Medicare and Longevity in International Perspective

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ABSTRACT (100 words)

When Medicare began in 1966, health insurance for those aged 65 and older became virtually universal. This paper examines whether Medicare reduced mortality rates of the eligible population. To do this, we estimate the differences in the annual mortality rates for men and women from 1959 through 1980 at ages 65 and older relative to the annual mortality rates for men and women aged 50-64 before and after 1966. We then contrast changing U.S. mortality patterns with those in a set of 12 comparison countries. Our results are consistent with the hypothesis that Medicare substantially lowered U.S. elderly mortality rates.

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INTRODUCTION

The United States (U.S.) Medicare program is among the most expensive government health care interventions in the world. As an insurance program, Medicare plays an important role in decreasing the financial risk of ill health among the elderly. It is reasonable to hypothesize that a program of this magnitude, as a health care intervention, should improve health. If Medicare has significantly improved the health of older Americans, mortality rates among this population should have declined more than they otherwise would have. Vaupel et al. (2003) emphasize the increasing evidence that mortality rates at older ages are malleable and strongly influenced by current conditions, and a policy change of the magnitude of Medicare could have immediate impact. Mortality rates among U.S. elderly began a sharp decline soon after Medicare's 1966 inception, but declines also occurred among the non-elderly and among non-U.S. elderly. There has been little systematic comparison of these declines across groups and countries, thus the extent to which Medicare contributed to these mortality declines is not well understood

In this paper we investigate the hypothesis that mortality rates for the U.S. elderly (age 65 and older) were lower after 1966 than they would have been in the absence of Medicare. Policy changes provide a rich source of information concerning the effects of various interventions and can be used to develop powerful research designs to assess the impact of specific policies (Cook and Campbell 1979). A widely-used approach to address the consequences of a policy change is to use difference-in-difference type fixed effects estimators.

To estimate the effect of the introduction of Medicare, we first compare elderly versus younger groups in the U.S., pre- and post-Medicare. We next compare elderly pre-post changes in the U.S. to those in a set of 12 comparison countries. Finally, we combine these two approaches using a difference-in-differences-in-differences strategy that compares older versus younger pre-post changes in the U.S. to those in other countries. Our major contribution is to compare U.S. mortality patterns with a large set of otherwise similar comparison countries that did not experience large changes in health insurance programs for the elderly during this period. We do this by exploiting the new availability of high quality, internationally comparable mortality data from the Human Mortality Database. The countries included in the comparison are Austria, Canada, Denmark, Finland, France, Germany (West), Italy, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom. These are all industrialized countries with representatively elected governments, and all had widespread government or employer-based health insurance during this period.[1] If we find similar age patterns in mortality changes in both the U.S. and other countries, this would suggest that Medicare induced expansions of insurance to uncovered populations could not explain U.S. mortality patterns.

The Medicare Program

Medicare was established by Title XVIII of the Social Security Act in 1965. When Medicare began in 1966, an entire class of Americans – those ages 65 and older – was guaranteed financial access to health services. Medicare was passed as an extension of Social Security, with goals of reducing poverty among the elderly as well as providing improved access to health care.[2] In the mid-1960s, the elderly were more likely to be poor: in 1966, 28.5 percent of the elderly lived at or below the poverty level, compared with 14.7 percent at or below poverty for the nation (Pauly 1986).

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[1] We considered including Japan in the analysis, but Japan had significant changes in national health insurance policies affecting only the elderly in the same period that Medicare was introduced (Ikegami 1996).
[2] The Medicaid program, which primarily provides health care to poor women and children but also to some indigent elderly, was authorized at the same time but did not become widespread until the early 1970s.

Health insurance is the main payer of health care in the United States. Figure 1 shows health insurance coverage in 1963, 1970 and 1976 for men and women ages 50-64, 65-79 and 80-94 based on National Health Interview Survey data. In 1963, approximately 75 percent of both men and women aged 55-64 had some health insurance, compared with 58 percent of men and women aged 65-79 and approximately one third of the oldest group of men and women. Medicare changed this dramatically. Coverage for those age 65 and older is almost universal in 1970 and 1976.

By providing near-universal health insurance for the elderly, Medicare reduced the price of care, and increased access to and use of health care. Access to health care clearly improved for the elderly. For example, hospital discharges for the elderly increased from 190/1000 in 1964 to 350/1000 in 1970 (Moon 1996). Quality of care may also have improved. Friedman (1973) reported that after Medicare began, elderly breast cancer patients were much more likely to have received both surgical and radiation treatments rather than only one form of treatment. This increased access and use of health care should incease survival probabilities among the previously-uninsured elderly, thereby reducing mortality rates.

For the purposes of the present investigation it is also useful to consider the size of the post-Medicare growth in U.S. health care expenditures in comparison with other countries. In fact, OECD (2002) data indicate that most of our comparison countries also increased expenditures sharply during this period, particularly during the 1970s. Despite the perception by some that Medicare caused a much more rapid growth in national health care expenditures in the U.S., in fact only Canada and Switzerland had lower growth rates among the 10 countries which we were able to compare during the 1960s and 1970s (Figure 2).[3] A more accurate description

[3] OECD did not publish health expenditure data for the Netherlands, Denmark and Italy in 1960 and 1970, so they are not included in these figures.

of relative expenditures is that the United States already had substantially higher per capita expenditures than other countries in 1960, prior to Medicare, and it was not until the 1980s that the United States expenditure growth again began to rapidly outpace other countries. Available data are not able to show what the more important comparison is for our purposes, however, and that is how expenditures on the *elderly in the United States* post-Medicare changed compared to the young and elderly in other countries. We hypothesize that health care expenditures for U.S. elderly increased much more rapidly after Medicare than was the case in other countries, but we do not have detailed international comparative data to explore this hypothesis in the present paper.

Conceptual links from insurance to mortality

Medicare can be hypothesized to improve health via several different pathways (Figure 3). First, by lowering financial barriers to health care, it is expected that Medicare increased the use of medical care (moral hazard effects of insurance). Many studies have found non-trivial price elasticities of demand for medical care in the United States (e.g., Manning, 1987). As noted above, there is evidence of increased use of the health system and of increases in treatment of the elderly soon after Medicare began. Lichtenberg (2002) reports a sharp increase in physician visits at age 65, continuing at about 2.8 percent annually to age 75. (See also Hadley 2002).

Second, Medicare could also affect health by reducing elderly poverty.[4] Income is strongly associated with many non-medical health inputs not provided by Medicare, such as

[4] Medicare was designed to improve the economic conditions of the elderly by reducing catastrophic health care expenditures. At the signing of the Medicare Bill in 1965, President Johnson stated, "No longer will older Americans be denied the healing miracle of modern medicine. No longer will illness crush and destroy the savings that they have so carefully put away over a lifetime so that they might enjoy dignity in their later years."

housing quality, home health and long-term care. One wealth effect of Medicare was as an entitlement valued at the cost of the insurance premium; however, even given large income elasticity estimates, this was probably not large enough to markedly increase health inputs for the average person. More important may have been the role of insurance in avoiding catastrophic expenditures, as it is likely that before Medicare many sick elderly had to forego other important non-Medical inputs in order to finance their medical care. Medicare, along with other government programs directed at the elderly, helped to significantly reduce the rates of poverty among the elderly (Preston 1984). It is plausible that U.S. elderly longevity was extended post-Medicare through this pathway.

Third, it is possible that the sharp increase in post-Medicare health expenditures in the United States led to improvements in the overall health care infrastructure. Fuchs (1999) reports research showing that Medicare and Medicaid resulted in a 75% increase in the volume of services reimbursed on a cost basis. Fuchs (1999: 94) notes, "After 1965, hospital expenditures started to explode. Between 1965 and 1971 per capita expenditures grew at approximately 14 percent annually." The flow of government health care funds could be used to upgrade most aspects of hospital care, including pay and investments in new technologies. This is important to consider for the present analysis not only because of the resulting effects on elderly health, but because this could potentially have improved non-elderly health as well (e.g., intensive care units grew rapidly in the early 1970s).

Finally, the expansion of health care insurance, including Medicare and Medicaid, affected development of new medical technologies. Because Medicare greatly increased insurance coverage among the population age 65 and older, it is likely that as a result of Medicare many technologies for elderly health problems became profitable to develop that otherwise would not have been developed as quickly, if at all (Weisbrod 1991). Lichtenberg (2002) argues that the primary factor in the declining mortality rates since 1960 was technological advance, measured by research and development in the pharmaceutical industry. He also shows evidence consistent with the hypothesis that federal spending on health care -- Medicare is the largest federal health program -- also had a significant effect in declining mortality rates.

If these increases in funds also affected the development of new medical technologies such as new drugs and advances in cardiac care, then this could have improved health for the non-elderly as well. Given the structure of Medicare, however, it is likely that technological change was age-biased. Furthermore, the possibility must also be taken into account that technological change induced by the U.S. Medicare system could also have spilled over to improve mortality in other comparison countries as well.

In our analyses, such spillovers to comparison groups would imply that our results underestimate the total mortality benefits of introducing the U.S. Medicare program. In the extreme, if there is complete technological spillover, then our   Unfortunately, the literature thus far has been unable to devise appropriate empirical strategies for disentangling the effects from insurance-induced access improvements from insurance-induced technological change.

Again this is important to consider for our analysis not only because of potential effects on the U.S. elderly, but because of the potential technological spillover benefits for other populations. In particular, technological change may also have led to mortality improvements among the elderly in our comparison countries, although the speed of diffusion may have been quite different across countries. Further research will be necessary to better understand to what extent our analyses underestimate the total effect

For many purposes it is crucial to distinguish the potential role of public insurance programs such as Medicare in effecting health through both of these pathways. For example, the distributional effects are different in these pathways. If the improved access to health care is important, then Medicare is likely to have had larger impacts on poorer groups who were less likely to be insured in the absence of Medicare. If the technological development is important, however, then higher socioeconomic groups may in fact be better positioned to capture the gains from induced technological progress in medicine (Goldman and Lakdawalla, 2001).

Medicare has been associated with at least part of the declining mortality rates in a number of studies (Preston 1984; Cassel et al. 1999; Fuchs 1999; Gornick et al. 1996). In spite of the strong association, it is difficult to disentangle the effects of the Medicare program on mortality rates from the effects of other contemporaneous changes. There have been relatively few formal tests of the relationship. Friedman (1973) examined mortality rates from 1965 through 1969, reporting a modest decrease in white male mortality over age 65, but no effect among females. Drevenstadt (2000) estimated mortality rates subsequent to Medicare based on the trend from 1960 to 1966, compared these estimates with mortality subsequent to 1966, and interpreted the difference as a possible function of Medicare. His results suggest that mortality would have been higher had Medicare not been introduced.

Empirical Evidence on Health Effects of Insurance

Authors such as Fuchs (1974) have long argued that, holding technology constant, marginal increases in medical care access are likely to have only small impacts on health outcomes. McKeown (1979) argued that technological innovation in medicine have had little historical impact on health improvements, although subsequent work has disputed his findings.

Rigorous empirical testing of these hypotheses, however, has proven difficult. A 1992 literature review (Office of Technology Assessment, 1992) concluded that although there were many associations documented in the literature between insurance and health, very little of this literature could be interpreted causally.

The frequently - cited exception to this is the RAND Health Insurance Experiment (Brook, 1984?), which randomized individuals to health insurance plans with different coinsurance levels for 3-5 years. While the resulting out-of-pocket price variation generated substantial demand elasticities, the extra utilization in the more generous plans did not appear to cause substantial health improvements, except perhaps in small sub-samples of children and the chronically ill. The study is not directly applicable to the elderly, however, as the study only included those under age 65. Nevertheless, these controversial results are frequently cited by those critical of medical approaches to improving population health.

More recently, a handful of additional quasi-experimental studies have further investigated the impacts of public insurance programs, particularly among the poor. In a recent literature review of these, Meltzer and Levy (2001) conclude that while health insurance expansions have some significant causal effects on health outcomes, those effects tend to be quite small.

DATA AND METHODS

Internationally Comparable Mortality Data

Mortality data for this analysis are national-level age-sex-year specific mortality rates from the Human Mortality Database (www.mortality.org), a joint project of the Department of Demography at the University of California, Berkeley and the Max Planck Institute for

Demographic Research in Rostock, Germany. Complete details on data and methods used to calculate the mortality rates are available at the site.

The data are at the national level for women and men, but they do not distinguish by race or ethnicity or any other socioeconomic variables. In this analysis, we use period central mortality rates from 1959 though 1980 for ages 50 through 94. We begin the analysis in 1959 because that is the first year data are available for the United States. The data are recognized as being of high quality, although there are concerns about mortality rates at the oldest ages in the United States and Canada (Kannisto 1994).

Research Design

The main causal question we address is: how much did elderly mortality improve after Medicare's implementation? Our estimation strategy is analogous to a "difference-in-differences" (DD) quasi-experimental design, implemented in a discrete time hazard regression context. The nature of Medicare's implementation allows for several quasi-experimental analyses, using multiple control groups, to better understand the range of the likely causal effect.

The first (DD) model is an age-comparison in the U.S.: the pre-post Medicare change in elderly mortality, compared to the change over the same period among control age-groups (under age 65) in the U.S. The second type of comparison is a difference-in-difference-in-differences (DDD) model that exploits international comparisons to control for underlying non-Medicare secular trends causing elderly mortality to decline at a different rate than non-elderly mortality. This can be interpreted in two ways: as the young-old pre-post age comparison in the U.S.

relative to that same comparison in control countries, or equivalently as an international elderly pre-post comparison relative to that same comparison among the non-elderly.[5]

To illustrate how these comparisons are implemented in the regression context, we begin with the simplest example of the young-old pre-post DD comparison in the U.S. Denote *Pre1966* as the "pre" period before Medicare's 1966 inception, and *Post1966* as the "post" period after Medicare began. Similarly denote *Over65* as those ages 65 and over who were age-eligible for Medicare, and *Under65* as the control age group not eligible for Medicare. We assume that the mortality rate *M* improves non-linearly over time, and consistently with the underlying binomial nature of the data, we model this using a logistic transform of mortality $m = \ln[M/(1-M)]$. The mortality rate improvement for elderly health associated with Medicare is then:

$$\Delta m_{\text{Over65}} = m_{\text{Post1966,Over65}} - m_{\text{Pre1966,Over65}}$$

Obviously many factors would likely affect Δm_{Over65} in addition to Medicare, including any secular trend decreases in mortality over time, such as those due to technological change or economic growth. Assuming that such changes affect the young and the old proportionately, those non-Medicare effects can be captured by the change over time in mortality for the *Under65* group:

$$\Delta m_{\text{Under65}} = m_{\text{Post1966,Under65}} - m_{\text{Pre1966,Under65}}$$

The simple difference-in-differences estimator using the young as controls is then:

$$\beta^{DD}_{US} = \Delta m_{\text{Over65}} - \Delta m_{\text{Under65}}$$

$$= (m_{\text{Post1966,Over65}} - m_{\text{Pre1966,Over65}}) - (m_{\text{Post1966,Under65}} - m_{\text{Pre1966,Under65}})$$

[5] This DDD model is particularly helpful for controlling for age-biased technological change (non Medicare-induced), although only to the extent that the age-biased change was similar across both the U.S. and the control countries.

This difference-in-differences estimator can be equivalently represented in regression notation as a grouped logit regression of mortality. The key explanatory variable is an indicator of Medicare eligibility, $Medicare_{year,age} = Post1966_{year} * Over65_{age}$, where in this simple DD example *year* indexes the year of data (*pre* or *post*) and *age* indexes the age group (*Under65* or *Over65*):

$$(1) \qquad m_{year,age} = \alpha + \beta^{DD}_{US}\, Medicare_{year,age} + \gamma Post_{year} + \delta Over65_{age} + \varepsilon_{year,age}$$

In this regression specification β^{DD}_{US} continues to the key parameter of interest, and this parameter will be identical to the above difference-in-differences estimator in applications with only two age groups and two periods.

It is quite plausible, however, that underlying secular mortality trends move at different rates for different age-groups in this period. In this case the simple young-old comparison will no longer be unbiased. In particular, it appears that there was age-biased technological change that favored the elderly; if this technology was developed independent of Medicare, this would cause over-estimation of the causal Medicare effect. However, under the assumption that the relative young-old trends (in the absence of Medicare) would have been similar in the United States and other countries during this period comparison countries can be used as an additional control group to potentially ameliorate this bias.

This control for age-biased change can be constructed analogously to the U.S. DD estimate, but using data from other countries:

$$\beta^{DD}_{nonUS} \quad = \Delta m_{Over65,\ nonUS} - \Delta m_{Under65,\ nonUS}$$

The DDD estimator then subtracts the non-U.S. relative growth across ages from the U.S. growth:

$$\beta^{DDD} = (\beta^{DD}_{US} - \beta^{DD}_{nonUS}) = (\Delta m_{Over65} - \Delta m_{Under65})_{US} - (\Delta m_{Over65} - \Delta m_{Under65})_{nonUS}$$

This DDD model can be estimated in the regression context using data on the young and old both pre and post Medicare in both United States (*US*) and comparison countries (country indexed by *c*), where the Medicare eligibility indicator of interest is now constructed as $Medicare_{year,age,c} = Post1966_{year}*Over65_{age}*US_c$:

$$\text{(2)} \quad m_{year,age,c} = \alpha_0 + \beta^{DDD}Medicare_{year,age,c} + \gamma_1 Post_{year}*US_c + \delta_1 Over65_{age}*US_c + \alpha_1 US_c + \beta_2\, Post1966_{year}*Over65_{age} + \gamma_2 Post_{year} + \delta_2 Over65_{age} + \varepsilon_{year,age}$$

Although equations (1) and (2) are valid DD and DDD representations, they may be inefficient in their parsimony of the age and year controls. Given that our data are observed annually for single-year age groups, we can explore whether our specification is improved when replacing the *Post* and *Over65* dummy variables with vectors of single-year time and age dummies. Similarly, since previous work such as Lee and Carter (1992) have indeed found age-variation in secular mortality trends, we can also explore richer specifications of the $Post1966_{year}*Over65_{age}$ interaction term in equation (2) by replacing it with a vector of age-specific year trend terms.[6]

We estimate these models as a maximum likelihood grouped logit. For example, with a simple pre-post young-old comparison in equation (1) there are only four data cells, containing the population *p* and number of deaths *d* for each age and time period. The grouped logit model expands the likelihood function by the number of individuals surviving or dying in each cell. For a given age-year cell (such as elderly in the pre period) the likelihood function *L* for that cell is:

$$L = F(z)^{d}(1- F(z))^{p-d}$$

where $z_{year,age} = \alpha + \beta\, Medicare_{year,age} + \gamma Post_{year} + \delta Over65_{age}$ and $F(z) = 1/(1+e^{-z})$. This is equivalent to an individual-level mortality logit, but is computationally less cumbersome given that we have millions of identical observations within each cell. Our actual estimated models are only slightly more complex than this four-cell example, as we retain our data measured at the individual year-age-sex level.

Note that an alternative interpretation of this grouped logit model is that it is a discrete-time Cox proportional hazards model, where including the full set of year dummies implies a fully non-parametric baseline hazard (Cox 1972). This discrete time model converges to the usual continuous time Cox proportional hazards model as the time unit (year in our case) approaches zero. Thus our DD and DDD framework implemented via grouped logit regression is quite naturally related to traditional survival modeling with time-varying covariates. It is worth noting that the mortality modeling literature includes extensive analysis of functional form choice, particularly as related to mortality patterns in old age; although the Cox-type model specified here is not as flexible as other potential models, our inclusion of a full set of age dummy variables alleviates functional form concerns for our purpose of estimating Medicare marginal effects.

A final modification of our specification is to allow the Medicare effect to vary by sex, age, and period. Specifically, we estimate separate models comparing the early years after

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[6] Our tables incorporate the year and age dummy vectors, although results are robust without them. We have conducted sensitivity analyses to including age-specific year trends in the models and the effects on the results are

implementation (1967-1973, denoted as *post1*) to the *pre* years (1959-1965), and then comparing the later years (1974-1980, denoted as *post2*) to the *pre* years. Finally, we estimate separate age and year models for different age groups, first comparing 65-79 year olds to the younger group (ages 50-64), and then comparing the oldest old (80-94) to the younger 50-64 age group. This enables more refined testing of which periods and groups experienced the most rapid declines in association with Medicare. Finally, we fully stratify all of these models by sex.

RESULTS

Descriptive Analysis of Demographic Patterns

Mortality rates at older ages declined across the 20th century in the U.S. with much of the change coming over the last 30 years. Drevestadt (2000) reports that life expectancy at age 65 increased by 5.8 years between 1900 and 1997, with 3.1 years (53.4 percent) of the increase after Medicare began. Table 1 lines 1-3 show the mortality rates for the three age groups (50-64, 65-79 and 80-94) for the period before Medicare (1959-1965), the period immediately following the implementation of Medicare (1967-1973), and for the subsequent period (1974-1980). Lines 4-5 of Table 1 shows the differences in mortality rates between the period prior to Medicare and the two later periods. Significant reductions in mortality are apparent, especially between the earliest and latest periods for women aged 65-79 and 80-94. Figure 4 shows a more detailed picture of the pattern of decline in mortality between 1959 and 1980.[7] For all age groups, mortality rates began declining sharply around 1970. While there are a number of possible reasons for the decreasing mortality rates, including advances in medical technologies and behavioral changes such as smoking cessation, this acceleration in the decline of mortality rates

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imperceptible, thus they are not included in the specifications reported.

[7] Note that mortality is graphed relative to 1966, the year Medicare began.

among older Americans coincides (after a short lag) with the beginning of the Medicare program.

Figure 5 shows mortality rates by age groups in the United States relative to the combined mortality rates of the 12 comparison countries. Across the period, mortality rates in the United States are notably higher under age 64, slightly higher at ages 65-69, crossing-over to lower mortality rates after age 70. Mortality rates among the oldest-old are consistently lower in the United States. This pattern at oldest ages is consistent with the pattern reported by Manton and Vaupel (1995), who show that, at least as early as the 1968 when their data began, life expectancy at age 80 and survival from age 80 to 100 in the United States was significantly higher than in Sweden, France, England and Japan. They suggested that this advantage in mortality at these ages might be in part due to greater access to health care made possible by Medicare. It is notable, however, that Figure 5 does not indicate any clearly visible trend breaks in U.S. elderly mortality in 1966.

The Appendix also contains figures comparing the United States mortality to each of the comparison countries individually. Particularly notable as an outlier is Japan, where mortality among the younger age groups increased unusually rapidly over this period. We do not fully understand this phenomenon, so we have chosen to drop Japan from the subsequent regression analysis that groups all countries together. We do this both because of this unusual pattern and because Japan introduced an elderly insurance program between 1968 and 1972, making it an inappropriate comparison. (Our main results are all robust to including Japan or not.)

DD and DDD regression results

Results of the DD analyses within the United States and the combined 12-country (without Japan) control group and the DDD analysis are also in Table 1. Lines 6-7 show the DD pre-post comparison of old versus young within the United States. The estimates for women show significant differences of between 6 and 10 percent improvement, consistent with a reduction of mortality rates attributable to the introduction of Medicare. The pattern for men is not as clear, with only men aged 80-94 having a substantial reduction in mortality. For both male age groups in the later period, there is a small but significant increase in the relative mortality rates relative to the period prior to Medicare.

Lines 8-10 show the estimates of mortality of the older groups for the combined 12-country control group, and lines 11-12 show the mortality rates changes of the older age groups relative to the young group. In the absence of age-specific shocks after 1966, such as age-biased technological change, DD models of pre-post elderly versus young mortality changes only in these non-U.S. countries should yield coefficient estimates of zero. In fact, lines 13-14 show significant age differences in mortality trends in these non-U.S. countries. For non-U.S. women, elderly mortality improved 2-9 percent following 1966 compared to the young's change; for non-U.S. men, estimates ranges from a 2 percent improvement to a 4 percent worsening. This suggests that the U.S. DD results are not attributable solely to the Medicare policy change. Under the assumption that the determinants of non-U.S. trends also affected the U.S. similarly, however, our DDD models will provide superior estimates of the Medicare effect.

Lines 17 and 18 of Table 1 show the DDD estimates, comparing age groups eligible for Medicare (65+) relative to a younger group after the introduction of Medicare (1966) relative to an earlier period in the United State where Medicare is in effect, relative to the same differences among a group of developed countries where there was no similar change in national health insurance policies in the late 1960s. In seven of the eight cells, mortality rates are significantly lower, ranging from 1 to 6 percent lower. In the final cell (men aged 80-94 in 1974-1980 relative to 1959-1964), the difference is 3% higher. Overall, these results are consistent with a positive effect of the introduction of Medicare on mortality rates.

We also estimated DDD models of mortality for each of the countries individually relative to the pattern in the United States. These results are shown in Table 2. Most of these specific country results are consistent with the results of the DDD models with the 12 countries combined, showing a significant decline in mortality rates of the two age groups of Medicare-eligible men and women relative to the mortality rates of men and women ages 50-64 in the United States relative to the control populations. For several of the largest countries (e.g. France and Germany), the estimates in each age-sex cell support the hypothesis of a reduction in mortality rates associated with the introduction of Medicare.

However, some of the countries have specific age-sex cells with estimates in the opposite direction than in the grouped estimate. For example, the result for Canada for women ages 65-79 for the period 1967-1973 (relative to the earlier period) has a coefficient of 0.0130, compared to the coefficient of –0.0248 in the all-country model. Other country-specific differences where the general pattern is inconsistent, with some positive and some negative estimates, are seen in the results for the United Kingdom (notably for women), Norway, Sweden and the Netherlands. The pattern for Denmark is consistently opposite of the estimates for the grouped model, indicating that elderly mortality dropped more quickly relative to younger groups in Denmark than in the United States. Upon further inspection, it is apparent that this last results is driven not by differential elderly mortality trends in Denmark versus the U.S., but rather by unusually slow mortality improvements in Denmark among the age 55-64 control group (see Appendix).

DISCUSSION

At the national level, mortality in the United States clearly dropped among the population age 65 and older, those covered by Medicare, the near-universal health insurance program for the elderly. We are able to carefully compare the changes in mortality rates after the introduction of Medicare in 1966 of the eligible population relative to groups not eligible to produce these estimates of a significant reduction in mortality that could be attributed to Medicare. The increased use of health services is the most widely cited mechanism that could account for this reduction of mortality. The second major mechanism is the indirect effect of technological changes made possible by the large increases in health care capital resulting from the entry of the U.S. government as a third-party payer. To the extent that such technological change also spilled over to younger groups or to the comparison countries, our estimates may be lower bounds of the true effects.

The DD model within the United States examines the relative changes in mortality between eligible age groups (65-79 and 80-94) men and women compared with men and women ages 50-64 for two periods after 1966 relative to 1959-1965. These results show a significant reduction in mortality rates for all but one of the age-sex comparisons attributable to Medicare. The mortality reductions were between 4 and 9 percent for women and between 1 and 4 percent for men. We add another level of control by adding the mortality rates in 12 industrialized countries in the DDD analysis. With this added level of control, we again found significant reductions in mortality in all but one of the age-sex comparisons, with reductions ranging from 1.3 and 5.8 percent for women and between 1 and 4.8 percent for men.

One limit to the analysis is our inability to examine the potential effects of Medicare by race. There is evidence that the initial effects of Medicare on African Americans was limited, a difference that may persist. In the period immediately after Medicare began, many hospitals in the south were slow to gain eligibility because of their reluctance to integrate. Even after integration, significant differences persist in the access to health services for African American elders who are eligible for Medicare. Because health services access is the presumed mechanism, these differentials in access may be reflected in mortality rates. Data by race within the United States are not yet available for the Human Mortality Database.[8] Further, it is not yet possible to examine other variations by socioeconomic status when comparing the United States with set of comparison countries.

An important lesson from our pattern of results is that comparisons between the United States and any single country may be quite misleading. For example, previous work has noted the similar mortality changes in the United Kingdom as in the United States, and used this to argue that Medicare may not have had important effects on United States mortality. After examining the larger set of comparison countries, however, such an inference would be premature. Our findings indicate that in comparison to the larger group of 12 other countries it may be plausible to infer a Medicare effect, but it will be important for future work to more carefully compare mortality determinants within each of these countries before more definitive conclusions can be drawn.

[8] One problem is that the 1960 Census aggregated all non-white persons into one category, making it more difficult to obtain denominators for the rates.

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Table 1: Mortality rates and difference estimates, relative to 12 comparison countries combined

		WOMEN			MEN		
Age Groups		50 - 64	65 - 79	80 - 94	50 - 64	65 - 79	80 - 94
	Analog	(A)	(B)	(C)	(D)	(E)	(F)
Mortality rate (per 1,000): United States							
(1) *pre*		9.54	35.82	127.59	18.76	57.90	158.93
(2) *post1*		9.11	32.44	116.25	18.52	57.05	152.91
(3) *post2*		7.98	27.31	99.22	15.74	50.39	139.50
Mortality change over time, vs. pre: United States							
(4) *post1*	(2)' - (1)'	-0.0461 ***	-0.1027 ***	-0.1059 ***	-0.0129 ***	-0.0157 ***	-0.0456 ***
(5) *post2*	(3)' - (1)'	-0.1798 ***	-0.2798 ***	-0.2833 ***	-0.1783 ***	-0.1469 ***	-0.1531 ***
DD: U.S. mortality changes, vs. young							
(6) DD: *post1*	(4) - (4A or 4D)		-0.0566 ***	-0.0597 ***		-0.0027 **	-0.0327 ***
(7) DD: *post2*	(5) - (5A or 5D)		-0.1000 ***	-0.1035 ***		0.0313 ***	0.0251 ***
Mortality rate (per 1,000): non-US							
(8) *pre*		8.05	38.52	15.55	15.45	55.37	17.77
(9) *post1*		7.39	34.40	14.19	15.00	56.10	17.04
(10) *post2*		6.63	29.32	12.65	14.03	52.62	16.26
Mortality change over time, vs. pre: non-US							
(11) *post1*	(9)' - (8)'	-0.0856 ***	-0.1174 ***	-0.1073 ***	-0.0302 ***	0.0139 ***	-0.0508 ***
(12) *post2*	(10)' - (8)'	-0.1946 ***	-0.2825 ***	-0.2402 ***	-0.0980 ***	-0.0538 ***	-0.1070 ***
DD: non-U.S. mortality changes, vs. young							
(13) DD: *post1*	(11) - (11A or		-0.0318 ***	-0.0217 ***		0.0441 ***	-0.0205 ***
(14) DD: *post2*	(12) - (12A or		-0.0879 ***	-0.0456 ***		0.0442 ***	-0.0089 ***
DD: Mortality changes, international comparison							
(15) DD: *post1*	(4) - (11)	0.0394 ***	0.0146 ***	0.0014	0.0173 ***	-0.0296 ***	0.0051 ***
(16) DD: *post2*	(5) - (12)	0.0148 ***	0.0026 **	-0.0431 ***	-0.0802 ***	-0.0931 ***	-0.0461 ***
DDD: Change in age difference over time -- international comparison							
(17) DDD: *post1*	(6) - (13)		-0.0248 ***	-0.0380 ***		-0.0469 ***	-0.0121 ***
(18) DDD: *post2*	(7) - (14)		-0.0121 ***	-0.0579 ***		-0.0128 ***	0.0340 ***

NOTES: The variables *pre, post1* and *post2* represent the time periods 1959-1965, 1967-1973, and 1974-1980, respectively. All calculations are weighted by the population of the single year of age-country cell, normalized over time. Difference estimates use the logistic transformation of crude death rates, indicated by, e.g. (1)'. "Analog" expressions refer to the rows and columns being differenced. "DD" implies differencing across age groups of the change over time in mortality in the U.S. (rows 6, 7) and non-U.S (rows 13, 14) populations, or across U.S. and non-U.S estimates of change over time (rows 15,16). "DDD" implies differencing of the U.S. and non-U.S. DD estimates of age and time differences in mortality. Analog differences are not exact because each cell is calculated from underlying data using regression methods. Statistical significance is indicated as: * p<0.1, ** p<0.05, *** p<0.01. Standard errors (not shown) are heteroskedasticity robust.

Table 2: Country-by-country DDD logit estimates of U.S. vs. non-U.S. pre-post differences in mortality for elderly relative to age 50-64 controls

	Women		Men	
Age Groups	65 - 79	80 - 94	65 - 79	80 - 94
Austria				
post1 vs. *pre*	-0.0841 ***	-0.0913 ***	-0.1138 ***	-0.0956 ***
	(0.0024)	(0.0025)	(0.0019)	(0.0023)
post2 vs. *pre*	-0.0941 ***	-0.1790 ***	-0.0571 ***	-0.0899 ***
	(0.0025)	(0.0025)	(0.0019)	(0.0023)
Canada				
post1 vs. *pre*	0.0130 ***	-0.0269 ***	-0.0174 ***	-0.0208 ***
	(0.0025)	(0.0025)	(0.0020)	(0.0024)
post2 vs. *pre*	-0.0123 ***	-0.0432 ***	0.0056 ***	0.0203 ***
	(0.0025)	(0.0026)	(0.0020)	(0.0024)
Denmark				
post1 vs. *pre*	0.0883 ***	0.1218 ***	0.0002	0.1110 ***
	(0.0024)	(0.0025)	(0.0020)	(0.0024)
post2 vs. *pre*	0.1639 ***	0.2080 ***	0.0483 ***	0.2109 ***
	(0.0025)	(0.0026)	(0.0020)	(0.0024)
Finland				
post1 vs. *pre*	-0.0667 ***	-0.0979 ***	-0.0092 ***	-0.0465 ***
	(0.0024)	(0.0024)	(0.0018)	(0.0022)
post2 vs. *pre*	-0.0364 ***	-0.0851 ***	0.0145 ***	0.0469 ***
	(0.0025)	(0.0025)	(0.0019)	(0.0023)
France				
post1 vs. *pre*	-0.0470 ***	-0.0631 ***	-0.0481 ***	-0.0158 ***
	(0.0025)	(0.0025)	(0.0019)	(0.0023)
post2 vs. *pre*	-0.0633 ***	-0.1419 ***	0.0072 ***	0.0383 ***
	(0.0026)	(0.0026)	(0.0020)	(0.0023)
Germany (West)				
post1 vs. *pre*	-0.0387 ***	-0.0658 ***	-0.0999 ***	-0.0692 ***
	(0.0024)	(0.0025)	(0.0019)	(0.0023)
post2 vs. *pre*	-0.0475 ***	-0.1095 ***	-0.0744 ***	-0.0478 ***
	(0.0025)	(0.0025)	(0.0020)	(0.0023)
Italy				
post1 vs. *pre*	-0.0474 ***	-0.0664 ***	-0.0802 ***	-0.0257 ***
	(0.0024)	(0.0025)	(0.0020)	(0.0023)
post2 vs. *pre*	-0.0854 ***	-0.1779 ***	-0.0399 ***	0.0015
	(0.0025)	(0.0026)	(0.0020)	(0.0024)
Netherlands				
post1 vs. *pre*	0.0138 ***	0.0013	-0.0307 ***	0.0835 ***
	(0.0025)	(0.0026)	(0.0020)	(0.0024)
post2 vs. *pre*	0.0289 ***	0.0195 ***	-0.0584 ***	0.1204 ***
	(0.0026)	(0.0027)	(0.0021)	(0.0024)
Norway				
post1 vs. *pre*	-0.0395 ***	-0.0497 ***	-0.0365 ***	0.0202 ***
	(0.0026)	(0.0026)	(0.0021)	(0.0024)
post2 vs. *pre*	0.0016	-0.0489 ***	0.0182 ***	0.1123 ***
	(0.0026)	(0.0027)	(0.0021)	(0.0025)

Table 2 (continued)

Sweden				
post1 vs. *pre*	-0.0150 ***	-0.0189 ***	-0.0018	0.0394 ***
	(0.0025)	(0.0026)	(0.0021)	(0.0024)
post2 vs. *pre*	0.0106 ***	-0.0202 ***	0.0652 ***	0.1257 ***
	(0.0026)	(0.0027)	(0.0021)	(0.0025)
Switzerland				
post1 vs. *pre*	-0.0570 ***	-0.0903 ***	-0.0484 ***	-0.0433 ***
	(0.0025)	(0.0025)	(0.0020)	(0.0023)
post2 vs. *pre*	-0.0369 ***	-0.1090 ***	-0.0190 ***	-0.0111 ***
	(0.0026)	(0.0027)	(0.0020)	(0.0024)
United Kingdom				
post1 vs. *pre*	0.0004	0.0095 ***	-0.0491 ***	-0.0275 ***
	(0.0024)	(0.0025)	(0.0019)	(0.0023)
post2 vs. *pre*	0.0122 ***	-0.0093 ***	-0.0179 ***	-0.0214 ***
	(0.0025)	(0.0025)	(0.0019)	(0.0023)

NOTES: Estimates are from the DDD regression specification. The variables pre, post1 and post2 represent the time periods 1959-1965, 1967-1973, and 1974-1980, respectively. Statistical significance is indicated as: * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Standard errors (shown in parentheses) are heteroskedasticity robust.

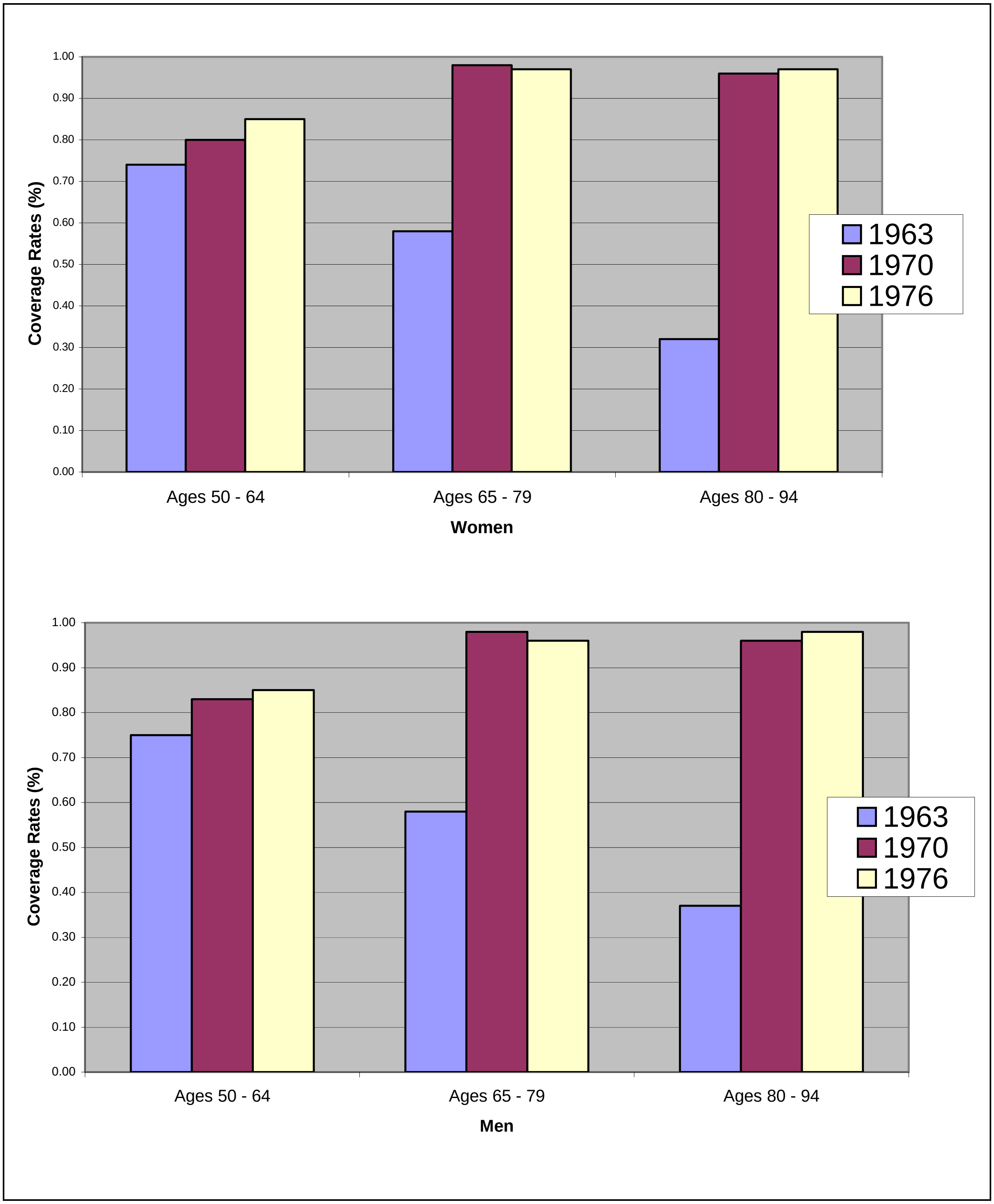


Figure 1: Trends in U.S. health insurance coverage

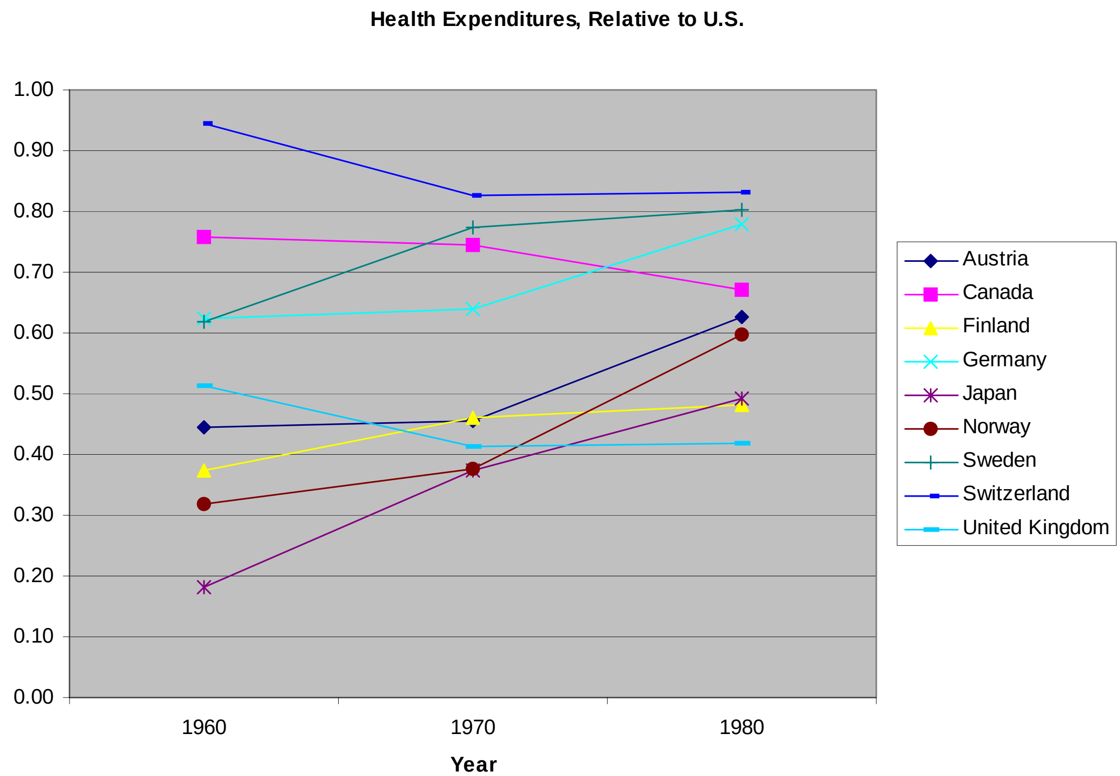


Figure 2: National health expenditures relative to U.S. (by PPP exchange rates), 1960-1980

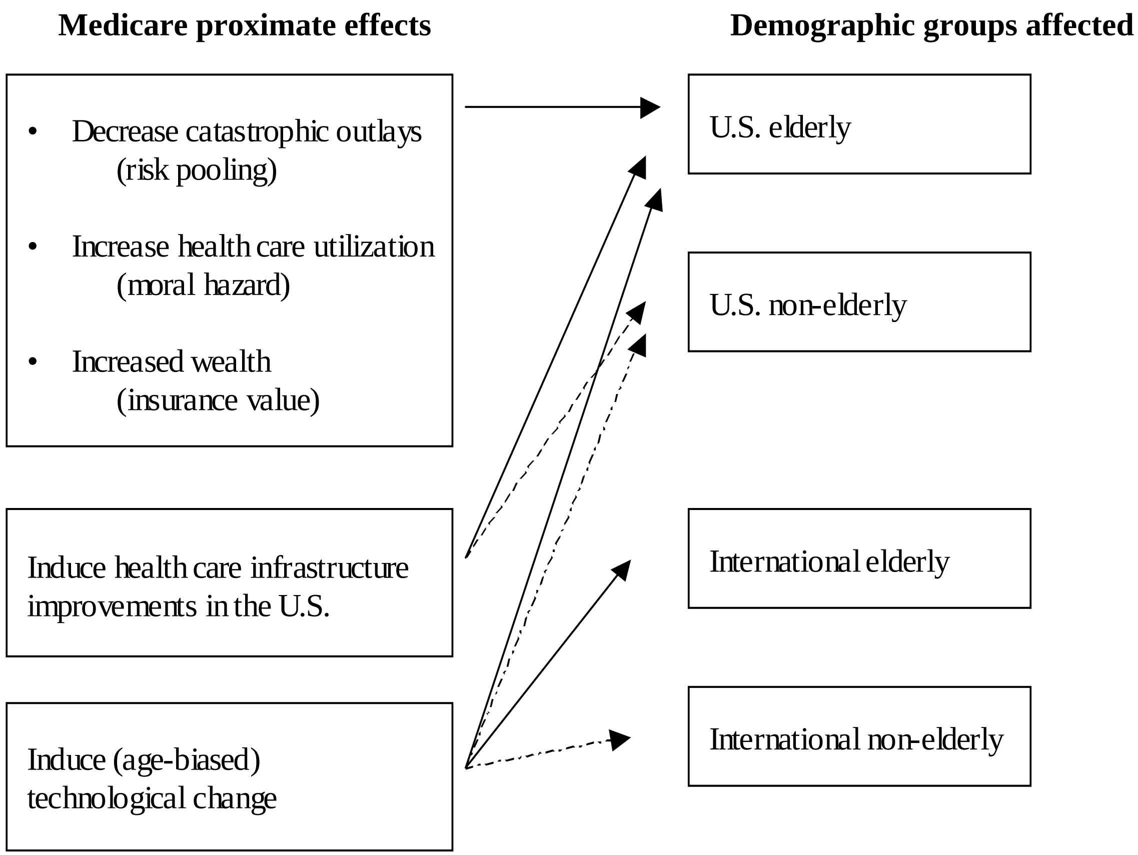


Figure 3: Pathways for Medicare effects

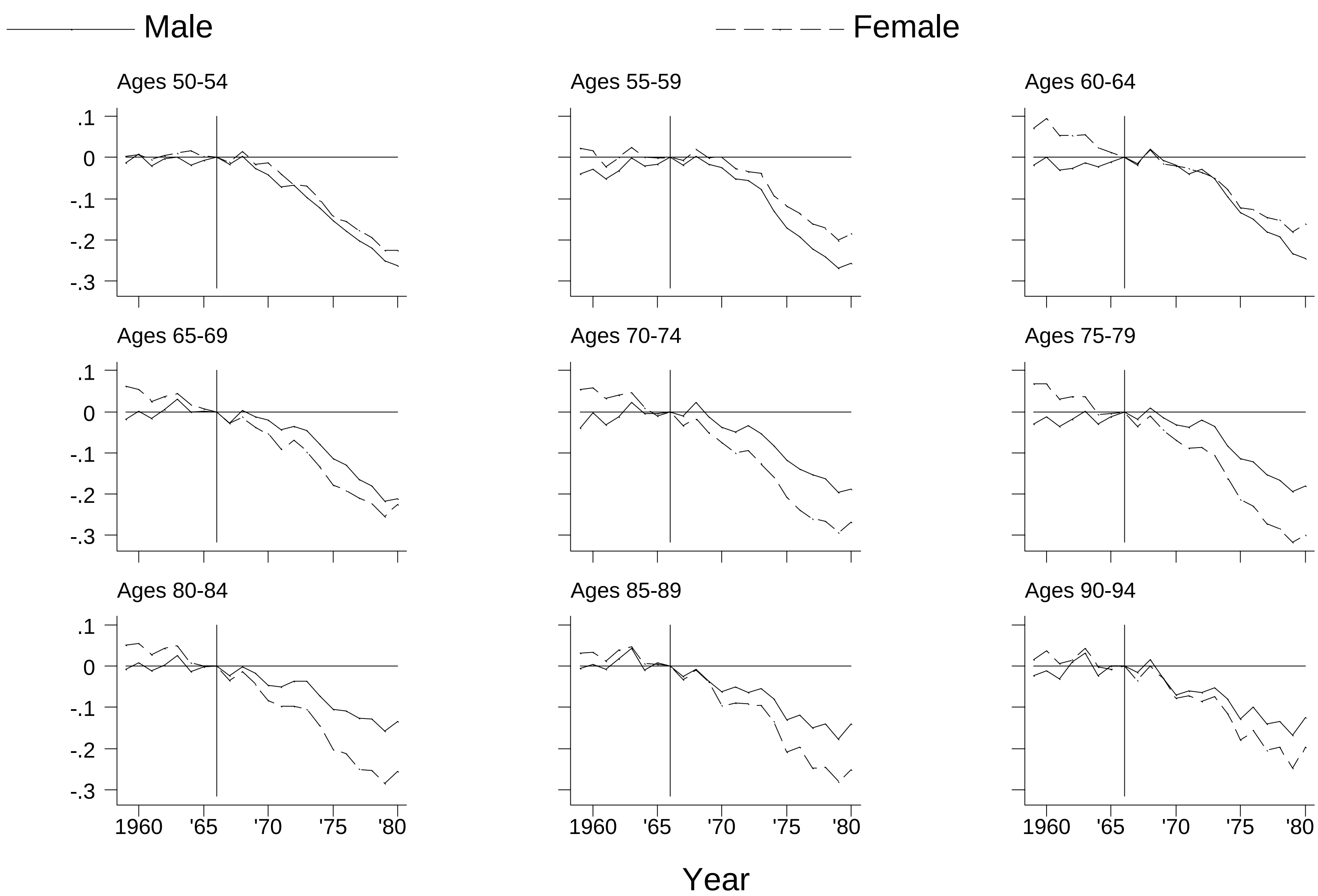
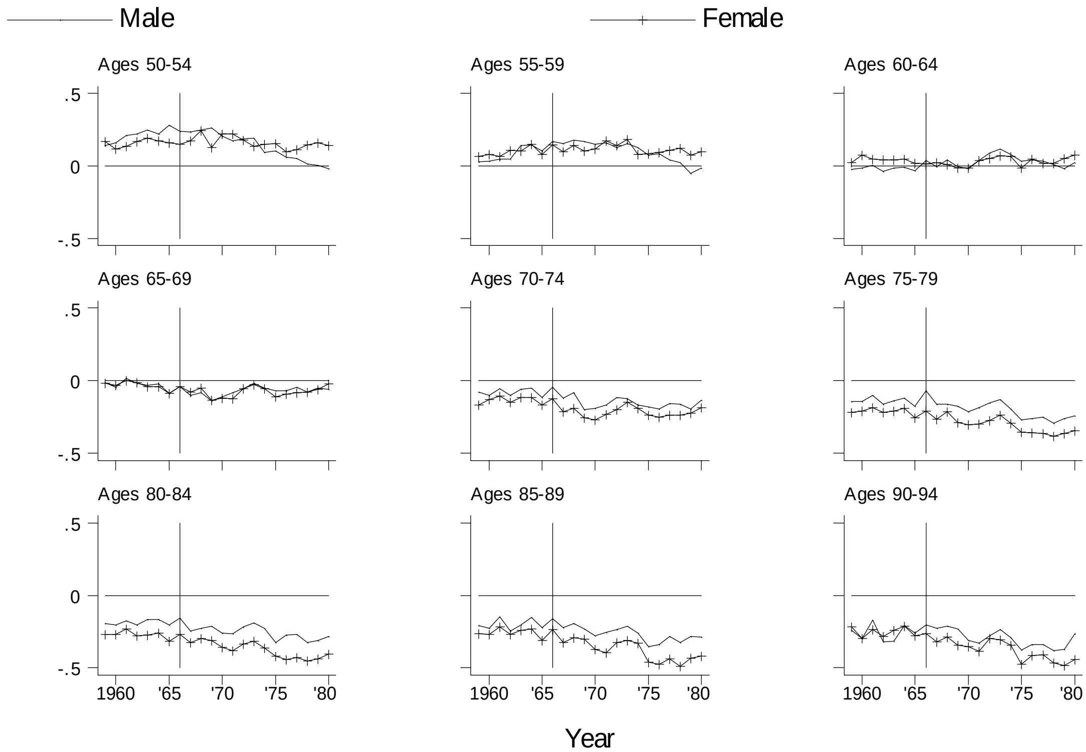


Fig. 4: U.S. Mortality Relative to 1966, by Year and Age

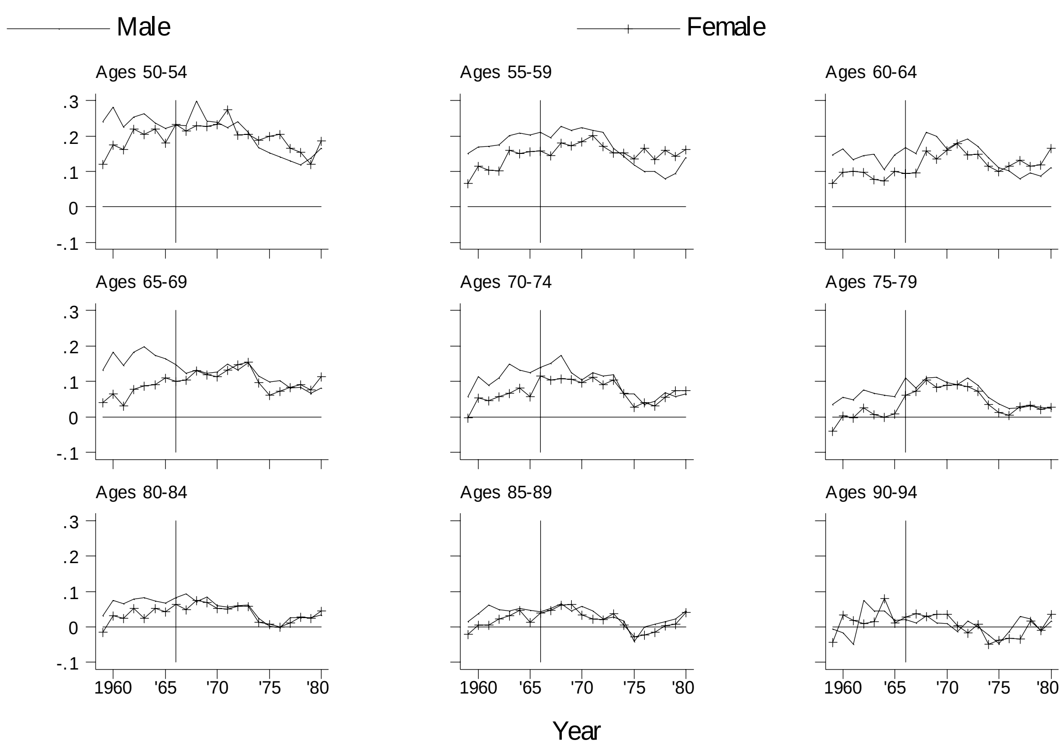
Fig. 5: U.S. Mortality Relative to Comparison Countries

Appendix

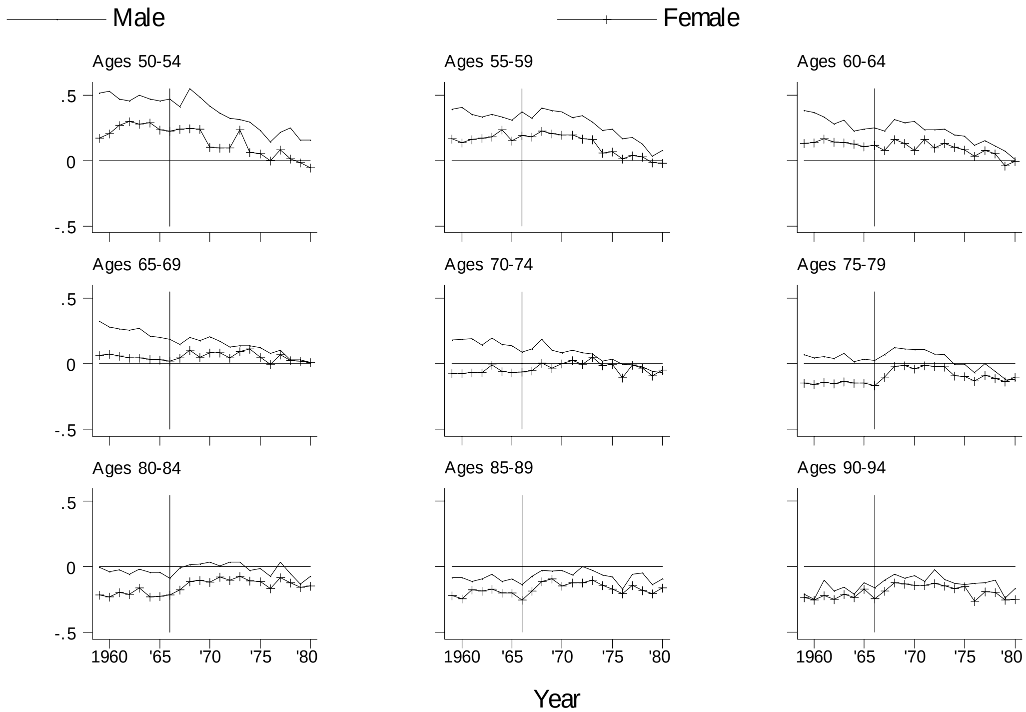
Graphs of U.S. Mortality Relative to Other Countries, by Country



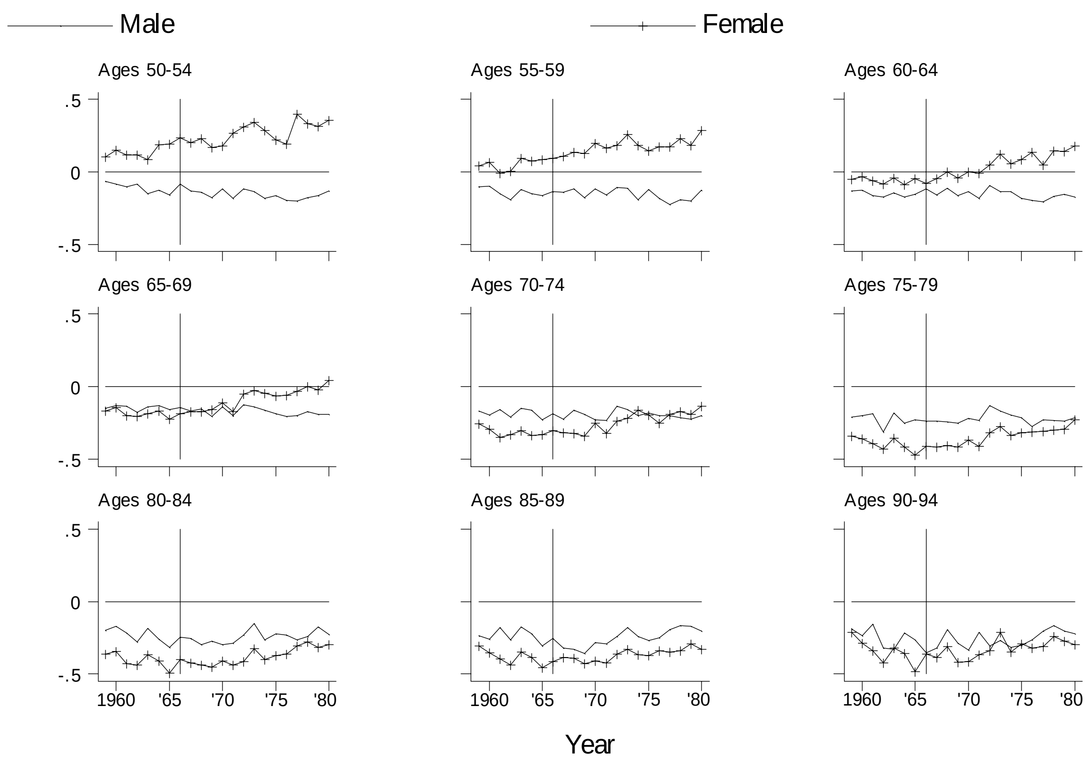
U.S. Mortality Relative to Other, by Year and Age: Austria



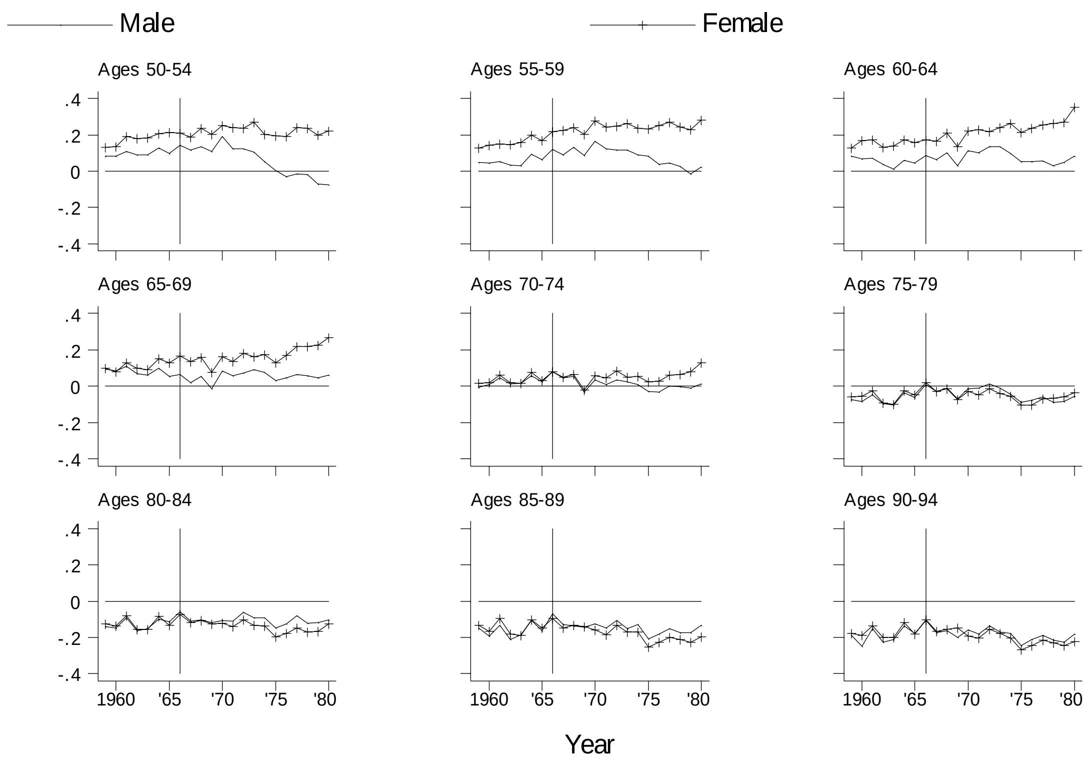
U.S. Mortality Relative to Other, by Year and Age: Canada



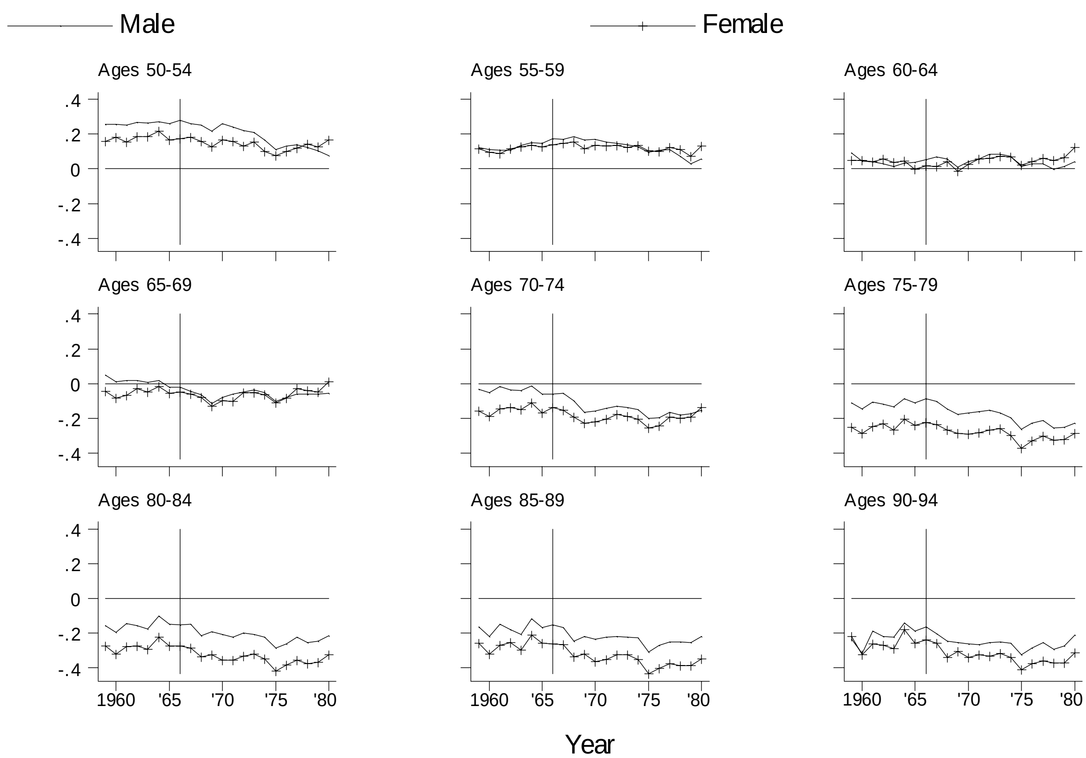
U.S. Mortality Relative to Other, by Year and Age: Denmark



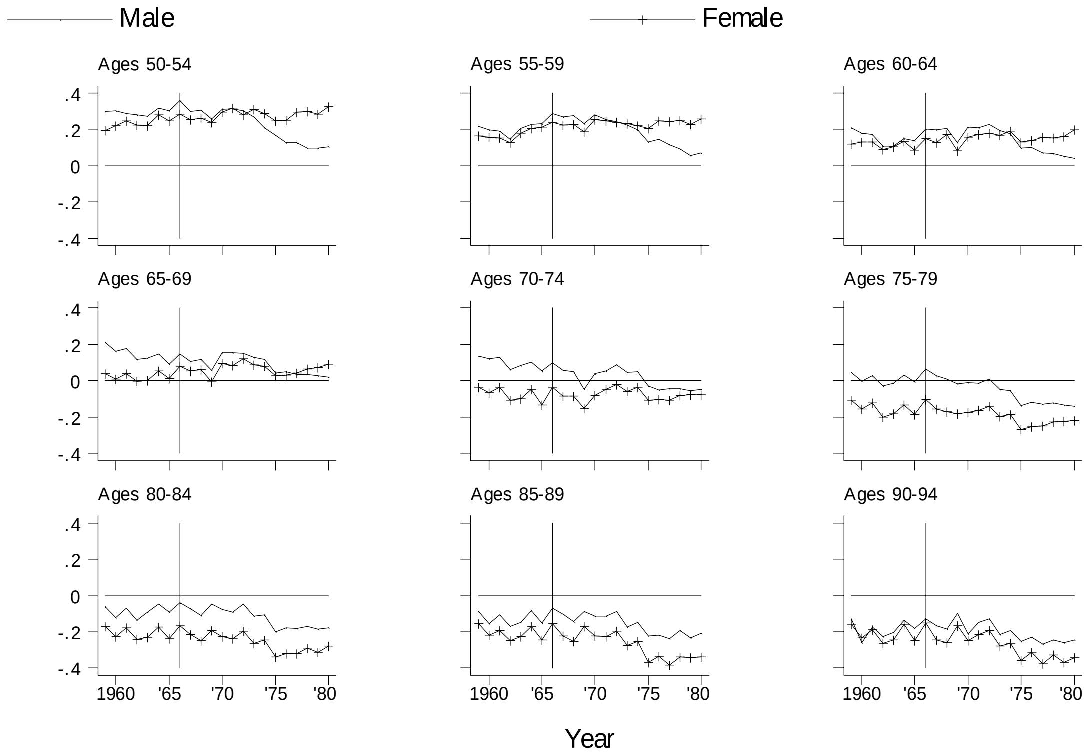
U.S. Mortality Relative to Other, by Year and Age: Finland



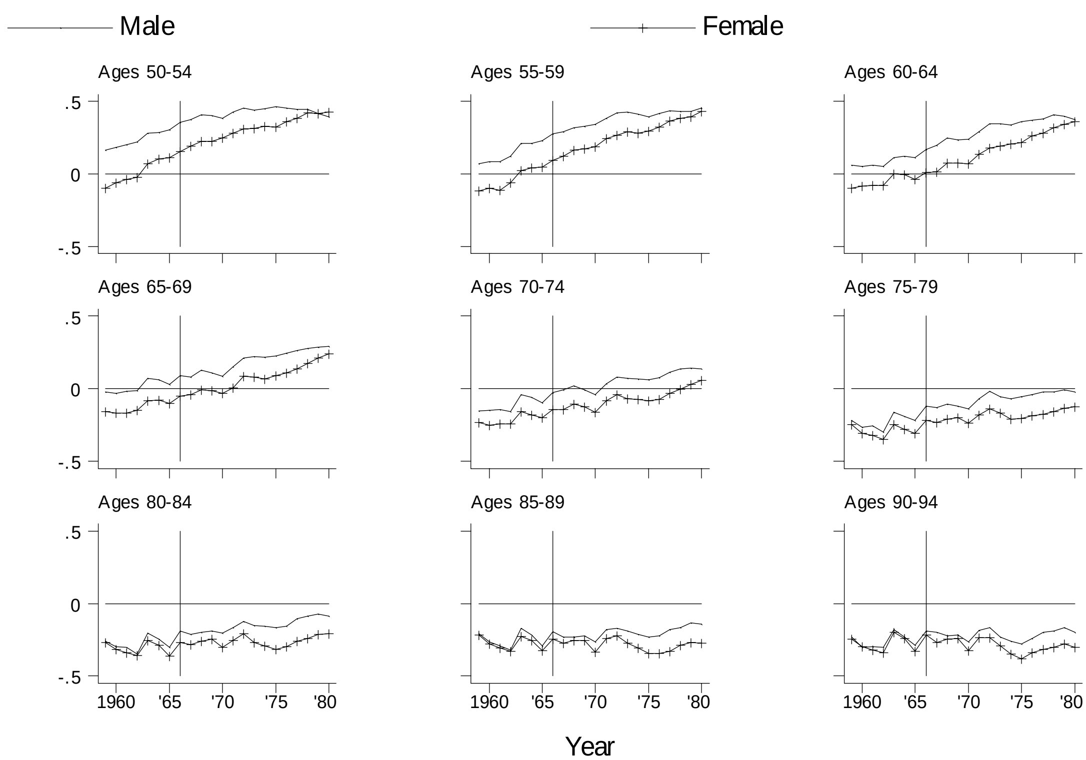
U.S. Mortality Relative to Other, by Year and Age: France



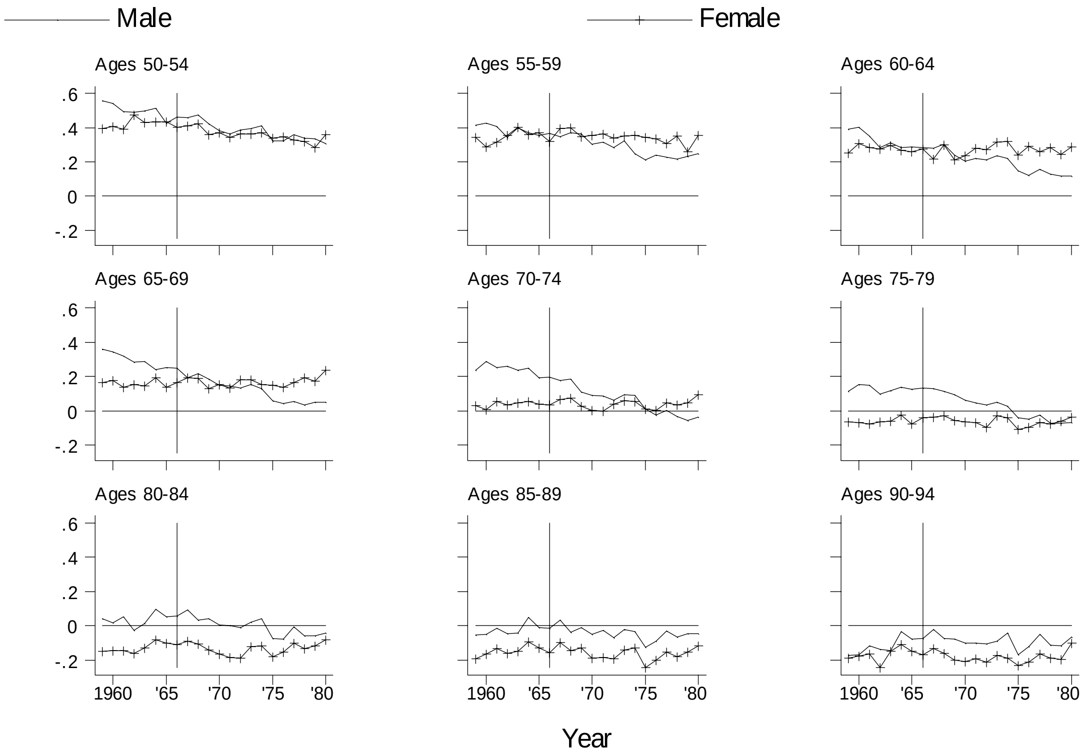
U.S. Mortality Relative to Other, by Year and Age: West Germany



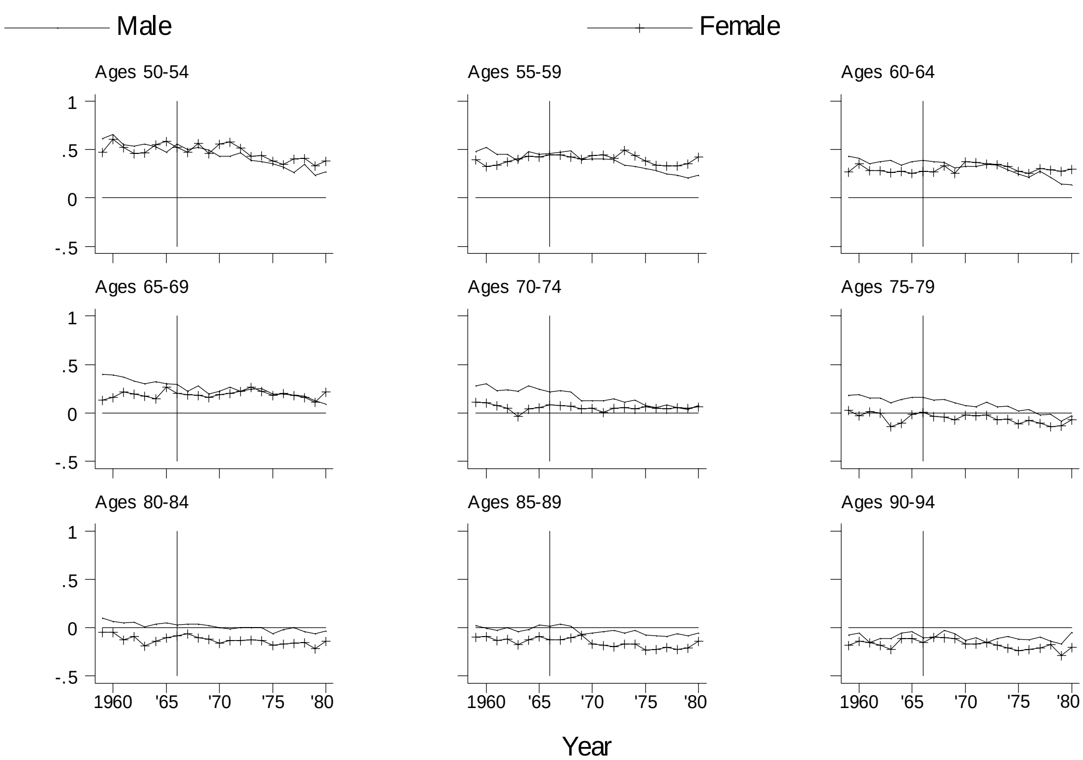
U.S. Mortality Relative to Other, by Year and Age: Italy



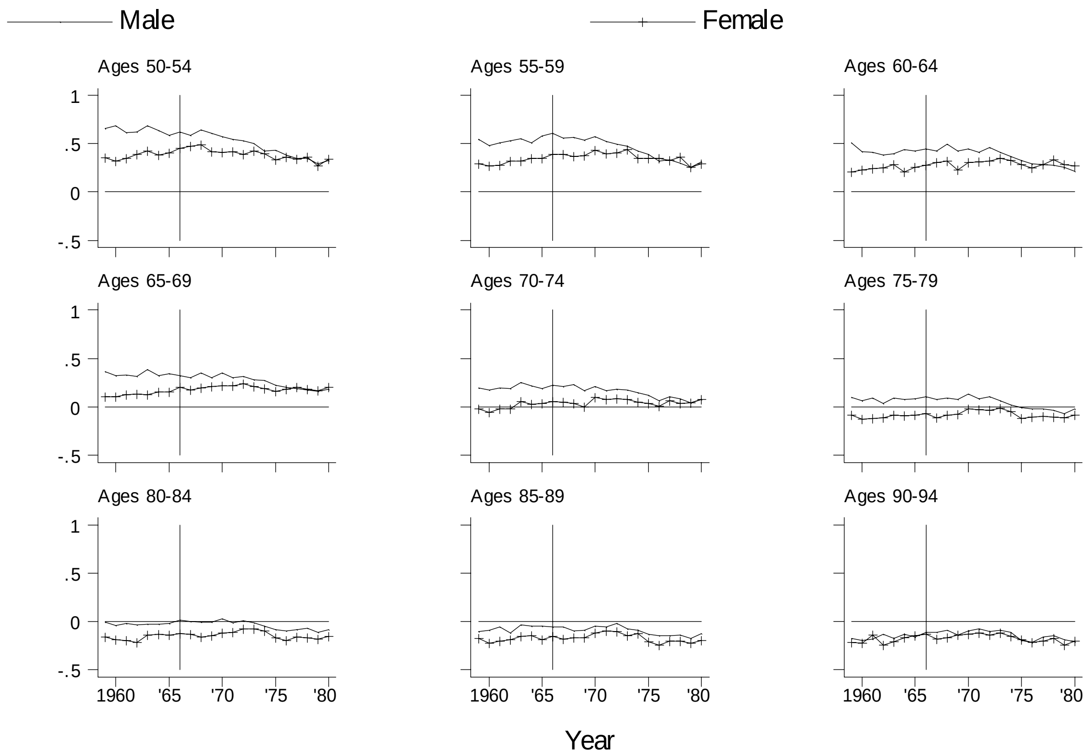
U.S. Mortality Relative to Other, by Year and Age: Japan



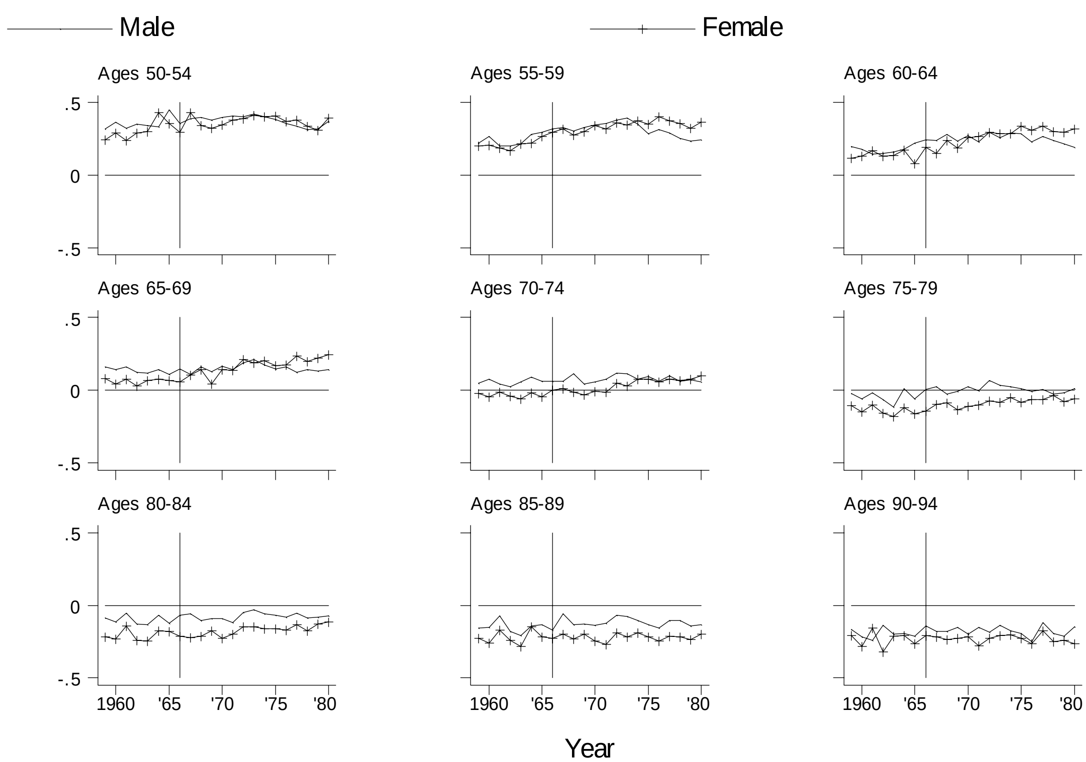
U.S. Mortality Relative to Other, by Year and Age: Netherlands



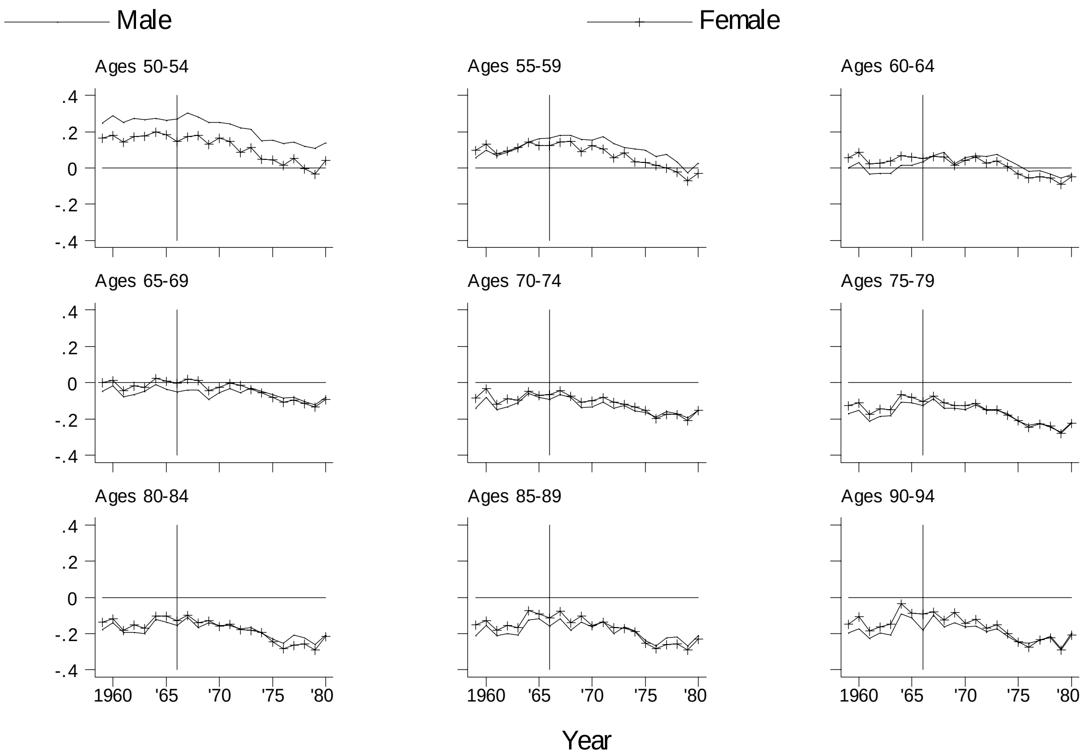
U.S. Mortality Relative to Other, by Year and Age: Norway



U.S. Mortality Relative to Other, by Year and Age: Sweden



U.S. Mortality Relative to Other, by Year and Age: Switzerland



U.S. Mortality Relative to Other, by Year and Age: United Kingdom