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What did Medicare do? The initial impact of Medicare on mortality and out of pocket medical spending ☆

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Abstract

We study the impact of the introduction of one of the major pillars of the social insurance system in the United States: the introduction of Medicare in 1965. Our results suggest that, in its first 10 years, the establishment of universal health insurance for the elderly had no discernible impact on elderly mortality. However, we find a substantial reduction in the elderly's exposure to out of pocket medical expenditure risk. Specifically, we estimate that the introduction of Medicare was associated with a 40% decline in out of pocket spending for the top quartile of the out of pocket spending distribution. A stylized expected utility framework suggests that the welfare gains from such reductions in risk exposure alone may be sufficient to cover almost two-fifths of the costs of Medicare. These findings underscore the importance of considering the direct insurance benefits from public health insurance programs, in addition to any indirect benefits from an effect on health.

JEL classification: H51; I11; I18
Keywords: Health Insurance; Medicare

> *"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"*
>
> Lyndon Johnson, July 30, 1965, at the Medicare signing ceremony in Independence, Missouri

A major economic rationale for social insurance is its potential to redress the consequences of market imperfections in private insurance markets. Public health insurance offers two potential benefits: direct risk reduction benefits and

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indirect health benefits. As the above quotation highlights, both of these potential benefits figured prominently in the motivation for the establishment of the U.S. Medicare program.

Analysis of the impact of health insurance has focused primarily on only one of these potential benefits — the impact of insurance on health outcomes. In general, for the non-infant population, the evidence points strongly to no or only very modest health benefits (see Levy and Meltzer, 2004 for a review of this literature). By contrast, the risk-reducing properties of health insurance, while at the core of any theoretical analysis of the benefits from insurance, have received comparatively little empirical attention. In this paper, we demonstrate empirically that, even in the apparent absence of health benefits, public health insurance can have important benefits from reducing risk exposure.

We study the impact of the introduction of Medicare, which provides nearly universal public health insurance coverage to the elderly. The introduction of Medicare in 1965 was, and remains to date, the single largest change in health insurance coverage in U.S. history. Its introduction was followed by a substantial and prolonged decline in elderly mortality (see Fig. 1). Nevertheless, using several different empirical strategies, we are unable to reject the null hypothesis that, in its first 10 years, Medicare had no effect on elderly mortality. Our evidence suggests that part of the explanation for this finding is that, prior to Medicare, elderly individuals with life-threatening, treatable health conditions sought care even if they lacked insurance, as long as they had legal access to hospitals.

Although we detect no impact of the introduction of Medicare on overall elderly mortality, we estimate that it was responsible for a substantial decline in the large right-tail of the distribution of out of pocket medical expenditures for the elderly. Specifically, we estimate that, in its first 5 years, Medicare was associated with a 40% decline in out of pocket spending for the top quartile of the out of pocket medical expenditure distribution. For the top decile of the out of pocket spending distribution, we estimate that Medicare was associated with a decline in out of pocket spending of close to 50%.

Within a stylized expected utility framework, we simulate the welfare gains associated with this change in risk bearing and compare it to the costs associated with Medicare. Our central estimate is that, for the first generation of Medicare beneficiaries, the consumption-smoothing benefits from Medicare alone may be sufficient to cover almost two-fifths of the social cost of Medicare. While this welfare calculation is based on a single-period, static model and is sensitive to the particular modeling assumptions, our overall findings underscore the importance of considering risk-reducing benefits in any evaluation of the impact of health insurance.

Moreover, it is important to emphasize that we cannot reject potentially large welfare gains from improved health as well. Although our point estimates do not indicate any statistically or economically significant effect of Medicare on

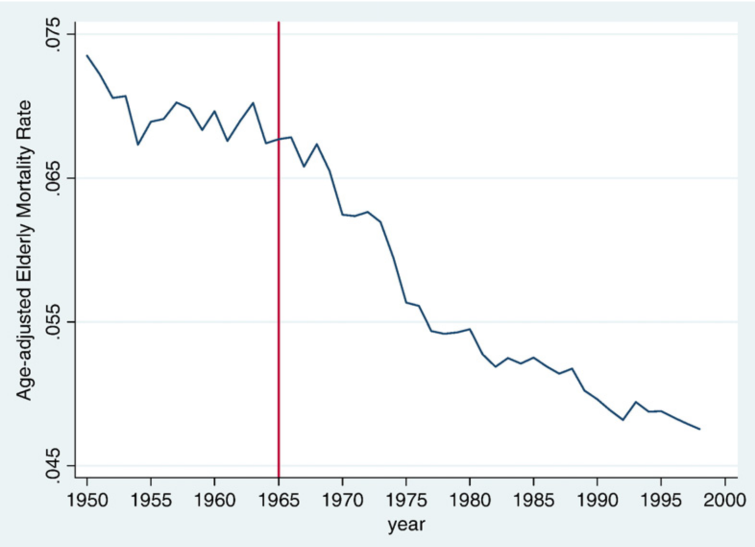


Fig. 1. Age-adjusted elderly mortality rate. Note: Graph shows the all-cause mortality rate (deaths per person) for individuals aged 65+. Figure is reproduced from Cutler and Meara, 2003, Fig. 9.4. The mortality rate in each year is the weighted sum of mortality rates for 65–74, 74–85, and 85+ age groups in that year, with weights reflecting the age distribution of the 65+ population in 1990. We are grateful to Ellen Meara for providing us with the data underlying their figure. Vertical line indicates 1965, the year before Medicare was implemented.

elderly mortality, our 95% confidence interval includes up to a 4% annual reduction in elderly deaths; under standard assumptions about the value of a life-year, the welfare benefits from such a mortality reduction would be sufficient to cover about three-fifths of the annual social cost of Medicare. Moreover, mortality is only one measure of health; the available data do not permit us to examine potential non-mortality health benefits from Medicare, such as reduced morbidity.

The rest of the paper proceeds as follows. Section 1 provides some brief background on Medicare. Section 2 analyzes the 10-year impact of Medicare on elderly mortality. Section 3 investigates the impact of Medicare on the distribution of out of pocket expenditures. Section 4 uses the estimates to perform a cost–benefit analysis of Medicare for the first generation of beneficiaries. Section 5 concludes.

1. Background on Medicare

The U.S. Medicare program is one of the largest public health insurance programs in the world. With annual spending of $260 billion per year, it constitutes about 17% of all U.S. health expenditures, one-eighth of the federal budget, and 2% of GDP (National Center for Health Statistics, 2002; Newhouse, 2002; US Congress, 2000).

Medicare was enacted in July 1965 and implemented essentially nationwide in July 1966. It provided virtually universal public health insurance to individuals aged 65 and older (coverage for the disabled was added in 1973). Individuals aged 65 and over are automatically enrolled in Medicare Part A, which covers up to 90 days of inpatient hospital expenses after an initial deductible and 25% co-insurance for days 61–90; it is funded by a payroll tax. The elderly can choose to enroll in Medicare Part B, which covers physician costs after an initial deductible and 20% (uncapped) co-insurance; it is funded partly by general revenues and partly by individual premiums which were designed to cover 50% of the program costs (Somers and Somers, 1967). Medicare's cost-sharing provisions and uncapped potential out of pocket spending make the extent of its consumption-smoothing properties a priori uncertain.

Medicare's impact on health insurance coverage for the elderly was enormous, increasing by 75 percentage points the proportion of the elderly with any meaningful health insurance (Finkelstein, 2007). Recent empirical work has shown that the introduction of Medicare was associated with a substantial increase in health care utilization (Dow, 2002; Cook et al., 2002; Finkelstein, 2007) and spending (Finkelstein, 2007). In more recent times, Medicare coverage is also associated with a substantial increase in health care utilization (Lichtenberg, 2002; Decker and Rapaport, 2002; McWilliams et al., 2003; Card et al., 2004.) and in reduced exposure to out of pocket medical expenditure risk (Khwaja, 2006).

2. Medicare and mortality

In this section, we examine the impact of the introduction of Medicare on elderly mortality through 1975. Mortality is, of course, only one measure of health. Our focus on mortality is motivated both by its importance and by the striking decline in elderly mortality rates that began shortly after the introduction of Medicare (see Fig. 1). From a practical standpoint, mortality is also one of the few objective, well-measured health outcomes; as a result, it is the focus of many of the studies examining the impact of health insurance on health (Levy and Meltzer, 2004). A limitation of this focus, however, is that we will miss any health benefits from Medicare that come in the form of reduced morbidity or functional limitations.

We use annual age- and state-specific mortality data from 1952–1975. Data from 1959 to 1975 are from the NCHS Multiple Causes of Death micro-data, which include the universe of death certificates; prior to that, we use aggregate published death statistics (Vital Statistics, various years). Alaska and Hawaii are excluded from the analysis since they do not enter the data until 1959. We look up to 10 years after Medicare's introduction for any impact of Medicare on mortality; since health is a stock, the impact of a change in health insurance coverage on mortality might occur only with a lag.

Previous work on the impact of Medicare on health outcomes has used the age variation in Medicare coverage to identify its effect, exploiting the fact that Medicare covers individuals over 65 but not under 65. This work points to, at best, very modest health benefits from Medicare, both at the time of its introduction (Dow, 2002; Cook et al., 2002) and in more recent times (Card et al., 2004). Using the same age-based identification strategy, we also find no compelling evidence of an impact of the introduction of Medicare on elderly mortality (Section 2.1). We explore two alternative sources of variation to further investigate Medicare's impact. In Section 2.2, we exploit geographic variation in the increase in insurance coverage associated with Medicare's introduction. In Section 2.3, we exploit variation in the timing of Medicare's implementation in certain Southern counties.

These additional empirical strategies serve two purposes. First, each of the three approaches has its own strengths and weaknesses, which we discuss below. Our finding of similar results from the three different empirical strategies therefore increases our confidence in the conclusion that Medicare appears to have had no impact on overall elderly mortality in its first 10 years. Second, the combined evidence from the three strategies helps shed light on why Medicare appears to have had only modest mortality benefits, at best; we discuss this in more detail in Section 2.3 below.

2.1. Mortality estimates based on Medicare's coverage by age

Fig. 2 shows trends in mortality rates for the "young elderly" (aged 65–74), who become covered by Medicare in 1966, and the "near elderly" (aged 55–64), who do not. The mortality decline for the young elderly begins several years *before* Medicare's introduction, while that for the near elderly begins slightly after. Not surprisingly, therefore, formal regression analysis does not indicate any impact of the introduction of Medicare on the mortality rate of the young elderly relative to the near elderly. Specifically, we estimate:

$$\ln(\text{deaths})_{ast} = \beta_1 \ln(\text{pop}'n)_{ast} + \beta_2 \text{elderly}_a + \alpha_s * 1(\text{state}_s) + \delta_t * 1(Year_t) + \sum_{t=1952}^{t=1975} \lambda_t (\text{elderly}_a) * 1(\text{Year}_t) + \sum_{n=-18}^{n=9} \gamma_n 1\left(\text{Mcaid}_{st}^n\right) + \varepsilon_{ast} \quad (1)$$

Our dependent variable is the log of the number of deaths in state *s* and year *t* in age group *a*. For the right hand side population variable, we construct annual, state- and age group-specific population estimates by fitting separate cubics to the 1950 through 1980 census data for each state-age group cell. In practice, the results are not sensitive to using the log of the death rate or the death rate as the left hand side variable instead of controlling for population on the right hand side. We include an indicator variable (elderly_a) for whether the deaths are for the young elderly rather than the near elderly, and a series of state and year fixed effects ($1(\text{State}_s)$ and $1(\text{Year}_t)$ respectively).

The key variables of interest are the series of year fixed effects interacted with the elderly indicator variable ($\text{elderly}_a * 1(\text{Year}_t)$). The pattern of coefficients on these variables (the λ_t's) shows the flexibly estimated trend in ln(deaths) over time for the Medicare-eligible young elderly population relative to the non-eligible near-elderly. Under the assumption that changes in the time pattern of mortality for the young elderly relative to the near elderly around 1965 reflect the

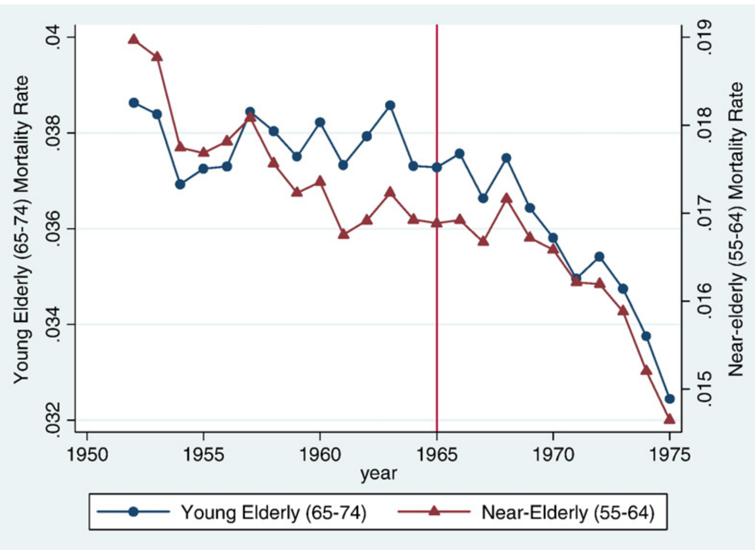


Fig. 2. Mortality rate trends by age group. Source: Authors' calculation of deaths per person based on mortality data from the NCHS Multiple Causes of Death micro-data (1959–1975) and Vital Statistics (various years) for 1952–1958. Population estimates are constructed based on census data as described in text. Vertical line indicates 1965, the year before Medicare was implemented.

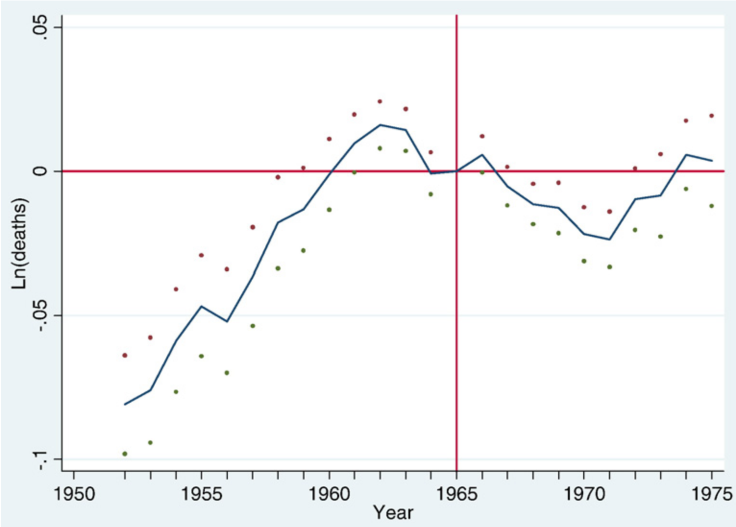


Fig. 3. Estimates of Eq. (1), the age identification strategy, for ages 55–74. Note: Graphs show the coefficients on the interaction of "elderly" with the year fixed effects (i.e. the λ_t's) from estimating Eq. (1). Dependent variable is log deaths for age group *a* in state *s* and year *t*. Other covariates are log population, an indicator variable for young elderly age group (vs. near elderly), state fixed effects, year fixed effects, and indicator variables for year since Medicaid implementation in the state. Standard errors are adjusted for an arbitrary variance–covariance matrix within each state. Vertical line indicates 1965, the year before Medicare was implemented.

effect of Medicare, the change in the pattern of λ_t's after the introduction of Medicare should provide an estimate of the effect of Medicare on ln(deaths).

Medicaid, the public health insurance program for the indigent was, like Medicare, also enacted in July of 1965. However, the timing of Medicaid implementation — unlike that of Medicare — was left up to the individual states (see Gruber, 2003 for details). We control for any impact of Medicaid on health outcomes by including a series of 27 indicator variables (Mcaid_{st}^{n}) for whether it is *n* years since the implementation of Medicaid in state *s* (where *n* runs from −18 to 9); the omitted year is the year of Medicaid implementation. In practice, the results are not sensitive to these controls, which is not surprising given that the relative impact of Medicaid (compared to Medicare) on the elderly was quite small; in 1970, Medicaid spending for the elderly on Medicare-eligible services (i.e. hospitals and physicians) was only about 4% of Medicare spending for the elderly on these services (U.S. Congress, 1994; Holahan, 1975).[1]

We report results from weighted estimation of Eq. (1) by OLS. The weights are the square root of the population of age group *a* in state *s* and year *t*. Unweighted estimates (not reported) are very similar. We adjust our standard errors to allow for an arbitrary covariance matrix within each state over time. Our empirical framework is quite similar to that of Dow (2002); we differ mainly in our adoption of a substantially more flexible functional form, and our inclusion of variables to control for Medicaid implementation.

Fig. 3 shows the λ_t's from estimating Eq. (1). The level of the graph is arbitrary; we set it at 0 in 1965, the omitted year. It indicates that, although mortality for the young elderly is declining relative to that of the near elderly after Medicare, this decline begins in 1962, four years before Medicare is implemented; moreover, this relative mortality decline for the young elderly reverses in the early 1970s. The visual impression of no compelling evidence of an impact of Medicare on young elderly mortality relative to near elderly is confirmed by statistical tests (not shown). We also found no evidence of an impact of Medicare for specific causes of death — such as cardiovascular disease — or for sub-populations where we might expect a bigger impact of Medicare on health: non-whites — who are among the most vulnerable in the population — and individuals in urban areas — where availability and access to medical care is much greater than in rural areas (not shown).

[1] Specifically, total Medicaid spending in fiscal year 1970 was two-thirds of Medicare spending (U.S. Congress, 1994). Holahan (1975) reports that about 35% of Medicaid spending was for the elderly, and only 10 to 15% of Medicaid payments for the elderly were for hospitals and physicians; nursing homes, which are not covered by Medicare, accounted for over half of Medicaid's spending for the elderly.

Table 1
Percent of elderly without hospital insurance, 1963 National Health Survey

Sub-region	Any insurance	Blue Cross
New England (CT, ME, MA, NH, RI, VT)	0.37	0.49
Middle Atlantic (NJ, NY, PA)	0.41	0.60
East North Central, Eastern Part (MI, OH)	0.32	0.55
East North Central, Western Part (IL, IN, WI)	0.42	0.75
West North Central (IA, KS, MN, MO, NE, ND, SD)	0.47	0.81
South Atlantic, Upper Part (DE, DC, MD, VA, WV)	0.45	0.75
South Atlantic, Lower Part (FL, GA, NC, SC)	0.50	0.81
East South Central (AL, KY, MS, TN)	0.57	0.88
West South Central (AR, LA, OK, TX)	0.55	0.85
Mountain (AZ, CO, ID, MT, NV, NM, UT, WY)	0.50	0.78
Pacific (OR, WA, CA, AK, HI)	0.52	0.87
U.S. National	0.46	0.73

Note: Data on individual's health insurance are from the 1963 National Health Survey, a national, random sample of households conducted from July 1962 to June 1963. Through a special request to the government, we obtained a version of the survey that identifies which of 11 sub-regions the individual is in. We limited the sample to the 12,757 individuals aged 65 and over. Minimum sample size for a sub-region is 377.

2.2. Mortality estimates based on geographic variation in insurance prior to Medicare

The age-based identification strategy is not well-suited to examining the impact of Medicare on mortality for the oldest of the elderly, for whom Medicare might conceivably have a larger mortality impact. In addition, the age-based strategy will be biased against finding an impact of Medicare if the treatment of individuals just under age 65 is affected by the insurance coverage Medicare provides to all individuals over age 65. Physician practice norms, concerns about malpractice liability, or joint costs of the production of health care could all contribute to "health insurance spillovers"; Baker (1997), Hellerstein (1998) and Glied and Zivin (2002) present evidence consistent with such spillovers.

We therefore employ an alternative strategy based on the substantial geographic variation in private health insurance coverage among the elderly prior to the introduction of Medicare. For this analysis, we limit our sample to individuals aged 65 and over. Table 1 shows the variation across sub-regions in the percent of the elderly without any hospital insurance or the percent without Blue Cross hospital insurance. The data are from the 1963 National Health Survey.[2] Using the Blue Cross measure, the increase in insurance coverage for the elderly associated with the introduction of Medicare ranged from a high of 88 percentage points in the East South Central United States to a low of 49 percentage points in New England.

Elderly insurance coverage rates are clearly not randomly assigned and are in fact highly correlated with socio-economic status. Our empirical approach is therefore to look for a break in any pre-existing level or trend differences in mortality rates at the time of Medicare's introduction in areas where Medicare had more of an effect on insurance coverage relative to areas where it has less of an effect. Using this same identification strategy, Finkelstein (2007) demonstrates a substantial impact of Medicare on hospital spending and utilization.

The basic estimating equation is:

$$\ln\left(\text{deaths}\right)_{\text{st}} = \beta_1 \ln\left(\text{pop}'n_{\text{st}}\right) + \alpha_s{*}1\left(\text{State}_s\right) + \delta_t{*}1\left(\text{Year}_t\right) + \sum_{t=1952}^{t=1975} \lambda_t\left(\text{pctuninsured}\right)_z{*}1\left(\text{Year}_t\right) + \sum_{n=-18}^{n=9} \gamma_n 1\left(\text{Mcaid}^n_{\text{st}}\right) + \varepsilon_{\text{st}} \quad (2)$$

The variables are defined as in Eq. (1), except that the key coefficients of interest — the λ_t's — are now the coefficients on the variable $(\text{pctuninsured})_z * 1(\text{Year}_t)$, the interaction between year effects and the percentage of the elderly population in sub-region z without private health insurance in 1963. Once again, we control for the potential effect of Medicaid through a series of 27 indicator variables for whether it is n years since or before the implementation

[2] The survey also contains information on coverage by surgical insurance. Surgical and hospital insurance coverage are highly correlated (correlation = 0.92); for simplicity, we focus on hospital insurance, since hospitals constitute the largest portion of expenditures. For more information on the data, see National Center for Health Statistics (1964).

of Medicaid in state *s* (Mcaid^{n}_{st}). We estimate Eq. (2) by OLS using the square root of the population in state *s* and year *t* for weights. Unweighted estimates (not reported) are very similar. We adjust our standard errors to allow for an arbitrary covariance matrix within each state over time.

We present results using the Blue Cross measure of insurance since, unlike most other forms of health insurance for the elderly, Blue Cross insurance provided meaningful coverage. In addition, Medicare benefits were explicitly modeled after these plans (Anderson et al., 1963; Ball, 1995; Newhouse, 2002). In practice the results are not sensitive to the choice of health insurance measure (not shown).[3]

Fig. 4 shows the λ_t's from estimating Eq. (2). Panel A shows that, for individuals aged 65 and over, mortality rates were rising in areas with less insurance relative to the areas with more insurance prior to the introduction of Medicare; this is not surprising since areas with less insurance are also poorer. The identifying (or, counterfactual) assumption is that, absent Medicare, the differential trend in mortality improvements would have continued. Any systematic divergence from this differential trend after 1966 would suggest an impact of Medicare. However, there is no indication of any divergence. In results not reported, we implemented statistical tests that confirm this visual impression. Again, we also found no evidence of an impact of Medicare for specific causes of death — such as cardiovascular disease — or for two sub-populations where health insurance might have been expected to have more of an impact on health: non-whites or individuals living in urban areas (not shown).[4]

One of the advantages of using the geography-based identification strategy instead of the age-based identification strategy is the ability to look at the effect of Medicare separately for different age groups. Panels B and C of Fig. 4 therefore report results separately for, respectively, individuals aged 65–74 and individuals aged 75 and over. For neither age group is there evidence of any differential decline in mortality rates in areas where insurance coverage increased more as a result of Medicare's introduction. Indeed, the results for individuals aged 65–74 suggest that Medicare is associated with an *increase* in mortality rates, while results for individuals aged 75+ indicate no impact of Medicare in either direction. Statistical tests (not reported) confirm this visual impression.

A concern with using geographic variation in private insurance coverage to identify the impact of Medicare is that areas of the country with different levels of insurance coverage might experience differential changes in mortality in the decade after Medicare for other reasons. For example, the mid-1960s through early 1970s were a period of innovation in the treatment of cardiovascular disease, including new information about the risks of smoking and the development of anti-hypertensives (Cutler and Kadiyala, 2003). If individuals in richer areas were more likely to adopt these health care innovations, this would bias our estimates of the mortality benefits of Medicare downward, since richer areas also had higher pre-Medicare insurance rates and thus a lower estimated impact of Medicare. To try to address this issue, we performed a triple-difference analysis by combining the age-based variation in the previous sub-section with the geographic identification strategy used in this sub-section. This analysis also yields no statistical or substantive impact of Medicare on mortality (results not shown).

2.3. The importance of insurance vs. legal access to hospitals: evidence from the segregated South

The above evidence suggests that — at least in its first 10 years — Medicare played essentially no role in the dramatic decline in mortality rates for the elderly that began in the late 1960s. Since Medicare was associated with a substantial increase in the elderly's use of hospital care (Dow, 2002; Cook et al., 2002; Finkelstein, 2007), this evidence implies that the Medicare-induced increase in health care consumption was relatively unimportant in contributing to the overall mortality decline among the elderly. These results raise the question of why the substantial increase in health care utilization associated with Medicare appears to have had little or no effect on elderly mortality.

Our third approach sheds some light on this. The approach is based on the fact that, for a hospital to be eligible to receive Medicare funding, it had to be racially desegregated. As a result, the implementation of Medicare increased non-whites' access to hospitals in segregated parts of the South (Smith, 1999; Almond et al., 2003). It also resulted in some staggered timing in the introduction of Medicare in parts of the South that had not desegregated their hospitals by

[3] In principle, the impact of Medicare varies not only according to the percent of the elderly without insurance but also the percent of the elderly in the area. In practice however, there is very little variation even across counties in the percent elderly.

[4] The results are also robust to a number of other specifications such as a linear rather than log-linear model, estimating the model separately by gender, excluding one subregion at a time, excluding all four Southern sub-regions at once, and excluding the Medicaid control variables (not shown).

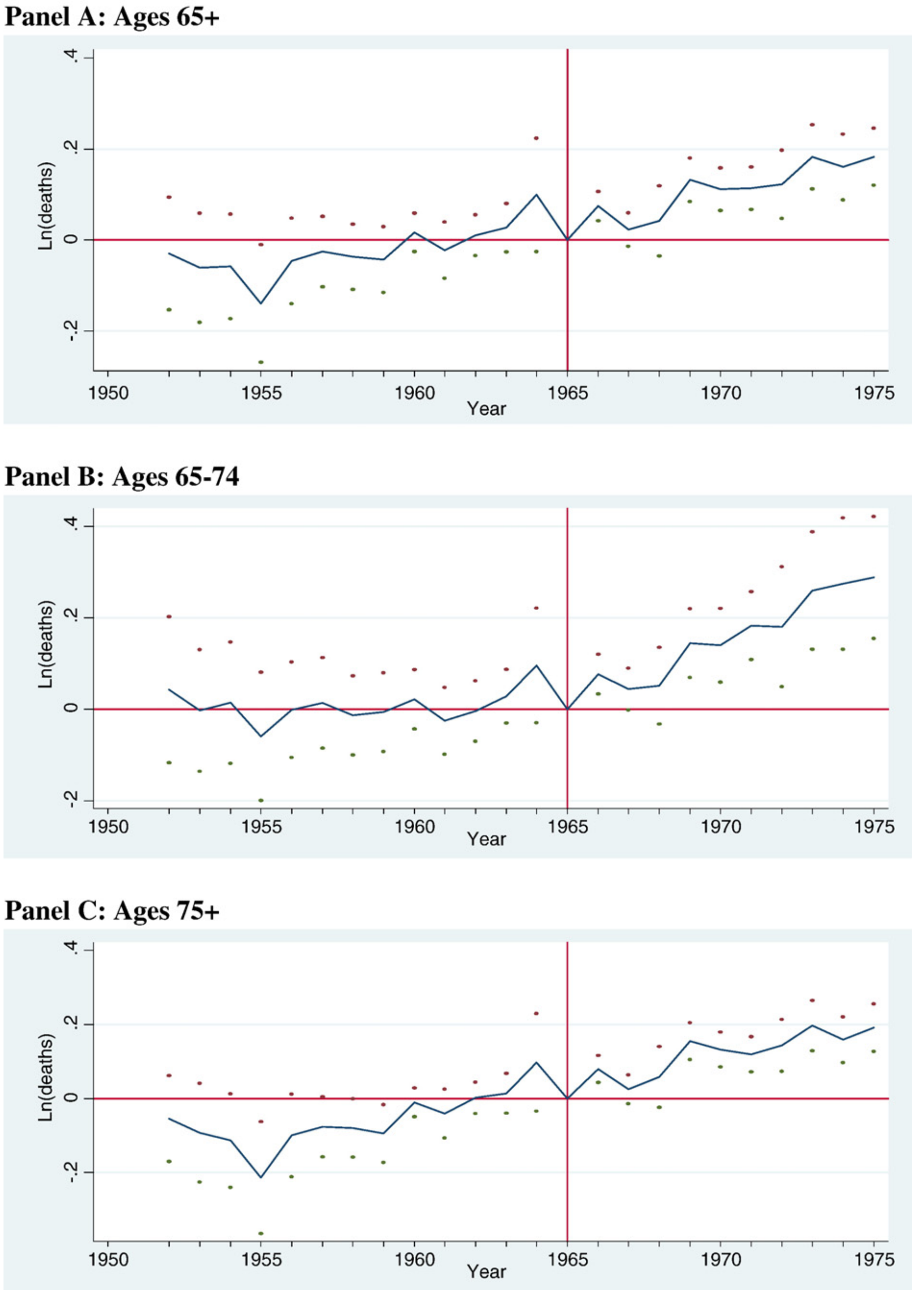


Fig. 4. Estimates of Eq. (2), the geographic variation strategy. Panel A: Ages 65+. Panel B: Ages 65–74. Panel C: Ages 75+. Note: Graphs show the coefficients on the interaction of "pctuninsured" with the year fixed effects (i.e. the λ_t's) from estimating Eq. (2). Dependent variable is log deaths in state *s* and year *t*. Other covariates are log population, state fixed effects, year fixed effects, and indicator variables for year since Medicaid implementation in the state. Standard errors are adjusted for an arbitrary variance–covariance matrix within each state. Vertical line indicates 1965, the year before Medicare was implemented.

the start of Medicare. Using the American Hospital Association's Annual Survey of Hospitals, we estimate that only three-quarters of counties in the entire South — and only one-quarter of counties in the Mississippi Delta — had a Medicare-certified hospital by the end of 1966.

Using this variation in timing of Medicare implementation, Almond et al. (2003) show that, in the Mississippi Delta, counties that had a Medicare-certified hospital by February 1969 — and had therefore desegregated by that point —

experienced dramatic declines in non-white *post-neonatal* mortality from diarrhea and pneumonia in the late 1960s relative to counties that did not have Medicare-certified hospitals. We follow Almond et al.'s (2003) empirical strategy and estimate the impact of Medicare on *elderly* mortality in the Mississippi Delta:

$$y_{ct} = \alpha_c{*}1(\text{country}_c) + \delta_t{*}1(\text{year}_t) + \lambda\text{Certified}_{ct} + \varepsilon_{ct} \tag{3}$$

The dependent variable is a measure of deaths in county c and year t. The regression includes a series of county fixed effects and year fixed effects ($1(\text{country}_c)$ and $1(\text{year}_t)$ respectively). The key coefficient of interest is λ, which represents the change in elderly mortality associated with having at least one Medicare-certified hospital in county c at time t. We adjust our standard errors to allow for an arbitrary covariance matrix within each county over time.

We estimate Eq. (3) separately by race, and within race by cause of death. As a result of this fine cutting of the data, a reasonably high proportion of counties has no deaths in a given year. We therefore report results in which the death rate (in levels) is the dependent variable as well as results in which ln(deaths) is the dependent variable and ln(population) is included on the right hand side. We estimate Eq. (3) using as weights the square root of the county- and race-specific population in year t.

Table 2 reports the results. The first two columns indicate that the introduction of Medicare had no discernible impact on overall elderly mortality in the Mississippi delta, either for non-whites (Panel A) or whites (Panel B). However, the next two columns suggest that the introduction of Medicare was associated with a statistically significant decline in non-white elderly *pneumonia* mortality rates. There is no evidence of comparable effects for whites, or for other causes of death. For example, the last two columns indicate no impact of Medicare on mortality from cardiovascular disease, which accounted for two-thirds of elderly deaths in 1965; improvements in cardiovascular disease mortality were also the primary cause of the decline in elderly mortality starting in the late 1960s (Cutler and Kadiyala, 2003).

Although statistically significant, the impact of Medicare on non-white elderly pneumonia mortality is substantively small. The point estimates suggest that Medicare is associated with a 35% (log-linear specification) or 0.1 percentage point (linear specification) decline in non-white elderly pneumonia deaths. Only 3.3% of elderly deaths in 1965 were from pneumonia; therefore even the larger estimate suggests that Medicare reduced non-white elderly overall mortality in these counties by only 1%. By contrast, pneumonia-related deaths were over one-quarter of infant deaths. This explains why Almond et al. (2003) estimate a substantially larger impact of Medicare on non-white post-neonatal mortality than we do for non-white elderly mortality, even though Medicare provided insurance coverage to the non-white elderly in addition to the access to hospitals it provided to non-whites of all ages.

More generally, these findings help explain our estimates that Medicare appears to have had little or no effect on overall elderly mortality. At the time of Medicare's introduction, hospitals were primarily effective at treating short-term acute illness, rather than chronic disease (Somers and Somers, 1961). Our findings suggest that — apart from non-whites who were denied access to hospital care in some places prior to Medicare — individuals with pneumonia and

Table 2
Estimated effect of having at least 1 Medicare-certified hospital in the county

	All causes of death		Deaths from pneumonia		Deaths from cardiovascular disease	
	Log-linear	Linear	Log-linear	Linear	Log-linear	Linear
Panel A: Non-White						
Certified	0.00025 (0.027)	−0.001 (0.002)	−0.345*** (0.137)	−0.001** (0.0003)	0.060 (0.043)	0.001 (0.002)
ln(pop'*n*)	0.446** (0.211)		0.341 (1.185)		.190 (0.330)	
Mean of dependent variable	4.58	0.066	0.937	0.002	4.046	0.039
N	425	425	304	425	425	425
Panel B: White						
Certified	−0.009 (0.033)	0.0002 (0.002)	0.025 (0.118)	−0.00013 (0.00026)	0.026 (0.040)	0.001 (0.001)
ln(pop'*n*)	0.747*** (0.192)		1.464*** (0.520)		0.642*** (0.185)	
Mean of dependent variable	4.16	0.061	0.734	0.002	3.709	0.039
N	425	425	311	425	425	425

Note: Results are from estimating Eq. (3) on the 25 counties in the Mississippi Delta for non-white and white elderly. We follow Almond et al. (2003) in their definition of the Mississippi Delta counties. Standard errors in parentheses; we allow for an arbitrary covariance matrix within each county over time. Data are from 1959–1975 only, since data before 1959 are not available at the county level by race. *, **, *** denotes significance at the 10%, 5%, and 1% levels, respectively.

Table 3
Summary statistics: 1963 spending, ages 65+

	Total spending	Total (public + private) insurance spending	Private insurance spending	Out of pocket spending	Total spending as % of income	Out of pocket spending as % of income
Total	844	75	75	770	10.4%	10.1%
Medicare-eligible (Parts A + B)	518	71	71	448	5.2	4.9
Hospital (Part A)	263	16	16	247	2.1	2.2
Physician (Part B)	255	55	55	201	3.1	2.7
Home visits	31	1	1	31	0.6	0.6
Drugs	294	3	3	291	4.6	4.6

Table reports mean spending in year 2000 dollars for individuals aged 65 and over in 1963. $N=658$. Individual income is calculated as household income divided by number of individuals in the household. We measure total insurance spending as private insurance spending in 1963, and as private insurance spending plus Medicare and Medicaid spending in 1970. The 1963 survey does not collect information on public insurance spending; however, we know that public assistance for medical spending prior to 1965 was virtually non-existent (Stevens and Stevens, 1974; United States Senate, 1963).

other infectious diseases that hospitals could treat effectively at the time were likely to seek medical care regardless of insurance status. This explains why we find evidence of an impact of Medicare's introduction on the elderly non-white pneumonia mortality rate in the segregated South — where the introduction of Medicare opened up access to hospitals for these individuals — but not for whites in the same areas (despite their low insurance coverage prior to Medicare), since whites already had legal access to these hospitals. It also explains why we find no discernable impact of Medicare's introduction on the elderly pneumonia mortality rate for either race using either the age-based or geography-based identification strategy (not shown).

If, prior to Medicare, individuals sought hospital care where it was likely to be effective regardless of insurance coverage, they must have paid out of pocket and/or relied on charity care. Consistent with this, the next section documents a large amount of out of pocket medical spending by the elderly prior to Medicare.

3. Medicare and exposure to out of pocket medical expenditure risk

To examine the impact of Medicare on out of pocket expenditure risk, we use individual-level data on health care expenditures from the 1963 and 1970 Surveys of Health Service Utilization and Expenditures. These data contain information on health care expenditures for 7802 individuals in 1963, and 11,619 in 1970. For much of the analysis, we limit the sample to the 3030 individuals aged 55–74 in either year.[5]

The data contain detailed information on medical spending both by type of spending (e.g. hospital, physician, drug) and by source of payment (out of pocket, private insurance, public insurance, and total). We construct out of pocket spending as the difference between total spending and total insurance spending.[6]

Table 3 provides some descriptive statistics on the medical spending by the elderly in 1963, prior to the introduction of Medicare. All dollar estimates in this and subsequent tables, or reported in the paper, are converted to 2000 dollars using the CPI-U. At $844, average annual per capita medical spending by the elderly in 1963 represented over 10% of income. Over 90% of this spending was paid out of pocket.[7] Sixty percent of these out of pocket expenditures were for medical services that subsequently became covered by Medicare (i.e. doctor and hospital expenditures); the rest were

[5] The surveys were conducted by the Center for Health Administration Studies and the National Opinion Research Center. The 1963 survey is designed to be representative of the non-institutionalized U.S. population; the 1970 survey also excludes the institutionalized population but over samples the elderly, rural areas, and the urban poor. Neither survey includes usable population weights. While the lack of sample weights can produce misleading estimates for how the distribution of out of pocket spending for the entire population changed between 1963 and 1970, there is no reason to suspect it will bias the difference-in-difference comparison of changes in spending for one age group relative to another. Spending data is based on individual self-reports, but attempts were made to verify insurance claims with third party payers. Neither survey contains geographic identifiers. For more details see ICPSR (1988) and ICPSR (2002).

[6] Out of pocket spending is reported directly in 1970 (but not in 1963). We compared the reported measure to our constructed measure in 1970 and found them to be the same in 92% of cases.

[7] This is similar to Boaz's (1978) finding that out of pocket medical expenditures absorbed a substantial fraction of the income of non-elderly disabled individuals in 1965.

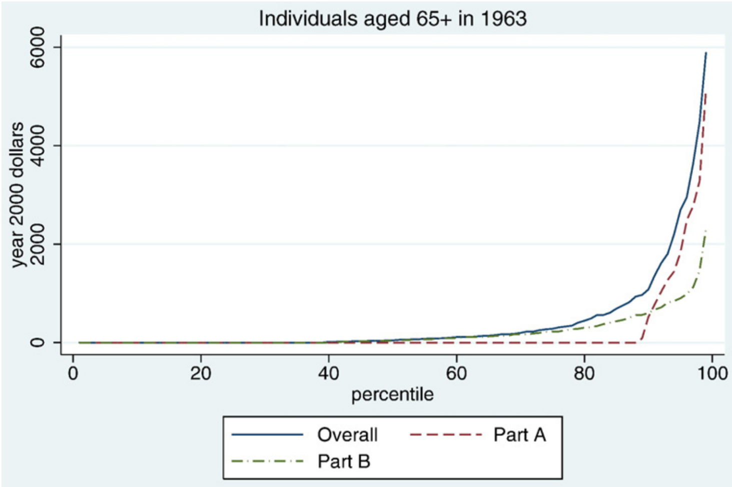


Fig. 5. Medicare-eligible out of pocket spending. Individual aged 65+ in 1963.

for drugs, primarily prescription drugs.[8] Fig. 5 indicates that there was a substantial right-tail to the distribution of elderly out of pocket medical expenditures in 1963 that would subsequently be covered by Medicare, a finding that, to our knowledge, has not been previously demonstrated. This right-tail also persists when we examine the distribution of out of pocket medical spending as a percentage of income (not shown).

Our empirical strategy is to compare changes in spending for individuals over age 65 to changes in spending for individuals under age 65 between 1963 and 1970. To increase the plausibility of the identifying assumption that, absent Medicare, changes in various types of spending for individuals above and below age 65 would have been the same, we focus primarily on changes in spending for the "young elderly" (ages 65 to 74) relative to that for the "near elderly" (ages 55 to 64). We also investigate the potential validity of this identifying assumption by examining changes in spending for adjacent age groups that experienced the same change (or lack of change) in Medicare coverage. For all of the spending categories we examine, mean spending in 1963 is substantively quite similar and statistically indistinguishable for the two age groups.

Of course, as previously noted, Medicaid was also introduced between 1963 and 1970. Unlike in the mortality analysis, however, we do not have geographic identifiers in these data, and therefore cannot exploit the variation across states in the timing of Medicaid introduction. (For the same reason, we also cannot use the geographic variation in Medicare's impact on insurance to identify its effects on out of pocket medical expenditures.) However, we believe any confounding effect of the introduction of Medicaid on the distribution of out of pocket expenditures for the elderly is likely to be small, and, if anything, to bias downward our estimated impact of Medicare on risk exposure. As previously noted, Medicaid spending for the elderly on Medicare-eligible services was only about 4% of Medicare spending in the early 1970s (NCHS, 2002; Holahan, 1975). Since Medicaid spending was higher for the near elderly (our control group) than for the young elderly (our treatment group), any impact of Medicaid likely biases downward our estimated impact of Medicare on the distribution of out of pocket spending.

3.1. Impact of Medicare on mean spending

Although our primary interest is in the impact of Medicare on the distribution of out of pocket spending, we begin with a brief analysis of the impact of Medicare on average spending of different types. Our basic estimating equation is:

$$\text{spend}_{iat} = \gamma X_{iat} + \beta_1 \text{elderly}_a + \beta_2 \text{year1970}_t + \beta_3 (\text{elderly}_a {*} \text{year1970}_t) + \varepsilon_{iat} \tag{4}$$

[8] We have not classified home health care as Medicare-eligible because Medicare covered only a very limited amount of home health care at that time (Somers and Somers, 1967). In practice, given how small home health care expenditures were, including it in Medicare-covered expenditures has little effect on any of the analysis.

Table 4
Changes in average Medicare-eligible expenditures

	Out of pocket spending	Private insurance spending	Total (public+private) insurance spending	Total spending
Panel 1: All spending				
Elderly*Year1970	−117.3 (106.5)	−507.1*** (97.0)	259.0* (150.2)	142.3(204.7)
Elderly	−110.6 (139.1)	−32.9 (118.7)	−156.8 (168.7)	−274.28 (240.30)
Year1970	4.73 (67.3)	562.08*** (95.93)	724.91*** (103.6)	714.14*** (137.21)
Panel 2: Hospital (Part A)				
Elderly*Year1970	−44.7 (89.8)	−465.9*** (87.6)	127.5 (133.84)	85.3 (171.1)
Panel 3: Physician (Part B)				
Elderly*Year1970	−72.58** (34.1)	−41.2* (23.3)	131.5*** (32.3)	57.0 (53.9)

Note: Table reports the coefficients from estimating Eq. (4) by OLS on a sample of 55 to 74 year olds. Panel 1 reports the results for all Medicare-eligible spending (i.e. hospital plus physician spending); in addition to the variables reported in the table, the regressions also include age and age squared, and indicator variable for male, married, and education group (6 years of school of less, between 6 and 12 years of school, or 12 or more years of school). Panels 2 and 3 report the results separately for hospital spending and physician spending; although to preserve space the coefficient on only one variable is reported, the regression analysis contains the exact same set of covariates as in Panel 1. Robust standard errors in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels respectively. All estimates are in year 2000 dollars. N=2,834

In this standard difference-in-differences framework, the coefficient of interest is β_3; it indicates the differential change in spend_{iat} between 1963 and 1970 for individuals aged 65 to 74 relative to individuals aged 55 to 64. The covariates (X_{iat}) consist of age, age squared, and indicator variables for male, married and education group (6 years of school or less, between 6 and 12 years, or 12 or more years of school); in practice, the results are virtually identical without these controls (not shown). We estimate Eq. (4) by OLS and calculate Huber–White robust standard errors.[9]

Table 4 reports the results for various Medicare-eligible spending categories. The first panel reports the results for all Medicare-eligible spending; the bottom two panels look separately at hospital spending and physician spending. The coefficient on Elderly*Year1970 in the first column indicates that the introduction of Medicare is associated with a decline in mean out of pocket spending by the young elderly relative to the near elderly of $117. This represents about a one-quarter decline in the out of pocket spending of the young elderly in 1963, but is not statistically significant. The estimated decline in mean out of pocket spending on physicians shown in the third panel is statistically significant and corresponds to about a one-third decline. These estimates are somewhat smaller than estimates of the impact of other social insurance programs on risk reduction. For example, Gruber (1997) estimates that the public unemployment insurance system reduces the fall in consumption associated with an unemployment spell by about two-thirds. However, we will show below that these estimates of the impact of Medicare on average out of pocket spending mask Medicare's real impact, which is concentrated in the right-tail of out of pocket spending.

The remaining three columns suggest that Medicare is associated with declines in private insurance spending, and increases in total insurance spending and total spending. Although the increase in total spending is not statistically significant, the point estimate on Elderly*Year1970 of $142.3 implies that Medicare was associated with an increase in total spending of 28% relative to average Medicare-eligible spending in 1963 of $518 (see Table 3). Interestingly, the estimates from the RAND health insurance experiment would also predict that the introduction of Medicare would be associated with a 28% increase in medical spending (Newhouse 1993; Finkelstein, 2007). In results not reported, we found no evidence of an impact of Medicare on drug spending, which Medicare does not reimburse.

The results also shed some light on the validity of inferring the impact of Medicare from the difference-in-differences comparison of changes in spending for the near elderly relative to the young elderly. The coefficient on *Elderly* is always statistically insignificant, indicating that in 1963 individuals aged 55–64 did not have statistically significantly different average spending from individuals aged 65–74; this lends some credence to the identifying

[9] In results not reported, we found that the *p*-values are essentially unaffected if we instead implement the randomized inference approach of Bertrand et al. (2004).

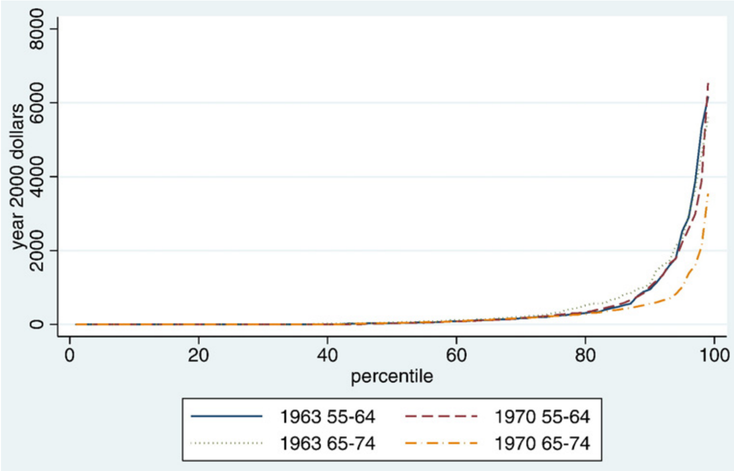


Fig. 6. Centiles of Medicare-eligible out of pocket spending by age group and year.

assumption that, in the absence of Medicare, these two age groups would have experienced similar changes in spending.

However, the results also suggest that the introduction of Medicare may have had spillover effects on health spending for the near elderly; the coefficient on *Year1970* indicates that the near elderly experienced large and statistically significant increases in total insurance spending and total spending between 1963 and 1970. This increase in spending among the near elderly may in part reflect the effect of Medicare, since there is evidence that Medicare encouraged increased hospital construction and new technology adoption (Finkelstein, 2007), which may have served to increase utilization among 55–64 year olds as well. Such spillover effects would bias downward our estimates of the impact of Medicare on the increase in total health spending, as increases in spending for the "control group" of near elderly may partly reflect the effect of Medicare. Consistent with this, Finkelstein (2007) finds a substantially larger impact of Medicare on total spending using a geographic-based identification strategy akin to that used in Section 2.2, which is less likely to be biased downward by such spillovers than the age-based identification strategy used in Eq. (4). As a result, we would caution against placing too much credence on the estimated increase in total spending associated with Medicare that comes out of the age-based identification strategy.

We are much more sanguine, however, about the merits of the age-based identification strategy for estimating the impact of Medicare on out of pocket spending. Of course, the same types of spillovers could also bias upward our estimate of the impact of Medicare on reducing out of pocket spending of the elderly, if the spillovers induced increased out of pocket spending by the near elderly. While we cannot rule out this possibility, the coefficient on Year1970 for out of pocket spending does not suggest a statistical or substantive change in mean out of pocket spending for the near elderly. Fig. 6 similarly indicates that the distribution of out of pocket spending did not change for the near elderly between 1963 and 1970. The difference-in-difference estimates of the impact of Medicare on out of pocket spending by the young elderly are thus virtually identical to the simple time series difference.

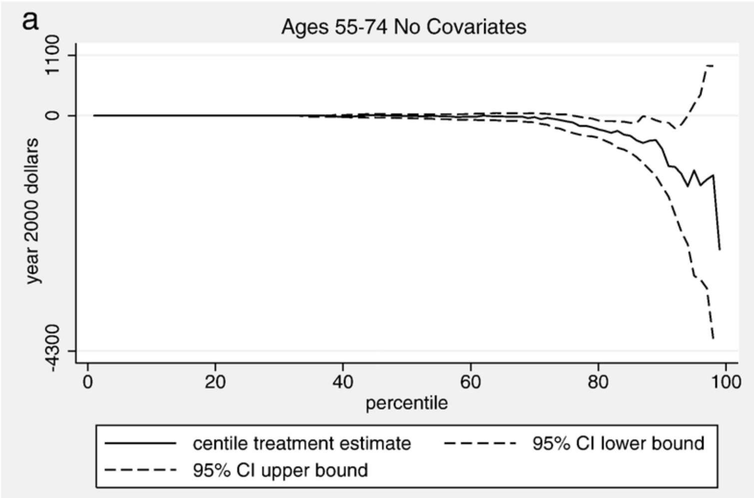
3.2. Effect of Medicare on the out of pocket spending distribution: centile treatment estimates

Fig. 6 also conveys the impact of Medicare on the *distribution* of out of pocket spending. The distribution of out of pocket spending for the near elderly in 1963 and 1970 as well as for the young elderly in 1963 all lie close to each other. By contrast, the distribution of out of pocket spending for the young elderly in 1970 (i.e. after Medicare) lies substantially below the other three distributions in the top quartile of the distribution.

To estimate the impact of Medicare on the distribution of out of pocket spending more formally, we estimate quantile treatment effects for each centile of the spending distribution, following the approach outlined in Bitler et al. (2006). The quantile treatment effect for quantile q is estimated as follows:

$$\Delta_q = \left\{\text{spend}_q(1970,\ \text{elderly}=1) - \text{spend}_q(1963,\ \text{elderly}=1)\right\} - \left\{\text{spend}_q(1970,\ \text{elderly}=0) - \text{spend}_q(1963,\ \text{elderly}=0)\right\} \quad (5)$$

To adjust for covariates, we replace the centile from the spending distribution with the centile from the distribution of spending residuals from a linear regression of spending on the covariates described above in the context of equation (4). We calculate confidence intervals for our estimates using the empirical standard deviation of 200 bootstrap replications of the quantile treatment estimates.



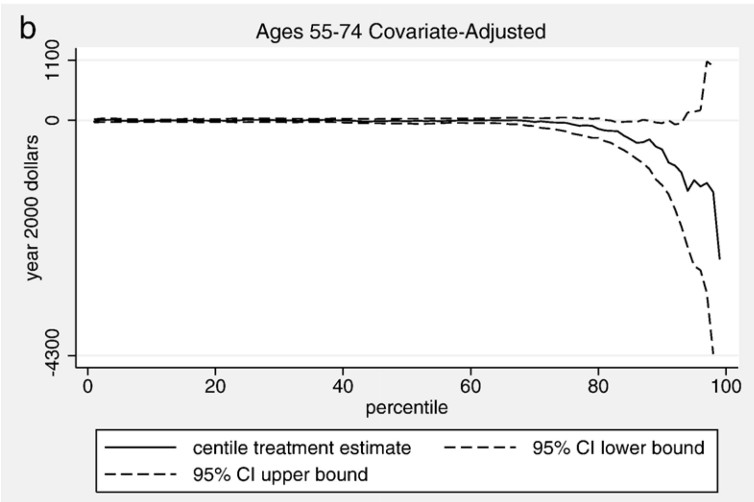


Fig. 7. Centile treatment estimates for Medicare-eligible out of pocket spending. a. Ages 55–74 No Covariates. Note: Based on estimating Eq. (5) for Medicare-eligible out of pocket spending. Dashed lines indicate 95% confidence intervals. The 95% confidence interval for the 99th percentile (−9174, 2044) is not shown on the graph. b. Age 55–74 covariate-adjusted. Note: Based on estimating Eq. (5) for Medicare-eligible out of pocket spending. The 95% confidence interval for the 99th percentile (−7036, 1737) is not shown on the graph. c. Ages 55–90 No Covariates. Note: Based on estimating Eq. (5) for Medicare-eligible out of pocket spending. The 95% confidence interval for the 99th percentile (−9814, 1392) is not shown on the graph. d. Ages 55–90 covariate-adjusted. Note: Based on estimating Eq. (5) for Medicare-eligible out of pocket spending. The 95% confidence interval for the 99th percentile (−7866, 1206) is not shown on the graph.

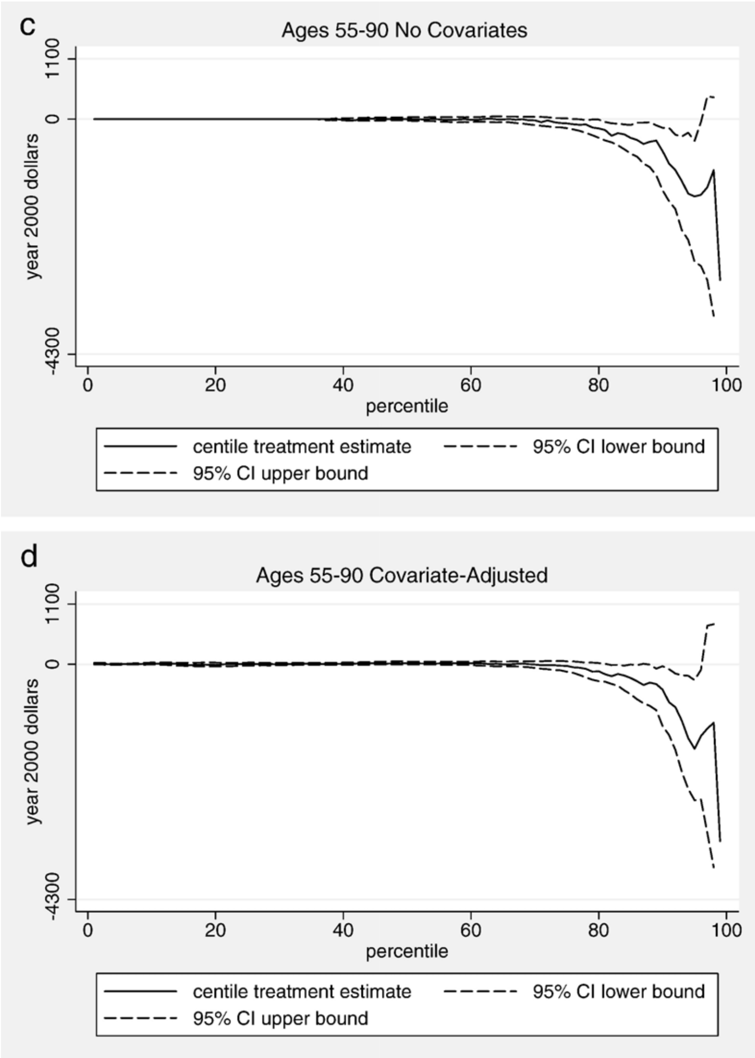


Fig. 7 (*continued*).

The results are shown without covariate adjustment (Fig. 7a) and with covariate adjustment (Fig. 7b). The results are striking. There is no evidence of an impact of Medicare on out of pocket spending until the top quartile of the out of pocket spending distribution. For this top quartile, the declines are dramatic, and increase monotonically throughout the quartile. Table 5 reports the point estimates — and statistical significance — of the 75th through 99th centiles in columns 3 and 4. They indicate that, on average, Medicare is associated with a 40% decline in out of pocket spending for the top quartile of the distribution.[10] The declines are even larger for the top decile, where Medicare is associated with an almost 50% decline in out of pocket spending, or an average decline of about $1200 per person. Fig. 7c and d show that the quantile treatment estimates look similar if we expand the elderly sample to include all those aged 65–90; these point estimates are reported in columns 5 and 6 of Table 5.

The quantile treatment estimator in Eq. (5) uses as a proxy for the change in spending that would have occurred for spending *quantile q* in the treatment group absent the introduction of Medicare, the change in spending that did occur for the same quantile *q* in the control group. An alternative estimator suggested by Athey and Imbens (2006) uses as a proxy for the change in spending that would have occurred for spending *level y* in the treatment group absent the

[10] These estimates are based on the covariate-adjusted specification. The estimates without covariates would suggest an almost 50% decline in out of pocket spending for the top quartile.

Table 5
Effect of Medicare on distribution of out of pocket spending

Centile	Out of pocket spending (ages 65–74 in 1963)	Centile treatment estimates			
		Individuals 55–74		Individuals 55–90	
		Overall (no covariates)	Overall (covariate-adjusted)	Overall (no covariates)	Overall (covariate-adjusted)
(1)	(2)	(3)	(4)	(5)	(6)
75	304	−105	−46	−78*	−31
76	326	−124*	−74	−94*	−56
77	395	−185**	−97	−104*	−64
78	422	−185**	−91	−97*	−84
79	456	−213**	−99	−154**	−136
80	512	−251**	−155	−171**	−129*
81	563	−278**	−183*	−201**	−183*
82	563	−314**	−191**	−305**	−218**
83	580	−279**	−197**	−258**	−178**
84	675	−347**	−278**	−280**	−206**
85	703	−368**	−341**	−344**	−252**
86	816	−452**	−410**	−382**	−310**
87	844	−499**	−400*	−454**	−380*
88	957	−459**	−347**	−414**	−336**
89	1002	−447**	−478**	−393**	−363**
90	1097	−608**	−531**	−587**	−464**
91	1463	−922**	−771*	−812**	−695**
92	1304	−937**	−825**	−935**	−785**
93	1711	−1064**	−951**	−1131**	−1031**
94	2127	−1291**	−1289*	−1363**	−1349**
95	2324	−1000*	−1094	−1415**	−1546**
96	2954	−1274*	−1208	−1384**	−1312**
97	3641	−1166	−1144	−1246	−1177
98	4637	−1090	−1309	−932	−1069
99	5599	−2444	−2527	−2940	−3236

Note: Centile treatment estimates are from Eq. (5). ** denotes significance at the 5% level; * denotes significance at the 10% level. Results below the top quartile tend to be 0 or very close to 0 and statistically insignificant.

introduction of Medicare, the change in spending that did occur in the control group at the quantile in the control group that corresponds to that same level y. Given the similarity of the treatment and control distributions in the pre-period (see Fig. 6), we find, not surprisingly, that the two approaches yield very similar results (not shown).

A potential concern with the foregoing analysis is that it assumes that, absent the introduction of Medicare, out of pocket spending at the top of the distribution would not have declined for the young elderly relative to the near elderly. We provide some indirect support for this identifying assumption. Fig. 8 examines how spending changed between 1963 and 1970 for adjacent age groups who both experienced the same change in Medicare coverage over this period. Fig. 8a shows that out of pocket spending in the top decile of the distribution actually *increased* for individuals aged 60–64 relative to individuals aged 55–59 (neither of whom became covered by Medicare), although the increase is not statistically significant. Fig. 8b indicates a decrease in out of pocket spending at much of the top end of the distribution for individuals aged 70–74 relative to individuals aged 65–69 (both of whom became covered by Medicare). However, the decreases are statistically insignificant and are about half the magnitude of the estimated decreases for individuals aged 65–74 relative to individuals aged 55–64. These findings suggest that our main analysis comparing 65–74 year olds to 55–64 year olds is not merely picking up an underlying change in the spending distribution that differs systematically by age.

4. Cost–benefit analysis

This section provides an analysis of the initial social cost of Medicare and compares it to the social welfare benefits experienced by the first generation of Medicare recipients. We consider potential benefits both from reduced mortality

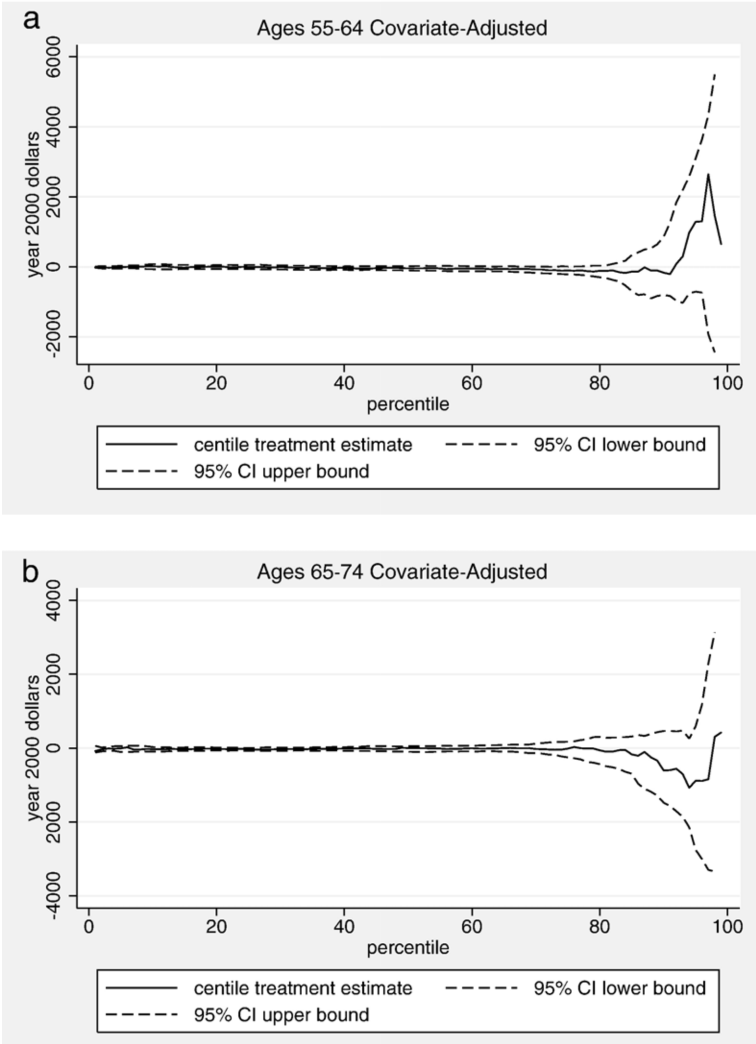


Fig. 8. Falsification exercises. Centile treatment estimates for Medicare-eligible out of pocket spending. a. Falsification exercise. Ages 55–64 covariate-adjusted. Note: Based on estimating Eq. (5) for Medicare-eligible out of pocket spending. Dashed lines indicate 95% confidence intervals. The 95% confidence interval for the 99th percentile (−7091, 5003) is not shown on the graph. b. Falsification exercises. Ages 65–74 covariate-adjusted. Note: Based on estimating Eq. (5) for Medicare-eligible out of pocket spending. The 95% confidence interval for the 99th percentile (−14088, 26512) is not shown on the graph.

and from decreased risk exposure. Our estimates of the annual social costs and benefits of Medicare in its initial years are summarized in Table 6. Because there is considerable uncertainty surrounding these estimates, Table 6 presents our central estimates, but also other plausible estimates in brackets; we discuss the sources of sensitivity in detail in the discussion below. It is also important to emphasize that all of this analysis applies to the impact of Medicare in its first few years, and hence for the first cohort of beneficiaries. Medicare's impact on later beneficiaries depends in part on the extent to which Medicare was responsible for the changes in the health care system experienced by later generations, which affected both mortality and medical expenditure risk. We discuss this issue briefly in the conclusion.

4.1. The social cost of Medicare

Medicare imposes two types of costs. First, there is the cost of raising the revenue to pay for the public program. In 1970, Medicare spending was (in 2000 dollars) $34 billion. The consensus estimate of 0.3 for the marginal cost of public funds in the US (Poterba, 1996) implies that the annual revenue raising costs associated with Medicare were

Table 6
Summary of cost–benefit analysis for first cohort of Medicare beneficiaries

	Total (billions of dollars)	Dollars per beneficiary
Annual social costs:		
Cost of public funds	10.2	537
Moral hazard costs [lower bound estimate]	18.5 [2.8]	974 [147]
Annual social benefits:		
Value of life-years saved [upper bound of 95th pct confidence interval]	0.7 [a] [17.1]	36 [a] [900]
Insurance value [range of estimates]	11 [2, 58.9]	585 [105, 3100]

This table reports our central estimates for the components of the cost–benefit analysis. Since, as we discuss in more detail in the text, there is considerable uncertainty about the magnitude of the benefits that we estimate, we provide some information in brackets next to each estimate on other plausible estimates. The cost estimates are taken from the existing literature and described in more detail in the text. All estimates are annual estimates in year 2000 dollars, and assume 19 million Medicare beneficiaries in the initial years.

[a] The point estimate used to calculate the value of the reduction in mortality associated with Medicare is statistically insignificant. We do not have any estimates of the reductions in morbidity associated with Medicare.

$10.2 billion. Second, there are the efficiency costs from the moral hazard effect of health insurance on increased health spending. By including all of the increase in health spending in our cost estimate, we provide an upper bound on the efficiency costs of Medicare, since part of the moral hazard effect comes from the income effect of health insurance, which does not have efficiency costs.

There is a considerable range in the moral hazard estimates for Medicare. The moral hazard estimates in Section 3.1 — which suggest that, by 1970, Medicare was associated with a 28% increase in the elderly's annual health spending —imply that Medicare was associated with a moral hazard cost of $2.8 billion per year[11]; this is quite similar to the predicted moral hazard effect of Medicare based on the RAND health insurance experiment (see Finkelstein, 2007). However, the RAND estimates exclude the elderly, and Chandra et al. (2007) have estimated a substantially larger price elasticity of demand for the elderly. Moreover, as already noted, our spending analysis based on the age variation in Medicare coverage will produce downward biased estimates of the impact of Medicare on total spending if Medicare had spillover effects that increase spending among the non-elderly. Indeed, Finkelstein (2007) estimates the general equilibrium impact of Medicare on hospital spending to be over 6 times larger than the estimates from partial equilibrium analysis based on age variation, or from extrapolation from the results of the RAND experiment. Finkelstein's (2007) estimates imply that, in 1970, Medicare was associated with a moral hazard cost of $18.5 billion per year. We use this larger estimate for our central estimate of the moral hazard cost of Medicare. Combining the moral hazard and public funds costs suggests that the total annual social cost of Medicare was $28.7 billion, or $1511 per elderly beneficiary; moral hazard alone is responsible for a cost of $974 per beneficiary, or about two-thirds of the total cost.

4.2. Social value of mortality reductions associated with Medicare

Our central estimate of the mortality impact of Medicare based on the geographic variation strategy is that, by 1970, Medicare was associated with a (statistically insignificant) decline in elderly deaths of 0.15% per year. Appendix A describes how we form this estimate. Given the average mortality rate for individuals 65 and over in 1965 of 6% (author's calculation from the data used in Section 2), and assuming that a life saved in year t will live for another four years[12], then (ignoring discounting) these estimates suggest that by 1970 Medicare was associated with an expected saving of 0.00036 (=0.0015 * .06 * 4) life-years per person per year. Using a standard estimate for the value of a statistical life-year of $100,000 (Cutler, 2004), this suggests that Medicare's mortality reduction was worth, on average, $36 per elderly person, or $0.7 billion annually.

[11] There were about 19 million people aged 65 and over in 1965 and their average per capita Medicare-eligible health spending in 1963 was $518 (see Table 3).

[12] It is difficult to know how long to assume a person whose death is averted by Medicare will live. We use the estimate from Cutler (2004) that improvements in cardio-vascular disease mortality (the primary cause of death among the elderly) have added on average about 4 years of life expectancy at age 45 since 1950. Similarly, the overall increase in life expectancy for a 65-year-old between 1950 and 2004 is 4.8 years (NCHS, 2006).

Our point estimate of (statistically insignificant) savings from mortality reductions of \$36 per person is small relative to our estimate of the per beneficiary social cost of Medicare of \$1511, or even just the moral hazard cost from increased spending of \$974 per year. However, it is important to benchmark our inability to reject the null hypothesis that Medicare had no effect on elderly mortality for the initial cohort of beneficiaries against the mortality reduction that would be needed to cover the social cost of Medicare. As discussed in Appendix A, our 95% confidence interval for the mortality effects of Medicare in 1970 includes declines of up to 3.9% in annual elderly deaths, which implies savings of 0.009 (=0.039 * .06 * 4) life-years per person. Again using a \$100,000 value of a statistical life-year, we cannot reject with 95% confidence a reduction in annual elderly mortality as valuable as \$900 per person, which would suggest that most of the increased spending of \$947 per person was socially valuable. Put another way, even a relatively small mortality reduction associated with Medicare — of a magnitude that we cannot reject in our data — may be sufficient to justify about three-fifths of the total social cost of \$1511 per beneficiary.

4.3. Social value of reduction in risk exposure associated with Medicare

We use a stylized expected utility framework to simulate the insurance value of the estimated reduction in risk exposure associated with Medicare for the first generation of beneficiaries. The analysis is predicated on the assumption that the elderly were underinsured prior to Medicare and therefore that reductions in risk exposure are welfare improving. This was the premise behind the Medicare legislation (Ball, 1995) and is consistent with the considerable empirical evidence of adverse selection in private health insurance markets (Cutler and Zeckhauser, 2000).

Our analysis of the insurance value of Medicare is similar in spirit to McClellan and Skinner (2006). However, while they use parametric assumptions about the price and income elasticity of demand for medical care to solve for the optimal consumption of medical care in the presence and absence of Medicare, we instead use our empirical estimates of the distribution of out of pocket medical expenditures across individuals before Medicare as inputs into the expected utility framework.

We assume the individual's utility $u(c)$ is a function of his non-health consumption (c). We assume the individual must satisfy a period-by-period budget constraint:

$$c = y - m$$

where y is his per-period income (such as from Social Security) and m is his out of pocket medical expenditures. m is a random variable with probability density function $f(m)$ and support $[0, \overline{m}]$. $f(m)$ depends both on the distribution of random health shocks, and on the nature of any health insurance held. The individual's expected utility is given by:

$$\int_0^{\overline{m}} u(y-m)f(m)dm$$

To calculate the welfare gain associated with increased health insurance coverage, we follow the approach used in the existing literature that calculates the welfare gains associated with other insurance products (e.g. Mitchell et al., 1999; Brown and Finkelstein, in press; Feldstein and Gruber, 1995) and compare the individual's risk premium under both the pre- and post-Medicare spending distributions. The risk premium (π) is the maximum amount that a risk averse individual would be willing to pay to completely insure against the random variable m. The risk premium π is therefore defined implicitly by:

$$u(y-\pi) = \int_0^{\overline{m}} u(y-m)f(m)dm$$

A decrease in risk exposure in the post-Medicare world relative to the pre-Medicare world will appear as a decline in the risk premium; this decline provides a measure of the insurance value (and hence welfare gain) of the Medicare coverage.

Our analysis is based on the sample of 703 individuals aged 65 and over in the 1963 Survey of Health Service Utilization and Expenditures. We construct individual income by dividing the household income reported in the data by the number of individuals in the household. Since pre-Medicare out of pocket medical expenditures are strongly positively correlated with household income, we divide our individuals into income terciles and assume that each individual faces the empirical out of pocket expenditure distribution of his income tercile; in other words, we compute each individual's expected utility by averaging over their utility given each possible out of pocket medical expenditure amount observed for his income tercile. Even with tercile-specific distributions of risk, it is still possible to get a draw that is very high relative to (or higher than) income, which is unrealistic relative to actual spending patterns. Empirically, the 95th percentile of the distribution of out of pocket spending as a share of income for individuals in the bottom tercile of the income distribution is 80%, so we cap out of pocket spending as a fraction of income for each draw at 80%.

We estimate the post-Medicare out of pocket spending distribution by mechanically adjusting the pre-Medicare 1963 distribution to account for what Medicare would have covered had Medicare existed in 1963.[13] Fig. 9 shows this mechanically adjusted distribution. For comparison, it also shows the pre-Medicare distribution and the pre-Medicare distribution adjusted using the quantile treatment estimates. As expected, the mechanical adjustment produces a distribution that lies below that from the quantile treatment adjustment, because the mechanical adjustment does not account for the moral hazard effects of Medicare on health care utilization.[14]

In estimating the welfare gain from risk reduction for the first generation of Medicare recipients, we must take into account two additional issues. First, the earliest Medicare cohorts received a windfall transfer. They received benefits from Medicare but did not pay the payroll taxes used to finance Medicare hospital coverage; premiums for physician benefits were also heavily subsidized from general revenue. Since our interest is in the social welfare benefits from Medicare rather than the private benefits from transfer payments, we assume for the purposes of our calculations that the beneficiaries "pay for" the actuarial expected cost of Medicare, so that the welfare benefits come only from reductions in the variance, and not the mean, of medical expenditures.[15] Specifically, in calculating the risk premium under the post-Medicare distribution, we subtract from the individual's income the average difference in out of pocket expenditures between his original pre-Medicare distribution and his post-Medicare distribution.

Second, when Medicare was introduced in 1965, the current elderly already had information about their health status. The insurance value of Medicare arises only from the reduction in the variance of ex ante uncertain medical expenses. The additional transfer that Medicare's introduction provided to the relatively unhealthy elderly, who already expected higher medical expenditures at the time of its introduction, did not reduce this uncertainty and, therefore, does not contribute to its insurance value.[16] To get a sense of how much the empirical ex-post variation in out of pocket spending across individuals reflects the realization of ex ante uncertainty from the perspective of the individual, we compared the observed variation in out of pocket spending to the variation conditional on health status measures. The data contain information on the individual's self-reported health status, number of days spent disabled, and dummy variables for whether the individual reports having had each of 18 different health symptoms at some point during the past year (such as fatigue, shortness of breath after light work, chest pains, aching joints, etc.) We estimate that the standard deviation of out of pocket medical spending in the data declines by about 15% once we control for these health measures, suggesting that only about 85% of the ex-post variation represents the realization of ex ante uncertainty.[17]

When we treat all ex-post spending variation as a realization of ex ante uncertainty, we estimate that, for a CRRA utility function with coefficient of relative risk aversion of 3, the average risk premium for individuals facing the

[13] The details of the Medicare benefits at the time of its introduction are taken from Somers and Somers (1967). Since the Part A co-payment depends on the length of the hospital stay, we draw on the data on the individual's length of hospital stay in calculating the part A cost sharing requirements for the individual.

[14] Both the income and substitution effect from Medicare lead to increased consumption of health care and hence out of pocket spending. This increased out of pocket risk reflects individual optimization decisions, and therefore should not be counted against their welfare gain. (Of course, the behavioral response does contribute to the social costs of the program, and we therefore account for these moral hazard costs in the cost-benefit analysis below.)

[15] For excellent discussions of the inter- and intra-generational distributional consequences of Medicare see McClellan and Skinner (2006) and Bhattacharya and Lakdawalla (2006). In the working paper version of this paper (Finkelstein and McKnight, 2005) we also present estimates of the private benefits from Medicare experienced by the first generation who received these benefits "for free".

[16] Such an issue would not apply to an analysis of the welfare effects of Medicare for later cohorts, since such analysis can treat all ex post variation as the revelation of uncertainty present at much younger ages. Of course, welfare analysis for later cohorts must address the difficult issues of what today's spending distribution would be in the absence of Medicare, as well as any long-run health benefits of Medicare's induced increases in spending.

[17] On the one hand, this calculation may overstate the amount of ex ante uncertainty, as our measures of the individuals' knowledge of their health are unlikely to be complete. On the other hand, this calculation may understate the amount of ex ante uncertainty as the analysis is in a cross-section, so that the (unexpected) realization of a bad health event may be contemporaneously correlated with higher out of pocket medical spending. Consistent with under-estimation of the amount of ex-ante health uncertainty in a cross section, in an analysis of panel data on the near-elderly from the 1969, 1971, and 1973 Retirement History Surveys, we find that the total standard deviation of out of pocket medical spending in 1971 and 1973 is reduced by only 6% when we control for measures of health status from the 1969 survey.

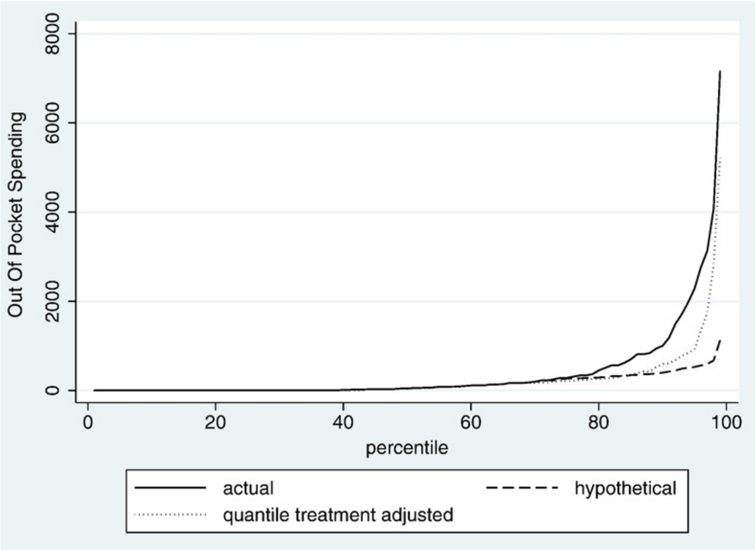


Fig. 9. Distribution of Medicare-eligible out of pocket medical expenditures. Note: Figure depicts distributions in year 2000 dollars. "Actual" shows the actual distribution of out of pocket spending for individuals aged 65 and over in 1963. "Quantile treatment adjusted" shows the distribution if the actual distribution is adjusted using the quantile treatment estimates in Fig. 7c. "Hypothetical" shows the distribution if the actual distribution is adjusted mechanically to account for what Medicare would have covered had Medicare existed in 1963.

distribution of out of pocket spending that existed prior to Medicare was $1027. This indicates that under the pre-Medicare spending distribution, the average individual would be willing to pay up to $1027 to avoid any future out of pocket medical expenditure risk. We estimate that this risk premium declines by $585 when the individual instead faces the post-Medicare risk distribution, suggesting an average welfare gain of $585 per individual. If we instead condition the risk distribution that each individual faces on a measure of his initial health status, we estimate that the risk premium prior to Medicare was $908, and declines by $560 due to Medicare.[18] There were about 19 million people aged 65 and over in 1965. This implies that Medicare's reduction in risk exposure was associated with $10.6 (=$560 × 19 million) to $11.1 billion (=$585 × 19 million) per year in welfare gains, or about $11 billion.

It is important to highlight that these estimates are quite sensitive to two particular assumptions. First, these estimates are, not surprisingly, sensitive to the choice of risk aversion coefficient — about which there is no clear consensus. Compared to an estimated annual welfare gain of about $11 billion with a coefficient of relative risk aversion of 3, the welfare gain falls to about $2 billion if we instead assume a coefficient of relative risk aversion of 1, and rises to about $34 billion under the assumption of a coefficient of relative risk aversion of 5.

Second, our welfare estimates are quite sensitive to the assumption we make about the maximum level of out of pocket medical expenditures as a share of income. This is also not surprising, as this assumption affects how low non-medical consumption may be driven by high medical expenses, and therefore how high the marginal utility of non-medical consumption can get. If we replace our baseline 80% cap on out of pocket medical expenses as a share of income with a cap of 60%, the estimated welfare gain from Medicare (assuming a coefficient of relative risk aversion of 3) falls from $11.1 billion to $5.7 billion; in a similar vein, the welfare estimate rises to $58.9 billion if we impose a cap of 99%.

One implication is that if, prior to Medicare, individuals were able to avoid high out of pocket medical spending relative to their income, our estimates may substantially over-state the welfare gains associated with Medicare. This might occur if medical expenditure shocks were financed out of savings, charity care, or transfers from relatives, or if they could be avoided by discretionary use of medical care. More generally, our use of a one-period model precludes

[18] Specifically, we further divide each income tercile into two groups based on whether the individual has the median number of health symptoms (2) or less, or whether the individual has more than the median. This measure of health status reduces the standard deviation of out of pocket medical expenditures by only 7%, or about half of the 15% reduction from the richer parameterization of health status described above. However, we do not have sufficient sample size to characterize the distribution of out of pocket spending risk for smaller sub-samples of individuals.

the possibility that individuals can use savings or other mechanisms to smooth the expenditure shock over several periods, which may lead us to over-state the welfare gains from Medicare. Somewhat reassuringly, Appendix B presents several pieces of evidence that suggest that out of pocket medical expenditures are funded to a large degree out of current, non-medical consumption. However we cannot rule out the possibility that individuals have some discretion in avoiding extremely low non-medical consumption. This possibility, together with the sensitivity of our welfare estimates to assumptions about the minimum level of non-medical consumption, suggests caution in placing too much weight on our central welfare estimate.

It is also worth noting several reasons why our estimates may underestimate the consumption-smoothing benefits associated with Medicare. First, our model treats medical expenditures as affecting the budget constraint only and does not allow for any utility from increased medical expenditures. While some of the increased spending associated with Medicare may have been socially inefficient, the cost-sharing provisions ensure that its social marginal benefit was not zero. Second, out of pocket medical expenditures are likely to be positively serially correlated. Feenberg and Skinner (1994) and French and Jones (2004) present evidence that shocks to out of pocket medical expenses are highly persistent over time, which suggests that the lifetime distribution of out of pocket spending for those aged 65 and over may be even more right-skewed than the annual distribution shown in Fig. 5. As a result, the reduction in risk exposure from Medicare may be even greater when estimated on a lifetime basis, rather than in a one-period framework.

For our central insurance value estimate, we assume a coefficient of relative risk aversion of 3, and assume that out of pocket medical spending never exceeds more than 80% of consumption. This implies that the annual social welfare benefits from Medicare's consumption-smoothing properties are about $11 billion, or almost two-fifths of the $28.7 billion social cost of the program. However, as noted, our welfare estimates are sensitive to our choice of the coefficient of relative risk aversion, as well as to how low non-medical consumption may be driven by high medical expenditures. Table 6 summarizes the range of estimates. At the low end, the estimates suggest that the direct insurance benefits of Medicare for the earliest cohort covered only about 7% of Medicare's costs; at the high end, the insurance benefits could be worth more than double the social cost of the program.

5. Conclusion

This paper has examined the impact of the introduction of Medicare, the single largest change in health insurance coverage in U.S. history. Using several different empirical approaches, we find no evidence that the introduction of nearly universal health insurance for the elderly had an impact on overall elderly mortality in its first 10 years. On the one hand, these results are not particularly surprising as even quite small reductions in elderly mortality associated with Medicare — of a range that we cannot reject in our data — would be sufficient to justify the increased spending associated with Medicare. Moreover, the available data do not permit us to examine potential non-mortality health benefits from Medicare, such as reduced morbidity. On the other hand, our findings suggest that Medicare did not play a role in the substantial declines in elderly mortality that immediately followed the introduction of Medicare. Our evidence suggests that the explanation lies in the fact that, prior to Medicare, lack of legal access — rather than lack of insurance — was the main barrier to receiving hospital care when individuals had life-threatening, treatable conditions.

We also find that, although Medicare did not produce measurable mortality benefits, it did provide considerable risk reduction benefits for the original recipients. We estimate that the introduction of Medicare was responsible for a striking and substantial decline in the right-tail of the out of pocket medical expenditure distribution for the elderly. For the top quartile of out of pocket medical spending, we estimate that the introduction of Medicare was associated with a 40% decline in out of pocket spending by 1970, relative to pre-Medicare levels.

A stylized expected utility framework suggests that the social welfare gains associated with this reduction in risk bearing may be substantial. These findings underscore the importance of considering the direct consumption-smoothing benefits of health insurance, in addition to any indirect benefits from the effect of insurance on health.

Our analysis focused on the impact of Medicare in its first 5 to 10 years. An interesting and important question for future work is how the impact of Medicare on mortality and risk exposure for subsequent generations of the elderly may differ from its impact on the original generation of beneficiaries. Of particular importance is that our analysis was done in a static environment in which medical technology is taken as given. Since the introduction of Medicare, there have been substantial improvements in medical technologies and increases in their use among the elderly. Finkelstein (2007) presents evidence that Medicare may have played a role in encouraging this technological progress. Since the increase in life expectancy from many of the new technologies is extremely large (Cutler, 2004), the longer-run impact of Medicare on mortality via induced technological change could be substantial. Medicare's impact on the nature of the health care system also suggests that the long-run impact of Medicare on the elderly's exposure to out of pocket medical expenditure risk may differ markedly from the impact we estimate on the original generation of beneficiaries.

Appendix A. Estimates of the mortality reduction associated with Medicare

As we discuss in Section 2, we are unable to reject the null hypothesis of no mortality improvement for the elderly associated with the introduction of Medicare. For our cost–benefit analysis, however, it is important to obtain a point estimate and a confidence interval for the potential mortality benefits of Medicare. We do this using the geographic variation strategy for Section 2.2; we do not use estimates from the age-based variation strategy (described in Section 2.1) since, as Fig. 3 makes apparent, any such estimates will be extremely sensitive to the (arbitrary) assumption regarding the time frame used to estimate the pre-Medicare relative trend in mortality for different ages.

In Section 2.2, we estimated a very flexible model of annual changes in mortality across different areas of the country (see Eq. (2)). This has the advantage of not imposing any restrictive functional form on the differential pattern of mortality improvements across different areas prior to Medicare. However, a primary drawback to using the estimates from Eq. (2) to form our central estimate of the impact of Medicare on mortality is that the estimate will be sensitive to the particular year's coefficients chosen for the "after Medicare" and "before Medicare" comparison (see e.g. Fig. 4a). To avoid this problem — and also to make more efficient use of all the data in estimating the effect of Medicare — we estimate a deviation from trend analysis of the form:

$$\ln(\text{deaths})_{st} = \beta_1 \ln(\text{pop}'n_{st}) + \alpha_s{*}1(\text{State}_s) + \delta_t{*}1(\text{Year}_t) + \beta_2(t_t{*}\text{pctuninsured}_z) + \beta_3\left(\max\left(0,\ (t-1965)_t\right){*}\text{pctuninsured}_z\right) + \sum_{n=-18}^{n=9} \gamma_n 1\left(\text{Mcaid}_{\text{st}}^{n}\right) + \varepsilon_{st} \tag{A1}$$

As in the flexible Eq. (2), Eq. (A1) includes a full set of state fixed effects (α_s's), a full set of year fixed effects (δ_t's, and a series of indicator variables for the number of years in the state since Medicaid was introduced (1($\text{Mcaid}_{\text{st}}^{n}$). However, instead of interacting a full set of year dummies with the sub-region's insurance coverage prior to Medicare as in Eq. (2), Eq. (A1) interacts a linear time trend with the sub-region's insurance coverage prior to Medicare(t_t * pctuninsured$_z$) and allows for a trend shift after the introduction of Medicare that varies with the sub-region's insurance coverage prior to Medicare (max(0,($t-1965$)) * pctuninusred$_z$). The coefficient of interest is β_3; it indicates the differential slope shift in 1966 experienced by hospitals with more of an impact of Medicare on insurance coverage relative to those with less of an impact. We use the same weights as used for estimation of Eq. (2) and similarly adjust our standard errors to allow for an arbitrary covariance matrix within each state. The primary drawback to this specification is the imposition of a less flexible functional form; however the evidence from estimation of Eq. (2) of a relatively smooth pre-period trend (see e.g. Fig. 4A) suggests that, in practice, our functional form restriction is unlikely to be overly restrictive.

For the sample of individuals aged 65 and over, we estimate β_3 to be −0.0004, with a standard error of 0.005. This implies that after five years (i.e. by 1970), Medicare was associated with a statistically insignificant decline in annual elderly deaths of −0.15% (~[exp(−0.0004×0.75×5)−1]), with a 95% confidence interval that runs from a reduction in mortality of 3.9% to a mortality increase of 3.6%.

Appendix B. Individual ability to avoid very low non-medical consumption

In our analysis of the insurance value of Medicare in Section 4.3, we cap out of pocket medical spending at 80% of income. Although our baseline assumption of 80% is consistent with the data, it is difficult to be certain either that individuals never exceed this cap or that they can always be forced to such a high level of medical spending. If, for example, individuals have some discretion over how much medical care they consume, or fund some of their very high medical expenditures out of savings or by transfers from relatives, they may be able to prevent their non-medical consumption from falling as much as our analysis would imply, and our analysis will over-estimate the insurance value of Medicare.

Data from the 1960–1961 Consumer Expenditure Survey on households whose head is 65 or older indicates that, controlling for a rich set of demographics, a $1 increase in out of pocket spending for hospitals or doctors (i.e. spending that would subsequently be covered by Medicare) is associated with a statistically significant $0.46 decrease in non-medical consumption. The decline in non-medical consumption is even higher, at $0.60, if we look only at hospital spending, which is arguably less discretionary (and has greater variance) than doctor spending. These results are consistent with the assumption of our model that higher out of pocket medical expenditures are associated with decreased non-medical consumption. However, given that the estimated decline is less than one-for-one, there may be more scope than our model allows for avoiding extremely low non-medical consumption.[19]

One way to avoid extremely low non-medical consumption, in the absence of Medicare, would be receipt of external assistance with high medical expenses, such as charity care or payments by relatives. However, in the 1962 Survey of Consumer Finances, only 5% of the elderly with "large" medical bills reported that they received help paying for these bills from relatives, friends, or charity.

Another very natural way to avoid extremely low non-medical consumption would be to finance high medical expenses out of savings. If this is a quantitatively important phenomenon, our analysis, which assumes that individuals cannot borrow or save across periods but must consume each period their net-of-medical expenditures income, may substantially over-state the welfare gains from insurance. However, evidence from the 1962 Survey of Consumer Finances suggests that our assumption may be reasonable for many elderly households, since the majority entered retirement with relatively little financial assets. Specifically, the data indicate that almost one-third of elderly households had no liquid assets whatsoever, and many of those who did have liquid assets had relatively small amounts. Consistent with this, only 30% of the elderly who reported "large" medical bills said they paid for some of the bill out of savings; by contrast, 80% reported paying out of current income. Of course, savings may be an important form of consumption-smoothing at the high end of the income distribution. We therefore re-calculated welfare gains separately for each income tercile to confirm that our estimate of the average per person welfare gain is not driven by disproportionate gains at the top of the distribution where we are likely to be over-estimating the gain. In fact, per person welfare gains were slightly higher for individuals in the lower portions of the distribution. Similarly, McClellan and Skinner (2006) report higher welfare gains from the consumption-smoothing benefits of Medicare among lower income households.

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[19] We suspect that our estimates are biased downward since individuals of higher unobserved socio-economic status likely consume more of both medical and non-medical spending. It is possible therefore that with richer data we might estimate a coefficient closer to 1. The 95% confidence interval on the relationship between out of pocket hospital spending and non-medical consumption ranges from -0.35 to -0.85.

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