Medicare, Hospital Utilization and Mortality: Evidence from the Program's Origins

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Abstract:

We examine changes in hospital utilization and mortality rates after Medicare's introduction in July of 1966 with the most comprehensive data ever used. The analysis applies the "age discontinuity" design of recent research to data both *before and after* Medicare's introduction, which allows us to account for pre-existing trends that vary by age.

We find: i) clear evidence that Medicare increased hospital care utilization and costs among the elderly, but at a lower rate than previously found; ii) significant mortality reductions in the eligible population that exhibit an age discontinuity *only after* Medicare's introduction – patterns not found in nations that did not introduce a Medicare-style program in the 1960's; and iii) the sharpest mortality reductions in acute causes of death (heart disease). We estimate that Medicare's introduction had a cost-per-life year ratio below $200 (in 1982-84 dollars). We then analyze changes over time in the characteristics of the "marginal" person who benefited from Medicare coverage. We find that the age-65 discontinuity in insurance rates fell over time, more so for blacks, the less-educated, poor and disabled. We also document a sharp increase in the mid-1980s in the use of coronary artery bypass graft (CABG) surgery on the Medicare eligible, which coincided with an increase in the *relative* Medicare reimbursement rate for this procedure.

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"No longer will older Americans be denied the healing miracle of modern medicine. No longer will illness crush and destroy the savings they have so carefully put away over a lifetime so that they might enjoy dignity in their later years. No longer will young families see their own incomes, and their own hopes, eaten away simply because they are carrying out their deep moral obligations."

- *President Lyndon B. Johnson, at the signing of the Medicare legislation, July 1965.*

I. INTRODUCTION

Medicare was established over 50 years ago and has had a profound effect upon the structure and functioning of the US health care system. Some have suggested that Medicare has caused much of the persistent rise in US health care costs, while others have credited Medicare with stimulating the major technological innovations and medical care advances observed over this time period (Weisbrod 1991). In addition, Medicare clearly serves to finance a great deal of Medical education and expansion of specialization that has occurred in American Medicine (Iglehart 1998). However, the impact of Medicare on the health of the elderly has been incompletely assessed with most studies examining only some restricted aspect of Medicare's impact either by estimating Medicare's impact in the current climate or by using aggregated historical data.

In this paper, we present evidence on the impact of Medicare at the time of its introduction on hospital utilization and health. We use two measures of health: rates of restricted activity, and mortality. We compare changes in these outcomes between the post-Medicare and pre-Medicare period (prior to 1966) for individuals that were eligible for Medicare (age greater than or equal to sixty-five) and for those that were ineligible for Medicare (age less than sixty-five). We further contrast these changes in outcomes in the United States with changes in other countries (e.g., Canada, England and Wales) that did not introduce a Medicare-type program in the 1960s.

We bring together the most comprehensive, detailed, recently released – data to meet our objective, including: 1) hospital and surgical insurance coverage rates *by age, both before and after* Medicare's introduction; 2) hospital discharge data *by age and cause* of admission from 1963 onward; 3) outpatient visit rates by age from 1963 on; 4) mortality rates by cause and age for the United States, United Kingdom, Canada, France and Japan from 1950 on; 5) mortality microdata *by cause and age* for the U.S. from 1960 on; and 6) activity limitation rates by age from 1963 on. These data allow for an analysis that utilizes the "age discontinuity" design of one set of studies, while accounting for pre-existing trends as done in the other set of more aggregated studies.

We find that between 1963 and 1968, hospital insurance coverage of those 65-69 years of age increased by 30 percentage points while hospital insurance coverage of those less than sixty-five increased by only about 5 percentage points. In addition, 28 additional elderly (per 1,000 individuals) between 65 and 69 years of age were discharged from a hospital in 1968-69 relative to the pre-Medicare period (1964-66). Over the same period, there was virtually no change in the hospital discharge rate among the non-elderly. Relative to the non-elderly, there were 35 fewer deaths among the elderly (aged 65-69) over the same period. Taken together, the results suggest that the Medicare program played a causal role in reducing the mortality rate among the elderly.

We also calculate the costs and benefits (measured in terms of life-expectancy conditional on survival until age 64). We construct cohort-specific survival curves for three birth cohorts: 1896, 1900, and 1904. The constructed survival curves show that, conditional on surviving until age 64, those born in 1904 lived 1.5 years longer than those born in 1896. We use the variation in birth years to construct a measure of exposure to the Medicare program. While no one from the 1896 birth cohort was exposed to Medicare between 65 and 69 years of age, all of their counterparts from the 1904 cohort were eligible for Medicare. Back of the envelope calculations suggest that it cost about $ 160 additional dollars to extend median life expectancy by one year.

Having established a beneficial effect of the program at the time of its introduction, we also gauge the effects of the program over the next forty years. We find that, in general, the effects of the program (measured in terms of the estimated discontinuity at age sixty-five) waned over time, partly as a result of changes in the characteristics of the "marginal" sixty-five year old individual eligible for Medicare. At the time of its inception, the "marginal" person was much more likely to be poor and/or disabled. Over time, other Government programs (e.g., Medicare's extension to the non-elderly disabled in January 1973, and Medicaid expansion for Supplemental Security Income (SSI) enrollees in 1974) made it possible for the poor and the disabled to gain health insurance even before turning sixty-five. Since the disabled were also more likely to benefit from health care, it is not surprising that the effects of Medicare estimated in studies using data of a more current vintage have found small effects.

We conclude that although there may valid reasons to cut back on Medicare expenditure, the program at its inception was an almost unqualified success in improving population health at a very reasonable cost. As the current debate on health care reform gathers steam, it may be instructive to understand the reasons underlying the success of Medicare in its early years.

In the next section, we provide a brief overview of changes in the health care market between 1965 and 1975, and existing research on the impacts of Medicare on health care utilization and health. Section III outlines our research design and empirical strategy. Section IV presents a summary of our data, section V presents our results. We discuss possible channels underlying our findings in section VI and conclude with a few policy implications in section VII.

II. BACKGROUND

A. Health and Social Insurance Expansions for the Elderly

By the middle of the 1960s, the United States had a health insurance system in place that excluded the majority of the poor, disabled, and the elderly. Health insurance coverage was almost exclusively linked to coverage via the employer.[1] Indeed the health insurance system stood in direct contrast to other developed countries such as Canada and England where National Health and Hospital Insurance systems ensured that all individuals had the right to health care. Against this backdrop, the health insurance expansion efforts over the next decade were stunning in scope, and represents to this day the most sudden and dramatic transformation of the health care system. Figure 1, Panels A and B reveal the magnitude of the change in health insurance. Panel A shows that the most dramatic change in the hospital insurance coverage of the elderly occurred between 1963 and 1968. Panel B shows that hospital insurance coverage between the two years increased discontinuously by about 25 percentage points at age sixty-five, after remaining close to 5 percent up until age sixty-five.

Medicare

Medicare came into effect in 1966, and was the most far-reaching Social Security legislation since the original Social Security Act. All individuals sixty-five and over as of July 1966 were provided hospital health insurance coverage (Part A) that included a $40 deductible

[1] The Kerr-Mills program provided some medical assistance to the elderly poor.

for first 60 days in hospital, and $10/day for every day beyond 60.[2] Part B was a voluntary medical health insurance program and included an out-of-pocket premium of $3 per month with a 20 percent coinsurance for diagnostic procedures, X-rays, etc. Approximately 19 million Americans were eligible for Medicare in July 1966 and 15 million availed of part B.[3] Only 15.5 million out of the 19 million eligible for Medicare were receiving Social Security benefits, and were mailed letters with information about program by October 1965. Extra efforts were undertaken to track down those not on the Social Security system, and all of the 19 million were sent letters by the first half of 1966 (Social Security Bulletin, 1966). In the first year program, 3.4 million Medicare beneficiaries were admitted to hospital. Relative to 1965, there was a 25 percent increase in hospital days per visit soon after introduction of Medicare.

Medicaid

Medicaid was introduced concurrently with Medicare and provided health insurance to the medically needy. Unlike Medicare, implementation of Medicaid was left up to individual States and eligibility was not discontinuous at age sixty-five. Thus, while most of the North introduced Medicaid in 1966, most of the South did not introduce Medicaid until 1970.[4] Further, since Medicaid eligibility was tied to welfare, a sizable fraction of the poor were not eligible and reimbursement rates to providers were lower than that provided by Medicare. The staggered introduction of Medicaid across states allows us to identify the separate impact of Medicare on utilization and health.

Social Security Benefits

At the end of 1968, 1.8 million people were receiving cash benefits who could not have received them under the law in effect at the end of 1963. Total social security benefits, including Medicare payments, rose from an annual rate of about $16 billion to an annual rate of about $32 billion--an increase of 100 percent. SS amendments in 1967 resulted in a 14 percent increase in

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[2]Individuals that were not on Social Security payroll were eligible for Medicare in July 1966 as long as they turned 65 years of age by January 1968 (Social Security Bulletin February 1966)

[3] One million were not receiving Social Security benefits because they had not contributed into the system. Yet, they were eligible for Medicare. This policy subsequently was changed in the 1970s so that only those that contributed into the system were eligible for Medicare.

[4] Much of North adopted Medicaid before 1967: IL (Jan. 66), NY (Oct. 66), PA (Jan. 66), OH (July 66), MI (Oct. 66). Much of South after 1969: AL (Jan. 70), MS (Jan. 70), NC (Jan. 70), AR (Jan. 70), FL (Jan. 70), VA (July 69), TN (Jan. 69), SC (July 68).

cash benefits to SS recipients.[5] The expansion of benefits between 1965 and 1967 allowed 62 million aged beneficiaries to stay above the poverty line (Social Security Bulletin 1970).

Health Insurance Expansion to the Non-elderly Disabled (1973) and Supplemental Security Income (1974) Recipients

Although the original expansion of Medicare substantially increased health insurance rates among the elderly, it left untouched the coverage rates of the non-elderly disabled. Since much of health insurance in the pre-Medicare period was tied to working, the disabled were most in need of health care and yet the least likely to have health insurance coverage.[6] Many of the disabled were covered by a cash-transfer program – the Social Security Disability Insurance (SSDI) program. Eligibility into this program was based on a very strict definition- individual disability had to be either diagnosed as long-term (expected to last more than one year), or was expected to result in death. After several unsuccessful attempts, Medicare was finally extended to the non-elderly disabled in January of 1973. Individuals were then automatically eligible for Medicare once they were on SSDI for a period of twenty-four months. Close on the heels of this expansion, Social Security introduced the Supplemental Security Income (SSI) program in 1974 that provided cash transfers to the poor elderly and the poor disabled. It was further established that everyone on SSI was eligible to be covered by Medicaid.

B. Mortality, Disease and Availability of Treatment

Over the first half of the 20th century, the development of drugs (vaccines) had all but eliminated (prevented) deaths due to infectious diseases. This reduction in deaths led to both an increase in life expectancy, and an increase in the mortality rates due to non-communicable disease (e.g., heart disease, stroke, and cancer) that affected individuals at middle and older ages. In 1961-62, about 25 % of individuals over sixty were diagnosed with some form of heart disease (authors' estimates from National Health Examination Survey I 1961-62). Against this backdrop, the importance of the hospital increased since inpatient and surgical care became the dominant mode of treating disease.

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[5] In 1965, the earliest retirement age to be eligible for full SS benefits was 62.

[6] The disabled are much less likely to be employed. In addition, health insurance premiums for the disabled were prohibitively high in the private health insurance market.

Several studies were underway to understand the risk factors for heart disease. Spearheading those efforts the Framingham Heart Study began in 1948, and surveyed individuals between the ages of 25 and 74. This cohort of individuals were then followed and resurveyed periodically. In the early 1960s, the study established[7] that high blood pressure, smoking, and cholesterol levels were all associated with heart disease. Around the same time, the advancement of science made it possible to successfully treat heart disease. Surgical treatment of heart disease was found to be very successful by the 1960s (Beck et al.,1958).[8] As of the latter half of the 1960s, both pacemakers and defibrillators (device to shock heart back into rhythm) were widely available (cite), 35 percent of hospitals had open heart surgery units by 1965 , and over 70 percent of non-profit hospitals had intensive care units by 1965 (Russell 1979). The technology to treat heart disease increased dramatically between 1971 and 1975 with an increased use of catheterizations (procedure to detect blocks in the coronary arteries), and Beta Blockers.

C. Previous Studies

Most of the work that has used individual level data to estimate the effects of Medicare has relied on data of relatively recent vintage- 1990 and beyond. For example, Card, Dobkin, and Maestas (2008) use data from the 1992-2002 periods, and show that Medicare eligibility at age sixty-five resulted in a 1 percentage point decline in the probability of death among patients with non-deferrable admissions into a hospital.[9] Using data from the 1990s, a separate study by the same authors finds that Medicare had rather negligible effects on mortality rates in the general period (Card, Dobkin, and Maestas 2004). Other studies using recent data find small to negligible effects of Medicare on health and mortality (Polsky et al., 2009), but much stronger effects on both utilization (Card, Dobkin, and Maestas 2007, McWilliams et al., 2007), and beneficial effects on clinical outcomes such as control of blood pressure and cholesterol levels (McWilliams et al., 2009). In general, overall evidence supports the hypothesis that in recent years, Medicare has resulted in increases in health care utilization but not a decline in mortality rates, except among emergency admissions.

[7] Some findings of the study were subject to heated debate

[8] The essential approach involved increasing blood supply to the heart and was found to prevent mortality due to heart disease.

[9] Admissions with a similar probability of admission on weekends and weekdays.

A few studies have used data from the 1960s to estimate the impact of Medicare on mortality (Finkelstein and McKnight 2008) and costs (Finkelstein 2007) at the time of its introduction. Friedman (1976) presents evidence that rates of limited activity fell more among the elderly than the non-elderly following the passage of Medicare. Studies by the Social Security Administration (1972) found that in the first five years of its existence, Medicare played a decisive role in increasing utilization rates while the number of days per hospitalization increased by 25 percent. A common feature of all of these studies is their reliance on data aggregated to 5-year age groups or at the regional level. The basic conclusion reached from these studies is similar to the conclusion reached from studies using current data: Medicare has resulted in increases in utilization (and costs), but has had rather negligible effects on mortality. We bring to bear on the topic recently released micro data on both hospital insurance and utilization from the National Health Interview Surveys (1963-2006). There are several advantages in the data we use. Specifically, we can calculate age-specific utilization (and costs), and are able to estimate the discontinuity in Medicare eligibility both before and after the introduction of Medicare.

The availability of age-specific data allows us to rule out several competing hypotheses- a possibility not afforded by aggregate data. For example, Finkelstein (2007) uses aggregate data from the American Hospital Association (AHA) and finds that hospital expenditure increased substantially following the passage of Medicare. Under the assumption that Medicare would cause a larger increase in health insurance among the elderly living in the South (relative to the North), the paper finds a more substantial increase health care costs in the South. However, the study may overstate the increase in utilization and costs since other simultaneous (with the introduction of Medicare) changes affected the health care market: (i) hospital integration; (ii) Medicaid; (iii) increase in personnel costs due to extension of minimum wage ($9-10/hour in $ 2007) to hospital employees in February 1967.[10]

A recent review of the literature (Levy and Meltzer 2007) on the impact of health insurance on health concludes that the majority of the studies are observational studies that do not speak to the causal impact of health insurance. Even the quasi-experimental studies have "looked at the expansions under relatively narrow contexts". For example, the Card, Dobkin,

[10] It is also likely that the increase in minimum wage was relatively more binding in the South than in the North. It was possible to charge the increase in daily expenses as a result of the minimum wage increase to Medicare.

and Maestas (2008) study examined the effect of Medicare on mortality among a relatively sick inpatient sample.

III. EMPIRICAL METHODOLOGY

A. Estimation of Medicare's Impact

We now discuss the empirical methodology we use to unravel the causal effect of Medicare on hospital utilization and health. Like a few recent studies, we use the comparisons around the Medicare eligibility threshold at age sixty-five to measure the impacts of the program.

We first specify a generic model to highlight the strengths of our methodology, and later present the regression equations actually estimated. Let y_{it} denote the outcome (health insurance, hospital utilization, restricted activity, mortality) for each observation i in period t. In any given year, let the relationship between the outcomes, age, and the covariates take the following form:

$$y_{it} = \beta_0 + \beta_1 f(age_{it}) + \beta_2 g(X_{it}) + \beta_3 D_{age_{it}>=65} + \varepsilon_{it} \qquad (1)$$

where f and g specify the functional form of the relationship between the outcome and age, and the outcome and the X's respectively, and the vector of variables in X_{it} includes categorical variables for education, income, region, employment status, marital status.[11]

Since the functional forms of f and g are not observed, we posit a regression equation that expresses the outcome (y_i) as a function of a fifth order polynomial in age, a linearly additive term in other correlates (X_i). We further split the age 65- and over dummy variable to include three age-categories: 65-69, 70-74, and 75-79. Without loss of generality, we ignore the time subscript, and rewrite equation 1 as

$$\begin{aligned} y_i = \alpha + \theta_1 \cdot 1(age_{65-69}) + \theta_2 \cdot 1(age_{70-74}) + \theta_3 \cdot 1(age_{75-80}) + \\ \lambda_1 \cdot age + \lambda_2 \cdot age^2 + \lambda_3 \cdot age^3 + \lambda_4 \cdot age^4 + \lambda_5 \cdot age^5 + X_i'\beta + \varepsilon_i \end{aligned} \qquad (2)$$

The estimated effect of Medicare eligibility-denoted by the parameters $\theta_1, \theta_2,$ and θ_3- is affected by the assumed functional form of the relationship between the outcome and age (a fifth-order polynomial), and the outcome and the X's (linear). Unlike any other previous study, however, we use the "discontinuity" along with the comparisons in the changes in these

[11] Indicator variables for race are also available and are used for running the Whites only analysis.

outcomes before and after the introduction of Medicare. This possibility us with a distinct advantage previous studies. In particular, the functional form of the relationship between age, the correlates X_i, and the outcome (expressed as f and g) may play a less important role when we examine changes between the pre- and post-Medicare periods. We return to this point in the results section.

Denoting the period after Medicare by A, and the period before Medicare by B, we estimate the following regression:

$$\begin{aligned} y_{it} &= \alpha + \gamma_1 \cdot 1(age_{65-69}) + \gamma_2 \cdot 1(age_{70-74}) + \gamma_3 \cdot 1(age_{75-80}) + \\ &\theta_1 \cdot 1(age_{A,65-69}) + \theta_2 \cdot 1(age_{A,70-74}) + \theta_3 \cdot 1(age_{A,75-80}) + \lambda_1 \cdot age + \lambda_2 \cdot age^2 + \\ &\lambda_3 \cdot age^3 + \lambda_4 \cdot age^4 + \lambda_5 \cdot age^5 + \delta_1 \cdot 1(After) + \delta_2 \cdot age \cdot 1(After) + X_{it}'\beta + \varepsilon_{it} \end{aligned} \quad (3)$$

In equation 3, the parameters of interest are $\theta_1, \theta_2,$ and θ_3 and represent the change in the regression discontinuity (at age sixty-five) between the post- and pre-Medicare periods. We further confirm that there are no discontinuities in the period before Medicare (1963-64).

B. Estimation of Cohort-Specific Survival Curves

In addition to estimating the effects of Medicare on mortality rates, it is important to measure Medicare's impact on life-expectancy. The standard method to do so is to use the published life tables. However, a well-known drawback in using the published life tables in the United States is that they are, by construction, cross-sectional. More specifically, they assume that the prevailing health care conditions (including medical technology, health insurance coverage, etc.) remain constant over time. In our context, based as it is on a period of dramatic changes in the health care scenario, the cross-sectional life tables cannot convey much useful information. Instead, we construct cohort-specific survival curves. To do so, we take advantage of the fact that individual-level mortality data are available from 1960 onwards. Since these data also provide information on the age of death, we can calculate the number of deaths from any given birth cohort. We present an overview of the approach taken to construct survival curves for the 1896 birth cohort- a cohort that was not affected by Medicare until they turned 70 years old. From the 1960 census, we can estimate, conditional on survival until age 64, the population of 64 year-olds. From the 1960 mortality files, we can calculate the number of individuals from the

1896 cohort that died (∵ the number of 64 year-olds that died). We use this number to calculate the mortality rate of 64 year olds in 1960.[12] This mortality rate is applied to calculate the population of 65 year olds alive as of 1961. We apply the mortality rate of 65-year olds in 1961 to estimate the number of survivors in 1962. We follow this logic to estimate the complete survival curve for the 1896 cohort. We similarly estimate the survivor curve for the 1899, and 1904 cohorts. We note that this method is very similar to the widely-used Kaplan Meier (KM) survival curve. However, we need to modify the standard approach take to estimate the KM curve since we cannot, by definition) the complete survival curve for the 1896 cohort.[13] Our methodology has been used by the Social Security Administration (Bell and Miller 2004). We note here that our approach assumes that the conditional probability of survival until age 64 does not change between the 1896 and 1904 cohort. We return to this issue in our discussion of results.

IV. DATA

In this section, we overview all the sources of data we use in our analysis. Here, we focus on describing how the main outcome variables were created, and some of the ways in which we have tried to gauge the extent of measurement error in our key variables. We present a more detailed description of the data used in an Appendix.

A novel feature of our paper is the use of micro-data on both hospitalization and health insurance coverage both before and after the introduction of Medicare in July 1966. Data on these variables come from the National Health Interview Survey (NHIS). We use data from the 1963-2006 NHIS surveys.[14] The NHIS samples about 40,000 households (~ 130,000) individuals from the civilian, non-institutionalized population of the United States. The NHIS contains information on health insurance coverage by types and payment sources, i.e., hospital and surgical insurance; private and public insurance. Between 1962 and 1968, insurance coverage data were collected in the NHIS in the fiscal years 1963 and 1968). Beginning in 1968, insurance data were generally collected every 2 years; and from 1989 on, data were collected every year.

[12] A typical problem in constructing cohort-survival curves is that they require that the entire cohort is dead (Siegal and Swanson 2004).

[13] In order to do so, we will need information about the total number of births in 1896, and in each subsequent year, the number of deaths from that birth cohort.

[14] The NHIS data from the 1962-1968 survey years was recently (January 2008) made publicly available. The questions from the 1963 survey cover the period July 1962-June 1963. The survey shifted to the calendar year format in 1968. In that year, surveys were administered using both the fiscal and calendar year formats.

For 1970, 1983, 1986, 1993, and 1996, only a subset of the sampled individuals received the health insurance questions, resulting in sample sizes ranging 45,000 to 56,000.

Data on hospitalization come are based on responses of sampled members to the question: "*Have you been discharged*[15] *from a hospital in the 12-month period prior to the interview*"? Questions are asked about both any hospitalization, and also about the specific cause of hospitalization. Since responses are self-reported, we would like to check the veracity of the information provided by validating with more objective measures of hospitalization. Unfortunately, there are no other data we have available that we can use to cross-validate the NHIS hospitalization data prior to 1970. Beginning in 1970, however, we are able to construct age-specific hospitalization measures from the National Hospital Discharge Survey (NHDS). In results not shown here, we verify that the NHIS and NHDS generate overall hospital discharge rates that are very similar.[16] However, at the level of individual causes, we find more discrepancies between the two series. Hence, we only use the NHIS data to generate the overall discharge rates, and use the NHDS (from 1970 onwards) to generate the cause-specific discharge rates.

We also created a dummy variable if the individual was limited in the extent of activity. The question asked if the individual was limited in activity due to any chronic conditions present at the time of the survey. [17] As with all self-reported responses on disability, it is possible that this variable is also plagued with measurement error, especially for those non-elderly individuals that are out of the labor force (Bound and Waidmann 2003). We return to this issue in our discussion of our findings.

The NHIS also provides information on several socio-economic variables that are potential correlates of the aforementioned outcome variables. These include levels of education, income, race, region of residence, age, employment, and marital status. We use these variables in creating regression "adjusted" estimates of the effects of Medicare on our hospitalization, limited activity rates, and mortality.

[15] A hospital discharge from the short-stay hospital is the completion of any continuous period of stay of one or more nights in a hospital (as an inpatient). We did not count hospital discharges that involved hospital admission (and subsequent discharge) of women discharged from a hospital after a normal delivery.
[16] Some of the discrepancies result from the fact that the NHIS, by definition, only includes data on patients discharged alive.
[17] A chronic condition was one that lasted at least three months. As a result, our disability variable may represent a long-term restriction in activity.

National Detail Mortality Files

In addition to limited activity rates, our other measure of health is mortality. We use the 1960-2006 National Mortality Detail Files that provide an annual census of deaths within the United States, derived from the standard Certificate of Death and processed by the NCHS. The data contain the universe of deaths and information on the deceased's race, gender, age at death, and cause of deaths according to the International Classification of Disease (ICD). [18] Although mortality is an objective measure of health, there may be concerns about the validity of number of deaths due to specific causes because of changes in ICD classification schemes. In particular, the scheme changed from ICD-7 to ICD-8 in 1968. Since we compare changes in mortality in the pre- and post Medicare periods, it is important to establish that the changes we observe in the number of deaths (due to a particular cause) are not reflecting changes in the way in which deaths are coded. Using the 1968 data, we estimate the number of deaths using both the ICD-7 and ICD-8 schemes. We find that the ICD revisions led to negligible changes in the cause-specific number of deaths, and bolster confidence in our estimated changes in cause-specific death rates in the pre- and post Medicare periods.

World Health Organization (WHO) Mortality Data

The United States was the only country to introduce a Medicare-type health insurance program in the 1960s (i.e., a program that provided health insurance to the elderly beginning in 1966). In order to exploit this fact, we pulled data from the WHO mortality files. The data provide us with the number of deaths by cause of death in 5-year age categories (e.g. 45-49, 55-59, 60-64, 65-69, 70-74, etc.). In analysis presented in this paper, we use the data from the United States, England and Wales, Canada, and France.[19] The data on population used to construct mortality rates are obtained from the WHO.[20] [21] An advantage of using the WHO data is that it allows us to

[18] Deaths of foreign residents of the United States were excluded from 1970 because those were not uniquely identified before 1970. The total deaths of foreign residents for aged 45 to 80 are 0.08%, on average for 1970 – 1974, relative to those of residents. For 1972, data files contain only 50 percent sample of deaths occurred in each states and thus we multiply the number of deaths for this year by 2 to get an annual number of deaths. Race-specific analyses exclude data for New Jersey in 1962 and 1963 because this state omitted the item on race from its death certificates.

[19] We also pulled data from several other countries such as Japan, and Germany, but do not include them in the current results. However, we note that the findings of our paper are not affected by the particular choice of countries.

[20] We verify that the population totals from the WHO are very close (but not the same) as the unrevised population totals provided by the Census Bureau.

construct a mortality rate series going all the way back to 1954.[22] This allows us to obtain a much clearer picture about trends in mortality rates in the decade before Medicare was introduced.

National Hospital Discharge Survey (NHDS)

The National Hospital Discharge Survey conducted by NCHS since 1965 is national sample of about 500 hospitals, which are non-federal, short-stay hospitals in the United States[23]. The NHDS sample contains about 75,000-100,000 individuals and about 200,000 inpatients records per each survey year. The annual survey is publicly available since 1970, and contains information on patient's age, gender, race, marital status, and geographic region of hospital's location; medical records for hospital admission, discharge, procedure, length of stay, and the patients' expected principal source of payment (available in public-use data from 1979 on).

In addition to using the NHDS to verify the accuracy of self-reported hospital discharge rates from the NHIS, we also use this survey to estimate the effects of Medicare eligibility on hospital discharge rates (by cause) over time. In particular, we are able to gauge the effects of Medicare on Coronary Artery Bypass Graft (CABG) rates. As mentioned earlier, the comparative effectiveness of this procedure (relative to angioplasty) in patients with significant narrowing and blockages of the heart arteries (coronary artery disease) is not known. Indeed, it is widely believed that the usefulness of CABG decreases substantially in older patients.

[21] Since our analysis is based on changes in mortality rates (overall and by-cause), the findings may be affected by changes in the ICD classification scheme. Indeed, it is theoretically possible that countries do not adopt an ICD scheme in the same year. We have verified that the countries used in our analysis adopt the ICD scheme in the same year (e.g. ICD-8 adopted in 1968,etc.)

[22] On the other hand, the detail mortality files only provide reliable mortality data from 1960 onwards.

[23] Short-stay hospitals were defined in NHDS as hospitals with an average length of stay of fewer than 30 days are included. Also only hospitals with six beds or more for patient use are included.

V. RESULTS

A. Effect of Medicare on Hospital Insurance Coverage

Panel A of Figure 1 plots the fraction of individuals with hospital health insurance for each age between zero and eighty. There are five lines corresponding to one pre-Medicare year (1963 fiscal year), and three post-Medicare years (1968 FY and 1968 CY, 1974 CY and 1986 CY). In 1963, after age twenty,[24] the plots roughly follow the labor force employment pattern reflecting the dominance of employer provided health insurance as a source of coverage. About eighty percent of the individuals between the ages 46 and 52 are covered by hospital insurance. There is a linear decline in health insurance coverage after age 60 reflecting individual retirement from the labor market. Between the years 1963 and 1968, there is roughly a parallel shift of the 1963 line until age sixty-four. In 1968, soon after the introduction of Medicare, insurance rates increased from 73 percent at age sixty-four to about 93 percent at age sixty-five.[25] Although everyone was eligible for Medicare once they turned 65 in 1968[26], roughly 7 % of the individuals do not have hospital insurance coverage. Over time, most of the elderly are covered by health insurance possibly reflecting greater awareness about the existence of Medicare for the elderly. In 1974, we also note a slight increase (relative to 1968) in the hospital insurance coverage for the near-elderly (55-64 year olds) and this pattern persists through 1986. These changes resulted in a decrease in a "jump" in hospital insurance rates at age sixty-five.

Panel B uses the same data as Panel A, but now plots the growth in hospital insurance rates (at every age) since 1963. In each year, the growth in insurance rates is fairly constant until age sixty-five. The constancy is remarkable and suggests that in the absence of Medicare, the growth in hospital insurance coverage would have been flat at all ages beyond sixty-five as well. Thus, we may be able to identify the effect of Medicare not merely at the discontinuity (i.e., age sixty-five), but at ages over sixty-five as well.

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[24] There is a considerable dip in hospital insurance coverage at age 18 (even in 1963) as children age out of their parents' health insurance policy. This pattern continues and is accentuated in later years since children lose Medicaid coverage around age 18 (in several states) in addition to being removed from employer provided health insurance of their parents.

[25] There is some increase in hospital insurance rates of the non-elderly (<65) between the 1968 fiscal year (July 1967-June 1968), and the 1968 calendar year due, in part, to the expansion of Medicaid to South Carolina and Washington D.C in July 1968.

[26] Up until the early 1970s, everyone who turned sixty-five was eligible for Medicare irrespective of contributions to the Social Security system.

Table 1 shows the discontinuity in hospital insurance rates for the elderly. The outcome variable is the percent with health insurance at each age. Column 1 confirms the finding in Panel A of Figure 1, and shows that before Medicare (1963), there is no discontinuity in insurance rates. Column 2 (Panel A) presents discontinuity estimates for the growth in health insurance coverage between 1963 and 1968. The point estimates suggest that 24 more elderly (aged 65-69) gained insurance coverage in 1968 that would have remained without health insurance coverage in 1963. Similarly, about 30 more elderly aged 70-74 , and 39 more elderly aged 75-79 , have hospital insurance in 1968 relative to 1963. Column 3 shows that the discontinuity in insurance rates falls slightly in 1974 (relative to that in 1968) due, in part, to the introduction of Medicare to the non-elderly disabled and the expansion of Medicaid enrollees. The next three columns of Panel A show that the results are robust to adjusting for several individual characteristics. Indeed, the explanatory power of the regression increases and standard errors on the estimates fall once we adjust for individual characteristics. The discontinuity estimates are larger for Blacks (Panel C) than Whites (Panel B) possibly indicative of greater employer provide health insurance among Whites.

B. Effect of Medicare on Hospital Discharge Rates

In Figure 2, Panel A, we plot the hospital discharge rates by age for the years 1963-64 and 1969-70. Hospital discharge rates decline between the ages of zero and thirteen, increase between ages 14 and 19, stay fairly constant until age 35, and then increase gradually over age.[27] Discharge rates in 1969-70 are very similar to that in 1963-64 until age sixty-four. There is a noticeable decoupling of the two lines beginning at age sixty-five. This figure provides strong evidence that Medicare resulted in an increase in hospital discharges. In Panel B, we plot the growth in hospital discharge rates since 1963-64. There is effectively a zero growth in discharge rates between 1963-64 and 1965-66, suggesting that there were no pre-Medicare trends in hospital discharge rates. On the other hand, there is a rapid growth in discharge rates for the elderly between the years 1963-64 and 1969-70. The discharge rates for the non-elderly do not increase between these periods suggesting that other programs changing concomitantly with Medicare such as the Civil Rights Act and the associated desegregation of hospitals, Medicaid

[27] Hospital admissions for delivery are omitted from Figure 2.

and Social Security payment increases are not the primary reason for the trends depicted in Figure 2.[28]

Table 2 presents results of the discontinuity in hospital discharge rates. The absolute value of the t-ratios is presented as well. The first set of three columns does not adjust for individual characteristics and essentially fits a regression model to the data plotted in Figure 2. Column 1a shows that in the period 1964-66, discharge rates for the elderly did not increase discontinuously at age sixty-five. Column 1b presents discontinuity estimates for the change in discharge rates between 1964-66 and 1968-69. We find that 28 additional elderly (per 1000) between 65 and 69 years of age were discharged from a hospital in 1968-69 relative to the pre-Medicare period (1964-66). For the same age groups, there were 35 additional discharges in 1971-72 relative to the pre-Medicare period. For any given year, the discontinuity in discharge rates was higher at older ages. Thus, in 1968-69, the discontinuity increased from 28 (per 1000) at ages 65-69 to over 76 (per 1000) at ages 75-80. We note that this pattern is very consistent with an increase in the discontinuity in hospital insurance rates with age (column 1b of Table 1). The results do not differ appreciably across Panels A (all races) and B (Whites). This finding is not surprising since our identification strategy relies on the discontinuity in Medicare eligibility at age sixty-five. Other programs that might have impacted Blacks and Whites differently (Civil Rights Act) did not rely on any age criteria to determine eligibility.

B. Effect of Medicare on Rates of Limited Activity

Panel A of Figure 3 plots the change in the rates of limited activity between two pre-Medicare periods (1963-64 and 1965-66) and a pre-Medicare and post-Medicare periods (1963-64 and 1969-70). There is virtually no change in limited activity rates in the two pre-Medicare periods. However, beyond age sixty-five the limited activity rates fall in the post-Medicare period. This graph makes a persuasive case that the introduction of Medicare may have helped lower limited activity rates. Since no pre-Medicare trends exist (Panel A), Panel B plots the change in limited activity rates using 1965-66 as the base period. In both years 1969-70 and 1971-72, it is pretty clear that Medicare reduced limited activity rates. However, between 1965-66 and 1973-74, we find that limited activity rates actually increased for the non-elderly aged 45-64. We hypothesize that much of this increase in the rates was due to an "earlier accommodation

[28] Medicare was the only program that strictly tied eligibility to age.

of health limitations" (Bound and Waidmann 1992). [29] In the appendix, we plot a similar change in rates as in Panel B, but separately for employed and unemployed. It is clear that when we restrict the sample only to those employed, Medicare helped lower the rates of self-reported disability. For the unemployed, disability rates presumably went up for the non-elderly as individuals withdrew from the labor market and reported limited ability to work so as to take advantage of a rise in benefits from disability insurance.[30]

In Panel C, we plot the annualized number of days with restricted activity for each age between forty-five and eighty.[31] While steadily increasing with age in the pre-Medicare period, the elderly report substantially less restricted activity days in 1971-72 than their counterparts in the 1963-64. On the other hand, for the exact same time periods, there is virtually no difference among the non-elderly.

Table 3 presents regression coefficients of the discontinuity in limited activity rates for the graphs plotted in Figure 3. The first column shows that in the pre-Medicare period, 1965-66, there is no significant discontinuity in rates upon turning sixty-five. The next three columns report the change in the coefficients by 1969-70, 1971-72, and 1973-74. By 1969-70, there were 35 less disabled elderly aged 65 to 69 than would have been the case in the absence of Medicare. The effects of Medicare on lowering self-reported disability rates continue to exist at older ages (70-74 and 75-79) as well. By 1973-74, the discontinuity estimates rise appreciably, but as Figure 3 depicts, much of this rise is because the increase in self-reported disability rates among the non-elderly. The last three columns report the change in limited activity rates after adjusting for individual characteristics. The discontinuity estimates are robust to inclusion of these characteristics, while the explanatory power of the regressions roughly doubles. Taken together, this suggests that Medicare eligibility may be randomly assigned since the covariates introduced are uncorrelated with the treatment but are correlated with the outcome (i.e., limited activity rates). We will return to this point more directly when we consider alternative explanations to our findings. The results of Whites (Panel B) are in general similar to those for all races (Panel A), but there is a slightly higher reduction in limited activity rates for Whites.

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[29] The evidence clearly suggests that the movement of older men in relatively poor health out of the labor force and onto disability rolls-a phenomenon that we shall refer to as the earlier accommodation of health limitations-can account for a large fraction of the drop in the work force attachment of these men that occurred during the 1970s.

[30] In particular, the non-elderly disabled enrolled in Social Security Disability Insurance (SSDI) for a period of twenty-four months were eligible for Medicare beginning in January 1973.

[31] The data appendix provides details on how this variable was constructed.

D. Effect of Medicare on Mortality Rates

I. Mortality Rates: Overall and By Cause of Death 1954-1989

Panel A of Figure 4 plots mortality rates in the United States between 1954 and 1989. The line with the solid squares represents the difference in the rates between those aged 65-69 and those aged 60-64. The line connected with triangles represents the differences between those aged 60-64 and 55-59. Although the data used here (provided by the WHO) are aggregated to five-year age categories, it provides us with a complete picture of mortality rates in the pre-Medicare era. The plots show that while the difference in the mortality rates between the Medicare eligible and ineligible groups fell rapidly in the post-Medicare period, the difference in rates between two groups ineligible for Medicare was left virtually unaffected. Between 1966 and 1971, 65-69 and 60-64 difference in rates fell by roughly 18 (per 10,000 individuals). Even considering the average mortality rate over the entire pre-Medicare period on which we have data (1954-1965), Panel A reveals that the difference in mortality rates between the age groups (65-69 and 60-64) fell by about 12 per 10,000 individuals. Panel B further confirms the fact that only the 65-69 minus 60-64 difference in mortality rates fell at the time that Medicare was introduced.

In Panels C and D, we plot the difference in mortality rates (65-69 and 60-64) by cause of death. More than half of the decline shown in the top line in Panel A is explained by heart disease. About 15 percent of the decline is due to stroke. None of the decline can be explained by either cancer or diabetes. This should come as little surprise since cancer treatment was virtually non-existent at the time.[32] We are a bit more cautious in drawing inferences about changes in diabetes mortality rates since it is likely that diabetes was a significant risk factor in heart disease deaths.

II. International Comparisons of Mortality Rates

Panel A in Figure 5 plots the age (65 to 69) – (60 to 64) difference in mortality rates for three countries: United States (solid squares), England and Wales (dashed line), and Canada (solid line). The US is the only country that shows a declining trend after 1967. Panel B confirms that for Medicare ineligible groups (60-64 minus 55-59), the US pattern looks very similar to that in the other two countries. Finally, in Panel C, we plot the difference in log mortality rates

[32] The inability to treat cancer at the time led Nixon to his "War on Cancer".

between age groups.[33] The sharp contrast between the United States and the other countries suggests very clearly that the relative mortality rate of the elderly fell in the immediate post-Medicare period.

III. Mortality Changes in the United States (1963-64 to 1973-74)

We next present results using the number of deaths (by age) from the mortality detail files and population counts from the census bureau. Panel A of Figure 6 plots the change in mortality rate relative to 1963-64. By 1965-66 no change in the mortality rates are observed and establishes the fact that no trends existed in the pre-Medicare period.[34]

When we consider the changes up until 1969-70, the graph suggests that mortality rate declined for only the ages affected by Medicare (65 and over). A similar pattern is observed when we plot the (1971-72)-(1963-64) difference in mortality rates. However, by 1973-74, there is a fall in mortality rates even at ages less than sixty-five. Panel B shows that much of this early decline in mortality rates is driven by declines in heart disease mortality rates. This finding may be consistent with the rapid increase in the role of medical care in treating heart disease.[35] On the other hand, it is also consistent with Medicare's extension to the disabled[36] under sixty-five years of age. Panel B also suggests that although there was a decline in deaths due to heart disease, deaths due to Cancer actually begins to increase beginning at age 72. This is consistent with a competing risks story where individuals that do not die from heart disease, end up dying at a later age from Cancer.[37] Panel B also confirms that the changes in heart disease mortality rate explain much of the overall changes in mortality.

Table 4 presents the regression discontinuity coefficients for the plots shown in Figure 4. The first three columns include data on all races, while the remaining three columns focus only

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[33] The log mortality rate is preferred by demographers because of the well established exponential relationship between mortality rate and age.

[34] We note that some part of the 1966 data on mortality counts refers could refer to deaths that occurred between July 1966 and December 1966. We find only minor differences when deaths that occurred in the second half of 1966 were removed from the numerator.

[35] This period was at the cusp of major improvements in treatment of heart disease including the use of Beta Blockers (reference).

[36] Individuals on SSDI for a period of 24 months were eligible for Medicare coverage beginning on January 1, 1973. Although mental ailments constitute the bulk of SSDI recipients today, in the early 1970s, SSDI recipients were primarily those with heart disease and/or diabetes and cancer (Social Security Administration).

[37] Using annual data on the number of deaths due to heart disease and Cancer, Honore and Llereas Muney (2006) show that the "War on Cancer" cannot be dubbed as a complete failure once we view dying from Cancer as a competing risk to dying from heart disease.

on Whites. We present results for all-cause mortality in Panel A, heart disease in Panel B, Stroke in Panel C, and Cancer in Panel D. Among those 65-69 years old, there are about 13 fewer deaths (per 10,000) in 1969-70 compared to their counterparts in 1965-66. This reduction in mortality rates remains fairly steady when we consider changes by 1971-72 or 1973-74. The mortality discontinuity is slightly lower when we only consider Whites as opposed to all races. However, we note that the discontinuity estimates for discharges (Table 2) are similar for Whites and all races. This might suggest that the non-Whites enter the hospital in worse health states than Whites so that the marginal benefit from hospitalization is higher among non-Whites. Remarkably, the lower mortality discontinuities for Whites (relative to results for all races) persist for each of the causes of death detailed in Table 4. Although, the number of deaths in the post-Medicare period is generally lower for all Medicare eligible age groups considered, we note that 2-3 more deaths due to cancer (per 10,000) in the 75-80 age group in 1973-74 relative to 1965-66. This may suggest that some of those that did not die at younger ages due to (say) heart disease or stroke, end up dying at later ages due to cancer- a distinct possibility since heart disease and cancer share some common risk factors (i.e., smoking).

E. Costs and Benefits of Medicare (1966-1970)

Although the mortality estimates suggest that there the introduction of Medicare led to a decrease in mortality, they do not directly allow us to measure the benefits of the program. However, as detailed in the methods section, we are able to construct cohort-specific survival curves to estimate the gains in life expectancy (conditional on survival until age sixty-four) for cohorts that were, to varying degrees, affected by Medicare between the ages of 65 and 69. In addition to simply measuring benefits, we also provide a baseline estimate of the cost of expanding Medicare. In estimates presented here, we use the costs of hospital discharges as our measure of the costs of the program.[38]

Table 5 presents the results of our calculations. The three columns represent our estimates of the costs and benefits of the program for the 1896, 1899, and 1904 birth cohorts respectively.

[38] Technically, since the Medicare program also included coverage for outpatient visits to the doctor (Part B), simply using hospital costs is likely to give us an underestimate of the total costs of the program. Nevertheless, data from the SSA indicates that in the first two years of the program, $ 6.3 billion was disbursed on hospital insurance (part A) and $ 2.1 billion dollars on part B. Thus, roughly 75 percent of total Medicare expenditures was devoted to part A of the program.

No one from the 1896 birth cohort was exposed to Medicare between the ages of 65 and 69. Relative to this cohort, there were 146.5 additional discharges (per 1,000) in the 1899 cohort, and 184.2 (per 1,000) in the 1904 cohort, while the median life expectancy (conditional on surviving until age 64) was 79.28, 80.26, and 80.73 respectively.[39] The average cost per discharge was about $ 1,250[40] in 1982-84 dollars. The cost per-life year is $ 187.3 for the 1899 cohort and $ 159.45 for the 1904 cohort. This calculation assumes that all of the gains in life expectancy can be attributed to the Medicare program. This does not seem completely unreasonable because we are only measuring gains conditional on survivors to age sixty-four. Indeed, given secular improvements in nutrition, and public health sanitation, the survivors to age sixty-four in the 1896 cohort were likely more positively selected (from the population of all births in 1896) than those in the 1904 cohort. This would imply that our estimate of the gains in life-expectancy would, if anything, underestimate the true gains in life expectancy across cohorts. Nevertheless, even if we were to take the conservative approach, and assume that only 50 percent of the over all gains in life expectancy is due to medical care,[41] our cost per-life year estimates would be $ 374.6 and $318.9 for the 1899 and 1904 birth cohorts respectively.

The aforementioned calculations are based on benefits accruing to the entire population. When we focus on only the increase in hospital discharges attributable to Medicare, the increase in life expectancy per person discharged from a hospital are considerably larger. To see this, we note that there were roughly 25 more elderly (per 100) that were insured in the age group 65-69 (Table 1). In addition, there were roughly 35 more individuals (per 1,000) aged 65-69 were discharged from a hospital (Table 2). Thus, approximately 1 in 7 (35/250) elderly who gained health insurance was discharged from a hospital. Thus, per person discharged, there was approximately a 8 year gain in life expectancy.

E. Alternate Explanations

Although the results presented thus far suggest that Medicare played a causal role in reducing mortality rates, it is possible that factors not directly accounted for in our analysis might affect the magnitude of our estimated parameters. Notwithstanding the fact that we cannot, by

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41 Cutler (2006) argues that even if we look at overall gains in life expectancy from 1960 onwards, about 50 percent may be attributed to medical care.

definition, assess the magnitude of the bias due to unmeasured factors, we try to understand whether other changes that occurred concomitantly with the introduction of Medicare somehow mask the true effect of Medicare. The strength of any research design is based on its ability to rule out alternate explanations of our findings. In sub-section I below, we show how we are able to separate the effects of Medicare from the effects of Medicare. Further, the strength of our research design is predicated on the notion that there were no other discrete changes at age sixty-five in the pre-and post-Medicare periods. The sub-sections II, III, and IV address concerns about the validity of our research design.

I. Medicaid

Introduced along with Medicare in July 1966, Medicaid remains, to this day, the most important source of health insurance coverage to the poor and disabled. Although Medicaid does not have an age eligibility requirement, it is possible to use Medicaid to supplement Medicare coverage, and to help pay the premiums involved in Medicare part B. It may thus be important to gauge the importance of Medicare in the absence of Medicaid. We exploit the fact that Medicaid was not adopted by any of the Southern states until January 1970. Thus, while most of the Northern States adopted Medicaid in 1966, most of the Southern States did not adopt Medicaid until 1970. Thus, for the Southern region of the US, the only health insurance program that was introduced between 1963-64 and 1968-69 was Medicare. Figure 7 plots changes in limited activity rates separately for the South and North. The magnitude of the discontinuity estimate is roughly the same in the South as it is in the North, and suggests that the effects of Medicare were fairly substantial even in the absence of Medicaid.

II. The 1965 and 1967 Social Security Amendments

The 1965 and 1967 amendments to the Social Security program increased cash earnings of recipients by about 20 percent between 1963 and 1967.[42] According to the Social Security Administration, at the end of 1968, about 1.8 million people were receiving SS who could not have received them under the law in place at end of 1963. The minimum cash benefit payable at age sixty-five increased 37 %- from $ 40 to $ 55 per month. More than 62 million aged beneficiaries were kept out of poverty as a result of the 1965 and 1967 amendments. We cannot

[42] Since Medicare was introduced as part of the "War on Poverty" program, there were other, more direct efforts to reduce poverty. Perhaps the most important among these was the SS amendments, but programs such as Head Start also played an important role in improving individual welfare (Ludwig and Miller 2007).

directly include income as a covariate in the mortality regressions since questions about income only began to be included in the mortality file beginning in the 1980s. Instead, from the NHIS we calculate, for each age, the fraction of individuals with income < 150 % of the poverty line. We estimate whether the SS amendments led to a discontinuous increase in income levels at age sixty-five. Table 6 presents those results. We find that there is no evidence that relative poverty rates declined substantially among the elderly (compared to the near-elderly) between 1965-66 and 1969-70 or 1971-72. This suggests that the SS amendments are unlikely to bias our estimated effects of the Medicare program.

III. Increase in Retirement at Age Sixty-five following Passage of Medicare

The importance of the health insurance for the elderly cannot be understated- and was one of the reasons underlying the original passage of Medicare. Indeed, it is possible in the pre-Medicare era that some individuals continue to work at age sixty-five and beyond simply to be assured of employer provided health insurance. The introduction of Medicare may induce such individuals to then retire from the labor force at age sixty-five. If retirement leads to an improvement in health (Bound and Waidmann 2007), the estimated effect of Medicare on mortality may be confounded by retirement. In order to check for this possibility, we estimated a regression of labor force participation on a fourth order polynomial in age, and a dummy variable for age greater than sixty-five. Table 6 shows that there was no discontinuous change of retirement probabilities at age sixty-five following the introduction of Medicare. This bolsters confidence in our finding that retirement was not a confounding factor in our estimates.

IV. Cohort-specific changes in Education

Although our regression results persuasively suggest that Medicare led to a causal decline in mortality rates, they still do not decisively rule out the presence of cohort specific differences in either education or early-child health. Indeed, this problem is simply an artifact of our inability to simultaneously identify year, age, and cohort effects in a regression framework. Using similar regressions to that discussed in the aforementioned paragraph, we check to see if there were discontinuous changes in education levels in cohorts born before and after 1898.[43] We find no evidence of such a discontinuity in education levels suggesting that the fall in mortality in the post-Medicare era is not caused because those cohorts have, on average, more educated individuals.

F. Reconciling Our Findings with Prior Studies Using Aggregate Data

In this paper, we find that Medicare's introduction had, arguably, substantial causal effects on improving the health of the elderly. Indeed, this finding seems to be at odds with findings from prevailing studies that point to a rather small impact of Medicare's introduction on mortality. The one study that found beneficial impacts of Medicare on mortality focused on a relatively sick inpatient sample. We review the findings of two different sets of studies, and try to understand the reasons underpinning the difference in findings.

A study by Finkelstein and McKnight (2007) finds that the introduction of Medicare had no impact on elderly mortality rates. The main set of results in their study compares the change in mortality rates of the elderly living in the North with the change for those living in the South. Under the maintained assumption that changes in insurance coverage due to Medicare would be higher in the South compared to the North, they hypothesize that the decline in mortality rates should be higher in the South.[44] In Panel A of Figure 8, we plot the growth in hospital insurance (by age) between 1963 and 1974 and show that hospital insurance coverage for the elderly did grow more in the South than in the North, although the same was true for the non-elderly. Similarly, in Panel B, we plot the growth in hospital discharge rates. We find that although the hospital discharge rates for the elderly did increase for Southern residents in the post-Medicare period, they also increased for those in the North. Table 7A confirms that the growth in hospital insurance coverage for the elderly is about 10 percent higher in the South than it is in the North. However, in Table 7B, we show that the growth in hospital discharge rates for the elderly is not significantly higher in the South. This finding suggests that the implied first-stage- the effect of health insurance coverage on discharge rates-is weak. In the absence of an effect of Medicare

[43] This approach is valid because decisions about education levels are made early on in the life-cycle. So the regression discontinuity at age sixty-five (in 1961-63) is estimating whether high school attainment changes discontinuously for cohorts born before 1898 and those born later.

[44] Their study used aggregate state-level data on hospital insurance coverage for the elderly in 1963, and assumed that states with the lowest coverage in 1963 (Southern states) would exhibit the maximum growth in health insurance coverage post-Medicare.

expansion on discharge rates, the negligible effects on mortality should not come as a surprise. On the contrary, it should be expected.

G. Effect of Medicare on Hospital Utilization

In general, overall evidence supports the hypothesis that in recent years, Medicare has resulted in increases in health care utilization but not a decline in mortality rates.
In order to investigate this further, we estimate the RD coefficients on the impact of Medicare for each of the years between 1970 and 2005. For this analysis, we restrict the sample to 45 to 69 year-olds. In Figure 8, Panel A, we present the results for overall hospital discharge rates, while Panel B presents the results for heart disease discharges. The figure shows the estimated RD at ages 65-69, and the associated confidence interval. For this analysis, we use data from the NHDS. Since the NHDS data begins in 1970, we cannot examine changes between the pre- and post-Medicare periods. However, we note that the size of the RD equals 36 (per 1,000 individuals), and is similar to the RD coefficient estimated off the changes (Table 2). We find that the coefficient has in general been declining reaching about 18 by the year 2000. This suggests that the effect of Medicare on hospitalization has, in general, fallen over time. However, the decline has not been monotonic. As Figure 8 reveals, the effect of Medicare has followed a cyclical pattern- its effect has been greatest in times of recession and least when the economy has been strong. This is possibly a reflection of individuals losing employer provided health insurance coverage in a recession. Panel B of Figure 8 reveals that much of the cyclical pattern is driven by acute conditions such as heart disease rather than chronic conditions such as diabetes.

H. Effect of Medicare on Mortality: 1970-1990

The fundamental finding from several studies using data from more recent years has found that Medicare has had rather small effects on mortality. The one exception is the study by Card, Dobkin, and Maestas (2008). However, their study was based on a finding using a sample of relatively sick inpatients. In this sub-section, we discuss the effects of Medicare on mortality in the two decades between 1969 and 1989. Figure 9 shows plots of the estimated coefficient on the dummy variable for age between 65 and 69, that are based on regressions for 50 to 69 year-olds with a quartic polynomial in age and using a moving sample of three years (with time effects). The findings reveal that beginning in about the mid-1980s, Medicare eligibility did not lead to a decrease in overall mortality rates. The basic conclusion remains the same even when we focus just on heart disease. We also note that the effects of Medicare are smallest during recession years (1971-73 and 1981-83)-possibly reflecting the possibility that most of the deaths occurring in recession years are “sudden” and are caused by increased stress levels. The effect of medical care, and hence the effect of health insurance, is possibly much less in this case.

VI. Discussion

The findings of this paper suggest that the introduction of Medicare led to both an increase in hospital utilization, and a decrease in mortality rates. In addition, back of the envelope calculations suggest that this decrease in mortality was achieved at a relatively low cost. Conditional on survival until age 64, an individual born in 1904 lived approximately 1.4 years than his counterpart born in 1896. There was approximately an 8 year gain in life expectancy for each additional elderly person discharged from the hospital in the early years (1969-70) of the Medicare program. Since the mid 1980s, however, we are unable to reject the hypothesis that Medicare had no impact on mortality. In this section, we discuss the possible reasons for our findings.

A. Changes in Characteristics of Marginal Person

As the quote at the beginning of this paper suggests, Medicare was introduced as a means to reduce the financial burden on the elderly- with medical care costs comprising a large share of their overall budget. Indeed, in some ways, it was meant to benefit those at the lower end of the income distribution- those that did not have the wherewithal to purchase private health insurance. In addition, it was the only source of health insurance for the disabled who suffered the double whammy of being out of work, and without health insurance. The introduction of Medicare provided the poor and disabled, for the first time, a source of health care coverage. Soon, other programs would be introduced; Medicaid was adopted by all states except Arizona by 1970, Medicare was extended to the non-elderly disabled in 1973, and those on SSI were eligible for Medicaid beginning in 1974. Thus, by the mid-1970s, many of those most in need of health care had access to health insurance. This fact is reflected in panels A and B of Figure 10, and in Table 8. Panel A of Figure 10 shows the Black-White difference in insurance coverage by age. To the extent that Black-White difference in insurance coverage is also correlated with (say) the difference in insurance coverage across income sub-groups, it is clear that in the period since the mid-1970s, Medicare eligibility at age 65 does not narrow the insurance coverage rates across the income sub-groups. Panel B shows the difference in insurance coverage between individuals that report activity limitations (due to chronic conditions) and those that do not. Once again, it is clear that much of the difference in insurance coverage between the sub-groups is removed by the mid-1970s.

In Table 8, we present estimates of the discontinuity in hospital insurance rates at age 65 over time. We present these estimates for various sub-groups. In 1968, only about 58 percent of the 60-64 year-old Blacks reported some form of hospital insurance while by 1986 more than 81 percent of Blacks reported hospital insurance coverage by 1978. This dramatic change in insurance coverage of the non-elderly resulted in a substantial fall in the RD coefficient- from 30 percent in 1968 to 18 percent a decade later. Similarly, for the non-elderly below the 150 % of the poverty line, 58 % reported hospital insurance coverage in 1968 while 80 % reported coverage by 1978. The discontinuity coefficient is also roughly halved- going from 30 % in 1968 to just over 15 % in 1968. A similar trend is observed for those with a high school education or less.

B. Increased use of expensive procedures such as CABG to treat coronary heart disease in the elderly

The evidence presented above clearly suggests that some of the changes in the estimated effect of Medicare on mortality may be attributed to changes in the characteristics of the marginal person. In addition to the rapid rise in health insurance coverage, the period beginning in the late 1970s and through the 1980s also witnessed a rapid influx of technology into the health care arena. Despite disagreements over the exact reasons underlying this surge in adoption of medical technology, this period marked a serious turning point in the production of medical care in the United States. In particular, the treatment options for coronary heart disease increased. Two widely used procedures to remove blockages in the coronary arteries are the Coronary Artery Bypass Graft (CABG), and Angioplasty.[45] The first CABG procedure was performed in New York City in 1960, but the surgery was not widely used until the second half of the 1970s. Even so, as Figure 11 panel B illustrates, it was initially largely used among

[45] Angioplasty was first developed in Zurich in 1977, and by the mid-1980s was widely adopted by leading medical centers.

individuals less than age 65. However, beginning in about the mid-1980s, CABG was increasingly used among the elderly patients with the gap between the numbers of procedures performed on 65-69 versus 60-64 year-olds decreasing rapidly. Indeed it appears from Panel B that the number of procedures among the non-elderly stays relatively constant out. This decline results in a greater discontinuity in the rate of CABG procedures at age 65. This is interesting in light of the fact that there have been few randomized control trails that show the superiority of the CABG procedure over less expensive alternatives such as angioplasty.[46] Although the increase in CABG rates among the elderly seen in Panel B may be due to greater refinements in the surgery leading to lower associated risk, the narrowing of the elderly and near-elderly gap is interesting. We note that in 1984, the reimbursement rate for CABG was $24,000/procedure under Medicare, while it was roughly $12,000/procedure outside of Medicare. This period was also at the cusp of the era of "selective contracting" where insurance companies could "shop" for the cheapest procedure. Medicare, possibly due to "downward sticky prices" did not enter into selective contracting. The higher relative price of CABG in Medicare may have led to an increased use of CABG among the elderly.[47] Although preliminary, these findings suggest that the decreased cost-effectiveness of Medicare may be due to the increased use of expensive medical technologies that do not lead to substantial improvements in population health. Thus, a "value-based" health insurance design must be seriously considered by Medicare. This design basically would reduce patient cost-sharing for those therapies that clinically benefit the patient.

VII. Summary and Conclusion

The impact of health insurance on health has been a long-standing and widely researched question in health economics. However, most studies examine the impact in a relative narrow context- either the effect for a particular sub-group, or in a particular time-period. In addition, most studies examine the effect of Medicare on health, without simultaneously examining the impact of Medicare on health care utilization. This is, in some ways, a glaring omission since the only way in which health insurance can affect health is via its impact on utilization. Thus, not finding an impact of Medicare on health may either imply that medical care has no effect on

[46] The short-run cost of angioplasty is only half of that of CABG.
[47] This analysis is clearly very preliminary. We are in the process of collecting data on the relative prices of procedures to treat coronary heart disease within and outside of Medicare. However, a detailed study on the issue, although interesting, is outside the scope of the current paper.

health or imply that health insurance has no effect on access to care. On the other hand, finding an impact of Medicare on health, but not finding an impact on utilization-even in studies with the most compelling designs- does not generate any specific policy prescription.

In this paper, we examine the effects-on hospital utilization and health-of arguably the most dramatic expansion of health insurance coverage in the United States- the introduction of Medicare in July 1966. We bring together the most comprehensive data that has been brought to bear to answer the question. We use individual level data on health insurance, hospitalization, and health both before and after the introduction of Medicare. Further, we exploit the fact that the United States was the only country to have introduced a Medicare-type program by comparing country-specific differences in mortality rates between the elderly and non-elderly in the pre- and post-Medicare periods.

We find that the introduction of Medicare had a causal impact on increase hospitalization rates, and in reducing mortality rates. Indeed, cost-benefit calculations suggest that conditional on survival until age 64, birth cohorts born in 1904 lived, on average, 1.4 years longer than the cohorts born in 1896. Thus, cohorts that were exposed to Medicare from age 65 onwards (1904 cohort) lived longer than their counterparts that were not exposed to Medicare until age 70 (cohorts born in 1896). More importantly, this gain in life expectancy was achieved at a cost of roughly 200 dollars per individual discharged from a hospital.

We also find that the effects of Medicare on mortality have, in general, declined over time. By the mid-1980s, we cannot reject the hypothesis that Medicare reduces mortality rates. We find some evidence that a large part of the declining effect of mortality is due to changes in the characteristics of the marginal person becoming eligible for Medicare at age 65. As the health insurance market for the non-elderly disabled and poor has expanded over time, those most in need of health care can, arguably, access it even before turning 65.

This paper has important implications for health care reform. First, it highlights the fact that health insurance can work- if targeted to the right individuals. Second, it also suggests that for these individuals, the use of expensive, high-cost technology is not essential to improve health outcomes. Medicare was introduced at a time when many of the technologies we see in the medical care arena were unavailable. Yet, it led to an unequivocal reduction in limited activity rates, and mortality rates. The mortality rates due to heart disease also plummeted among the elderly in the post-Medicare era despite the fact that Beta Blockers, and modern revascularization procedures had not infiltrated the market. It is possible that some technologies are indeed beneficial in improving health outcomes, but much more vigorous screening procedures must be employed before they enter the market. The recent emphasis on studies on comparative effectiveness of medical technologies is a step in the right direction. It takes over 10 years for a new drug to make it to the market, and often, randomized control trials must decisively demonstrate that the drug is substantially more effective than already existing drugs. Similar demands must be made of new medical technologies.

Current proposals call for a cut in Medicare expenditures by over 500 million dollars to help defray some of the cost of expanding health insurance. While such cuts are probably warranted, they do not detract from the fact that Medicare, in its early years, led to a causal improvement in the health of the elderly population at a very reasonable cost. It is probably time to understand, in some detail, the health care market of the 1960s and early 1970s. Health insurance expansion has worked once in the past, and if we understand the reasons for the success in Medicare's early years, health care reform may be so designed so that the proposed expansion can once again lead to improved health.

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Data Appendix

National Health Interview Survey (NHIS)

The National Health Interview Survey is a continuing nationwide sample survey of households conducted by National Center for Health Statistics (NCHS) to gather information on the health of the American people since July 1957. The NHIS utilizes a questionnaire which contains information on personal and socio-demographic characteristics, illnesses, injuries, chronic conditions, activity limitations, insurance coverage, hospital utilizations, personal health expenses, and other health topics. The population covered by the sample for the NHIS is the civilian, non-institutionalized population of the United States living at the time of the interview.[48] The NHIS includes about 35,000 to 40,000 household, which has 75,000 to 100,000 individuals in each survey year. The sample is designed in such a way that the sample of households interviewed each week is representative of the target population and that weekly samples are additive over time. Thus, to represent national counts, the NHIS provides quarterly, semi-annual, and annual sampling weights.

The public-use microdata files are available starting from fiscal year 1963. From 1963 to 1967, the survey was based on fiscal year, e.g., the reference period for the fiscal year 1967 is July 1966 to June 1967. For the transition period of 1968, the interview was based both on fiscal and calendar year. From 1969 on, all interviews are based on calendar year.

Insurance Coverage

The NHIS contains information on health insurance coverage by types and payment sources, i.e., hospital and surgical insurance; private and public insurance. During 1959 – 1968, insurance coverage data were collected in the NHIS in three years (1959, fiscal year 1963, and 1968). During 1968 – 1986, such data were generally collected every 2 years; and from 1989 on, data were collected every year. The sample sizes for the insurance questions were about 100,000 varying over the years. For 1970, 1983, 1986, 1993, and 1996, only a subset of the sample, or a half-year sample, received the health insurance questions, resulting in sample sizes ranging 45,000 to 56,000.

From 1959 to 1980, NHIS asked questions about hospital and surgical insurance separately and it further provides information on Blue Cross and Blue Shield coverage among those covered by private insurance until 1980.[49] Questions about private insurance coverage were asked for persons of all ages for all years, while Medicare coverage was only asked of persons aged 65 years and over in 1968 – 1976. Direct questions about Medicare for persons of *all ages* and Medicaid were asked starting in 1978 and questions about military coverage starting in 1982.

Medicare coverage

To include Medicare coverage for *all ages* including persons covered under Medicare disability and end-stage renal disease provisions in 1974 and 1976, we include persons who reported as their reason for no insurance “received care through Social Security Medicare.”

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[48] It would be noted that data are not collected in the interview for persons who died during the reference period.

[49] In 1982, the separate associations for Blue Cross (covering hospitalizations) and Blue Shield (covering physician care) merged, making the separation between hospital and physician insurance less distinct.

Medicaid coverage

For Medicaid coverage in 1974 and 1976, we include persons who reported "receive care through Medicaid or welfare" as their main reason for not having insurance or persons who reported receipt of services paid by Medicaid during past year or eligible for such payment under Aid to Families with Dependent Children (AFDC) or Supplemental Security Income (SSI).

Military coverage

Before 1982, we counted persons who report "receive care through military coverage or Veteran's benefits" as their main reason for no insurance as covered under the military coverage. It includes the Civilian Health and Medical Program for Uniformed Services (CHAMPUS), the Civilian Health and Medical Program for Veterans Administration (CHAMP-VA), and Veterans Administration (VA) health care benefits.

Hospital Discharge

A hospital discharge from the short-stay hospital is the completion of any continuous period of stay of one or more nights in a hospital as an inpatient except the period of stay of a well newborn infant[50]. A hospital discharge is recorded whenever a present member of the household is reported to have been discharged from a hospital in the 12-month period prior to the interview week. The estimates in this paper were based on discharges which occurred the 6-month period prior to the interview to reduce the recall bias.

From 1982 on, the reason for each hospitalization is no longer included because it is generally recognized that the National Hospital Discharge Survey (NHDS) obtains more complete and accurate hospital diagnosis information

[need to explain about merging with person file?]

Average Length of Stay per Discharge

The length of hospital stay is the duration in days (exclusive of the day of discharge) of a hospital discharge. The average length of stay per discharge is computed by dividing the total number of hospital days for a specific group by the total number of discharges for the same group.

Activity Limitation due to Chronic Conditions

Persons are classified into four categories according to the extent to which their activities are limited at present as a result of chronic conditions.[51]

1) Persons unable to carry on major activity for their group. Major activity refers to ability to work, keep house, or engage in school or preschool activities.

2) Persons limited in amount or kind of major activity performed.

3) Persons not limited in major activity but otherwise limited

4) Persons not limited in activities

[need to explain for 1982?]

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[50] A short-stay hospital is one in which the type of service provided by the hospital is general; maternity; eye, ear, nose, and throat; children's; or osteopathic; or it may be the hospital department of an institution.

[51] A condition is considered to be chronic if (1) the condition is described by the respondent as having been first noticed more than 3 months before the week of the interview or (2) it is one of the conditions on the "Check List" provided by field interviewers.

In 1982, significant change in questions on activity limitation, especially for the elderly

Number of Days with Restricted Activity

A day of restricted activity is one on which a person cuts down on his usual activities for the whole of that day because of an illness or an injury. Restricted activity covers the range from substantial reduction to complete inactivity for the entire day. Since the questionnaire asks for the respondent's experience over the 2 weeks prior to the week of interview, the estimated quarterly total is 6.5 times the average 2-week estimate produced by the 13 successive samples taken during the that quarter (*each week* a probability sample of households is interviewed). Thus, we annualized the number of days by summing of the four quarters estimates. This implies that the restricted activity days of persons *interviewed during a year* is treated as though it measured the total restricted activity days *during the year*. It would be noted that persons who have permanently reduced their usual activities because of a chronic condition might not report any restricted-activity days during a 2-week period. Therefore, absence of restricted-activity days does not imply normal health.

Average costs per hospital discharge

Data were obtained for each person for hospital bills as an inpatient, doctors' bill, medicine costs, dentists' bills, and other medical expenses. The expenses included all bills paid (or to be paid) by the person himself, his family, or friends, and any part paid by insurance.
It excludes health insurance premium, workmen's compensation, charitable or welfare organizations, military services, Veterans Administration, and Government (FY1963).

Socio-demographic variables

- Age: the age recorded for each person is the age at last birthday.
- Race: persons are classified as white, black, or other
- Region: the Northeast, the North Central, the South, and the West[52]
- Education of individual: each person is classified in terms of the highest grade of school completed.
- Family income: the total of all income received by members of family in the 12-month period preceding the week of interview.[53] The income is categorized basically by increment of $1,000.
- Employment status: persons 17 years of age and over who reported that at any time during the two-week period covered by the survey they either worked at or had a job or business are currently employed. Current employment includes paid work; self-employment in business, farming, or professional practice; and unpaid work in a family business or farm.
[different from CPS]
- Marital status: married, separated, widowed, divorced and never-married
- Veteran status: Wartime (World War I, II, Korean War, Vietnam Era, Post-Vietnam) and Peace time veteran

[52] The Northeast – Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania; the North Central – Michigan, Ohio, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, Nebraska, the South – Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Texas, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and the West – Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Alaska, Oregon, California, Hawaii.

[53] Income from all sources is included, e.g., wages, salaries, rents from property, pensions, and help from relatives.

National Hospital Discharge Survey (NHDS)

The National Hospital Discharge Survey conducted by NCHS since 1965 is national sample of about 500 hospitals, which are non-federal, short-stay hospitals in the United States[54]. The NHDS sample contains about 75,000-100,000 individuals and about 200,000 inpatients records per each survey year. It contains information on patient's age, gender, race, marital status, and geographic region of hospital's location; medical records for hospital admission, discharge, procedure, length of stay, and the patients' expected principal source of payment (available in public-use data from 1979 on). All discharge diagnoses and procedures were listed on the medical record in the order of the principal, or the first-listed one, followed by the order in which all other diagnoses or procedures were entered on that record. From 1965 to 1978, a maximum of five diagnostic codes were assigned for each discharged patient, while this was increased to seven in 1979. If the medical information included surgical or nonsurgical procedures, a maximum of three codes for these procedures were assigned during the period 1965 – 1978, with the maximum increased to four in 1979.
The public-use microdata files are available starting from 1970.

Hospital Discharge

The number and rates of hospital discharge based on the NHDS is compatible with those based on the NHIS, except some differences in the definition of hospital utilization. Unlike the NHIS, the NHDS includes patients who die in the hospital as well as nursing homes. In addition, hospitalizations of inpatients for less than 1 day are included in the NHDS, but not the NHIS.

Patients' Expected Principal Source of Payment

From 1968 to 1970, information on hospital charges and sources of payment was collected from a subsample of the NHDS. No information on charges or sources of payment was collected in the NHDS from 1971 to 1976. Beginning in 1977, data on patients' principal sources of payment were collected in the NHDS sample. Estimated in this paper are based on what patients indicated as the *expected* principal source of payment. In some cases the expected source of payment may not have been the actual source of payment because it is recorded on time of admission.

[54] Short-stay hospitals were defined in NHDS as hospitals with an average length of stay of fewer than 30 days are included. Also only hospitals with six beds or more for patient use are included.

National Mortality Detail Files
The 1960-2006 National Mortality Detail Files are an annual census of deaths within the United States, derived from the standard Certificate of Death and processed by the NCHS. The data contain the universe of deaths and information on the deceased's race, gender, age at death, and cause of deaths according to the International Classification of Disease (ICD).
[Deaths of foreign residents of the United States were excluded from 1970 because those were not uniquely identified before 1970. The total deaths of foreign residents for aged 45 to 80 are 0.08%, on average for 1970 – 1974, relative to those of residents.]
For 1972, data files contain only 50 percent sample of deaths occurred in each states and thus we multiply the number of deaths for this year by 2 to get an annual number of deaths.
Figures by race exclude data for New Jersey in 1962 and 1963 because this state omitted the item on race from its death certificates.

The ICD codes for each cause of death used in this paper are following;

ICD codes for Cause of Deaths

Cause of Death	1958 – 1967 (ICD-7)	1968 – 1978 (ICD-8)	1979 – 1998 (ICD-9)	1999 – (ICD-10)
Heart Disease	400-402, 410-443	390-398, 402, 404, 410-429	390-398, 402, 404 410-429	I00-I09, I11, I13, I20-I51
Malignant Neoplasms (Cancer)[1]	140-205	140-209	140-208	C00-C97
Cerebrovascular Disease (stroke)[2]	330-334	430-438	430-434, 436-438	I60-I69
Diabetes Mellitus	260	250	250	E10-E14
Influenza and Pneumonia	480-483, 490-493	470-474, 480-486	480-487	J10-J18
Accidents[3]	E810-E835, E800-E802, E840-E962	E810-E823, E800-E807, E825-E949	E810-E825, E800-E807, E826-949	V01-X59, Y85-Y86

1. Including neoplasms of lymphatic and hematopoietic tissues
2. For ICD-7, vascular lesions affecting central nervous system
3. Motor vehicle accidents and all other accidents; Unintentional Injuries (ICD-10); without suicide (intentional self-harm;ICD-10) or homicide (assault;ICD-10)

For adequacy of cause-specific mortality discontinuity in this paper, we scrutinize the degree of comparability resulting from the introduction of the ICD-8, used beginning in 1968. The comparability ratio was calculated as the ratio of the number of deaths due to a given cause in ICD-8 to those in ICD-7. A ratio of greater than one results from an increase in assignments of deaths to a cause in ICD-8 as compared with ICD-7. Based on coding the same deaths occurring in 1966 by both the ICD-7 and ICD-8, the published comparability ratios for Heart Disease, Cancer, Stroke, Diabetes Mellitus, and Influenza & Pneumonia are 1.0045, 1.0017, 0.9905, 0.9971, and 1.0440, respectively (DHEW 1975).

This ratio implies that the change from ICD-7 to ICD-8 could result in an *underestimate* the decrease in deaths due to Heart Disease between 1965-66 and 1969-70.

World Health Organization (WHO) Mortality Database

The data are official national statistics in the sense that they have been transmitted to the World Health Organization by the competent authorities of the countries. The WHO database comprises deaths registered in national vital registration systems with underlying cause of death as coded by the relevant national authority

The database contains population, live births, and number of deaths by country, year, sex, *age group* and cause of death as far back from 1950. Data are included only for countries reporting data properly coded according to the International Classification of Disease (ICD).

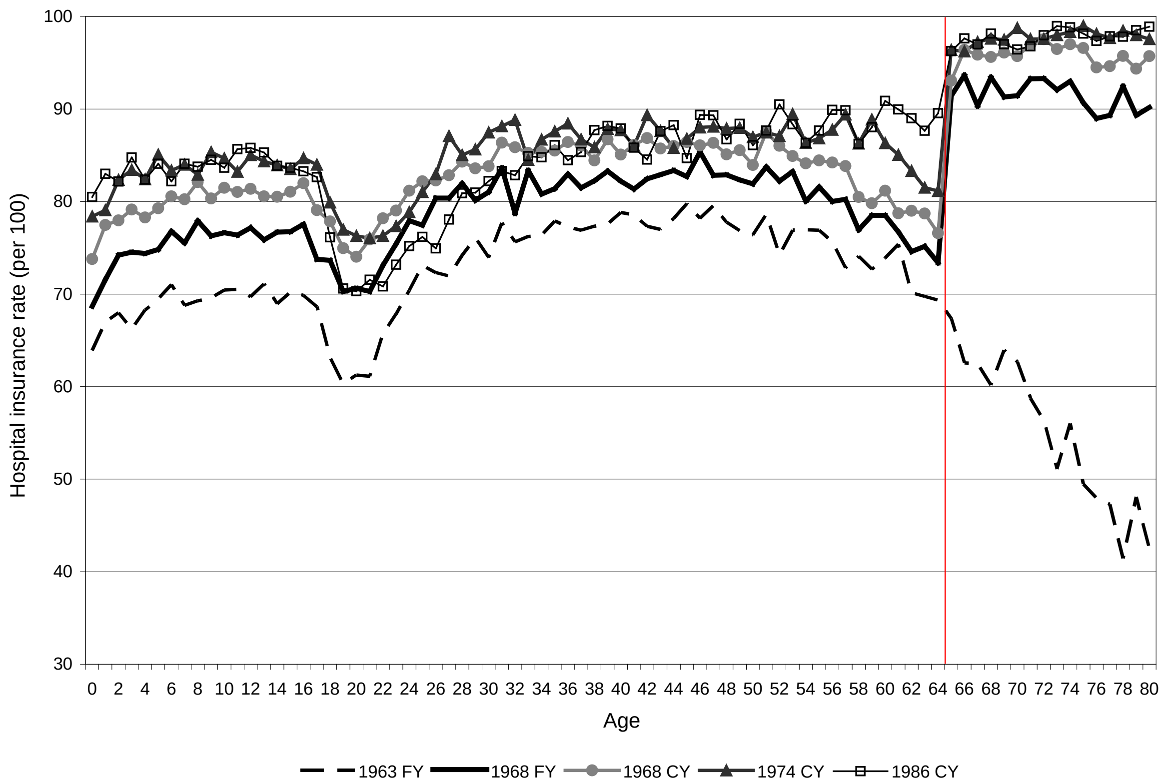
Population

For calculating mortality rates by single age, we use postcensal estimates for the 1960s and intercensal estimates for all other years from the Bureau of the Census.

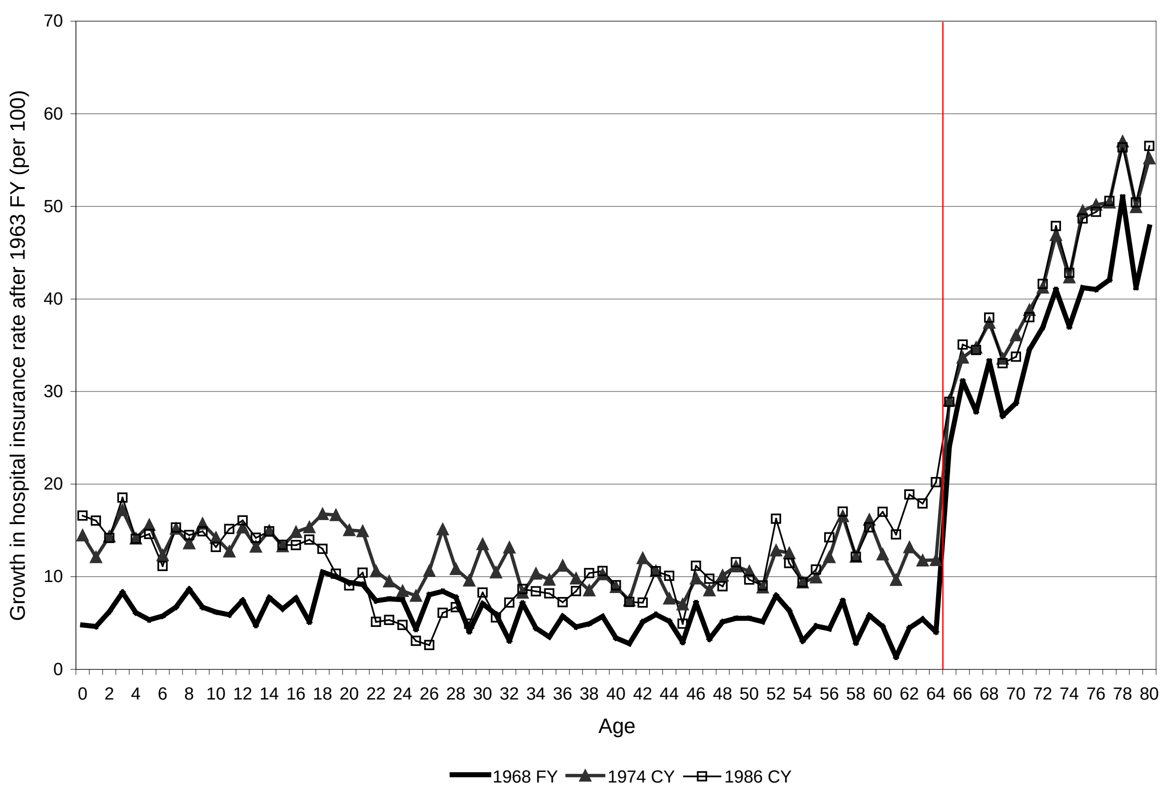
All populations are calculated as of July 1st for each year.

Figure 1: Hospital Insurance rates in the United States, by age and year

A. Percent with hospital insurance



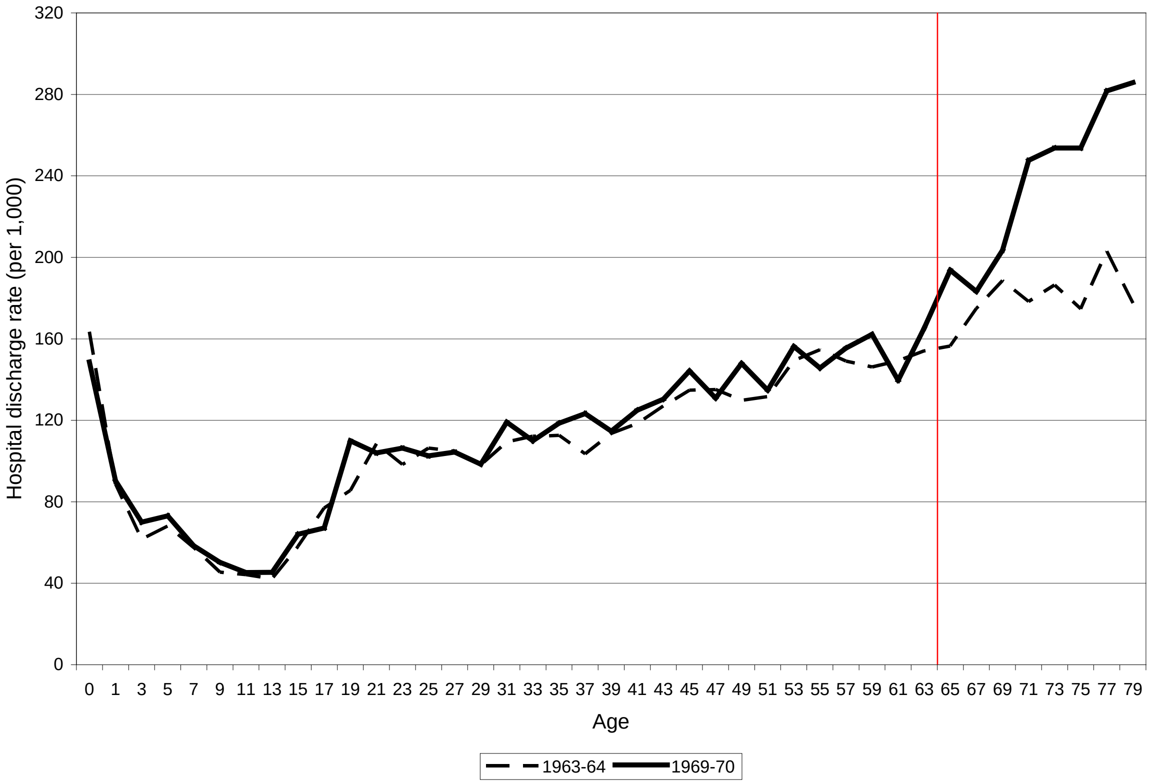
B. Growth in percent with hospital insurance after 1963 fiscal year



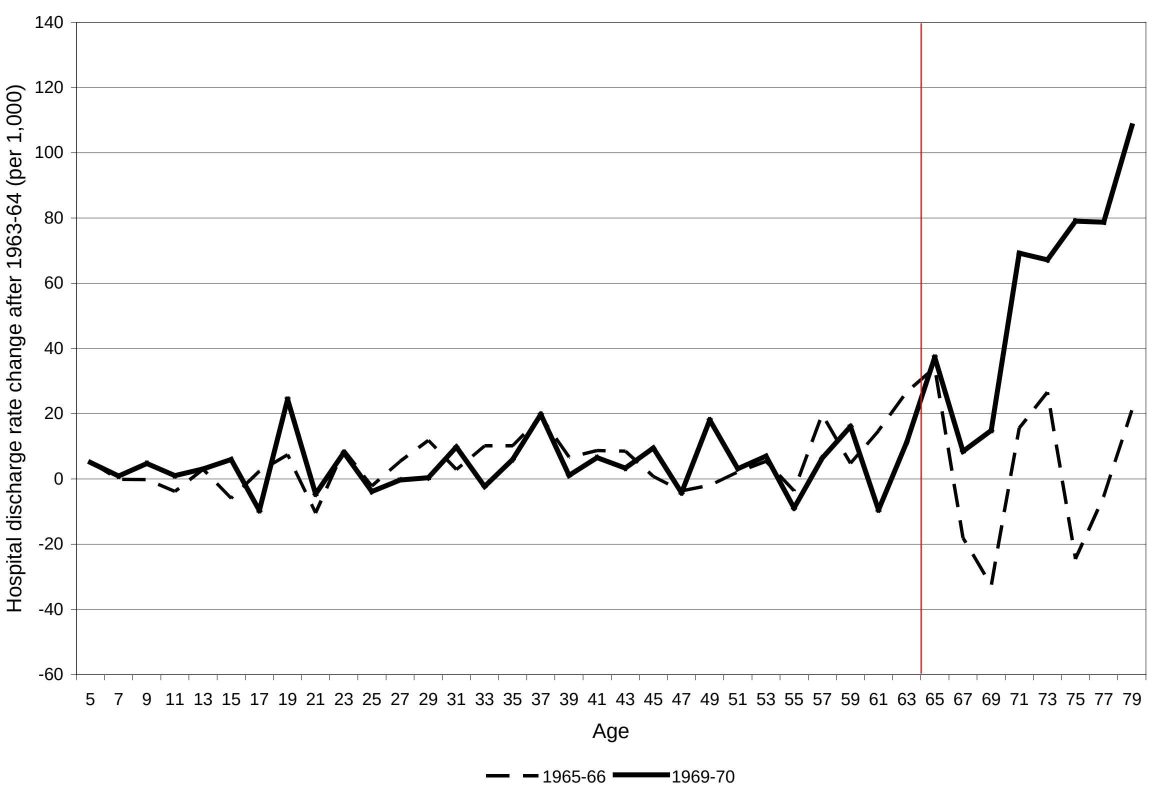
Notes: Data come from the *National Health Interview Surveys*.

Figure 2: Hospital Discharge rates from the *National Health Interview Survey*,
For all races by age and year

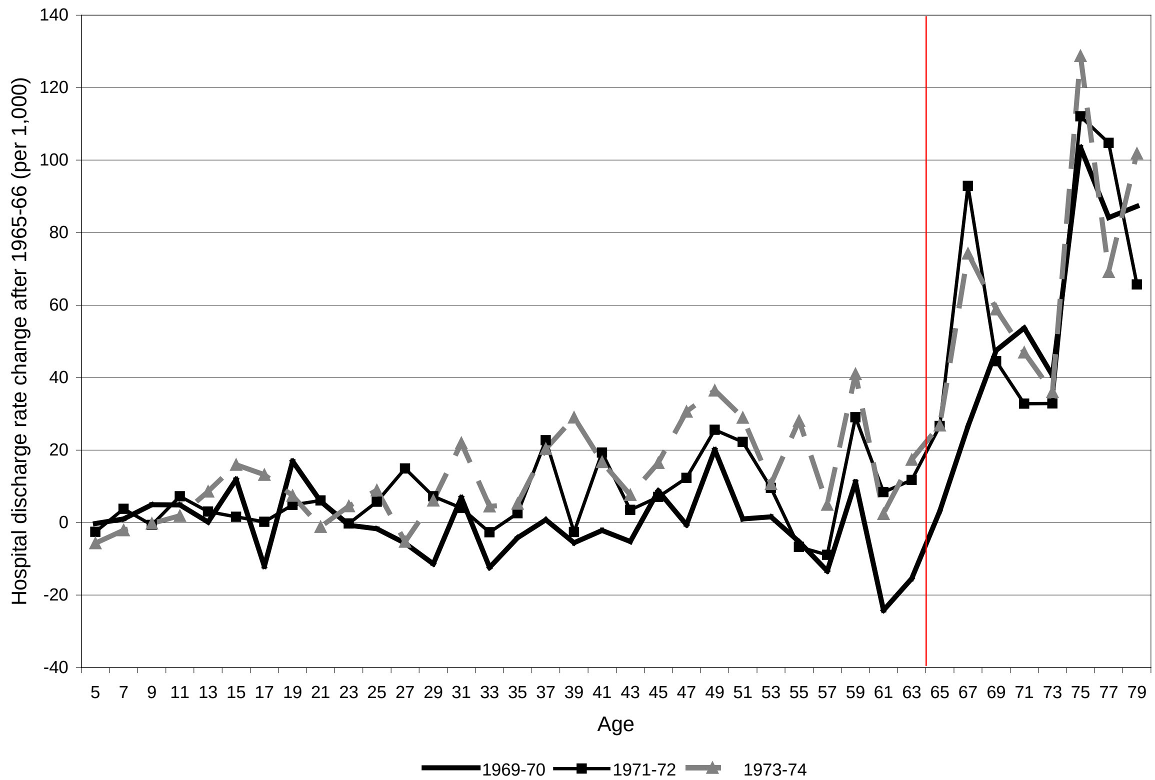
A. Hospital discharge rate per 1,000 individuals



B. Growth in hospital discharge rate after 1963 to 1964



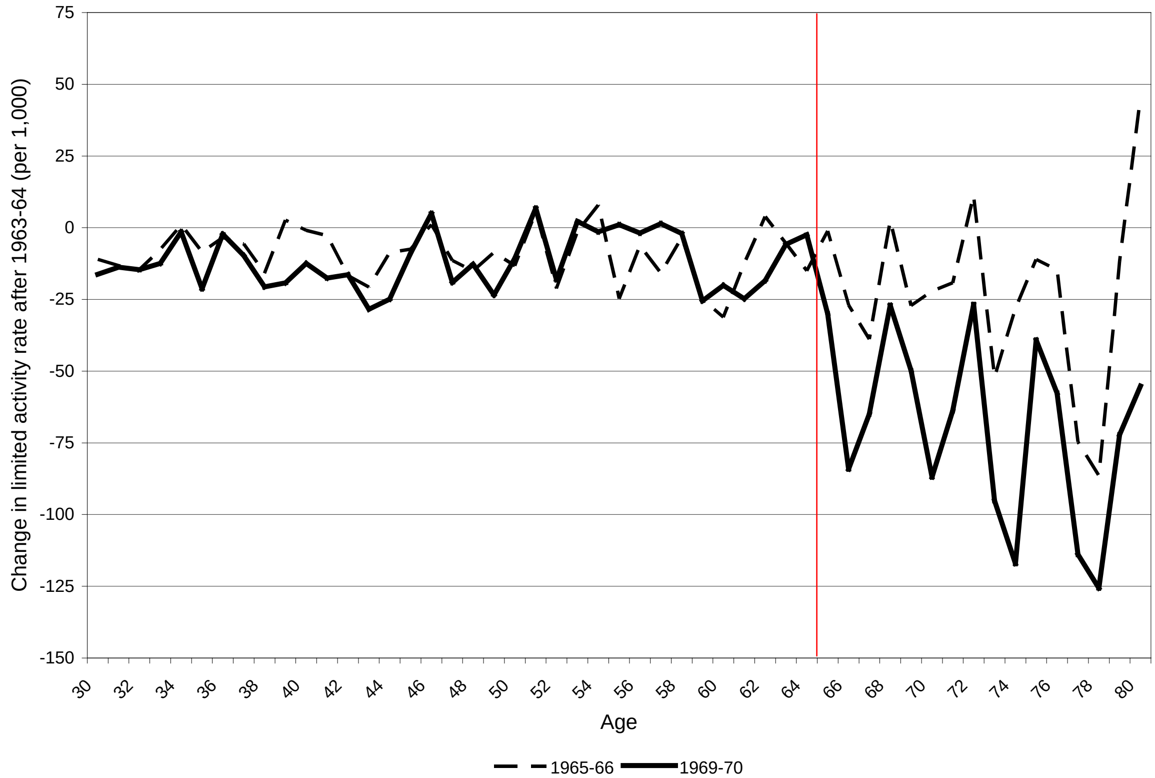
C. Growth in hospital discharge rate after 1965 to 1966



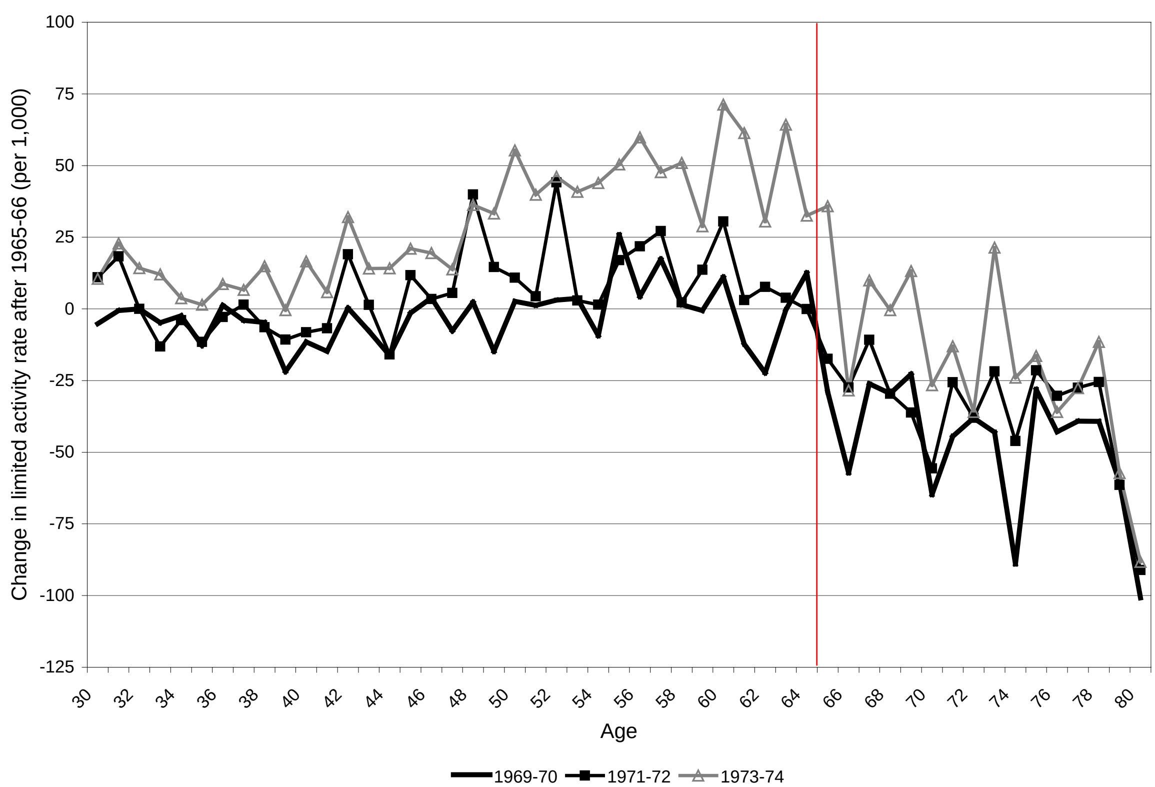
Notes: Data come from the *National Health Interview Surveys*. Discharges due to delivery of infant are excluded from the hospital discharge rate.

Figure 3: Limited Activity Rates (due to chronic conditions), per 1,000 individuals

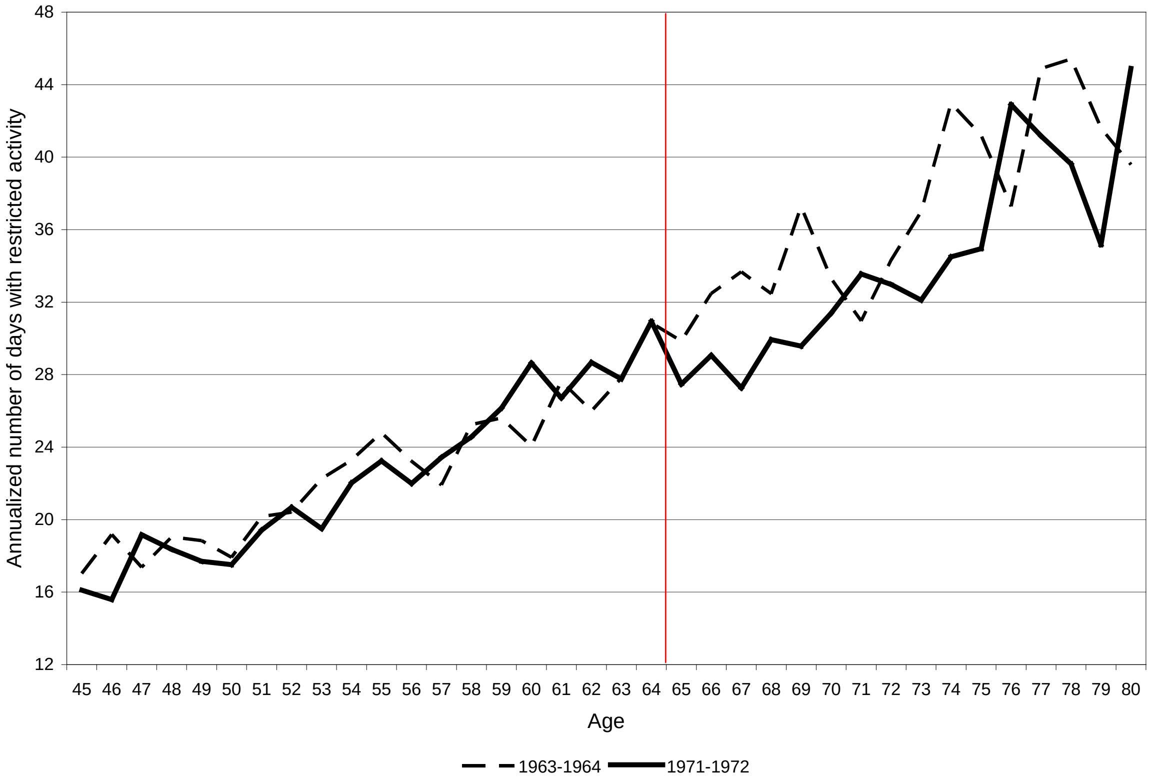
A. Change in limited activity rate relative to 1963-1964



B. Change in limited activity rate relative to 1965-1966



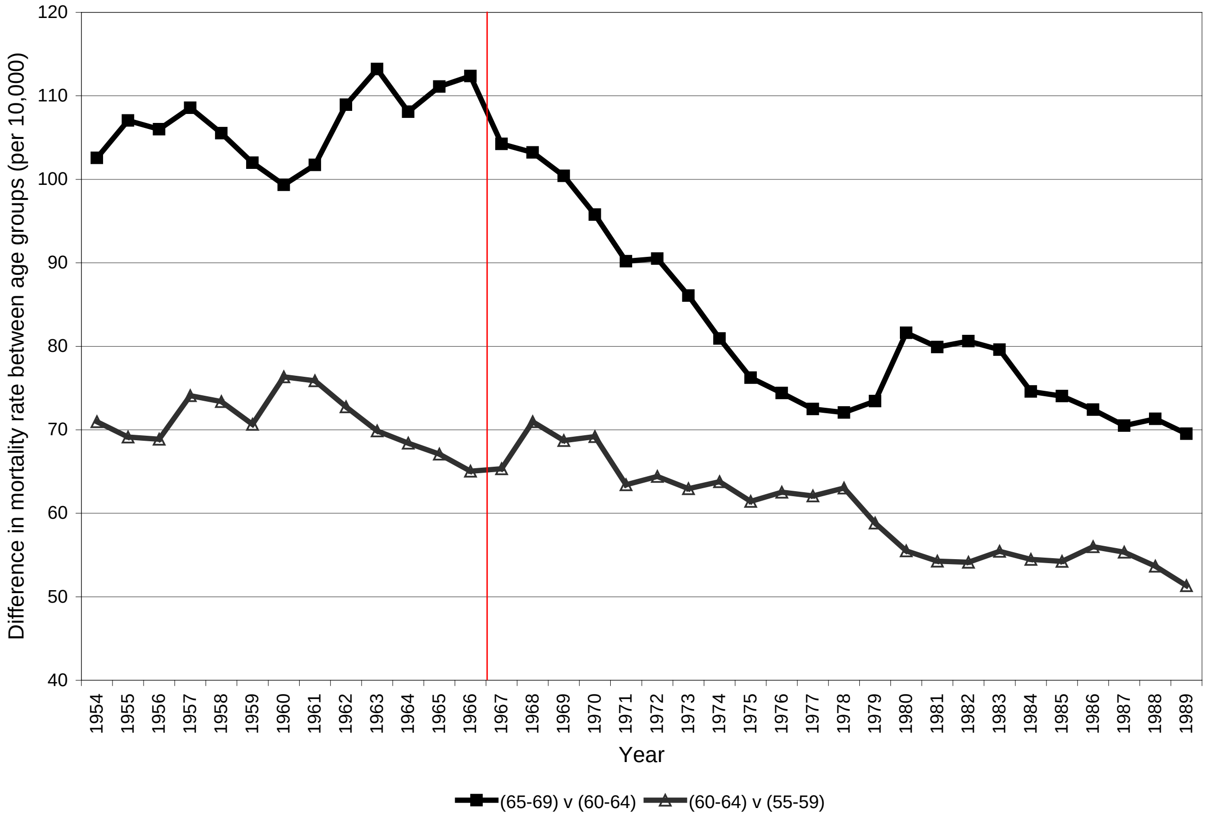
C. Annualized number of days with restricted activity



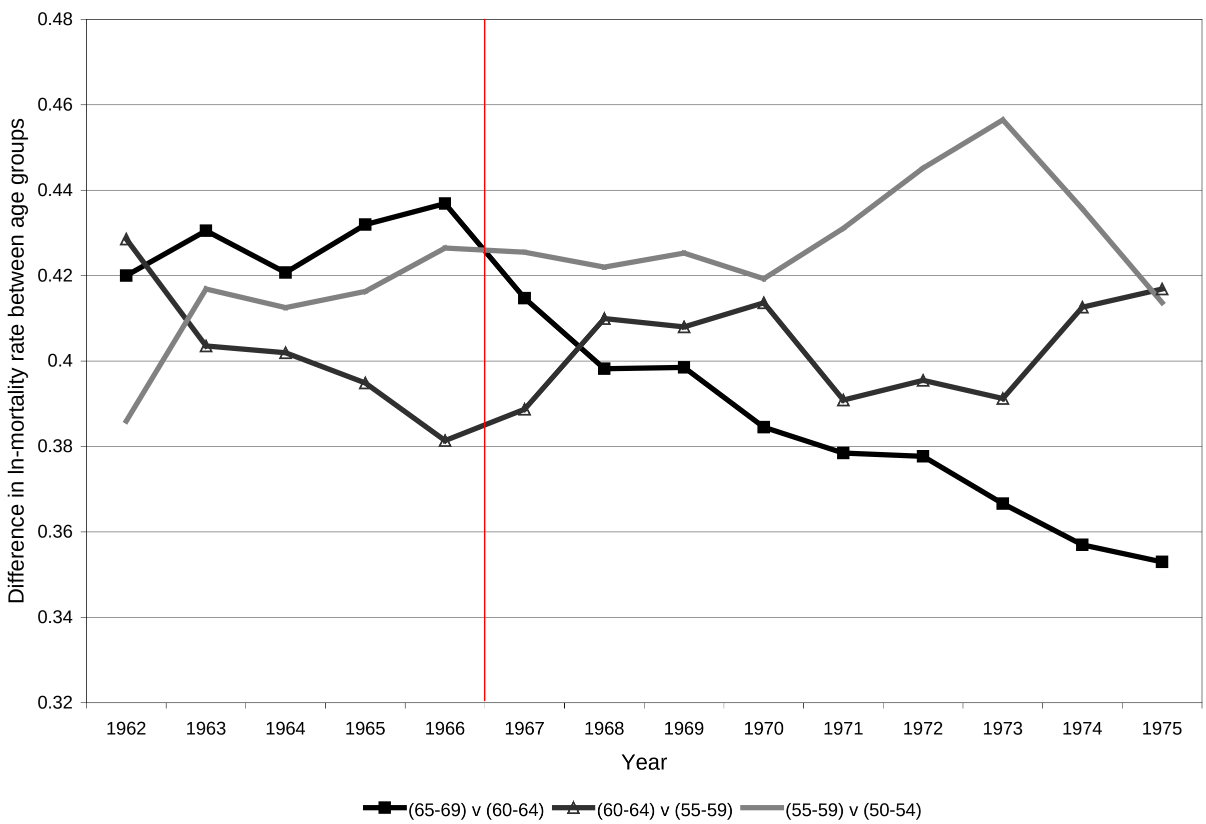
Notes: Estimated discontinuity effects [absolute value of t-ratio]] for ages 45-80 deviated from 5th-order polynomial, year and year-age effects: age 65-69 = -5.46 [3.92]; age 70-74 = -4.16 [2.06]; age 75-79 = 4.35 [1.59]

Figure 4: Mortality rates over time in the United States, differences across age groups

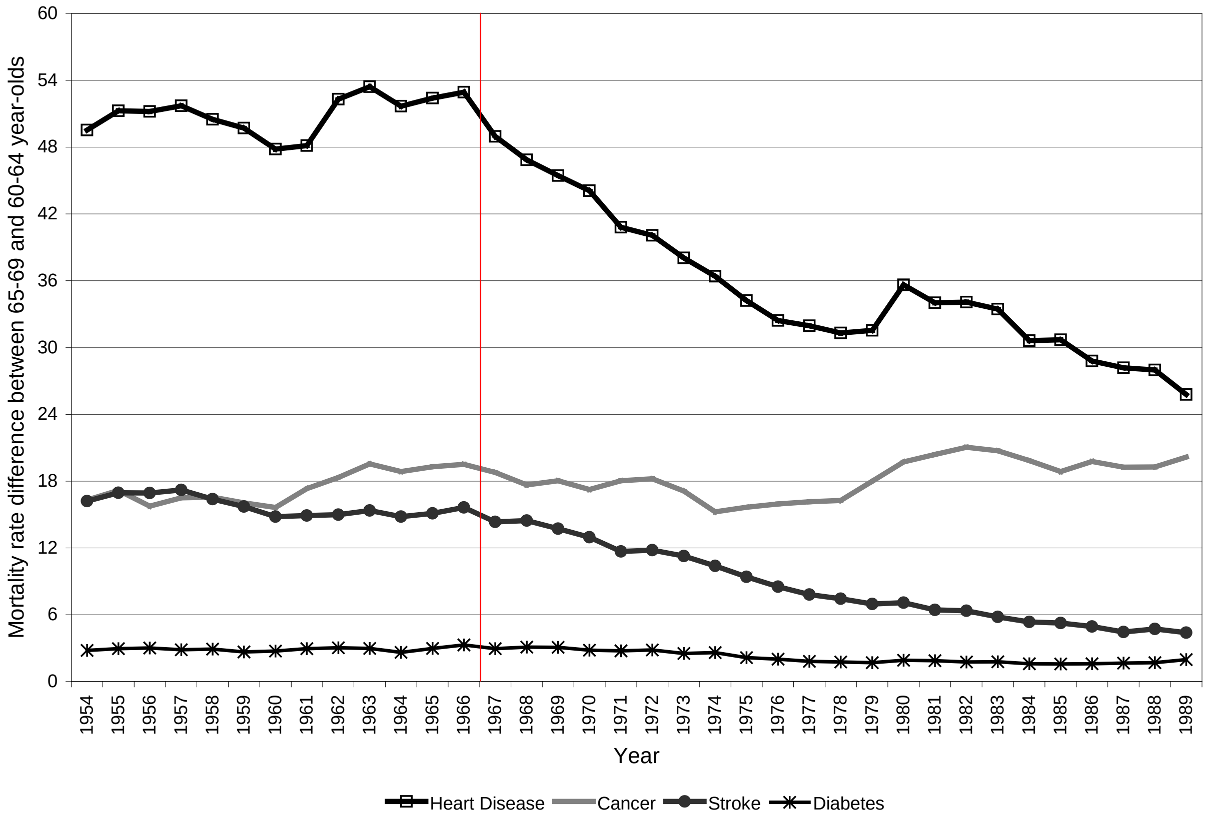
A. Age group differences in all-cause mortality rates (per 10,000 individuals)



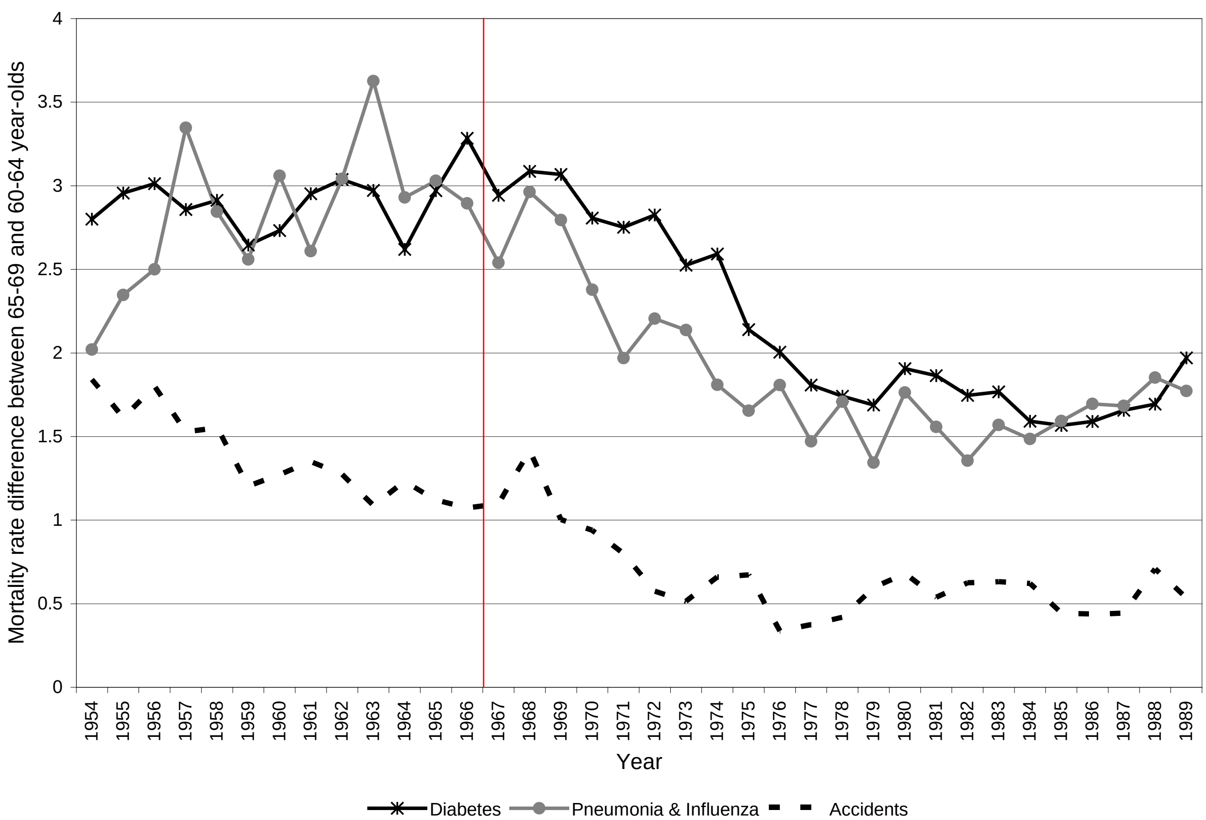
B. Age group differences in natural logarithm of all-cause mortality rate



C. Mortality rate differences between 65-69 and 60-64 year olds, by cause of death



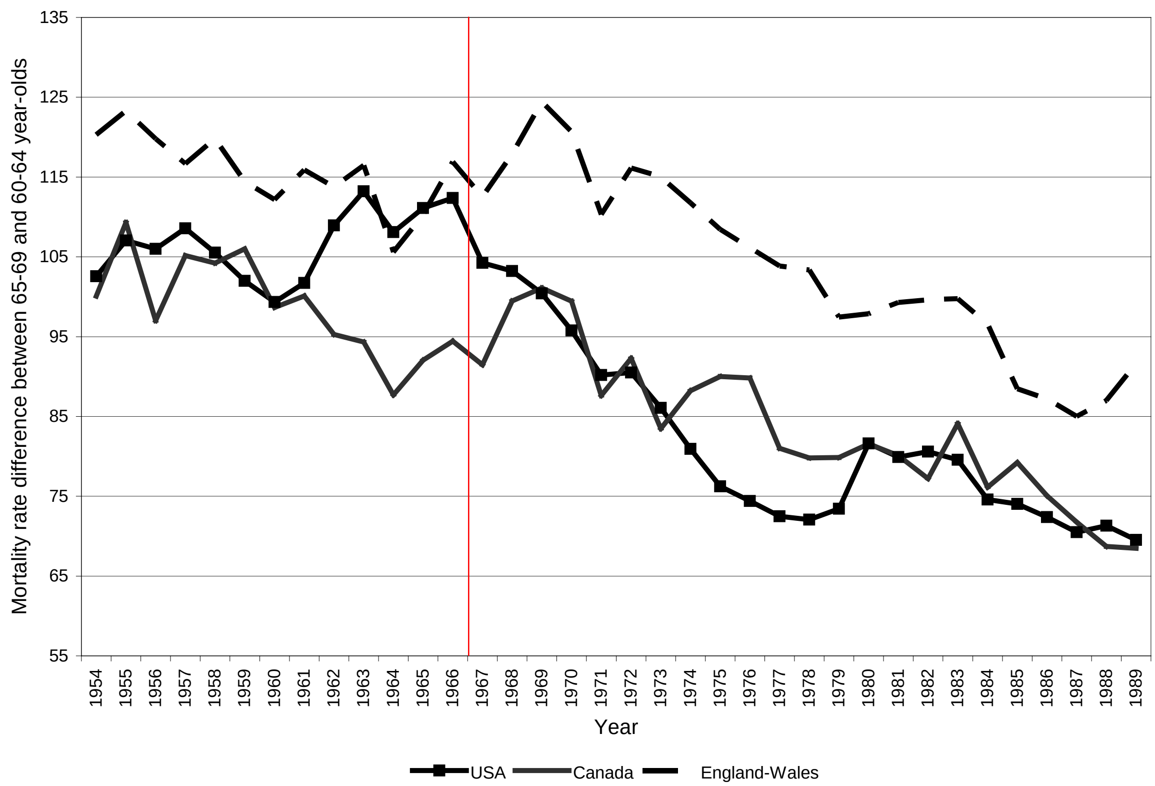
D. Mortality rate differences between 65-69 and 60-64 year olds, by cause of death



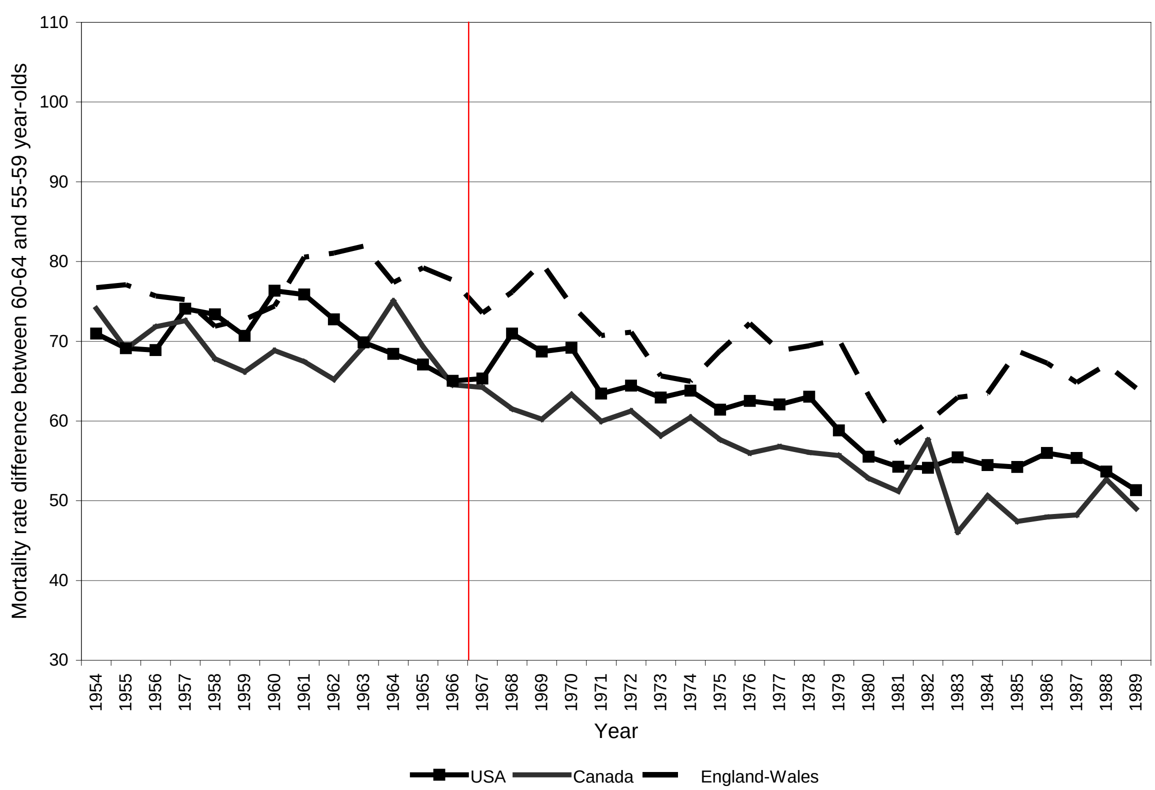
Notes: Data come from the *World Health Organization Mortality Files*. The mortality rates are for the entire United States population – that is, it includes blacks and whites, as well as other races.

Figure 5: Between age-group differences in all-cause mortality rates (per 10,000), United States, Canada, United Kingdom, France

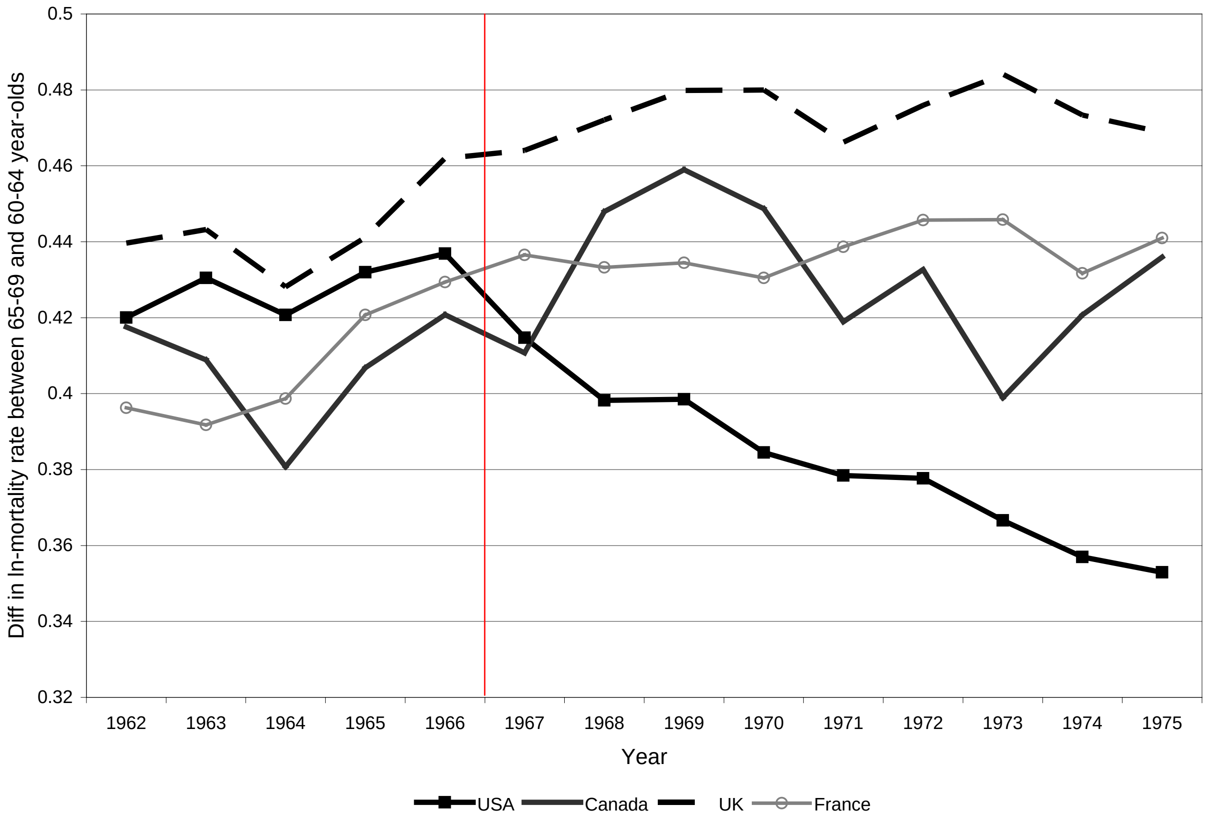
A. Difference in mortality levels between 65-to-69 and 60-to-64 year olds



B. Difference in mortality levels between 60-to-64 and 55-to-59 year olds



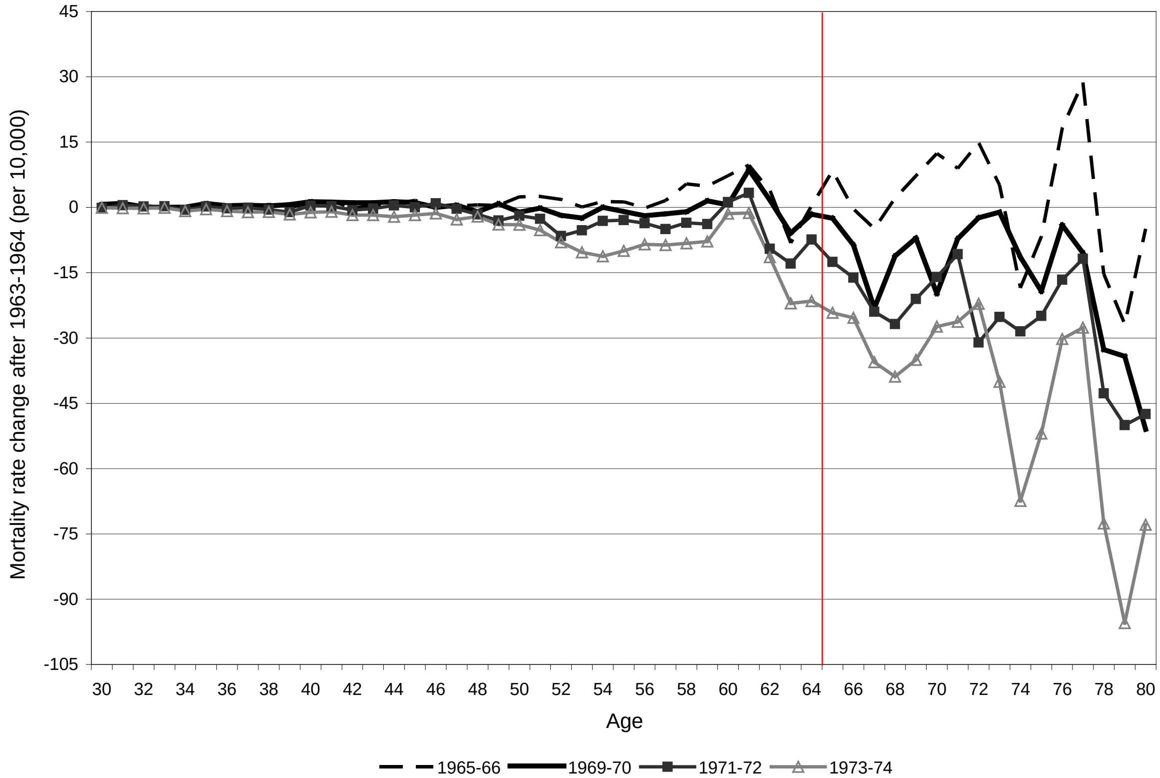
C. Difference in log-mortality between 65-to-69 and 60-to-64 year olds



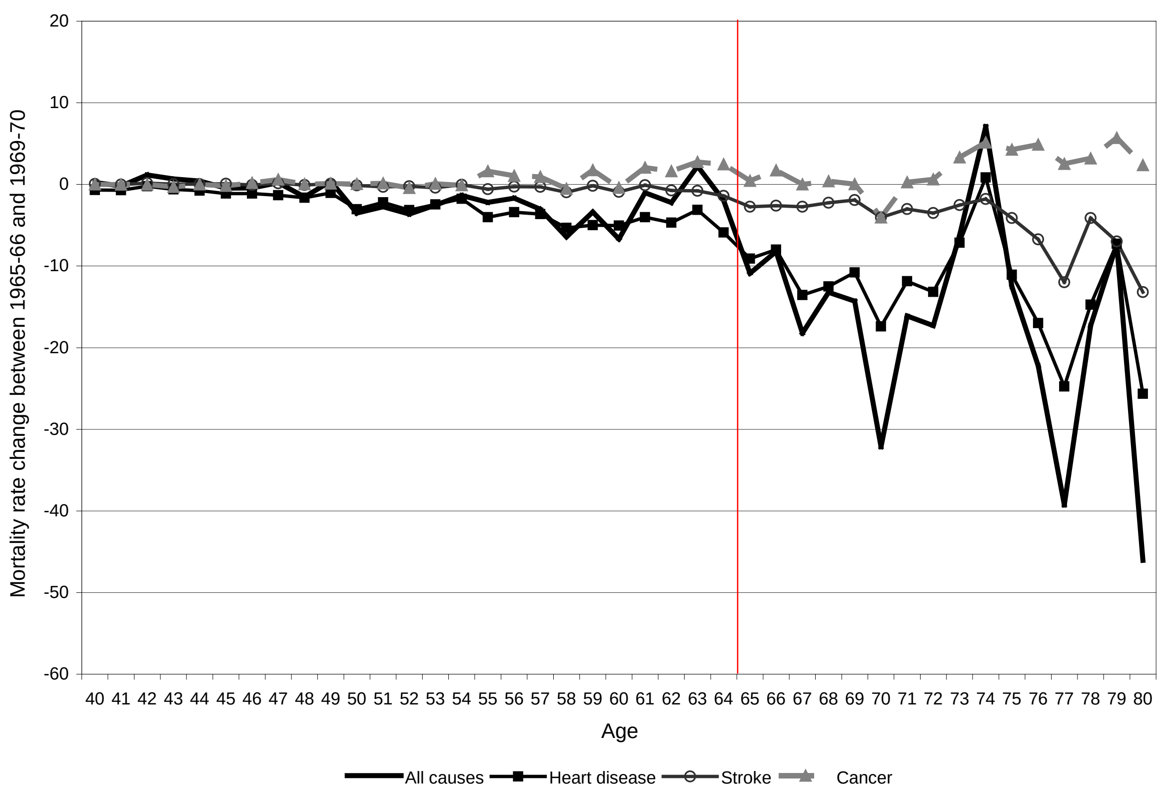
Notes: Data come from the *World Health Organization Mortality Files*.

Figure 6: Mortality rate changes by age and year, Whites only

A. Change in all-causes mortality rates relative to 1963-1964



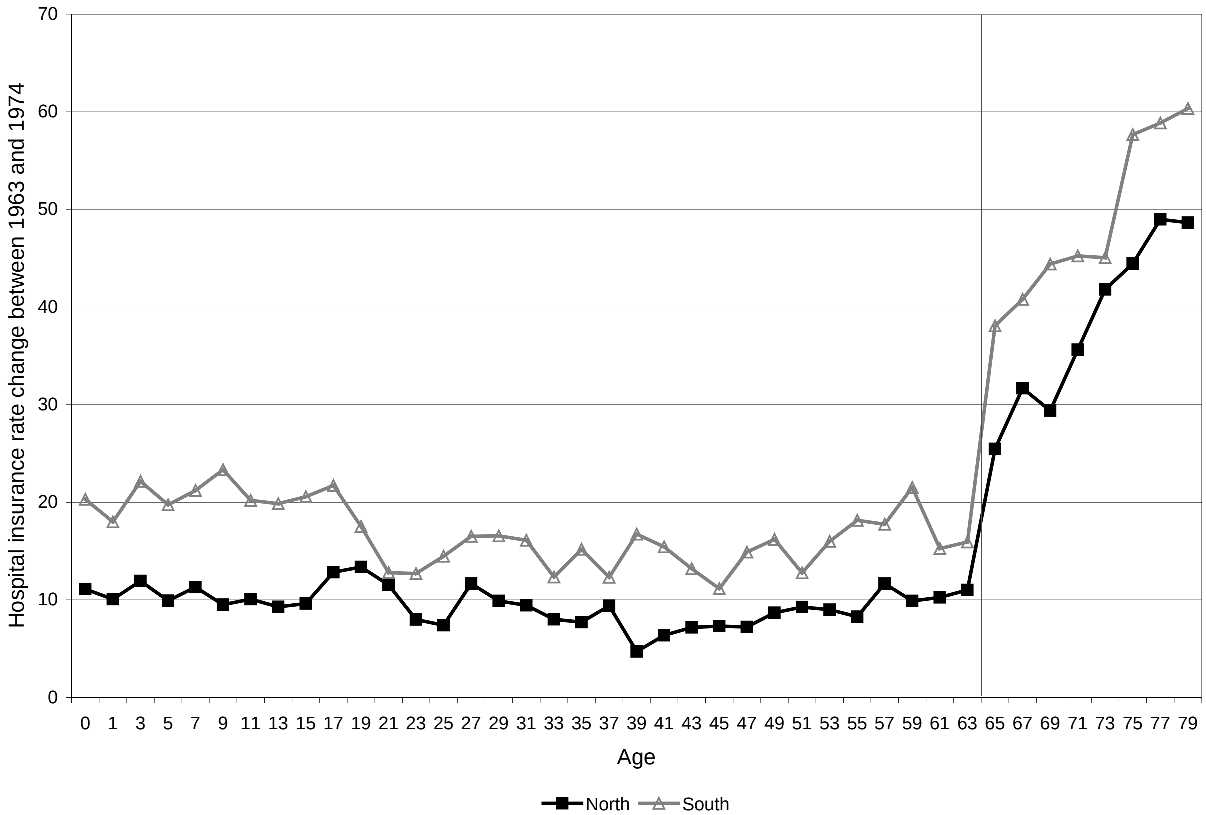
B. Change in mortality rate between 1965-1966 and 1969-1970, by cause of death



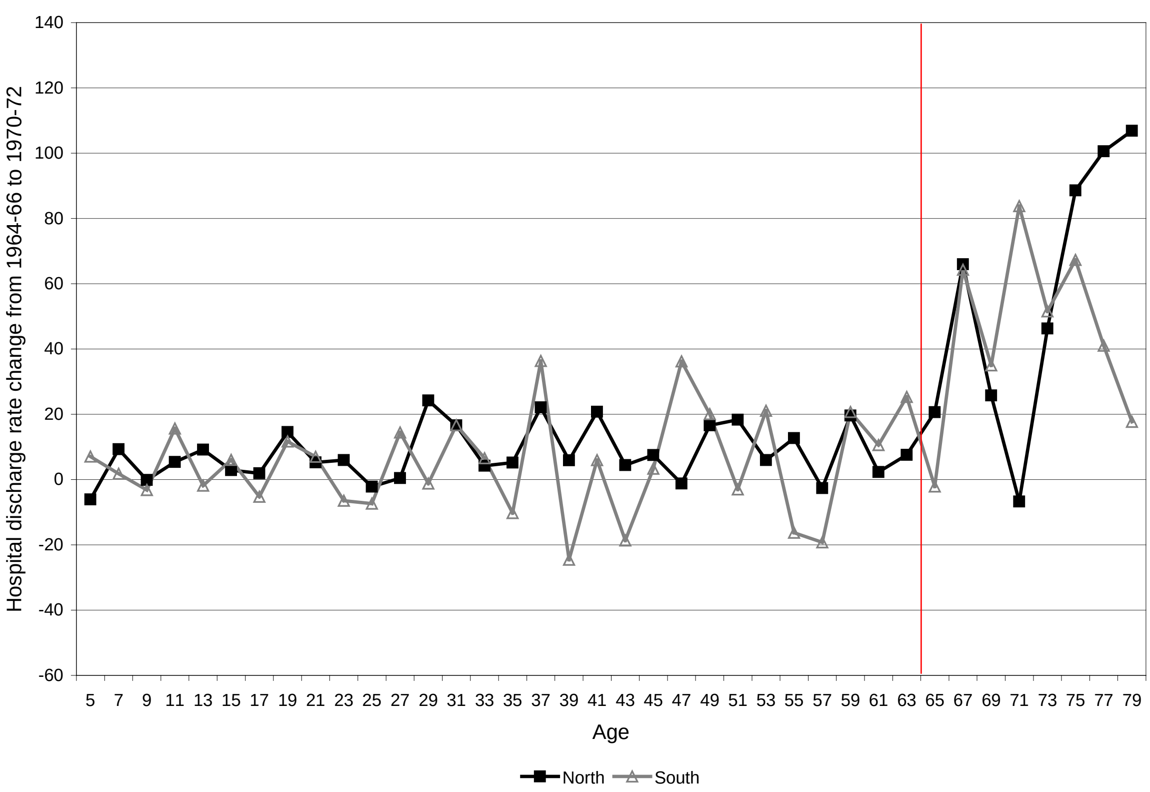
Notes: Mortality counts come from the *Mortality Detail Files* and age-specific, population sizes come from the (unrevised) *Census* counts.

Figure 7: Growth in hospital insurance and discharge rates in the North and South

A. Growth in hospital insurance for whites between 1963 and 1974, North and South



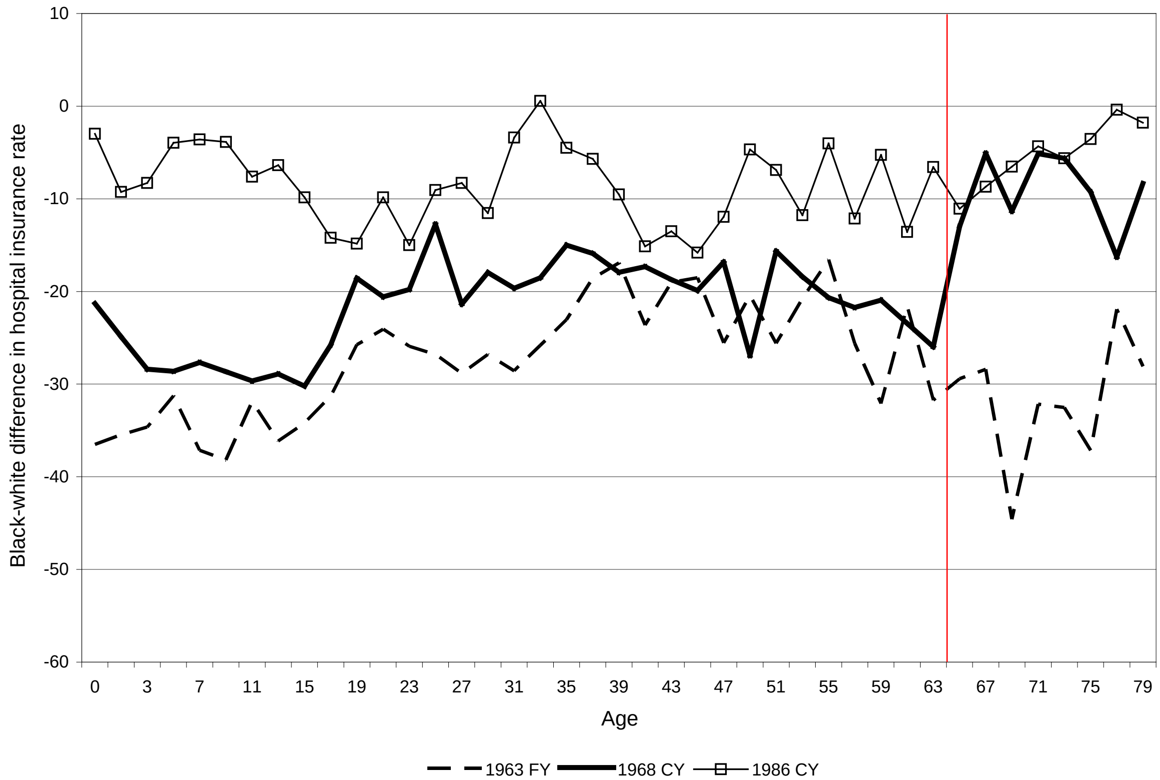
B. Growth in hospital discharge rate between 1964-1966 and 1970-1972, North and South



Notes: Data come from the *National Health Interview Surveys*.

Figure 8: Differentials in hospital insurance rates across time

A. Black-white difference in percent with hospital insurance



B. Insurance rate gap between persons with and without activity limitations (due to chronic conditions)

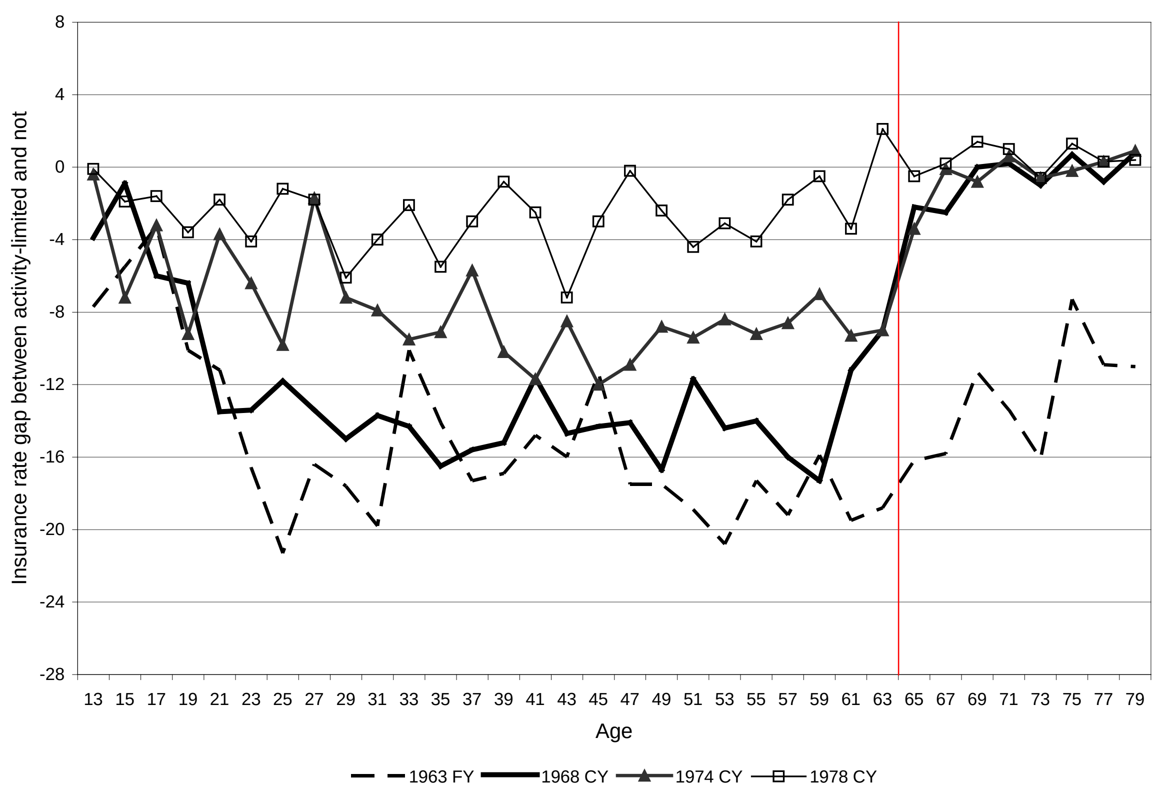
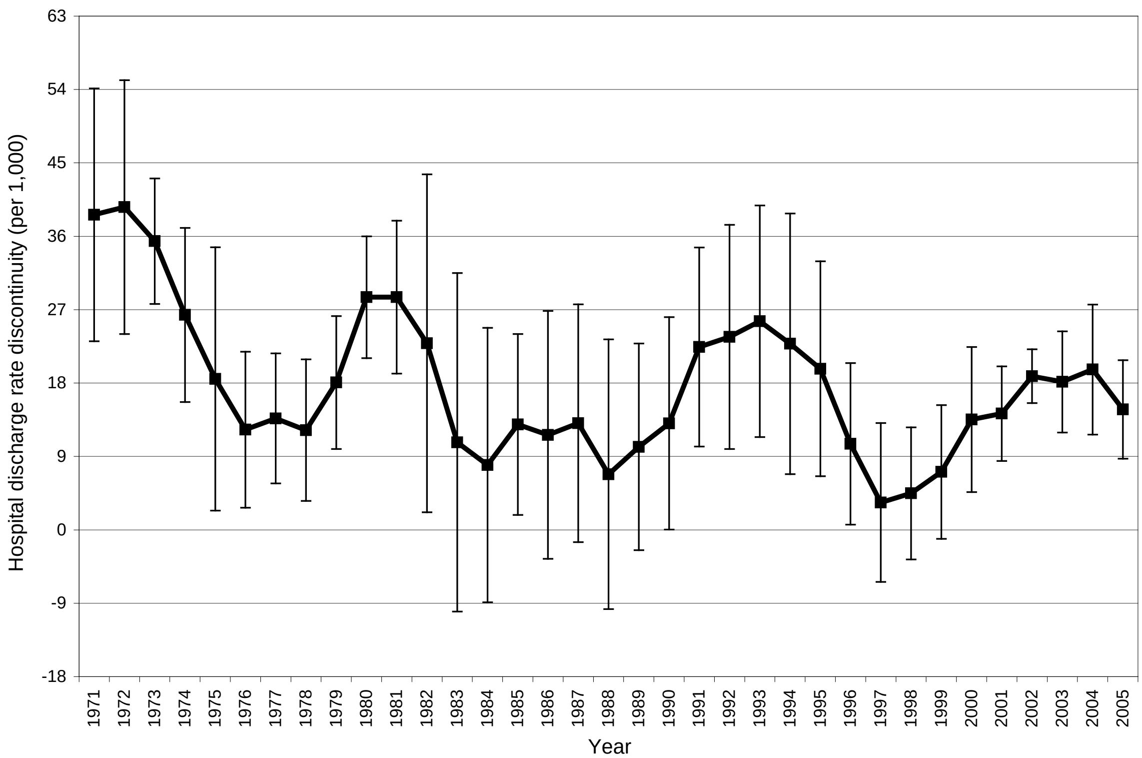
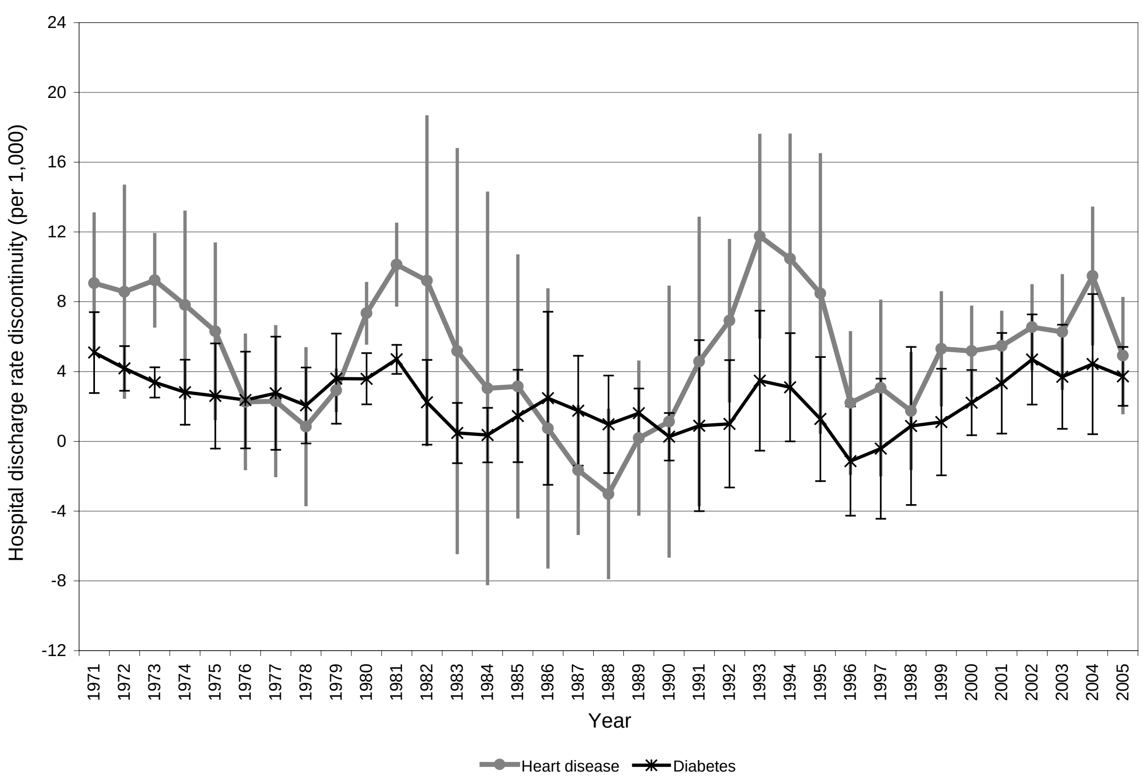


Figure 9: Hospital discharge rate discontinuities at age-65 based on *NHDS*

A. All hospital discharges



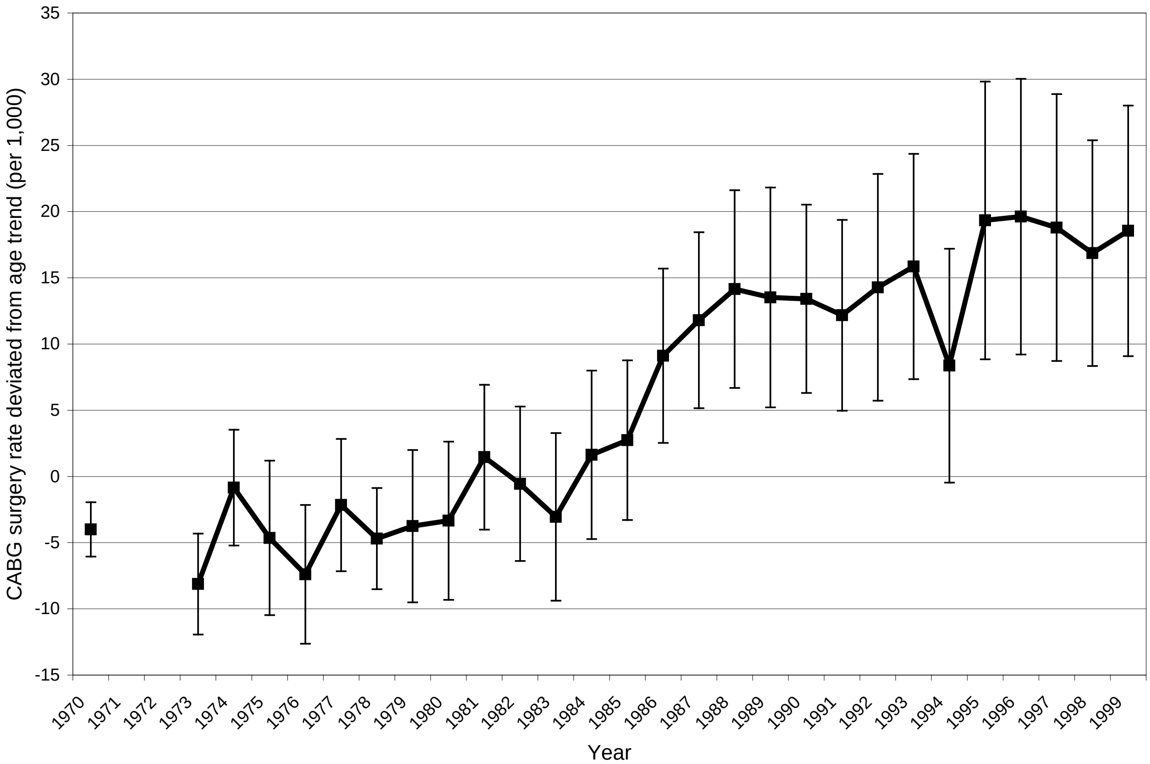
B. Heart disease and diabetes discharges



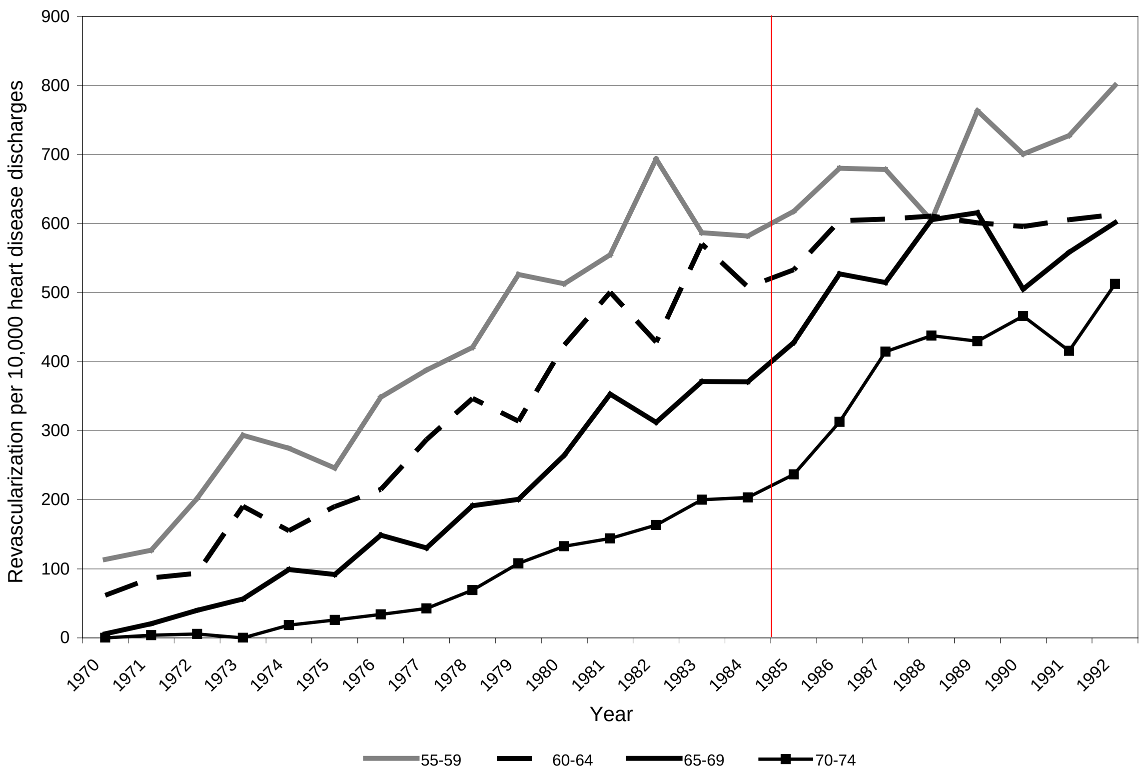
Notes: Data are from the *National Hospital Discharge Surveys* merged to population counts. Discharge rates are the number of admissions divided by the population for each year-age cell. Plots are of the estimated coefficient on an indicator for being aged 65-69 based on regressions for 50 to 69 year-olds with a quartic polynomial in age and using a moving sample of three years (with time effects). Regressions are weighted by cell population sizes and the (±) 2*s.e. bands shown have been corrected for age-level clustering and heteroskedasticity.

Figure 10: Age 65-and-over discontinuity in coronary artery bypass graft (CABG) surgery rate, Among hospital discharges

A. Age 65-and-over CABG discontinuity deviated from age trend (ages 50-and-over)

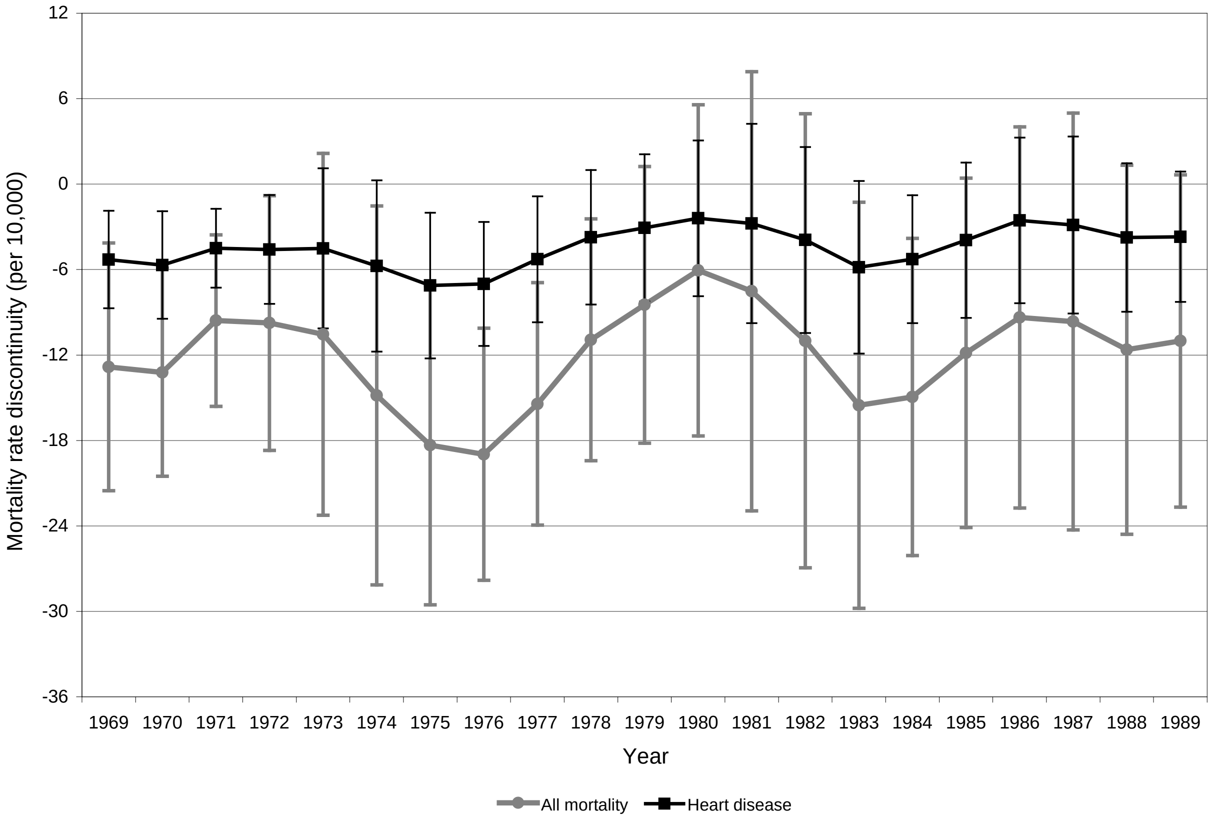


B. CABG rates for heart disease discharges, by age group and over time



Notes: Data come from the *National Hospital Discharge Surveys*. Results are from year-specific, linear probability regressions that include age trends and use samples of discharges aged 50 and over. Vertical lines in Panel A represent (±) twice the standard error of the estimate, corrected for heteroskedasticity.

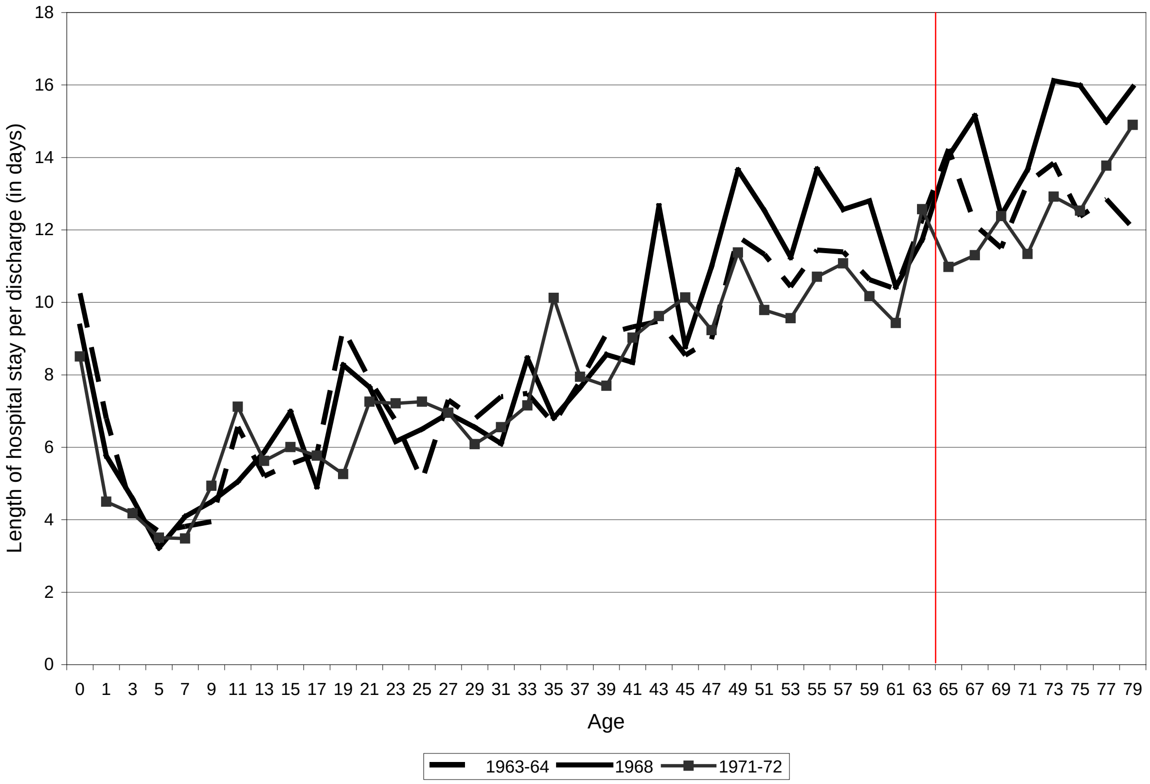
Figure 11: Age 65 to 69 discontinuities in change in mortality rates after 1964 to 1966



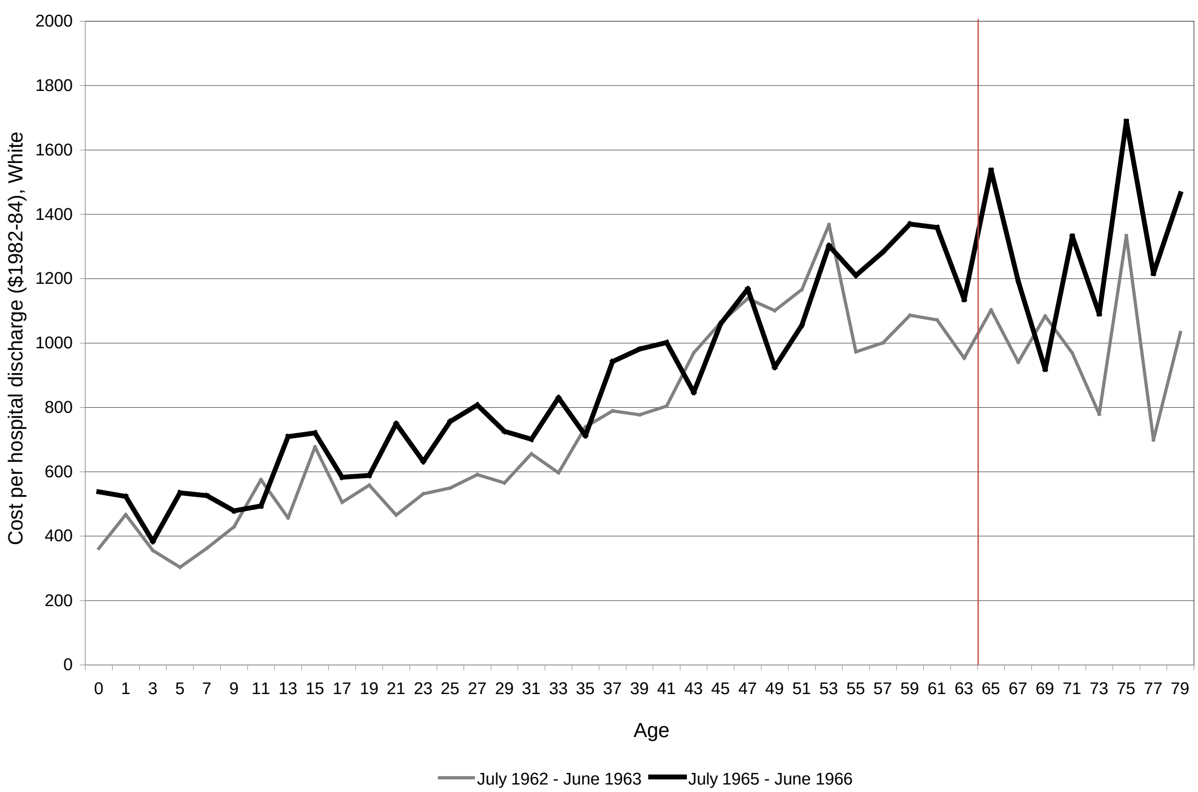
<u>Notes:</u> Data come from the *Mortality Detail Files* merged to population counts. The regressions that generate the plots are based on age-specific mortality rates for 50 to 69 year-olds, and estimate the change in the age-65 discontinuity relative to the baseline period of 1964 to 1966. Each regression contains six years of data (3 years baseline, 3 years after Medicare) and includes time effects, a quartic polynomial in age, and a cubic polynomial in age interacted with an indicator for post-Medicare years. Thus, each point represents a moving average of three years. Regressions are weighted by cell population sizes and the (±) 2*s.e. bands shown have been corrected for age-level clustering and heteroskedasticity.

Figure A1: Length-of-stay and Costs per hospital discharge for whites, by year and age

A. Average length-of-stay (in days) per hospital discharge

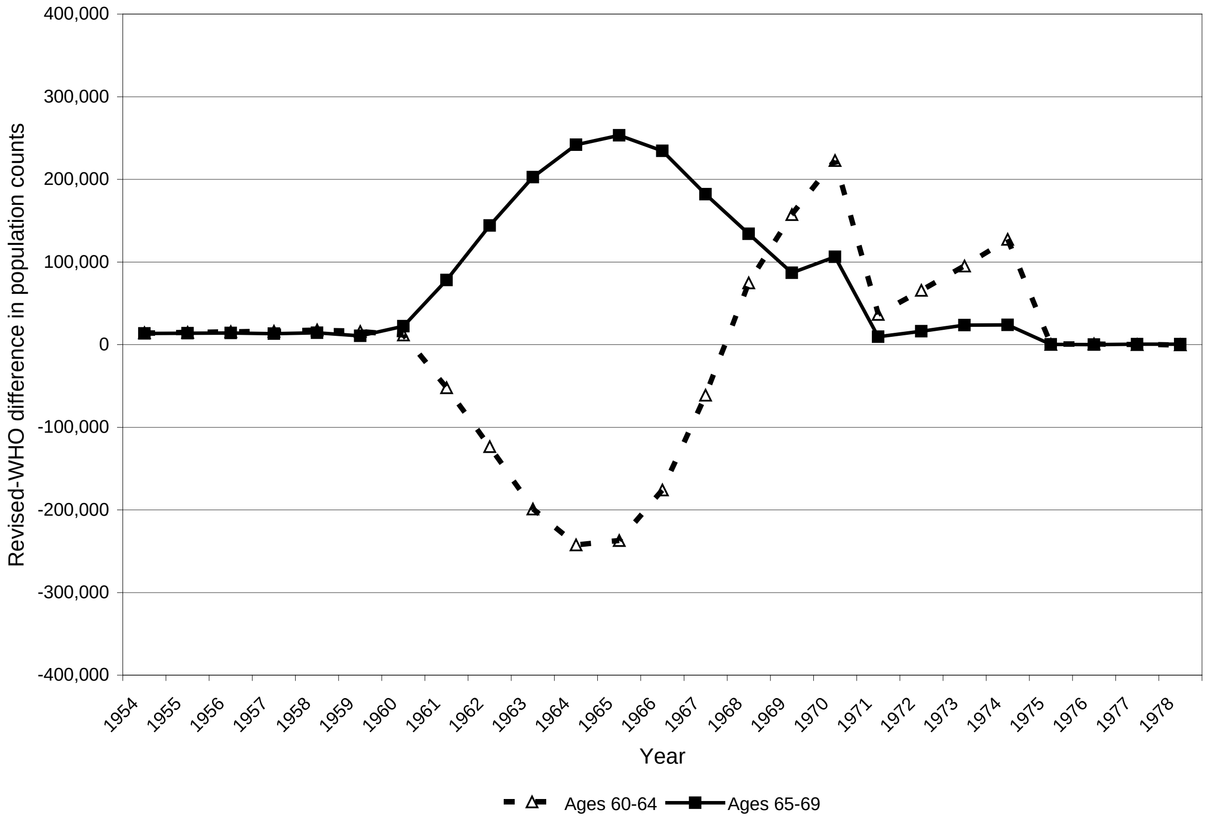


B. Average costs (in 1982-1984 dollars) per hospital discharge (change to all races)



Notes: Data come from the *National Health Interview Surveys*.

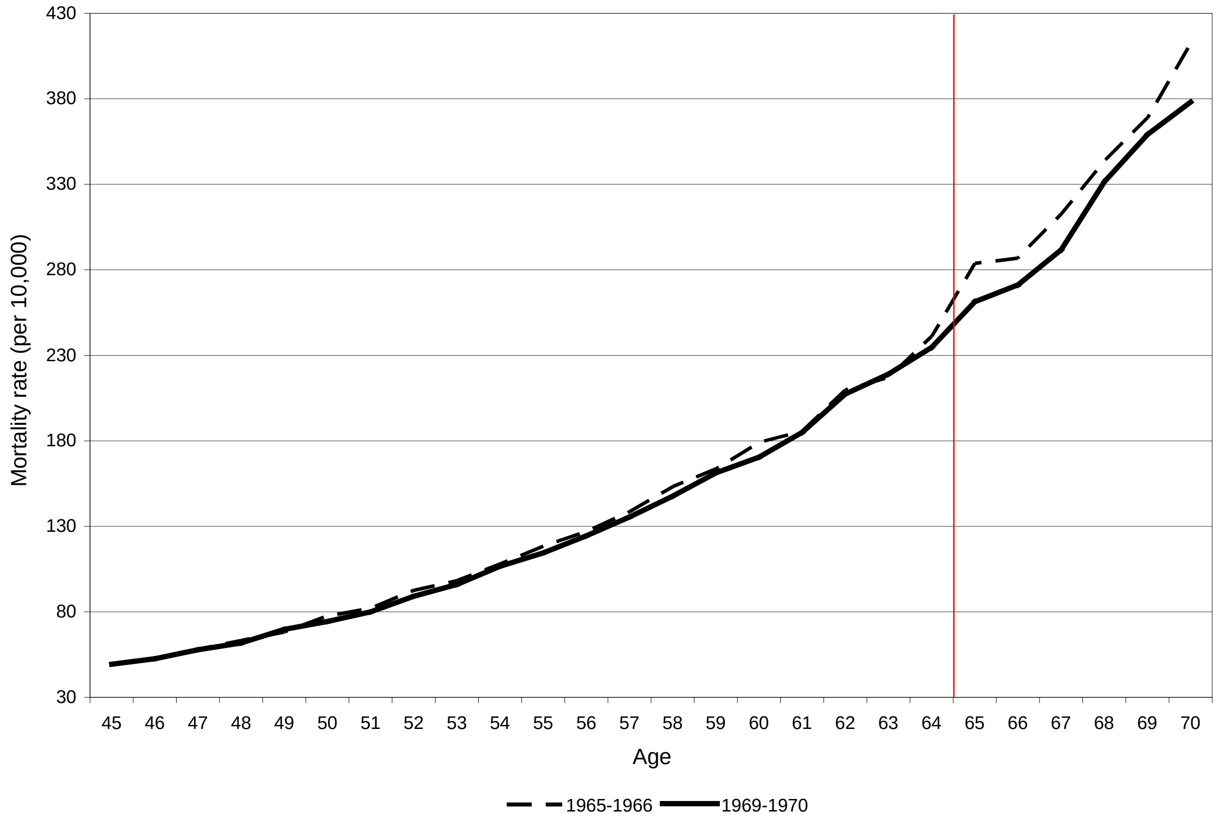
Figure A2: Difference between Intercensal (Revised) and *WHO* population counts



Notes: Data come from U.S. Census Bureau (Intercensal counts) and *World Health Organization* (*WHO*) mortality database.

Figure A3: All-cause mortality rates by age, 1965-1966 and 1969-1970

A. All races



B. Whites only

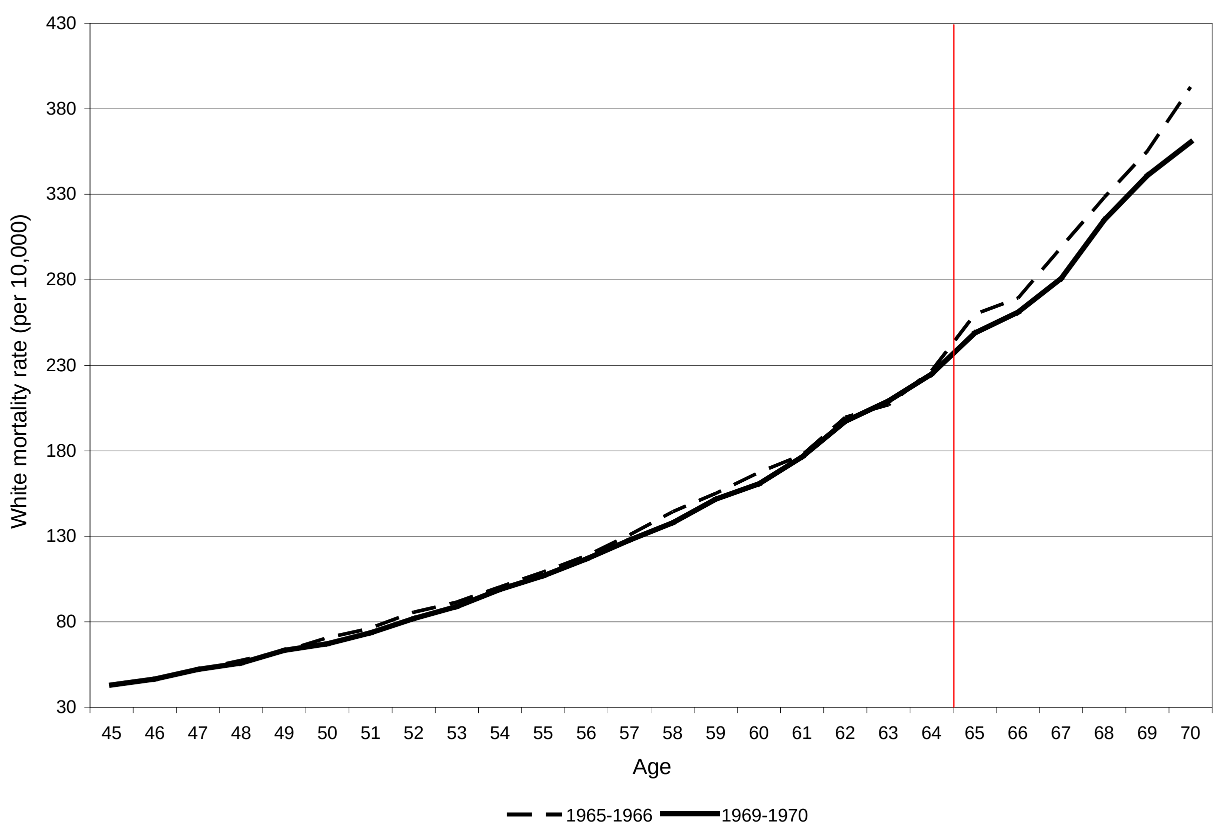
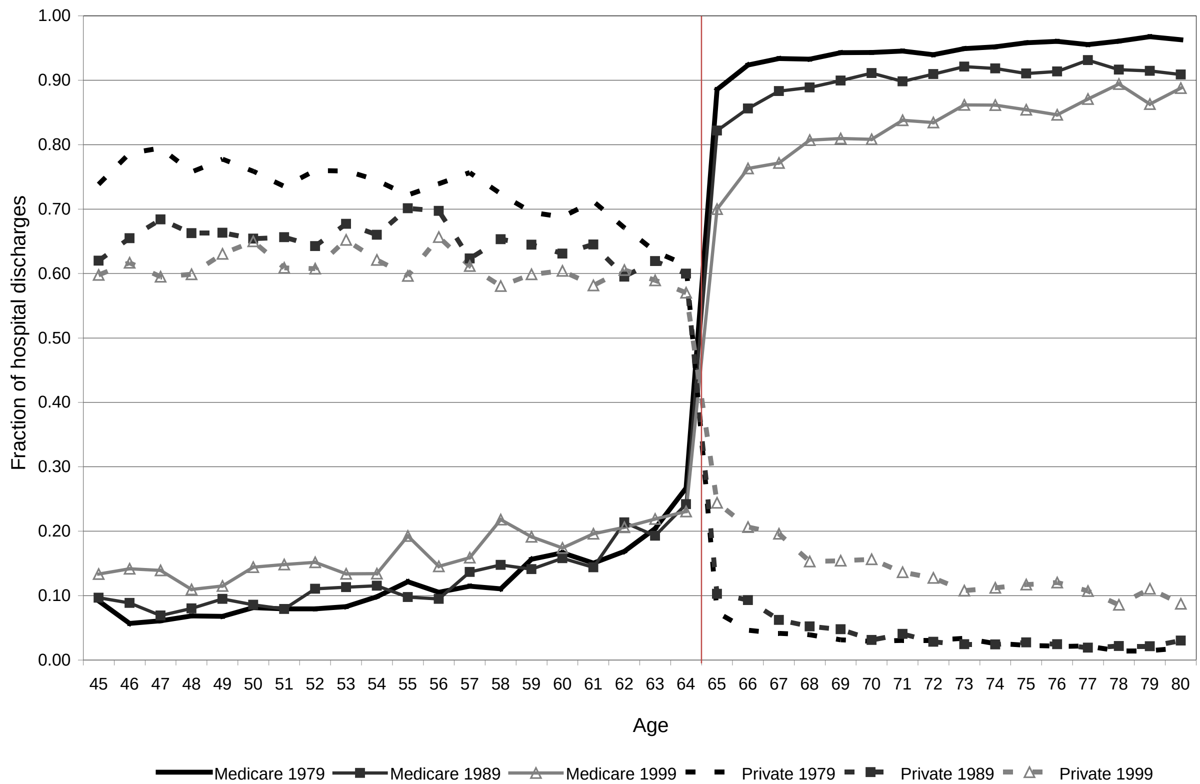


Figure A4: Fractions of hospital discharges for whom primary source of coverage is Medicare or private insurance



Notes: Data come from the *National Hospital Discharge Surveys*.

Table 1: Discontinuity in hospital insurance rates at ages 65-and-over, among individuals aged 45 to 80
[absolute value of t-ratio]

	Discontinuity in hospital insurance rate (per 100) by age group (deviated from fifth-order polynomial in age)					
	Unadjusted for individual characteristics			Adjusted for individual characteristics		
		Growth after FY 1963 by			*Growth* after FY 1963 by	
	FY 1963 (1a)	FY 1968 (1b)	CY 1974 (1c)	FY 1963 (2a)	FY 1968 (2b)	CY 1974 (2c)
A. All races						
Ages 65 to 69	-1.88	23.68***	18.79***	-0.14	24.79***	17.80***
	[1.20]	[19.18]	[16.10]	[0.10]	[21.57]	[16.08]
Ages 70 to 74	0.46	30.38***	24.61***	2.44	30.91***	23.90***
	[0.15]	[19.70]	[16.86]	[0.86]	[21.53]	[17.28]
Ages 75 to 80	-1.94	38.79***	34.21***	0.83	39.61***	33.05***
	[0.42]	[20.12]	[18.89]	[0.19]	[22.08]	[19.25]
Year effect	---	4.98	-3.34	---	3.11	-2.55
		[1.49]	[1.03]		[1.03]	[0.84]
Year-age trend (÷10)	---	-0.01	2.71***	---	-0.37	1.42***
		[0.01]	[4.47]		[0.65]	[2.53]
R-squared	0.042	0.058	0.097	0.212	0.207	0.217
Sample Size	39,164	78,298	73,445	39,164	78,298	73,445
B. Whites only						
Ages 65 to 69	-1.97	22.56***	17.87***	-0.57	23.68***	16.68***
	[1.22]	[17.96]	[15.07]	[0.38]	[20.00]	[14.74]
Ages 70 to 74	1.47	28.48***	23.61***	2.53	29.16***	22.61***
	[0.47]	[18.12]	[15.97]	[0.85]	[19.69]	[16.02]
Ages 75 to 80	0.04	38.23***	33.71***	1.44	38.84***	32.42***
	[0.01]	[19.54]	[18.29]	[0.32]	[21.01]	[18.41]
Sample Size	35,545	71,099	66,755	35,545	71,099	66,755
C. Blacks only						
Ages 65 to 69	-2.36	36.01***	30.66***	1.23	37.14***	30.84***
	[0.42]	[7.54]	[6.67]	[0.24]	[8.20]	[6.94]
Ages 70 to 74	-15.96	54.47***	44.40***	-5.60	53.06***	42.39***
	[1.57]	[9.28]	[7.83]	[0.57]	[9.45]	[7.58]
Ages 75 to 80	-27.36*	48.45***	46.65***	-13.66	49.84***	45.84***
	[1.82]	[6.43]	[6.71]	[0.94]	[7.02]	[6.83]
Sample Size	3,358	6,678	6,183	3,358	6,678	6,183

Notes: Samples based on forty-five to eighty year-olds in the *National Health Interview Surveys*. Outcome variable is percent with hospital insurance. FY 1963 and FY 1968 are for fiscal years (July 1 to June 30); CY 1974 is for calendar year (January 1 to December 31). All analyses are weighted by *NHIS* annual sampling weights and adjust for a fifth-order polynomial in age, year effects, and year effects interacted with age. Individual characteristics in columns (2a) to (2c) include indicators for gender, race, region of residence, education and income category fixed effects, unemployment status, married/separated/divorced/widowed status, and (peace-time/wartime) veteran status. Estimated standard errors are corrected for heteroskedasticity.
*** significant at 1-percent level, ** significant at 5-percent level, * significant at 10-percent level

Table 2: Discontinuity in hospital discharge rates at ages 65-and-over, among individuals aged 45 to 80
[absolute value of t-ratio]

	Discontinuity in discharge rates from short-stay hospital in past 12 months (per 1,000) (deviated from fifth-order polynomial in age)					
	Unadjusted for individual characteristics			Adjusted for individual characteristics		
		Growth after 1964-66 by			*Growth* after 1964-66 by	
	1964-1966	1968-1969	1970-1972	1964-1966	1968-1969	1970-1972
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
A. All races						
Ages 65 to 69	3.11	27.74**	35.32***	-5.06	26.60**	35.44***
	[0.29]	[2.50]	[3.13]	[0.43]	[2.39]	[2.94]
Ages 70 to 74	-23.25	46.35***	31.46***	-30.08	45.74***	33.42***
	[1.21]	[3.69]	[2.81]	[1.38]	[3.61]	[2.93]
Ages 75 to 80	-83.97***	75.98***	83.10***	-87.19***	73.68***	82.33***
	[3.21]	[3.89]	[6.45]	[2.95]	[3.75]	[6.25]
Year effect	---	14.99	8.03	---	16.79	8.84
		[0.53]	[0.36]		[0.59]	[0.38]
Year-age trend (÷10)	---	-3.92	-0.03	---	-4.15	-0.69
		[0.72]	[0.01]		[0.75]	[0.16]
Sample Size	114,846	228,944	225,884	114,846	228,944	225,884
B. Whites only						
Ages 65 to 69	2.62	27.74**	37.10***	-4.97	26.20*	36.99***
	[0.23]	[2.00]	[2.99]	[0.41]	[1.89]	[2.79]
Ages 70 to 74	-23.66	46.27***	31.38**	-29.58	45.49***	32.40***
	[1.27]	[3.14]	[2.63]	[1.43]	[3.07]	[2.69]
Ages 75 to 80	-74.33***	68.92***	87.39***	-77.24**	66.10***	85.70***
	[2.70]	[3.35]	[6.32]	[2.58]	[3.18]	[6.08]
Year effect	---	9.27	2.87	---	11.29	2.56
		[0.28]	[0.12]		[0.34]	[0.10]
Year-age trend (÷10)	---	-2.92	0.48	---	-3.11	0.03
		[0.46]	[0.11]		[0.48]	[0.01]
Sample Size	104,688	208,204	205,323	104,688	208,204	205,323

Notes: See notes to Table 1. Samples based on forty-five to eighty year-olds in the *National Health Interview Surveys*. Outcome variable is number of discharges from short-stay hospital in past twelve months per 1,000 individuals. For 1964 to 1966, discharges are for fiscal years; for 1968 they are for both fiscal and calendar year; 1969 and 1970 to 1972 are for calendar years. Estimated standard errors are corrected for heteroskedasticity and clustering at the age-level over time.
*** significant at 1-percent level, ** significant at 5-percent level, * significant at 10-percent level

Table 3: Discontinuity in activity limitation at ages 65-and-over, among individuals aged 45 to 80
[absolute value of t-ratio]

	Discontinuity in activity limitation rate (per 1,000), deviated from fifth-order polynomial in age							
	Unadjusted for individual characteristics				Adjusted for individual characteristics			
		Change after 1965-1966 by				*Change* after 1965-1966 by		
	1965-1966	1969-1970	1971-1972	1973-1974	1965-1966	1969-1970	1971-1972	1973-1974
	(1a)	(1b)	(1c)	(1d)	(2a)	(2b)	(2c)	(2d)
A. All races								
Ages 65 to 69	13.64	-34.98***	-32.10***	-53.69***	-8.89	-32.33***	-33.28***	-45.20***
	[1.13]	[4.09]	[4.77]	[3.79]	[0.80]	[3.71]	[4.81]	[3.24]
Ages 70 to 74	15.66	-57.89***	-45.24***	-83.89***	-5.99	-60.61***	-43.71***	-69.27***
	[0.99]	[5.23]	[4.53]	[6.02]	[0.34]	[5.64]	[5.03]	[4.85]
Ages 75 to 80	-5.89	-51.66***	-45.00***	-112.15***	-19.04	-60.38***	-51.48***	-102.56***
	[0.26]	[3.96]	[3.51]	[6.46]	[0.80]	[4.67]	[4.00]	[5.59]
Year effect	---	-2.75	34.43	-34.67	---	-3.03	33.18	-2.35
		[0.14]	[1.38]	[1.13]		[0.15]	[1.35]	[0.07]
Year-age trend (÷10)	---	0.70	-3.84	14.21**	---	3.97	0.60	14.01**
		[0.18]	[0.87]	[2.44]		[1.03]	[0.13]	[2.27]
R-squared	0.080	0.070	0.067	0.066	0.157	0.148	0.149	0.149
Sample Size	77,994	148,629	155,797	147,154	77,994	148,629	155,797	147,154
B. Whites only								
Ages 65 to 69	9.83	-39.66***	-36.95***	-59.50***	-9.33	-37.36***	-40.10***	-51.20***
	[0.69]	[4.50]	[4.60]	[3.85]	[0.74]	[4.28]	[5.22]	[3.39]
Ages 70 to 74	8.50	-59.65***	-50.05***	-85.59***	-8.21	-63.03***	-49.98***	-70.61***
	[0.44]	[5.04]	[4.68]	[5.62]	[0.41]	[5.47]	[5.27]	[4.51]
Ages 75 to 80	-13.09	-56.23***	-44.24***	-115.87***	-20.22	-63.58***	-53.97***	-108.18***
	[0.48]	[4.15]	[3.24]	[6.24]	[0.73]	[4.65]	[4.02]	[5.51]
Sample Size	71,243	135,198	141,787	134,120	71,243	135,198	141,787	134,120

Notes: See notes to Table 1. Samples based on forty-five to eighty year-olds in the *National Health Interview Surveys*. Outcome variable is indicator for activity limitation due to chronic conditions (per 1,000 individuals). Fiscal years are used for 1965 to 1966; calendar years for every other year. Estimated standard errors are corrected for heteroskedasticity and clustering at the age-level over time.
*** significant at 1-percent level, ** significant at 5-percent level, * significant at 10-percent level

Table 4: Discontinuity in mortality rates at ages 65-and-over, among those aged 45 to 80
[absolute value of t-ratio]

	Discontinuity in mortality rate (per 10,000) by age group and cause (deviated from fifth-order polynomial in age)					
	All races			Whites only		
	Change after 1965-1966 by			*Change* after 1965-1966 by		
	1969-1970 (1a)	1971-1972 (1b)	1973-1974 (1c)	1969-1970 (2a)	1971-1972 (2b)	1973-1974 (2c)
A. All-cause mortality						
Ages 65 to 69	-13.08***	-17.02***	-20.30***	-9.90***	-11.67***	-14.09***
	[4.53]	[6.99]	[5.93]	[4.52]	[4.62]	[4.78]
Ages 70 to 74	-6.07	-8.26	-8.64*	-10.56*	-14.41***	-16.97***
	[0.77]	[1.50]	[1.92]	[1.70]	[2.70]	[6.19]
Ages 75 to 80	-17.75***	-10.60**	-24.03***	-19.67***	-15.51***	-27.77***
	[2.93]	[2.23]	[4.52]	[3.52]	[3.46]	[6.80]
B. Heart disease mortality						
Ages 65 to 69	-5.93***	-8.67***	-10.27***	-5.03***	-6.74***	-8.19***
	[4.92]	[8.29]	[6.18]	[4.65]	[5.49]	[5.04]
Ages 70 to 74	-1.31	-4.29	-4.92**	-3.48	-6.94**	-8.76***
	[0.37]	[1.50]	[2.64]	[1.21]	[2.51]	[6.45]
Ages 75 to 80	-7.64***	-5.31*	-13.58***	-8.70***	-7.57***	-15.22***
	[2.79]	[1.98]	[5.11]	[3.30]	[2.85]	[7.76]
C. Stroke mortality						
Ages 65 to 69	-1.89**	-2.97***	-3.51***	-1.44***	-2.03***	-2.42***
	[2.62]	[6.44]	[6.21]	[5.35]	[6.50]	[6.39]
Ages 70 to 74	-1.24	-2.63***	-3.41***	-1.74***	-3.53***	-4.49***
	[1.51]	[2.72]	[4.06]	[3.68]	[4.44]	[7.34]
Ages 75 to 80	-5.34***	-5.50***	-7.83***	-5.99***	-6.49***	-8.69***
	[3.61]	[4.58]	[5.29]	[4.21]	[5.64]	[6.09]
D. Cancer mortality						
Ages 65 to 69	-2.36***	-1.71***	-2.88***	-1.61***	-0.60	-1.53**
	[3.74]	[2.92]	[3.61]	[2.76]	[0.90]	[2.01]
Ages 70 to 74	-1.20	0.39	0.92	-1.89	-0.49	-0.36
	[0.68]	[0.36]	[0.99]	[1.24]	[0.43]	[0.48]
Ages 75 to 80	0.51	3.65***	2.64***	0.52	3.13***	2.51***
	[0.51]	[3.92]	[2.90]	[0.58]	[3.37]	[3.04]

Notes: Data consist of mortality rates for forty-five to eighty year-olds calculated at the year-by-age level from the *National Mortality Detail Files* (see text for further details). The outcome variable is the mortality rate (per 10,000 individuals) in each calendar year. All analyses use cell population counts as frequency weights and adjust for a fifth-order polynomial in age, year effects, and year effects interacted with age. Estimated standard errors are corrected for heteroskedasticity and clustering at the age-level over time.

*** significant at 1-percent level, ** significant at 5-percent level, * significant at 10-percent level

Table 5: Cost-per-life year ratios (for whites)

	Birth year		
	1896 (1)	1899 (2)	1904 (3)
Age at end of 1966	70	67	62
Ages eligible for Medicare	70+	67+	65+
Ages of added Medicare relative to 1896 cohort	---	67 to 69	65 to 69
Added discharges (implied) relative to 1896 cohort	---	146.5 (per 1,000)	184.2 (per 1,000)
Median life expectancy (for survivors to age 64)	79.28	80.26	80.73
Percent surviving to			
Age 71	80.2	81.2	81.7
Age 76	62.3	64.6	66.3
Age 81	43.7	47.2	49.0
Age 85	30.0	33.0	34.2
Cost-per-life year ($1982-84)		$187.30	$159.45
Cost-per-QALY ($1982-84)			

Notes: Additional discharges calculated from regression similar to that used in Table 2, column (1c) for whites, except using sample of 45 to 69 year-olds and allowing for different indicators for each age between 65 and 69. Use the age-specific survival rates for each birth cohort as weights when summing up the additional discharges. Average cost-per-discharge $1,250 in 1982-84 dollars. See text for more details.

Table 6A: Hospital insurance rates for South and North regions, before and after Medicare
(estimated standard error)

	Hospital insurance rates (per 100) by region and age group									
	July 1, 1962 to June 30, 1963					*Growth* by 1974 Calendar Year				
	age 5-14 (1a)	age 35-44 (1b)	age 45-54 (1c)	age 55-64 (1d)	age 65-74 (1e)	age 5-14 (2a)	age 35-44 (2b)	age 45-54 (2c)	age 55-64 (2d)	age 65-74 (2e)
A. All races										
South	56.94	68.99	68.93	63.02	53.71	20.93***	14.52***	14.11***	17.62***	42.23***
						(0.73)	(0.89)	(0.90)	(1.09)	(1.10)
North	78.79	83.26	82.62	79.49	66.25	10.01***	7.06***	8.25***	10.23***	31.89***
						(0.45)	(0.54)	(0.54)	(0.65)	(0.73)
South − North	-21.86***	-14.28***	-13.69***	-16.47***	-12.54***	10.92***	7.46***	5.86***	7.39***	10.34***
	(0.62)	(0.76)	(0.79)	(0.97)	(1.23)	(0.86)	(1.04)	(1.05)	(1.27)	(1.32)
B. Whites only										
South	63.97	72.21	72.52	66.64	58.52	17.87***	13.83***	13.25***	16.66***	38.14***
						(0.79)	(0.92)	(0.93)	(1.14)	(1.18)
North	81.82	84.73	83.83	80.90	67.55	8.27***	6.56***	8.02***	9.60***	30.75***
						(0.45)	(0.53)	(0.54)	(0.65)	(0.73)
South − North	-17.86***	-12.51***	-11.31***	-14.26***	-9.03***	9.59***	7.28***	5.22***	7.06***	7.39***
	(0.67)	(0.80)	(0.82)	(1.03)	(1.31)	(0.91)	(1.06)	(1.07)	(1.31)	(1.39)

Notes: Estimated standard errors corrected for heteroskedasticity.
*** significant at 1-percent level, ** significant at 5-percent level, * significant at 10-percent level

Comparison of difference in insurance rates for 55-64 and 65-74 year-olds in the South versus North.

1. All races
    - i) July 1962 to June 1963 = 3.93 (per 100), [t-ratio = 2.51]
    - ii) *Growth* by 1974 Calendar year = 2.95 [1.62]
2. Whites only
    - i) July 1962 to June 1963 = 5.23 (per 100), [t-ratio = 3.14]
    - ii) *Growth* by 1974 Calendar year = 0.33 [0.17]

Table 6B: Growth in hospital discharge rates after Medicare for South and North regions
(estimated standard error)

	Growth in hospital discharge rates (per 1,000) between 1964-1966 and 1970-1972				
	age 5-14 (1)	age 35-44 (2)	age 45-54 (3)	age 55-64 (4)	age 65-74 (5)
A. All races					
South	3.26	-9.31	15.08	2.55	42.95***
	(2.74)	(9.97)	(10.44)	(9.06)	(13.63)
North	2.51	4.14	9.83**	8.12	30.66***
	(2.56)	(4.27)	(4.33)	(5.42)	(9.77)
South − North	0.75	-13.45	5.25	-5.57	12.29
	(3.59)	(8.47)	(11.93)	(8.12)	(16.24)
B. Whites only					
South	0.83	-15.62*	8.34	-5.34	38.65***
	(2.71)	(9.27)	(12.61)	(9.80)	(13.67)
North	1.31	0.48	8.86	7.42	31.37***
	(2.85)	(5.13)	(5.32)	(5.21)	(10.23)
South − North	-0.48	-16.10*	-0.52	-12.76	7.28
	(3.16)	(8.30)	(13.76)	(10.02)	(13.91)

Notes: Estimated standard errors corrected for heteroskedasticity and clustering at the age-level over time.
*** significant at 1-percent level, ** significant at 5-percent level, * significant at 10-percent level

Comparison of difference in discharge rates for 55-64 and 65-74 year-olds in the South versus North.

3. All races, *Growth* between 1964-66 and 1970-72 = 17.86 [0.97]
4. Whites only, *Growth* between 1964-66 and 1970-72 = 20.04 [1.15]

Table 7: Discontinuity in hospital insurance rate at age-65 across time, individuals aged 45 to 69
[absolute value of t-ratio]

	Insurance rate at age 65 (per 100), deviated from fourth-order polynomial in age					
	1963 FY (1)	1968 CY (2)	1974 CY (3)	1978 CY (4)	1984 CY (5)	1986 CY (6)
All races	-2.98	17.84***	15.89***	10.71***	9.01***	7.27***
	[1.72]	[14.36]	[14.05]	[11.33]	[9.44]	[5.63]
{ages 60-64 rate}	{71.7}	{78.9}	{83.5}	{89.3}	{89.7}	{89.4}
Sample Size	32,875	31,459	28,613	26,502	24,514	14,193
Whites	-3.24	16.39***	15.13***	9.58***	8.06***	7.65***
	[1.81]	[13.24]	[13.50]	[10.07]	[8.62]	[5.99]
	{74.3}	{81.1}	{85.2}	{90.2}	{91.0}	{90.3}
Blacks	0.54	30.14***	20.39***	18.81***	15.60***	0.58
	[0.09]	[5.46]	[3.93]	[4.63]	[3.39]	[0.10]
	{46.3}	{57.5}	{68.1}	{81.7}	{79.3}	{81.6}
Whites only						
HS graduate or less	-3.46	18.42***	16.39***	9.97***	8.41***	9.08***
	[1.75]	[13.21]	[12.81]	[8.97]	[7.31]	[6.01]
	{72.6}	{79.2}	{84.0}	{89.4}	{89.9}	{89.4}
Some college or	-6.39	6.88***	9.39***	6.25***	4.54***	3.41
more	[1.61]	[2.95]	[4.24]	[3.71]	[3.31]	[1.72]
	{86.0}	{90.7}	{91.1}	{94.6}	{95.5}	{95.0}
Below 150% of	-0.73	30.09***	28.52***	15.81***	17.29***	16.08***
poverty line	[0.22]	[8.45]	[9.49]	[5.88]	[4.92]	[3.00]
	{52.8}	{58.6}	{70.3}	{80.7}	{75.9}	{72.8}
Above 150% of	-2.03	12.66***	8.02***	5.09***	5.24***	4.54***
poverty line	[0.99]	[10.56]	[7.02]	[5.38]	[6.00]	[4.15]
	{83.9}	{87.0}	{90.8}	{94.4}	{94.8}	{95.2}

Notes: See notes to Table 1. Samples based on forty-five to sixty-nine year-olds in the *National Health Interview Surveys*. Entries are the estimated coefficient on an indicator equal to one if the individual is aged 65 to 69 from year-specific regressions that adjust for a fourth-order polynomial in age. Estimated standard errors are corrected for heteroskedasticity. For a two-person household, 150 percent of the poverty line (median income) is $2,982 ($4,868) in 1963, $3,393 ($6,809) in 1968, $4,817 ($10,406) in 1974, $6,374 ($14,165) in 1978, and $10,707 ($24,565) in 1986. The income cutoffs used in the *NHIS* for 150 percent of the poverty line are below $3,000 in 1963 and 1968, below $5,000 in 1974, below $7,000 in 1978, and below $10,000 in 1986.
*** significant at 1-percent level, ** significant at 5-percent level

Table A1: Discontinuity in hospital discharge rates at ages 65-and-over, among individuals aged 45 to 80
[absolute value of t-ratio]

	Discontinuity in discharge rates from short-stay hospital in past 12 months (per 1,000) (deviated from fifth-order polynomial in age)					
	Unadjusted for individual characteristics			Adjusted for individual characteristics		
	Growth after 1964-66 by			*Growth* after 1964-66 by		
	1968-1969	1970-1972	1973-1974	1968-1969	1970-1972	1973-1974
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
A. All races						
Ages 65 to 69	22.55***	35.28***	25.37***	21.12***	34.55***	19.28**
	[3.27]	[3.91]	[3.24]	[2.94]	[3.52]	[2.44]
Ages 70 to 74	39.19***	31.40***	25.23***	38.18***	32.18***	20.48***
	[6.31]	[3.92]	[5.07]	[6.20]	[3.77]	[4.14]
Ages 75 to 80	66.73***	83.03***	72.51***	63.92***	80.72***	64.71***
	[4.93]	[11.80]	[5.32]	[4.73]	[11.54]	[4.77]
Year effect	-6.06*	7.87**	22.82***	-5.48*	5.16	23.58***
	[1.94]	[2.30]	[6.66]	[1.75]	[1.43]	[5.93]
Sample Size	228,944	225,884	184,006	228,944	225,884	184,006
B. Whites only						
Ages 65 to 69	23.88**	37.74***	25.82**	22.11**	37.02***	19.50*
	[2.59]	[3.53]	[2.37]	[2.33]	[3.18]	[1.78]
Ages 70 to 74	40.96***	32.26***	30.50***	39.83***	32.45***	25.00***
	[5.85]	[3.49]	[6.43]	[5.80]	[3.36]	[5.06]
Ages 75 to 80	62.05***	88.53***	67.43***	58.78***	85.76***	59.60***
	[4.98]	[9.78]	[4.22]	[4.67]	[9.58]	[3.78]
Year effect	-6.38*	5.47	20.97***	-5.40	2.71	21.83***
	[1.84]	[1.46]	[6.48]	[1.51]	[0.67]	[5.36]
Sample Size	208,204	205,323	167,565	208,204	205,323	167,565

Notes: See notes to Table 2. Samples based on forty-five to eighty year-olds in the *National Health Interview Surveys*.
*** significant at 1-percent level, ** significant at 5-percent level, * significant at 10-percent level