objective function is somewhat analogous to the human capital criterion of benefits from health programs.[9]

Suppose that two programs, labeled 1 and 2, or two situations (say, before and after Medicare), are to be compared. Required changes in the quantity of saving before retirement will be ignored in the welfare comparison. A measure of the welfare gain to the elderly for situation 2 is the "equivalent transfer" τ defined by

$$T_2 \cdot E[u(c_2 - \tau)] = T_1 \cdot E[u(c_1)] \tag{2}$$

The measure τ is the amount of nonmedical consumption whose loss in situation 2 leaves the objective function at the same value as

in situation 1. The introduction of an arbitrary constant or scale factor in the objective function would not change τ.[10]

Further analysis of τ depends on a parametric specification of risk aversion. The following function with constant absolute risk aversion will be assumed:

$$u(c_i) = 1 - \exp\left[-R(y_i - \pi_i - z_i)\right] \tag{3}$$

where R is the parameter measuring the degree of risk aversion.[11] It is now possible to solve (2), letting $\omega = T_2/T_1$ and $K = e^{-R(y_1 - \pi_1)}E(e_{Rz_1})$, to obtain

$$\tau = (y_2 - y_1) - (\pi_2 - \pi_1) + \frac{1}{R}\log\left[\frac{E(e^{Rz_1})}{E(e^{Rz_2})}\right] + \frac{1}{R}\log\left(\frac{\omega + K - 1}{\omega K}\right) \tag{4}$$

This specific measure provides a means for comparing dollars of cash transfer with relative improvement in average health status.[12] For constant τ, the rate of substitution between ω and y_2 is

$$\left.\frac{dy_2}{d\omega}\right|_{\tau\text{constant}} = -\frac{1}{R}\left[\frac{(1-K)}{\omega(\omega+K-1)}\right] < 0 \text{ when } \omega > 1$$

There is some evidence that plausible values for R currently lie in the range 10^{-4} to 10^{-3}. Consider $R = 5\cdot(10)^{-4}$. Then a hypothetical 1 per cent improvement in health status raises τ by \$172 at $K = 0.1$. Notice that relatively small values of K are appropriate given typical values of R and y_1.

For comparisons with and without Medicare, information on the z_1 distribution may be obtained from a 1962 survey by social security (see Epstein and Murray, 1967). Complete information on the z_2 distribution is not readily available, although it is presumed that direct cost risk has been greatly reduced.[13] The increased premium cost $\pi_2 - \pi_1$ has been rather high. There are two components of π_1, previous public reimbursement π_1^g, and the cost of previous private insurance. According to Cooper *et al.* (1973), average per capita reimbursement under all public programs to the elderly was \$131 in fiscal 1966, and it rose to \$498 in fiscal 1969. Medicare is a program for which $y_2 - y_1 = \pi_2 - \pi_1^g$; there is no lump cash transfer. There is an indirect cash transfer, that portion of premiums $\pi_1 - \pi_1^g$ representing previous private insurance that is discontinued. This transfer may be guessed for 1966 by using the benefit ratio for all private insurance, which implies an average reimbursement to the elderly of \$109.[14]

Conceivable alternative programs could use a lower π_2, say π_2^*,

by reimbursing only "catastrophes" and in addition raise cash benefits to y_2^* with the same total cost if $y_2^* - y_2 = \pi_2 - \pi_2^*$. Whether such a strategy would promote much less average health improvement is a key question. The rest of this paper will concentrate on econometric attempts to assess health status change.

3. MEDICARE AND AGGREGATE MORTALITY EXPERIENCE

This section deals with a test of whether there was a biased improvement in U.S. mortality after 1966—biased in favor of persons over age 65. A specification of the statistical properties of aggregate mortality is applied to the data classified by year, 1934–1969, and by age, 35 and over in five-year age intervals. The statistical specification is an application of econometric methods that does not seem common in mortality studies. The deterministic core of the model is the Gompertz view of the aging process after maturity, known in demography since 1825.

Causality cannot be established at the level of aggregation used here. The more modest objective of a model is to monitor some potentially stable relationship suggested by firmer knowledge at a lower level. For a particular disease process, a reimbursement program like Medicare would promote earlier treatment and more intensive consumption of medical services.[15] When health results are compared for different dates in time, technological or environmental change may swamp the price effects. The inference of technical change from the stochastic properties of an otherwise stationary relationship is nothing new in econometrics.[16]

Per capita expenses on personal health care for the elderly rose from $440 in fiscal 1966 to $720 in fiscal 1969, a gain of 64 per cent. For younger persons, the increase was only 32 per cent.[17] Expenses for hospital care accounted for $160 of the increase for the elderly, a rise of nearly 100 per cent. In the first year of the program, it seems that as much as half of the increased hospital expense of $46 represented previous "charity" care.[18] After the first year, total expense continued to rise rapidly.

The Health Interview Surveys provide additional information on the changes in use of health services by different age groups. The relative increase in hospital care for the elderly represented higher admission rates and longer stays, as shown below.[19]

	1963–1965		1968–1969	
	Discharge Rate per 1,000	Mean Stay	Discharge Rate per 1,000	Mean Stay
All ages	128.3	8.3	125.6	9.1
Age 45–64	147.9	11.0	143.1	11.3
Age 65+	186.3	12.7	232.6	15.3

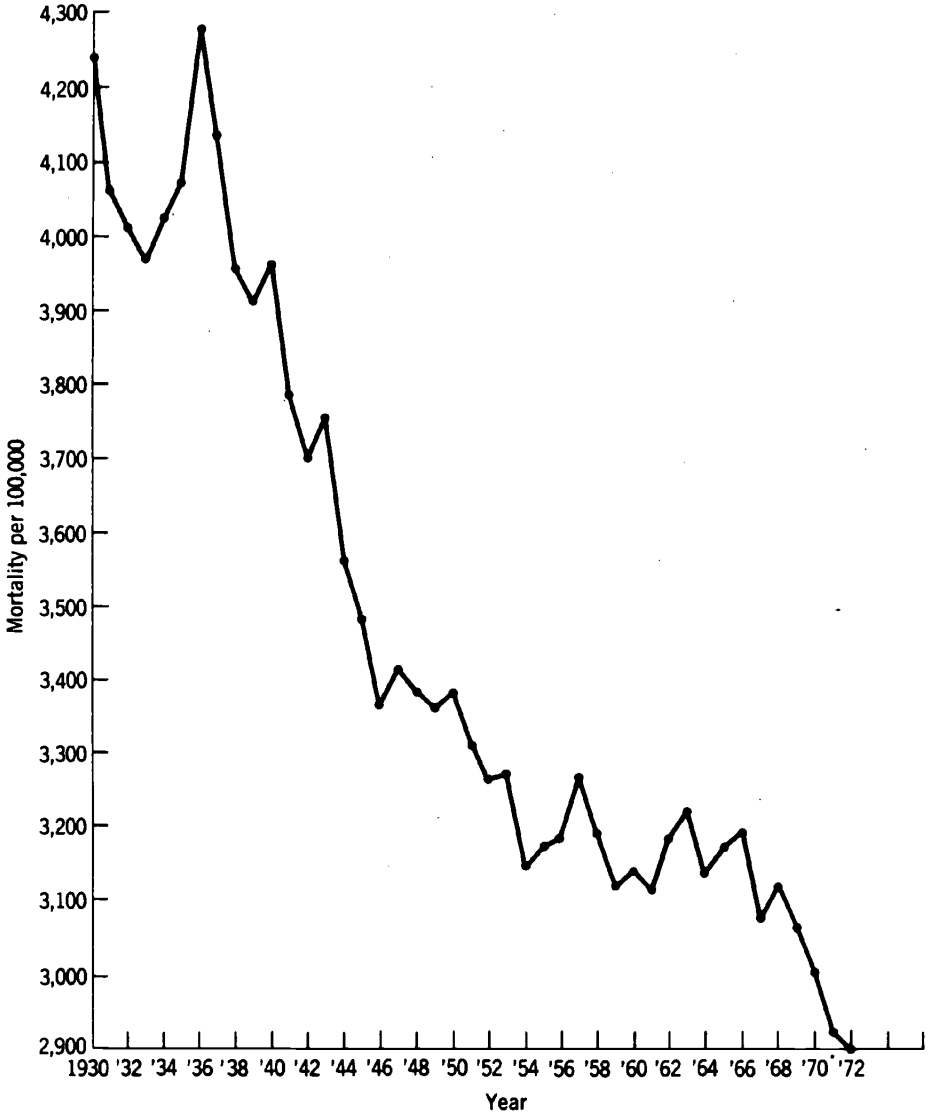
The increased discharge rate and mean stay for the elderly were not uniform across disease categories. Certain diseases of the heart, the largest single category of discharges, rose from 11.2 per cent of discharges to 12.8 per cent. Other categories showing an increased share of discharges were diseases of the eye, respiratory conditions, arthritis, and diseases of bones and joints. Marked increases in mean stay occurred for infective and parasitic diseases, mental and personality disorders, and diseases of the nervous system. These categories of increased hospital care suggest that declines in mortality may be only a small part of health improvement.

Recently, econometric studies of mortality have dealt with regional variation in age-specific or age-adjusted mortality rates. Differences in environment, medical care, income, education, and racial composition are taken to be causal determinants of differences in regional death rates. Auster, Leveson, and Sarachek (1969) estimate an elasticity of mortality for whites with respect to health expenditure of about −0.1, with a standard deviation almost as large in absolute value. The independent effect of higher average income seems to be an increase in average mortality. Silver (1972) found no significant association between state and local government spending for health and mortality in SMSA's.

The quantitative information generated by these studies would not seem applicable to the problem at hand—predictions by age of mortality over time. A relationship with an age-adjusted dependent variable cannot be an aggregate of the same relationship for each age group.[20] Moreover, an age-specific death rate changes over time partly because it refers to different people with different histories.

The series in Figure 1 seems to display a change in trend after 1966, which can be compared with other age-specific series. Yet the various age-specific series are not independent because of the aging process. Biometricians often present mortality data organized by cohort—i.e., the mortality rate for the same group of people compared over time as the group ages. After age 35, cohorts seem to follow Gompertz' Law—the logarithm of mortality is linear in age.[21] Five recent cohort curves are plotted in Figure 2.

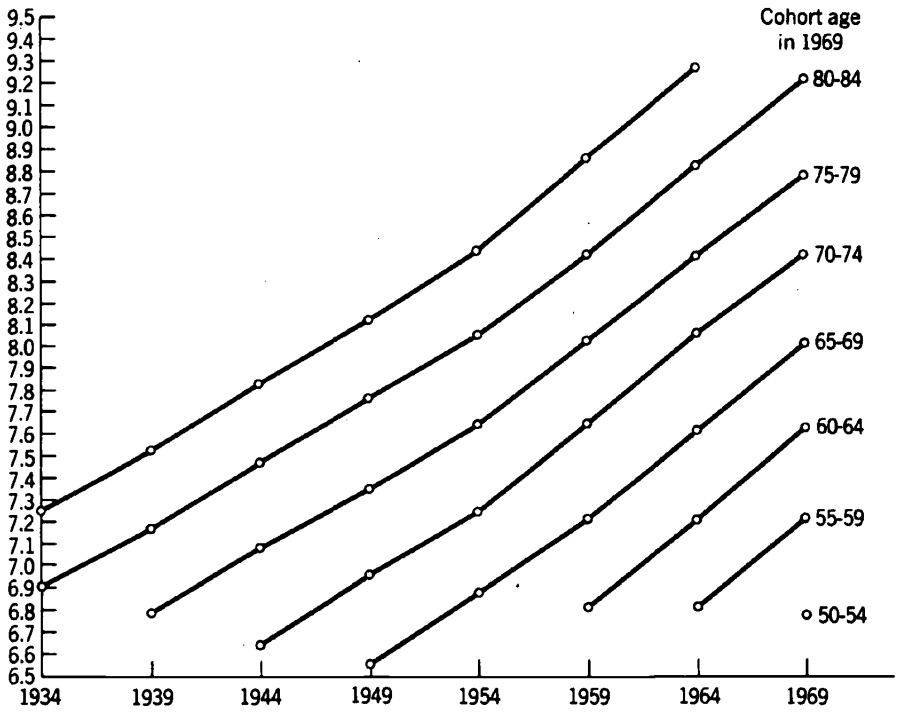
FIGURE 1 Mortality for Age 65–69; All Races and Sex (per 100,000)



SOURCE: U.S. National Center for Health Statistics.

*Calculated from preliminary 10% sample for 1970–1972.

FIGURE 2 The Logarithm of Mortality as a Function of Age: Cohort Curves, All Races and Self, Combined



Define the following variables:

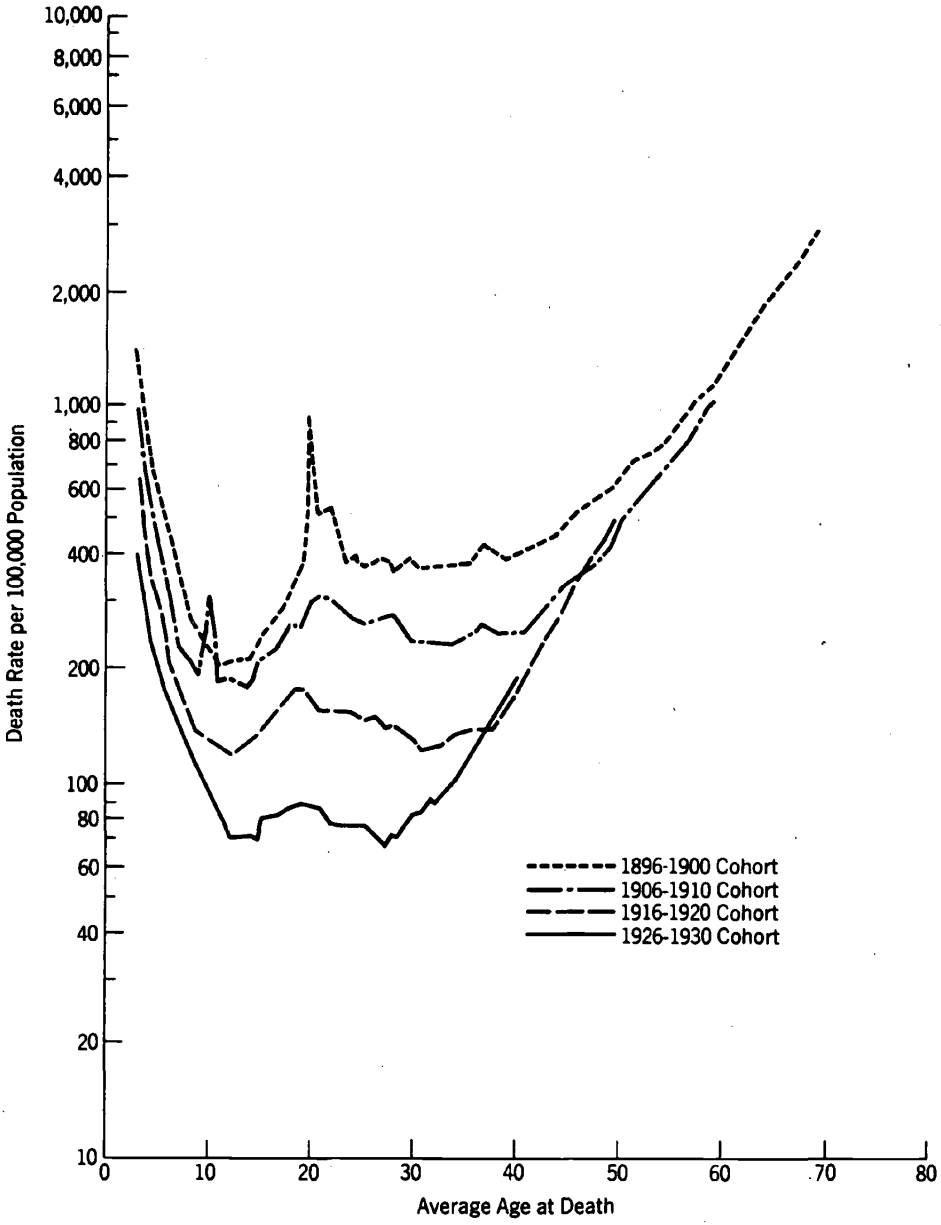
m_{it} = mortality rate for cohort i in year t
a_{it} = the age of cohort i in year t
c_i = a cohort-specific constant
B = a constant common to all cohorts

Then Figure 2 might be described with a cohort model that is a complete reconstruction of independent time series,

(5) $$m_{it} = c_i B^{a_{it}}$$

Further refinement in the cohort model is suggested by data such as in Figure 3, reprinted from Moriyama and Gustavus (1972). It seems that more recent cohorts after age 35 have a lower c_i and a higher B; that is, they begin at a lower rate but rise faster. A more careful inspection of this phenomenon reveals a flaw in the pure cohort model. Two cohort curves in Figure 3 cross the previous

FIGURE 3 Cohort Mortality, White Female



SOURCE: Moriyama and Gustavus (1972).

cohorts at the same calendar date. In Figure 2, the older cohorts seem to abruptly change slope after 1954.

A modification of the cohort model with a proportional shift in all mortality rates at each date will now be discussed. Let m_{at} be the mortality rate for the group age a in year t, and let m_{-1} stand for $m_{a-1,t-1}$. Then suppose that

$$m_{at} = (1 + \lambda_t) \cdot B \cdot m_{-1} + u_{at} \tag{6}$$

where u_{at} is a random disturbance with mean zero. Because each m_{at} is an observed relative frequency between 0 and 1, and because each observation is for a group of different size, the disturbance u_{at} will be heteroskedastic, but with easily estimated variance.[22] A further stochastic property of u_{at} is suggested in discussions of epidemics—that u_{at} may be negatively correlated with $u_{a-1,t-1}$.

The model (6) was estimated by the established two-step, generalized least squares procedure. Since 1969 is the latest year for which mortality by five-year age interval is tabulated, the years used are 1969, back by five-year intervals through 1934.[23] In each year ten age groups are used, the youngest being age 35–39.[24] Separate analyses were made for white males and for white females.

A test of the effect of Medicare is whether the shift parameter, λ, for 1969 is significantly lower for the elderly than a separately estimated value for the young.[25] Since λB is an unrestricted linear parameter in (6), significance tests may be easily obtained with the t statistic. In Table 1 are the relevant parameter estimates. The overall fit of the model is extremely close, and a maximum likelihood search for a first-order negative correlation between u_{at} and $u_{a-1,t-1}$ produced too small a value to be meaningfully different from zero.

The relative improvement for older white males in 1969 is statistically significant at the 5 per cent level, while the hypothesis of equal parameters in the female case cannot be rejected. Tables 2

TABLE 1 Estimates of Shift Coefficients λB for 1969 (standard errors in parentheses)

	$(\lambda\hat{B})$ Under Age 65	$(\lambda\hat{B})$ Age 65–84	$\hat{B}$
White male	.14	.03	1.436
	(.04)	(.03)	(.018)
White female	.06	.15	1.437
	(.09)	(.06)	(.033)

TABLE 2 Actual and Predicted Mortality Rates for White Males (per 100,000)

Age[a]	Actual 1964	Actual 1969	Predicted 1969	95% Interval
42	414	425	390	± 10
47	688	685	628	16
52	1,133	1,108	1,044	28
57	1,801	1,774	1,720	46
62	2,694	2,758	2,734	73
67	4,104	4,010	4,089	198
72	5,876	6,107	6,230	165
77	8,402	8,557	8,919	237
82	12,698	12,191	12,754	339

[a]Midpoint of five-year interval.

and 3 compare actual mortality rates in 1969 with predicted values derived by fitting through 1964 and assuming that λ for 1969 will be the same as for 1964. These comparisons have the same obvious indications as the parameter tests.

It is puzzling that a gain for older men is apparent but not for older women. Table 3 indicates that mortality was meaningfully lower for older women in 1969 than in 1964, but there was also a strong decrease predicted by cohort experience. The test for nega-

TABLE 3 Actual and Predicted Mortality for White Females (per 100,000)

Age	Actual 1964	Actual 1969	Predicted 1969	95% Interval
42	234	241	238	13
47	367	365	367	19
52	562	551	576	31
57	831	819	882	47
62	1,260	1,231	1,304	70
67	2,087	1,966	1,978	106
72	3,364	3,278	3,276	176
77	5,600	5,301	5,281	284
82	9,794	8,998	8,792	473
89				

tively autocorrelated residuals did not indicate misspecification of Constant B in (6). The difference in result by sex will not be seen in the disability data of the next section.

The extent of improvement in mortality for white males is not immediately suitable for the welfare assessment in (4). If we take T to be the sum of annual survival rates, then T will rise somewhat less than in proportion to the fall in mortality. In particular, for a mortality reduction of about 5 per cent at every age, suggested by Table 1, ω would be about 1.03. This ignores improvement in health status of the living, to be discussed below.

4. DISABILITY AND THE CONSUMPTION OF HEALTH SERVICES

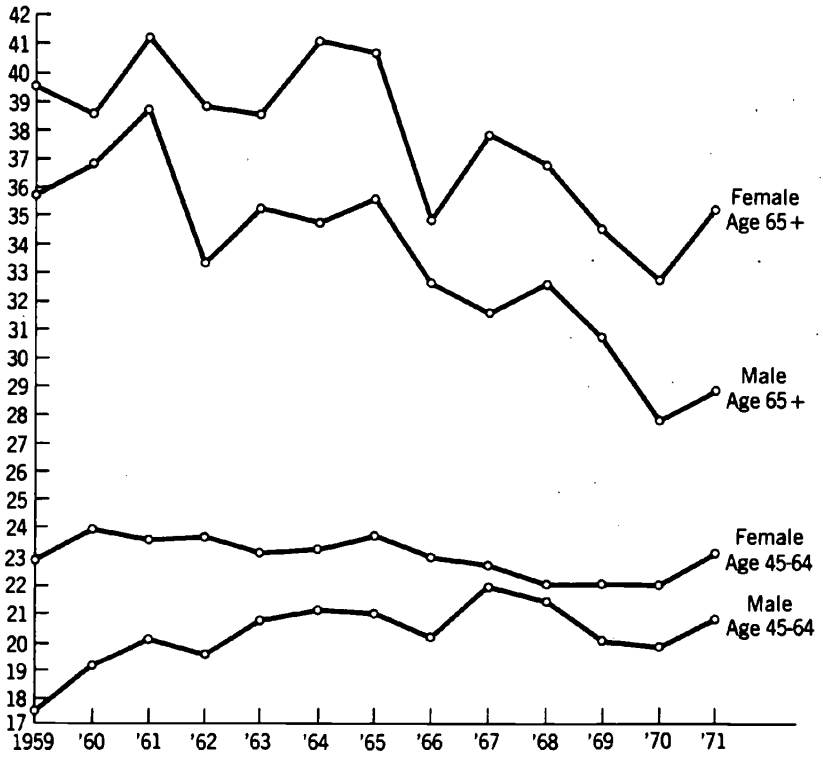
This section reports a study of disability using interview data collected by the National Center for Health Statistics. Reductions in disability augment social welfare gains stemming from mortality reduction, and the extent of one type of improvement might not be easily inferred from the extent of the other.[26]

The first data to be examined are age-specific disability rates over time, 1959–1971. The data suggest relative gains for older men and women since 1965. The disability measure used here is the number of restricted activity days, R, defined as days in which usual activities are substantially reduced because of illness or injury.

In Figure 4, average R is plotted over time for four age-sex classes. In the preceding section I stated that a set of age-specific time series should not be treated as if each were independent. Here, however, the age categories are too broad and the time series too short to adequately treat the autoregressive properties of disability. Instead, it seems more plausible to test for a stable contemporaneous relationship between R and the utilization of health services.

Annual expenditures on personal health care per capita have been calculated by Cooper *et al.* (1973). These may be converted to constant dollar units with the BLS price index for medical care. Values of per capita real expense, PRE, for different age groups are available after 1966. For this period, per capita real expense for persons over age 65, PREA, has been regularly about 2.5 times PRE for the entire population. Survey evidence for 1962 showed PREA $\approx$ 1.5 PRE. This factor was assumed to hold throughout 1959–1965.

FIGURE 4 Restricted Activity Days per Person



SOURCE: U.S. National Center for Health Statistics.

During the brief time period covered in Figure 4, there is not a significant relationship between R and PRE for persons aged 45–64. For females, however, the trend lowers beginning in 1966, which is almost significant.

For the elderly, the data support a significant relationship between R and PREA. The regression of R on PREA yields a coefficient estimate for men of -0.018 (t statistic -5.2), and for women -0.013 (t statistic -3.4). If the effect of Medicare is taken to be the rise in PREA from 1.5 PRE to 2.5 PRE, then in 1969 the program is associated with a decline of 5.7 disability days for men and 4.1 days for women. These declines would have been 18 per cent and 11 per cent, respectively. These estimates are crude and upwardly biased by the omission of variables such as income or social security cash benefits, since other goods and services may be purchased that reduce disability. Over a longer time series, the problem of

exogenous technical progress might be treated by distinguishing cause-specific disability rates.

One possible means of combining information on disability reduction with information on mortality reduction will now be discussed. The aim is to construct a useful scalar measure of relative improvement, ω, to use in (4).

Recall that $\omega = T_2/T_1$, where each T_i is a factor multiplying the annual expected utility of consumption of goods other than health services. Let S_{ti} be the probability of survival to year t under program i. Let a_{ti} be a factor that reduces utility of those alive depending on the level of average disability; specifically, let

$$a_{ti} = 1 - \frac{\text{disability days in year } t}{365}$$

One particular way of formulating the planning agency's tradeoff between survival and disability is

$$T_i = a_{1i} + \sum_{t=1}^{L} S_{ti}\, a_{ti} \tag{7}$$

where $S_{ti} = 0$ for all $t > L$. Perhaps the major reservation in advocating such a measure is a suspicion that it would not be appropriate for situations wherein mortality increases despite improvements in the health of the living. In the practical application here, changes in mortality will be seen to govern the scalar index ω.

In the following table (7) is used to compute values of ω for men and women aged 65–69 in 1969, r being the relative decline in mortality rates and d the relative decline in disability days.

Men				Women			
r	d	T	ω	r	d	T	ω
0	0	11.32		0	0	16.44	
.03	.10	11.64	1.028	.03	.10	16.87	1.026
.06	.10	11.85	1.047	.06	.10	17.13	1.042
.03	.20	11.75	1.038	.03	.20	17.04	1.036
.06	.20	11.97	1.057	.06	.20	17.31	1.052

The importance of disability and health status measures seems destined to grow. Further use of the Health Interview Surveys will treat disability as an outcome of environmental events, the use of medical services, and the lagged effects of past behavior. A preliminary approach to production function analysis in survey data is

reported below. The results were not encouraging; they suggest refinements in research methods and the need for longitudinal samples.

Previously, Grossman (1972, pp. 55–66) has reported estimates of the determinants of cross-sectional variation in disability. After application of two models with disability as a dependent variable, he suggests that the more convincing interpretation of the data is given by a model of the demand for "flows" of good health.[27]

Grossman's attempt to estimate with consistent methods the effect of medical care in reducing disability did not yield reliable results.[28] My preliminary study led to a similar conclusion.

The Health Interview Survey for 1969 provides the number of restricted activity days for an individual during the two weeks prior to interview. Each quarter of the year, however, is a separate random sample of the U.S. population. Therefore, average disability for subpopulation i in a two-week period, $\bar{R}_i$, is seasonally unbiased. The method of choosing subpopulations will be considered below. The probability of a disabling condition does not depend on contemporaneous use of medical care, and by analogy to Gompertz' Law is assumed to rise exponentially with age. The length of disability, given its occurrence, is assumed to depend negatively on the intensity of medical care.

Define the following averages for subpopulation i:

MDV = number of physician visits (12 mos.)
HOS = number of hospital days (12 mos.)
HI = proportion with hospital insurance
HG = proportion with education at least through high school graduation
INS = 0.25 (HI) + (1-HI) a crude estimate of average net price of medical care.

Let the prefix L for any variable name denote a logarithmic transformation.

In the absence of data on past use of medical care, I attempted to specify the static production function over groups

$$(8) \qquad L\bar{R}_i = \alpha_0 + \alpha_1 \mathrm{AGE}_i + \alpha_2 \mathrm{LMDV}_i + \alpha_3 \mathrm{LHOS}_i + \alpha_4 \mathrm{LHG}_i + u_i$$

Problems of identification and simultaneity bias must now be discussed, and methods for grouping and consistent estimation described. In reality, there are a variety of illnesses, each with a different established method and intensity of medical treatment. Some conditions that are treated with more than average intensity may nevertheless have worse than average disability results, which, of course, carries no implication that the choice of treatment

was inefficient. One suspects, therefore, correlation between amount of care and the residual in (8). Identifying information may not be present in the sample—e.g., variables that affect MDV and HOS but are not correlated with the residual in (8). I assumed that income and price of care are variables that may be used as instruments in estimating (8). Only a crude measure of price was available.

The population over 45 was classified into 9 age categories and 7 income groups, yielding 63 subpopulations. The grouping strategy, in addition to removing seasonality, sought to use an instrumental technique to purge LMDV and LHOS of correlations with u. Classification by age may not advance the above strategy, so (8) was estimated by two-stage least squares with LINS, LHGP, AGE, and income dummy variables used as the exogenous variables. The computed estimates of α_2 and α_3 were positive, which seems primarily to reflect a failure to identify the true parameters of a production relation.

Fruitful research on cross-sectional variation in disability may be aided by cause-specific analysis, or supplementary information on regional quality variation and standards of medical care. The longer-term effects of differences in intensity or quality of medical care may require repeated interviews with the same individuals.

CONCLUDING REMARKS

It was not the purpose of this paper to conclude whether Medicare is or was better than some other program. The purpose was to demonstrate the feasibility of deriving and usefully combining information on health status, cash transfers, and risk bearing. The social welfare function suggested in this paper is one of an infinity of formulations. The need to use some such precise formulation for planning government intervention in personal health decisions seems obvious.

NOTES

1. The dominant private insurance plans also cover health loss with a matching grant. The welfare formulation in this paper is not meant to explain how the private insurance system or Medicare arose, but may be relevant to the question of why they survive.
2. The effect of higher taxes and higher prices for health services on younger persons will not be considered.

3. Despite the short time span, the data suggest a break in trend after 1965 that is consistent with a stable relationship between real per capita health expense and days of restricted activity. A cross-section multivariate analysis in 1969, however, did not permit the identification of such a "production" relationship.
4. See H. Somers and A. Somers, *Medicare and the Hospitals: Issues and Prospects* (Washington, D.C.: The Brookings Institution, 1967), Ch. I.
5. Each person who votes may weigh his own potential gain or loss against the gain or loss of others. Pauly (1971) suggests that the existence of such consumption externalities is the key impetus behind public reimbursement programs for medical care. In the general analysis of government there will be many SWF's. Rothenberg (1961) argues that the community can come to a prior agreement on a single SWF to be implemented by neutral technocrats.
6. The problem of adverse selection and other high private transaction costs argue for public administration of insurance, but this is not synonymous with the application of a SWF.
7. The exposition may be carried through with an addition to y of the annuity value of other assets as long as these are unaffected by program change. Also, c is assumed to be non-negative.
8. The same objective function may be offered with the following justification: Assume that each period has independent and identically distributed outcomes of current expense and that individual utility is the sum of utility in all periods lived. Then, average summed utility will be

   $$E[u(c)] \cdot (1 + S_1 + S_2 + \ldots)$$

   where S_j is the probability of survival to period j, averaging over all initial conditions.
9. Both criteria are weighted sums of future planner-perceived gains to the representative individual. Use of the human capital criterion does not typically recognize risk preference. See, e.g., Weisbrod (1961) and Rice (1966). Both criteria override individual preferences with regard to discounting the future, and individual subjective probabilities. Discounting could be incorporated in the SWF used here.
10. The concept is analogous to "certainty equivalence." Therefore, extrapolation to situations with no risk would suffer from a recognized drawback—consumer preferences may be somewhat incomparable between the case of no risk and some risk.
11. The specification of Constant R has been applied in discussions of health insurance by Zeckhauser (1970), Friedman (1971), Feldstein (1972), and Arrow (1974).
12. Suppose that T is the sum of survival rates given in an earlier note. If the entire survival curve is shifted up by proportion $r > 1$, then ω is slightly less than r; specifically,

    $$\omega = r - (r - 1)/T_1$$

13. This conclusion may depend on the precise manner of treating free care in the pre-Medicare period. The appropriate z_1 distribution is what would have been observed in the year for which all comparisons are made, in this paper 1969.
14. Elderly persons were likely to have insurance with less extensive reimbursement, but were likely to be paying higher premiums for individual coverage. In 1969 they might have been paying more than this amount in the absence of Medicare.
15. This distinction may have practical relevance for a minority of diseases such as

cancer. The distinction attempts to recognize that consumer response to lower prices may be more directly relevant to early treatment than to the mode of treatment. The behavior of physicians as decision-making agents with some leeway to exercise their own preferences may show a more complicated response to public programs. See Fuchs (1972, Ch. 4) and Friedman (1974).

16. An early example in the literature on economic growth is R. Solow, "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, 39 (1957), pp. 312–320.
17. During this period the CPI medical care component rose by about 15 per cent. The expenditure data are from Cooper *et al.* (1973).
18. See R. Lowenstein, "Early Effects of Medicare on the Health Care of the Aged," *Social Security Bulletin* (April 1971).
19. The utilization data in this section are from "Age Patterns in Medical Care, Illness, and Disability," *Vital and Health Statistics*, Series 10, Nos. 32 and 70.
20. This particular problem could be corrected in the linear case by age-adjusting all the independent variables. The question of proper pooling is more serious. Silver computes a coefficient of concordance between separate rankings of regions for age-specific mortality. The values for this statistic are quite low in 1960, and are more troubling for men than for women.
21. Since Gompertz' initial suggestion, more complicated models and speculations have been offered. For most of these formulations, the rate of increase in mortality is approximately constant from "maturity," falling off gradually at older ages. See Spiegelman (1968), pp. 163–170.
22. If the true value of m_{at} is μ, then the variance at u_{at} is $\mu(1 - \mu)/n_{at}$, where n_{at} is number alive at beginning of year t.
23. I must thank Joan Klebba, National Center for Health Statistics, for helpful assistance with these data.
24. The open-ended group, age 85+, was ignored.
25. A three-year period may be too soon to capture the effect of earlier treatment of serious illness, as the trend in Figure 1 suggests. When later data become available, the possibility must be considered that technical or environment change has been slanted in favor of the elderly. For example, a decline in the proportion of cigarette smokers may have occurred more rapidly and with greater effect among the elderly.
26. Fuchs has discussed the extent of correlation between mortality and disability measures across regions. See "Some Economic Aspects of Mortality in the United States," National Bureau of Economic Research, 1965, mimeo. The possibility should not be overlooked that over time, reduced mortality at older ages might raise the average observed disability of the living.
27. Of primary interest to Grossman is the stock of health that represents both the capitalization of future flows and the lagged effects of past investment choices.
28. The regression used a NORC sample of 550 members of the labor force in 1963 with some disability days.

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9 COMMENTS

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Bernard Friedman's paper is really two very interesting papers. Unfortunately, the bridge between them is not as strong as it could be. The first is an application of welfare theory to provide a framework for analyzing Medicare. The second is an empirical investigation of the effects of Medicare on the health status of the aged. In these brief comments the model and its assumptions are reviewed, other important issues to consider are identified, and the empirical results are examined.

Friedman proposes an intriguing model to compare the welfare of the aged before and after Medicare. The novel aspect of the model is the attempt to incorporate three health-related features into the welfare function. They are (1) consumption of medical services, (2) risk spreading, and (3) health status. The concept of "equivalent transfer," τ, which purports to measure the monetary value of welfare gains in these three features, is developed. One of the basic ramifications of the model is that all welfare gains are attributed to Medicare.

The model is a two-period life-cycle formulation. It assumes that a representative individual (in period 1) saves out of current income. At the critical age (period 2), all saving ends and the individual receives an annuity and a reimbursement contract for the purchase of medical services.[1] Future consumption of goods and services is governed by two other variables: (1) Z, a random variable reflecting out-of-pocket expenses for noncovered medical services, and (2) π, average spending on health insurance premiums, both public and private. Assuming no borrowing, lending, or saving, consumption of goods and services other than medical care, C, is defined by the identity[2] $C = y - \pi - Z$.

With this consumption identity, Friedman specifies an objective function. It is $T \cdot E[u(c)]$, the product of average health status T as perceived by the central planning authority and the expected value of a utility function $u(c)$. Friedman comments that this objective function is "the social perception of individual welfare at the critical age." To compare welfare of the aged before and after Medicare, Friedman incorporates the equivalent transfer τ into the objective function. The definition of τ is embodied in the following equation

$$T_2 \cdot E[u(c_2 - \tau)] = T_1 \cdot E[u(c_1)]$$

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where subscripts 1 and 2 refer to pre- and post-Medicare, respectively. Friedman describes τ as "the amount of nonmedical consumption whose loss in situation 2 leaves the objective function at the same value as in situation 1." Positing a negative exponential utility function with the property of constant absolute risk aversion, Friedman solves the above equation for τ.

The model is an intriguing conceptual approach that incorporates the consumption of medical services, risk spreading, and health status in comparing the welfare of the aged before and after Medicare. However, in examining Medicare (or other public programs) there are some other important issues to consider. For example, under what circumstances should the government intervene in the private market? If government intervenes, what policy instruments should be employed? What are the total (i.e., general equilibrium) effects of intervention on the rest of society? Friedman's formulation does not address itself to these fundamental issues.

In the case of Medicare, one key reason for public intervention was the failure of the private market to provide health insurance for the elderly. Largely out of the labor force, the elderly lacked the opportunity to purchase health insurance at group rates. In addition, experience rating, the competitive tool of the commercial companies, forced the Blues to abandon community rating, which to a certain extent had allowed some aged persons to purchase protection at reasonable rates. Finally, an institutional feature of the market is that unlike life insurance, one cannot purchase health insurance on an annuity basis. For these reasons an adequate market for health insurance for the aged failed to develop. Distributional considerations provide yet another, albeit interrelated, rationale for the creation of Medicare, since many elements of society had empathy with the elderly, a majority of whom are poor. If these distributional considerations are viewed in a more global framework, one should consider the welfare of the givers as well as the receivers.[3]

Inasmuch as public intervention can lead to greater efficiency under these circumstances, the question becomes, "What policies should be used?" When Medicare was being debated, several approaches—subsidies for the purchase of private insurance, creation of insurance pools, and having the government act as underwriter—were considered. It would be useful to develop a model to compare the implications of these alternative mechanisms. Such a model could also be useful in addressing some of the important questions in the current national health insurance debate.

The second part of Friedman's paper is an empirical investigation of whether the health status of the elderly improved after Medicare. Indeed, these results are encouraging, although they are far from definitive. First, he attempts to measure improvements in mortality. Because this measure ignores improvements in the health status of the living, changes in disability are also measured. Finally, mortality and disability are integrated to obtain a comprehensive indicator of the change in health status.

Friedman acknowledges the problem of attempting to discern causality with aggregate mortality data but aspires to a less grand objective of finding an associative relationship. The critical assumption of this approach is that *all* the change in health status is attributed exclusively to one program—

Medicare. Changes in health status arising from other programs such as housing subsidies, food stamps, cleaner environments, and increases in real income (Social Security benefits) are not properly accounted for.

Two tests of improvement in mortality of the aged are performed with cohort mortality data. In the first test a modified cohort mortality model is estimated for white males and females. Although the model indicates improvements in mortality for white males, the hypothesis of no improvement or indeed retrogression in mortality for white females cannot be rejected.

The second test applies the model to mortality data for each of eight cohorts up to 1964. The estimated equation is then used to predict what 1969 mortality would have been if the underlying pre-Medicare trends continued. A test of the effect of Medicare is whether the actual 1969 mortality rate is significantly different from the predicted 1969 mortality. Friedman finds that for white males there is a significant difference for six cohorts (four cohorts under age 65 in 1969 and the oldest two over 65). For white females, the actual is significantly different from the predicted for only one of the nine cohorts (age 62).

Although these results are encouraging, they are hardly unambiguous. In view of the insignificant result for white females, it may be premature to attribute improvements in mortality for males to Medicare, especially since so many other social programs were changing at the same time. In any case, it may also be that a three-year period is too short to detect improvements in health status, especially for the aged, who have many chronic conditions that might be affected only slightly by medical care.

Since improvements in mortality do not take into account improvements in the health of the living, changes in disability are also considered. In a crude model, Friedman regresses days of restricted activity for the aged on real per capita expenditures for the aged and reports highly significant results. Friedman suggests that in 1969 Medicare is "associated with a decline of 5.7 disability days for men and 4.1 disability days for women." These results should be interpreted cautiously since other important variables may be omitted from the model. Moreover, there is a problem of causality, and "free care" in the pre-Medicare period may not be adequately accounted for.

Friedman then attempts to combine mortality and disability to determine the likely range of the relative improvement in health status. He uses one of many possible sets of assumptions, and in view of the value judgments this specification presumes, several alternative combinations might have been more helpful. Friedman computes the relative improvement in health after Medicare for several possible values of the improvement in mortality and disability. Unfortunately, he does not use the relative improvement in health to calculate τ, the dollar value of welfare gains.

In summary, Friedman has presented an interesting model to analyze the welfare effects of Medicare on beneficiaries. To the extent that his empirical results can be attributed to Medicare, they reflect favorably on the program. Nevertheless, the model is limited in applicability and leaves untested many other important aspects of a national health financing system.

NOTES

1. That is, the Medicare reimbursement contract reimburses eligible persons for specified medical services if these services are rendered by recognized providers.
2. It is unclear how this model relates to the institutional features of Medicare. For example, Part A of Medicare (primarily for institutional services) is mandatory and is financed by a payroll tax on employers and currently employed workers. Benefits are paid out of current income and indeed this feature may be viewed as an intergenerational transfer of wealth. Part B (primarily for noninstitutional services) is a voluntary program financed by premiums set annually and paid by both the beneficiary and government general revenues. Indeed, one can make an analogy between the government and private employers if we consider Part B as a large group policy with premiums paid by both enrollees and by government contributions.
3. See especially Irwin Garfinkel, "Is In-Kind Redistribution Efficient?," *Quarterly Journal of Economics*, 87 (May 1973), pp. 320–330.

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I shall limit my comments to Friedman's attempt to determine the effect of Medicare on mortality. This is, as he points out, a hazardous undertaking. The available data cover only three full post-Medicare years, 1967–1969, possibly too short a period for any significant changes in mortality to emerge. In the short run death rates are subject to many random influences such as influenza epidemics or variations in the severity of winter weather.

Even if a longer period were available, however, the problem of establishing a causal connection between Medicare and mortality change would be formidable. For the population as a whole, long-run trends in mortality are determined primarily by environmental and behavioral changes and by advances in medical technology, not by changes in quantity of medical care. From 1900 to the mid-1930s, age-adjusted mortality of U.S. whites decreased at an average rate of about 1.3 per cent per year. The decline, which was only slightly more rapid for females than for males, was mostly the result of rising real income and of basic public health measures. Very little was attributable to advances in medical science or increased quantity of medical care.

From the mid-1930s to the mid-1950s, age-adjusted death rates fell at a much faster rate: 1.7 per cent per year for white males and 2.9 per cent per year for white females. The acceleration was the result of rapid advances in medical technology, particularly the development of anti-infectious drugs.

Around 1954–1955 there was an abrupt change in trend (pointed out by Friedman in his cohort charts). Since then, the age-adjusted male death rate has been approximately constant. The female rate has continued to decline but at a much slower pace: 0.7 per cent annually.

To test for the effects of Medicare, Friedman employs a cohort model with observations at five-year intervals back to 1934. Regressions through 1964 yield predicted age-specific mortality for 1969 that he compares with actual mortality. He finds a significant result for males but not for females.

A close examination of Friedman's Table 2 reveals a curious pattern of deviation between actual and predicted mortality rates in 1969, with the relative deviation decreasing systematically with age, as shown in my Table 1 below.

By splitting the population at age 65, Friedman finds a significant "Medicare effect," but if the population were split at 55 or 75, a significant difference between the older and younger ages would also emerge. There may be some real phenomena at work that are systematically reducing mortality more with increasing age, or the pattern may result from some bias in the cohort model. But the conclusion of a Medicare effect seems premature.

Friedman's cohort model is only one of several imperfect approaches that can be followed to test for Medicare effects. The mortality of any population in a given year is a function of its age, the state of medical science, the quantity of care available, the current environment, plus a host of past medical and environmental variables and previous mortality experience. Because cohort, age, and year are linked in an identity relationship, it is not possible to completely identify their separate effects.

I have attempted to test for a Medicare effect on mortality by fitting regressions of the form $\ln M = a + bT$ to annual data for the periods 1955–1965 and 1967–1969.[1] In no case can we reject the null hypothesis of no difference between the periods. The F values are typically very small.

I have also used the 1955–1965 regressions to derive predicted values for the Medicare years. The percentage difference between the actual and the predicted values for these years is shown in Table 2. Again, there is no evidence that Medicare has had a significant effect on the mortality of the aged.

I do not find this result very surprising. Current changes in mortality, in my view, are determined primarily by nonmedical factors. During the decade of the 1960s, for instance, the death rate for emphysema for white males ages

TABLE 1 Relative Deviation between Actual Mortality and Friedman's Predicted Mortality, White Males, 1969

Age	$(A - P)/P$
42	+9.0%
47	+9.1
52	+6.1
57	+3.1
62	+0.9
67	−1.9
72	−2.0
77	−4.1
82	−4.4

SOURCE: Table 2 in Friedman's paper.

TABLE 2 Percentage Deviation between Actual and Predicted Death Rates, 1967–1969[a]

Sex	Age	1967	1968	1969	Average 1967–1969
Males	45–54	−1.4	+0.1	−2.3	−1.2
	55–64	+0.4	+2.5	+0.2	+1.1
	65–74	−1.5	+0.8	−2.4	−1.0
	75–84	−1.4	+1.4	+0.5	+0.2
Females	45–54	−0.3	+2.2	−0.6	+0.5
	55–64	+1.2	+5.1	+3.3	+3.2
	65–74	+0.3	+2.4	+0.7	+1.1
	75–84	−2.8	+0.2	−1.5	−1.4

[a] Predicted values based on regressions fitted to annual data, 1955–1965.

65–74 more than doubled, the rate for lung cancer increased by 25 per cent, and the rate for arteriosclerotic heart disease went up by 15 per cent. These increases were not the result of a deterioration in the quantity or quality of medical care. During the same decade there were substantial (more than 25 per cent) decreases in the death rates for cancer of the large intestine, rectum, and prostate. The medical profession has no firm explanation for these declines and they are not believed to be the result of more medical care.

To pursue seriously the question of the effect of Medicare on mortality, several different approaches should be tried. For instance, it would be desirable to disaggregate by cause of death. Particular attention could then be paid to those categories wherein there is some reason to believe that increased access to medical care should make a difference (e.g., infectious diseases). It might also be useful to disaggregate by state and region. There was probably some geographic variation in the impact of Medicare on utilization of care by the aged, and one could test for a relation between such utilization and changes in mortality. Along the same lines, it might be useful to look at recent mortality experience in countries that did not experience any shift in care for the elderly.

These comments, which have been limited to mortality, do not do justice to the ambitious scope of Friedman's paper. They reflect my own belief in the need for more intensive investigation of sharply defined questions.

NOTES

1. The year 1966 is omitted because Medicare was partially in effect.

M = age-sex-specific death rates
T = time