Spring 5-12-2017

Medicaid Expansion and Hospital Closures: Examining Hospital, County, and State Effects in the Wake of the Affordable Care Act

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ABSTRACT

MEDICAID EXPANSION AND HOSPITAL CLOSURES: EXAMINING HOSPITAL, COUNTY, AND STATE EFFECTS IN THE WAKE OF THE AFFORDABLE CARE ACT

By

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April 25th, 2017

INTRODUCTION: Since 2010, there has been a wave of hospital closures and mergers across the United States. These closures have likely impaired access to ambulatory care services for many communities, particularly those in which only one hospital is present. Given that decisions to expand Medicaid were state-specific, there may be differences in number and type of hospital closures between states that expanded and did not expand Medicaid

AIM: The present study aims to investigate the association between state level Medicaid expansion and short-term hospital closures from 2010-2016 using multilevel modeling of hospitals, counties, and states. This analysis aims to control for hospital differences, county demographics, and state insurance market factors.

METHODS: Hospital level data was obtained from the Center for Medicaid and Medicare Services. For contextual county effects, small area health insurance, income, and poverty estimates were included (U.S. Census 2013). State decisions on Medicaid expansion and state-level insurance market data was also assembled and analyzed. Multilevel models were estimated in STATA gllamm.

RESULTS: Medicaid non-expansion was not associated with a greater risk of hospital closure once included in the multilevel model. Further, rural vs. urban status was not predictive of hospital closure. Smaller hospitals, nonprofit hospitals, and hospitals with a history of ownership change were associated with closure risk. Critical access hospital status was a protective factor against closure.

DISCUSSION: Local, state, and federal policies supportive of small and nonprofit hospitals may be beneficial in preventing more hospital closures in the coming years. Further, in-depth financial research and increased awareness of both the historical and current trends in hospital closures is recommended for researchers and policymakers.

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by

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B.S., KENNESAW STATE UNIVERSITY

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the
Requirements for the Degree

MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA
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APPROVAL PAGE

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Acknowledgments

This work would not have been possible without the guidance and support of several individuals. First, to Brandon Attell: Thank you for the substantial statistical guidance, emotional support, and encouragement. Every time I began getting distracted or off track, you were always there to remind me “finish your thesis”. However, jesting aside, your support has been incredibly influential in my success and I could not be more grateful.

Second, enormous thanks and acknowledgements to my outstanding thesis committee. Dr. Lee Mobley’s previous research on hospital closures and belief in me both inspired me on the present topic and often gave me the additional push needed to carry the torch to the finish line. Dr. Eric Wright’s extensive knowledge of health systems was instrumental in my development of the systems-thinking lens required for this thesis and for future research. Finally, Dr. Katherine Masyn’s mentorship and guidance on both career and research topics has also buttressed my thesis and my training as a whole. To my thesis committee, thank you for your support and guidance in this work.

Finally, I would like to acknowledge my work family, including Jana Pruett and Bill Wrencher, for supporting a healthy work-life balance as I completed this work, providing expertise and support on Medicaid, finance, and other special topics, and serving as attentive thought partners for thesis-critical topics and ideas. I really appreciate the support, time, and thought-provoking discussions.

Author's Statement Page

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Table of Contents

List of Tables

List of Figures

Introduction

Overview

Since 2010, there has been a wave of hospital closures and mergers across the United States (Kaufman et al., 2016; Leemore, 2016; Thomas, Holmes, & Pink, 2016). Many of these closures have been small hospitals in rural areas (Kaufman et al., 2016). These closures have likely impaired access to ambulatory care services for many communities, particularly those in which only one hospital is present (Reiter, Noles, and Pink, 2015). Given that decisions to expand Medicaid were state-specific, there may be differences in number and type of hospital closures between states that expanded and did not expand Medicaid. There exists a body of literature on hospital closures from the 1980s and 1990s with the introduction of managed care to the American healthcare system, but very little research has attempted to capture the wave of hospital closures following the affordable care act (ACA). Several research and policy groups have begun describing the extent of hospital closures following the ACA, but no present studies exist which fully detail the associations between Medicaid expansion decision and hospital closures in the context of hospital factors, county-level sociodemographic characteristics, and other market factors. Although one previous paper has uncovered preliminary findings on rural hospital closures from 2010-2014, this research only compared rural hospital closures between counties (Kaufman et al. 2016).

The Present Study

The present study aims to investigate the association between state level Medicaid expansion and all hospital closures from 2010-2016 using multilevel modeling of hospitals, counties, and states. This analysis aims to control for hospital differences (hospital type, size, special designations), county demographics (percent uninsured, percent unemployed, population

density), and state insurance market concentration. The primary research question driving this study is “What is the association between Medicaid expansion and hospital closures”. Secondary research questions include “Is state insurance market concentration associated with hospital closures” and “Are certain types of hospitals or counties more likely to experience a hospital closure”? I hypothesize that states that did not expand Medicaid were more likely to experience hospital closures from 2010-2015. More specifically, uncompensated care reimbursement rates were scheduled to decrease nationwide with the ACA. The timing of the decrease was to be phased in over several years, and the inception of it was pushed further into the future several times by Congress. However, regardless of the eventual timing of it, hospitals in states with no Medicaid expansion were well aware of this looming debacle. The ACA intended to obviate the need for this portion of hospital revenue by diminishing the percent of patients seen without insurance (essentially reducing uncompensated care). Uncompensated care reimbursement was to be decreased and phased out regardless of Medicaid expansion status. When not replaced by a commensurate increase in patients with insurance, most hospitals in states that did not expand Medicaid saw a dismal future. I hypothesize this policy change has resulted in hospital closures in states that did not opt for Medicaid expansion. I hypothesize that closures will be hospitals that critically depended on increased reimbursement for uncompensated care costs (rural, public, critical access hospitals, non-profits in poor areas, etc.).

Review of the Literature

The Need for Healthcare Reform Prior to the Affordable Care Act

The Patient Protection and Affordable Care Act (ACA), known by some as “Obamacare”, was developed with the intent of providing greater access, affordability, and quality of healthcare for those in the United States (Obama, 2016). However, before the ACA, there were several

deficiencies in these three areas of healthcare in the U.S. that spurred the impetus for healthcare reform. In 2008, the percent of Americans without health insurance was estimated at 14.7%, with those under age 18 at 8.9% and those between age 18 and 64 at 19.7% (Cohen, Martinez, & Zammitti, 2016). Uninsured status in the United States is associated with low access to care, financial volatility, poor health, and preventable death (Baicker et al., 2013; Sommers, Baicker, and Epstein, 2012; Sommers, Long, and Baicker, 2014). Additionally, the high proportion of uninsured Americans burdens the U.S. healthcare system with billions of dollars annually (Hadley, Holahan, Coughlin, & Miller, 2008). The cost of care for uninsured Americans is uncompensated by a third-party insurance payer and instead falls predominantly (~75%, an estimated $43 billion in 2008) on the government in the form of Medicaid and Medicare Disproportionate Share Hospital (DSH) reimbursements, direct care programs (such as the VHA, IHS, and others), supplemental payment programs, and state and local taxes (Hadley, Holahan, Coughlin, & Miller, 2008). Further, downstream medical-model approaches, patient safety concerns, and failing coordination of care all represented quality of care issues that spurred the development of the ACA (McGlynn, Asch, Adams, etc., 2003; McCarthy, How, Fryer, Radley, & Schoen, 2011). Taken together, these access, cost, and quality concerns evinced the need for legislative action in determining healthcare policies and strategies that would improve the United States healthcare system.

Key Policy and Procedural Changes

The Patient Protection and Affordable Care Act (H.R. 3590), cleared the Senate December 24th, 2009, the House on March 21st, 2010, and was signed into law two days later on March 23rd, 2010. Though a summary of the law in its entirety is beyond the scope of this paper, key provisions relevant to the present research are summarized here, including 1) The Hospital

Readmission Reduction Program (HHRP), 2) Medicaid and Medicare DSH reimbursement reductions, and 3) expansion of the Medicaid program. Section 3025 of the ACA created the "Hospital Readmissions Reduction Program", added to section 1886(q) of the Social Security Act (Center for Medicare and Medicaid Services, 2016). The HRRP required reduced Medicare payments from the Center for Medicare and Medicaid Services (CMS) through the inpatient prospective payment system (IPPS) to hospitals with readmissions deemed preventable. This was intended to spur hospitals to provide greater quality of care for Medicare beneficiaries by linking beneficiary outcomes to CMS reimbursement payments. Another key provision of the ACA is the reduction of Disproportionate Share Hospital (DSH) reimbursements for both Medicaid and Medicare payments. DSH payments are increased Medicaid and Medicare payments to hospitals that serve a high percentage of uninsured and low-income patients. These payments help to financially support hospitals that provide a disproportionate amount of uncompensated care to vulnerable populations and have been vital to the financial viability of hospitals in the "safety net" (American Hospital Association, 2015; Kaiser Commission on Medicaid and the Uninsured, 2013). The reasoning for this reduction in payments was the projected increase of newly-insured patients under the ACA, thus reducing the need for uncompensated care payments for uninsured patients (Kaiser Commission on Medicaid and the Uninsured, 2013). In fiscal year 2016, DSH allotments totaled over 11.9 billion dollars in the United States (Federal Register, Volume 81, No. 2017, 2016). Finally, the most widely reported portion of the ACA was the section on the expansion of the Medicaid program. This provision expanded Medicaid eligibility to individuals at or below 138% of the federal poverty line (FPL) and allowed income-scaled tax credits for those with moderate income (> 100% FPL and < 400% FPL). This was intended to assist

Americans and their families with purchasing health insurance through the newly created insurance marketplaces.

The U.S. Supreme Court and State Decisions for Medicaid Expansion

Though the ACA was crafted to be implemented nationally, the Supreme Court of the United States (SCOTUS) reviewed the constitutionality of the law in the 2012 case of the National Federation of Independent Business (NFIB) vs. Sebelius. Though SCOTUS ruled on June 28th, 2012 that the ACA was constitutional, the decision also gave states the option of opting-out of Medicaid expansion (567 U. S. NFIB vs. Sibelius, 2012). This ruling left the majority of the ACA intact to be implemented on a nationwide level, but Medicaid expansion was left to each individual state. Medicaid expansion, set to go into effect January 1st, 2014, was adopted by 24 states including Washington D.C. and opted-out of by 26 states (Obamacare Facts, 2017). However, seven states decided to expand Medicaid after January 1st, 2014, including Michigan, New Hampshire, Pennsylvania, Indiana, Alaska, Montana, and Louisiana (Kaiser Family Foundation, 2017). Of the 31 states to expand Medicaid as of the end of 2016 (32 including D.C.), seven states utilized 1115 waivers to include more state-specific approaches to Medicaid expansion including Arizona, Arkansas, Indiana, Iowa, Michigan, Montana, and New Hampshire. 1115 waivers are demonstration programs that allow states flexibility in approaches to expanding Medicaid eligibility and improving programs (Center for Medicare and Medicaid Services, 2017). These waivers, authorized by section 1115 of the Social Security Act and approved by the secretary of Health and Human Services, are often discussed as the route that more conservative states expand Medicaid. Given this variability in state expansion of the ACA, it can be expected that healthcare systems may be differentially affected in states that did and did not expand Medicaid.

Hospital Closures and Historic Policy Effects

As core institutions in the delivery of healthcare in the United States, hospitals are vital facilities in the delivery of emergent, non-acute, and outpatient care (Shi & Singh, 2015). The hospital model of care has dominated the U.S. healthcare system since the beginning of the 20th century and continues to consume the largest share of healthcare spending today (Raffel, 1980; Shi & Singh, 2015). Historically, many hospitals have faced financial instability in the face of policy changes, alternative reimbursement strategies, and the introduction of managed care (Shi & Singh, 2015). These financial pressures have caused many hospitals to close, though patterns of hospital closures have varied in recent decades. For example, the 1982 Tax Equity and Fiscal Responsibility Act (TEFRA) shifted Medicare reimbursement from cost-plus to a prospective payment system (PPS). In the wake of this reimbursement change, 550 hospitals closed in the 1980s (Balotsky, 2005). Later in the 1990s, managed care became much more prevalent in the U.S. The strictest form of managed care, Health Maintenance Organizations (HMOs), have been associated with lowering profitability and utilization (Clement and Grazier, 2000). Following the uptake of managed care, around 500 hospitals closed between 1990 and 2000 due to financial reasons (Office of the Inspector General, 2003).

Following these historical waves of hospital closures, health systems researchers have investigated potentially influential factors associated with the closure of a hospital. One case-control analysis of urban hospitals closures from 1980-1987 found that for-profit ownership, belonging to a multi-institution system, the number of services and facilities offered, and the number of admissions were all significant protective factors against closure. This study also found that closure was more likely in communities with a higher percentage of black residents (a proxy measure for socioeconomic status (Whiteis, 1992). In an analysis of both urban and rural

hospital closures from 1985-1988 drafted in response to congressional request, several factors were found associated increased probability of closure including small hospital size, low patient volume, low area per capita income, higher Medicaid inpatient days, and for-profit ownership (United States General Accounting Office, 1990). Although this analysis indicated that rural hospitals had greater vulnerability to closure, this was due to a greater prevalence of other risk factors (small size, low patient volume) in rural hospitals. After controlling for these characteristics, rural hospitals were not significantly more likely to close than urban hospitals (United States General Accounting Office, 1990). From 1987 to 1991, 193 general acute care hospitals closed in rural areas. The hospitals that closed tended to be for-profit owned, maintain less beds, and have low occupancy rates. The causes behind these closures were cited as rising costs, reduced occupancy, and decreased revenue (Office of the Inspector General, 1993). From 1990 to 2000, 296 urban hospitals closed. These closed hospitals, compared to open hospitals, had less beds, lower occupancy, slightly higher Medicare and Medicaid utilization, and tended to have an average net income loss the year prior to closure (Office of the Inspector General, 2003).

Hospital Closures in Recent Years

More recently, researchers have begun investigating the risk of hospital closures in relation to the macro-level policy effects of the ACA. For rural hospitals between 2010 and 2016, Kaufman et al (2016) found a significantly lower 2009 operating and total margin among closed hospitals compared to open ones. This study also found low utilization to be a risk factor rural hospital closure and that community socio-demographic factors were similar between open and closed rural hospitals (Kaufman et. al, 2016). Another study examined 105 rural hospital closures from 2005 to 2015 and found that closed rural hospitals were located in communities with higher unemployment rates and a greater percentage of Black and Hispanic populations

when compared to other financially distressed open rural hospitals (Thomas, Holmes, & Pink, 2016). In terms of the ACA, researchers have found that hospitals in states that did not expand Medicaid eligibility may have heightened financial pressure due to the provision of a greater amount of uncompensated care as a percent of revenues compared to hospitals in states that expanded Medicaid eligibility (Reiter, Noles, & Pink, 2015).

Methods and Procedures

Data sources

The primary outcome of interest at present was hospital closures between 2010 and 2016. Hospital level data was obtained using the Center for Medicare and Medicaid Services (CMS) December 2016 Provider of Service (POS) file. This file includes a census of all Medicare providers in the United States including hospitals, home health agencies, rural health clinics, and many others. The file includes variables on facility type, size, university affiliations, ownership, staffing, termination status, termination date, geographic identifiers (e.g., state FIPS codes, county FIPS codes, and street addresses), and other information. Rural vs. urban location was included in descriptive statistics, but excluded from the primary multilevel models due to high correlation with critical access hospital status and bed count. In lieu of rural vs. urban status, population density was used as a proxy measure for hospital urbanicity and was included in statistical models at the county-level.

For contextual county effects, data was compiled from both the small area health insurance estimates (SAHIE) and the small area income and poverty estimates (SAIPE) portions of the 2013 United States census. SAHIE estimates are model based estimates, consistent with the American Community Survey, that provide county and state level data on the number and percent of people insured and uninsured by race/ethnicity, sex, age, and income. SAHIE data is

frequently used for assessing geographic differences and temporal changes over time for health insurance coverage in the United States. SAIPE estimates are also model based estimates, but focus centers on the household income and the number / percent of people in poverty at the school-district, county, and state level. These estimates provide the basis for decision making regarding the allocation of federal funds to local programs in impoverished communities. Additionally, population estimates and land-mass data (square miles of each county) were obtained from the 2010 U.S. Census and the 2010 Area Health Resource File and were used to calculate population density (United States Census Bureau, 2010; Health Resources and Services Administration, 2010).

At the state level, data came from multiple sources. State decisions on the expansion of Medicaid programs under the Affordable Care Act or 1115 waivers were drawn from the Kaiser Family Foundation's Medicaid expansion decision tracker (Kaiser Family Foundation, 2017). Expansion under the ACA or under an 1115 waiver was coded as Medicaid expansion. States were coded as expanding Medicaid if the expansion date was any time during the year 2014 (see figure 1 for Medicaid expansion status by State). Although some states expanded Medicaid programs later than 2014, these were coded as non-expansion for the present analyses. In total, 26 states were coded as expanding Medicaid and 22 were coded as non-expanding. State-level insurance market data was obtained from the American Medical Association's competition in health insurance study, (American Medical Association, 2015) which provides private managed care health insurance market concentration (Herfindahl index). A more concentrated industry has fewer, larger plans and is expected to be more resilient and better positioned to offer plans on Exchanges and keep premium rates higher. Another variable of interest is the percent of state population covered under employer sponsored healthcare plans, obtained from the 2013 Medical

Expenditure Panel of the Agency for Healthcare Research and Quality (Agency for Healthcare Research and Quality, 2013). States with a greater proportion of people covered under self-insured plans are more impervious to market changes induced by the ACA.

In order to create an analytic file with variables from all three levels of analysis (i.e., hospital, county, state), a unique identifier variable was computed in both the hospital and county file by concatenating state and county FIPS codes. This allowed each hospital and county a five character unique numeric identifier that would permit hospital level data to be merged to their associated county level census data. State level data was merged to the resulting file by state FIPS codes. The final resulting file had observations from all counties, though some counties were missing hospital level data. These were counties without a hospital as defined for the present study (i.e., short-term acute care, critical access hospital). For statistical analyses, all counties without hospitals were not analyzed. See figure 2 for a map of all counties and the number of hospitals per county.

Definitions and Inclusion / Exclusion Criteria

For the present analysis, only healthcare facilities categorized in the CMS POS file as a hospital were included (Provider category code = 01 [Hospital]). Of these hospitals, only short-term and critical access hospitals were coded for closure (Provider category subtype code = 01 or 11, respectively). Closures were coded by examination of provider termination status, which includes a single category for voluntary mergers and closures (note that this variable does not distinguish between closures and mergers). This indicator is historical in that hospitals that have closed previously are still included in the POS file. If the termination status was coded as voluntary merger/closure that occurred between January 1st, 2010 and December 31st, 2016, the hospital was coded as a *potential* closure for further investigation. Of these potential closures (n

= 292), 57 were identified by previous researchers as confirmed closures (Cecil G. Sheps Center for Health Services Research, 2017), though not all confirmed closures previously identified were present in the current file (n = 20). Previously confirmed closures that were identified as potential closures in the present file were included as closed hospitals (20 critical access and 37 short-term hospitals). All other potential closures not identified by previous researchers were investigated by web searches for news reports, government documents, and other supporting evidence to substantiate closure status. Each supporting document or news article was saved and attached to individual hospitals in a closure tracking file. Potential closures were coded as previously identified closure, currently identified closure, merger, open hospital (no indication of status change), or other status change. Potential closures were coded in blocks by state over several months to avoid the potential for fatigue error. Hospitals that had a termination code = 7 in the POS file (i.e., other provider status change) were investigated further. If these hospitals had a corresponding open provider with the same address and an original participation date shortly after the termination date, the hospital was coded a conversion to a different provider status (e.g., to critical access hospital or other). These hospitals were included in the analysis as open providers using hospital characteristics before the reported conversion (n = 65). However, hospitals with termination code 7 within this time frame that did not have a corresponding open provider were dropped from the analysis (n = 10). Additionally, hospitals that had original Medicare participation dates between January 1st, 2010 and December 31st 2016 were not included in the analysis (i.e., new hospitals).

Coding

Dummy indicators were utilized for all categorical variables in multivariable analyses. Critical access hospitals served as an indicator for comparison to other short-term hospitals.

Major and graduate medical school affiliation was combined and compared to the referent category of limited or no affiliation. Categorization of hospital size by bed count was coded similarly to previous researchers (United States General Accounting Office, 1990), but slightly varied to capture hospitals of a very small size (≤ 25 beds). Non-expansion of Medicaid served as a state level indicator variable for comparison to states that did expand Medicaid.

Analysis and Software

The log-odds of hospital closure were estimated using a series of three-level hierarchical fixed effects models with a logit link function. Models estimated included: 1) Random intercepts only, 2) Hospital main effects, 3) County main effects, and 4) State main effects. The three-level random intercepts logistic regression follows the general formulas presented below. As with simple logistic regression, slope coefficients may be exponentiated for interpretation as odds ratios, and 95% CIs can also be derived using the standard deviations with the estimates and exponentiation. The below equations employ Raudenbush and Bryk notation as presented in the HLM 7 guide to hierarchical linear and nonlinear modeling (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2011).

Equation 1 specifies the logit link function such that η_{mijk} is the log-odds of membership in category *m* (closed = 1) over the log-odds of membership in category *M* (closed = 0).

$$\eta_{mijk} = log\left(\frac{\phi_{mijk}}{\phi_{Mijk}}\right) \qquad \text{(Eq. 1, Logit link function)}$$

Where…

$$\phi_{Mijk} = 1 - \sum_{m=1}^{M-1} m_{ijk} \qquad \text{(Eq. 2)}$$

At level 1 (i.e., hospitals)…

$$Y_{ijk} = \pi_{0jk} + \pi_{1jk}\alpha_{1ijk} + \pi_{2jk}\alpha_{2ijk} + \cdots + \pi_{pjk}\alpha_{pijk} \qquad \text{(Eq. 3)}$$

Where

π_{pjk} (p = 0,1,…,*P*) are *level-1 coefficients*,

and α_{pijk} is a *level-1 predictor p* for hospital *i* in county *j*, in state *k*.

At level 2 (i.e., counties)…

$$\pi_{pijk} = \beta_{p0k} + \beta_{1k}X_{1jk} + \beta_{p2k}X_{2jk} + \cdots + \beta_{pQ_pk}X_{Q_pjk} + r_{pjk} \quad \text{(Eq. 4)}$$

Where

B_{pqk} (*q* = 0,1,…,*Qp)* are *level-2 coefficients*;

X_{qjk} is a *level-2 predictor*; and

r_{pjk} is a *level-2 random intercept*.

At level 3 (i.e., states)…

$$\beta_{pqk} = \gamma_{pq0} + \gamma_{pq1}W_{1k} + \gamma_{pq2}W_{2k} + \cdots + \gamma_{pqS_{pq}}W_{S_{pq}k} + u_{pqk} \quad \text{(Eq. 5)}$$

Where

γ_{pqs} (*s* = 0,1,…,S_{pq}) are *level-3 coefficients*,

W_{sk} is a *level-3 predictor*, and

U_{pqk} is a *level-3 random intercept*.

Hospital closures were coded and linked to news articles in Microsoft Excel. This allowed for ease of hyperlink use for closure articles and color organization of states for coding in blocks. All file management / merging, data cleaning, variable recoding, univariate statistics, and bivariate analysis was completed using SAS 9.4. Multivariable multilevel logistic models

were estimated using the "GLLAMM" package in Stata/IC 14.2 (Rabe-Hesketh, Skrondal, & Pickles, 2004). Geographic maps were created using QGIS 2.14.

Results

Univariate Descriptive Statistics

A total of 4,631 short-term hospitals were open in 2010 (see Table 1). Of these hospitals, 126 closed between January 1st, 2010 and December 31st, 2016. See Table 1 for descriptive statistics of hospital type, ownership, size, and medical school affiliation. Across all hospitals, the mean number of changes in ownership was 1.2 with a minimum of zero and maximum of ten (see Table 2). Across all counties, 17.1 percent of the population was uninsured, the Median Household Income (MHI) was $44,173, and the median population density was 53 people per square mile. At the state-level, the average percent of people covered under a self-insured employer-sponsored health plan was almost 60% (see Table 2). Additionally, the average Herfindahl index of market concentration was 0.3, ranging from 0.1 (highly competitive market) to 0.7 (oligarchical market).

Bivariate Analyses

Figure 1 displays the raw number of short-term facility closures between January 1st, 2010 and December 31st, 2016 in states expanding (26) and not expanding Medicaid (22). There were 126 total hospital closures with 47 in Medicaid expansion states and 79 in non-expansion states. Among states that did not expand Medicaid, the odds of having a hospital closure were 4.5 times the odds having a hospital closure among state that expanded Medicaid (see table 4; $p = .026$). A total of 51 rural hospitals (2.75% of all rural hospitals) and 75 urban hospitals (2.83% of all urban hospitals) closed during the specified time period. See Table 3 for a full descriptive breakdown of hospital characteristics by rural vs. urban status and closure status. Bivariate

logistic regression was employed with all hospital-level variables to determine association with hospital closure. At the bivariate level (see Table 4), fewer beds, nonprofit ownership, and more previous changes in ownership were statistically significant risk factors for closure. Critical access hospital status was a statistically significant protective factor against closure. For-profit ownership and medical school affiliation were not significant predictors of hospital closure.

Multilevel Models

Four multilevel models were fit to the data (i.e., intercepts only, hospitals, counties, and states). Model 2 with only hospital-level predictors provided the best fit to the data, $X^2(2, N = 4{,}631) = 81.14$, $p < .001$. At the hospital level, critical access status was associated with substantially reduced odds of closure compared to other short-term hospitals (OR = 0.26). Medical school affiliation was not a significant protective factor against hospital closure (OR = 0.98). Compared to very large hospitals (200+ bed count), those with 25 or fewer beds (OR = 9.30), between 26-99 beds (OR = 5.22), and between 100-199 beds (OR = 2.89) were significantly more likely to experience closure. Non-profit ownership was also significantly associated with risk of closure (OR = 3.64). Additionally, a higher number of hospital ownership changes was significantly associated with closure (OR = 1.13). After including county-level covariates, the model fit was not significantly improved (see Table 5). Only county-level population density was associated with risk of closure such that a higher population density was associated with a greater risk of hospital closure ($\beta = 4.29e^{-05}$). Among the state-level predictors, including percentage of population self-insured, state insurance market concentration, and non-expansion of Medicaid, none were significantly associated with hospital closure. See figure 3 for a geographic map of counties with at least one closure in the context of state-level Medicaid expansion decision.

Discussion

Health Care Systems and Policy

Given recent media attention and national concerns over hospital closures and health care reform, this paper examined short-term hospital closures in both rural and urban areas between 2010 and 2016. At the bivariate level, states that did not expand Medicaid had greater odds of having a hospital closure. However, when accounting for the effects of hospital characteristics, county demographics, and state market factors, the relationship became non-significant. This is particularly interesting given recent concerns regarding and attempts to repeal and replace the Affordable Care Act (H.R. 1628-American Health Care Act, 2017). Although, this finding may be sensitive to the definitions of expansion as well as the timing of closures. It is possible that the policy effects on closures may take additional time to manifest. Though recent hospital closure did not appear to have statistically significant patterns with investigated variables at the state level in the multivariable hierarchical model, it is highly probable that the legislated policy has shifted the hospital industry as a whole (Leemore, 2014). Given the recent consolidation of the hospital market, either through closure or mergers, it is critical that policymakers contemplate the potential effects of changes or repeal of the ACA. Following the implementation of this landmark policy, the health care system has shifted to accommodate the law's provisions and requirements. Additional shifts or the removal of the ACA may have unforeseen consequences so soon after such a rapid consolidation of the market.

Risk Factors for Short-Term Hospital Closures

In contrast to historical trends in hospital closures, the present study found that nonprofit hospitals were at greater risk of closure when compared to government owned hospitals. Historically, for-profit hospitals have exhibited a greater risk of closure, with even greater risk

among rural for-profit hospitals (United States General Accounting Office, 1990). This is particularly interesting given that, under the ACA, non-profit hospitals have additional accountabilities regarding assessing community health needs, limiting charges on those eligible for financial assistance (Shi and Singh, 2015). However, in keeping with previous literature, hospitals with a greater number of beds were less likely to close. Larger hospitals often have greater occupancy rates and substantial financial backing from donors and property taxes (Shi & Singh, 2015). Further, hospitals with a greater number of ownership changes were more likely to close. As a proxy measure of hospital stability, it is not surprising that this trend arose. In the health care industry, struggling hospitals often undergo several changes in ownership before at last falling victim to financial pressures and debts. Additionally, although hypothesized as a protective factor, medical school affiliation was not associated with hospital closure. This may indicate that recent health care industry pressures have not discriminated between hospitals' university affiliation status, but rather by known risk factors such as bed count, ownership, and stability. Finally, although greater population density was associated with higher risk of closure, this effect was small (see Table 5). This may indicate little difference between the risk of hospital closure in rural vs. urban areas. Additional multilevel model analyses controlling for hospital urbanicity indicated no difference in risk of closure between hospitals located in rural and urban areas.

Strengths and Limitations

There are several strengths to this study. The CMS provider of service files are virtually a census of all hospitals in the United States. As Medicaid / Medicare are such ubiquitous reimbursement mechanisms in the U. S. health care system, hospitals that do not participate are exceedingly rare. Additional strengths of this study include the hierarchical control of county and

state factors and the inclusion of both rural and urban hospitals. Although these findings are substantively intriguing, there are several limitations to consider in the present study. The present analysis only included proxy measures of hospital profitability and financing and focused on a subset of all hospitals (i.e., short-term general and critical access hospitals). Future researchers should examine hospital closures with a greater focus on hospital financing, payer share, operating margins, and perhaps scope of hospital services, including long-term care facilities and / or psychiatric hospitals. With expansions in insurance coverage for mental health under the ACA, this research may be enlightening. Future researchers should also examine hospital closures and mergers in conjunction, potentially as a marker for "financial distress" that may allow additional statistical power.

In addition, this study only examined the subset of U.S. counties where hospitals were actually present in 2010, truncating the sample of all possible hospital locations. Selection bias may be manifest in such a truncated sample, which would require more complex modeling that the scope of the current work. There also may be difficulty in detecting effects due to statistical power issues, as only 126 short-term general hospitals closed over the reported period. Furthermore, the spatial interdependence of the hospitals across the landscape could be considered using a spatial regression model. The study simplified the measure of hospital closures as a dichotomous outcome aggregated over the period between 2010 and 2016. As a cross-sectional study, causality is impossible to determine at present. For example, all states may not have exhibited equal closure risk pre-Medicaid expansion. In order to address this concern, future researchers should utilize longitudinal methods (such as hierarchical growth models) to examine the years prior to Medicaid expansion in conjunction with the years examined at present. Further, the policy effects of the ACA were simplified to coding as state-level Medicaid

expansion in the year 2014. The temporal ordering of the effect of Medicaid expansion may be mixed to the inclusion of hospitals from 2010 onward. In order to identify the effects of the law's individual policy changes, it may be beneficial to both tease out the timing of each policy's implementation and to examine hospital closures from the period prior to the passage of the ACA in 2010. This would allow a better comparison of both the individual policy effects and the entire effect of the ACA as opposed to simply the Medicaid expansion decision.

Implications and Future Directions

Although hospital closures are often examined as a rural problem, the present study found no greater risk of closure for rural compared to urban hospitals. However, hospital size, ownership, and previous changes in ownership were significantly associated with closures among short-term general and critical access hospitals in the U.S. during 2010-2016, and may help in identifying hospitals at increased vulnerability in coming years. Given historical research indicating higher likelihood of closure among for-profit hospitals, it may be prudent to investigate unique pressures or policy changes on non-profit hospitals. Recent policy and insurance market changes have undoubtedly changed the health care landscape in the U.S. Given these changes, some reconfiguring of health care delivery systems is to be expected. Many communities have begun using alternative facility models such as free-standing emergency rooms (ERs) or urgent care clinics. These models of care delivery may serve a valuable function, particularly in areas that have experienced a decrease in healthcare access (a hospital closure perhaps) or where hospital ER use is excessive and costly relative to a complementary system with free-standing ERs to alleviate some of the financial pressure. Local, state, and federal policies supportive of small and nonprofit hospitals may be beneficial in preventing more hospital closures in the coming years. Further, in-depth financial research and increased

awareness of both the historical and current trends in hospital closures is recommended for researchers and policymakers.

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Appendix: Tables and Figures

Figure 1

Hospital Closures by Medicaid Expansion Status

Expansion States	Nonexpansion States
• Experienced **47** hospital closures: **41** short-term and **6** critical access. • A total of **2.09%** of hospitals open in 2010 closed by December 2016. • Includes: Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Illinois, Iowa, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oregon, Rhode Island, Vermont, Washington, and West Virginia.	• Experienced **79** hospital closures: **63** short-term and **16** critical access. • A total of **3.32%** of hospitals open in 2010 closed by December of 2016. • Includes: Alabama, Florida, Georgia, Idaho, Indiana, Kansas, Louisiana, Maine, Mississippi, Montana, Nebraska, North Carolina, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Wisconsin, and Wyoming.

Note: Alaska and Hawaii were not included in present analyses, but both states adopted the Medicaid expansion.

Table 1

Hospital Sample Characteristics

Characteristic	N = 4,631
Hospital Type	
Short-Term	3343 (72.2)
Critical Access Hospital	1288 (27.8)
Ownership	
For-Profit	2738 (59.1)
Non-Profit	861 (18.6)
Government	1032 (22.3)
Certified Bed Count / Size	
≤ 25 Beds	1426 (30.8)
26-99 Beds	957 (20.7)
100-199 Beds	835 (18.0)
200+ Beds	1413 (30.5)
Medical School Affiliation	
Limited / No Affiliation	4056 (87.6)
Major / Graduate	575 (12.4)

Table 2

Descriptive Statistics for Continuous Measures: Hospitals, Counties, and States

	Median	Mean	SD	Min	Max
Hospital-Level					
Certified Bed Count	95.0	172.7	215.2	2	2449
Change of Ownership Count	1.0	1.2	1.4	0.0	10
County-Level					
Percent Uninsured	16.9	17.1	5.3	3.0	38
Population Density	53.4	301.7	1918.3	0.0	69179.0
Median Household Income	44173.0	46011.9	11237.3	10153.0	99950.0
State-Level					
Percent Self-Insured	58.4	59.7	6.6	46.7	73.5
Insurance Market Concentration	0.3	0.3	0.1	0.1	0.7

Note: Insurance market concentration is a Herfindahl Index with a possible range from 0 to 1, with 0 indicating many insurance providers and 1 indicating a monopoly.

Table 3

Comparison of Characteristics of Open and Closed Hospitals: 2010-2016

	Closed Hospitals (N=126)		Open Hospitals (N=4,505)	
	Rural (n=51)	Urban (n=75)	Rural (n=1,855)	Urban (n=2,650)
Hospital Type				
Short-Term	33 (64.7)	71 (94.7)	839 (45.2)	2400 (90.6)
Critical Access Hospital	18 (35.3)	4 (5.3)	1016 (54.8)	250 (9.4)
Ownership				
For-Profit	19 (37.3)	38 (50.7)	1002 (54.0)	1679 (63.4)
Non-Profit	21 (41.2)	31 (41.3)	219 (11.8)	590 (22.3)
Government	11 (21.6)	6 (8.0)	634 (34.2)	381 (14.4)
Certified Bed Count / Size				
≤ 25 Beds	22 (43.1)	16 (21.3)	1038 (55.6)	356 (13.4)
26-99 Beds	23 (45.1)	23 (30.7)	509 (27.4)	402 (15.2)
100-199 Beds	4 (7.8)	23 (30.7)	227 (12.2)	581 (21.9)
200+ Beds	2 (3.9)	13 (17.3)	87 (4.7)	1331 (49.5)
Medical School Affiliation				
Major / Graduate	1 (2.0)	8 (10.7)	42 (2.3)	524 (19.8)
Limited / No Affiliation	50 (98.0)	67 (89.3)	1813 (97.7)	2126 (80.2)

Note:

Table 4

Bivariate Logistic Regression of Associations between Measures and Hospital Closures

	Odds Ratio	Std. Err.	*p*-value	95% Lower CL	95% Upper CL
≤ 25 Beds (ref >200 Beds)	2.552	0.154	.002	1.397	4.660
26-99 Beds (ref >200 Beds)	4.706	0.150	<.001	2.612	8.479
100-199 Beds (ref >200 Beds)	3.114	0.163	<.001	1.647	5.889
Change of Ownership Count	1.201	0.055	<.001	1.079	1.337
For-Profit Hospital (ref = Government)	1.269	0.130	.392	0.735	2.192
Non-Profit Hospital (ref = Government)	3.838	0.133	<.001	2.417	7.034
Rural (ref = Urban)	1.218	0.086	.250	0.870	1.703
Medical School Affiliation (ref = No aff.)	0.535	0.174	.073	0.270	1.061
Critical Access Hospital (ref = Short-term)	0.541	0.119	.010	0.340	0.861
Medicaid Nonexpansion (state-level)	4.500	3.050	.026	1.192	16.988

Note: No aff., limited or no medical school affiliation. Bed county category type three analysis of effects indicated an overall effect of bed count on the log odds of hospital closure, X^2 (3, N = 4,631) = 27.77, $p < .001$. Ownership (i.e., for-profit vs. government and non-profit vs. government) type three analysis of effects indicated an overall effect of ownership on the log odds of hospital closure, X^2 (2, N = 4,631) = 40.11, $p < .001$.

Table 5

3-Level Hierarchical Generalized Linear Model Analysis

	Model 1	Model 2	Model 3	Model 4
Fixed Effects				
Intercept	0.02 (0.01)	2.94e-3 (1.50e-3)**	0.01 (0.01)	1.32e-03 (2.10e-03)
Critical Access Hospital		0.29 (0.11)**	0.26 (0.10)***	0.26 (0.10)***
Medical School Affiliation		0.98 (0.38)	0.88 (0.36)	0.89 (0.36)
For-profit Ownership		1.59 (0.47)	1.63 (0.49)	1.72 (0.52)
Nonprofit Ownership		3.50 (1.07)***	3.57 (1.09)***	3.64 (1.12)***
Small Hospital (≤25 beds)		9.30 (3.87)***	9.35 (3.95)***	9.33 (3.94)***
Medium Hospital (26-99 beds)		5.22 (1.77)***	5.02 (1.74)***	4.96 (1.72)***
Large Hospital (100-199 beds)		2.89 (1.00)**	2.90 (1.02)**	2.93 (1.03)**
Change of Ownership Count		1.16 (0.07)*	1.15 (0.07)*	1.13 (0.06)*
Median Household Income			1.00 (1.01e-05)*	1.00 (1.03e-05)
Percent Uninsured			0.99 (0.02)	0.99 (0.02)
Population Density			1.00 (2.07e-05)	1.00 (2.08e-5)*
Percent Self-Insured				1.03 (0.02)
Insurance Market Concentration				2.12 (2.38)
Non-Expansion of Medicaid				1.10 (0.29)
Error Variance				
Level-1	3.2899	3.2899	3.2899	3.2899
Level-2 Intercept	0.00858 (0.36449)	0.45149 (0.48729)	0.44909 (0.48162)	0.46989 (0.46360)
Level-3 Intercept	0.36321 (0.18754)	0.17506 (0.14119)	0.16979 (0.13447)	0.12066 (0.12082)
Model Fit				
-2LogLikelihood	1144.34	1063.20	1056.14	1052.46
Likelihood ratio test	-	81.14***	7.06	3.68
AIC	1146.34	1081.20	1080.14	1082.46
BIC	1152.78	1139.16	1157.43	1179.07

Note: All estimates presented as odds ratios; *, $p<.05$; **, $p<.01$; ***, $p<.001$; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion (i.e., Schwarz Criterion).

Figure 2

Count of Hospitals by County: 2010

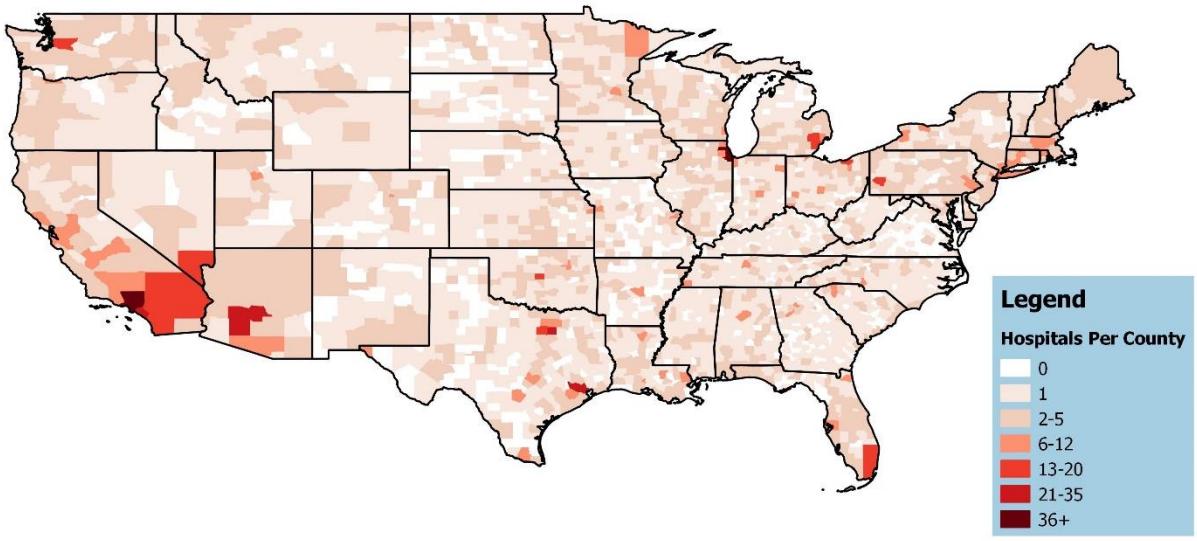

Figure 3

Counties with Short-Term Hospital Closures and Number of Closures by State: 2010-2016