Subsidies and Structure: The Lasting Impact of the Hill-Burton Program on the Hospital Industry*

Andrea Park Chung
Carnegie Mellon University

Martin Gaynor
Carnegie Mellon University
University of Bristol
NBER

Seth Richards-Shubik
Lehigh University
NBER

This draft: August 11, 2016

*We are grateful to Amy Finkelstein for generously providing us with the 1948-1975 AHA data, and Heidi Williams for generously providing us with the Hill-Burton project register data. Finkelstein's and William's efforts collecting and digitizing the data were supported by Award Number P01AG005842 and Award Number P30AG012810, respectively, from the National Institute on Aging of the National Institutes of Health. We wish to thank Arie Beresteanu, Gautam Gowrisankaran, Heidi Williams, and participants at the ASSA/Health Economics Research Organization meeting, the NBER Health Economics program meeting, the UIC Institute of Government and Public Affairs seminar series, the Annual Health Economics Conference, and the Lehigh University Economics Department seminar series for their helpful comments and suggestions. The usual caveat applies.

Abstract

We study the effect of public subsidies from the Hill-Burton program on hospital capacity, organization of the hospital industry, and utilization. We estimate that the program accounted for a net increase of over 70,000 beds nationwide, and that these effects lasted well beyond twenty years. We also show that differences in the number of hospital beds per capita between high and low income counties, rural and urban counties, and the South and the rest of the country fell substantially. We conclude that the program largely achieved its goals, with substantial and long lasting effects on the U.S. hospital industry.

JEL Classification: I11, I18, H51, H54

Keywords: Hospitals, Government subsidies, Industry structure

1 Introduction

Health care is a large part of the U.S. economy ($2.9 trillion, 17.4% of GDP in 2013), and the hospital industry is a large part of this sector (31% of health care spending and 5.6% of GDP) (Hartman et al., 2015). The functioning of the hospital industry is critical to the overall performance of health care. While hospital pricing, output, quality, and technology adoption have been the subject of a great deal of study, there has been relatively little attention focused on the determinants of the structure of this industry. Industry structure obviously plays a critical role on the supply side, but also affects demand. Location affects travel time, capacity affects waiting time, market structure affects strategic interactions among providers, and these then feed back into equilibrium price and quality determination. Yet in spite of the importance of industry structure, relatively little attention has been paid to this topic.[1]

The structure of the hospital industry has changed substantially over time, in terms of the total number of hospitals, their capacity, and ownership composition. Beginning in the post-WWII era, the industry grew substantially, from 4,375 non-federal short-term general hospitals in 1948 to 5,875 in 1975.[2] Most of the growth over this period came from non-profit and public hospitals, with a decline in the number of for-profit hospitals. Over this same period the hospital industry was the target of a large federal government program designed to affect industry structure: the Hill-Burton program. This program provided substantial subsidies for construction to non-profit and public hospitals, but not to for-profits. A logical question that emerges is what the impact of this program was on the hospital industry in

[1]For some important exceptions, see Gowrisankaran and Town (1997), Finkelstein (2007), and Abraham et al. (2007).

[2]These are what are generally meant by the term "hospital." Other types of hospitals are long term or specialized facilities, e.g., psychiatric, rehabilitation, orthopedic, etc. Federal hospitals (e.g., veterans and military hospitals) are not open to the general public. The overwhelming majority of U.S. hospitals are non-federal short-term general hospitals.

terms of size, location, and ownership composition. A government program directed toward capital investment could have profound, long lasting impacts on an industry.

In this paper we examine the impact of this large federal program on the hospital industry. The Hospital Survey and Construction Act of 1946, commonly referred to as the Hill-Burton program, marked the federal government's first major entrance into the general health care services sector (David, 2010; Stevens, 1999). This intervention was motivated by a perceived lack of supply of health care for workers in war production facilities during the Second World War, as well as a lack of access to health care for individuals in poor, rural areas of the U.S. The Hill-Burton program remains the largest piece of federal legislation to provide subsidies for the construction of non-profit and local governmental hospitals. From July 1947 through June 1971, $28 billion in funds were distributed for the construction and modernization of health care institutions.[3] We argue that the timing of the distribution of Hill-Burton funds was exogenous and use this to evaluate the impact of the program.

A program of this magnitude can have substantial impacts through changes in service capacity, changes in the number of firms, and changes in the ownership mix.[4] Furthermore, little is known about the long-term consequences for supply and utilization. We estimate the effects of the Hill-Burton program on supply, organization and utilization in the hospital industry, and the extent to which this large federal investment in non-profit and public hospitals may have displaced growth at hospitals that otherwise would have occurred, particularly at for-profits.

To our knowledge, we are the first to use historical records from the American Hospital Association to document changes in the hospital industry brought on by the Hill-Burton program. Specifically, we estimate the impact of the program on the supply of hospitals and beds over time in counties that received the federal subsidies. We find large and persistent increases in hospital bed capacity, which then led to increases in the utilization of hospital

[3]Inflation-adjusted to 2012 dollars.

[4]Finkelstein (2007) finds large impacts from the introduction of the Medicare program.

services. However the increases in capacity at subsidized hospitals were partially offset by reductions in capacity, particularly at for-profit hospitals.

The literature studying the impact of the Hill-Burton program itself is surprisingly sparse, given the large scale of the program. A notable exception is Lave and Lave (1974), who find a significant association between Hill-Burton funds per capita and an increase in total hospital beds per capita. However, their measure includes tuberculosis, mental health, and chronic disease beds in addition to general acute care beds. They do not find a significant increase in short-term general beds per capita when they include population and socioeconomic control variables. Further, their use of state-level data masks variation in responses to the program within each state, and since all states received some funding, there are no control groups with which to compare a counterfactual outcome.[5] We use counties rather than states as the unit of analysis, which is a more accurate reflection of how the program worked. Additionally, the existing literature on the Hill-Burton program has not considered the issue of crowd-out or estimated the response of for-profit organizations.[6]

We provide detailed background information on how the Hill-Burton program was operationalized in Section 2. Section 3 contains information on the data and explains our identification strategy, which draws on certain institutional details provided in Section 2. The empirical results of our main model specification are presented in Section 4. We also include the results from several robustness checks, including a falsification exercise with the leads of the treatment (Section 4.2) and an instrumental variables approach (Section 4.3),

---

[5]There are a number of counties that received no funding over the life of the program.

[6]Clark et al. (1980) use a more descriptive approach and to find that only about one-third as much of the relative convergence in bed supply would have occurred in 1950-1970 had there been no Hill-Burton program. Brinker and Walker (1962) also evaluate the impact of the program during the first 7 years in 2 states. They find that the program resulted in increases in bed capacity. However, conclusions about the program at the national level cannot be drawn from their paper.

which verify our main results. Section 5 assesses the crowd-out effects of the program, the potential spillovers to neighboring counties, and cost of the program per bed generated. Section 6 addresses the impact of the program on health care utilization, and Section 7 provides descriptive evidence about long-run effects and changes in the distribution of the supply of hospital beds. We conclude in Section 8.

2 The Hill-Burton Program

The Hill-Burton program was enacted with the Hospital Survey and Construction Act of 1946. At the time of its inception, the program was a response to the shortage of health facilities for war production workers, as well as the perceived scarcity of health resources in parts of the country, particularly in the South (Stevens, 1999). When initially enacted, the Hill-Burton program provided for $75 million ($714 million in 2012 dollars) in funds annually to be distributed among states over 4 years.[7] This amount was raised to $150 million ($1.45 billion in 2012 dollars) annually in 1949. Online Appendix Figure A1 depicts the geographic distribution of hospital beds per capita in 1948, at the start of the program. Based on data from the American Hospital Association, there were a total of 4,375 short-term acute care hospitals in the U.S. in 1948. Lighter shading denotes fewer beds per capita. In 1948, 667 of the 3,100 counties in the U.S. (about 22%) had no hospital. The majority of southern counties and counties in the middle of the country had little or no supply of hospital beds.

The central federal authority for the program was the Federal Hospital Council at the U.S. Department of Health, Education and Welfare. Funds were distributed to the states based on a specific allotment formula in the legislation. Online Appendix Table A1 illustrates this formula using an example of 3 hypothetical states with the same population but with high, average, and low per capita income, respectively.[8] The formula was designed to provide

[7]The average construction cost of hospitals newly built with Hill-Burton funds between 1948-1950 was $866,300, or $8.3 million in 2012 dollars.

[8]Once a state had 4.5 beds per 1,000 people, Hill-Burton funds could no longer be distributed to that state. However, no state in the U.S. ever reached that limit (Feshbach,

lower income states with a relatively larger portion of the Hill-Burton funds, but with no state receiving less than $10,000. For example, in 1950 Georgia was one of the lowest per capita income states and received $2.6 million in funding, which amounts to $0.76 per person. Meanwhile California, one of the wealthiest states, received $1.6 million, or $0.15 per person. The funds from the program paid for up to one-third of the costs for construction or renovation. Throughout the life of the program, the federal government spent over $3.7 billion ($28 billion in 2012 dollars), which spurred about $12.8 billion ($96 billion in 2012 dollars) in construction, addition, replacement and remodeling of health care facilities.

In order for any state to receive its share of the funds, it first had to submit a state plan to the Surgeon General of the U.S. Public Health Service, and the Surgeon General had to approve the plan. Each state was required to take inventory of its hospitals to determine the need for hospital beds. Using this information, the state was required to develop a state plan, in which counties were prioritized based on its population, bed need and whether or not it was a rural county. We provide a specific example using the state of Georgia in Online Appendix A1.1.

Next, once a state plan was approved by the Surgeon General, the state was entitled to their specified allotment to cover one third of expenditures for construction, additions and remodeling of health care facilities. The state plan then became the roadmap for distributing funds within a state, and states were required to ensure that funds were distributed roughly in accordance with their priority list. The state did not actually distribute the funds until a construction application was approved for a specific project, and each project had to be approved by both the state agency and the Federal Hospital Council. The applicants proposing specific Hill-Burton construction projects included the states themselves, local governments, public agencies, and non-profit agencies. They submitted their applications to the state agency overseeing the program, which processed the applications in the order of priority and then forwarded them to the Surgeon General. However if a higher priority

1979).

project did not have the financial resources necessary for the construction, maintenance and operation of the project, then lower priority projects would be forwarded to the Surgeon General out of order of priority.

Once the application for a specific project was approved, the Hill-Burton funds were distributed by the state to the county or other entity to build the facility. Online Appendix Figures A3 and A4 summarize both steps of the allocation process and distribution of funds. We can see that disbursement of these funds occurred at the state level with enforcement and monitoring at the federal level. However, final control of the program was placed with the Federal Hospital Council. Online Appendix Table A2 provides summary statistics on the projects and funding amounts approved over time (the table is discussed in the next section).

The maps in Figure 1 provide additional detail regarding the distribution of funds to states. The top panel details the approval of Hill-Burton funds across states in 1948 (normalized by state population). We see that funds were concentrated in southern states, with Alabama, Mississippi and New Mexico receiving the most funding per capita. The bottom panel summarizes total approved funding over the length of the program, from 1947-1971. Again, we see that the majority of funding went to the southern states, particularly Mississippi and Arkansas.

3 Data and Methods

3.1 Data

We use three main data sources in this paper: the Hill-Burton Project Register, the American Hospital Association Survey of Hospitals, and the Area Resource File. The relevant summary statistics are presented in Tables 1 and Online Appendix Tables A2 and A3. The details are discussed below.

Hill-Burton Project Register

The Hill-Burton Project Register is a publication by the U.S. Department of Health, Education and Welfare and contains data that are a compilation of all hospital and medical facility projects approved under the Hill-Burton program from 1947 to 1971 (U.S. Department of Health, Education and Welfare, U.S. Public Health Service, 1971). It includes information on the following variables for each project approved under the program: unique project number, location of the project (city, county and state), name of the facility, type of facility (general acute care, tuberculosis, mental hospital, etc.), dollar amount of federal funds, total estimated construction cost, number of beds planned, and date of approval. We restrict the analysis to Hill-Burton funds spent on non-federal short-term general (acute care) hospitals. These short-term general hospitals are the focus of this paper because they are the facilities that are open to the general public and provide a broad range of services.

There were a total of 10,490 projects funded by the Hill-Burton program (excluding U.S. territories) at a total federal cost of $27.3 billion (in 2012 dollars). When we limit the projects to short-term general hospitals, there are 5,567 total projects with $19.5 billion spent on those projects. Online Appendix Table A2 lists the number of such projects approved each year, with the total number of beds, proposed construction costs, and federal subsidy amounts. There is variation from year to year in the number of projects and the total subsidy amounts because the approval of funding depended on the submission and review of projects on an individual basis, as described in the previous section.

American Hospital Association Annual Survey of Hospitals

Our data on the primary outcomes in terms of capacity and utilization come from the annual American Hospital Association (AHA) survey of hospitals for the years 1948 to 1975, which includes data on the characteristics of all hospitals registered with the AHA in the United States. These data are available in hard copy form in the annual August issue of *Hospitals: The Journal of the American Hospital Association*.[9] While the AHA survey data have been used by many to study the hospital industry, few have used these older data to study the industry in its more formative years.

[9] These data are known for their accuracy and completeness. See Online Appendix A1.2 for a brief discussion and Finkelstein (2007) Online Appendix for additional details.

The unit of observation in the AHA survey is a hospital-year, and we have data on the following variables: hospital name, city, county, state, total beds, admissions, and days. We also observe the ownership structure of the hospital (non-profit, non-federal public, federal, and for-profit) and the type of hospital (short-term, long-term, general, non-general). We eliminate federal hospitals, such as Public Health Service, military, and Veterans Administration hospitals (about 5% of hospitals each year), and keep only short-term general hospitals (excluded are long-term stay hospitals, children's hospitals, maternity hospitals, etc.). There are no AHA survey data for 1954, so we interpolate values for each variable in that year by taking the averages of their values in 1953 and 1955. We aggregate the AHA data to the county level by summing all hospital beds by ownership type and counting the number of hospitals in a county. We aggregate to the county level because Hill-Burton funds were typically prioritized by county (we discuss this further in the next section, 3.2, on methodology).

The average and median numbers of beds, admissions, and hospitals by ownership type are shown in Table 1, for the entire sample and separately for counties that received Hill-Burton funding and those that did not. The never-funded counties are on average smaller than the funded counties and have fewer hospitals, but they have roughly the same number of beds per capita as the funded counties in the year when those counties were first funded. Online Appendix Table A3 gives these figures for counties separated into population terciles. The bottom two terciles are similar in terms of hospital beds and admissions per capita, while the counties in the largest tercile have more beds and admissions on average.

Figure 2 shows national trends over time in the average numbers of beds and admissions per capita in total and by ownership type. This was a period of rapid expansion in the hospital industry: from 1948 to 1975 the total number of beds per 1,000 population increased from about 3 to almost 4.5. The growth of non-profit and public hospitals accounted for most of this increase. The number of for-profit beds per capita initially declined, but had a modest net increase of 0.2 beds per 1,000 over the full time period. The number of admissions per 1,000 population almost doubled over this time period from 85 to 150, due to increases in non-profit and public admissions. For-profit admissions decreased slightly over this time period from 0.093 to 0.088 per 1,000.

Area Resource File

The Area Resource File (ARF) contains data on county-level characteristics compiled from a variety of sources, such as the U.S. Census Bureau, American Medical Association, and the Bureau of Labor Statistics (Area Resource File (1983)). While there are hundreds of variables available in the ARF, very few of these are available from the 1940s. For that period we can obtain data on Census population estimates (totals and shares by age and race), median family income, and the number of non-federal physicians.

Because of substantial changes in county boundaries that occurred in the 1970s in the state of Virginia, we were unable to match county-level characteristics with the AHA data in the state of Virginia. For this reason, we exclude Virginia from the anlaysis. In addition, we exclude Alaska and Hawaii from our analyses as they became U.S. states in the middle of our sample period.

Summary statistics for the ARF data are contained in Table 1. On average, the population in counties in our sample in 1953 was about 51,940, and the median family income was $24,352 (in $2012). Funded counties were more populous, with almost 4 times the average population of counties that never received funding. These counties were also slightly richer, with a higher average median family income compared to never funded counties.

3.2 Overview of Methodology

We choose the unit of analysis as the county because Hill-Burton funds were prioritized by county (or groups of counties designated as Health Service Areas).[10] While it is possible to

[10]Health Service Areas are not available electronically for use in our analysis. Thus, we are assuming that counties grouped in the same service area were equally likely to receive funding. This seems probable since rural counties were grouped with each other rather than being grouped with urban counties. Similarly, urban counties were grouped together.

proceed with a more aggregate analysis at the state level, allowing finer granularity in the unit of analysis is preferable since a state level analysis would overlook substantial within-state variations in capacity and funding. Further, a state level analysis will have no “untreated” units, because all states received funding in the first year of the program. Because not all counties received Hill-Burton funds, we are able assess how hospital capacity changed in counties that received Hill-Burton funding compared to those that did not. In addition we exploit the timing of when a county was funded relative to others.

We define a county as being exposed to the Hill-Burton program starting in the first year any funding was approved for a project in the county. Accordingly we create an indicator $Treat_{it}$ that equals 1 in the year that funding was approved for the first Hill-Burton project in county i, and 0 otherwise. Throughout the period 1948 through 1971, counties were treated in this way at different points in time. In order to take into account the staggered nature of receipt of Hill-Burton funds, we use an “event study” framework and estimate how outcomes changed over time relative to the first year of treatment. To do this we use a series of lags of the first-treated dummy, $Treat_{i,t-m}$, to trace out the effect of receiving first funding m years ago, where m ranges from 0 to 20 years.[11]

The effect of the Hill-Burton program on hospital capacity should be captured by the treatment variable and its lags. However there may be other factors that shift the demand and supply of hospital beds and therefore also determine hospital capacity. We control for observed factors using county-level socioeconomic variables that are likely associated with demand shifts. In addition, it is possible that there are unobserved factors that determine the number of beds in a county and are thus still present in the error term. We take advantage of the fact that we have panel data by including county fixed effects, which control for any unobserved characteristics of counties that do not change over time. We also include year

[11]This is a similar approach to Wolfers (2006), who studies how divorce reform laws adopted at different times by different states affect outcomes, such as suicide rates and domestic violence.

fixed effects to capture any secular national trends that may affect the number of beds per capita. Last, since non-profit and public hospitals were eligible for Hill-Burton funding, but for-profits were not, we estimate regressions both for the net effect on total beds and separately for beds at non-profit or public hospitals and at for-profit hospitals. In each case, the regression specification is as follows:

$$\text{Beds per } 1{,}000_{it} = \theta + \sum_{m=0}^{m=20} \beta_m Treat_{i,t-m} + X_{it}'\delta + c_i + \lambda_t + \varepsilon_{it}, \tag{1}$$

where the $Treat_{i,t-m}$ are the dummy variables indicating if the county first received Hill-Burton funding m years ago, the X_{it} are observable county socioeconomic and demographic variables, the c_i are county fixed effects, the λ_t are year effects, and the ε_{it} are random error terms. The coefficients β_m indicate the effects on bed supply due to first receiving Hill-Burton funding m years ago.

Since our data are from 1948 to 1975, we choose $m = 0, \ldots, 20$ so that we can track the longer term impacts on capacity for counties treated in the earlier part of the program. We include one additional indicator for lags of 21 years or more. The X_{it} are controls for county characteristics that likely affect the overall demand for beds, including total population and socioeconomic factors measured as median family income and the percentage of population that is non-white. We also include the percentages of the population over the age of 65 and under the age of 5 since these two age groups are more likely to demand higher levels of health care services. Last, we include the number of non-federal physicians per 1,000 population, as the presence of more physicians in a county likely relates to a greater demand for hospital beds. All regressions are estimated using weights for county population.[12] To

[12]Whether or not to use weights is not a straightforward matter in this context (Solon et al. (2015)), and accordingly we have reproduced all analyses without weights (see the Online Supplemental Appendix). The unweighted average treatment effects are larger than the weighted estimates. We prefer the weighted estimates because they are more conservative,

capture the important heterogeneity in treatment effects by population size we also estimate these regressions separately for each population tercile.

3.3 Identification

3.3.1 Possible Challenges to Identification

The inclusion of year and county fixed effects in our model means that the treatment effect parameters (β_m) are identified from within county variation. Thus our model controls for any fixed differences across counties that are correlated both with our explanatory variables and with hospital capacity.[13] Nonetheless, the $Treat_{it}$ variable may still be endogenous. It is possible, for example, that counties were more likely to receive Hill-Burton funding at times when they faced (unobservably) low hospital demand or high construction costs. This would introduce a negative correlation with the error term in the regression equations, thus leading us to underestimate the effect of the program. Alternatively, the opposite could be the case – counties that were well prepared and would have added hospital beds anyway are the ones that received funding. In this case we would overestimate the impact of the program. Thus our regressions may produce biased estimates of the effect of the Hill-Burton program on bed capacity if there are any omitted factors that vary within counties over time and are correlated with the Hill-Burton treatment variable. For this to be an issue it must be that the unobservable time varying factors are correlated with the exact timing of first receiving funding, given the staggered nature of the treatment and the outcomes that we observe.

Though we cannot test if such omitted variables exist, we assess the exogeneity of the timing of treatment in multiple ways. We estimate the above regressions with leads of the treatment indicator, and find no evidence of substantial trends prior to receiving funding (Section 4.2). We also use the priority rankings in the state plans to instrument for counties being treated early in the program, and this analysis indicates a large local average treatment effect among these counties (Section 4.3). Third, we consider whether spillovers to adjacent

and they have the advantage of aggregating more easily to national-level impacts.

[13]Results are robust if we include county-specific linear or quadratic time trends.

counties could contaminate the control observations and bias our estimates, and we find no changes in the treatment effect when such spillovers are incorporated (Section 5.1).

3.3.2 Institutional Details and the Exogeneity of Treatment

We now discuss institutional factors that we believe support the assumption of exogeneity of the exact timing of treatment. Because the federal allocation of funds was set by formula, the main concern would be with the distribution of funds at the state level; i.e., whether states selectively picked counties to receive funding based on unobserved confounders. Because we are looking at changes in availability of beds year over year, we specifically want to consider how a county's propensity to be "exposed" to the program was related to the change in beds before funding was approved. For example, states may have selected counties they felt were "mature" and ready for growth. In that case, we may suspect that consumer or hospital advocacy groups may have been able to lobby for funding, and thus, played a role in determining whether a county would receive funds. These "behind the scene" political bargaining events may be unobserved and correlated with the change in beds in that county and would also be correlated with whether or not a county received funds.

However, there is some strong evidence that politics played a limited role, if any, in the allocative process of the program. Feshbach (1979) has an interesting discussion of the de-politicized nature of the allocative process of distributing Hill-Burton grants.

> "Bureaucratic procedure rather than direct political conflict determined the allocation of Hill-Burton funds. The distribution of Hill-Burton grants was depoliticized. Unlike federal project grants, Hill-Burton funds were not allocated by announcing the availability of funds, receiving a set of applicants and then making a decision based on the appropriateness of the application and the relative power and resources each applicant can bring to bear on the decision-making process....The rules and regulations [of the Act] reduced the importance of the direct use of power by individual hospitals, the entire industry, or other program beneficiaries in allocating Hill-Burton grants."

> “The Hill-Burton Program disbursed funds geographically through the use of a formula which determined each Health Service Area’s ‘need’ for hospital beds. Each area was ranked according to its need and then funds were distributed automatically. This automatic formula allocation system reduced popular and partisan political influence on individual grant allocations...Applicants had little space to exercise influence except when competing applications existed from one area or when the states had surplus of funds to disburse at the end of the fiscal year.”

This is echoed in Starr (1982).

> “The states were to estimate regional hospital needs; when an applicant from an area received a grant, the area would go to the bottom of the list and wait another turn. These arrangements were meant to minimize “politics”; the entire process was presented as a scientific exercise.”

Thus, we believe the implementation of the program was largely insulated from political influence. The highly structured rules and regulations written into the Act ensured that political struggles would be minimized.

As mentioned previously, it is also possible that states provided funding only to counties that they perceived as slow growing. In this case, we would expect that our estimates on the impact of the program would be biased downward. For this to be true, there would have to be some unobserved component of those counties that states used as a criterion for selecting them for treatment. One would think that the main drivers of growth, without the program, would have been demand factors, such as population, income, and the racial composition of the county. We already control for these basic demographic characteristics, so we would need some variable that would affect selection even after controlling for these factors. We further control for time-invariant characteristics of counties that might contribute to being slower growing counties by adding in county fixed effects.

4 Effects on Hospital Capacity

4.1 Average Effects on Capacity

The left hand panel of Figure 3 plots our estimates of β_m from specification (1), in models estimated using total beds per 1,000 and separately by ownership type (the coefficients are also listed in Online Appendix Table A4).[14] These coefficients give the program's treatment effect over time. Overall, there is a large and statistically significant increase in the supply of beds in response to a county receiving Hill-Burton funds. The top panel plots the effect of receiving Hill-Burton funds on hospital beds in the targeted sectors: non-profit and public hospitals. Much of the impact occurs within the first 3 to 4 years, the typical length of time to complete a hospital construction project. However there is further growth over the remainder of our follow-up period, which reflects the impact of additional projects within the same county and projects that took longer to complete.[15] The estimated effects are substantial. Five years after the first Hill-Burton project was approved, treated counties have 0.4 additional beds in non-profit and public hospitals per 1,000 population. The average effect continues to rise to 0.6 beds per 1,000 after 20 years from when the first project was approved.

The second graph in the left-hand panel shows the effect on beds in for-profit hospitals. The average supply of for-profit beds drops when a county receives Hill-Burton funds, and levels off at a decrease of about 0.1 beds per 1,000 after three years. This provides one indication of a crowding out effect of the program, as the subsidy was not available to for-profit hospitals. However crowd-out was also possible within the non-profit sector, which represented the vast majority of the hospital industry at that time.[16]

---

[14]The figures in the right hand panel include leads to assess pre-trends. These figures are discussed in Section 4.2, which follows this section.

[15]Additionally, if earlier projects were larger on average, this would increase the longer-run effects which are estimated from counties treated in the early years of the program.

[16]For more details on crowd-out, see Chung et al. (2016).

The bottom graph in the left-hand panel plots the effect on total hospital beds in a county; i.e., the net effect of the program accounting for the equilibrium response of other entities in the market. The estimates show that the Hill-Burton program had large and lasting effects on hospital capacity. After 20 years, the long-run effect was a net increase of about 0.5 beds per 1,000 population. This represents a 20 percent increase over the pre-treatment average of 2.36 beds per 1,000 in counties that were funded. In an average sized funded county (population 65,900), these effects would translate to a net growth of about 20 beds after 5 years and about 30 beds after 20 years.

There is substantial heterogeneity in the average treatment effects across the terciles of county population, as shown in the 3 graphs in the left-hand panel of Figure 4 (full coefficients are reported in Online Appendix Table A5).[17] This is not surprising given the large differences in average funding amounts per capita, which are reported in Online Appendix Table A3. Among funded counties, the average subsidy amount over the life of the program was \$219 per capita in the first population tercile, \$140 in the second, and \$76 in the third (in \$2012).[18] In the first tercile the net effect on hospital beds was an increase of nearly one bed per 1,000 after 5 years and reached two beds per 1,000 after 20 years. In the second tercile the effect was smaller but still substantial: 0.6 beds after 5 years and 1.4 beds after 20 years. In the third tercile the effect was smaller but still (marginally) statistically significant, with a long-run effect of 0.4 beds per 1,000 after 20 years (though a wide confidence range). These differences in the funding amounts and treatment effects are in line with the goals of the program to increase hospital capacity in rural and other underserved areas.

Overall, these results indicate that the Hill-Burton program had a substantial net positive effect on U.S. hospital capacity.[19] Funding led to large and long lasting increases in the

[17]The right hand panel includes leads. It is discussed in Section 4.2.

[18]Regression models with the subsidy amounts are presented in Section 5.2. Including these amounts explains much of the heterogeneity seen across population terciles.

[19]The Medicare program was implemented during our sample period (in 1965), so it is

number of hospital beds. However, the program did crowd out private, for-profit hospitals. In other words, counties that received Hill-Burton funds saw large increases in non-profit and public capacity and in those same counties, for-profit hospitals decreased capacity, converted to non-profit status, or exited altogether. As a consequence, not only did the Hill-Burton program affect capacity in terms of the number of beds, it had a lasting and profound impact on the composition of the hospital industry. For-profit hospitals were a small portion of the hospital industry to begin with, and the Hill-Burton program further marginalized these hospitals by providing construction and expansion grants to their non-profit and public competitors. The newer non-profit and public health facilities may have drawn patients away from the smaller for-profit hospitals, thereby reducing demand for for-profit hospitals, which ultimately caused them to decrease their presence in these markets.

4.2 Assessment of Pre-Trends

Given the staggered implementation of the program, our panel regression model can be extended to include leads of the treatment indicator. This allows us to test for the presence of pre-trends in hospital capacity prior to receiving funding. However, because the nature of the Hill-Burton program required applicants to develop construction proposals in advance of applying for funding, we need to allow some time for an adjustment period before funding was approved. We consider there to be a 6-year adjustment period leading up to funding, following Lave and Lave's (1974) documentation that the pre-construction planning period averaged about 6.5 years during the Hill-Burton program. In order to test for differences prior to this adjustment period, we include up to 9-year leads of the treatment variable. The

possible our results could be contaminated by the Medicare implementation. To examine this, we restrict our sample to the period prior to the establishment of Medicare and estimate the same specification. The signs, magnitudes, and significance of the coefficients are essentially unchanged. Therefore it does not appear that our results are due to the implementation of Medicare. Column 1 in Online Appendix Table A6 lists these results.

regression specification is as follows:[20]

$$\text{Beds per 1,000}_{it} = \theta + \sum_{m=-9}^{m=20} \beta_m Treat_{i,t-m} + X_{it}'\delta + c_i + \lambda_t + \varepsilon_{it}.$$

The estimated treatment effects from these models, and their point-wise confidence bands, are plotted in the right-hand panel of Figure 3 (the full coefficients are reported in Online Appendix Table A7). Visually we can see there is little change to the overall patterns found in the regressions without treatment leads. The top graph in the right-hand panel in the figure plots the effect of receiving Hill-Burton funds on non-profit and public beds. The estimates are very close to zero and not statistically significant (individually) prior to the year a county was funded. To formally test for pre-trends we evaluate the joint significance of the leads prior to the adjustment period, i.e., in years 7, 8, and 9 before funding. We get an F-statistic of 0.23, with a p-value of 0.87. Thus, we find no evidence of a trend prior to treatment.[21] This suggests that those counties which did receive funding were neither more nor less likely to grow in the absence of funding. This should alleviate some of the concern that the treatment coefficients could be picking up growth or decline at non-profit or public hospitals that would have occurred without the program.

The middle graph in the right-hand panel plots the average changes in for-profit beds before and after a county received Hill-Burton funds. Here the effects between years 7 and 9 prior to funding are statistically different from zero (F-statistic=2.42, p-value=0.065),

[20]Again, there are separate regressions for total, non-profit and public, and for-profit beds.

[21]Estimates can also be interpreted in terms of placebo tests. Suppose we take the 5-year impact as an estimate of the treatment effect. The estimate is 0.356 (p=0.0293). Instead using 1, 2, or 3 years prior to the actual approval date as placebo tests, the artificial 5-year impact would correspond to the estimates for years 4, 3, or 2 post-treatment: 0.309 (p=0.0546), 0.205 (p=0.196), or 0.594 (p=0.706). Thus we see a declining estimate of the treatment effect with an increasing p-value in these placebo tests.

although the magnitudes are quite small (about -0.07 beds per 1,000).[22] The decline in for-profit beds becomes more pronounced two years before a county is first funded, and about half of the total, long-run decrease in for-profit capacity has already occurred by the time that funding is approved. This may suggest that for-profit hospitals were decreasing capacity relative to non-treated counties in response to Hill-Burton funds, even before a county actually received any funding. It is plausible that for-profit hospitals were anticipating the impacts of the program since funding information was publicly available at the start of the program.[23] It is also possible that these are small pre-existing trends. If that is the case, then our estimates will somewhat overstate the magnitude of the crowd-out effect on for-profit hospitals.

The bottom graph plots the results using total beds as the dependent variable. The pre-trend of 7, 8 and 9 years prior to funding are not statistically different from zero (F-stat=0.69, p-value=0.56). There is a downward trend in total beds closer to the year of treatment, which is driven by for-profit beds. The long-run net effect of the program is smaller here than in the regression without leads, and the treatment effects are no longer (individually) statistically significant (see Online Appendix Table A7). This is in contrast to the long-run effect on non-profit and public beds, which is quite similar in the specifications with and without leads.

To explore this difference, and to further examine the heterogeneity in treatment effects, we present estimates from regressions with leads that are estimated separately by population tercile. These appear in the right-hand panel of Figure 4 and Online Appendix Figure A5 (full coefficients are in Online Appendix Table A8). For the first and second terciles, the estimates of the net effect of the program are very similar between the specifications with

[22] If this indicates an endogeneity bias due to selection of counties that were losing for-profit beds, the bias is clearly small and would reduce our estimates of the program's impact.

[23] Prior work has found that for-profit hospitals respond rapidly to changes in their economic environment (Hansmann et al., 2003; Chakravarty et al., 2006).

and without leads. Only in the third tercile is there a notable difference when leads are included. This likely reflects a difficulty in obtaining precise estimates for the full span of leads and lags, as most large counties were treated relatively early in the program.[24]

4.3 Instrumental Variables Analysis

As discussed previously, the main empirical analysis assumes no selection on unobservables. In other words, we assume that there are no time-varying unobservable factors that relate to the exact timing of when counties received Hill-Burton funding. While we feel this is quite plausible based on the institutional details of the program, to mitigate concerns about the exogeneity of funding we also employ an instrumental variables strategy to see how our estimates may change. We have no instruments available that vary at the county level over time. Instead we use a cross-sectional instrument, the priority rankings in the State Plans, to estimate a treatment effect for counties funded during the first 3 years of the Hill-Burton program. This is the time when we might think that there would be the most non-random selection of counties to receive funding.

Because the instrument is cross-sectional, we examine a single 5-year difference in the number of beds. The regression model is as follows:

$$\Delta_{5yr}(\text{Beds per 1,000})_i = \pi_0 + \pi_1 Treat_{i,1948-50} + \Delta_{5yr} X_i' \delta + W_i' \theta + u_i \qquad (2)$$

(because there are no county fixed-effects, we include time invariant county characteristics, W_i: land area and rural status). We do not use longer differences (e.g., 10 years) because doing so would contaminate the control group as more counties would receive funding during the time over which we take the difference.[25] This contamination would bias the estimates of the program's effect downward. For the 5-year differences, we define counties to be treated

[24]The estimates for the third tercile are sensitive to the inclusion of a handful of very large counties that were treated relatively late in the program, so that they would be the most informative observations for the estimates of the longer leads.

[25]For example, to focus on just counties first funded in 1948, one could take the 10-year

if they were first funded in 1948, 1949, or 1950, and we take differences with the number of beds in these counties in 1953, 1954, or 1955, respectively. For counties without their own treatment ($Treat_{i,1948\text{-}50} = 0$), the 5-year difference is taken from 1949 to 1954. We choose to use the 5-year difference from 1949-1954 so that the controls would be in the middle of the range used for treated counties. Thus our estimate of the growth in beds in the control counties would only be contaminated by counties receiving funding in 1951 and 1952. We know from our prior estimates that, on average, it took roughly three years after a project was approved for counties to show additional non-profit or public beds. So we think the potential contamination bias from counties first funded in 1951 and 1952 is limited because it would require the new beds to appear within one or two years from the time of approval.

We use each county's initial priority ranking in the State Plans as the instrument. Counties received priority rankings of A through G, with A representing the highest priority for funding. We converted these ranking into numbers such that a prioirty rank of 1 coincided with a priority of A. Thus, a county with a better priority ranking (lower number) had a higher probability of obtaining funding, but it was by no means a guarantee. Of the 420 counties nationwide with a priority rank of 1, 121 were funded during 1948-1950, 113 were funded after 1950, and 186 were never funded. For those with a priority rank of 2, 88 were funded in 1948-1950, 122 after 1950, and 102 were never funded. For the remaining 867 counties with lower priority scores, 183 were funded during 1948-1950, 409 eventually, and 276 were never funded. Thus the probability of being funded in 1948-1950 was clearly higher for counties with ranks of 1 or 2.

The instrument appears well suited to address at least one hypothetical reason for violations of the exogeneity of the timing of treatment. If projects tended to be proposed for

---

difference in beds from 1948 to 1958. The "controls" for these counties would be all others that did not receive funding in 1948, and we would also take a 10-year difference for those counties. But it is possible that many of these counties would receive funding in the interim, say in 1953, and would also experience growth in beds from 1953 to 1958 due to the program.

Hill-Burton subsidies at a time when the relevant entities within a county were particularly well organized and resourced, these entities may have been prepared to add hospital capacity even without the program. This would bias the estimated treatment effects upward. The priority rankings did not take into account local organizational capabilities, so the instrument should be orthogonal to such factors.

We report the instrumental variable results in Table 2 (full results with parameter estimates for all the county controls are in Appendix Table A9). Column (1) shows the first-stage estimates (a linear probability model for being funded in 1948-50). As can be seen, the priority ranking had a strong and highly significant impact on the probability a county received Hill-Burton funding early in the program. The F-statistic on the instrument equals 50.60 (p-value <0.001). Column (2) contains the instrumental variable estimate of the effect of receiving Hill-Burton funding on the 5-year change in the total hospital beds per capita in a county. The effect is large and precisely estimated at about 1.5 beds per 1,000. The effect on non-profit and public beds in column (3) is similar in magnitude and precision, while the effect on for-profit beds in column (4) is essentially zero and imprecisely estimated. Column (5) presents the OLS estimate of the same 5-year effect on total beds for comparison. It is much smaller at 0.5 beds per 1,000, which indicates that counties induced into treatment by their priority ranking had substantially larger (local average) treatment effects than the average effect during this time period. The fact that the local average treatment effects estimated with this approach are larger than the corresponding estimates from our regression models provides further evidence that our main estimates do not overstate the program's effect.

5 Spillovers and Cost per Bed

5.1 Spillovers from Neighboring Counties

A potential concern for assessing the effects of the program is spillovers across counties, whereby one county would be less likely to add hospital capacity if a neighboring county received Hill-Burton subsidies. Such spillovers, if present, would bias our estimates of the treatment effect by contaminating the untreated counties.

To assess this issue, we estimate regressions that include indicators for whether a neighboring county was treated. However, there is little variation after the initial years of our data because over half of the counties in the sample have a neighbor treated by 1949. Accordingly, rather than using panel models, we estimate the effect of being treated ($Treat_i$) or having a neighbor treated ($Treat_j$) in 1948-50 on the growth in beds over a single 5-year period (like the IV analysis discussed previously). These regressions take the following form:

$$\Delta_{5yr}(\text{Beds per 1,000})_i = \pi_0 + \pi_1 Treat_{i,1948-50} + \pi_2 Treat_{j,1948-50} + \Delta_{5yr} X_{it}' \delta + W_i' \theta + u_i. \quad (3)$$

The dependent variable is the 5-year difference in the total number of beds per 1,000 in a county.[26] The control variables (X_{it}) are the same as before; also, because there are no county fixed-effects, we include two time-invariant regressors (W_i): county land area and rural status. The reference county (i) is defined to be treated ($Treat_{i,\text{1948-50}} = 1$) if it was first funded in 1948, 1949, or 1950, and the 5-year difference in beds per 1,000 is taken to 1953, 1954, or 1955, accordingly. The indicator for treatment in an adjacent county similarly reflects whether any neighbor was first funded in 1948 to 1950. Similar to the IV analysis, for counties without their own treatment ($Treat_{i,\text{1948-50}} = 0$), the 5-year difference is taken from 1949 to 1954.

The results from these regressions, estimated nationwide and within each population tercile, are presented in Table 3 (full results with parameter estimates for all the county controls are in Appendix Table A10). In each of these samples there is almost no change in the estimated treatment effects when the indicator for treatment in an adjacent county

[26]We do not use longer differences (e.g., 10 years) because doing so would contaminate the control group as more counties would receive funding during the time over which we take the difference. This would bias the estimates of the program's effect downward. See the description of the IV analysis for further discussion on this point.

is added. There appear to be modest positive spillovers from adjacent counties in the top tercile, although these results may be driven by a small number of counties with very large populations. For counties in the first and second terciles, the estimated spillovers are statistically insignificant and negligible relative to the actual treatment effects. Thus, it appears that any cross-county geographic spillovers were minimal.

5.2 Subsidy Amounts and Cost per Bed

We next assess the federal cost per bed from the program, which provides some insight into the extent of crowd-out as well as a basic measure of cost effectiveness. Specifically we use information on the federal subsidy amount for each project from the Project Register. We define the (equilibrium) cost per bed as the average federal expenditure per bed that was generated, net of the crowd-out effect. In addition, the subsidy amounts provide information on the intensity of treatment, which can help to explain the heterogeneity in treatment effects seen across population terciles.

The federal subsidy amounts for each project can be included in our panel regressions by adding a variable $FundPC_{it}$ as the per capita dollar amount of Hill-Burton subsidies approved for projects in county i in year t (in \$2012). We also include a simple indicator $Apprv_{it}$ for the approval of one or more projects in county i in year t. The panel regression model is then as follows:

$$\text{Beds per 1,000}_{it} = \theta + \sum_{m=0}^{20} \alpha_m FundPC_{i,t-m} + \sum_{m=0}^{20} \beta_m Apprv_{i,t-m} + X_{it}'\delta + c_i + \lambda_t + \varepsilon_{it} \quad (4)$$

The funding coefficients ($\alpha_m, m = 0, \ldots, 20$) give the gain in beds per 1,000 population from an additional dollar per person in funding (or equivalently, an additional \$1,000 per 1,000 population) that was approved m years ago. The approval dummies $Apprv_{it}$ are included to distinguish between the effect of any funding being approved and the effect of the amount of funding.

The estimates of α_m for a subset of lag lengths are reported in Table 4, and the full coefficients from this model appear in Online Appendix Table A11. For example, five years after funding was approved the effect is 0.0032 per dollar. This is the increase in the number of hospital beds per 1,000 population, net of any crowd-out effects, for every $1 per person of Hill-Burton funding. These effects on capacity continue to rise throughout the follow-up period. Twenty years after funding was approved, every $1 per capita of Hill-Burton funding resulted in a net increase of over 0.0063 beds per 1,000 population.

Using the latter number as our estimate of the long-run effect, we can say that there would be an additional 1 bed per 1,000 population for every additional $160 per person (= $1/0.0063) of Hill-Burton funding. Multiplying out the per capita units on both sides, this indicates that about $160,000 in Hill-Burton funds were spent per bed added, on net, as a result of the program. On the other hand, data from the Hill-Burton Project Register indicate that the average subsidy amount per bed planned in these projects was $55,000 (in $2012). Thus the actual federal expenditure per *net* additional bed ($160,000) was three times larger than the direct subsidy amount per bed ($55,000), which suggests that approximately two-thirds of the funding effort was offset.

Additionally, this specification shows that the subsidy amounts can account for a large portion of the heterogeneity in average treatment effects across population terciles. For example, in our base specification the average treatment effects 15 years post-approval (β_{15}) by tercile are 1.71, 1.10, and 0.40 beds per 1,000 in terciles 1, 2, and 3 respectively (from Online Appendix Table A5). If we multiply the average per capita subsidy amounts for each tercile (from Online Appendix Table A3) by the funding coefficient for 15 years post-approval in the present specification (α_{15}) and add the treatment dummies, this gives us average effects of 1.41, 0.70, and 0.21 beds per 1,000 in terciles 1, 2, and 3.[27] The average treatment effects using the funding amounts are close to the treatment effects estimated from the base specification, indicating a large part of the difference between small and large counties' effects can be accounted for by differences in the per capita subsidy amounts.

[27]Calculations for the average treatment effects are: Tercile 1: $(0.00256 \times 219.36 + 0.855) = 1.41$; Tercile 2: $(0.00238 \times 140.25) + 0.366 = 0.70$ Tercile 3: $(0.00284 \times 75.7) + 0.0497 = 0.21$.

6 Effects on Utilization

The goal of the Hill-Burton program was to address perceived shortage and access problems in health care, particularly in poor, rural counties. The mechanism was to fund increased capacity. As we have demonstrated, the program was quite successful in terms of increasing the number of hospital beds. The logical next question is whether there was an increase in utilization commensurate with this increase in capacity.

We estimate the program's effects on utilization using the same specification as before, model (1), but now with hospital admissions per 1,000 as the dependent variable. The results are shown in Figure 5, which plots the estimated treatment effects over time (i.e., $\beta_m, m = 0, \ldots, 20$). The full coefficients are reported in Online Appendix Table A12. The increases in utilization follow the increases in capacity very closely (see Figure 3 for comparison). Five years after the first Hill-Burton funding was approved for a county, admissions at non-profit and public hospitals increased by 13 per 1,000. This was offset by an average decrease in admissions at for-profit hospitals of 3.7 per 1,000. The long-run net effect of the program was an average increase of about 15 total admissions per 1,000. This is an 18 percent increase over the pre-treatment average of 82 admissions per 1,000 in counties that were funded, which is similar to the net proportional increase in bed supply. In an average sized funded county (population 65,900), the long-run effect translates to a net addition of almost 1,000 hospital admissions annually after 20 years.[28]

As with the increases in hospital capacity, there is also substantial heterogeneity across population terciles in the effect on admissions. Figure 6 shows these estimates (full coefficients are listed in Online Appendix Table A13). In the smallest tercile the average long-run effect is over 50 admissions per 1,000, and in the middle tercile the long-run effect is also quite large and exceeds 40 admissions per 1,000.

[28]Column 2 in Online Appendix Table A6 lists estimates for the effect on admissions, limiting the sample to the period before Medicare. Like the capacity analysis, our results are robust to this sample restriction.

This large expansion in utilization suggests that there was unmet excess (or latent) demand for hospital services in many locations prior to the implementation of the Hill-Burton program. One possible explanation for the lack of a supply response on the part of the industry is the presence of capital constraints. At present U.S. hospitals are large businesses and capital is overwhelmingly obtained through markets (debt for non-profits and equity for for-profits). However, during the period of the Hill-Burton program, that was not the case. Hospitals were heavily dependent on private philanthropic contributions. Stevens (1999) (p. 33), for example, states that

> "Capital came almost entirely from private gifts, endowments, and donations until after World War II, and predominantly from these sources until the 1970s."

Stevens (1999) Table 11.2 documents that non-profit hospitals financed 40.7 percent of construction costs from private contributions in 1965, versus 24.2 percent by borrowing. Another source in Stevens (Table 11.3) shows that in 1968, 21 percent of funding for all hospitals' (not just non-profits) construction costs came from philanthropy and 38 percent from debt. While these data are not definitive, they suggest that capital markets for hospitals were not well developed at the time of the Hill-Burton program, and so hospitals may have faced significant capital constraints.

In addition, the analysis of utilization provides a further opportunity to check for spillovers across counties. It is certainly possible that additional hospital capacity in one county might have drawn patients from neighboring counties. This would bias our estimates of the program's effects on utilization, as control counties that are adjacent to a treated county would see a decrease in admissions at their hospitals. To assess this, we estimate regressions similar to (3), but now with the 5-year change in admissions per 1,000 as the dependent variable. The results, in Online Appendix Table A14, show no significant effects on admissions if a neighboring county was funded (although marginally significant in Tercile 2), and no changes in the estimated treatment effects.

7 Aggregate and Long-Run Impacts of Hill-Burton

To conclude the analysis, here we offer some assessments of the aggregate and long-run impacts of the Hill-Burton program. First we use the most flexible version of our panel regressions (those with both treatment indicators and subsidy amounts) to project the program's contribution to the growth in hospital bed supply nationwide during the life of the program. Then we provide two descriptive analyses that, while they do not follow our main empirical approach, may offer valuable additional insights. The first estimates the association between total funding amounts and hospital capacity many years after the program ended. The second shows the substantial decline in the variation in bed supply based on county income and location, which occurred concurrently with the program. To be clear, we regard these analyses as descriptive in nature, but they are useful to portray the broad scope of the possible impacts of the Hill-Burton program.

First, we use our panel models that include the subsidy amounts to compute the aggregate impact of the Hill-Burton program. The results are shown in Table 5, which uses specification (4) estimated both nationally and by population tercile (coefficient estimates in Online Appendix Table A15). The estimated models generate baseline predictions for the number of beds per 1,000 in each county, which we then aggregate by multiplying out the county population and adding across counties. The baseline predictions are fairly close to the observed numbers of hospital beds both nationwide and in each tercile in 1948 and 1975.[29] Then we make counterfactual predictions for 1975 using the estimated models but setting the funding amounts ($FundPC_{it}$) and approval dummies ($Apprv_{it}$) to zero. This projects the counterfactual number of beds per 1,000 in each county in 1975 without the Hill-Burton

[29]The aggregated predictions do not exactly match the observed amounts due to restrictions in the regression specifications such as the fact that county fixed effects cannot vary over time. Were we to use the observed values instead (i.e., taking the weighted sum of the actual number of beds per 1,000 in each county, weighted by county population), the baseline predictions would of course match the observed amounts exactly.

program. The difference between the aggregate number of beds in the counterfactual vs. the baseline prediction for 1975 is our measure of the program's total impact. We prefer the results using regressions estimated separately by tercile as this is the most flexible specification which allows for further heterogeneity in the treatment effects. These results are shown in column (5). The overall impact attributed to the program from this approach is nearly 73,000 beds (858,532 – 785,643), which represents 17 percent of the total growth from 1948 to 1975 in the baseline predictions (858,532 – 427,711).

Next, to provide descriptive evidence on the program's effects long after it ended, we estimate cross-sectional regressions for the association between total Hill-Burton subsidies and the number of beds per capita by ownership type in 1990. These regressions are at the county level and include our usual control variables as well as state fixed effects.[30] Table 6 reports the results of these regressions, which include separate estimates for 1975 as a reference point. The association between total Hill-Burton subsidies per capita over the life of the program and the number of beds per 1,000 in a county in 1975 is 0.005. This means that an additional $100 of funding per capita is associated with an additional 0.5 beds per 1,000. The association drops only modestly by 1990, to 0.004. Multiplying this with the average funding amount of $130 would account for a difference of 0.55 beds per 1,000. This is a substantial amount, and it suggests the large effects of the program on hospital capacity may have continued decades after the program ended.

Finally we provide some information on distributional changes that occurred during the time of the program. The Hill-Burton program was intended to address perceived shortages of hospital capacity in areas that were predominately poor and rural. One would therefore expect it to have an impact on the distribution of bed supply based on these factors. Table 7 shows the changes from 1948 to 1975 in the distribution of hospital beds per 1,000 conditional on median family income, location, and rural status. Over the life of the Hill-Burton program, areas with relatively low bed supply largely caught up with areas that initially had more

[30]Regressions without state fixed effects yield similar results.

capacity. Counties with median family income in the bottom quintile saw an increase of 2.3 beds per 1,000 while the growth in the top quintile was only 0.5 beds. The South added 1.8 beds per 1,000 while the Northeast added only 0.7 beds. Rural counties had an increase of 2.4 beds per 1,000 while non-rural counties actually saw a decrease of 0.25 beds over this time period. Overall the standard deviation of beds per 1,000 across counties decreased from 5.9 in 1948 to 2.5 in 1975. While this does not prove that the Hill-Burton program caused these changes, it is clear that substantial progress was made toward the goals of expanding hospital capacity in underserved areas and equalizing access to hospitals throughout the U.S.

8 Summary and Conclusions

Our analysis of the Hill-Burton program on hospital capacity provides evidence on the impact of this program on the evolution of the U.S. hospital industry and feeds into the larger debate about how government spending may crowd out private activity. Billions of governmental dollars were poured into the hospital sector during the time-period we study. This program had a profound and lasting impact on the U.S. hospital industry. Our capacity estimates show a large growth in non-profit and public beds per capita in response to the program.

We find long-lasting impacts of the Hill-Burton program on the hospital industry, with the gains in beds lasting over 20 years. This has implications for how the hospital market structure changed over this time period to evolve into what it is today. Large gains in capacity or the entry and exit of hospitals affects the quantity and quality of hospital services provided as well as pricing behavior of hospitals. Our results reveal that the Hill-Burton program was particularly pivotal in shaping the market structure of the hospital industry by introducing large gains in the supply of beds over a 25-year period, as well as subsidizing the growth of non-profit and public hospitals, while crowding out growth by for-profits.

The Hill-Burton program resulted in a large expansion in hospital utilization, suggesting that there was excess or latent demand for hospital services in many locations prior to the implementation of the program. Finally, over the life of the program areas with relatively low numbers of beds per capita (areas with low income, rural areas, and the South) largely caught up with areas that had greater hospital capacity.

We note that our research has limitations. In particular, while we have tried to identify causal effects and rule out possibilities of other factors driving the results, there is always the possibility that some of what we've identified as being due to the Hill-Burton program was in fact driven by other causes. Furthermore, our empirical framework does not allow us to address how counterfactual policies would have affected the industry. In addition, although we've examined the effect of the program on hospital market structure, capacity, and utilization, we have not examined impacts on health. A key question is whether the Hill-Burton program was "worth it," and information on health impacts is needed to address this question. This is an important topic for future research.

References

Jean Marie Abraham, Martin Gaynor, and William Vogt. Entry and competition in local hospital markets. *Journal of Industrial Economics*, 55:265–288, 2007.

Area Resource File. US Department of Health and Human Services, Health Resources and Services Administration, Bureau of Health Workforce, Rockville, MD, 1983.

Paul Brinker and Burley Walker. The Hill-Burton Act: 1948-1954. *The Review of Economics and Statistics*, 44:208–212, 1962.

Barry Chiswick. Hospital utilization: An analysis of SMSA differences in occupancy rates, admission rates, and bed rates. *NBER Chapters in Explorations in Economic Research*, 3:24–76, 1976.

Andrea Chung, Martin Gaynor, and Seth Richards-Shubik. Subsidies and structure: The lasting impact of the Hill-Burton program on the hospital industry. Working Paper No. 22037, National Bureau of Economic Research, 2016.

Lawrence Clark, Marilyn Field, Theodore Koontz, and Virginia Koontz. The impact of

Hill-Burton: An analysis of hospital bed and physician distribution in the United States, 1950-1970. *Medical Care*, 18:532–550, 1980.

Guy David. Trends in hospital ownership type and capacity: A decomposition analysis. *Nonprofit and Voluntary Sector Quarterly*, 39:356–370, 2010.

Dan Feshbach. What's inside the black box: A case study of allocative politics in the Hill-Burton program. *International Journal of Health Services*, 9:313–339, 1979.

Amy Finkelstein. The aggregate effects of health insurance: Evidence from the introduction of Medicare. *Quarterly Journal of Economics*, 122:1–37, 2007.

Gautam Gowrisankaran and Robert Town. Dynamic equilibrium in the hospital industry. *Journal of Economics and Management Strategy*, 6:45–74, 1997.

Micah Hartman, Anne B. Martin, David Lassman, Aaron Catlin, and the National Health Expenditure Accounts Team. National health spending in 2013: Growth slows, remains in step with the overall economy. *Health Affairs*, 34(1):150–160, 2015.

Judith Lave and Lester Lave. *The Hospital Construction Act: An evaluation of the Hill-Burton program, 1948-1973*. American Enterprise Institute for Public Policy Research, 1974.

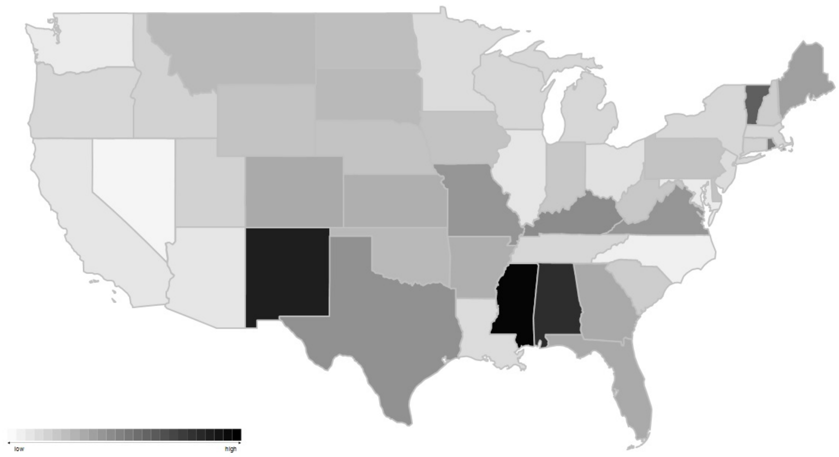
Gary Solon, Steven Haider, and Jeffrey Wooldridge. What are we weighting for? *The Journal of Human Resources*, 50:301–316, 2015.

Paul Starr. *The Social Transformation of American Medicine*. Basic Books, 1982.

Rosemary Stevens. *In Sickness and in Wealth: American Hospitals in the Twentieth Century*. Johns Hopkins University Press, 1999.

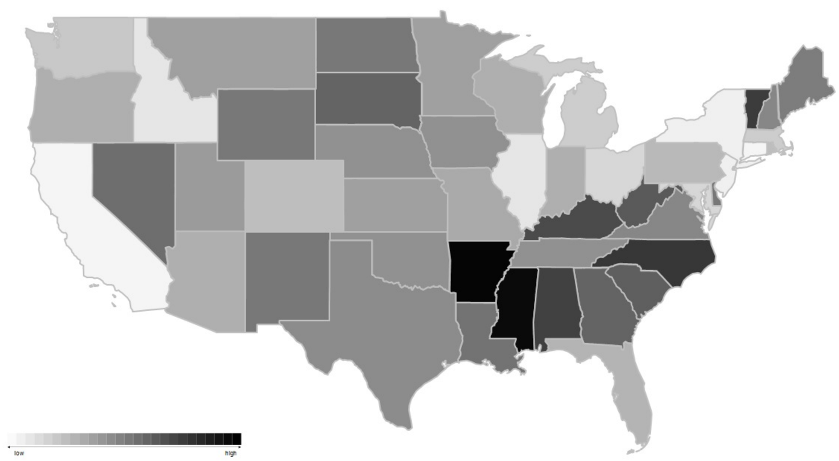
U.S. Department of Health, Education and Welfare, U.S. Public Health Service. Hill-Burton Project Register, July 1, 1947 - June 30, 1971. *Office of Program Planning and Analysis*, 1971.

Figure 1: State-Level Hill-Burton Funding Per Capita



Funding in 1948. Range is from $0 per capita in NV to $32.2 in MS (in 2012 $)

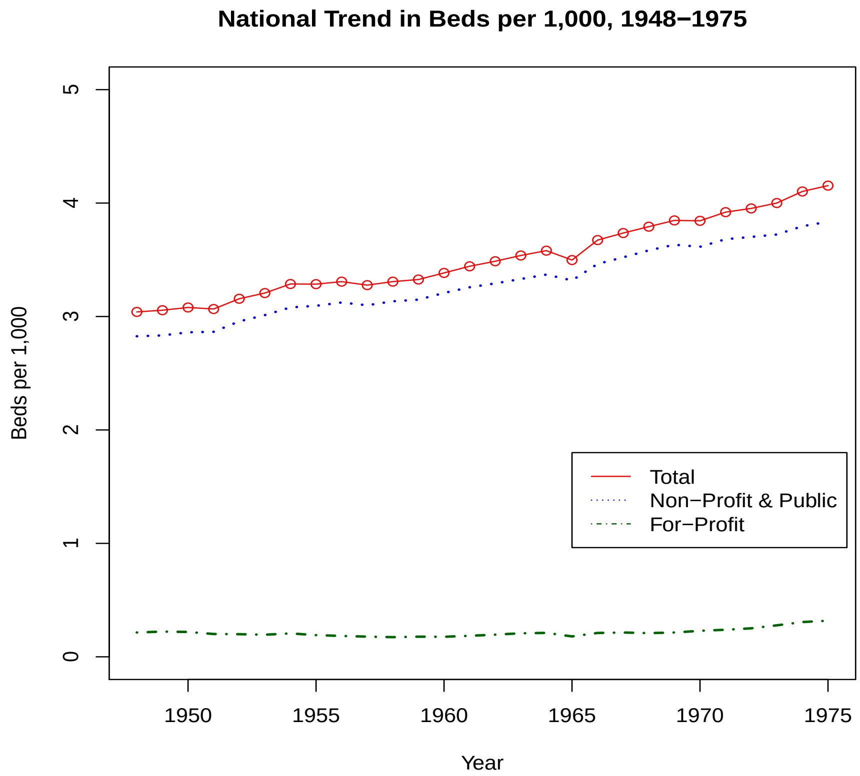
Source: Hill-Burton Project Register



Funding 1947-1971. Range is from $57.3 in CA to $236.6 per capita in AR (in 2012 $)

Source: Hill-Burton Project Register

Figure 2: National Trend in Beds and Admissions Per Capita (PC), 1948-1975



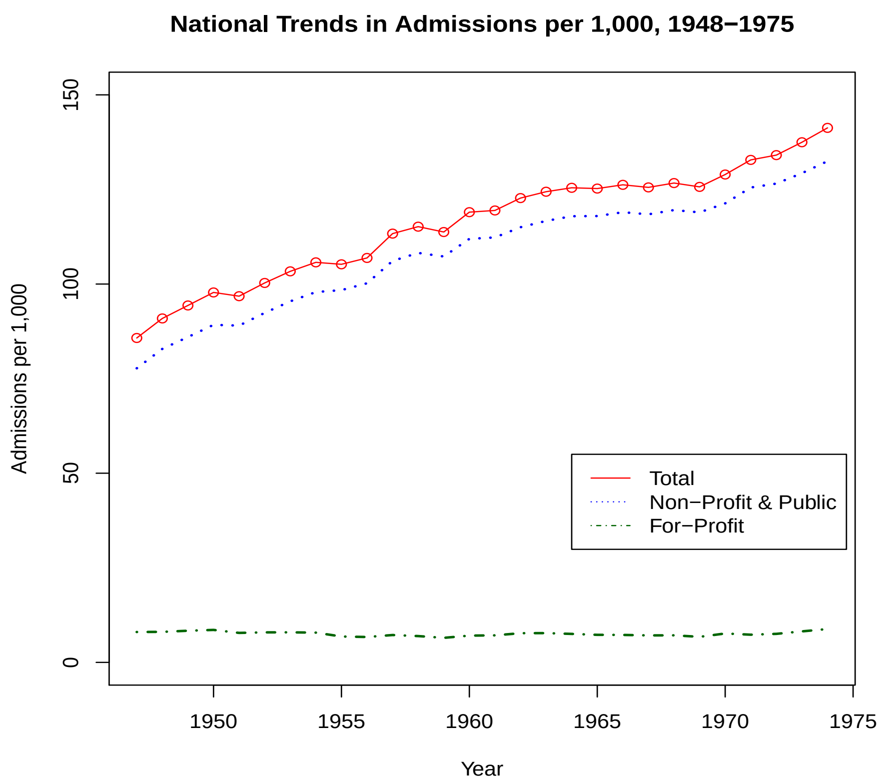


Figure 3: Effect of Hill-Burton Program on Hospital Beds per 1,000 without and with Leads

Figure plots estimates of treatment effects ($\hat{\beta}_m$) and 95% confidence intervals from equation (1)

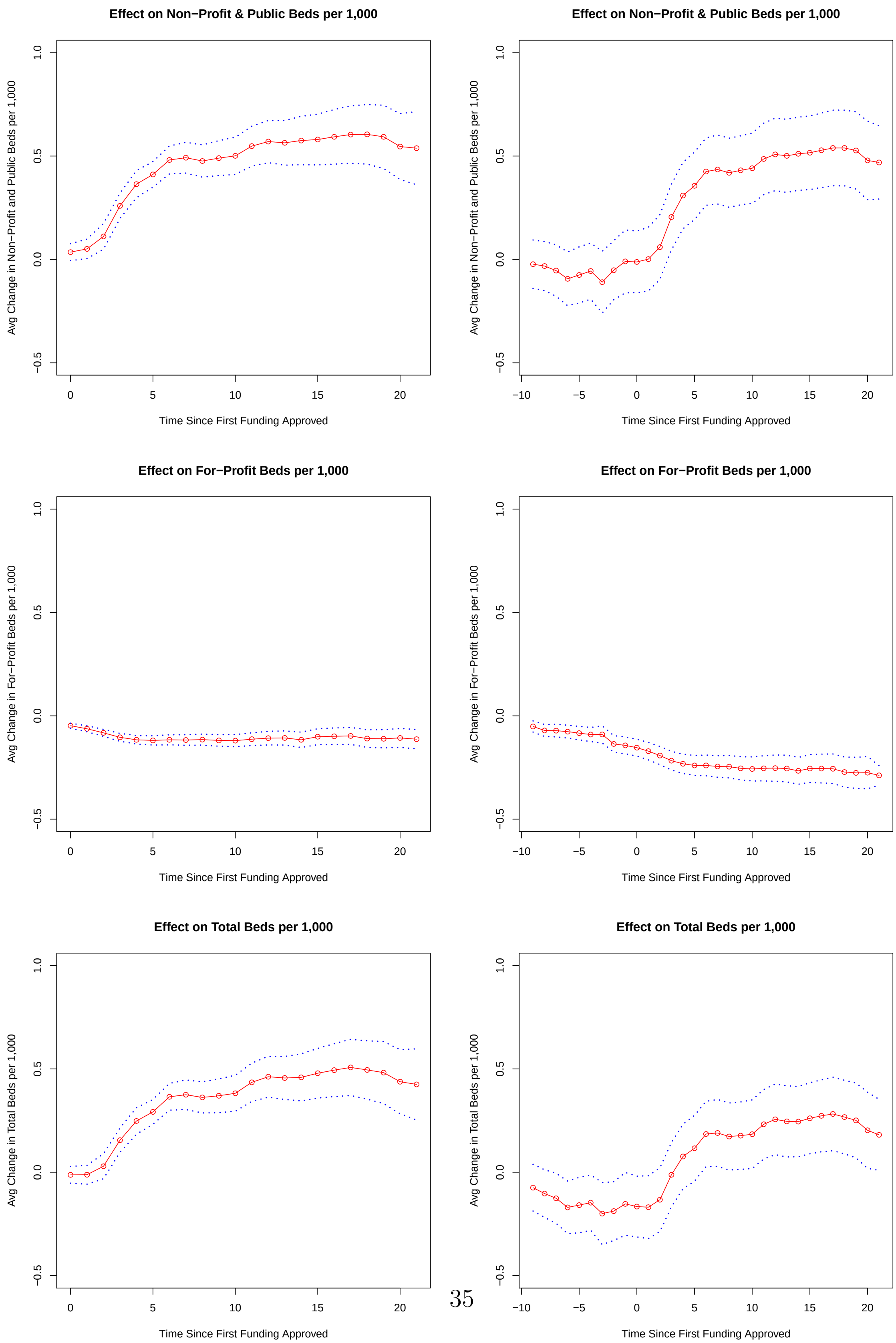


Figure 4: Effect on Hospital Beds per 1,000 by Population Tercile without and with Leads

Figure plots $\hat{\beta}_m$ *and 95% confidence intervals from equation* (1) *estimated separately by tercile.*

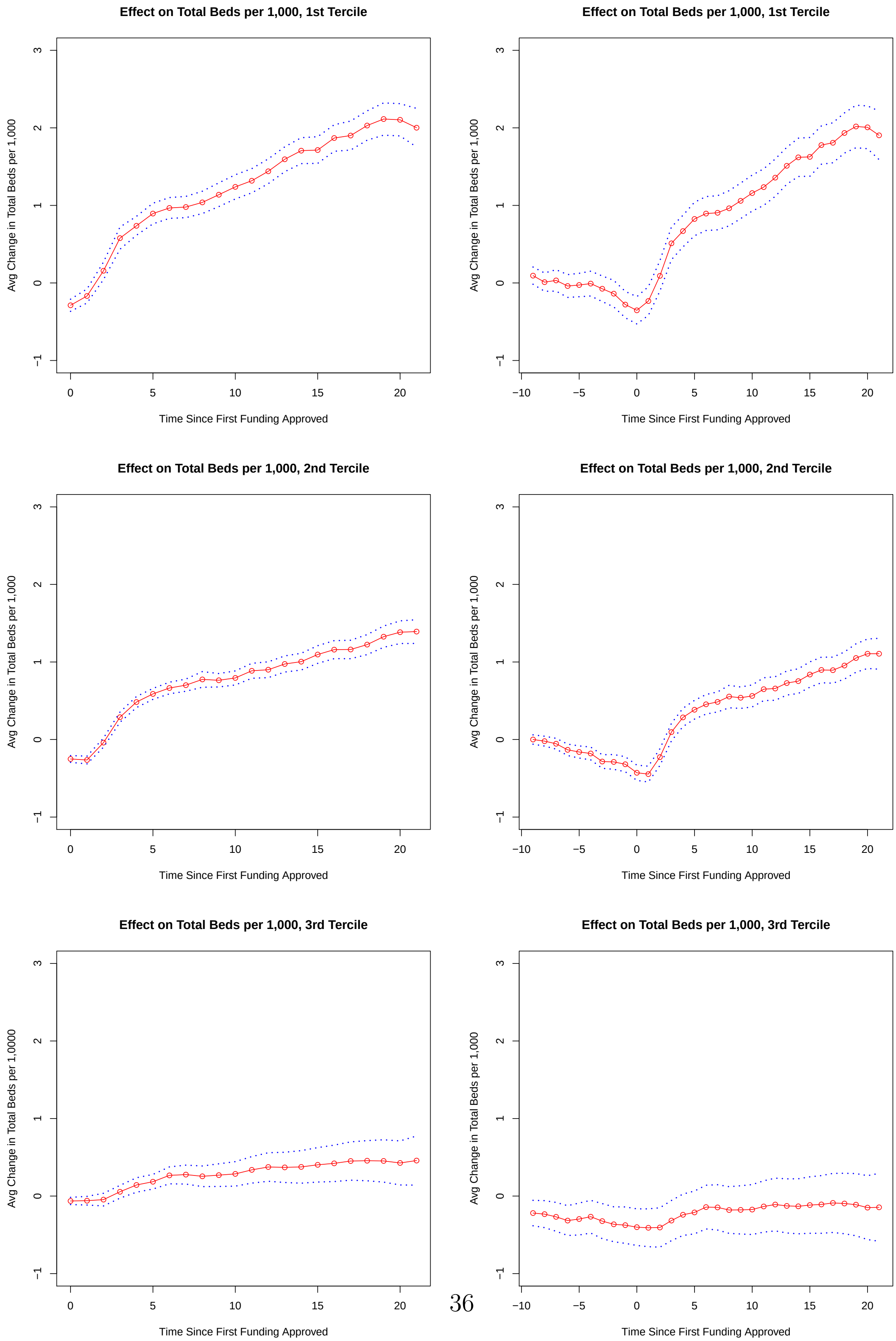


Figure 5: Effect of Hill-Burton Program on Hospital Admissions per 1,000

Figure plots estimates of treatment effects ($\hat{\beta}_m$) and 95% confidence intervals from equation (1), with hospital admissions per 1,000 as the dependent variable.

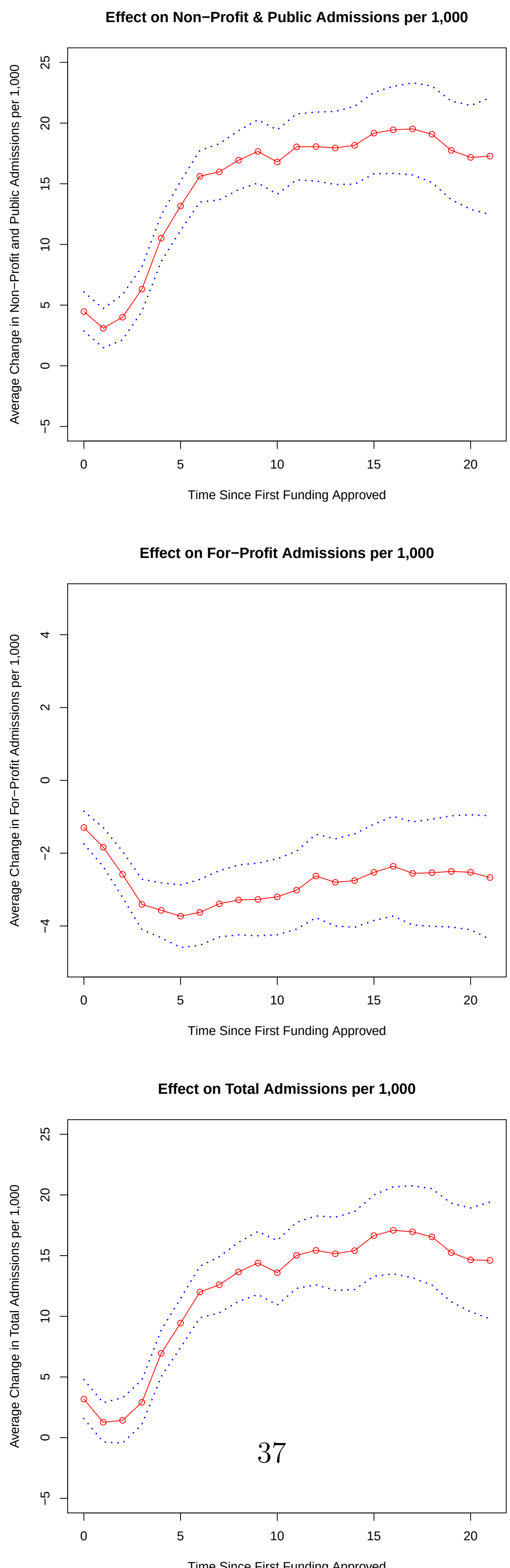


Figure 6: Effect on Hospital Admissions per 1,000 by Population Tercile

Figure plots $\hat{\beta}_m$ and 95% confidence intervals from equation (1), with hospital admissions per 1,000 as the dependent variable, estimated separately by tercile.

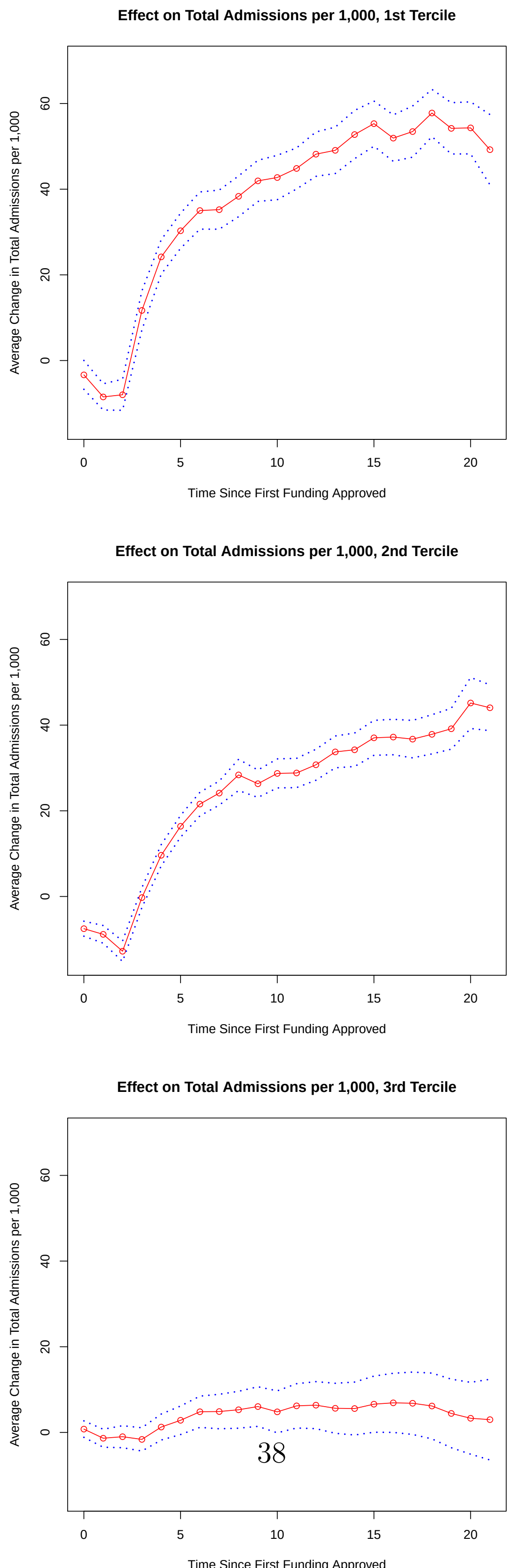


Table 1: Summary of County Level Data

	All Observations (N=2,967)		Received Funding* (N=2,106)		Never Funded* (N=862)	
Variable (Source)	Mean	Median	Mean	Median	Mean	Median
Hospitals (AHA)						
Non-Profit / Public	1.28	1.0	1.50	1.0	0.39	0
For-Profit	0.33	0	0.34	0	0.26	0
Total	1.60	1.0	1.84	1.0	0.64	0
Beds per 1,000 pop. (AHA)						
Non-Profit / Public	2.30	1.70	2.09	1.76	1.86	0
For-Profit	0.33	0	0.27	0	0.39	0
Total	2.63	2.15	2.36	2.06	2.25	0
Admits. per 1,000 pop. (AHA)						
Non-Profit / Public	72.13	56.13	72.51	67.00	52.37	0.14
For-Profit	11.99	0.08	9.37	0.06	14.92	0.13
Total	84.06	74.28	81.83	76.13	67.17	0.24
County Characteristics (ARF)						
Population	51,940	18,570	65,889	24,282	14,516	9,970
Median Family Income	$24,352	$24,720	$28,248	$26,931	$21,493	$21,381
% Population Over 65	9.7%	9.3%	9.6%	9.3%	10.6%	9.5%
% Population Under 5	11.7%	11.3%	11.0%	11.0%	12.5%	11.3%
% Non-White	10.9%	2.1%	10.8%	2.9%	11.7%	1.0%
Non-Fed. MDs per 1,000	0.7	0.6	0.7	0.6	0.6	0.5
HB Funding (HBPR)						
Total Funding	- - -	- - -	$3.46M	$2.38M	- - -	- - -
Total Funding per Capita	- - -	- - -	$129.98	$102.41	- - -	- - -

* For counties that received Hill-Burton funding, means and medians are reported for the year they first received funding. The median year that these counties first received funding was 1953. For all counties that were never funded, means and medians are reported for 1953 to match the median year among the funded counties.

Table 2: Instrumental Variable Estimates of Effect on Hospital Capacity

Dependent variables: single difference from 1948-50 to 1953-55

in beds by ownership type per 1,000 population.

	(first stage)	(second stage)			(OLS)
Explanatory	Treated 1948-50	Total Beds	N-P / Pub. Beds	For-Prof. Beds	Total Beds
Variable	(1)	(2)	(3)	(4)	(5)
Priority Level	-0.0642***				
	(0.00902)				
Treated 1948-50		1.491***	1.500***	-0.00410	0.514***
		(0.336)	(0.327)	(0.129)	(0.0573)
County Controls?	yes	yes	yes	yes	yes
First-stage F-stat	50.60				
Observations	1,410	1,410	1,410	1,410	1,423
R-squared	0.240	0.035	0.034	0.011	0.201

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 3: Effect of Hill-Burton Projects in Own vs. Adjacent Counties on Hospital Beds

Dependent variable: single difference from 1948-50 to 1953-55 in hospital beds per 1,000 population.

Explanatory Variable	Nationwide (1)	Nationwide (2)	Tercile 1 (3)	Tercile 1 (4)	Tercile 2 (5)	Tercile 2 (6)	Tercile 3 (7)	Tercile 3 (8)
HB Funded	0.466***	0.467***	1.490***	1.494***	0.802***	0.805***	0.405***	0.401***
	(0.0408)	(0.0410)	(0.147)	(0.147)	(0.0965)	(0.0962)	(0.0604)	(0.0608)
Adj County HB Funded	0.229***		0.138		0.0418		0.273***	
	(0.0473)		(0.115)		(0.101)		(0.0725)	
County Controls?	yes	yes	yes	yes	yes			
Observations	2,703	2,703	826	826	894	894	976	976
R-squared	0.165	0.157	0.183	0.181	0.117	0.116	0.181	0.169

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Effect of Amount of Funding on Hospital Beds per 1,000

Dependent variable: total hospital beds per 1,000 population.

Time Relative to Year of Funding	Total Beds
Year of HB Funding	-0.000601*
	(0.000312)
1 Years Later	-0.000603*
	(0.000343)
2 Years Later	0.000241
	(0.000396)
3 Years Later	0.00147***
	(0.000394)
4 Years Later	0.00260***
	(0.00044)
5 Years Later	0.00323***
	(0.000445)
6 Years Later	0.00349***
	(0.000472)
⋮	⋮
21+ Years Later	0.00630***
	(0.00085)
Observations	83,002
R-squared	0.956

Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Aggregate Effect of Hill-Burton Program on Hospital Capacity

Variable	**National**	**Tercile 1**	**Tercile 2**	**Tercile 3**	**T1+T2+T3**
	(1)	(2)	(3)	(4)	(5)
From regressions with funding amounts:					
Baseline Predicted Total Beds in 1948	427,712	13,827	33,183	380,701	427,711
Baseline Predicted Total Beds in 1975	859,267	36,733	81,434	740,365	858,532
Counterfactual Predicted Total Beds in 1975 (w/out Hill-Burton)	819,942	28,785	63,335	693,523	785,643
Observed quantities:					
Total Beds in 1948	435,220	16,218	35,247	383,754	435,219
Total Beds in 1975	871,019	40,264	85,249	744,766	870,279
N	2968	989	989	989	

Table 6: Long-Run Effects of Hill-Burton Funding on Hospital Capacity

Dependent variables: beds by ownership type per 1,000 population.

Explanatory Variable	Total, 1975 (1)	Total, 1995 (2)	N-P / Pub., 1975 (3)	N-P / Pub., 1990 (4)	For-Prof., 1970 (5)	For-Prof., 1990 (6)
H-B $ per capita	0.504***	0.424***	0.593***	0.446***	-0.0894***	-0.0228*
(1948-75)	(0.041)	(0.030)	(0.040)	(0.030)	(0.012)	(0.0128)
Population	0.000656	0.00777***	-0.00879***	0.000429	0.00944***	0.00734***
	(0.00343)	(0.00215)	(0.00340)	(0.00215)	(0.00099)	(0.000907)
Med. Fam. Inc.	6.37E-07	-1.73e-05***	-4.45E-06	-2.03e-05***	5.08e-06***	3.03e-06**
	(4.99E-06)	(2.95E-06)	(4.95E-06)	(2.96E-06)	(1.43E-06)	(1.25e-06)
Prop. Pop. 65+	14.07***	15.38***	13.28***	13.58***	0.787	1.799***
	(1.905)	(1.288)	(1.887)	(1.289)	(0.546)	(0.543)
Prop. Pop. <5	22.49***	35.46***	23.15***	31.25***	-0.66	4.209**
	(6.035)	(5.019)	(5.980)	(5.023)	(1.731)	(2.118)
MDs per 1,000	0.959***	0.696***	0.938***	0.653***	0.0206*	0.0425***
	(0.0430)	(0.0249)	(0.0426)	(0.0250)	(0.0123)	(0.0105)
Prop. NonWhite	-0.275	-1.361***	0.329	-1.075***	-0.604***	-0.286**
	(0.483)	(0.308)	(0.478)	(0.308)	(0.138)	(0.130)

State FEs	yes	yes	yes	yes	yes	yes
Observations	2,968	2,964	2,968	2,964	2,968	2,964
R-squared	0.331	0.428	0.353	0.429	0.323	0.317

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Distribution of Beds per 1,000 by County Income, Census Region, and Rural Status

	Means in 1948*	**Means in 1975***	**Change, 1948 to 1975**
Median Family Income			
Quintile 1	0.839	3.136	2.297
Quintile 2	1.725	3.699	1.974
Quintile 3	2.413	3.757	1.344
Quintile 4	3.269	4.950	1.681
Quintile 5	3.491	4.060	0.569
Diff: High – Low Quintile	2.652	1.814	-
Census Region			
Midwest	3.347	4.601	1.254
Northeast	2.890	3.617	0.727
South	2.508	4.323	1.815
West	3.585	3.692	0.107
Diff: Northeast – South	0.351	-0.706	-
Rural/Nonrural			
Nonrural	3.853	4.466	0.613
Rural	2.148	3.682	1.534

Diff Nonrural-Rural	1.705	0.784	-

	StdDev in 1948	**StdDev in 1975**	**Change, 1948 to 1975**
Beds per 1,000	3.000	2.308	-0.692

All calculations are weighted by county population.