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Health Insurance and the Growth of Health Spending: *Evidence from the Introduction of Medicare*

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Abstract: Rising expenditures have been a defining feature of the health care sector over the last half-century. I investigate whether health insurance played a role in this rapid growth of the health care sector by studying the single largest change in health insurance coverage in American history: the introduction of Medicare in 1965. I use the substantial regional variation in insurance levels among the elderly before 1965 to identify the impact of Medicare. I find robust evidence that Medicare is associated with an increase in hospital labor and capital inputs, as well as hospital spending; these effects persist through 1975 (the end of the study period). Several pieces of evidence suggest that Medicare affected not only the level of health spending but also its growth rate. For example, I find that the introduction of Medicare is associated with an increase in the rate of diffusion of the then-new medical technologies. A preliminary calculation suggests that Medicare accounts for one-third of the annual growth of real per capita hospital spending since 1965.

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Over the last forty years, the dramatic rise in medical expenditures has been one of the most salient features of the health care industry. Total health care expenditures as a share of GDP have almost tripled, from about 5 percent in 1960 to about 14 percent in 2000 (CMS, 2002). Rapid technological change in the health care sector is widely regarded to be the primary factor responsible for these soaring health care expenditures (see e.g. Newhouse, 1992 or Fuchs, 1996).

During the same period, the spread of health insurance coverage has also dramatically altered the *source* of health care funding. In 1960, less than half of all medical expenditures were covered by third-party insurers. By 2000, insurance paid for 80 percent of medical expenditures. Increases in both public and private health insurance coverage have played important roles in this rise in insurance coverage (National Center for Health Statistics, 2002).

Initially, both private and public health insurance reimbursed on a "fee-for-service" basis for whatever expenditures were incurred. It has since been widely conjectured that this type of insurance system has been a driving force behind the rapid creation and adoption of new medical technologies and the rise in health care costs (see e.g. Feldstein 1971, Pauly 1986, Weisbrod 1991, Cutler, 2002a). Beginning in the 1980s, such concerns prompted a dramatic shift away from fee for service health insurance toward managed care in both public and private health insurance plans. Several decades after the "managed care revolution" began, dissatisfaction with managed care is high [[cite]], while the impact of managed care on stemming the rise in health expenditures remains the subject of considerable debate (Glied, 2000).

Was fee-for-service health insurance an important contributor to the rapid growth of health expenditures that started in the 1960s? That fee-for-service health insurance creates incentives for increased health care consumption in a static framework is both conceptually clear (see e.g. Feldstein, 1973) and empirically well documented (see e.g. Newhouse, 1993). The dynamic effects of health insurance on the health care sector are less obvious, both conceptually and empirically.

In a widely cited article, Weisbrod (1991) has conjectured that fee for service health insurance has contributed to the growth of health care spending by encouraging the diffusion, and therefore in turn the development, of expensive new medical technologies. However, we have a very limited understanding of the role of economic incentives in affecting technological change in medicine. In contrast to Weisbrod's (1991) hypothesis of insurance-induced technological change, others have conjectured that physicians – as a result of their training – operate according to a "technological imperative" that induces them to adopt new technologies (Fuchs, 1998). Indeed, long prior to Medicare, American hospitals were distinguished by their interest in and early use of new technologies (Stevens, 1999). In addition, if technology adoption is primarily driven by physicians attempting to increase their income (i.e. to supplier-induced demand), the income effect of health insurance on physicians could result in a slowing of the rate of technological diffusion (see e.g. McGuire and Pauly, 1991).

The empirical literature on the determinants of technological change in medicine provides only limited insights into the effect of fee for service health insurance on technological change in medicine. Recent empirical evidence suggests that the for-profit investment decisions of pharmaceutical companies are responsive to financial incentives (Finkelstein 2004, Acemoglu and Linn, 2004); however, it is not clear whether the same reaction function should be expected for the technologies used – and often developed – by doctors or hospitals, which have been responsible for the bulk of expenditure growth, at least until recent years [[cite]]. Studies of the effect of managed care on technology adoption have tended to find that hospitals in areas with increased managed care penetration experience less rapid diffusion of new technologies (e.g. Cutler and Sheiner 1998, Baker and Phibbs 2002). However, it is not clear how to interpret this result; managed care not only changes the financial incentives of providers relative to fee for service health insurance but also includes direct oversight and regulation of service provision and technology adoption (Glied, 2000). As a result, it is unclear how the economic incentives in health insurance arrangements *per se* affect technological change in medicine.

To investigate the dynamic effects of fee for service health insurance, I study the single largest change in health insurance coverage in American history: the introduction of Medicare in 1965. Medicare provides public health insurance coverage to all individuals over age 65; starting in 1973, it also covered the disabled. Prior to its introduction, health insurance coverage for the elderly was minimal (see e.g.

Greenfield, 1966; Stevens and Stevens 1974). After its introduction, real per capita health expenditures grew rapidly (National Center for Health Statistics, 2002). Today, the Medicare program annually spends over $260 billion (about 17 percent of all health expenditures and 2 percent of GDP) and provides health insurance coverage to 40 million people (National Center for Health Statistics 2002, US Congress 2000).

Yet we know surprisingly little about the impact of this fundamental change in US health policy (Meara et al., 2002). Indeed, to my knowledge, the only evidence of the effect of Medicare on the health care sector comes from comparisons of time series patterns before and after its introduction (Feldstein 1971, Feldstein and Taylor 1977). The fundamental challenge is to isolate the causal effect of the introduction of this uniform nationwide program from other underlying secular trends in the health care sector.

In order to do so, I identified substantial geographic variation prior to the introduction of Medicare in the percentage of the elderly with effective private health insurance (to be defined more precisely below). I estimate that the increase in insurance coverage for the elderly associated with the introduction of Medicare ranged considerably, from a high of 88 percentage points in the East South Central United States to a low of 49 percentage points in New England. I use this variation to identify the causal impact of Medicare.

My analysis of the impact of Medicare on the health care sector focuses on the hospital sector. Hospitals are the single largest component in health spending, as well as the single largest contributor to the growth in health spending (National Center for Health Statistics, 2002). Indeed, the growth pattern of hospital spending mirrors the overall growth in health spending (see Figure 1). To study the impact of Medicare on the hospital sector, I unearthed hard copy data from the annual surveys of the American Hospital Association (AHA) of every AHA-registered hospital in the U.S from 1948 to 1975. These data allow me to construct an annual, hospital-level data base of hospital utilization, employment, beds, spending, and technology adoption over this 27 year period.

In the short run (i.e. the first five years after the introduction of Medicare) I find robust evidence that Medicare is associated with an increase not only in hospital utilization but also in measurable hospital inputs – employment and beds – and in hospital spending. The estimated effects are large. A conservative estimate suggests that Medicare was associated with a 14 percent increase in real hospital expenditures between 1965 and 1970; this suggests that Medicare can account for two-thirds of the above-average growth in real hospital expenditures between 1965 and 1970 relative to previous 5 year intervals.

I find that Medicare's effect on the growth of the hospital sector not only persists in the second five years after Medicare introduction (i.e. 1970 to 1975) but also manifests itself in a growth in hospital inputs and expenditures *per patient day*. The estimates suggest that Medicare is responsible for just over half of the growth in expenditures per patient day in its second five years (i.e. 1970 to 1975). Importantly, it is this growth in hospital expenditures per patient day – rather than increases in the number of patient days – that has driven the time series growth in health expenditures (Newhouse, 1992). Medicare is therefore associated with an increase in what in turn has been behind the growth in total expenditures. This is suggestive of a long-run effect of Medicare on the growth of hospital spending.

Since the identification of the effect of Medicare becomes increasingly difficult as one gets further away from its introduction, I concentrate my analysis of the long-run effects of Medicare on looking for evidence of a mechanism by which Medicare would affect long run growth in the health sector. Consistent with such a mechanism, I find evidence that the introduction of Medicare is associated with an increased rate of diffusion of two then-diffusing technologies: the post-operative recovery room (an early form of intensive care for post-operative patients, particularly coronary patients), and radioactive diagnostic isotope therapy (an expensive new diagnostic tool used primarily for cancer patients). The evidence suggests that Medicare is associated with an increase in the long-run proportion of hospitals with these technologies, rather than just a speeding up in time of diffusion that would have happened anyway. Since I do not find evidence of an effect of Medicare on two other then-diffusing technologies (the Intensive Care Unit and the EEG), overall the estimates imply that, in its first 10 years, Medicare was responsible for about one-fifth of the diffusion of the measurable technologies.

I also find suggestive evidence that private health insurance coverage among the non-elderly increased more rapidly after the introduction of Medicare in areas of the country where Medicare had more of an effect on the insurance rate of the elderly. This finding is consistent with Weisbrod's (1991) conjecture that health insurance not only encourages the adoption of new technologies but also that new technologies – by increasing the mean and variance of health expenditures – in turn increased demand for health insurance; this feedback loop provides an additional channel by which health insurance will contribute to the growth rate of health expenditures.

I combine the various findings to estimate the contribution of Medicare to the annual growth in real per capita hospital spending. A preliminary back of the envelope calculation implies that Medicare is responsible for one-third of the annual growth in real per capita hospital spending since 1965.

The rest of the paper proceeds as follows. In Section 1, I provide a conceptual framework for thinking about whether and by what mechanisms fee for service health insurance might affect the growth rate of health expenditures; I also provide a brief review the related existing empirical literature. Section 2 describes the empirical strategy used to identify the impact of Medicare. Section 3 describes the hospital data. Section 4 presents the basic estimates of the effect of Medicare on hospitals. Section 5 presents several pieces of complementary evidence that suggest that Medicare affects the long-run growth rate of hospital spending. The last section concludes.

1. Static and Dynamic Effects of Health Insurance

1.1 Static effects of health insurance

It is natural to expect health insurance to be associated with an increase in the level of health spending. By lowering the marginal cost of medical care faced by the consumer, health insurance encourages increased consumption of this care and hence, increased expenditures. Consistent with this, a substantial empirical literature has documented the static moral hazard effects of health insurance on the demand for medical care (see Cutler and Zeckhauser 2000 for a review of this literature).

On the supply-side, there is little direct evidence of how providers respond to increases in fee for service health insurance coverage. While it seems natural that providers should respond to the increased resources and lower marginal cost to the consumer of care by increasing the supply of health care inputs, the limited empirical evidence suggests that when faced with increased marginal incentives to attract patients and increased aggregate resources, hospitals do little in the way of increased real activity (Duggan, 2000). Below, I will argue that the introduction of Medicare is associated with increased hospital capital and labor inputs, as well as increased hospital spending.

1.2 Dynamic effects of health insurance: what might we expect?

While the static effects of health insurance on the health care sector are conceptually straightforward, it is considerably less clear whether health insurance should have a dynamic effect on growth in the health care sector. By lowering the marginal cost of medical care, health insurance increases demand for medical care at a point in time; such increased demand should persist as long as the health insurance exists, and thus increase the level of resource use in the health care sector. In order for health insurance to affect growth in the health care sector, there must be some link between health insurance coverage today and the growth in health insurance expenditures between today and tomorrow.

There is widespread consensus among economists that technological change has been the driving force behind the growth in health expenditures (e.g. Newhouse 1992, Fuchs 1966, Cutler and McClellan 2001). Thus the most likely way that fee for service health insurance contributed to the growth of health spending is by encouraging technology development and diffusion. By lowering the marginal cost of technology use, fee for service health insurance can increase utilization of these technologies and thus the financial incentives to develop and adopt new such technologies. By increasing the arrival rate of new technologies – which is the driving factor behind the rise in health care expenditures – health insurance may therefore increase the growth rate of the health care sector. In addition, Weisbrod (1991) has conjectured that the adoption of new medical technologies which increase the mean and variance of health care expenditures increases the value of – and hence the demand for – health insurance; this feedback loop provides an additional channel by which health insurance can contribute to the growth rate of health expenditures.

While theoretically plausible, it is a priori unclear whether, in practice, fee for service health insurance increases the adoption of new technologies – let alone whether there is a feedback loop to increased insurance demand. As noted, one alternative is that physicians operate according to a "technological imperative" (Fuchs 1998); in such an environment, major new technologies may be adopted regardless of the insurance environment, and insurance may have little or no effect on increasing the rate of technological diffusion.

Another alternative, the supplier-induced demand theory of physician behavior, suggests that fee-for-service health insurance could in fact slow the rate of technological diffusion. Medical providers not only provide treatment but also influence treatment decisions; they may do so in order to maximize their net income and leisure, while receiving some disutility from demand "inducement" (McGuire and Pauly, 1991). The introduction of Medicare, which increased the marginal return to provider activity, has both an income and substitution effect for providers. If the income effect dominates, Medicare could reduce the intensity of treatment – and therefore the adoption of new technologies. Consistent with a large income effect, several studies that examine changes in Medicare reimbursement rates find that reductions in fees are associated with substantial increases in provider volume (Rice 1983, Rice 1984, Christensen 1992, Wedig et al, 1989), although exceptions exist (e.g. Escarce 1993). Evidence of physician-induced demand also exists in non-Medicare settings (e.g. Gruber and Owings 1996). As Fuchs (1996) concludes "the hypothesis that fee-for-service physicians can and do induce demand for their services is alive and well."

1.3: Dynamic effects of health insurance: evidence

To my knowledge we have no evidence of the effect of traditional fee for service health insurance on the development or adoption of new medical technologies. There is, however, a literature of the effect of the introduction of a variety of supply side constraints – which, taken together, fall under the general rubric of "managed care" – into what was a generous fee for service environment.

Whether managed care affects the growth rate of health expenditures is not clear. The introduction of the Medicare Prospective Payment System (PPS) appears to have reduced health spending levels, but not contained the growth in health spending (Schwartz 1987, McClellan 1997). A recent review of the empirical literature on managed care in private health insurance concluded that its effect on spending growth is "inconclusive", with the most compelling evidence for a role for managed care in slowing spending growth coming from evidence that it is associated with a decline in the rate of diffusion of new medical technologies (Glied, 2000).

Several empirical papers have compared technology diffusion rates across areas with different managed care penetration rates. The key challenge to such analysis is whether unobserved hospital area characteristics are correlated with both the rate of managed care penetration and technology diffusion. In general, these papers have found that areas with higher managed care penetration rates have slower rates of technology adoption (Cutler and Sheiner 1998, Baker 2001, Baker and Phibbs 2002), although some studies have not found this result (Lange and Sussman 1993, Chernew et al., 1997).

It is hard to know how to interpret evidence that managed care is associated with a reduced diffusion rate of new technologies. The term "managed care" covers a variety of arrangements that includes not only financial incentives for providers to reduce technology use because – unlike with fee for service insurance – they now bear the marginal cost of any spending, but also direct monitoring and review of technology adoption and use (Glied, 2000). The experience of other countries has demonstrated that direct regulation in the form of global budgets and restricted access to new technologies can, by itself, be effective at reducing the growth in health care expenditures (Cutler, 2002b). If the direct regulatory aspects of managed care are, similarly, what is primarily responsible for any effects on technology diffusion, this tells us little about the role of the incentive effects of insurance *per se*; utilization review and other controls on the spread of new technology were absent from hospitals in both the pre- and post-Medicare eras (Stevens, 1999).

2. A framework for studying the impact of Medicare

2.1 Brief Background on Medicare

Medicare and Medicaid were both enacted in July of 1965. Medicare provides universal public health insurance to the elderly. Medicaid provides public health insurance to the indigent. In their early years, Medicaid accounted for 30 percent of combined Medicare and Medicaid hospital spending (National Center for Health Statistics, 2002).

Medicare is a federal program and was implemented uniformally across the United States on July 1, 1966. By contrast, both the design and the timing of Medicaid implementation was left up to the states. Although the focus of the paper is on Medicare, I control for the effect of Medicaid in the empirical work, and briefly discuss those results below.

Medicare had an enormous impact throughout the country on health insurance coverage for the elderly. Prior to Medicare, public health insurance coverage for the elderly although available in principle to the indigent elderly, was in practice extremely limited and effectively non existent (Stevens and Stevens, 1974; United States Senate 1963). Private health insurance for the elderly was also relatively rare (Anderson and Anderson 1967, Epstein and Murray, 1967). I estimate that only one-quarter of the elderly had meaningful private health insurance in 1963.[1] Following the implementation of Medicare on July 1 1966, insurance coverage rates among the elderly increased almost instantaneously to virtually 100 percent.[2] As a result, the introduction of Medicare increased the proportion of the elderly with health insurance by 75 percentage points.

Medicare's design – both in terms of its benefit package and its reimbursement principles – was explicitly modeled after the existing Blue Cross and Blue Shield health insurance system (Ball, 1995, Stevens and Stevens 1974). The Blue system was among the most generous – if not the most generous – of existing health insurance plans in terms of its coverage (Anderson et al., 1963). Like the Blue system, Medicare reimbursement was done on the basis of "reasonable costs of services" (Somers and Somers 1967). In addition, the early Medicare regulations built in generous allowances for capital deprecation (Somers and Somers 1967, United States Senate 1970).

To identify the effect of Medicare separately from any underlying secular trends, I identified considerable geographic variation in private health insurance rates among the elderly prior to the introduction of Medicare. These insurance rates ranged from a high of 51 percent in New England to a

[1] Specifically, this is the percent of the elderly with Blue Cross hospital insurance. See Section 2.2 for more detail.
[2] Medicare coverage was extended essentially instantaneously to the elderly. Consistent with this, the self-reported coverage rate among individuals aged 65+ in the 1970 NHIS for Medicare Part A (hospital insurance) is 95 percent (author's calculation).

low of 12 percent in the East South Central United States. As a result, the extent of Medicare's impact on insurance coverage varied substantially across different areas of the country. To my knowledge, this paper is the first to document this regional variation in the impact of Medicare on insurance coverage for the elderly.

This geographic variation in private health insurance coverage among the elderly prior to Medicare serves as the primary means of identifying the causal effect of Medicare on the outcomes of interest.[3] Prior to the introduction of Medicare, hospitals in areas with different private insurance rates among the elderly differ in terms of both their levels and their growth rates, with hospitals in areas that have more insurance coverage growing more rapidly. I estimate the effect of Medicare by examining whether there is a trend break in these annual differences across areas around the time of Medicare's introduction in 1965; I attribute deviations from the pre-period relative trend in these areas to the introduction of Medicare.[4] The identification assumption is that without Medicare the pre-period relative trend (i.e. the degree to which these regions were diverging) would have continued. I have almost 20 years of data prior to the introduction of Medicare that allows me to examine this identifying assumption.

A seemingly natural alternative identification strategy would be to compare changes in health spending before and after the introduction of Medicare for individuals just above and just below age 65. However, annual data on health spending and health care utilization for the elderly and non-elderly are not available during this time period, and I know of no data on technology use -- or hospital activity more generally – by age in this period. Several studies using lower frequency, individual-level data have compared health care utilization among the elderly and non-elderly and found an impact of the introduction of Medicare on measures such as number of doctor visits or hospital days (Dow 2002, Cook

[3] Although variation in the percentage of the population that is elderly would be a natural additional source of variation to use to identify the impact of Medicare, in practice there is not enough variation in the percentage of the sub-region (or even of the county) that is elderly for this form of variation to be very helpful. I explore using this additional variation in the robustness analysis below.
[4] This estimate will not capture any effect of Medicare on the previously-insured that operates via its income effect.

et al. 2002).[5] To my knowledge, no studies have used this age strategy to study the effect of Medicare on health spending. A difficulty with using comparisons across age groups to study the effect of Medicare on health spending is that Medicare may well affect spending on individuals under age 65, particularly in a hospital setting where not only physician practice norms and fear of liability might prevent differential treatment but where there are substantial joint costs to the production of health care.

In the remainder of this section I describe in more detail the regional variation in insurance coverage among the elderly prior to the introduction of Medicare, and lay out the formal econometric framework.

2.2 The Varying Impact of Medicare: Evidence from the 1963 National Health Survey

Data on private insurance rates for the elderly prior to Medicare come from the 1963 National Health Survey (NHS), a national random sample of households from July 1962 through June 1963.[6] The survey contains 138,604 individuals; for purposes of analysis, I restrict the sample to the 12,757 individuals who are age 65 and over. Through a special request to the government, I obtained a version of the survey that identifies which of 11 sub-regions the individual is in, as well as whether the area is designated rural or urban.[7]

A key issue in identifying the impact of Medicare using differences across areas in the proportion of elderly with private health insurance is that while many elderly individuals had some private insurance, it was often quite minimalist in nature and effectively provided very little in the way of insurance (Epstein and Murray 1967, Anderson and Anderson 1967). For many of these nominally-insured individuals therefore, the introduction of Medicare would still have a substantial impact on their effective insurance coverage. Fortunately, the NHS contains data not only on whether the individual has hospital insurance and whether he has surgical insurance, but whether the plan is a "Blue Plan" (i.e. Blue Cross and Blue

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[5] These studies, as well as Finkelstein and McKnight (2004), have found only limited effects of the introduction of Medicare on health outcomes; Lichtenberg (2001) is an exception in this regard. A related literature has compared health care utilization and health outcomes for individuals just under and just over age 65 in more recent cross-sectional data (Decker and Rapaport 2002, McWilliams et al 2003, Card et al., 2004). This literature has reached similar conclusions in terms of an impact of Medicare on health care utilization but a very limited impact on health outcomes.

[6] I am very grateful to Will Dow for his help in getting access to these data.

[7] The public use version only contains information on which of four census regions (northeast, north central, west, and south) the individual is in and whether the individual lives in an urban or rural area; the survey is designed to be representative at this level (National Center for Health Statistics, 1964).

Shield). As noted above, the Blue Plans were not only among the most comprehensive of private insurance plans, but – perhaps even more importantly – Medicare's design was explicitly modeled on the Blue Cross and Blue Shield plans. Thus the proportion of the elderly population with a Blue Plan provides a very good measure of the proportion of the elderly who had Medicare-equivalent coverage prior to Medicare.[8]

Figure 2 shows the geographic distribution of the elderly without private Blue Cross (BC) hospital insurance coverage. [9] Such insurance would cover the hospital expenses subsequently covered by Medicare Part A. Across the 11 sub-regions, insurance coverage ranges from a high of 51 percent in New England to a low of 12 percent in the East South Central Region. In general, insurance coverage is highest in the North Eastern and Northern United States and lowest in the South and West. However, there is considerable variation between sub-regions within the 4 major census regions; the variation in insurance rates between sub-regions within a region is about half that of the variation between regions.

Table 1 reports the percentage of the elderly without BC hospital insurance for each sub-region. For comparison, it also reports the percentage without any hospital insurance.[10] Nationwide, 73 percent of the elderly report not having Blue Cross hospital insurance, while only 45 percent report not having any hospital insurance. The variation across sub-regions in "any hospital insurance" is also substantially more compressed than the variation in Blue Cross hospital insurance. However, both show the same basic geographic patterns. By either measure, insurance coverage is highest in the North Eastern United States

[8] A potential concern is that the Blue Plans held by elderly individuals might be substantially different (and in particular, less generous) than typical Blue Plans, especially since the elderly were more likely to have non-group plans (Anderson et al., 1963). However, this does not appear to be the case. Reed (xx) conducted a national survey of non-group Blue Cross-Blue Shield plans for the elderly in late 1962 and early 1963 and provides detailed information on the coverage offered by the various plans. I compared the benefit formulas of those plans with Medicare's original benefit formula and found that they were quite comparable.

[9] Hospital insurance denotes insurance which pays all or part of a hospital bill for a hospital insurance; it does not include coverage of doctor's or surgeon's bills. The hospital bill always includes the cost of room and meals and may also include the costs of other services such as operating room, laboratory tests, and X-rays. Surgical insurance is insurance which pays all or part of the bill for a doctor or surgeon for an operation whether or not it is performed in the hospital or the doctor's office (National Center for Health Statistics, 1964). I do not separately use the data on whether the individual has a Blue Shield surgical insurance (which is subsequently covered by Medicare Part B) because the coverage patterns are virtually identical.

[10] All measures of health insurance in the NHS explicitly exclude "dread disease" plans, free care or public welfare assistance, insurance which pays bills only in case of accidents (such as liability insurance held by a car owner), and insurance which pays only for loss of income (National Center for Health Statistics, 1964).

and lowest in the South and West; the correlation between the two measures is 0.63. Below, I demonstrate that the estimated effect of Medicare is robust to using any hospital insurance instead of Blue Cross hospital insurance to measure the percent of the elderly whose insurance coverage changed as a result of Medicare. Table 1 also indicates that within each sub-region, rural areas have lower insurance coverage rates than urban areas; I make use of this variation as well in some of the sensitivity analysis below.

Using county-data from the 1960 census, I examined what characteristics of the areas are correlated with insurance coverage. Not surprisingly, insurance coverage is positively correlated with measures of socio-economic status. Counties in sub-regions with lower levels of insurance coverage have lower median income, lower median schooling, and a higher fraction non-white. Three-quarters of the variation in insurance levels at the sub-regional level can be explained by including (flexibly) county differences in race and in the distribution of schooling and income.

Thus the empirical approach takes areas that had pre-existing differences in fundamentals –as well as insurance coverage – and examines what happens when they are brought up to the same level of insurance. Because of the pre-existing differences in insurance coverage we would expect – if insurance affects outcome levels and growth rates – to see differences across these areas in the level and growth rate of hospital outcomes in the pre-period. Indeed, we will show this to be the case below.

A key assumption for using these insurance differences to identify the effect of Medicare is that private insurance for the elderly prior to Medicare was meaningful, so that variations are also meaningful. I discussed above the qualitative evidence that this is the case, at least for Blue Cross insurance. Figure 3 shows the percentage change in real per capita spending for hospitals overall and by private insurance. These two series track each other pretty closely throughout the second half of the 20th century, with the noted exception of 1966 and 1967 where there is a dramatic increase in total spending and a dramatic *decline* in private insurance spending; this is indicative of crowd out and suggests that for some people at least, private insurance was redundant of what Medicare subsequently covered. In addition, Finkelstein and McKnight (2004) find a decline in private insurance hospital expenditures (and an increase in total hospital expenditures) between 1963 and 1970 for individuals aged 65 to 74 relative to individuals aged

55 to 64 in the National Medical Expenditure surveys; this also suggests that there is a crowd out effect of Medicare on private insurance spending.[11]

2.3 Econometric model

The primary empirical strategy is to compare changes in a variety of hospital-level outcomes in regions of the country where Medicare had a larger effect on the percentage of the elderly with health insurance to areas where it had less of an effect. The basic estimating equation is given by:

$$\log(y_{ijt}) = \alpha_j + \delta_t + \sum_{m=-5}^{+3} \beta_m mcaid_{ms} + \sum_{t=1948}^{t=1978} \lambda_t (pctuninsured)_z * \delta_t + \varepsilon_{ijt} \qquad (1)$$

The dependent variable is the log of outcome *y* in hospital *i* in county *j* and year *t*; I estimate the equation in logs because the hospitals vary considerably in size, and therefore constraining the outcomes to all grow according to a series of common (level) year fixed effects seems inappropriate. The α_j 's are county fixed effects that control for any fixed differences across counties in the outcome of interest. The δ_t 's are year fixed effects that control for any common secular year effects for the whole nation.

The indicator variables $mcaid_{ms}$ indicate whether it is the m^{th} year after the implementation of a Medicaid program in state *s*.[12] These variables are therefore designed to control for any impact of Medicaid. This is separately identified from the impact of Medicare because the timing of the implementation of Medicaid – unlike Medicare – varied across states. By July 1, 1966 (the date that Medicare was implemented) 22 states – consisting of about half the population of the United States – had implemented their Medicare programs. Implementation continued at a steady rate over the next four

[11] Unfortunately, the data do not provide any geographic identifiers and therefore we cannot compare changes in private insurance spending across different areas of the country. However, results by socio-economic group show a pattern of larger decreases in private insurance coverage (and smaller increases in total spending) for groups of higher socioeconomic status.

[12] The earliest time period (-5) denotes 5 or more years prior to Medicaid adoption while the latest time period (+3) denotes 3 or more years after the adoption of Medicaid in state *s*.

years, with all but two states implementing a Medicaid program by 1970.[13] In practice, I find that the estimated effects of Medicare are not sensitive to controlling for when each state implemented Medicaid.

The key variables of interest are the interactions of the year fixed effects with the percentage of the elderly population in geographic area *z* without private health insurance in 1963 ($(pctuninsured)_z * \delta_t$). The pattern of coefficients on these variables – the λ_t's – shows the (flexibly estimated) trend in the dependent variable over time in areas where a high percentage of the population lacked insurance prior to Medicare relative to areas where a low percentage of the population lacked insurance prior to Medicare. The change in the trend of these λ_t's before and after the introduction of Medicare can therefore provide an estimate of Medicare's impact.

Ideally, we would like the percentage of the elderly without Blue Cross hospital insurance in the hospital's *market*. This suggests using either the county level – which is probably a little too small – or the state level – which is probably a little too big.[14] From a practical standpoint, however, we do not have private insurance rates at the state or county level. We have estimates of private insurance coverage for each sub-region, and within each sub-region separately for urban and rural areas.

For my baseline specification I use the variation at the sub-region level; I adjust the standard errors to allow for an arbitrary covariance matrix within each sub-region over time. Below, I show below that the results are essentially unchanged when I use variation in insurance rates at the state or county level instead. I also show that the results are robust to using variation across areas in the percentage of the population that is elderly as well as the percentage of the elderly without private insurance; this reflect the fact that there is relative little variation in the percentage of the population that is elderly.

3. Data: The American Hospital Association Annual Survey

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[13] Specifically, by January 1967 26 states (consisting of 62 percent of the population) had implemented a Medicaid program. These numbers increased to 37 states (77 percent of the population) by January 1968, 40 states (80 percent of the population) by January 1969, and 49 states (99 percent of the population) by January 1970 (US Department of Health, Education and Welfare, 1970 and population estimates from the 1960 census).

[14] Many papers define the "metropolitan area" as the relevant hospital market, although this then does not permit the inclusion of rural hospitals. I plan to identify the metropolitan area that each hospital is in future versions.

The American Hospital Association's (AHA) annual surveys of every AHA-registered hospital in the U.S. have been widely used by economists to study technological diffusion and hospital expenditures from the 1980s through the present (e.g. Baker and Phibbs (2002), Cutler and Sheiner (1998), Duggan (2000)). Although annual, hospital-level survey results have been published in the August issue of *Hospitals: The Journal of the American Hospital Association* since 1927, the historical data have been largely ignored.[15] I used these publications to create a 27-year electronic database of these survey results starting in 1948, the first year that information on hospital technologies is included. Appendix A [not yet written] provides a detailed description of the data, including sample definition and data quality.

I limit the sample to the two-thirds of hospitals that are private. This results in an annual sample with – on average – about 4,500 hospitals per year. Approximately three-quarters of these hospitals are non-profit, the rest are for-profit. About 20 percent of the excluded public hospitals are federal hospitals (i.e. army, navy, air force, and Veteran's Administration hospitals) that are not affected by Medicare; below I explore using these hospitals as controls in an alternative identification strategy.

The remaining public hospitals are state and local hospitals; these are excluded because the patient base of these hospitals consisted almost entirely of poor (often non-paying or poorly-paying) patients whom private hospitals did not want (see Stevens 1999). Since public hospitals therefore served a predominantly (or perhaps exclusively) uninsured population, regional variation in insurance rates will not be correlated with variation in patients' insurance status across public hospitals in different locations. The identification strategy is therefore ill-suited to examining the effect of Medicare on public hospitals; such estimates will be biased down. Consistent with this, I find (in results not reported) that when I estimate the results below for the full-sample of hospitals (private and state-and local) the qualitative patterns remain but the magnitudes are attenuated.[16]

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[15] Russell (1977, 1979) and Russell and Burke (1975) are important exceptions.

[16] The non-random sorting of insured individuals across hospital types also suggests that the estimated effects on private hospitals may be biased down as well. We would like to measure the percent of potential patients without private insurance in private hospitals in a given area, but instead observe the percent of the population without private insurance in a given area; since the public hospitals attract almost entirely patients without insurance, the

The data contain a rich set of information on each hospital. In particular, the data contains annual information on each hospitals' total expenditures, payroll expenditures, employment, beds, admissions and number of patient days, as well as information on whether the hospitals has each of a variety of new technologies. All data on utilization (admissions and patient days) and beds are exclusive of newborns. Hospital beds are a commonly-used proxy for a hospital's capital stock. Hospital employment includes all paid personnel (both full time and the full-time equivalents for part-time personnel) except for interns, residents and students; payroll expenditures are similarly defined. Note that paid personnel do not include physicians, since they are not employed or paid by hospitals.[17]

Total expenditures are the sum of payroll and non-payroll expenses; payroll expenditures constitute about 60 percent of total hospital expenditures. Non-payroll expenditures include employee benefits, professional fees, depreciation expenses, interest expenses, and other expenses (such as supplies). The fact that depreciation is included indicates that major capital purchases will not show up immediately in expenditure data.

The expenditure variables are the most likely to be measured with error in these data, in that the proportion of hospitals who fail to report this information is highest. The overall response rate to the AHA surveys is over 90 percent in all the years in question (and often above 96 percent), and of hospitals responding, essentially all report information on beds, and about 93 percent report information on admissions, patient days, and employment. However, only about 83 percent report payroll or total expenditure information.

The AHA does not report hospital revenue during this time period; estimates of Medicare-induced changes in hospital expenditures therefore do not include any increased markup of hospital expenditures. The National Health Expenditure data for hospitals (shown in Figure 1) is based on AHA data on

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variation in our observed measure is actually greater than the variation in the true measure and thus our estimates will be biased down.

[17] Although the data are not generally broken down by type of personnel, the 1964 data indicate that just over half of hospital paid personnel is devoted to the "professional care of patients" (i.e. nurses and technicians). The remainder are approximately evenly divided among "household and property", "dietary", "administrative and general" and "other."

revenues which were specially released to the government for this purpose.[18] As a result, my estimates will be conservative estimates of the contribution of Medicare to the total rise in hospital expenditures as measure by the National Health Expenditure Data.

Table 2 provides a list of all the outcome variables used in this study, the time period over which they are available in the data, and the sample mean in the period immediately prior to the introduction of Medicare (1962-1964). All expenditure variables are converted to 1960 dollars using the CPI-U.

Table 2 also reports the mean of the outcome variables in the 1962 – 1964 period separately for counties in the bottom decile in terms of the percentage of the elderly without insurance (i.e. who experienced the lowest impact of Medicare on the insurance rate) and hospitals in counties in the top decile by percentage of the elderly without insurance (i.e. .who experienced the largest impact of Medicare on the insurance rate). Not surprisingly, the mean for all outcome variables is higher in areas with a lower percentage of the elderly without insurance. Indeed, given that below I will show an effect of Medicare on almost all of these outcomes, it would be surprising if the levels were same in the pre-period when insurance rates were so different.

Figure 4 shows the national time series patterns for all of the non-innovation outcomes (I discuss the new technologies separately in Section 5). All of the outcomes – admissions, patient days, real expenditures, real payroll expenditures, employment and beds – are increasing over the entire period of the data. The figure also shows a quadratic fitted to the pre period data (1965 and earlier). A comparison of the fitted quadratic to the actual trends shows increases in total and payroll expenditures as well as employment and beds after 1965 relative to the pre-existing trends. There is also evidence of an increase relative to trend in patient days, but not in admissions. Of course, extrapolating off of the time series can potentially be quite misleading. The 1960s were a period of great social change, as well as some improvements in medicine (Stevens, 1999).

[18] Even those data are not entirely based on revenues as the AHA does not report revenue information for all types of hospitals. Where they do not have revenue information, the data are based on expenditures and an estimated inflation factor (personal communications with Katherine Levin and Aaron Catlin).

4. Hospital Response to Medicare

4.1 Basic results

The core findings for the hospital response to Medicare are summarized in Figure 5. Figure 5 shows the $\lambda_t's$ from estimating equation (1) for six different dependent variables: admissions and patient days (i.e. hospital utilization), employment and beds (i.e. hospital inputs) and payroll expenditures and total expenditures. The $\lambda_t's$ are the coefficients on each of the year effects interacted with the percentage in that area uninsured in 1963. The $\lambda_t's$ therefore identify annual changes in the dependent variable in areas in which no one had Blue Cross insurance in 1963 *relative* to areas in which everyone had insurance.[19] Since the coefficients identify only changes in the dependent variable relative to the omitted year (1963), I normalize λ_t in 1963 to the difference in the mean of the dependent variable in 1962-1964 for the sub-region with the highest proportion of elderly without BC insurance relative to the sub-region with the lowest proportion of the elderly without BC insurance. The circles indicate the 95 percent confidence interval for each coefficient. A vertical line demarcates 1965, the year in which Medicare is enacted.[20]

There are two primary points of interest in the graphs in Figure 5, and they are apparent for all of the six outcomes. First, although Figure 4 indicates that all of these outcomes are growing in absolute terms, Figure 5 indicates that for the 17 years prior to 1965, these outcomes are growing relatively more slowly in areas where a lower proportion of the elderly had private insurance in 1963. Given that the analysis will suggest that Medicare had an effect on the growth rate of various hospital measures, it is reassuring that rates of growth are different prior to Medicare in areas of the country with different insurance rates.

[19] One might be concerned that the coefficient is therefore estimated off of out-of-sample variation, since Table 1 indicates that the percent without insurance only ranges from 88 percent to 49 percent. Below, I show that the results are robust to interacting the year effect with an indicator variable for whether 75 percent or more of the elderly in the area do not have private insurance, rather than including the percent without private insurance linearly.

[20] Data from year *t* are from the survey period October (t-1) to September (t). Since Medicare was enacted in July 1965 and implemented in July 1966, 1965 (i.e. October 1964 to September 1965) is taken as the year prior to Medicare. It is possible, although unlikely, that anticipatory effects of Medicare's enactment could be felt as early as the 1965 data. The data year 1966 covers the period October 1965 through September 1966; it is therefore possible to see either an anticipation effect or the beginning of an actual effect.

Second, the slower growth in low insurance areas relative to high insurance areas reverses itself dramatically after 1965 (the year in which Medicare is enacted). Hospital outcomes begin to rise steadily in areas that previously had little insurance (i.e. areas where Medicare had a large impact on insurance coverage) relative to areas that previously had more insurance (i.e. areas where Medicare had less of an impact on insurance coverage). The results for hospital inputs (middle row) are particularly dramatic.[21]

Table 4 reports the results of a variety of statistical tests of the coefficients graphed in Figure 5. Each column shows the results for a different dependent variable. The test design is motivated by the evidence in Figure 5 which indicates a decline in the pre period for the low insurance areas relative to the high insurance areas followed by a reversal of this trend. Therefore, to quantify the effects of Medicare, I estimate the n-year change in λ_t after the introduction of Medicare relative to the n-year change in λ_t before the introduction of Medicare.

For example, the first five-year change in the outcome after the introduction of Medicare relative to before is calculated as follows:

$$\Delta 5 \equiv (\lambda_{1970} - \lambda_{1965}) - (\lambda_{1965} - \lambda_{1960}) \qquad (2)$$

$\Delta 5$ thus denotes the estimated change in the level of the outcome before and after the introduction of Medicare. More precisely, $\Delta 5$ describes the 5-year change in the log of the outcome after the introduction of Medicare relative to the 5 years prior to the introduction of Medicare for areas that had 100 percent of the elderly without BC insurance in 1963 relative to areas that had none of the population without BC insurance in 1963.

The first three rows of Table 4 report the estimates for the 2-year, 5-year and 10-year change in the outcome, respectively; the p-value is reported in parentheses below the estimate. Because the reference period changes with the test, comparisons across the test cannot be used to gauge changes in growth; rather, these should be thought of as alternative estimates of the level effect of Medicare. The estimates

[21] Not surprisingly, given the problems with a high proportion of missing data discussed above, the results for expenditures (bottom row) are somewhat noisier than for the other variables, although the basic patterns are indicative of an effect of Medicare.

provide statistical confirmation of the visual evidence in Figure 5; they uniformly indicate that the introduction of Medicare is associated with a substantial and statistically significant increase in all of the dependent variables.[22]

The fourth row of Table 4 represents a first look at whether Medicare affects growth rates rather than just levels of the outcome variables. It compares the relative change in the log outcome variable between 1975 and 1970 to the relative change between 1965 and 1960. In other words:

$$\Delta_{Second} 5 \equiv (\lambda_{1975} - \lambda_{1970}) - (\lambda_{1965} - \lambda_{1960}) \qquad (3)$$

Note that this estimated effect of Medicare in its second five years is calculated using the same pre-period change (1965 compared to 1960) as in the calculation of the effect of Medicare in the first five years (row 2). The estimates in row 4 indicate that Medicare is associated with a statistically significant increase in all six outcomes over the second five years relative to the changes in the pre period. However, for both utilization measures – admissions and patient days – the increase associated with Medicare in the second five years is about half the size of the increase in the first five years (row 2); the difference in these two estimates are statistically significant at the 10 percent level. This suggests that the effect of Medicare on growth in utilization may have begun to attenuate. By contrast, the effect of Medicare on the other four outcomes over the second set of five years is statistically indistinguishable from the effect on the first 5 set of years. As discussed above, models by which health insurance increases the growth rate of health spending typically do not involve increasing the long run growth rate in admissions or patient days, but in increasing the growth rate of inputs into patient care (often technology); indeed, patient days per capita have been roughly constant over the last half century (Newhouse, 1992).

All of the results thus far speak to the impact of Medicare; however, Medicaid was also enacted during this same time period. Equation (1) controls for the effect of Medicaid by including indicator variables for the year relative to the enactment year in each state. Looking at the coefficients on these variables, it appears that the timing of Medicaid implementation across states was not uncorrelated with

[22] The estimates also imply that Medicare is associated with a slight (but not statistically significant) decline in average length of stay (i.e. patient days / admissions).

trends in hospital outcomes; the estimates show a decline in hospital outcomes in areas prior to Medicaid adoption (recall that this conditions on year and county fixed effects, as well as the interaction of year with the percent of the elderly without insurance in the pre period). A comparison of this decline relative to the trend after Medicaid enactment does not show any systematic or robust evidence of an impact of Medicaid on hospitals. This is certainly consistent with other evidence that hospitals exhibit little "real" response to increased incentives from Medicaid (Duggan 2000). It may be that Medicaid – by offering lower reimbursement rates and targeting a less desirable clientele from the hospital perspective (i.e. the poor) – did little to affect hospital choice of inputs. However, the pre-existing trend suggests that using the timing of state adoption to identify the effects of Medicaid may be problematic. Neither the estimates of the effects of Medicaid or of Medicare from equation (1) are affected by leaving out the controls for the other.

4.2 Contribution of Medicare to national changes

The estimates in Table 4 depict the change in the outcome in areas in which no one had insurance prior to Medicare relative to areas in which everyone had insurance prior to Medicare. To translate these into an estimated effect of Medicare, we need to multiply the estimates in Table 4 by 0.75 (the average percentage point increase in insurance coverage associated with the introduction of Medicare).

All of the results have been estimated at the hospital-level. If Medicare were associated with a change in the number of hospitals, hospital-level estimates would give a misleading picture of the total effect of Medicare. I do not find evidence of a change in hospital numbers associated with Medicare when I aggregate to either the county or state level and re-estimate equation (1) with the dependent variable set at the log of hospital numbers. However, the magnitude of the estimated coefficients shown in Table 4 attenuates when the data are aggregated to the county level. This reflects the fact that the estimated λ_t's vary across hospitals of different size, as shown in Table 5. In Table 5, I stratify the sample based on which quartile of hospital size (defined by number of beds) the hospital was in in 1957.[23] To conserve

[23] Estimates are therefore based on data from 1957 forward.

space, I report results only for the first five year estimate, but other estimates are similar. The estimated impact of Medicare tend to be smallest in the largest quartile of hospitals and biggest in the second smallest quartile.

Unfortunately, it is not possible to determine whether these differential estimates by hospital size represent heterogeneity in the λ_t's (i.e. hospitals of different sizes responded differently to Medicare) or whether there was simply less variation across areas in the percentage of patients with insurance coverage in the larger hospitals (e.g. they all took the insured or the non-insured); I do not have any information on the sorting by insurance status across hospitals of different size. To the extent that the differences are due to heterogeneity in the λ_t's, our best estimate of the national impact of Medicare comes from averaging the results across the four different quartiles; this is shown in the fifth column of Table 5 ("weighted average") which averages the estimates for the first four quartiles and multiplies by 0.75. For comparison, the estimates on the pooled (i.e. non-stratified) sample (also multiplied by 0.75) are shown in the last column; these are identical to the baseline specification in Table 4 except that – for comparability to the stratified estimates – the sample starts in 1957.

The results from the averaging of the stratified sample are consistently lower than those from the pooled sample. The estimates from combining the stratified samples indicate that, in its first five years, Medicare is associated with a 14 percent increase in total hospital expenditures. Data from the National Health Expenditure Accounts indicate that real hospital expenditures grew by 63 percent between 1965 and 1970, compared to only 41 percent over the previous five years. The estimates therefore suggest that Medicare was responsible for two-thirds of the above-average growth in hospital spending in Medicare's first five years.

I explored the potential heterogeneity in the effect of Medicare more directly by examining the effect of Medicare separately in urban and rural hospitals. This is not subject to the same problems as the cut by hospital size, as I have separate estimates of the private insurance rates by rural and urban areas (see Table 1). Table 6 reports the estimates separately for the bottom and top half of hospitals by percent urban in the county; the cutoff is 67 percent urban, based on the 1960 census data on percent urban by county (hospitals are disproportionately in urban areas relative to population). The results – shown in Table 6 – use variation in insurance coverage at the county level so as to capture the urban / rural variation. I use the insurance rate in urban areas in the sub-region for the top half of hospitals by percent urban and the insurance rate in rural areas in the sub-region for the bottom half of hospitals. The results suggest substantive and statistically significant effects in both urban and rural areas, with perhaps some suggestive evidence of slightly larger effects in urban areas.

4.3 Robustness

I investigate the robustness of the basic findings to a number of alternative specifications. A major concern is whether the results in the preceding section can simply be explained by mean reversion. The areas that were more affected by Medicare were ex ante different from the areas less affected, as can be seen by their lower pre-period means of the outcome variables (Table 2) and their relatively declining pre-period trend in these variables (Figure 5). Moreover, the estimates in the last row of Table 4 indicate a steeper decline over the 1965 to 1960 period relative to the 1960 to 1955 period for all outcomes but beds. These declines are particularly striking for the expenditure variables – payroll and total expenditures – and can be seen in the graphs. This therefore raises potential concerns about mean reversion.

The fact that the effects of Medicare appear to persist in the long-run somewhat alleviates this concern. As another way of examining whether the results can be explained simply by mean reversion, Figure 6 shows the results when state-specific linear trends are included in the estimation of equation (1). Interestingly, the inclusion of state-specific linear trends results in a pre-period trend that is now essentially flat over the pre period for admissions, beds and payroll expenditures, although it continues to be declining for the other three variables. The estimated effect of Medicare n-years after 1965 is essentially unaffected by the inclusion of state-specific linear trends. This can be seen statistically by comparing the first two rows of Table 7; these report the estimated 5-year change in the outcome variable associated with Medicare from the baseline specification (row 1) and when state-specific linear trends are added to the baseline specification (row 2). Throughout the sensitivity analysis in Table 7, I report only the 5-year estimates to conserve space, although other estimates look similar.

Row 3 of Table 7 reports the results when hospital fixed effects are included in equation (1) instead of county fixed effects.[24] Medicare is associated with a statistically significant increase in all of the variables except for total expenditures in this specification. However, the magnitude of the effect is substantially lower than in the baseline specification.[25]

Rows 4 and 5 examine the sensitivity of the estimates to measuring the percentage of the elderly without Blue Cross hospital insurance at the state or county level instead of at the sub-region level. State- and county-level insurance estimates are imputed based on the sub-region in which the area is located and information from the 1960 census on the percentage of the county or state that is urban.[26] This is not surprising given that the variation in insurance coverage across counties within sub-regions is only one-quarter as great as the variation across sub-regions.

The last four rows of Table 5 report results based on alternative ways of parameterizing the differential impact of Medicare on insurance coverage across areas of the country. Row 6 reports the results from interacting the year fixed effects in equation (1) with an indicator variable for whether the sub-region has 75 percent or more of the elderly without BC hospital insurance (rather than including a linear measure of the percent without insurance as in the baseline specification). Three sub-regions (New England, Middle Atlantic, and East North Central (Eastern Part)) have less than 75 percent of the elderly without BC hospital insurance (see Table 1); these three sub-regions include a little under one-third of all

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[24] In order to do so, I had to link hospitals across years of the survey based on the identifying information contained in the hospital name, town, county and state. Thus far, this panel has been put together for the years 1957 – 1975 only.

[25] I suspect the difference is coming not from the inclusion of hospital fixed effects per se – and not from the fact that the sample only starts in 1957 – but rather from the fact that a fair amount of data is lost in the fixed effects estimation because many of the hospitals are in the sample for less than the full 19 years. Indeed, when I limit the sample to those in for the whole 19 years, the estimates with county fixed effects and hospital fixed effects are very similar.

[26] The coefficients from estimation of a model with predicted right hand side variables are consistent, but biased towards 0; in addition, the standard errors need to be adjusted (Murphy and Topel (1985), Angrist and Krueger (1995)). Standard errors in row 5 (6) are clustered at the state (county) level. Given the imputation procedure, they need to be further adjusted.

hospitals. The results are robust to this alternative specification, and the implied effect of Medicare is roughly similar.[27]

Row 7 shows the results from interacting the year effects with the percent of elderly without any hospital insurance (rather than without Blue Cross hospital insurance). The estimated effect of Medicare remains statistically significant for all variables but beds; the implied effect of Medicare is quite similar to that in the baseline specification.[28]

In principle, the impact of Medicare varies according to the percentage of expenditures in the hospital market that become covered by insurance due to Medicare, and this depends not only on the percent of the elderly without insurance but also on the percentage of the elderly in the hospital market. Row 8 therefore estimates the effect of Medicare from interacting the year fixed effects in equation (1) with the share of hospital expenditures covered by elderly insurance. In practice however, there is very little variation in the percent elderly. Across the 11 sub-regions, the percentage of the elderly ranges only from 7.7 to 11.2 (even across counties, the inter-quartile range in percentage elderly is only 8.3 to 12.6). I estimate from the 1963 National Medical Expenditure Survey that hospital spending per individual aged over 65 is double that per individual under age 65. Variation in the share of hospital expenditures covered by elderly insurance is therefore given by:

$$(\text{Percent of Elderly Without BC Insurance})_z * \frac{(\#\text{ of Elderly})_z}{(\#\text{ of Elderly})_z + 0.5 * (\#\text{ of NonElderly})_z}$$

The average share of hospital expenditures accounted for by the elderly is 0.18 (i.e. on average 9 percent of the sub-region is elderly). The results are robust to using this alternative source of variation, and the

[27] On average there is a difference in insurance rates of 28 percentage points between areas in with more than 75 percent without insurance and areas with less than 75 percent without insurance. Therefore the implied effects of Medicare will be the same if the baseline estimates are about 3.5 times those in Row 6. In fact, the ratio of estimates tends to be about this, and ranges from a low of 2.9 (beds) to a high of 4.4 (expenditures).

[28] Recall that Medicare is associated with a 75 percent increase in Blue Cross insurance but only a 45 percent increase in "any insurance." Thus the implied effect of Medicare in Row 1 is derived by multiplying the estimates by 0.75, while in Row 7 it is derived by multiplying the estimates by 0.45.

implied effects of Medicare are similar.[29] To allow for the greater variation in percentage elderly than exists across sub-regions, I also tried re-estimating equation (1) using the variation in the percentage elderly and insurance coverage across counties; the results were very similar (not shown).

The final row of Table 7 makes use of a very different source of variation: the fact that Medicare did not directly affect Veteran Administration (VA) hospitals. VA hospitals could not seek reimbursement from Medicare; Medicare-eligible veterans are covered by the VA if they receive care at a VA facility and by Medicare if they receive care elsewhere [cite]. I therefore estimate an alternative version of equation (1) comparing changes over time in private hospitals relative to VA hospitals:

$$\log(y_{ijt}) = \alpha_j + \delta_t + \sum_{m=-5}^{+3} \beta_m mcaid_{ms} + \gamma * PRIVATE_i + \sum_{t=1948}^{t=1978} \lambda_t (PRIVATE)_i * \delta_t + \varepsilon_{ijt}$$

The regression now includes an indicator variable for whether the hospital is private or a VA hospital, and the λ_t's identify changes in the dependent variable in areas in private hospitals relative to VA hospitals. There are only about 165 VA hospitals, compared to about 4,500 private hospitals. The outcome variables are rising in private hospitals relative to VA hospitals in the years prior to Medicare. The analysis thus once again must involve a deviation from trend. The five-year effect estimates are shown in row 9. There is evidence of a statistically significant increase in patient days, employment, payroll expenditures, and total expenditures, but not in beds or admissions.

5. The long-run effects of the introduction of Medicare

The results in Figure 5 and Table 4 are suggestive of an effect of Medicare on the growth of the health sector, rather than just its level. They indicate that hospital inputs and expenditures continue to grow in the areas more affected by Medicare relative to areas that are less affected by Medicare even 10 years after Medicare was introduced. While suggestive, however, these results are far from conclusive. As is almost always the case with difference-in-difference estimates, the identification strategy becomes

[29] The estimated impact of Medicare in Row 8 is no longer 0.75 times the coefficient estimates as it is in Row 1 (since 0.75 is the average percentage point increase in elderly insurance due to Medicare) but 0.75*0.18 (i.e. the average percent of the elderly without BC insurance times the average share of the elderly in expenditures).

more suspect the further one gets from the intervention. For this reason, I did not extend the analysis more than 10 years after Medicare.

Instead, to shed light on whether Medicare has a long-run effect on the growth rate of the health care sector, I investigate whether there is any evidence for the *mechanisms* by which health insurance may affect growth rates. In the remainder of this section I present three pieces of evidence that are suggestive of such mechanisms. I then use the evidence to perform a preliminary calculation of Medicare's contribution to the rise in real per capita hospital expenditures since 1965.

5.1 Indirect Evidence: Inputs and Expenditures Per Patient Day

I decompose the effect of Medicare on expenditures and inputs into the component that is due to an increase in patient days, holding inputs per patient day fixed, compared to an increase in inputs holding patient days fixed. The results suggest that – after its first five years – Medicare is associated with an increase in hospital inputs and expenditures *per patient day*. It is the increase in expenditures per patient day – rather than more people going to the hospital or staying longer – that has been behind the long run increase in health expenditures; indeed, admission rates are barely changed since 1960 while length of stay has fallen (Newhouse, 1992). The fact that Medicare is also associated with an increased treatment intensity per patient day is therefore consistent with Medicare having a long-run effect on growth rates.

The decomposition is shown in Table 8 which reports estimates of the effect of Medicare on inputs and spending *per patient day*. The results are based on estimating equation (1) on the dependent variable given in the column heading. To get at the *growth pattern* associated with Medicare, Table 8 shows estimates at various time intervals relative to a constant base period (1965-1960). The results indicate that patient days and hospital inputs and spending grow at roughly the same pace in the first two years and the first five years after the introduction of Medicare. However, in the second five years, both inputs per patient day and spending per patient day increase. All of these increases are statistically significant. Moreover, with the exception of beds, the increase per patient days in the second five years is statistically significantly larger than the change in the first five years. The increase in beds per patient day suggests that Medicare is associated with a decline in occupancy rates (i.e. patient days / beds); this is consistent with Medicare's generous capital depreciation allowances, which created incentives for inefficient expansion (Somers and Somers 1967, United States Senate 1970).[30]

The last column of Table 8 shows the growth pattern of wages (payroll expenditures / employment). There is evidence of an increase in wages in both the first five years after the introduction of Medicare and in the subsequent five years. This is somewhat surprising given that the labor supply of nurses technicians, housekeeping etc. might be expected to be relatively elastic. One possibility is that the increase in wages reflects an increase in the marginal product of the hospital employees – perhaps due to the adoption of new technologies.

The point estimates in Table 8 suggest that Medicare was associated with an increase in expenditures per patient day of about 12 percent between 1975 and 1970. Over this same period, expenditures per patient day grew by 22 percent nationwide. The estimates therefore suggest that, in its second five years, Medicare is associated with just over half of the increase in expenditures per patient day.

5.2 Medicare and the diffusion of new technologies

Technological change is believed to be the major cause of spending growth in the health sector. In this section I present evidence of an effect of Medicare on technological change by showing that Medicare is associated with an increased rate of diffusion of several then-new technologies in the hospital sector. Recent empirical evidence suggests that the development of new medical technologies – at least new pharmaceutical products – is affected by the expected return to such development (Finkelstein 2004, Acemoglu and Linn 2004). This suggests that if we find evidence of an effect of Medicare on hospital technology adoption, this may well feed back into an effect on the development of new hospital technologies.

The AHA data contains information on whether the hospital has a variety of what are current or new technologies; these data have been widely used to study hospital technology diffusion in later periods

[30] Of course, it is also possible that bed construction lags bed planning, and therefore the decline in occupancy rates may have been unintended and a result of poor forecasting.

(e.g. Cutler and Sheiner 1998, Baker 2001, Baker and Phibbs, 2002). An attractive feature of the data is that new technologies tend to be asked about relatively early in the diffusion process; for example, when ICU's are first asked about in 1958, only 7 percent of hospitals have them. Because any technology adoption effects may be expected to occur with more of a lag than a change in utilization or employment, the results here will necessarily be more speculative than those in Section four. In addition, any estimates of the effect of Medicare on technology diffusion using these data probably represent a lower bound for the total effect of Medicare on technology diffusion. The hospital is only asked whether it has a given technology, not how many it has, how often it has been used, or whether an upgrade to the next-generation version of the technology has occurred. In addition, new technologies that only start to come in the late 1960s and early 1970s (such as the cardiac intensive care unit, or open heart surgery facilities both of which were added to the survey in 1969) and whose entry may have been induced by Medicare will not be captured by the empirical framework since there is no pre-period.

I identified four major technological innovations that that the AHA includes in its data over the relevant time frame and whose diffusion has been identified as playing an important role in hospital cost increases.[31] Two of these – the Post-Operative Recovery Room (POR) and the Intensive Care Unit (ICU) – represent labor-intensive organizational innovations; they are known collectively as "intensive care facilities." The Post-Operative Recovery Room is the earlier of the two innovations, and in effect was the first type of intensive care facility in hospitals. Both are based on the idea that critically ill patients should be kept apart from other patients and given a higher level of attention; the recommended nurse-patient ratio in the POR and ICU is 1:1. Although electronic monitoring equipment and laboratory tests were used to assist in the constant monitoring of the patient's condition, the fixed investment costs were

[31] Information in this paragraph and the subsequent one is based heavily on Russell and Burke (1975), Russell (1977) and Russell (1979). Russell (1977) identifies one other important hospital innovation during this time period, the respiratory therapy department. It does not enter the AHA data until 1968 and therefore I do not investigate.

relatively low, and the major investment expense came in the form of the intensive nursing required.[32] The POR and ICU were used on a relatively wide set of patients, particularly coronary patients.

The other two technologies – Diagnostic Radioactive Isotope Therapy (DR) and the Electroencephalograph (EEG) – represent capital intensive diagnostic technologies with extremely high fixed costs that are used on a more limited set of patients. DR produces a picture of an organ by tracing a radiation-emitting substance that is injected into or swallowed by a patient.[33] The major use of this diagnostic technology was for cancer patients. The EEG records electrical impulses from the brain, and was used as a diagnostic tool for brain tumors and intracranial lesions.

Figure 7 shows the diffusion patterns of the four technologies.[34] All four are rapidly diffusing over the 1960s. The Post-Operative Recovery Room is the oldest of the technologies; two-thirds of hospitals have adopted by 1965, compared to only about a 30 percent for the other three technologies.

A natural way to study the technology adoption process is via a hazard model (Rose and Joskow 1990, Baker and Phibbs 2002). Following the approach taken by Baker and Phibbs (2002), I define my sample as the set of hospitals in a base year, and define adoption as the first year in which the hospital reports having the technology for two consecutive years;[35] I treat as censored hospitals who exit the sample before the end or who have not adopted by the end.

I define the sample as hospitals that are in the data in 1957 and drop any hospital that already has the technology at the start of the sample period.[36] As can be seen from Figure 7, the percentage of hospitals that had already adopted at the start of the study period was 36 percent for post-operative recovery rooms, 16 percent for DR, and 12 percent for the EEG. The ICU was only first asked about in 1958, at which

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[32] For example, in the late 1960s, the cost of setting up an ICU was roughly $2,000 per bed, while the cost per patient day in the ICU was 3 to 4 times the daily cost for a ward patient.
[33] The equipment for a unit doing only two or three major procedures a day cost $20,000 to $60,000 in 1973.
[34] Unfortunately – with the exception of the postoperative recovery room – the other technology variables were not asked in the two to three years (1966 to 1968) following Medicare; refer to Table 3 for details.

[35] In practice, the results are not sensitive to defining adoption this way rather than the first year the hospital reports having the technology.
[36] The starting date of 1957 is the earliest year for which the linking of hospitals across years of data has been completed thus far.

point 7 percent of hospitals had one; for the ICU therefore, the analysis starts one year later and I drop hospitals who had an ICU in 1958.

I adopt the standard proportional hazard model, in which covariates are assumed to shift the baseline hazard rate proportionally. A key issue with hazard modeling is the specification of the time dependence in the baseline hazard. The time pattern is particularly crucial here since the identification of the effect of Medicare comes from differential changes across areas in the time pattern. Rather than assume a functional form for the underlying secular time pattern, I use an exponential model – i.e. a constant baseline hazard – and include as covariates indicator variables for year and indicator variables for year interacted with percentage uninsured. This allows for a flexible time pattern and a direct study of how the time patterns vary across areas that are differentially affected by Medicare. I estimate:

$$h_{ijt}(t) = \mu \exp(\alpha_j + \delta_t + \sum_{m=-5}^{+3} \beta_m mcaid_{ms} + \sum_{t=1948}^{t=1978} \lambda_t (pctuninsured)_z * \delta_t) \qquad (4)$$

The hazard is thus modeled as a constant baseline hazard rate (μ) and covariates that proportionally shift the hazard. As in equation (1), these covariates consist of area fixed effects (α_j), year fixed effects (δ_t), indicator variables for the year in the state relative to the adoption of Medicaid ($mcaid_{ms}$), and the key variable of interest: the interaction of the year fixed effects with the percentage of the elderly who did not have Blue Cross hospital insurance in 1963 ($(pctuninsured)_z * \delta_t$). [37] For technologies in which data are not available for some years (see Table 2), the year fixed effects and the interaction of the year fixed effects with percentage of the elderly who did not have Blue Cross hospital insurance in 1963 are omitted.[38]

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[37] The area-fixed effects are at the state level rather than the county level here due to the difficulty of estimating the model with county-level fixed effects. The previously reported findings are essentially unaffected by the use of state-level fixed effects instead of county-level fixed effects in estimating equation (1).

[38] As a result, the estimated year fixed effect for the hazard for the year after a gap in the data will in fact reflect a hazard rate over a longer interval, and will thus be a biased estimate of the one-year hazard; this should not, however, bias the estimates of the relative difference in hazards between areas with different percentages of the elderly without BC insurance in 1963 (i.e. the estimates of the λ_t 's).

As in equation (1), the coefficients of interest are the pattern of the λ_t 's. These show the changes in the adoption hazard in areas where none of the elderly has in insurance in 1963 relative to areas where all insurance in 1963. Figure 8 shows the graphs of these coefficients. The graphs are scaled in 1958 to the 1962-1964 difference in hazard rates for areas with 100 percent insurance vs. none; for all four technologies, the adoption rate is lower in areas with less insurance.

The top row shows the results for the labor-intensive care provision technologies (Post-operative Recovery Room and ICU). The bottom panel shows the results for the two diagnostic technologies: diagnostic radioactive isotope therapy and EEG. The graphs indicate that, in the 9 years prior to the introduction of Medicare, the difference in hazard rates in high insurance areas relative to low insurance areas is roughly constant. This hazard rate however increases for low insurance areas relative to high insurance areas for the Post-Operative Recovery Room (top left panel) with about a four year lag after the introduction of Medicare; the effect appears to persist out until 1975. There is also evidence of an increase in the hazard rate of adoption of the Diagnostic Radioactive Isotope Therapy for low insurance areas relative to high insurance areas in the years after the introduction of Medicare (bottom left panel). There is no evidence of such a Medicare effect for ICU adoption (top right panel) or EEG adoption (bottom right panel).

Given the general flatness in the pre period combined with the noisiness of the estimates relative to those in Figure 4, I report results from a simple pre- vs. post- hazard test, rather than changes in the hazard in the post period relative to the pre period. I define the POST test as follow:

$$\text{POST TEST: } 0.1 * \sum_{t=1966}^{t=1975} \lambda_t = 0.125 * \sum_{t=1958}^{t=1965} \lambda_t \qquad (5)$$

This test is adapted in obvious ways to deal with missing years.[39] In addition, because years 1966, 1967 and 1968 in some combination are missing for many of the variables, I also define a LAGPOST test as follows:

[39] Estimation of equation (4) by interacting “pctuninsured” with a single post dummy rather than individual year effects yields indistinguishable results.

LAGPOST test: $0.142 * \sum_{t=1969}^{t=1975} \lambda_t = 0.125 * \sum_{t=1958}^{t=1965} \lambda_t$ (6)

Table 9 reports the results. Consistent with the evidence in Figure 8, Table 9 shows a statistically significant increase in the hazard rate for the Post-Operative Recovery Room and the Diagnostic Radioactive Isotope Therapy in the period after Medicare introduction relative to before, in areas that had little insurance relative to areas that had more insurance. There is no evidence of an effect for the other two technologies.

To facilitate interpretation of the hazard estimates, I use the estimates from equation (4) to predict the cumulative adoption probability in each year. I also predict the adoption probabilities under the counterfactual of no Medicare introduction in 1965. To generate this counterfactual, I assume that the relative difference in the hazard rates between areas with difference *pctunins* in the post period would have been – in the absence of Medicare – the average of the differential hazard rates in the pre-period.

The resulting estimates are shown in Figure 9 for the Postoperative Recovery Room and the Diagnostic Radioactive Isotope Therapy, the two innovations for which the introduction of Medicare is associated with a statistically significant change in the hazard rate of adoption. These figures indicate how much lower the diffusion of the new technologies would have been by 1975 in the absence of Medicare. For both innovations, the introduction of Medicare is associated with an increase of 11 percentage points in the proportion of hospitals with the innovation by 1975. Interestingly, for both innovations, the estimates suggest that diffusion would have essentially stopped by around 1970 in the absence of Medicare. This suggests that at least part of the Medicare effect on technology diffusion is to increase the long-run proportion of hospitals with the technology, rather than just a speeding up in time of diffusion that would have happened anyway. In other words, the estimates imply that as a result of Medicare, some hospitals adopt the technology that would otherwise not have done so.

What proportion of the technology diffusion between 1965 and 1975 is due to Medicare? The numbers behind Figure 9 imply that 60 percent of the diffusion of the Post-Operative Recovery Room and half the diffusion of the Diagnostic Radioactive Isotope Therapy between 1965 and 1975 is due to

Medicare. However, for the other two technologies – the Intensive Care Unit and the EEG – Medicare was estimated to have no effect on the diffusion of new technologies. On average, the estimates from the hazard models imply that the percentage of the hospitals with a given technology increased by 26 percentage points between 1965 and 1975.[40] Given that Medicare is associated with an increase of 11 percentage points in the proportion of hospitals with two of the technologies, this suggests that 20 percent of the measured diffusion of new technologies between 1965 and 1975 was due to Medicare. Allowing for a lag in the effect of Medicare on the adoption of new technologies, if we look just in the 1970 to 1975 period, the estimates imply that, overall, Medicare was responsible for one-third of the measured adoption of new technologies over this period.

5.3 Medicare and the growth of private insurance

Finally, I provide some extremely suggestive evidence for the feedback mechanism between technological change and health insurance conjectured by Weisbrod (1991). Weisbrod (1991) conjectured not only that health insurance encouraged the adoption of new technologies but also that new technologies – by increasing the mean and variance of health expenditures – in turn increased demand for health insurance. This feedback loop provides an additional channel by which health insurance will contribute to the growth rate of health expenditures.

I investigate this by looking at what happens to private health insurance coverage for the non-elderly in areas where Medicare had more of an impact on elderly insurance coverage. Weisbrod's (1991) theory would imply that in areas where Medicare had more of an impact on elderly insurance coverage, health spending would increase more (as we saw above) and that, as a result, the demand for health insurance would increase more for the non-elderly, since they are now exposed to a greater variance in health expenditures, since a given health shock is subject to more intensive treatment (as we saw above, Medicare is associated with an increase in expenditure per patient day). This of course requires that the

[40] As can be seen in Figure 9, the percentage of hospitals with a Post Operative Recovery Room increases by 19 percentage points and the percentage with a Diagnostic Radioactive Isotope Therapy increases by 24 percentage points. In results not shown, I estimate the comparable numbers for the EEG and the ICU are 23 and 37 percentage points respectively.

new technologies adopted as a result of Medicare – or the increased intensity of use of existing technologies – were applied – at least to some degree – to the non-elderly as well as the elderly. This seems very plausible, given the substantial joint costs across patients in the hospital production function (i.e. the large fixed costs of technologies and employment) as well as the likely homogenizing tendencies of medical ethics, practice norms or fear of malpractice on physician treatment of different types of patients. Consistent with such treatment "spillovers", existing empirical evidence is suggestive of both large physician treatment norms (Hellerstein, 1998) and effects of the typical insurance status of a physician's patients on the treatment of his patients that are of a different insurance status (Glied and Graff Zivin, 2002).

I therefore look between the 1963 and 1970 National Health Surveys (NHS) at changes in the private BC hospital insurance of the non-elderly across areas of the country that were more or less affected by Medicare. I limit the sample to individuals aged 21 to 64. The measure of how affected the area was by Medicare is the percentage of the elderly without BC hospital insurance in 1963; this gives the percentage point increase in insurance for the elderly associated with the introduction of Medicare.

Unfortunately the 1970 NHS does not contain information about the individual's sub-region (of which there are 11) but it does contain information about the region (of which there are 4); the previous results in the paper are robust to using regional variation. I also know whether the individual is in an urban or rural area, and have separate measures of elderly insurance coverage in 1963 by that (see Table 1). I therefore estimate:

$$y_{ijt} = X_{ijt}\beta + \alpha_j + \beta_1 YEAR1970 + \beta_2 (YEAR1970 * pctunins) + \varepsilon_{ijt} \qquad (7)$$

y_{ijt} is a binary variable for whether individual *i* in geographic area *j* at time *t* has Blue Cross hospital insurance or not. α_j is a fixed effect for which of the 8 geographic areas (4 regions and whether urban or rural) the individual is in. YEAR1970 is an indicator variable for whether it is 1970 (rather than 1963). X is a series of covariates; specifically I include indicator variables for the individual's gender, marital status, race, and education (less than or equal to elementary school, less than or equal to high school, college or more), and a linear control for the individual's age. The key variable of interest is $YEAR1970 * pctunins$; the coefficient on this variable indicates the change between 1963 and 1970 in non-elderly health insurance rates for individuals in areas where elderly insurance changed a lot due to the introduction of Medicare relative to areas in which they changed less.

Table 10 shows the coefficient on $YEAR1970 * pctunins$ when equation (7) is estimated with and without covariates. It shows results separately for the full sample (individuals aged 21 – 64) and the older individuals (those aged 50-64). The results are suggestive of the spillover mechanism posited by Weisbrod (1991). Areas of the country where Medicare has more of an impact on insurance coverage – and where the above results demonstrate that Medicare thus had more of an impact on spending and technological change – are associated with a higher rate of increase in private health insurance coverage among the non-elderly between 1963 and 1970. The point estimates imply that areas in which none of the elderly were insured in 1963 experienced an 8 percentage point higher increase in insurance coverage among the non-elderly than areas in which all of the elderly were previously insured.[41] Accounting for the fact that Medicare on average increased insurance coverage by 75 percentage points, this implies that Medicare is associated with a 6 percentage point insurance in insurance coverage among the non-elderly. Of course, these results are only suggestive; other things could have been going on between 1963 and 1970 in these regions to affect them differently.

5.4. Medicare and the Growth of Health Spending: What do the results imply?

[[This Section Especially Preliminary.]]

Given the preceding results, a natural question is the degree to which Medicare is responsible for the overall observed growth of real per capita health expenditures since 1965. In this section, I therefore use the results in this paper to back out the implied contribution of Medicare to the growth rate of medical

[41] Although I can only measure whether individuals have health insurance, in principle one might also expect to see an effect on the generosity of coverage of individual's health insurance.

technology, and thus of medical expenditures. Naturally, such a calculation is inherently more speculative than the previous empirical estimates.

I estimated that Medicare was responsible for a 20 percent increase in the diffusion of new technologies. The data suggested that this diffusion effect occurs with a lag, but that it is detectable by the end of Medicare's first 10 years in existence. Therefore, assuming for simplicity that the induced diffusion all occurs with a 10 year lag and using a 5 percent real interest rate, this estimate implies that Medicare is associated with a 12.5 percent increase in the EPDV of the market size for a new innovation.

This increase in market size should in turn affect the incentives to develop new hospital technologies, and thus the arrival rate of new hospital technologies. Acemoglu and Linn (2004) estimate that a 1 percent increase in market size is associated with a 4 percent increase in the entry of new non-generic drugs. Of course, the innovation response for hospital technologies may well be different from that of pharmaceuticals. Unfortunately, however, I know of no estimates of the effect of market size on the arrival rate of new hospital technologies. Combining this estimate with my estimate of a 12.5 percent increase in the EPDV of the market size for a new hospital technology, this suggests that Medicare would increase by 50 percent the arrival rate of new hospital technologies.

Let δ_0 denote the baseline (i.e. absent Medicare) steady state level of diffusion of a new hospital technology and let λ_0 denote the baseline arrival rate of new technologies. The steady state increase in technology absent Medicare is therefore given by $\delta_0\lambda_0$ and, incorporating the effect of Medicare, is given by $(1.2*\delta_0)(1.5*\lambda_0) = 1.8*\delta_0\lambda_0$. Thus via its effect on technology diffusion, Medicare accounts for 45 percent of the observed steady state annual increase in medical technology.

In addition, I estimated that Medicare contributed to an increase in hospital insurance coverage among the non-elderly. The effect of Medicare on the share of hospital expenditures covered by insurance is therefore larger than its direct effect would imply. Its direct effect is the increase in insurance coverage among the elderly of 75 percentage points times the share of hospital expenditures prior to Medicare that the elderly account for; above, I estimated that number to be 0.18.[42] Therefore Medicare directly increases the share of hospital expenditures covered by insurance by 13.5 percentage points (not accounting for moral hazard). In Section 5.3 I estimated that Medicare is associated with a 6 percentage point increase in insurance among the non-elderly (who account for 82 percent of hospital expenditures prior to Medicare).

Therefore, in addition to its direct effect of 13.5 percentage points on the share of hospital expenditures covered by insurance, Medicare indirectly contributes to a 5 percentage point increase in this share through its effect on health insurance demand among the non-elderly. Medicare's total effect on insurance coverage is thus 1.4 times its direct effect. Therefore the above estimate that Medicare accounts for 45 percent of the steady-state increase in medical technology must be scaled by 1.4, suggesting that – accounting for Medicare's effect on private insurance demand – Medicare accounts for 63 percent of the steady state increase in medical technology.

The consensus among health economists is that technology explains well over half of the growth in real per capital health expenditures over the last half-century (Newhouse 1992, Fuchs 1996, Cutler xx). Taking the contribution of technology to the growth in health expenditures at its lower bound of 50 percent, my estimates therefore imply that Medicare can account for about one-third of the growth in real per capital health expenditures since 1965.

6. Conclusion

This paper has examined the relationship between health insurance and the growth in health expenditures by studying the single largest change in health insurance coverage in U.S. history: the introduction of Medicare in 1965. I find robust evidence that, in the first five years after its introduction, Medicare is associated with an increase in hospital utilization, measurable hospital inputs (i.e. employment and beds), and hospital spending. The estimated effects are large. As a lower bound, I estimate that Medicare is associated with a 14 percent increase in real hospital expenditures between 1965 and 1970.

[42] In the 1960 census, 9 percent of the country is aged 65 plus. In the 1963 National Medical Expenditure Survey, I estimate that hospital spending per capita on individuals aged 65 plus is double that for individuals below age 65.

I also present three pieces of evidence that point to a long-run effect of Medicare on the growth rate of hospital expenditures. First, I find that the introduction of Medicare is associated with an increase in expenditures per patient day; it is this increase in expenditures per patient day – rather than an increase in patient days – that accounts for the growth in real per capita health expenditures over the last 50 years (Newhouse, 1992); my estimates suggest that Medicare is associated with just over half of the increase in expenditures per patient day between 1970 and 1975. Second, I find that Medicare is associated with an increase in the diffusion rate of the then-new technologies; it is such technological change in medicine that is believed to be the primary force behind the growth of health expenditures (Newhouse 1992, Fuchs 1996, Cutler xx). Specifically, I estimate that Medicare is responsible for about one-fifth of the measurable diffusion of new technologies between 1965 and 1975, and one-third of the diffusion between 1970 and 1975. And third, I find that private health insurance coverage among the non-elderly increased more rapidly between 1963 and 1970 in areas of the country where Medicare had more of an effect on the insurance rate of the elderly. This finding is consistent with Weisbrod's (1991) conjecture that health insurance not only encourages the adoption of new technologies but also that new technologies – by increasing the mean and variance of health expenditures – in turn increases demand for private health insurance; this feedback loop provides an additional channel by which health insurance will contribute to the growth rate of health expenditures. A preliminary calculation based on these estimates suggests that Medicare is responsible for about one-third of the annual growth of real per capita hospital spending since 1965.

This paper has concentrated on the link between health insurance and health spending. Of course, it is important to understand not only the costs of health insurance coverage, but also the benefits. In related work, Finkelstein and McKnight (2004) examine the impact of the introduction of Medicare on health outcomes and on risk exposure. In its first 10 years, we find no evidence of an effect of Medicare on mortality; our evidence suggests that this is due to the design of Medicare which focused on providing acute, inpatient hospital care in a time period when mortality among the elderly was primarily due to chronic conditions best treated outside of a hospital setting. However, we find evidence that Medicare is associated with a substantial reduction in the elderly's exposure to out-of-pocket medical expenditure risk, with striking declines in the right-hand tail of the out-of-pocket medical expenditure distribution.

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[[not yet complete]]

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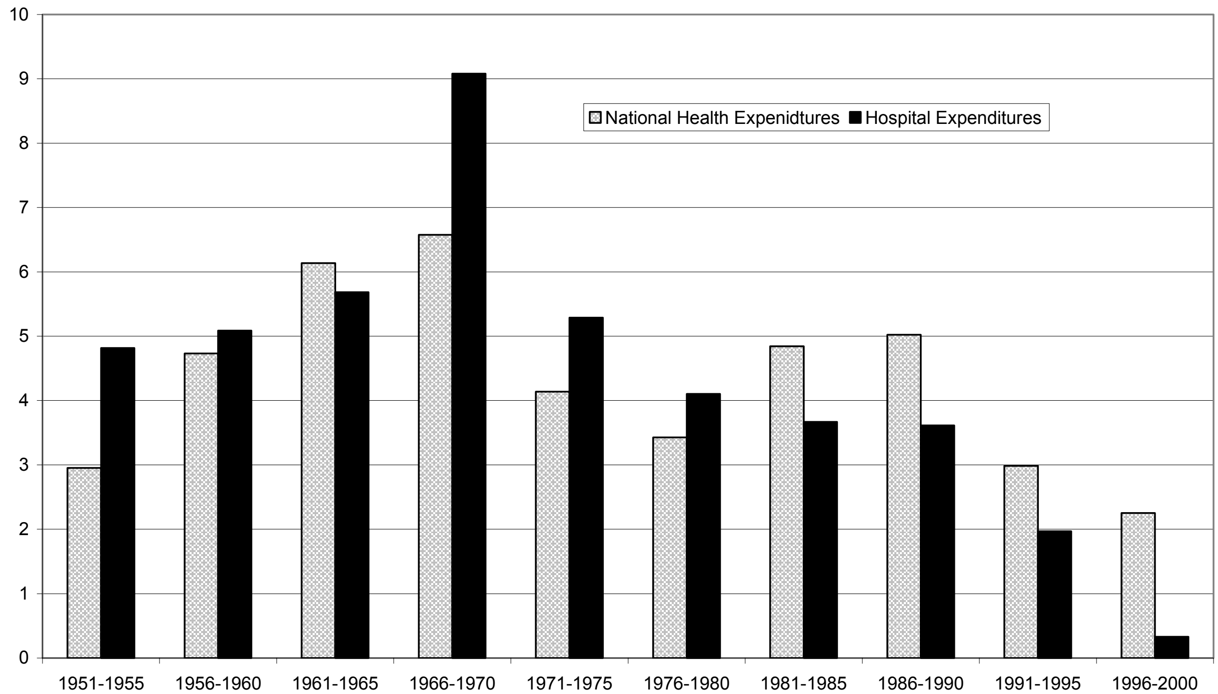
Figure 1: Average Annual Percent Increase in Real Per Capita Expendtitures



Source: Post 1960: National Center for Health Statistics, 2002. Pre 1960: Compendium of National Health Care Expenditure Data

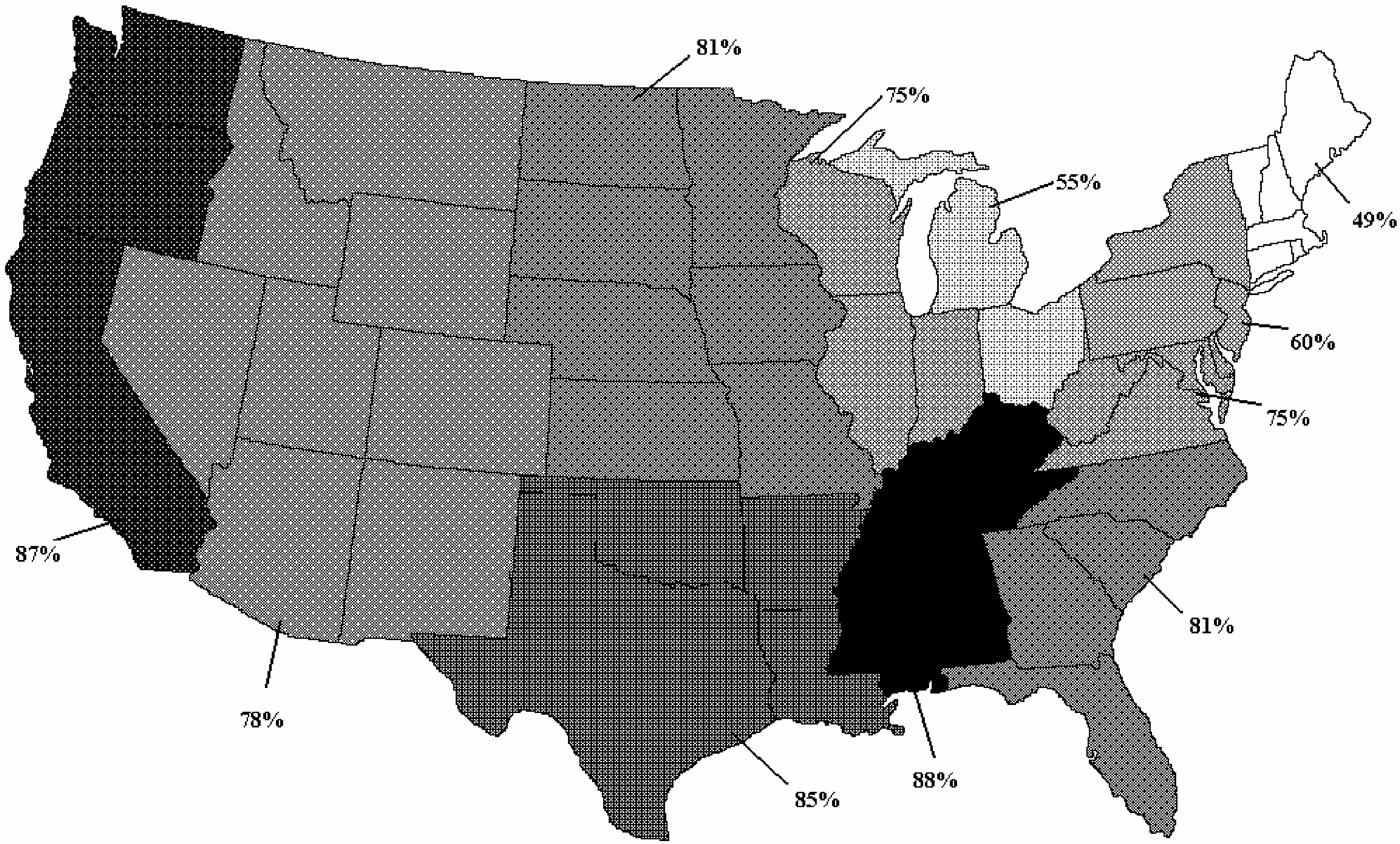
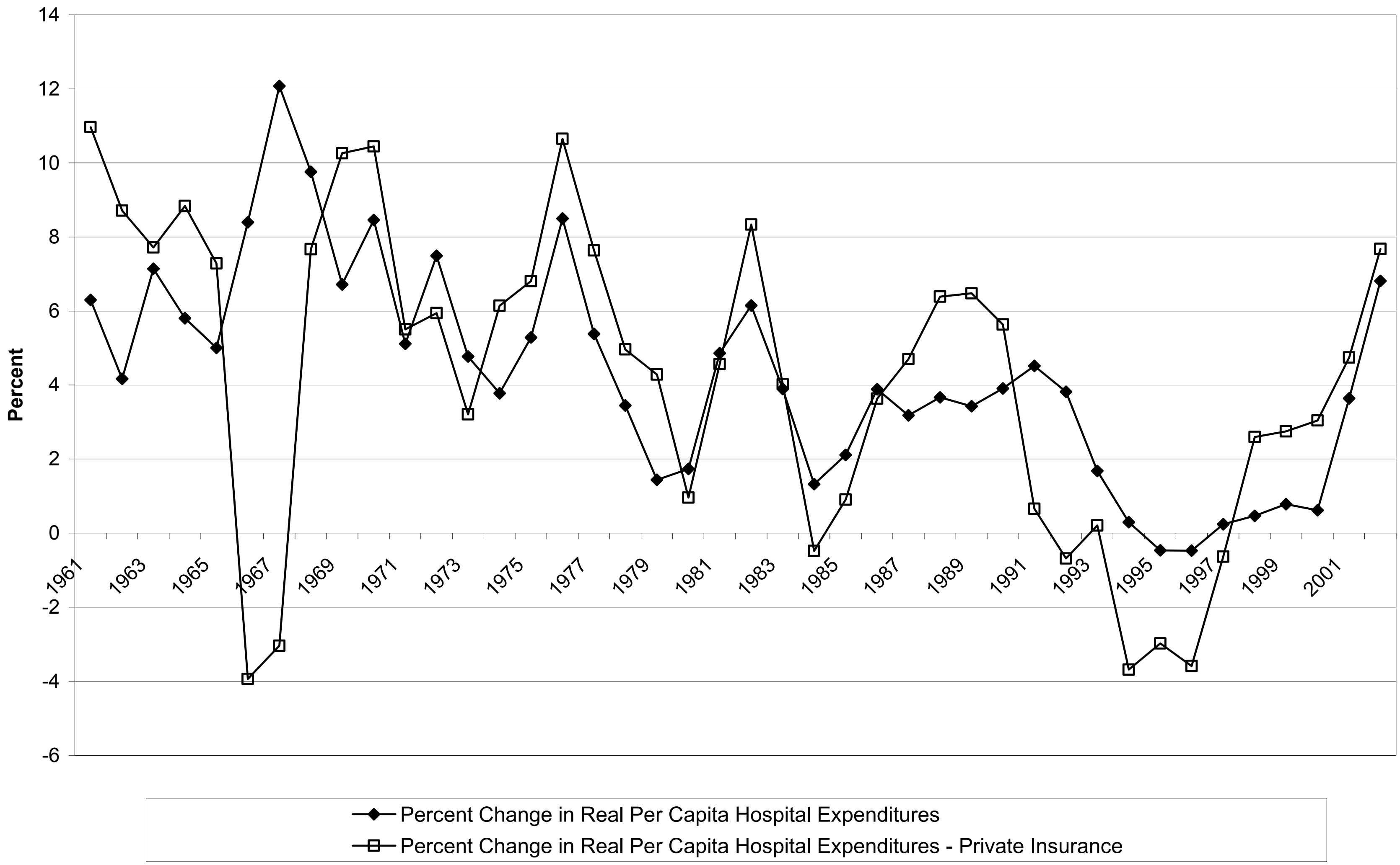
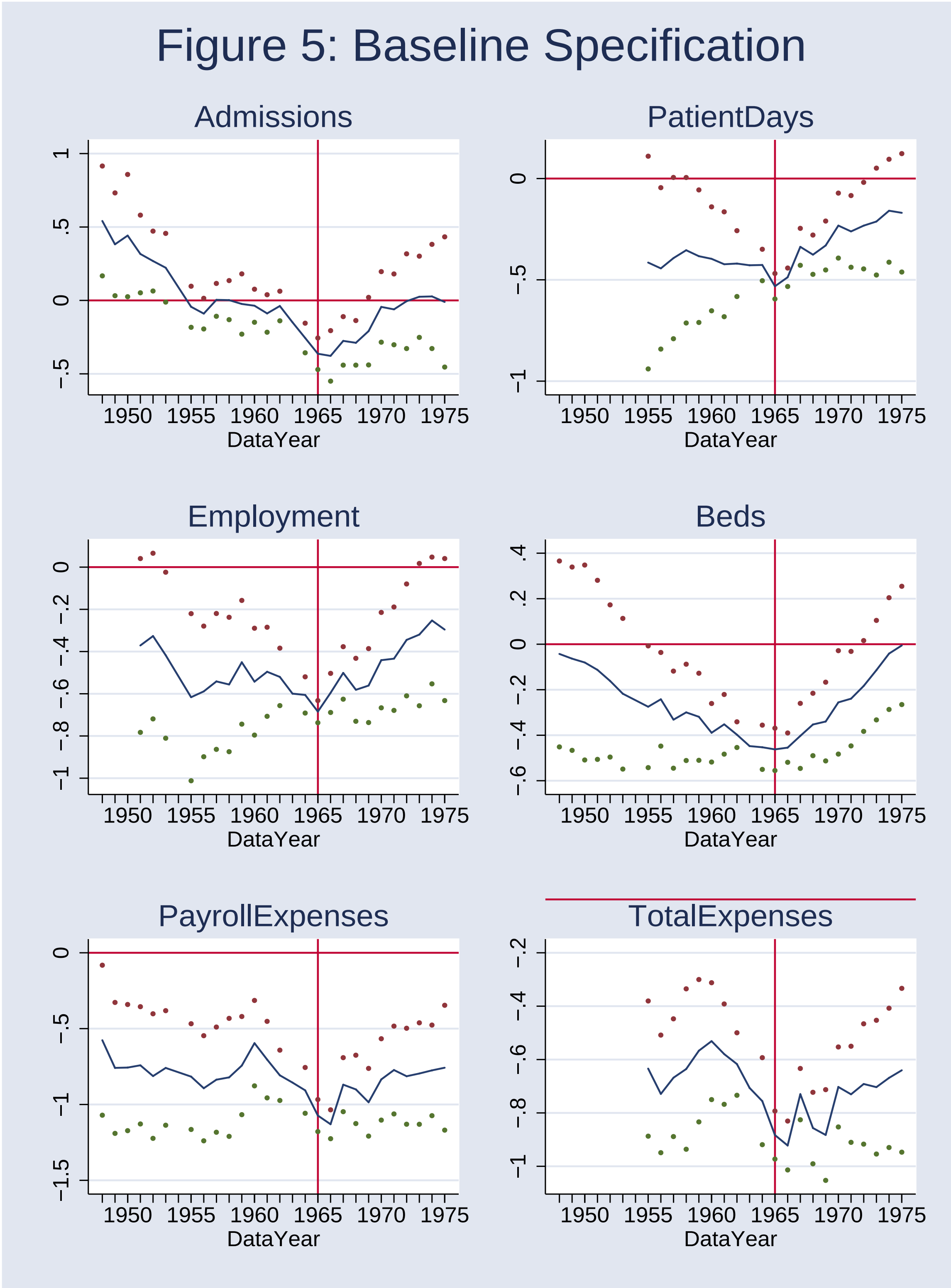


Figure 2: Percent of Elderly Without Blue Cross Hospital Insurance by Sub-region. Data are from 1963 National Health Interview Survey. Darker areas denote a higher percent without Blue Cross Health Insurance; Lighter areas denote a lower percent without Blue Cross health insurance.

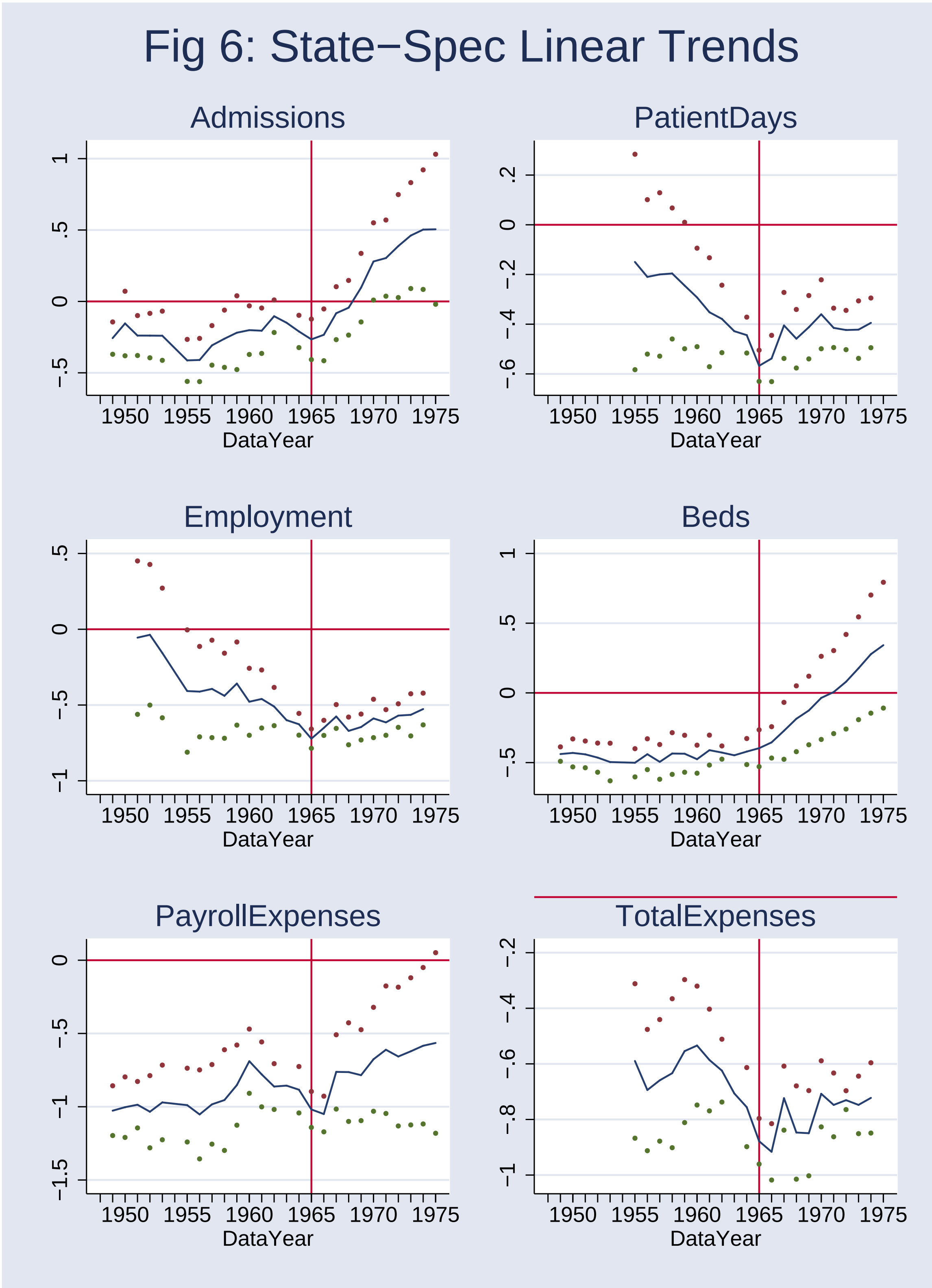
Figure 3: Percent Change in Real Per Capita Hospital Expenditures



Note: All variables are in Millions. Expenditure variables are in constant (1960) dollars.



Note: Figure 2 graphs the pattern of the λ_t coefficients from estimating equation (1) for the dependent variable at the top of each graph; all dependent variables are in logs. The dots show the 95 percent confidence interval. The graph is set in the reference year (1963) to the average difference in the dependent variable between the top and bottom decile of hospitals by percentage without private insurance.



Note: Figure 6 graphs the pattern of the λ_t coefficients from estimating equation (1) with the inclusion of state-specific linear trends as covariates. The dependent variable is given at the top of each graph; all dependent variables are in logs. The dots show the 95 percent confidence interval. See notes to Figure 5 for more information.

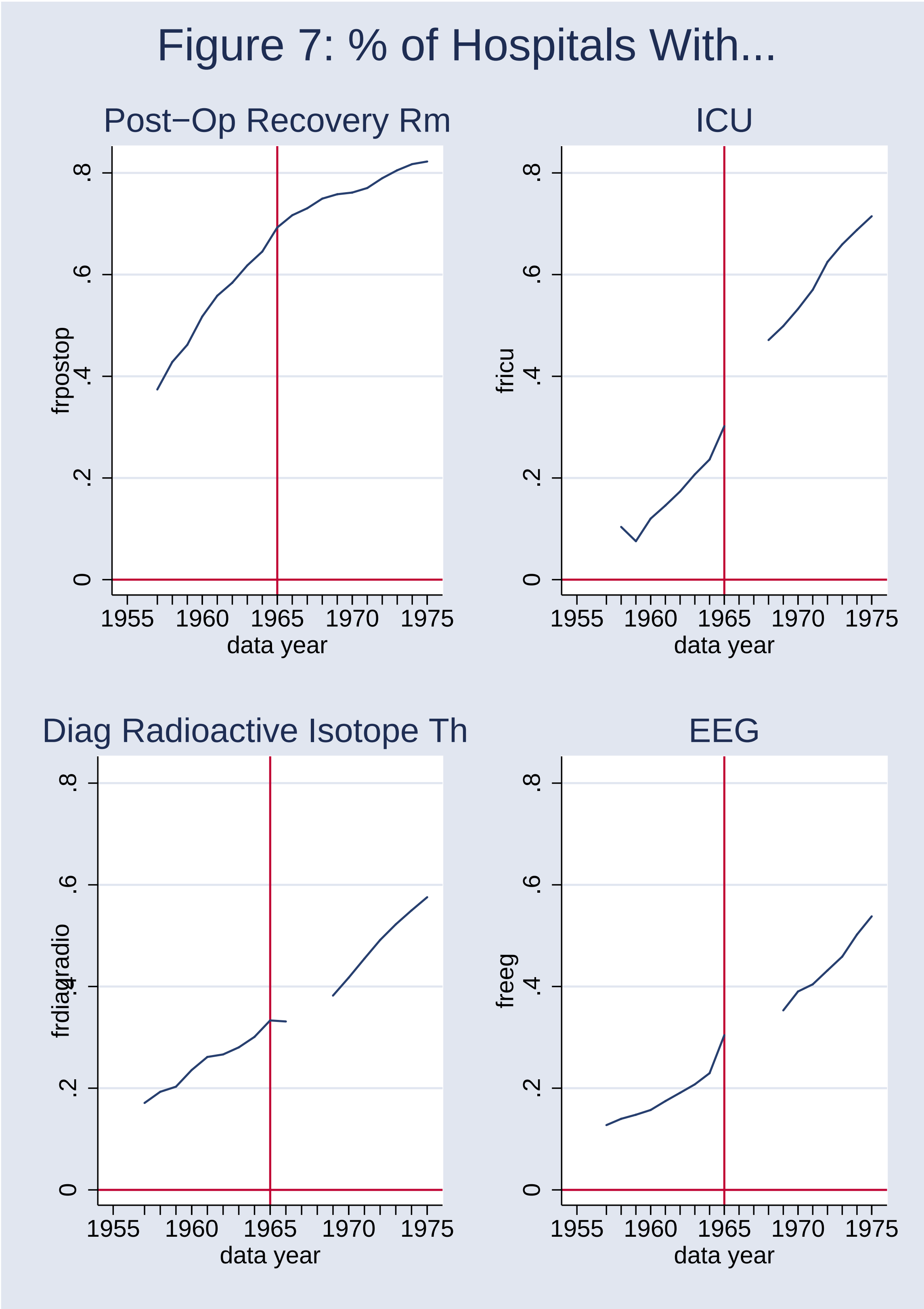
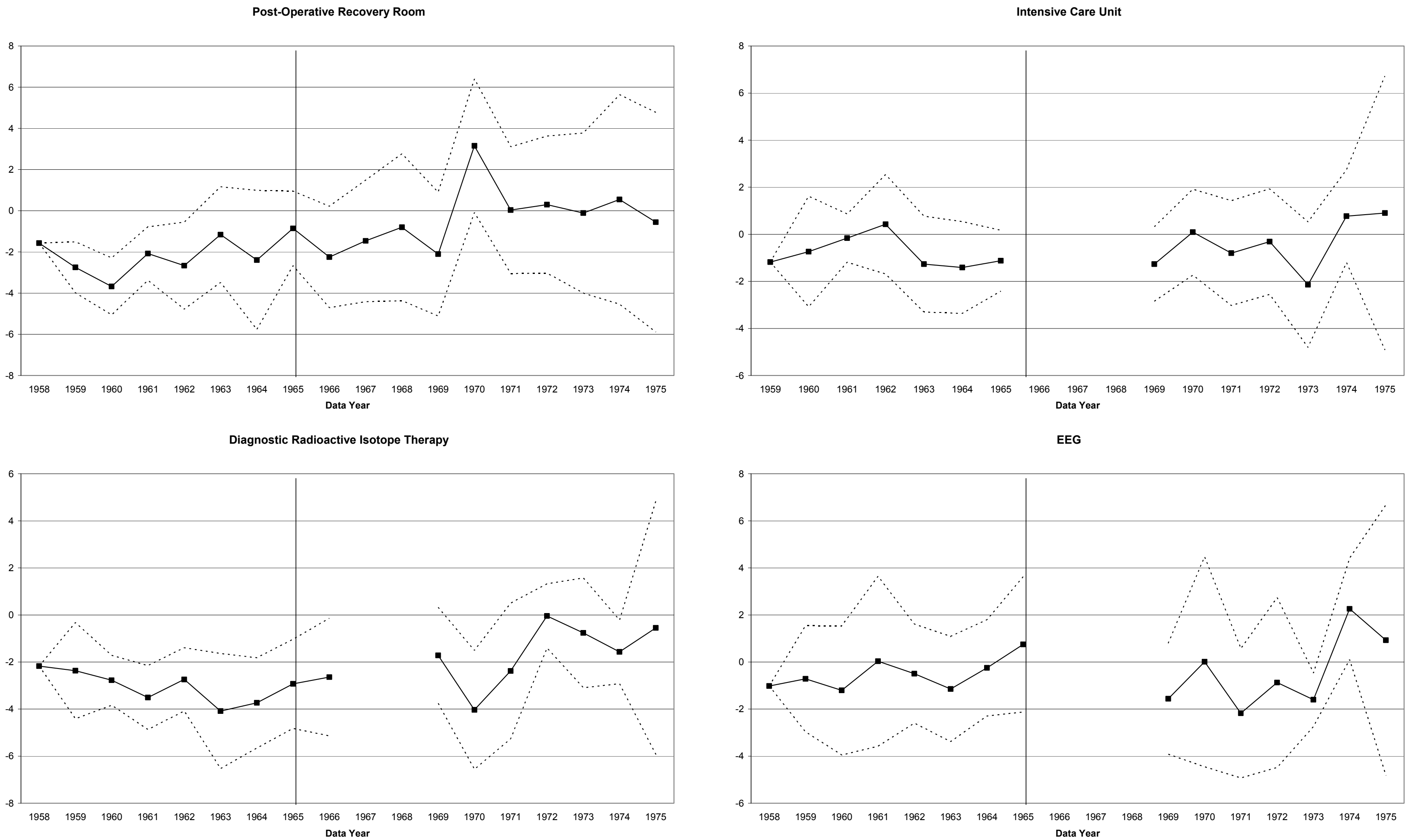


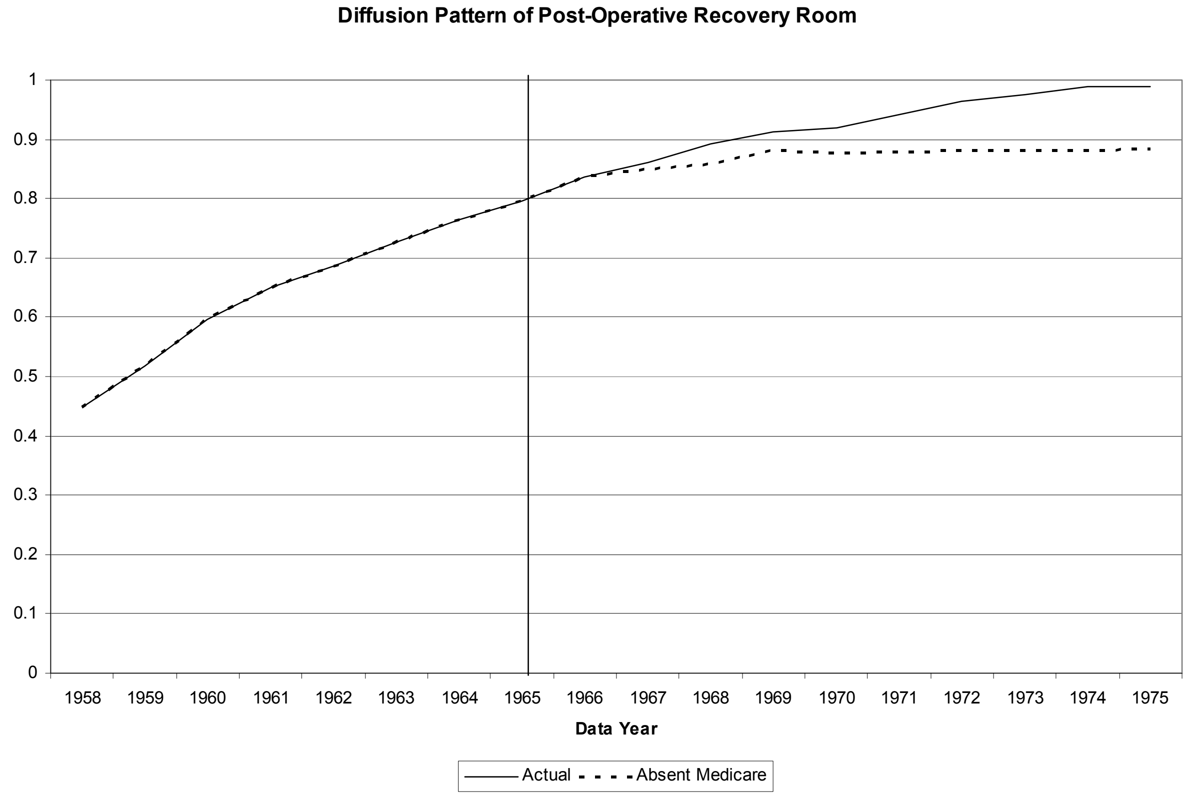
Figure 7: % of Hospitals With...
Post−Op Recovery Rm
ICU
Diag Radioactive Isotope Th
EEG
frpostop
fricu
frdiagradio
freeg
0
.2
.4
.6
.8
1955
1960
1965
1970
1975
data year

Figure 8: Effect of Medicare on the Hazard Rate of Technology Adoption



Note: Figure 8 displays the pattern of the λ_t coefficients from equation (4) for the adoption hazard given by the title. The dots show the 95 percent confidence interval. The graph is set in the reference year (1963) to the average difference in the hazard rate for areas with no insurance relative to areas in which everyone has insurance in 1962-194.

Figure 9: Estimated Diffusion Rates With and Without Medicare



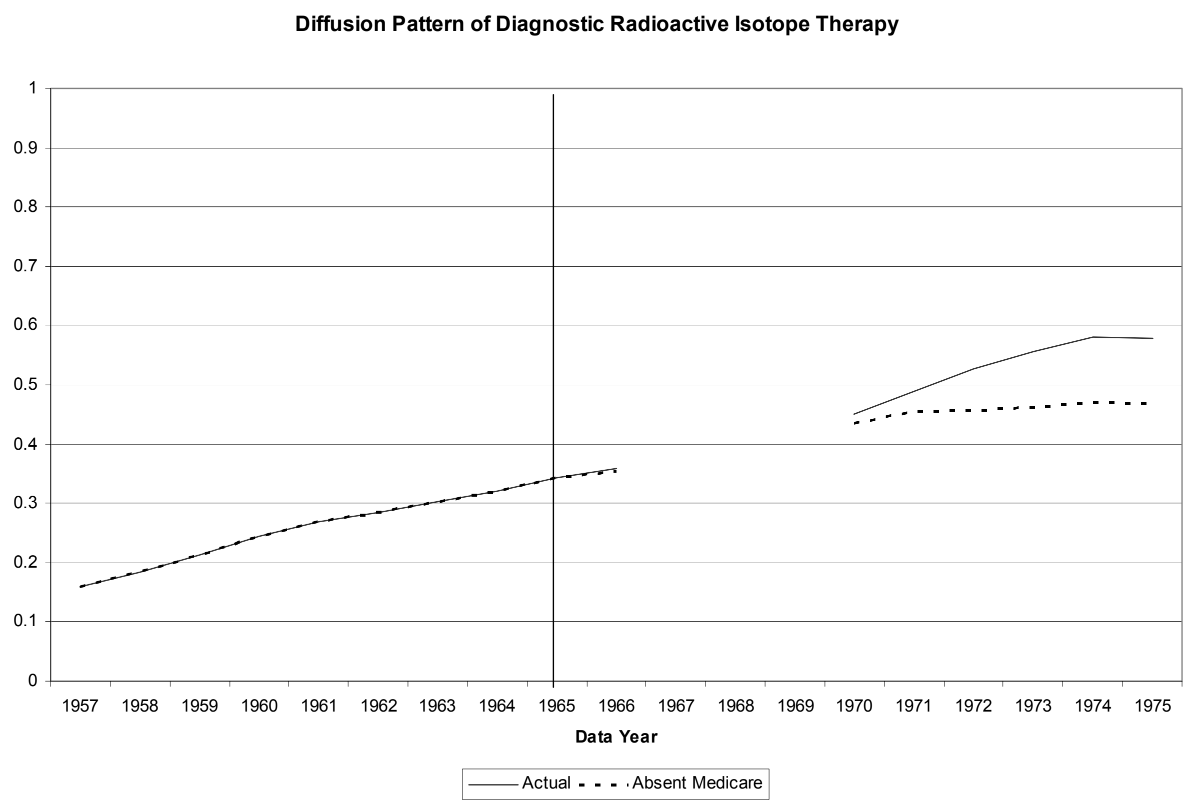


Table 1: Percent of Elderly Without Hospital Insurance, 1963

	Any Insurance	Blue Cross	Blue Cross By: Urban	Rural
New England (CT, ME, MA, NH, RI, VT)	0.37	0.49	0.48	0.55
Middle Atlantic (NJ, NY, PA)	0.41	0.60	0.57	0.71
East North Central, Eastern Part (MI, OH)	0.32	0.55	0.51	0.68
East North Central, Western Part (IL, IN, WI)	0.42	0.75	0.71	0.84
West North Central (IA, KS, MN, MO, NE, ND, SD)	0.47	0.81	0.75	0.91
South Atlantic, Upper Part (DE, DC, MD, VA, WV)	0.45	0.75	0.70	0.84
South Atlantic, Lower Part (FL, GA, NC, SC)	0.50	0.81	0.77	0.86
East South Central (AL, KY, MS, TN)	0.57	0.88	0.83	0.91
West South Central (AR, LA, OK, TX)	0.55	0.85	0.85	0.86
Mountain (AZ, CO, ID, MT, NV, NM, UT, WY)	0.50	0.78	0.73	0.88
Pacific (OR, WA, CA, AK, HI)	0.52	0.87	0.86	0.91

Note: Data are from the 1963 National Health Survey. Minimum sample size for a sub-region is 377. Minimum sample size for an urban (rural) sub-region is 177 (123).

Table 2: Description of Dependent Variables from the AHA data

Outcome Category	Dependent Variable	First year data present	Missing in subsequent years[+]	Sample Mean (1962 – 1964)	Sample Mean (1962 – 1964) in counties w/ percent uninsured in the Bottom decile	top decile
Total Expenditures ($1960, '000)	Real total expenditures	1955	None	1,410	2,117	517
	Real payroll expenditures	1948	None	870	1,316	300
Major Inputs	Beds	1948	None	125	163	54
	Employment	1951	None	229	340	85
Utilization	Inpatient Admissions	1948	None	4,448	5,611	2,225
	Inpatient Days	1955	None	36,410	55,396	13,516
	Technology Adoption Variables: Binary Variables for whether the hospital has a:					
Organizational Innovations	Intensive Care Unit (ICU)	1958	1966-1967	0.20	0.25	0.09
	Post-operative recovery room	1951	None	0.60	0.66	0.35
Other Innovations	Diagnostic radioactive isotope therapy	1952	1967-1968	0.27	0.34	0.08
	EEG	1948	1966-1968	0.20	0.27	0.05

Note: All variables are measured annually at the hospital level. Hospitals in counties in the bottom decile in terms of percent uninsured have between 48 and 53 percent of the elderly uninsured; Hospitals in counties in the top decile in terms of percent uninsured have 87 and 91 percent of the elderly uninsured. These estimates are based on insurance estimates using the sub-regional and urban by rural variation. Employment and payroll expenditures exclude residents and interns.

[+] 1954 is currently missing for all variables.

Table 4: Basic Results: Baseline Specification

	Utilization		Inputs		Expenditures	
	Log Admissions	Log Patient Days	Log Employment	Log Beds	Log Payroll Expenditures	Log Total Expenditures
Level Effects Estimated Over Different Time Periods						
1. First Two Years:	0.302***	0.298***	0.268***	0.074	0.421***	0.329***
(1967-1965 vs. 1965-1963)	(0.002)	(0.0000)	(0.0000)	(0.387)	(0.0000)	(0.0000)
2. First Five Years:	0.646***	0.435***	0.386***	0.279**	0.715****	0.532***
(1970-1965 vs. 1965-1960)	(0.0001)	(0.0004)	(0.0002)	(0.034)	(0.0003)	(0.0008)
3. First 10 Years	0.673***	0.479**	0.457**	0.644***	0.572***	0.492***
(1975-1965 vs. 1965-1955)	(0.001)	(0.043)	(0.017)	(0.0000)	(0.003)	(0.008)
Timing of Effect						
4. Second Five Yrs:	0.361***	0.198	0.287**	0.323***	0.554***	0.414**
(1975-1970 vs. 1965-1960)	(0.0004)	(0.15)	(0.034)	(0.0001)	(0.002)	(0.014)
Changes in the Pre Period						
5. Pre-Period:	-0.333*	-0.154**	-0.216	0.041	-0.698***	-0.454***
(1965-1960 vs. 1960-1955)	(0.092)	(0.033)	(0.14)	(0.74)	(0.0000)	(0.010)
N	112,323	86,401	99,523	119,402	94,789	77,598

Notes: Estimates of equation (1). Column heading shows dependent variable. Variation (z) is at the sub-region level. P-values in Parentheses. ***, **, * denotes significance at the 1 percent, 5 percent, and 10 percent level respectively. "First Five Years" test is given by equation (2); "Second Five Years" test is given by equation (3). Differences in sample size across the columns primarily reflect different starting years for the various variables (see Table 2); however, to some extent they also reflect different proportions of missing data (see discussion in Section 3). I find (in results not reported) that the results are not sensitive to limiting all variables to a common sample.

Table 5: Estimated Effect Across Hospitals of Different Sizes (First Five Years)

	Bottom Quartile	Second Quartile	Third Quartile	Top Quartile	Implied National Estimates of the Effect of Medicare: Weighted Average	Pooled Sample Estimate
Log Admissions	0.58** (p=0.02)	0.74** (p=	0.49** (p=0.02)	-0.23 (p=.11)	0.30	0.49
Log Patient Days	0.306 (p=0.36)	0.322* (p=0.08)	0.132 (p=0.45)	0.09 (p=0.18)	0.16	0.32
Log Paid Personnel	-0.06 (p=0.70)	0.302** (p=0.02)	0.039 (p=0.72)	0.212** (p=0.03)	0.09	0.27
Log Beds	0.165 (0.39)	0.26** (0.03)	0.21** (0.04)	0.120 (0.35)	0.14	0.20
Log Payroll Expenditures	0.304 (0.32)	0.60*** (0.001)	0.34 (0.18)	-0.181 (0.021)	0.20	0.47
Log Total Expenditures	0.199 (0.36)	0.539*** (0.004)	0.278*** (0.0002)	-0.237** (0.02)	0.14	0.38

Note: Estimates of equation (1) using sample from 1957 forward. Left hand column shows dependent variable. First four columns show estimates separately for each quartile, defined based on bed size in 1957. "Implied National Estimates" multiply estimates by 0.75 since this is the average effect of Medicare on insurance coverage. Weighted average averages the estimates across quartiles. Pooled estimates are from the baseline specification on the whole sample for 1957 forward. All estimates are for first 5 years; "First Five Years" test is given by equation (2). Variation (z) is at the sub-region level. P-values in Parentheses. ***, **, * denotes significance at the 1 percent, 5 percent, and 10 percent level respectively. See text for more details.

Table 6: Differential Effects on Hospitals (First Five Years)

	Utilization		Inputs		Expenditures	
	Log Admissions	Log Patient Days	Log Employment	Log Beds	Log Payroll Expenditures	Log Total Expenditures
"Rural" hospitals	0.516** (0.021)	0.483** (0.019)	0.285 (0.12)	0.385*** (0.001)	0.598*** (0.005)	0.468** (0.016)
"Urban" hospitals	0.710** (0.014)	0.453** (0.021)	0.405** (0.046)	0.239 (0.12)	0.804*** (0.0003)	0.589*** (0.001)

Note: estimates of equation (1) separately for hospitals in the bottom half of hospitals by percent urban in the county ("rural" hospitals) and for the top half of hospitals by percent urban in the area ("urban" hospitals). Separate estimates of the percentage without insurance are used for the "rural" and "urban" sub samples based on the separate estimates of the percentage without insurance in rural and urban areas (see Table 1). All estimates are for first 5 years; "First Five Years" test is given by equation (2). Variation (z) is at the county level. P-values in Parentheses. ***, **, * denotes significance at the 1 percent, 5 percent, and 10 percent level respectively. See text for more details.

Table 7: Private hospitals; robustness (5 year effect)

		Utilization		Inputs		Expenditures	
		Log Admissions	Log Patient Days	Log Employment	Log Beds	Log Payroll Expenditures	Log Total Expenditures
1.	Baseline specification	0.646*** (0.0001)	0.435*** (0.0004)	0.386*** (0.0002)	0.279** (0.034)	0.715**** (0.0003)	0.532*** (0.0008)
2.	State-specific linear trends	0.610*** (0.000)	0.482*** (0.000)	0.377*** (0.000)	0.282** (0.024)	0.672*** (0.002)	0.515*** (0.001)
3.	Hospital FE's	0.142* (0.072)	0.278**** (0.0001)	0.110* (0.100)	0.184*** (0.003)	0.200** (0.021)	0.072 (0.3781)
Alternative geographic area (z) at which percent without insurance measured							
4.	State	0.674*** (0.002)	0.443*** (0.010)	0.398*** (0.008)	0.289* (0.075)	0.736*** (0.000)	0.547*** (0.000)
5.	County	0.674*** (0.000)	0.493*** (0.000)	0.410*** (0.004)	0.352*** (0.001)	0.720*** (0.000)	0.525*** (0.000)
Alternative sources of cross-sectional variation in Medicare impact							
6.	75%+ w/o BC insurance	0.149*** (0.000)	0.119*** (0.0000)	0.097*** (0.0000)	0.095*** (0.0000)	0.173*** (0.0000)	0.120*** (0.0000)
7.	% w/ *any* private insurance	0.986** (0.028)	0.686** (0.013)	0.668*** (0.010)	0.285 (0.278)	1.414*** (0.000)	1.007*** (0.006)
8.	Variation in % elderly as well as % ins	2.66** (0.04)	2.25*** (0.003)	1.30* (0.099)	1.58** (0.049)	2.82** (0.018)	2.204** (0.022)
9.	Private vs. VA Hospitals	-0.072 (0.122)	0.168*** (0.0000)	0.083*** (0.010)	0.033 (0.32)	0.225*** (0.0000)	0.116*** (0.002)

Notes: Table cells report the estimate of the five-year effect of Medicare from estimating equation (1); "First Five Years" test is given by equation (2). Columns show the dependent variable. P-values are in parentheses. ***, **, * denotes significance at the 1 percent, 5 percent, and 10 percent level respectively. Each row reports the results from an alternative specification as follows:

- Row 1: Baseline results from Table 4.
- Row 2: State-specific linear trends are added to the baseline specification.
- Row 3, instead of interacting the year effects with the percent of the elderly without BC insurance in 1963, the year effects are instead interacted with an indicator variable for whether the sub-region has 75 percent or more of the elderly without BC insurance (and standard errors are clustered at this level).
- Row 4: hospital fixed effects are included instead of county fixed effects. Note however that now the sample only starts in 1957 (instead of 1948).
- Row 5 (6): substitutes percent of elderly without BC insurance measured at the sub-region level in the baseline specification for measurements at the state (county) level; these estimates are imputed based on the sub-region and the percent urban in the state or county. Standard errors are now clustered at the state (county) level.
- Row 7: substitutes the percent of the elderly without BC hospital insurance in the baseline specification for the percent of the elderly without any private hospital insurance
- Row 8: Uses variation in percentage of the population that is elderly as well as variation in the percentage of the elderly who have BC insurance as the right hand size variable. See text for further details.
- Row 9: Compares changes in private hospitals to changes in Veteran Administration (VA) hospitals which were unaffected by Medicare; see text for further details.

Table 8: Long Run Estimates

	Inputs Per Patient Days		Spending Per Patient Day		Log Wages
	Log Employment per Patient Day	Log Beds per patient day (1/occupancy)	Log Payroll Expenditures Per Patient Day	Log Total Expenditures Per Patient Day	
First Two Years: 1967-1965 vs. 0.4* (1965-1960)	-0.004 (0.96)	-0.128 (0.112)	0.081 (0.123)	-0.015 (0.75)	0.069 (0.198)
First Five Years: 1970-1965 vs. 1965-1960	-0.055 (0.59)	-0.088 (0.39)	0.148 (0.113)	-0.025 (0.72)	0.188*** (0.0007)
Second Five Years: 1975-1970 vs. 1965-1960	0.099** (0.028)	0.138* (0.092)	0.255*** (0.0008)	0.164** (0.050)	0.120* (0.054)
N	85,782	86,400	75,999	77,369	85,670

Notes: Estimates of equation (1). Column heading shows dependent variable. Variation (z) is at the sub-region level. P-values in Parentheses. ***, **, * denotes significance at the 1 percent, 5 percent, and 10 percent level respectively. "First Five Years" test is given by equation (2); "Second Five Years" test is given by equation (3). See text for more details.

Table 9: Medicare and technology adoption

	Intensive Care Facilities		Diagnostic Technologies	
	Post-operative recovery room	Intensive Care Unit	Diagnostic Radioactive Isotope Therapy	EEG
POST test	1.82** (0.021)	0.298 (0.60)	1.33*** (0.002)	(same test as LAGPOST)
LAGPOST test	2.32*** (0.002)	0.358 (0.54)	1.46*** (0.002)	0.075 (0.92)

Note: Table shows the estimates from the POST test and LAGPOST test given in equations (5) and (6); p-values are in parentheses. These tests are based on coefficients from estimating the hazard model given in equation (4) for the technology shown in the column headings. ***, **, * denotes significance at the 1 percent, 5 percent, and 10 percent level respectively.

Table 10: Medicare and the demand for health insurance among the non-elderly

	Individuals Aged 21-64		Individuals Aged 50-64	
	No Covariates	With Covariates	No Covariates	With Covariates
Year1970*Pctuninsured	0.081*** (0.028)	0.057** (0.028)	0.092* (0.052)	0.082 (0.052)
N	92,631	90,969	26,758	25,939

Note: Table shows the coefficient on Year1970*Pctuninsured from estimating equation (7). Robust standard errors are in parentheses. ***, **, * denotes significance at the 1 percent, 5 percent, and 10 percent level respectively.