Estimating Needed Capacity of Nursing Home and Hospital Beds:

Is the Eugene-Springfield MSA at Capacity?

By
Megan Stratman
and
Matthew Spellman

Presented to the Department of Economics, University of Oregon, in partial fulfillment of requirements for honors in Economics.

under the supervision of
Professor Bruce Blonigen

June 2006

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Abstract: We analyzed the impact of demographic, socioeconomic and Certificate of Need (CON) regulation variables on the supply of nursing home and hospital beds across the nation and specifically in the Eugene-Springfield area. Our results indicate that CON regulation restrict the supply of nursing home beds and do not adversely affect the supply of hospital beds. We found that Eugene-Springfield currently has an insufficient supply of nursing home and hospital beds.

Keywords: Certificate of Need; nursing home beds; hospitals beds

Approved: ____

Professor Bruce Blonigen Date

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1. Introduction

As the U.S. population is projected to grow by 48% from 2000 to 2050, it is imperative that the supply of health care maintains pace with the increased demand. Nursing homes and hospitals are two primary means of health care that will be impacted by this growth. Maintaining an adequate supply of beds for both is particularly important due to the rapidly growing elderly population. In 2003, 12.4% of the American population was sixty-five years and older; this number is projected to increase to 20.7% by 2050.[1] The elderly portion of America is increasing both relative to other age segments and in longevity; in 2003, the average expected additional lifespan of a person sixty-five years old is 18.5 years.[2] The combination of a growing general and elderly population, and increased longevity of the elderly will increase demand for nursing home and hospital beds. Therefore, it is essential to estimate the needed supply of nursing home and hospital beds in a given locale.

The current hospital situation in the Eugene-Springfield area highlights the necessity of estimating the needed capacity of beds. The two hospitals that serve the Eugene-Springfield area are Sacred Heart and McKenzie-Willamette. Sacred Heart, a non-profit owned by PeaceHealth and located in Eugene, is the largest with 438 beds. McKenzie-Willamette, a for-profit owned by Triad Inc. and located in Springfield, has 105 beds. In the past year, PeaceHealth has moved forward with its plans to establish a new 362-bed, $350 million medical center located along the McKenzie river in north Springfield. Triad, concerned about increased competition in Springfield, decided to relocate to north Eugene. However, PeaceHealth also decided to remodel its existing Hilyard campus facility near downtown Eugene into a 104-bed hospital that will

[1] http://www.census.gov/ipc/www/usinterimproj/natprojtab02a.pdf
[2] http://www.aoa.gov/PRESS/fact/pdf/Attachment_1304.pdf

house an inpatient psychiatric unit, inpatient rehabilitation unit, a geriatrics unit and a 24-hour emergency department.[3]

In a free market, the supply and demand for nursing home and hospital beds would fluctuate until reaching equilibrium. In the majority of states, however, the market is regulated by Certificate of Need (CON) regulations. The purpose of a CON regulation is to control hospital and other health care costs by preventing unnecessary construction of new hospital or other institutional beds and preventing the unnecessary duplication of services. Oregon has had CON regulations for hospitals since 1971 and for nursing homes since 1973.

In February 2006, the Oregon Department of Health Services granted a Certificate of Need for the 104 beds at the Hilyard campus. Also in February, Triad submitted an application for its 148-bed, $225 million hospital in Eugene.[4] There has been significant debate within the community over whether the Eugene-Springfield area needs this many additional beds.

The need to estimate needed capacity is apparent. We will build two models that analyze the needed capacity of nursing home and hospital beds. By using national data, we can control for the influence of demographic and socioeconomic trends and CON regulations. We will use our models to estimate the needed capacity of beds in the Eugene-Springfield area.

The rest of the paper proceeds as follows. The next section is a review of literature. The following sections discuss our methodology and hypotheses and how the data is collected. The remaining sections estimate our regression models and then use the results to estimate needed capacity in the Eugene-Springfield area. We conclude by comparing estimated needed capacity with current capacity.

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[3] All statistics concerning Eugene-Springfield situation may be found online at http://www.registerguard.com/
[4] http://www.oregon.gov/DHS/news/

2. Literature Review

There is extensive literature studying factors of nursing home and hospital bed capacity and the impact of CON regulations on the health care industry.

2.1. Nursing Homes

The literature on nursing homes ranges from analyzing factors of demand for nursing home care at the individual level to substitutes of nursing homes to the interaction between market concentration, quality and cost of nursing homes.

Garber and MaCurdy (1989) study a targeted group of low-income elderly Americans who have high-risk health characteristics and analyze what factors contribute to the likelihood of admission and duration of admission. They emphasize three main categories of characteristics that are important determinants of institutionalization. The first factor is demographics; nearly every study that controls for age has found that aging is associated with an increased risk of institutionalization.

The second factor is health and functional status. Two main measures of functional status are Activities of Daily Living and Instrumental Activities of Daily Living which measure the ability to perform basic functions (like dressing and eating) and more complex tasks (like shopping and handling finances). The third factor is financial status. Based on past findings where being poor led to higher rates of institutionalization, they speculate this may be explained by increased utilization of home health services by wealthier people.

In their study, Garber and MaCurdy include the following variables: demographics, health and functional status, social supports (marital status and number of living children), Medicaid and supplemental insurance, home ownership and educational attainment. Using individual level data, they find the following variables decrease the likelihood of admission to nursing homes: home ownership, having living children and being non-white. The following variables are found to increase the likelihood of admission: Medicaid participation, advanced age, functional impairments and dementia. Income is not a significant factor. Advanced education is associated with increased duration of institutionalization.

Lakadawalla and Philipson (1999) analyze how the supply of long-term care responds to an aging population. They argue that aging may decrease per capita demand for long-term care because the supply of family-provided care (a substitute) may increase. They also examine the impact of marital status on the probability of institutionalization. They show the supply of nursing home beds contracts with the longevity of the scarcer gender, typically males, and expands with the healthy life-expectancies of the abundant gender, typically females. In general, the female is able to care for her husband in his old age and home-based care is substituted for market-based nursing home care. By the time females need living assistance, they tend to be widowed and need to seek market-based care. Growth in elderly males reduces the per capita demand for market care while growth in elderly females raises per capita demand. Using microdata, they find the presence of a spouse more than halves the probability of institutionalization. They also point out that increases in the relative health of elderly have helped slow the rate of growth of long-term care.

Some studies focus on the demand and supply of nursing home care; others analyze the interaction of market concentration, efficiency and quality. Zhou and Suzuki (2005) investigate whether care providers in highly competitive markets have a higher level of quality and efficiency than those in highly concentrated markets. Previous research has conflicting conclusions. Some studies show that hospitals tend to compete on non-price assets. Consequently, hospitals provide too many high-technology services and hire excess staff which raises patient costs. Other studies suggest that competition leads to substantially lower costs. From their model on the Japanese home care industry, the authors find that competition is associated with lower costs. In another study, Gertler and Waldman (1992) find that increases in competition are associated with higher levels of both quality and cost.

2.2. Hospitals

The importance of examining the healthcare marketplace can be seen through its frequent appearance in legislative and policy debates. Furthermore, we need to recognize the strength of the preferences individuals have for cost effective, high quality and easily accessible health care. There has been a high level of theoretical interest surrounding the issue of hospital capacity and utilization, but many studies were conducted prior to the 1986 abolishment of mandatory CON regulations and neglect recent developments that have occurred in the legislation of the law. The implications of CON regulations on the number of hospital beds are now more relevant to examine as we can compare areas that have CON laws versus those that provide healthcare in a competitive market. Nevertheless, the older studies still serve an important role in our study as they suggest factors that influence the market for an area's need for hospital beds.

A study by Joskow (1980) determines what factors affect a hospital's supply decisions and classifies them as being the fundamentals of a hospital's constraint function. Joskow argues that three characteristics of the market constrain the ability of a hospital to maximize its objective function. First, a hospital must at least break even, where revenues earned are sufficient to cover costs. Second, the constraint can be determined by the demand for health care services. To capture aggregate community demand, Joskow suggests various demographic factors: population, the extent of insurance coverage of the population and birth and death rates.

Last, Joskow reiterates that hospital behavior may be constrained by government regulation. This will be examined explicitly in our statistical analysis below.

There are also papers that analyze the "appropriate" role of competition in health care markets, a topic that has been debated by federal and state legislators, judges and academia for years. In a report by the Federal Trade Commission and the Department of Justice (2004), they argue that the structure of the extensive regulation of the health care market at federal and state levels has significantly altered competition unnecessarily. The authors state that the "government's actions as both a both purchaser and regulator have profound effects on the rest of the health care financing and delivery markets as well" and that "price regulation, even if indirect, can distort provider responses to consumer demand and restrict consumer access to health care services" (FTC 2004).

The paper also examines the current operation of the health care market, with specific focus on consumers and their methods of obtaining health insurance, including publicly funded programs (Medicare and Medicaid), employer-provided and individual. In their analysis of the competitive responses of hospitals, the authors contend that while some hospitals attempt to find ways to decrease costs, improve quality and compete more efficiently, others often exercise market power to demand price increases from consumers and seek to prevent entry of new competing hospitals (FTC 2004). This is consistent with the argument that is currently being made by Triad in the Eugene-Springfield area concerning PeaceHealth's recent operations of expansion and relocation. Ed Whitelaw, principal with the consulting group ECONorthwest, states that "market concentration by one entity increases the bargaining power of the hospital in its negotiations with insurance providers, which can result in higher fees for hospital services. [With PeaceHealth's expansion] Lane County can expect more market concentration, less competition and higher prices."[5] The authors recognize that if prices were to increase, the hospital would argue that rather than contributing to the rise in increased market power, it is instead a result of pressures such as shortages of nurses and other personnel, rising liability premiums, the costs of improved technology and the obligations of indigent care (FTC 2004). The paper recognizes that some studies find the relationship between competition and hospital prices is that high hospital concentration is coupled with increased prices, regardless whether the hospitals are for-profit or non-profit (FTC 2004).

2.3. Certificate of Need

As mentioned previously, CON regulation attempts to control costs and prevent unnecessary duplication of health care. There is ongoing debate about the impact of CON regulation and whether it is beneficial or detrimental to the health care industry. As this paper seeks to determine how CON influences needed capacity, it is important to understand the history and discussion of CON regulation.

As of June 30, 2004, 37 states and the District of Columbia have active CON laws that regulate the supply of healthcare facilities in a designated area (Chung 2005). Proponents of CON argue that by controlling costs in the health sector, CON regulations can improve and/or protect the quality of care and access to needed services for the majority of the population. Opponents of the CON process contend that such constraints can pose serious "competitive concerns that generally outweigh CON programs'" alleged economic benefits (FTC 2004). They argue that this determent from a competitive market can result in reduced access, higher prices, decreased quality of care and serve primarily to protect existing providers. In states with CON laws, the methodology for determining nursing home bed need is generally based on a state's bed to population ratio. In Tennessee, for example, Senate Bill No. 2463, passed during the 1998

[5] http://www.registerguard.com/

legislative session, establishes a bed need formula that the State's Health Facilities Commission must follow when granting CON for nursing home beds in the state. The formula[6], given below, is for "county-bed need" and uses a population-based statistical methodology:

bed need = (0.0005 * *pop 65 and under*) + (0.0120 * *pop 65-74*) + (0.0600 * *pop 75-84*) + (0.1500 * *pop 85+*)

In addition, age specific consumption rates, a desired occupancy rate and future population growth are often taken into account (Weiner 1998). Some state's governing agencies do not use any mathematical formula to determine how many beds should be in an area. Instead, they base their decisions on general criteria that usually involve various demographic and economic factors.

Congress passed the National Health Planning and Resources Development Act of 1974 to require states to implement the CON law. These federal requirements for health planning and CON were removed in 1986, but as stated above, as of June 30, 2004, 37 states (including the District of Columbia) continue their CON programs for nursing facilities (Chung 2005).

Whether CON regulations are currently implemented in a state or not, within individual states there is active debate about whether CON should be maintained, removed, or, in the case of states that have eliminated CON, reapplied. During 2002, state legislatures discussed more than 30 proposals related to CON.[7]

Oregon's CON process has been in operation since 1971 and nursing facilities have been covered under the program since 1973. The Oregon CON program's strategies are defined as:

(a) Promoting development of more effective methods of delivering health care;

(b) Improving distribution of health care facilities and services;

[6] http://www2.state.tn.us/health/statistics/
[7] http://jama.ama-assn.org/

(c) Controlling increase of health care costs, including the promotion of improved competition between providers;

(d) Promoting planning for health care services at the facility, regional and state levels;

(e) Maximizing the use of existing health care facilities and services which represent the least costly and most appropriate levels of care; and

(f) Minimizing the unnecessary duplication of health care facilities and services.[8]

According to Statute 442.315, Oregon CON laws state that any new hospital or new skilled nursing or intermediate care service or facility that is attempting to move outside of its current service area shall obtain a CON from the Department of Human Services prior to development. After a formal application is submitted by the facility, the Department of Human Services Health Division sets rules specifying criteria and procedures, using the aforementioned strategies as a guideline, for making decisions on the need for the new services or facilities and is the decision-making authority.[9]

The effect that state CON regulations have on the economics of health care markets is analyzed in a variety of literature. Previous studies examine the impact CON regulation on a state's health care supply. Most focus on the implications on the state's health care spending. Conover and Sloan (1998) examine the impact of CON regulation for hospitals on measures of health spending per capita and hospital supply. Using time series cross-sectional methodology, they estimate the net impact of CON policies. They find that mature CON programs are associated with a modest long-term reduction in total per capita spending along with a slight

[8] http://www.oregon.gov/DHS/
[9] http://www.oregon.gov/DHS/

(2%) reduction in bed supply, but higher costs per day and per admission. They find no evidence of a surge in acquisition of facilities or in costs following removal of a state's CON regulations.

A study by Harrington, Swan, Nyman, and Camillo (1997) examine the effects of state CON requirements on the change in nursing home bed growth over a 13 year period between 1979 and 1993. Running a two-stage least squares regression analysis using data primarily from surveys of state officials concerning their state's policies, while treating CON as an endogenous variable, they predict the change in nursing home beds per aged population in the states. The study finds that states with CON regulations do have significant reductions in the growth in nursing home beds.

Joskow's results, based on an analysis that occurred when every state was required to implement CON laws, indicate that CON regulation and other efforts to restrict hospital capacity have a significant impact on hospital bed supply decisions. One goal of this paper is to reexamine these results by analyzing the health care industry using updated market information, improved data accessibility and the state-to-state variation of CON regulation that allows states to determine whether they should enact a regulation or let the hospitals participate in a competitive market.

Because of the ambiguity of operating with or without CON regulations in the health care market, this study will evaluate the influence of CON regulation on the supply of nursing home and hospital beds in an area by comparing it to an area with the same characteristics but without CON. Specifically, we recognize the 14 states not currently under CON regulations as our control group and the metropolitan statistical areas within them as the areas where market forces determine the number of health care facilities and beds.

3. Methodology and Hypothesis

3.1. Nursing Home Bed Hypotheses

For the nursing home regressions, our dependent variable is the number of nursing home beds in each Metropolitan Statistical Area (MSA). Our regressions intend to determine which variables significantly impact the number of nursing home beds in a MSA and to estimate the number of beds needed in the area. From our regressions, we will be able to determine whether Eugene-Springfield is at, exceeding or below capacity relative to other communities with the same characteristics.

We choose our explanatory variables based on previous research. Our first explanatory variable is the total population (male and female) 65 years and older measured in thousands of persons. We hypothesize that the coefficient on this variable will be positive, indicating that the demand for nursing home beds will increase as the number of persons increases.

Our second explanatory variable is males 65 years and older, measured in thousands. We hypothesize this variable will be negative. Past literature has shown that as the share of males 65 years and older increases, demand for nursing home beds decreases, all else constant. It is common for the wife to provide in-home support for her aging husband which decreases his demand for nursing home care. However, the female tend to be widowed and living alone by the time she needs assistance. Consequently, she has a higher probability of entering a nursing home to attain this help. Since male longevity has increased over the past several decades, this trend may be lessening.

Our third variable is whether the MSA is in a state that has a Certificate of Need (CON) law. As explained earlier, the majority of states have CON regulations which attempt to regulate the supply and costs of nursing home beds. Due to this governmental intervention, CON regulations create a market distortion in the nursing home industry. We hypothesize that the coefficient on the CON regulation variable will be negative; that is, the presence of CON regulations constricts nursing home bed capacity. We use a dummy variable to capture the effect of CON regulations (if present in the year 2004), where 1 denotes presence of CON regulation and 0 denotes no CON regulation. Since CON regulations vary by state and some MSAs cross state boundaries, we assigned the dummy variable according to the state that contains the largest number of nursing home beds in that MSA. For example, MSA 2240 includes cities in both Minnesota and Wisconsin. Minnesota does not have a CON law while Wisconsin does. Since more nursing home beds are in Minnesota, the CON law dummy variable is 0. See Appendix A for a list of all applicable MSAs and their assigned dummy variable.

Our fourth variable is the number of persons 65 and older that are below the poverty level, measured in thousands of persons. We hypothesize that the coefficient on this variable will be negative, although we also see arguments indicating a positive coefficient. Intuition suggests that persons living below the poverty level are unable to afford nursing home care; consequently, the more people living below the poverty level, the fewer nursing home beds are needed. However, Medicaid does cover nursing home expenses for persons who meet the state-determined poverty level and certain health-related criteria.[10] This suggests a positive correlation between number of persons living below the poverty level and number of beds. Qualifying for Medicaid is a stringent and complex process and relatively few elderly are on Medicaid. In addition, qualifications vary greatly by state.[11] Knowing this, we argue that while Medicaid may increase nursing home admission, there are not enough elderly on Medicaid to capture this. Another argument for a positive relationship between poverty level and beds are

[10] http://www.consumerreports.org/cro/personal-finance/longterm-care-insurance-1103/what-medicaremedicaid-cover/index.htm
[11] http://www.kff.org/medicaid/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=14325

others studies find that higher levels of income lead to lower rates of nursing home admission. The primary explanation is that the elderly with higher levels of income are more likely to hire in-home assistance because it is preferred over nursing home care.[12]

Our fifth variable is presence of functional disability. Most studies include Activities of Daily Living and Instrumental Activities of Daily Living data to control for functional impairments. As these data are unavailable by MSA, we instead used data from the Census Bureau for people 65 years and older who have a self-care disability or a go-outside-of-home disability, measured in thousands. We hypothesize that the coefficient on this variable will be positive. That is, as the number of people with functional impairments increase, the demand for nursing home beds will also increase.

Our final variable is educational attainment. Some literature has indicated an impact of education level on nursing home demand. For our regression, we use data for people 65 years and older who have some college or higher, measured in thousands. We hypothesize that the coefficient on this variable will be positive. The relationship between health and education is ambiguous; economists have not yet determined which factor has the greatest impact on the other, or the interplay between the variables. However, we hypothesize that a higher level of education correlates with a longer lifespan and, thus, an increased likelihood of nursing home admission.

See Table 1 for a summary of the descriptive statistics.

[12] Garber and MaCurdy (1989)

Table 1: Descriptive Statistics of Nursing Home Variables

Variables	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Dependent Variable					
Nursing home beds	320	3688.688	6073.136	222	54401
Regressors (in 1,000s)					
Total population 65+	320	81.761	129.693	7.662	1109.821
Total males 65+	320	33.443	52.288	3.310	429.536
Below poverty level 65+	320	7.109	13.867	0.297	172.583
Disability 65+	320	23.305	40.170	1.605	396.666
Some college 65+	320	29.129	47.123	2.1	375.003

3.2. Hospital Bed Hypotheses

Our models in this study focus on nursing home bed capacity and hospital bed capacity. These regressions share similar characteristics, such as demographics and the impact of CON regulation, but have important differences.

For this model, the dependent variable, similar to the nursing home model, is the total number of staffed hospital beds in a MSA. Several explanatory variables should help determine needed capacity of staffed hospital beds in a MSA. The first factor is total population, measured in thousands of persons. We hypothesize that the coefficient on this variable will be positive, indicating that the demand for hospital beds will increase as the number of persons increases.

Based on intuition and literature, our second hypothesized variable is the total population of persons 65 and older. As in our nursing home bed model, we hypothesize that the sign on the coefficient should be positive; the higher the population of persons more susceptible to health complications due to old age, the higher number of needed hospital beds.

The third variable is the total population of childbearing age females. We define childbearing age as 15 to 44 years old. We hypothesize that the coefficient on this variable is positive: the greater the number of women of childbearing age, the greater the number of hospital beds needed for childbirth.

The fourth variable is insurance coverage. We hypothesize that the coefficient on this variable is positive: the greater degree of health care coverage, the greater the accessibility of health care and, therefore, the greater the propensity to use it. The data is gathered at the state level and captures the number of persons that are covered through employer-provided, individual, Medicaid, Medicare or other public health insurance plans.

Our final variable is the presence of CON regulations. We hypothesize that the coefficient on the CON dummy variable should be negative. MSAs under CON regulation, such as the Eugene-Springfield MSA, have restricted competition which should lead to a shortage in bed supply.

See Table 2 for a summary of the descriptive statistics.

Table 2: Descriptive Statistics of Hospital Variables

Variables	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Dependent Variable Hospital Beds	232	1682.823	1891.007	126	12617
Regressors (in 1,000s) Total population	232	461.879	641.453	57.813	5819.100
Total population 65+	232	56.800	71.055	7.662	459.992
Childbearing age females	232	100.017	128.555	11.852	1000.189
Population covered by insurance	232	388.925	551.353	45.672	5237.190

4. Data Collection

We collect data according to Metropolitan Statistical Areas (MSA) as defined by the U.S. Census Bureau for the year 2000.[13] A MSA, according the Census Bureau, is a "core area containing a substantial population nucleus, together with adjacent communities having a high degree of social and economic integration with that core."[14] Using MSAs allows us to assume that the smaller communities lying outside city boundaries have access to the nursing homes and

[13] Definitions for the MSAs may be found online at http://www.census.gov/population/estimates/metro-city/99mfips.txt.
[14] http://www.census.gov/population/www/estimates/metroarea.html

hospitals located within the city or surrounding areas. It is important to note that some areas are listed as Consolidated Metropolitan Statistical Areas (CMSA). These areas contain several Primary Metropolitan Statistical Areas (PMSA) which are more specific than the CMSAs. Consequently, we include the PMSAs and exclude the broader CMSAs; this enables greater precision.

4.1. Nursing Homes

For the nursing home model, we need to collect number of nursing home beds (our dependent variable) and demographic data. The Medicare website provides the number of nursing home beds by city and county in the year 2005.[15] Using MSA definitions, we aggregate the number of beds in each MSA. To gather the demographic data, we use the data (by MSA and PMSA) from the 2000 U.S. Census.[16] From this point forward, MSAs and PMSAs will be jointly referred to as MSAs.

4.2. Hospitals

Our dependent variable in the hospital model is the number of hospital beds. The American Hospital Association (AHA) database supplies the number of staffed hospital beds according to MSA for the year 2000. The types of hospitals included are investor-owned (for-profit), nongovernmental not-for-profit, government (nonfederal and federal), osteopathic and service hospitals.

As in the nursing home model, we collect demographic data (by MSA) from the U.S. Census Bureau for the year 2000. Since data on insurance coverage is unavailable by MSA, we gather state-level data from the Kaiser Family Foundation (KFF) for the year 2003.[17] We assume that a MSA has a health insurance coverage rate consistent with the state-level rate.

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[15] The Medicare website may be found at www.medicare.gov.
[16] U.S. Census data is found at the U.S. Census Bureau website, www.census.gov.
[17] The KFF website can be found at www.statehealthfacts.org

Consequently, each MSA within a state is given the same rate as the state. For example, the Eugene-Springfield, Oregon, MSA is assumed to have a rate of health insurance coverage consistent to that of Oregon as a whole.

5. Regression Analysis

5.1. Nursing Home Bed Analysis

For the nursing home bed study, we show five different specifications of our model where with each new specification we incorporate a new variable. This allows us to see the additional explanatory power for each new variable. Our base model uses the dependent variable of nursing home beds and the independent variables of total population of 65 years and older in thousands and population of males 65 years and older in thousands. Both variables are statistically significant at the 1% level and the R^2 is very high at 0.9513, indicating that 95.13% of the variation in the number of nursing home beds is explained by these independent variables. The regression model states that, holding all other variables constant, for a 1,000 person increase in population aged 65 and older, approximately 228 more nursing home beds are needed. Holding population constant, for every additional 1,000 males aged 65 and older, approximately 456 fewer nursing home beds are needed. These findings confirm our hypotheses.

To this base model, we add the CON law dummy variable. The coefficients on both the total population and the male population are statistically significant at the 1% level and the coefficient on the CON law dummy variable is statistically significant at the 10% level. The R^2 is slightly higher at 0.9516. The coefficients on the population variables are approximately the same as the base model. The model states that, holding all other variables constant, a MSA in a state with CON laws is associated with approximately 215 fewer nursing home beds than a state without CON laws. This finding indicates that CON laws are in fact restricting bed supply.

To this base model, we add elderly population below the poverty level, measured in thousands. The coefficient on total population increases slightly to 283 and the coefficient on male population decreases by approximately 100 to -565. Both coefficients remain significant at the 1% level. The coefficient on CON decreases slightly to -265 but increases in significance to the 5% level. The coefficient on poverty level is also significant at the 5%. It indicates that, holding all else constant, for a 1,000 person increase in elderly below the poverty level 99 fewer nursing home beds are needed.

We next add the population 65 years and older with a self-care or go-outside-of-home disability, measured in thousands. The coefficient on total population decreases slightly to 276 and the coefficient on male population remains approximately the same. Both coefficients remain statistically significant at the 1% level. The coefficient on the CON law variable increases to -283 and remains statistically significant at the 5% level. Neither of the coefficients on poverty nor disability is statistically significant.

Finally, we add the total population 65 years and older that has some college education and higher (in thousands). The coefficient on total population now increases slightly to 285 and the coefficient on males decreases to -592. Both remain statistically significant at the 1% level. The coefficient on CON is approximately the same and remains significant at the 5% level. The coefficients on the poverty, disability and education variables are statistically insignificant. See Table 3 for regression results.

Table 3: Nursing Home Bed Regression Results

Explanatory Variables	Base Model (1)	Base Model with CON (2)	Model (2) add Poverty Level (3)	Model (3) add Disability (4)	Model (4) add College (5)	Model (5) (6)
Population 65+ per 1,000	228.818*** (29.240)	228.424*** (29.416)	282.730*** (44.287)	275.876*** (40.701)	284.517*** (41.418)	254.627*** (55.758)
Males 65+ per 1,000	-456.28*** (69.288)	-455.145*** (69.726)	-565.278*** (96.307)	-563.788*** (91.789)	-591.855*** (101.193)	-497.182*** (124.072)
CON 1=yes		-214.8397* (127.026)	-265.400** (133.772)	-283.001** (126.274)	-285.208** (121.122)	
65+ Below Poverty Level per 1,000			-98.898** (45.627)	-132.891 (85.570)	-124.816 (89.417)	-88.899* (49.681)
65+ Disability per 1,000				31.586 (50.690)	26.833 (53.961)	
65+ some college per 1,000					9.343 (26.434)	
State fixed effect dummy	No	No	No	No	No	Yes
R-squared	0.9513	0.9516	0.9560	0.9563	0.9564	0.9662

Robust standard errors are in parentheses, with ***, ** and * denoting statistical significance (two-tailed test) at the 1, 5 and 10% levels, respectively.

We also try including the female widow variable but notice its addition greatly increases the standard errors of the other variables. We speculate this is due to high multicollinearity with the total population variable. By running a pairwise correlation test, we discover that there is a collinearity of 0.9965 between the widow and total population variables. Consequently, we remove the widow variable from our regressions to avoid multicollinearity.

Based on the coefficients' high levels of statistical significance and the high R^2 of our third regression, we decide the variables that best estimate needed capacity of nursing home beds are the total elderly population, the number of elderly males, whether there are CON laws and elderly population below the poverty level. To determine the needed capacity in a MSA, our regression equation is:

$$nhbeds = 282.730\ totalpop65 - 565.278\ male65 - 265.400\ CON - 98.898\ poverty + 369.196$$

5.2. Hospital Bed Analysis

Replicating the process used in the nursing home model, the hospital bed model to determine needed bed capacity begins with a base model and additional models are formulated in order to gauge the interaction of the variables in each subsequent regression. The base model uses the total number of staffed beds as the dependent variable and total population as the explanatory variable. Total population is found statistically significant at the 1% level and R^2 is 0.8320; this indicates that 83.20% of the variation in the number of hospital beds is explained by the independent variable. It is important to note that this R^2 is relatively high considering only one explanatory variable is included in the model. To simplify interpretation, the independent variable is divided by 1,000 to create a coefficient that represents the effect of a 1,000-person change in the population in a MSA has on the number of hospital beds needed. The regression model indicates that, holding all other variables constant, for a 1,000 person increase in total population, approximately 2.7 more hospital beds are needed. This positive influence of total population reflects our hypotheses.

To this base model, we add the total population of persons 65 and over in thousands. The coefficients on both total population and total population 65 and older are statistically significant at the 1% level and positive, as we hypothesized. The coefficient on total population remains positive, indicating the addition of elderly population is justified. The model indicates that, holding total population constant, for every additional 1,000 persons 65 and older, approximately 13 more hospital beds are needed.

Table 4: Hospital Bed Regression Results

Explanatory Variables	Base Model (1)	Base Model with Population over 65 (2)	Model (2) add Females Child Bearing Age (3)	Model (2) add Population Insured (4)	Model (2) add CON (5)	Model (2) add State Fixed Effects (6)
Total Population per 1,000	2.713*** (0.255)	1.372*** (0.337)	0.401 (0.295)	1.903 (3.340)	1.371*** (0.335)	1.237*** (0.313)
Population 65+ per 1,000		13.169*** (3.152)	12.391*** (2.937)	13.015*** (2.721)	13.207*** (3.139)	15.551*** (3.268)
Females of Child Bearing Age per 1,000			5.420*** (1.685)			
Population covered by health insurance per 1,000				-.602 (2.967)		
CON 1 = Yes					-58.440 (99.629)	
State Fixed Effects	No	No	No	No	No	Yes
R-squared	0.8320	0.8705	0.8781	0.8706	0.8707	0.9154

Robust standard errors are in parentheses, with ***, ** and * denoting statistical significance (two-tailed test) at the 1, 5 and 10% levels, respectively.

The third variable we add to the model is the total population of childbearing age (15 to 44 years old) females. The coefficient on this variable is highly statistically significant at the 1% level; however, the coefficient on total population becomes statistically insignificant. That the total population variable becomes insignificant after including childbearing age females indicates that population levels of childbearing age females may not vary enough state to state to be a significant factor. With that said, we stay consistent with literature that suggests this demographic does influence the number of hospital beds needed in an area but is instead captured within the total population variable.

In our next model, we include the number of persons covered by health insurance (either employer-provided, individual, Medicaid, Medicare or other), measured in thousands, and omit childbearing age females. The coefficients on both health insurance coverage and total population are statistically insignificant; the population over 65 remains statistically significant at the 1% level. Similar to the childbearing age variable, this result suggests that insurance levels may not vary enough by state to be a significant factor in the model.

In our final model, we include total population, total elderly population and the CON dummy variable. The coefficients on total population and elderly population are very close to what they are in the second model (which includes only those two variables) and remain statistically significant at the 1% level. The coefficient on the CON dummy variable is statistically insignificant. Thus, the model indicates that the CON laws do not distort the market; that is, the state's criteria accurately determines the number of beds that would be needed in a competitive market. See Table 4 for regression results.

Based on the statistical significance of the coefficients of the second model (which includes total population and total population of persons 65 and older), we determine this model is most representative of needed capacity for staffed hospital beds in a MSA. Our regression equation is:

$$\textit{Hospital beds} = 1.372\ \textit{totpop} + 13.169\ \textit{pop65over} + 309.189$$

6. Applying Regressions

6.1. Nursing Homes

In the previous section, we ran several regressions using nursing home beds as our dependent variable. We selected the model that best estimates needed capacity of beds and will now apply that regression to several MSAs to determine whether they are at, below or above needed capacity.

Recall that our final regression included total elderly population, total elderly male population, the presence of CON and elderly population below the poverty level. The equation is: $\textit{nhbeds} = 282.730\ \textit{totalpop65} - 565.278\ \textit{male65} - 265.400\ \textit{CON} - 98.898\ \textit{poverty} + 369.196.$

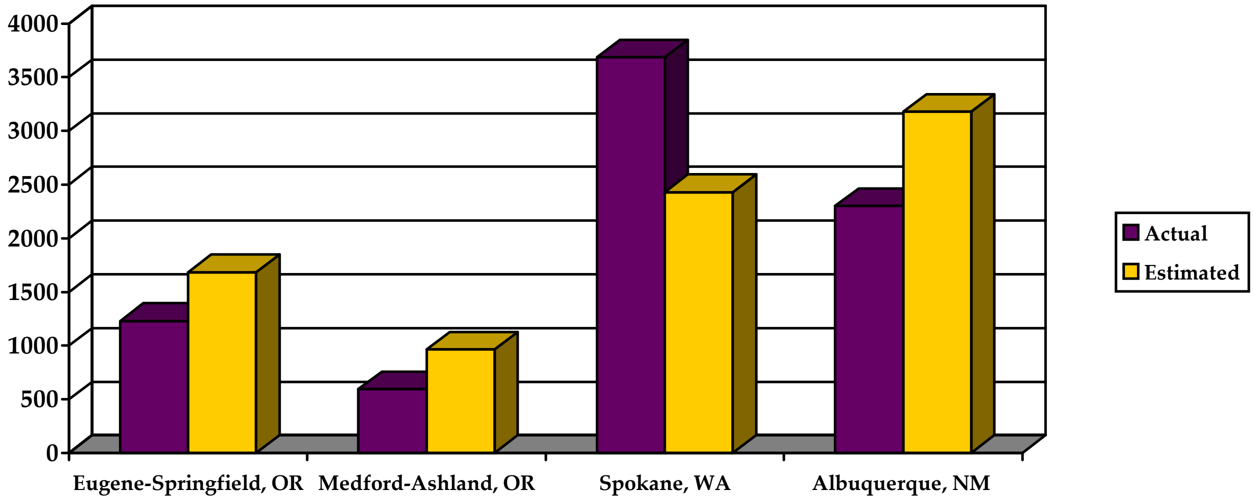
Table 5: Nursing home bed MSA-specific data, estimations and comparisons

MSA	Total Pop 65+	Male Pop 65+	Presence of CON 1=yes	65+ Below Poverty Level	Estimated # of Beds	Actual # of Beds	Difference: Actual – Estimated
Eugene-Springfield OR	42,954	18,140	1	3,149	1,683	1,229	– 454
Medford-Ashland OR	28,991	12,635	1	1,944	966	596	– 370
Spokane WA	51,949	21,198	1	4,021	2428	3,686	+ 1258
Albuquerque NM	80,421	33,995	0	7,213	3177	2,302	– 875

To estimate needed capacity, we insert a MSA's data into the above equation. We will estimate needed capacity in the following MSAs: Eugene-Springfield, OR; Medford-Ashland, OR; Spokane, WA; and Albuquerque, NM. The Oregon MSAs will help show if there are similarities within the state; the Washington MSA will allow a comparison between the two northwestern states; and New Mexico does not have CON regulations. Table 5 shows the data used for each MSA, the estimated number of beds and the actual number of beds.

As Table 5 shows, Eugene-Springfield, Medford-Ashland and Albuquerque are all under needed capacity while Spokane is above needed capacity. Chart 1 provides a visual of the difference between estimated and actual numbers of beds in these MSAs. Specifically, our regression estimates that, based on its demographic characteristics, the Eugene-Springfield MSA needs approximately 454 more beds than it currently has. It is important to note that although the Eugene-Springfield MSA includes the entirety of Lane County, it is reasonable to assume the majority of nursing home bed demand lies within the Eugene-Springfield area.

Chart 1: Graph of actual and estimated number of nursing home beds



6.2. Hospitals

For our hospital bed model, we use our final regression equation to determine the needed capacity of hospital beds in Eugene-Springfield. The final regression equation includes total population and total elderly population: *Hospital beds = 1.372 totpop + 13.169 pop65over + 309.189.*

Again, for comparison purposes, we apply the model to another MSA in Oregon (Medford-Ashland), a MSA in another state with CON regulations (Spokane, WA), and a MSA in a state without CON regulations (Albuquerque, NM). The results are presented in Table 6.

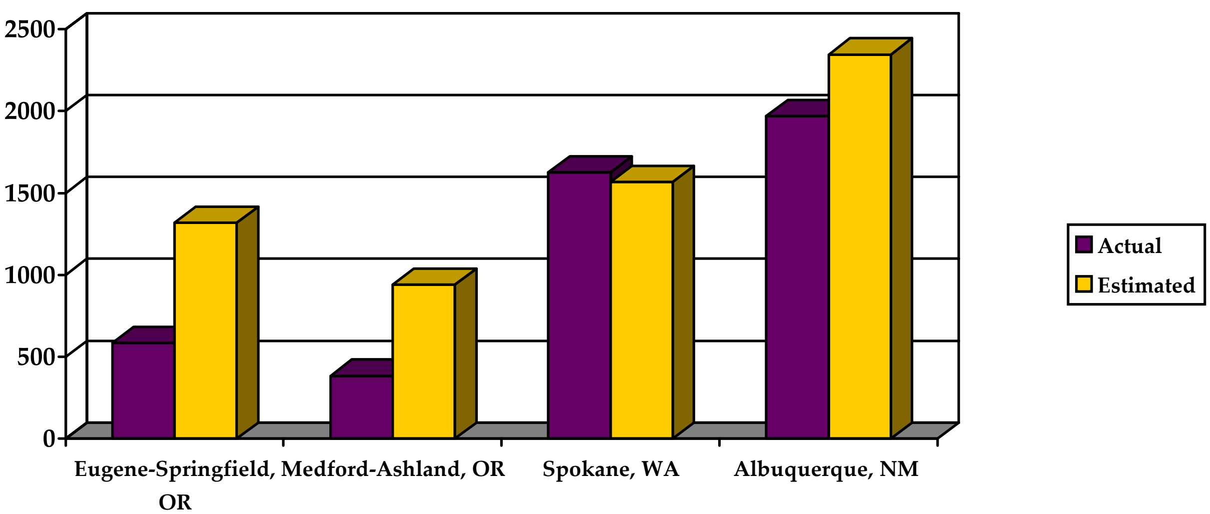
The regression estimates that the Eugene-Springfield MSA needs approximately 1318 staffed hospital beds, based on its characteristics. With a current total of 586 beds, the model suggests the area needs approximately 732 additional staffed hospital beds. Again assuming Eugene-Springfield's predominance of Lane County, the majority of this need should lie within the Eugene-Springfield area.

Table 6: Hospital bed MSA-specific data, estimations and comparisons

MSA	Total Pop	Total Pop over 65	Estimated # of Beds	Actual # of Beds	Difference: Actual – Estimated
Eugene-Springfield	322,959	42,954	1,318	586	-732
Medford-Ashland	181,269	28,991	940	384	-556
Spokane, WA	417,939	51,949	1,567	1,625	+58
Albuquerque, NM	712,738	80,421	2,346	1,970	-376

We again see in Table 6, consistent with the nursing home regression, that Eugene-Springfield, Medford-Ashland and Albuquerque are below needed capacity and Spokane is above needed capacity. Chart 2 provides a visual of the difference between estimated and actual numbers of beds in these MSAs.

Chart 2: Graph of actual and estimated number of hospital beds



7. Alternative Specifications

7.1. Log-Log Model

Our nursing home and hospital bed models use linear functional forms to estimate needed capacity. We want to see whether log-log functional forms would provide better estimates since a log-log model normalizes everything into percent changes. Using our selected nursing home bed model (total elderly population, elderly males, presence of CON and elderly below poverty level), we run another regression in log-log form. The regression equation is:

$$\ln(nhbeds) = 6.097 \ln(totalpop65) - 5.02 \ln(male65) - 0.165 \ln(CON) - 0.158 \ln(poverty) - 6.934.$$

The signs on each coefficient are the same as the linear model; the coefficient on the poverty level variable is statistically significant at the 5% level and the remaining coefficients are statistically significant at the 1% level. In addition, the needed capacity estimates are very similar to the estimates from our linear regression. For example, the log-log model estimates the Eugene-Springfield MSA needs 1689 beds; the linear model estimates 1683 beds.

Next, we convert our linear model for hospital beds to a log-log functional form. The regression equation is:

$$\ln(hospital\ beds) = 0.817 \ln(totpop) + 0.0512 \ln(pop65over) + 2.208.$$

The coefficient for population over 65 is less statistically significant, now at the 10% level. Nevertheless, if we are to look at the predictions, they are consistent with the linear model; the Eugene-Springfield, Medford-Ashland and Albuquerque MSAs are all under capacity while the Spokane MSA stays above.

The log-log models provide estimations consistent with the linear models; this indicates that our linear models can be seen as the correct specifications to be used.

7.2. State Fixed Effects

We return to our linear regression models and investigate state fixed effects. The regression model applied in *Section 6.* compares a specific MSA to MSAs across the nation. Now we want to determine whether there is a fixed effect that occurs in an individual state. In other words, we will now control for each state's fixed effect. Specifically, we will control for Oregon's fixed effect—whether there are factors in Oregon that impact needed nursing home and hospital bed capacity.

To control for state fixed effects, we create a dummy variable for each MSA in every state. The dummy variable takes the value of 1 if we are investigating that particular state's fixed effects. For example, when looking at Oregon's state fixed effects, the fixed effect dummy variable takes the value of 1 for all the MSAs in Oregon and a value of 0 for the MSAs in the remaining states.[18]

For nursing homes, we run a regression including the state fixed effects dummy variable, elderly population, elderly males and elderly below the poverty level. We exclude the CON dummy variable because this effect is captured by the state fixed effects dummy variable. See Column (6) in Table 3 for the regression results. All of the coefficients are statistically significant and the R^2 is very high at 0.9662. The coefficient on the Oregon fixed effects dummy variable is -866 and is statistically significant at the 10% level. This indicates that the MSAs in Oregon are below capacity for nursing home beds, relative to MSAs in other states.

As for hospitals, we run a regression including the state fixed effects dummy variable, total population and elderly population. Similar to the nursing home model, both of the explanatory coefficients are statistically significant at the 1% level and the R^2 is high at 0.9154.

[18] Some MSAs cross state boundaries. These MSAs are assigned to the state in which the majority of nursing home beds are located. See Appendix 1 for a list of all applicable MSAs and their assigned state.

The coefficient on the Oregon fixed effects dummy variable is approximately -532 and is statistically significant at the 1% level, once again indicating that all MSAs in Oregon are below capacity for hospital bed, relative to MSAs in other states. See Column (6) in Table 4 for the regression results.

There are several factors that may cause Oregon to have lower needed capacity: the influence and/or strength of CON regulations relative to other states; preferences of its residents (for example, preferring home-based care rather than nursing home care); or other characteristics unique to Oregon.

Using this regression with Oregon's fixed effects, we estimate needed nursing home bed capacity in Eugene-Springfield to be 736 beds, which indicates an excess of 493 beds. This shows that after controlling for Oregon's fixed effects, Eugene-Springfield is not under capacity when compared to other Oregon MSAs. Conversely, the estimate of needed hospital bed capacity in the MSA is 681 beds, still indicating an undersupply of 95 beds. We conclude that for hospital beds, after controlling for Oregon's fixed effects, Eugene-Springfield is slightly under capacity compared to other Oregon MSAs.

8. Conclusion

Our study shows that the Eugene-Springfield area needs increased capacity in both nursing home and hospital beds. These results show there is excess demand not currently met by hospital bed supply, indicating there should be no concern over the planned hospital expansions. These regressions that control for demographic, socioeconomic and CON regulation characteristics are important to ensure that the supply of beds meets the demand. It is particularly important to carefully monitor supply in states with CON regulations. Our regression results indicate that the CON regulations constrict the supply of nursing home beds below market demand. However, CON regulations for hospital beds appear to accurately supply the demanded number of beds. The growth of the American population, in particular the elderly, emphasizes the need for adequate supply of nursing home and hospital beds. Studies such as this are important tools for policy-makers to use when determining needed supply of health care.

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Appendix A.

Some Metropolitan Statistical Areas (MSAs) cross state boundaries. In order to gauge the effect of CON regulations or state fixed effects, we assign these MSAs to the state in which the majority of the MSA's beds are located. The following chart lists the affected MSAs and their assigned unique state:

MSA code	Assigned state
0600	Georgia
1520	North Carolina
1560	Tennessee
1640	Ohio
1660	Kentucky
1800	Georgia
1900	Maryland
1960	Illinois
2440	Indiana
2520	North Dakota
2720	Arkansas
2985	Minnesota
3760	Missouri
4120	Nevada
4160	Massachusetts
4520	Kentucky
4920	Tennessee
5120	Minnesota
5920	Nebraska
6160	Pennsylvania
6440	Oregon
6450	New Hampshire
6480	Rhode Island
7040	Missouri
8360	Texas