Certificate-of-Need Laws and Hospital Quality

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Abstract

We investigate the effect of certificate-of-need (CON) laws on the quality of hospitals. As of 2015, 36 states and the District of Columbia required healthcare providers to seek approval from a state's healthcare regulator before making any major capital expenditures. These requirements restrict entry into the healthcare market. Therefore, incumbent medical providers in states with CON laws may face fewer competitive pressures. Hospital service quality is one important margin on which hospitals compete. In this paper, we test the hypothesis that hospitals in states with CON laws provide lower-quality services than hospitals in states without CON laws. Our results do not allow us to reject the hypothesis that CON hospitals deliver lower-quality care than non-CON hospitals. Nor do our results show that hospital quality is higher in CON states. Our overall results suggest that CON regulations lead to lower-quality care for some measures of quality and have little or no effect on other measures of quality. The results are largely robust to a variety of alternative samples and quality measures.

JEL codes: I110, I180, H75, L130, D430

Keywords: healthcare, welfare, hospitals, certificate of need, CON, entry, competition, quality, quality competition, nonprice competition, Medicare, Hospital Compare

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Since the mid-1970s, the majority of states have required healthcare providers to seek approval from the state's healthcare planning agency before making any major capital expenditure. As of 2015, 36 states and the District of Columbia had laws in place that allow them to approve or reject spending on new facilities, devices, and services based on community "need." These certificate-of-need regulations, or CON laws, were enacted with the goal of restraining healthcare spending.[1]

One objective of these CON laws is to limit entry into the medical profession. By forcing healthcare providers to seek government approval before expanding facilities, offering new services, or purchasing new equipment, these regulations potentially restrict new providers from entering the marketplace. When regulations restrict entry into a market, incumbent providers face fewer competitive pressures. Hospital service quality is one margin on which hospitals compete. The decisions and efforts of hospital administrators and staff members are among the determinants of hospital quality. Decision makers in hospitals facing fewer competitive pressures may therefore set lower standards of quality or effort.

One relevant issue with respect to the margins on which hospitals compete is how hospital prices are determined. When prices are determined administratively rather than by the market, hospitals cannot compete through pricing and therefore have an incentive to compete more intensely on nonprice margins such as the quality of care. Thus, economic theory predicts

[1] The National Health Planning and Resources Development Act of 1974, the original impetus for CON laws, contains the following language in its statement of purpose: "The massive infusion of Federal funds into the existing health care system has contributed to inflationary increases in the cost of health care and failed to produce an adequate supply or distribution of health resources, and consequently has not made possible equal access for everyone to such resources." Pub. L. No. 93-641 (1975).

that free entry and competition among hospitals facing regulated prices will tend to increase the equilibrium quality of patient care. In contrast, hospitals facing market-determined prices may compete on both price and quality margins. The effect of free entry and competition on equilibrium hospital quality in a system of market-determined prices is therefore ambiguous. In their review of the literature on competition in healthcare markets, Gaynor and Town (2011, 81–82) find that empirical work generally confirms these theoretical predictions: “Most of the studies of Medicare patients show a positive impact of competition on quality,” whereas “the results from studies of markets where prices are set by firms (e.g., privately insured patients) are much more variable.”

Supporters of CON regulations have suggested that these regulations have a positive impact on healthcare quality. For instance, in response to a Federal Trade Commission critique of CON laws, the American Health Planning Association (AHPA) argued that “recent empirical evidence shows substantial economic and service quality benefits from CON regulation and related planning” (AHPA 2005, 14). Further, Thomas Piper, director of Missouri’s CON program, told a joint Federal Trade Commission–Department of Justice hearing that “quality is improved” thanks to Missouri’s CON program (Piper 2003, 27).

Specifically, CON supporters argue that a state regulator’s ability to set standards and monitor utilization rates positively affects the quality of healthcare services (Thomas 2015; Steen 2016). This argument is based on research that links procedural volume with better outcomes: As practitioners serve more patients with the same condition and perform the same procedure more often, they become more specialized and proficient, leading to better patient outcomes (Halm, Lee, and Chassin 2002). By restricting the number of providers through CON laws, regulators aim to allocate more patients to existing providers, thereby increasing providers' expertise and improving patient outcomes (Cimasi 2005).

However, several scholarly works do not find evidence of a systematic difference in the quality of care between providers in states governed by CON laws and those in non-CON states. For example, Polsky et al. (2014) examine the effects of CON laws for home healthcare services and find no significant differences in rehospitalization rates or expenditures between CON and non-CON states. Further, Paul, Ni, and Bagchi (2014) find that CON laws are associated with shorter emergency department visits. Lorch, Maheshwari, and Even-Shoshan (2011) find that mortality rates for infants with low birth weight are not significantly different between CON and non-CON states, although CON states with large metropolitan areas have significantly lower all-infant mortality rates than non-CON states.

A number of studies examine the relationship between CON laws and mortality after coronary artery bypass graft (CABG) surgeries—with contradictory results. Cutler, Huckman, and Kolstad (2009) find that CABG mortality rates declined after Pennsylvania repealed its CON laws. However, Ho, Ku-Goto, and Jollis (2009) find no difference between CON and non-CON states with respect to CABG mortality rates. Two studies of 1990s data report that CABG mortality rates are higher in non-CON states (Vaughan-Sarrazin et al. 2002; Rosenthal and Sarrazin 2001).

Studies examining the effect of CON laws on the quality of health care typically suffer from two limitations. First, inadequate data on provider quality limit scholars to investigating how CON regulations affect the quality of specific procedures, such as CABG, rather than considering quality across multiple margins. Second, studies on this topic, with the exception of Polsky et al. (2014), have difficulty untangling the causal effect of CON laws from other important factors that independently affect healthcare quality and that might be correlated with whether a state has a CON program.

Biased estimates might be owing to unobserved hospital patient characteristics, such as systematic geographic variation in the severity of illnesses. For example, if hospitals in CON states have patients who are less healthy but healthiness is unobserved or unmeasured, then lower hospital quality in those states might be attributable to patient characteristics rather than to CON laws. Geographic variation in healthcare utilization or provider quality might also be a confounding factor, if systematic variation across the country is correlated with the presence of CON laws but not caused by those laws.

In this paper, we propose an empirical design that addresses those omitted-variable issues and that allows us to estimate a causal effect. First, we exploit a dataset whose stated purpose is to measure hospital quality objectively, across many aspects of the patient experience. Second, we build on the identification strategy of Polsky et al. (2014), which allows us to estimate the causal effect of CON regulations on the quality of hospital services. This empirical strategy compares outcomes of hospitals in a particular healthcare market that are located in a CON state with outcomes of hospitals in the same healthcare market that are located in a non-CON state. By focusing only on hospitals in these specific markets and assuming that unobserved patient- and geographic-level heterogeneities are similar on both sides of the CON border within one market, we can estimate the causal effect of CON regulations on hospital quality.

The data used in our analysis come from Hospital Compare, a database maintained by the Centers for Medicare and Medicaid Services (CMS). Hospital Compare contains more than 100 quality indicators from more than 4,000 Medicare-certified hospitals (CMS 2016b). These measures include readmission and mortality rates for common conditions, quality- and process-of-care indicators, and patient-experience surveys. CMS used these measures because they represent some of the most common, costliest, and most variable factors affecting individual hospitals' performance. When considered together, these measures are meant to capture the overall quality of care by a given provider. According to CMS, the purpose of these data is to provide a consistent and objective tool for patients to compare quality when selecting a healthcare provider. We use provider-level quality metrics for nine different conditions from more than 900 hospitals for the years 2011–2015 to assess the effect of CON laws on hospital quality.

Our findings show that the quality of hospital care in states with CON laws is not systematically higher than the corresponding quality in non-CON states. Moreover, we find support for the hypothesis that in states where CON laws regulate provider entry into healthcare markets, incumbents tend to provide lower-quality services. In particular, we find that mortality rates for pneumonia, heart failure, and heart attacks are significantly higher in hospitals in CON states relative to those in non-CON states. We also find that deaths from complications after surgery are significantly higher in CON states. Further, our findings provide some evidence that CON regulations are associated with lower overall hospital quality, although the corresponding point estimates are not always precise. We present balancing tests and conduct several robustness tests whose results support the causal interpretation of our findings.

Regulatory Background

CON programs were adopted nationwide when the National Health Planning and Resources Development Act of 1974 became law (Cimasi 2005). The act was part of the federal government's plan to develop a national health planning policy, and the legislation required federal agencies to establish specific health policy goals, priorities, and guidelines (Cimasi

2005). The act also incentivized all 50 states to adopt a process by which healthcare providers would seek approval from their state's health planning agency before making any major capital expenditure, such as a building expansion or purchasing new medical devices (NCSL 2016). The stated goal of this policy was to ensure that the additional medical services to be provided did not exceed community need. Once a regulator determined that there was community need, the applicant was granted permission to commence the project—hence the term *certificate of need* (NCSL 2016).

The National Health Planning and Resources Development Act of 1974 provided strong incentives to the 50 states to implement CON programs by tying certain federal healthcare funding to the states' enactment of CON programs (Cimasi 2005). In addition, the federal government directly subsidized the development of state CON programs. These federal policies encouraged the states that did not already have a CON program to adopt CON regulations. In 1974, 23 states had some form of CON regulations, and by 1980 the number had increased to 49. The National Health Planning and Resources Development Act of 1974 was repealed in 1986, lifting the requirement that states maintain CON programs and eliminating the associated federal subsidy. Subsequently, some states kept their CON laws and others repealed theirs. Table 1 lists the states with CON laws for the years 2011–2015 and the facilities, equipment, and procedures that those states regulated. States did not significantly change their CON programs between 2011 and 2015.

Table 1. Certificate-of-Need Regulations in the United States

	Acute Hospital Beds	Air Ambulance	Ambulatory Surgical Centers	Burn Care	Cardiac Catheterization	Computed Tomography Scanners	Gamma Knives	Home Health	Hospice	Intermediate Care Facilities/Mental Retardation	Long Term Acute Care	Lithotripsy	Nursing Home Beds/Long Term Care Beds	Medical Office Buildings	Mobile Hi Technology	Magnetic Resonance Imaging (Scanners	Neo-Natal Intensive Care	Obstetrics Services	Open Heart Surgery	Organ Transplants	Positron Emission Tomography Scanners	Psychiatric Services	Radiation Therapy	Rehabilitation	Renal Failure/Dialysis	Assisted Living & Residential Care Facilities	Subacute Services	Substance/Drug Abuse	Swing Beds	Ultra-Sound	Counts by State
AK	X		X		X	X	X				X	X	X		X	X	X	X	X	X	X	X	X		X		X				19
AL	X	X	X	X	X		X	X	X		X		X				X	X	X	X		X	X	X	X			X	X		20
AR								X	X	X			X									X				X					6
CT	X		X		X	X			X		X		X		X	X	X	X	X	X	X	X	X					X			17
DC	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	28
DE	X		X		X						X	X	X								X		X								8
FL	X								X	X	X		X				X			X		X		X			X	X			11
GA	X		X		X		X	X		X	X	X	X				X	X	X		X	X	X	X				X			17
HI	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	27
IA	X		X		X					X	X		X						X	X		X	X								10
IL	X		X		X					X	X		X				X	X	X	X				X	X		X		X		14
KY	X		X		X			X	X	X	X		X		X	X	X		X	X	X	X	X	X				X			18
LA										X			X													X					3
MA		X	X				X					X	X			X	X		X	X	X	X	X	X				X			14
MD	X		X	X	X			X	X	X	X		X				X	X	X	X		X		X				X			16
ME		X	X	X	X	X	X				X	X	X		X	X	X	X	X	X	X	X	X	X	X			X	X	X	23
MI	X	X	X		X	X	X				X	X	X		X	X	X		X	X	X	X	X						X		18
MO	X				X	X	X			X	X	X	X		X	X					X		X	X		X					14
MS	X		X		X		X	X	X	X	X		X			X			X		X	X	X	X	X			X	X		18
MT			X					X		X			X											X				X	X		7
NC	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X			25
NE													X											X							2
NH			X		X						X		X		X	X			X		X	X	X	X				X			12
NJ	X			X	X			X		X	X		X				X		X	X		X		X							12
NV	X		X							X			X																		4
NY	X		X	X	X	X		X	X			X	X		X	X	X	X	X	X			X	X	X						18
OH													X																		1
OK										X			X									X					X				4
OR									X		X		X																X		4
RI	X		X		X	X	X		X		X		X		X	X	X	X	X	X	X	X	X	X			X	X			20
SC	X		X		X		X	X	X	X	X	X	X		X	X	X		X		X	X	X	X			X	X			20
TN	X		X	X	X			X	X	X	X	X	X			X	X		X		X	X	X	X			X	X	X		20
VA	X		X		X	X	X			X	X	X	X		X	X	X	X	X	X	X	X	X	X							19
VT	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	30
WA	X		X	X	X			X	X		X		X				X	X	X	X		X		X	X		X		X		17
WI										X			X														X				3
WV	X		X		X	X		X	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X			X			21

Source: NCSL (2016).

In states with CON programs, healthcare providers who seek to enter a market, to expand their facilities, or to offer new services must submit an application to their state's healthcare planning agency for approval. Virginia, a state with a CON program that covers comparatively many aspects of medical care, is representative in this regard.[2] Applicants must first submit a letter of intent to the Virginia Department of Health and to the appropriate regional health planning agency. Next, the applicant submits a formal application and pays a fee of up to $20,000. Submissions are reviewed by state regulators in 60-day batches, depending on the type of facility or procedure under review. The Code of Virginia requires the regional healthcare planning agencies to hold at least one public hearing for each application, at which point competitors of an applicant are given the opportunity to challenge the need for the proposed medical service. Regional planners then submit their recommendations and reasoning to the department, which reviews the applications and recommendations and may hold additional hearings. At the end of this process, the department makes a recommendation and submits the application to the state health commissioner for final approval or denial (Virginia Department of Health 2015).

The criteria for assessing CON applications are usually specified in regulations promulgated by each state's planning agency (Cimasi 2005). For instance, Virginia mandates that the state health commissioner consider eight factors when determining whether there is a public need for a new project: (1) whether the project will provide or increase access to health services; (2) whether the project will meet the needs of residents; (3) whether the project is consistent with current rules for medical facilities, such as minimum utilization rates; (4) to what extent the project will foster beneficial competition; (5) how the project will affect the healthcare

[2] For a summary of Virginia's application process, see Virginia Department of Health (2015, 18).

system, such as the utilization and efficiency of existing facilities; (6) the project's feasibility, including financial costs and benefits; (7) to what extent the project will provide improvements in the financing and delivery of services; and (8) the project's contribution to research, training, and improvements to health services, in the case of a project proposed by or affecting a teaching hospital (Va. Code § 32.1-102.3 (2009)). However, the Code of Virginia does not rank these criteria with respect to their importance, leaving discretion to regulators as to how to weigh each criterion in their decisions.

In addition to their role in monitoring and managing applications for proposed healthcare projects, state CON programs set highly specific standards that govern the use of facilities and procedures (Cimasi 2005). Virginia's CON program sets rules that apply to 18 different healthcare services and facilities; collectively, these rules are called the State Medical Facilities Plan. For example, in the section that sets standards for CT scans, the plan states that "CT services should be within 30 minutes driving time one way under normal conditions of 95% of the population of the health planning district" (12 Va. Admin. Code § 5-230-90 (2009)). Other aspects of the plan set standards for determining minimum utilization rates, timing for services to be introduced or expanded, levels of staffing, and the minimum number of bassinets at facilities offering newborn services.

This level of specificity is typical for state CON programs. The South Carolina Health Plan, for example, requires applicants seeking a CON for diagnostic catheterization services to "project that the proposed service will perform a minimum of 500 diagnostic equivalent procedures annually within three years of initiation of services, without reducing the utilization of the existing diagnostic catheterization services in the service area below 500" per laboratory (South Carolina Health Planning Committee 2015, VIII-5). Similarly, Missouri's CON regulations state that “approval of additional intermediate care facility/skilled nursing facility (ICF/SNF) beds will be based on a service area need determined to be fifty-three (53) beds per one thousand (1,000) population age sixty-five (65) and older minus the current supply of ICF/SNF beds” (Mo. Code Regs. tit. 19, § 60-50.450 (2014)).

Data

We use a selection of CMS metrics to estimate the difference in quality between hospitals in CON and non-CON states, including rates at which patients develop or die from surgical complications, patient survey results, readmission rates, and mortality rates. Here, we explain where and how we obtained those data and why we chose those specific metrics. In this section, we also describe what aspect of quality each metric is intended to capture, how each metric is calculated, and our reasoning for including these metrics for measuring hospital quality.

We use data from CMS’s Hospital Compare to examine variation in the quality of hospitals’ medical services. Hospital Compare was launched in 2005 as part of an effort to “make it easier for consumers to make informed healthcare decisions and to support efforts to improve quality in U.S. hospitals” (CMS 2016b). CMS partners with the Hospital Quality Alliance, whose members include the American Hospital Association, American Medical Association, and US Chamber of Commerce. Before Hospital Compare, hospitals reported quality measures voluntarily. The Medicare Modernization Act of 2003 included incentives for hospitals to begin reporting data to CMS (Werner and Bradlow 2006). Today, CMS requires hospitals seeking reimbursement for any services funded by Medicare or Medicaid to provide data about the quality of their services and to meet minimum quality thresholds (Medicare.gov 2016).

For the years 2011–2015, we analyze the effect of state CON laws on nine different quality-of-care indicators. One measure meant to capture the quality of surgical patient care is *Deaths among Surgical Inpatients with Serious Treatable Complications* (PSI #4). This measure is a composite of mortality rates. It measures how many deaths occur per 1,000 patients who develop a serious complication after surgery. Hospital Compare considers this measure to be an indicator of quality because higher-quality hospitals identify complications sooner, treat them correctly, and thus incur fewer patient deaths.[3]

The denominator in PSI #4 comprises all hospital-level surgical discharges age 18 and older who developed complications of care, including pneumonia, pulmonary embolism or deep vein thrombosis, sepsis, shock or cardiac arrest, and gastrointestinal hemorrhage or acute ulcer. The numerator in PSI #4 comprises all discharged patients (included in the denominator) who died after developing a complication. Excluded from the computation of this measure are patients age 90 and older, patients transferred to an acute-care facility, and patients with missing discharge disposition, gender, age, quarter, year, or principal diagnosis information. The annual rate for the *Death among Surgical Inpatients with Serious Treatable Complications* measure is calculated using data over 20 months. For example, the data used to compute this measure in 2011 are for the period October 2008–June 2010.

[3] A hospital's performance on the *Deaths among Surgical Inpatients with Serious Treatable Complications* measure is an accurate indicator of quality of care, assuming that providers in CON and non-CON states turn away patients at the same rate. If this assumption does not hold, it may be that hospitals in CON states only appear to perform worse on this measure. For example, if CON regulations give incumbents the market power to be able to turn away all but the most seriously ill patients, the CON hospitals' quality metrics would tend to be lower because they are treating a pool of less healthy patients, not because they provide lower-quality care. Alternatively, use of the *Deaths among Surgical Inpatients with Serious Treatable Complications* measure will result in underestimation of the effect of CON laws on hospital quality if patients with the most serious risk of dying choose high-quality hospitals and if those patients develop complications not because of poorer hospital care but because they are very ill. Therefore, the direction of the potential bias is theoretically ambiguous.

Postoperative Pulmonary Embolism or Deep Vein Thrombosis (PSI #12) measures the number of cases of pulmonary embolism or deep vein thrombosis per 1,000 adult surgical discharges. According to the Centers for Disease Control and Prevention (CDC), patients recovering from surgery are at an increased risk of developing potentially deadly blood clots in their deep veins (deep vein thrombosis) and lungs (pulmonary embolism) (CDC 2016). Page (2010) notes that a 2010 study by the Healthcare Management Council found that postoperative pulmonary embolism and deep vein thrombosis together were the second most common hospital-acquired conditions after bedsores. These conditions are also the most expensive conditions to treat, averaging $15,000 per case or $564,000 per hospital per year. The denominator of this measure comprises all patients age 18 and older who underwent an operating-room procedure. The numerator comprises all patients included in the denominator who developed deep vein thrombosis or pulmonary embolism as a secondary diagnosis. Excluded were patients who were diagnosed with deep vein thrombosis or pulmonary embolism before or on the same day as the first operating-room procedure, patients undergoing childbirth, and patients with missing discharge disposition, gender, age, quarter, year, or principal diagnosis information. The annual rate for the *Postoperative Pulmonary Embolism or Deep Vein Thrombosis* measure is calculated using data collected over 20 months. For example, the data used to compute this measure in 2011 were collected from October 2008 to June 2010.

Another hospital quality measure, which comes from the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey, is the percentage of patients surveyed who gave their hospital a 9 or 10 overall rating during their last inpatient stay, on a scale of 1 (lowest) to 10 (highest). The survey was developed in 2005 by CMS in partnership with the Agency for Healthcare Research and Quality (CMS 2016a). This survey is based on a standardized instrument and data collection methodology that allows for cross-hospital comparisons of patients' experiences for different aspects of care. The instrument contains 27 questions, including one asking patients to provide an overall rating of their hospital on a 10-point scale. CMS segments the survey data into three tranches: the percentage of patients who rated their hospital as "low," defined as 6 or below; the percentage of patients who rated their hospital as "medium," defined as 7 or 8; and the percentage of patients who rated their hospital as "high," defined as 9 or 10. We use the last measure in our analysis.

The HCAHPS survey is administered to a random sample of eligible hospital patients, which includes all inpatients over age 18 who did not receive a psychiatric diagnosis. Excluded from the sample are patients in hospice and nursing home care, prisoners, patients with foreign home addresses, and patients excluded because of local regulations. Hospitals survey their eligible sample of patients randomly each month, and hospitals are required to complete at least 300 surveys over a 12-month period. Eligible patients in the sample can be surveyed 48 hours to six weeks after being discharged. Hospital-level results are updated on the Hospital Compare website every quarter, and each quarter's measures are based on the previous 12 months of data. CMS adjusts the HCAHPS data on the basis of each hospital's patient mix. This adjustment allows for comparisons across hospitals with heterogeneous patients.[4]

We include six additional hospital quality variables: *Pneumonia Readmission Rate* (READM-30-PN), *Pneumonia Mortality Rate* (MORT-30-PN), *Heart Failure Readmission Rate* (READM-30-HF), *Heart Failure Mortality Rate* (MORT-30-HF), *Heart Attack Readmission Rate* (READM-30-AMI), and *Heart Attack Mortality Rate* (MORT-30-AMI). These variables separately measure the readmission and mortality rates for pneumonia, heart failure, and heart

[4] For more detail about the patient mix adjustment, see CMS (2008b).

attack patients. These measures represent conditions with relatively high morbidity and mortality rates that “impose a substantial burden on patients and the healthcare system” and for which “there is marked variation in outcomes by institution” (CMS 2012, 3). Moreover, these metrics are commonly used to evaluate hospital quality (Werner and Bradlow 2006; Zuckerman et al. 2016).

Readmission rates measure unplanned readmissions for any cause to any acute-care hospital within 30 days of discharge from a hospitalization for the given medical condition. Mortality rates measure deaths from any cause within 30 days of a hospital admission for patients hospitalized with the given medical condition. CMS computes the readmission and mortality rates using a hierarchical model and then “risk standardizes” these measures. Thus, these rates take into account patient characteristics that may make death or unplanned readmission more likely. Further, these rates account for hospital-specific effects, which are CMS estimates based on a specific hospital’s impact on its patients’ likelihood of being readmitted or dying.

A hospital’s risk-standardized readmission rate and risk-standardized mortality rate are defined as the ratio of the number of predicted readmissions or deaths associated with a given condition to the number of expected readmissions or deaths associated with that condition. The predicted rate is an estimate of the number of readmissions or deaths within 30 days at a given hospital for patients discharged for a given condition. This rate takes into account the hospital’s patient risk factors (estimated from hospital-specific patient administrative data collected by CMS) and includes an estimate of the hospital-specific effect. The expected readmission and mortality rates are calculated using the same patient risk factors and use the average of all estimated hospital-specific effects in the nation.[5]

[5] For more detail about how these measures are calculated, see QualityNet (2016).

The risk-standardized readmission rate and the risk-standardized mortality rate comprise patients who are Medicare fee-for-service beneficiaries age 65 and older discharged from nonfederal acute-care hospitals with a principal discharge diagnosis of pneumonia, heart failure, or heart attack. The measures exclude admissions for patients who were discharged on the day of their admission or the following day, those who were transferred to another acute care hospital, those who were enrolled in a Medicare hospice program any time in the 12 months before the hospitalization, those who were discharged against medical advice, and those who were not previously hospitalized in the 30 days before death. The data to compute the annual risk-standardized readmission rate and the risk-standardized mortality rate are collected over a three-year period. This approach increases the number of cases per hospital, which allows for a more precise estimate and thus accommodates more variation in hospital performance (CMS 2007). For example, the measures for 2011 were calculated using data collected from July 2007 to June 2010.

CMS collects Hospital Compare data and recalculates the quality measures periodically, usually annually or quarterly. CMS updates the measures analyzed in this study annually. Hospital Compare data might be missing for any given provider for a number of reasons. There might be too few cases or patients to report data for a given condition because the number does not meet the minimum threshold for public reporting, because the number is too small to generate a reliable estimate of hospital performance, or because of protection of personal information. CMS might not include particular provider data because of data inaccuracies, because a particular hospital does not have data that meet the selection criteria, or because no data are available.

Because of variations in data availability, the number of providers differs by the type of quality measure. Some hospitals have no reported data for some measures. Missing data can be a potential drawback of our identification strategy because a hospital's decision about whether to report data may be nonrandom (Werner and Bradlow 2006). For example, missing data might be correlated with lower quality. If this is the case, and if CON laws are indeed associated with lower-quality hospitals, then we would underestimate any negative effect, in absolute value, of CON laws on quality.

More aggregate hospital quality measures became available only recently. As part of the Dartmouth Atlas of Health Care (Dartmouth Atlas Project 2016), a number of aggregate quality measures were constructed to capture the rate of posthospitalization events among Medicare patients. In 2013, Hospital Compare started providing aggregate quality indicators to facilitate high-level hospital comparisons. In addition to medical condition–specific quality measures, we test whether these aggregate quality measures differ between hospitals in CON and non-CON states.

Empirical Framework

Our identification strategy exploits the fact that, on occasion, a local healthcare market is divided between two states, one with a CON law and the other without. Our measure for a local healthcare market is a hospital referral region (HRR), which comes from the Dartmouth Atlas of Health Care (Dartmouth Atlas Project 2016). HRRs are defined on the basis of referral patterns for patients having major cardiovascular surgical procedures and for neurosurgery. There are 306 HRRs in the United States.

Our empirical model is

$$\text{Quality}_{ijm} = \beta_0 + \beta_1\, CON_j + \boldsymbol{\beta_2} \boldsymbol{X}_{ijm} + \boldsymbol{v_m} + \varepsilon_{ijm}, \qquad (1)$$

where the dependent variable is a quality measure for hospital i in state j and healthcare market m. Thus, two or more states can be contained in a given market. The variable CON_j

equals 1 if state *j* has a CON law and 0 otherwise. The model also includes market-level fixed effects ($\boldsymbol{v_m}$). In this model, we estimate the coefficient of interest, β_1, based on states that vary in whether they have a CON law and are located in the same healthcare market.

Following Polsky et al. (2014, 3), we use the Dartmouth Atlas of Health Care's HRR as the identifying healthcare market because it "defines a contiguous locality within which most tertiary hospital care referrals are contained, and because it is the area most linked to geographic variation." By estimating the coefficient on CON_j, we control for unobservable heterogeneity, such as geographic variation and illness severity, which varies across HRRs. The applicability of this model assumes that the markets that cross the borders of CON and non-CON states are otherwise the same, and we test this assumption below.

Our empirical model also controls for demographic factors that may vary across CON and non-CON states and that are also determinants of hospital quality. Specifically, we control for the percentage of people over age 65 in provider *i*'s zip code, the percentage of people who are not white, the percentage without a high school diploma, the percentage without insurance, and the average annual income for individuals in provider *i*'s zip code. For example, hospitals in higher-income areas may appear to perform better on the quality metrics because wealthier patients may be healthier, on average, than less wealthy patients. Similarly, hospitals in areas with a larger population of elderly residents may appear to provide worse-quality care because older people may be less healthy than younger people on average.

We also control for hospital-level characteristics that may impact the quality of care. These include the percentage of total patient days used by Medicare beneficiaries and the natural logarithm of the number of patient days at hospital *i.* The number of patient days is an indicator of hospital size and represents the total amount of time that the services of an institution are used by a hospital inpatient. The share of Medicare patient days is an indicator of the demographics of the population the hospital serves. All covariates are contained in the ***X*** vector in equation (1).

In our preferred specification, we calculate the coefficient on CON in equation (1) using a pooled panel regression with hospital-level quality data for the years 2011–2015. We cluster standard errors on the individual hospital level to compensate for the fact that observations are not independent. As a robustness check, we calculate the same equation for each individual year, omitting the year dummy variables. Further, we perform a variety of additional robustness checks to determine whether our results are driven by chance findings.

Table 2 shows the reporting rates for our quality measures for the example year 2011, which has a reporting rate typical for the remaining years in our sample. In the full sample of 4,542 hospitals, between 40 and 90 percent of hospitals reported data for a given measure. The lowest reporting rate is for *Death among Surgical Inpatients with Serious Treatable Complications* (42 percent), and the highest reporting rate is for *Pneumonia Readmission Rate* and *Pneumonia Mortality Rate* (90 percent each).

In our subsample, which consists of the 921 hospitals included in our empirical model for the year 2011, the reporting rate is slightly lower. Specifically, for a given measure, between 30 and 85 percent of hospitals reported data. In this subsample, the reporting rates mirrored those from the overall sample. The lowest reporting rate was for *Death among Surgical Inpatients with Serious Treatable Complications* (32 percent), and the highest reporting rate was for *Pneumonia Readmission Rate* and *Pneumonia Mortality Rate* (86 and 85 percent, respectively).

Table 2. Reporting Rates for Hospital Quality Metrics in the Full Sample and the Restricted Sample, 2011

Measure name [CMS code]	Full sample (*n* = 4,542)			Restricted sample (*n* = 921)		
	Providers in CON states	Providers in non-CON states	Overall reporting rate	Providers in CON states	Providers in non-CON states	Overall reporting rate
Death among surgical inpatients with serious treatable complications [PSI #4]	1,296 (44%)	626 (39%)	42%	122 (30%)	175 (34%)	32%
Postoperative pulmonary embolism or deep vein thrombosis [PSI #12]	2,015 (68%)	1,109 (70%)	69%	202 (50%)	334 (64%)	58%
Percentage of patients giving their hospital a 9 or 10 overall rating [HCAHPS]	2,500 (85%)	1,326 (83%)	84%	286 (71%)	428 (83%)	78%
Pneumonia readmission rate [READM-30-PN]	2,736 (93%)	1,350 (85%)	90%	364 (90%)	425 (82%)	86%
Pneumonia mortality rate [MORT-30-PN]	2,726 (92%)	1,341 (84%)	90%	361 (90%)	423 (82%)	85%
Heart failure readmission rate [READM-30-HF]	2,639 (89%)	1,270 (80%)	86%	329 (82%)	391 (75%)	78%
Heart failure mortality rate [MORT-30-HF]	2,604 (88%)	1,239 (78%)	85%	321 (80%)	384 (74%)	77%
Heart attack readmission rate [READM-30-AMI]	1,603 (54%)	727 (46%)	51%	145 (36%)	216 (42%)	39%
Heart attack mortality rate [MORT-30-AMI]	1,867 (63%)	840 (53%)	60%	172 (43%)	253 (49%)	46%

Notes: CMS = Centers for Medicare & Medicaid Services; CON = certificate of need; HCAHPS = Hospital Consumer Assessment of Healthcare Providers and Systems. The restricted sample reflects our fixed-effects model and includes only providers in HRRs that cross the borders between states with and without CON laws.

Sources: CMS (2014); Hospital Compare Data Archive (2011); Dartmouth Atlas Project (2016); NCSL (2016).

Data on CON laws in each state are available from the National Conference of State Legislatures (NCSL 2016). The number and type of medical devices and procedures regulated by

CON laws vary across states. For example, the District of Columbia has extensive CON legislation, whereas Ohio only regulates nursing home beds. We define a state as having a CON law if it has at least one CON regulation in place. Since none of the 50 states or the District of Columbia changed their CON regulations between 2011 and 2015, state coding remained consistent over our entire sample.

The annual data for the control variables of income, age, education, and race are from the decennial census dataset and the Census Bureau's American Community Survey 5-Year Data averages dataset. We compiled demographic data at the zip code level using the Census Bureau's American FactFinder. The annual data for the control variables of hospital size and the number of Medicare patients served are available at the individual hospital level from CMS's Healthcare Cost Report Information System.

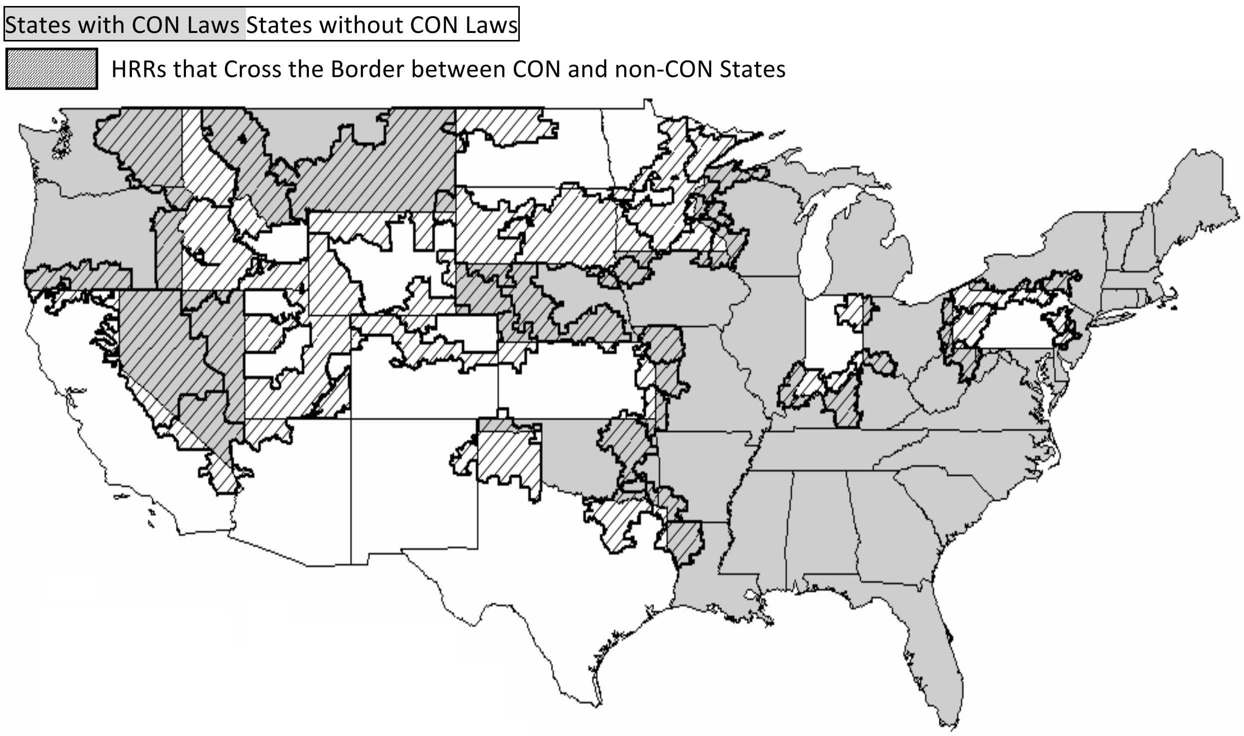
Results

Descriptive Statistics

We began with a dataset that has an average of 4,630 hospitals per year for the years 2011–2015, for a total of 23,152 observations. Of these hospitals, an average of 2,989 per year are located in the District of Columbia and the 36 states that had some form of CON regulations between 2011 and 2015. On average, 1,641 hospitals per year are located in non-CON states.

Next, among all 306 HRRs in the country, we identified 39 HRRs that contained hospitals in both CON and non-CON states in each year except 2014. For 2014, we identified 38 HRRs that included CON and non-CON states. Figure 1 presents a map of the state-border-crossing HRRs in the contiguous United States. Table 3 provides a list of these HRRs, as well as the CON and non-CON states located in each HRR for the year 2011, and table 4 shows the number of providers on the CON side and the non-CON side of the border in each HRR. The state-border-crossing HRRs contain on average 962 hospitals per year, of which 422 are located in CON states and 540 are located in non-CON states. This subsample represents about 21 percent of the observations in our original dataset.

Figure 1. HRRs that Crossed the Borders of States with and without CON Laws, 2011



Note: HRRs = hospital referral regions; CON = certificate of need.
Sources: NCSL (2016); Dartmouth Atlas Project (2016).

Table 3. HRRs that Crossed the Borders of States with and without CON Laws, 2011

HRR number	Non-CON states	CON states	HRR number	Non-CON states	CON states
22	TX	AR, OK	296	PA	NY
103	CO, KS	NE	324	ND	MT
104	CO, WY	NE	327	IN	OH
151	ID	OR	335	PA	OH
179	IN	IL, KY	340	KS	OK
180	IN	OH	343	CA	OR
196	SD	IA, NE	346	PA	NJ
205	IN	KY	351	PA	NY, OH
219	TX	LA	356	PA	NJ
250	MN	MI, WI	357	PA	OH, WV
251	MN	WI	359	PA	NY
253	MN	IA	370	SD	NE
256	MN	WI	371	MN, SD	IA
267	KS	MO, OK	383	KS, NM, TX	OK
268	KS	MO	391	TX	OK
274	WY	MT	423	CO, ID, UT, WY	NV
276	ID	MT	440	ID	OR, WA
277	KS	NE	445	PA	MD, WV
279	AZ, CA	NV	448	MN	IA, WI
280	CA	NV	-	-	-

Note: HRRs = hospital referral regions; CON = certificate of need.

Sources: NCSL (2016); Dartmouth Atlas Project (2016).

Table 4. Number of Providers in HRRs that Crossed the Borders of States with and without CON Laws, 2011

HRR number	Providers in non-CON states	Providers in CON states	HRR number	Providers in non-CON states	Providers in CON states
22	3	5	296	1	5
103	29	10	324	6	1
104	4	1	327	2	21
151	7	2	335	2	7
179	10	11	340	2	38
180	17	5	343	2	7
196	1	13	346	15	1
205	9	21	351	14	3
219	2	17	356	38	6
250	11	4	357	34	10
251	61	11	359	5	1
253	10	2	370	11	2
256	7	7	371	46	7
267	3	8	383	17	2
268	17	30	391	68	2
274	7	26	423	34	1
276	1	14	440	9	23
277	1	32	445	1	9
279	4	17	448	1	10
280	6	11	-	-	-

Note: HRRs = hospital referral regions; CON = certificate of need.

Sources: NCSL (2016); Dartmouth Atlas Project (2016).

Table 5, panel A, shows results from testing whether there are any systematic differences in the population characteristics between states with and without CON regulations, using the year 2015 as an example. In each panel, the unit of observation is a hospital in the year 2015. Given that we know the location of each hospital, we match annual zip code–level variables to each hospital for each year that it appears in our dataset. Panel A shows that zip codes in CON states tend to have a higher number of minorities as a share of the total population than zip codes in non-CON states. Hospitals in states with CON laws also tend to to be larger and serve a larger share of Medicare patients than non-CON hospitals.

Table 5, panel B, shows results from testing whether there are any significant differences within the subsample of hospitals in HRRs that cross state borders, where state CON status varies within an HRR. Here, the comparison of differences in means shows that, although there are statistically significant differences between the CON and non-CON hospitals within a border-crossing HHR, the differences in demographics tend to be quantitatively small. Residents of zip codes on the non-CON side of the border tend to be slightly better educated and to have about 10 percent higher incomes than those on the CON side. Because higher levels of education and income may be associated with higher-quality hospitals, differences in these variables, to the extent they are unmeasured or not included in our regression model, will tend to overstate any negative effect of CON on the quality of hospital services provided. We therefore include controls for both variables in our regression models.

Table 5. Differences-in-Means Tests—Covariates, 2015

Panel A: All CON states versus all non-CON states	Non-CON states	CON states	Difference	*t* Statistic	Observations
Percent over age 65	16.3	15.9	0.3	0.46	51
Percent nonwhite	16.3	24.8	−8.6	−1.98	51
Percent with no high school diploma	17.8	16.6	1.2	1.20	51
Percent uninsured	14	13.2	0.8	0.66	51
Number of patient days	21,460	34,200	−12,740	−2.22	51
Medicare patient days as a share of total patient days	36.3	43	−6.7	−3.20	51
Per capita income (US$)	$26,794	$27,193	−$399	−0.26	51
Panel B: HRRs in both CON and non-CON states	**HRR in non-CON**	**HRR in CON**	**Difference**	***t* Statistic**	**Observations**
Percent over age 65	17	17.5	−0.5	−0.64	77
Percent nonwhite	12.7	14	−1.3	−0.56	77
Percent with no high school diploma	15.7	18.4	−2.7	−2.24	77
Percent uninsured	12.4	13.3	−0.8	−0.82	78
Number of patient days	18,756	15,163	3,593	1.04	77
Medicare patient days as a share of total patient days	39.3	42.4	−3.20	−1.40	68
Per capita income (US$)	$26,977	$24,817	$2,159	1.91	77

Notes: CON = certificate of need; HRRs = hospital referral regions. The unit of analysis is the individual provider. Data for percent over age 65, percent nonwhite, percent with no high school diploma, percent uninsured, and per capita income are the average from the provider's zip code. Data for the number of patient days and Medicare patient days as a share of total patient days are from the individual provider. All *t* statistics are clustered at the individual provider level.

Sources: CMS (2014); Hospital Compare Data Archive (2015).; Dartmouth Atlas Project (2016); American FactFinder (2016); NCSL (2016).

Hospital Quality Indicators

Table 6 provides results from testing whether there are any significant quality differences between hospitals in CON states and hospitals in non-CON states. We find that nearly all the quality measures are statistically significantly worse in CON states than in non-CON states. Among the nine measures of quality of care, readmission rate, and mortality rate, only *Heart Attack Mortality Rate* is not significantly different between CON states and non-CON states. The metrics with the largest-magnitude differences are *Pneumonia Readmission Rate* and *Heart Failure Readmission Rate*: On average, hospitals in CON states have over 0.5 percentage points more pneumonia and heart failure patient readmissions than non-CON states, implying about five additional readmissions per 1,000 patient discharges.

Table 7 provides results from studying differences in outcomes for the 39 HRRs that cross the border between a CON state and a non-CON state. Restricting the analysis to these HRRs, we again find statistically significant quality differences between hospitals on the CON side of the border compared with those on the non-CON side. *Heart Attack Mortality Rate* is the only metric that does not differ between CON states and non-CON states. The largest-magnitude difference is *Pneumonia Mortality Rate*, and the magnitude of this estimate is similar to that shown in table 6.

Table 7 shows that, for these 39 HRRS, hospitals in CON states appear to perform worse on all quality indicators but one: Hospitals in CON states now perform better on average on *Postoperative Pulmonary Embolism* than hospitals in non-CON states by about 4 cases per 1,000 discharges. Nevertheless, these summary statistics of hospital quality indicators provide some preliminary evidence that hospitals in states with CON regulations tend to score lower on quality measures than those in states without CON laws.

Table 6. Differences-in-Means Tests—Hospital Quality Indicators for All CON States vs. All Non-CON States, 2011–2015

Measure name [CMS code]	Mean sample	Non-CON states	CON states	Difference	Clustered *t* statistic	Observations
Death among surgical inpatients with serious treatable complications (deaths per 1,000 surgical discharges with complications) [PSI #4]	115.1	113.2	116.0	−2.9	4.24	9,537
Postoperative pulmonary embolism or deep vein thrombosis (per 1,000 surgical discharges) [PSI #12]	4.5	4.3	4.6	−0.3	4.95	15,390
Percentage of patients giving their hospital a 9 or 10 overall rating (percentage points) [HCAHPS]	69.7	70.5	69.3	1.2	−4.35	19,853
Pneumonia readmission rates (percentage points) [READM-30-PN]	17.8	17.5	17.9	−0.5	13.17	20,645
Pneumonia mortality rate (percentage points) [MORT-30-PN]	11.9	11.8	12.0	−0.3	5.22	20,559
Heart failure readmission rate (percentage points) [READM-30-HF]	23.5	23.2	23.6	−0.5	9.79	19,316
Heart failure mortality rate (percentage points) [MORT-30-HF]	11.7	11.6	11.8	−0.2	3.79	18,901
Heart attack readmission rate (percentage points) [READM-30-AMI]	18.5	18.3	18.7	−0.4	8.20	11,377
Heart attack mortality rate (percentage points) [MORT-30-AMI]	15.1	15.0	15.1	−0.1	1.44	12,792

Notes: CON = certificate of need; CMS = Centers for Medicare & Medicaid Services; HCAHPS = Hospital Consumer Assessment of Healthcare Providers and Systems. The unit of analysis is the individual hospital. Data are collected at the individual hospital level. Readmission and mortality rates are calculated using data from Medicare patients only. All *t* statistics are clustered at the individual provider level.

Sources: CMS (2014); Hospital Compare Data Archive (2011, 2012, 2013, 2014, 2015); Dartmouth Atlas Project (2016).

Table 7. Differences-in-Means Tests—Hospital Quality Indicators for HRRs in Both CON and Non-CON States, 2011–2015

Measure name [CMS code]	Mean sample	HRRs in non-CON states	HRRs in CON states	Difference	Clustered *t* statistic	Observations
Death among surgical inpatients with serious treatable complications (deaths per 1,000 surgical discharges with complications) [PSI #4]	113.1	111.1	116.0	−4.9	3.12	1,539
Postoperative pulmonary embolism or deep vein thrombosis (per 1,000 surgical discharges) [PSI #12]	4.4	4.5	4.2	0.4	−2.99	2,779
Percent of patients giving their hospital a 9 or 10 overall rating (percentage points) [HCAHPS]	71.3	71.9	70.5	1.4	−2.37	4,006
Pneumonia readmission rate percentage points) [READM-30-PN]	17.6	17.5	17.7	−0.2	2.83	4,141
Pneumonia mortality rate (percentage points) [MORT-30-PN]	12.0	11.8	12.2	−0.5	5.12	4,112
Heart failure readmission rate (percentage points) [READM-30-HF]	23.3	23.2	23.5	−0.3	2.64	3,659
Heart failure mortality rate (percentage points) [MORT-30-HF]	11.8	11.6	12.1	−0.4	4.87	3,552
Heart attack readmission rate (percentage points) [READM-30-AMI]	18.5	18.4	18.5	−0.1	0.94	1,806
Heart attack mortality rate (percentage points) [MORT-30-AMI]	15.1	15.0	15.3	−0.3	2.74	2,033

Notes: HRRs = hospital referral regions; CON = certificate of need; CMS = Centers for Medicare & Medicaid Services; HCAHPS = Hospital Consumer Assessment of Healthcare Providers and Systems. The unit of analysis is the individual hospital. Data are collected at the individual hospital level. Readmission and mortality rates are calculated using data from Medicare patients only. All *t* statistics are clustered at the individual provider level.

Sources: CMS (2014); Hospital Compare Data Archive (2011, 2012, 2013, 2014, 2015); Dartmouth Atlas Project (2016).

Pooled Panel Regression Results

Table 8 presents estimates from five regression models that pool annual data on hospital quality from 2011 to 2015. We present estimates only for the coefficient of interest, that is, the coefficient on the *CON* dummy variable in equation (1). In each model specification, the CON coefficient is identified as the difference in the quality of medical services between hospitals in CON states and hospitals in non-CON states. Identification does not come from variation over time in CON laws because none of the 50 states or the District of Columbia changed their CON laws between 2011 and 2015.

In columns A and B, the unit of observation is a hospital in our full sample of 23,151 providers in the country from 2011 to 2015. Column A contains results from the bivariate regression of a given hospital quality measure on the CON dummy variable. Column B contains results from a multivariate regression that controls for average income, age, race, percent uninsured, and education of people in a provider's zip code, as well as the hospital's size, the number of Medicare patients it serves, and year indicators. In columns C through E, the unit of observation is a hospital in the previously identified subsample of HRRs that contain providers in both CON and non-CON states. Columns C and D contain results for the same bivariate and multivariate regressions as in columns A and B but consider only the subsample of hospitals in border-crossing HRRs. Column E is our preferred specification and contains results from the HRR fixed-effects model using the restricted sample of hospitals and including the controls from the multivariate regression.

The estimates from the pooled bivariate and multivariate regressions using both the full sample and the restricted sample contained in table 8, columns A through D, demonstrate that, in the vast majority of cases, hospitals in CON states perform worse on the quality indicators than hospitals in non-CON states. In our preferred specification with HRR fixed effects in table 8, column E, the estimates of the quality indicators of *Death among Surgical Inpatients with Serious Treatable Complications*, *Pneumonia Mortality Rate*, *Heart Failure Mortality Rate*, and

Heart Attack Mortality Rate are statistically significantly higher in states with CON laws than in non-CON states. These findings support the hypothesis that CON regulations lower the quality of medical services. The change in magnitude of the coefficient in column E relative to the other columns suggests that unmeasured or unobserved variables are correlated with quality of care and whether a state has a CON law.

Table 8, column E, shows that the 30-day mortality rate for pneumonia patients is more than 0.6 percentage points higher in CON states than in non-CON states. Further, the 30-day mortality rates for heart failure and heart attack patients are 0.33 and 0.37 percentage points higher in CON states, respectively. This means that the average mortality rates for these conditions in CON states are, respectively, about 2.5 and 3 percent higher than the average in non-CON states. These results imply that the average hospital in a state with CON regulations experiences between 3 and 6 more deaths per 1,000 discharges than hospitals in non-CON states, depending on the illness.

The largest difference for all measures is in *Death among Surgical Inpatients with Serious Treatable Complications*. This measure is a composite of the number of deaths that occur following a serious complication after surgery. The estimate for this measure implies that hospitals in CON states average 6 more deaths per 1,000 surgical discharges that resulted in complications. Put another way, the mortality rate from complications is about 5.5 percent higher in CON states compared with the average mortality rate for the restricted sample.

Table 8, column E, also shows that readmission rates tend to be either the same or higher in states with CON regulations, although none of these differences are statistically significant at the 5 percent level. Furthermore, column E shows that the difference in the rate of *Postoperative*

Pulmonary Embolism or Deep Vein Thrombosis and the percentage of patients giving their hospital an overall HCAHPS rating of 9 or 10 is not significantly different from zero.

Table 8. Pooled Regression Results, 2011–2015

Measure name [CMS code]	**(A) Full-sample bivariate model**	**(B) Full-sample multivariate model**	**(C) Restricted-sample bivariate model**	**(D) Restricted-sample multivariate model**	**(E) HRR fixed-effects model**
Death among surgical inpatients with serious treatable complications (deaths per 1,000 surgical discharges with complications) [PSI #4]	2.87*** (0.68) R^2 = 0.00	2.68*** (0.70) R^2 = 0.08	4.90*** (1.59) R^2 = 0.02	4.06*** (1.52) R^2 = 0.16	6.18** (2.45) Adj R^2 = 0.26
Postoperative pulmonary embolism or deep vein thrombosis (per 1,000 surgical discharges) [PSI #12]	0.28*** (0.06) R^2 = 0.01	0.28*** (0.06) R^2 = 0.10	−0.42*** (0.13) R^2 = 0.01	−0.43*** (0.13) R^2 = 0.18	−0.07 (0.17) Adj R^2 = 0.24
Percent of patients giving their hospital a 9 or 10 overall rating (percentage points) [HCAHPS]	−1.18*** (0.27) R^2 = 0.00	−0.43 (0.31) R^2 = 0.14	−1.37** (0.59) R^2 = 0.01	−0.42 (0.68) R^2 = 0.26	−1.04 (1.01) Adj R^2 = 0.34
Pneumonia readmission rate (percentage points) [READM-30-PN]	0.45*** (0.03) R^2 = 0.02	0.49*** (0.05) R^2 = 0.22	0.19*** (0.07) R^2 = 0.00	0.16 (0.11) R^2 = 0.22	-0.01 (0.13) Adj R^2 = 0.35
Pneumonia mortality rate (percentage points) [MORT-30-PN]	0.26*** (0.05) R^2 = 0.01	0.24*** (0.07) R^2 = 0.06	0.49*** (0.09) R^2 = 0.02	0.53*** (0.14) R^2 = 0.07	0.63*** (0.19) Adj R^2 = 0.14
Heart failure readmission rate (percentage points) [READM-30-HF]	0.47*** (0.05) R^2 = 0.01	0.51*** (0.06) R^2 = 0.32	0.27** (0.11) R^2 = 0.00	0.22 (0.15) R^2 = 0.34	0.09 (0.19) Adj R^2 = 0.43
Heart failure mortality rate (percentage points) [MORT-30-HF]	0.17*** (0.04) R^2 = 0.00	0.22*** (0.05) R^2 = 0.10	0.43*** (0.09) R^2 = 0.02	0.48*** (0.12) R^2 = 0.12	0.33** (0.17) Adj R^2 = 0.23
Heart attack readmission rate (percentage points) [READM-30-AMI]	0.36*** (0.04) R^2 = 0.01	0.31*** (0.05) R^2 = 0.46	0.10*** (0.11) R^2 = 0.00	0.10 (0.11) R^2 = 0.47	0.19 (0.14) Adj R^2 = 0.57
Heart attack mortality rate (percentage points) [MORT-30-AMI]	0.07*** (0.05) R^2 = 0.00	0.15*** (0.05) R^2 = 0.19	0.33 (0.11) R^2 = 0.01	0.27** (0.11) R^2 = 0.24	0.37** (0.15) Adj R^2 = 0.30
Controls	*No*	*Yes*	*No*	*Yes*	*Yes*

HRR fixed effects	*No*	*No*	*No*	*No*	*Yes*
Number of providers	*23,151*	*23,151*	*4,811*	*4,811*	*4,811*

Notes: CMS = Centers for Medicare & Medicaid Services; HRR = hospital referral region; HCAHPS = Hospital Consumer Assessment of Healthcare Providers and Systems. The model specifications in columns A and B consider the full sample of hospitals in the United States. The specifications in columns C through E consider only hospitals in HRRs that cross the border between CON and non-CON states. The unit of analysis is the individual provider. Clustered standard errors by provider are in parentheses. Controls for percent over age 65, percent nonwhite, percent with no high school diploma, percent uninsured, and per capita income are the average from the provider's zip code. Controls for the number of patient days and Medicare patient days as a share of total patient days are from the individual provider. Controls also include year dummy variables. Readmission and mortality rates are calculated using data from Medicare patients only. The number of observations varies between the bivariate and multivariate regressions (details are available from the authors on request). *** statistically significant at (at least) the 1% level. ** statistically significant at (at least) the 5% level. * statistically significant at (at least) the 10% level.

Sources: CMS (2014); Hospital Compare Data Archive (2011, 2012, 2013, 2014, 2015); Dartmouth Atlas Project (2016); American FactFinder (2016).

One potentially confounding factor that is not captured in our model is the impact of the Hospital Readmissions Reduction Program (HRRP), a provision of the Affordable Care Act that penalizes hospitals for excess 30-day readmissions following Medicare fee-for-service patient discharges (CMS 2016c). Penalties are assessed on the basis of hospitals' readmission rates for three conditions: heart attack, heart failure, and pneumonia. The new provision became applicable to hospital discharges in 2012, and hospitals with higher-than-expected 30-day readmission rates for the three conditions faced a maximum 1 percent reduction in payments for discharges in 2013, increasing to 2 percent in 2014 and 3 percent in 2015.

The penalties associated with the HRRP may account for the absence of systematic differences in readmission rates, as with those observed for mortality rates. If CON hospitals had higher readmission rates than non-CON hospitals prior to the HRRP, the penalties under the program would incentivize those hospitals to lower their readmission rates more quickly than non-CON hospitals. There is some evidence that hospitals are responding to the HRRP. For example, Zuckerman (2016) finds that readmission rates fell sharply for the conditions targeted by the HRRP and that they fell less sharply for readmissions following discharges for other hospitalizations. Zuckerman notes that "the drop in readmissions mostly occurred during the period between the enactment of the Affordable Care Act in March 2010 and the start of the Hospital Readmissions Reduction Program in October 2012, when hospitals would have taken action to avoid facing penalties" (Zuckerman 2016, 2). This drop in response to the HRRP coincides with the beginning of our study period and may partly explain why we do not observe larger differences in readmission rates between CON and non-CON hospitals.

Overall, our results do not support the hypothesis that CON hospitals deliver better-quality care than non-CON hospitals. In fact, we tend to find the opposite: Nearly all the coefficients in our regressions suggest that CON regulations lead to lower-quality care, although not all estimates are significant in all our specifications.

Robustness Checks

Regression Results by Year, 2011–2015

To test whether the pooled panel regression results are being driven by chance findings, we also present the results of the HRR fixed-effects model for the same quality measures for each individual year from 2011 to 2015. However, our previous results are unlikely to be driven by changes in the number of HRRs crossing state borders because that number stayed very similar from 2011 to 2015. Moreover, the number of providers in these border-crossing HRRs also remained very static during these years.

The results of these additional tests are largely consistent with the pooled regression model. Table 9 summarizes these results. *Death among Surgical Inpatients with Serious Treatable Complications* is statistically significantly higher for hospitals in CON states in each year except 2013, implying a difference of between 4 and 10 additional deaths per 1,000 surgical discharges at CON hospitals. The difference in *Pneumonia Mortality Rate* between CON and non-CON hospitals is also statistically significant in each year, representing between nearly 6 and 8 additional deaths per 1,000 pneumonia discharges. Furthermore, we find that *Heart Failure Mortality Rate* and *Heart Attack Readmission Rate* are higher at CON hospitals than non-CON hospitals, although the differences are not statistically significant in every year.

In our regressions by year, we again find that the readmission rates were generally no different at CON hospitals than non-CON hospitals for 2011–2015. One exception is *Pneumonia Readmission Rate* in 2012, when it was 0.23 percentage points lower in CON hospitals. The other exception is *Heart Attack Readmission Rate,* which is different from zero in 2011 and 2012, has the predicted sign in these two years, and is statistically significant. In these two years, *Pneumonia Readmission Rate* and the *Heart Attack Readmission rate* are, respectively, 0.34 and 0.33 percentage points higher in hospitals located in CON states.

Also consistent with our baseline estimates, the difference in the *Postoperative Pulmonary Embolism* rate between CON and non-CON hospitals was not significantly different from zero in each year except 2011, when the point estimate was 0.43 percentage points lower for CON hospitals than non-CON hospitals. This rate represented a little more than 4 additional deaths per 1,000 discharges for non-CON hospitals.

Table 9. Regression Results by Year, 2011–2015

Measure name [CMS code]	2011	2012	2013	2014	2015
Death among surgical inpatients with serious treatable complications (deaths per 1,000 surgical discharges with complications) [PSI #4]	9.83*** (1.34) Adj R^2 = 0.19	5.93** (2.68) Adj R^2 = 0.19	4.89 (3.57) Adj R^2 = 0.22	3.91** (2.02) Adj R^2 = 0.23	5.56** (2.58) Adj R^2 = 0.22
Postoperative pulmonary embolism or deep vein thrombosis (per 1,000 surgical discharges) [PSI #12]	−0.43** (0.21) Adj R^2 = 0.18	−0.10 (0.14) Adj R^2 = 0.19	0.11 (0.10) Adj R^2 = 0.13	0.06 (0.15) Adj R^2 = 0.14	0.03 (0.14) Adj R^2 = 0.16
Percent of patients giving their hospital a 9 or 10 overall rating (percentage points) [HCAHPS]	0.08 (0.99) Adj R^2 = 0.27	−0.37 (1.04) Adj R^2 = 0.29	−1.80 (1.18) Adj R^2 = 0.32	−0.73 (1.21) Adj R^2 = 0.29	−1.41 (1.06) Adj R^2 = 0.28
Pneumonia readmission rate (percentage points) [READM-30-PN]	0.02 (0.15) Adj R^2 = 0.23	−0.23** (0.11) Adj R^2 = 0.25	−0.10 (0.16) Adj R^2 = 0.24	0.13 (0.17) Adj R^2 = 0.16	0.16 (0.14) Adj R^2 = 0.08
Pneumonia mortality rate (percentage points) [MORT-30-PN]	0.77*** (0.20) Adj R^2 = 0.09	0.62*** (0.18) Adj R^2 = 0.08	0.59*** (0.19) Adj R^2 = 0.07	0.67*** (0.12) Adj R^2 = 0.10	0.57*** (0.15) Adj R^2 = 0.12
Heart failure readmission rate (percentage points) [READM-30-HF]	−0.07 (0.22) Adj R^2 = 0.15	−0.12 (0.14) Adj R^2 = 0.16	0.04 (0.16) Adj R^2 = 0.19	0.14 (0.14) Adj R^2 = 0.23	0.31 (0.21) Adj R^2 = 0.22
Heart failure mortality rate (percentage points) [MORT-30-HF]	0.38** (0.19) Adj R^2 = 0.16	0.31 (0.19) Adj R^2 = 0.15	0.34** (0.17) Adj R^2 = 0.17	0.25 (0.15) Adj R^2 = 0.22	0.28** (0.15) Adj R^2 = 0.23
Heart attack readmission rate (percentage points) [READM-30-AMI]	0.34** (0.17) Adj R^2 = 0.21	0.33* (0.18) Adj R^2 = 0.22	0.21 (0.14) Adj R^2 = 0.18	−0.04 (0.12) Adj R^2 = 0.12	−0.13 (0.17) Adj R^2 = 0.13
Heart attack mortality rate (percentage points) [MORT-30-AMI]	0.49*** (0.15) Adj R^2 = 0.12	0.43*** (0.14) Adj R^2 = 0.13	0.46** (0.15) Adj R^2 = 0.16	0.27 (0.18) Adj R^2 = 0.18	0.21 (0.20) Adj R^2 = 0.11
Number of providers	*921*	*1,060*	*1,076*	*957*	*999*

Note: CMS = Centers for Medicare & Medicaid Services; HCAHPS = Hospital Consumer Assessment of Healthcare Providers and Systems. The unit of analysis is the individual provider. Clustered standard errors by state are in parentheses. Controls for percent over age 65, percent nonwhite, percent with no high school diploma, percent uninsured, and per capita income are the average from the provider's zip code. Controls for the number of patient days and Medicare patient days as a share of total patient days are from the individual provider. Readmission and mortality rates are calculated using data from Medicare patients only. *** statistically significant at (at least) the 1% level. ** statistically significant at (at least) the 5% level. * statistically significant at (at least) the 10% level.

Sources: CMS (2014); Hospital Compare Data Archive (2011, 2012, 2013, 2014, 2015); Dartmouth Atlas Project (2016); American FactFinder (2016).

Regression Results Excluding Low-Provider HRRs

One concern regarding the previous results might be that results from the pooled panel regression model are sensitive to the fact that some HRRs in our subsample have only a few hospitals on one side of the state border that runs through them. Table 4 illustrates the potential issue: In 2011, almost one-third of HRRs that crossed the border between CON and non-CON states had only a few hospitals on one side or both sides of the border. If one or more of those hospitals is abnormally high or low performing on the quality indicators, such skewedness in the data might drive our findings in tables 8 and 9.

To address this issue, we restrict our fixed-effects model to exclude all HRRs with three or fewer providers on one or both sides of the border. We do this for each year from 2011 to 2015.[6] Table 10, column A, contains the results from our original pooled panel regression model with fixed effects. Column B shows the results of the same model while omitting the HRRs with three or fewer providers on one side or both sides of the border, which we find are largely consistent with the results from column A.

The magnitudes of the coefficients on CON in the regressions that do not include low-provider HRRs (column B) are similar to the coefficients in the original model (column A). Differences in *Death among Surgical Inpatients with Serious Treatable Complications* and *Pneumonia Mortality Rate* between CON and non-CON hospitals remain statistically significant. The coefficients on *Heart Failure Mortality Rate* and *Heart Attack Mortality Rate* are similar but lose significance because the standard errors increase. The measures for readmission rate remain statistically insignificantly different from zero. These results provide evidence that the original results were not driven by outliers in the low-provider HRRs.

[6] For 2011, this criterion eliminates 24 HRRs and 417 providers from our subsample. For 2012, we exclude 23 HRRs and 414 hospitals. For 2013, we exclude 23 HRRs and 419 hospitals. For 2014, we exclude 21 HRRs and 401 hospitals. For 2015, we exclude 22 HRRs and 427 hospitals.

Table 10. Robustness Checks, 2011–2015

Measure name [CMS code]	(A) Original fixed-effects model	(B) Omitting low HRRs	(C) Omitting unbalanced HRRs	(D) Omitting low-CON states
Death among surgical inpatients with serious treatable complications (deaths per 1,000 surgical discharges with complications) [PSI #4]	6.18** (2.45) Adj R^2 = 0.26	7.59*** (2.37) Adj R^2 = 0.26	5.09** (2.52) Adj R^2 = 0.25	6.74*** (2.44) Adj R^2 = 0.24
Postoperative pulmonary embolism or deep vein thrombosis (per 1,000 surgical discharges) [PSI #12]	−0.07 (0.17) Adj R^2 = 0.24	0.02 (0.21) Adj R^2 = 0.28	0.08 (0.24) Adj R^2 = 0.21	−0.11 (0.18) Adj R^2 = 0.25
Percent of patients giving their hospital a 9 or 10 overall rating (percentage points) [HCAHPS]	−1.04 (1.01) Adj R^2 = 0.34	−1.77* (1.04) Adj R^2 = 0.37	−2.00* (1.10) Adj R^2 = 0.39	−3.19*** (1.09) Adj R^2 = 0.34
Pneumonia readmission rate (percentage points) [READM-30-PN]	−0.01 (0.13) Adj R^2 = 0.35	0.19 (0.15) Adj R^2 = 0.36	0.19 (0.18) Adj R^2 = 0.33	0.19 (0.15) Adj R^2 = 0.35
Pneumonia mortality rate (percentage points) [MORT-30-PN]	0.63*** (0.19) Adj R^2 = 0.14	0.61*** (0.23) Adj R^2 = 0.17	0.55** (0.26) Adj R^2 = 0.17	0.48** (0.23) Adj R^2 = 0.12
Heart failure readmission rate (percentage points) [READM-30-HF]	0.09 (0.19) Adj R^2 = 0.43	0.05 (0.20) Adj R^2 = 0.43	−0.05 (0.21) Adj R^2 = 0.43	0.32* (0.20) Adj R^2 = 0.44
Heart failure mortality rate (percentage points) [MORT-30-HF]	0.33** (0.17) Adj R^2 = 0.23	0.33 (0.21) Adj R^2 = 0.26	0.32 (0.24) Adj R^2 = 0.26	0.37* (0.19) Adj R^2 = 0.25
Heart attack readmission rate (percentage points) [READM-30-AMI]	0.19 (0.14) Adj R^2 = 0.57	0.22 (0.17) Adj R^2 = 0.57	0.08 (0.19) Adj R^2 = 0.57	0.36** (0.17) Adj R^2 = 0.57
Heart attack mortality rate (percentage points) [MORT-30-AMI]	0.37** (0.15) Adj R^2 = 0.30	0.25 (0.19) Adj R^2 = 0.32	0.30 (0.22) Adj R^2 = 0.32	0.33** (0.17) Adj R^2 = 0.29
Number of providers	*4,811*	*2,765*	*1,934*	*3,447*

Notes: CMS = Centers for Medicare & Medicaid Services; HRRs = hospital referral regions; CON = certificate of need; HCAHPS = Hospital Consumer Assessment of Healthcare Providers and Systems. Column A contains original fixed-effects regression results. Column B contains results after dropping HRRs with three or fewer hospitals on either side of the border. Column C contains results after dropping HRRs that have at minimum four times fewer the number of providers on one side of the border than the other. Column D contains results after dropping observations in states with below the median number of CON laws. The unit of analysis is the individual provider. Clustered standard errors by provider are in parentheses. Controls for percent over age 65, percent nonwhite, percent with no high school diploma, percent uninsured, and per capita income are the average from the provider's zip code. Controls for the number of patient days and Medicare patient days as a share of total patient days are from the individual provider. Controls also include year dummy variables. Readmission and mortality rates are calculated using data from Medicare patients only. *** statistically significant at (at least) the 1% level. ** statistically significant at (at least) the 5% level. * statistically significant at (at least) the 10% level.

Sources: CMS (2014); Hospital Compare Data Archive (2011, 2012, 2013, 2014, 2015); Dartmouth Atlas Project (2016); American FactFinder (2016).

Regression Results Excluding Unbalanced HRRs

Another concern regarding our estimates in the pooled panel regression model is that some of the border-crossing HRRs contain a highly unbalanced number of hospitals on one side of the market compared with the other side. Table 4 again illustrates the potential issue. For instance, in 2011, HRR number 371 contained 46 hospitals on the non-CON side of the border but only 7 on the CON side. To address this potential issue, we further restrict our model to exclude all HRRs in which there are at least four times more providers on one side of the border than the other. This omits 23 HRRs and 2,877 providers from our subsample. Table 10, column C, contains the pooled panel regression results omitting these unbalanced HRRs, and we find the results are very similar to those in columns A and B.

Regression Results Excluding States with Few CON Laws

In our original model, a state is defined as a CON state if it had at least one CON regulation. However, the effects of CON regulations may be cumulative, meaning that states with a lot of entry restrictions may see larger quality differences than states with relatively few. In this case, we would expect states with only a few CON laws to look more like non-CON states in terms of hospital quality than states with more comprehensive CON programs. By treating all CON states the same, our model could be missing these cumulative effects and thus be underestimating the true impact of CON laws on hospital quality.

To address this issue, we further restrict our subsample to exclude hospitals in any CON state that has fewer than four CON laws, the median number of laws for the CON states in our subsample. This omits 1,364 providers and 10 HRRs from the subsample. The results are again consistent with the original pooled regression model and, further, provide evidence that states with the most restrictive CON programs have systematically lower-quality hospitals than non-CON states.

Table 10, column D, contains the pooled panel regression results omitting states with the fewest CON laws. As in the original model, we find that differences between CON and non-CON hospitals in *Death among Surgical Inpatients with Serious Complications*, *Pneumonia Mortality Rate, Heart Failure Mortality Rate*, and *Heart Attack Mortality Rate* remain statistically significant. Furthermore, estimates for the difference in *Heart Failure Readmission Rate* and *Heart Attack Readmission Rate* are also statistically significant using the restricted sample. We also find that CON hospitals have, on average, three percentage points fewer patients rating their hospital a 9 or 10 overall on the HCAHPS survey than do non-CON hospitals.

Aggregate Hospital Quality Measures

One possible limitation of our previous findings may be that our individual quality variables do not fully capture all aspects of provider quality. This limitation stems from two issues: The first is that there is no consensus about the most important individual variables to examine when assessing overall hospital quality, and the second is that until recently there were no aggregate measures that were designed to allow for high-level comparisons across hospitals. In this section, we attempt to compensate for the second issue by incorporating five additional quality measures that are meant to capture hospital quality at a more aggregate level.

Goodman, Fisher, and Chang (2011) use data on Medicare patients to construct five hospital-level metrics that capture the quality of care for patients who have had medical and surgical procedures. The first post-discharge event is *30-Day Readmission Rate after Medical Discharge*, which captures readmissions within 30 days of discharge as a percentage of all Medicare patients classified as having a "medical" hospital visit.[7] The second event is *14-Day Ambulatory Visit Rate after Medical Discharge*, which measures the percentage of medical patients who required outpatient care within 14 days of discharge. The third event is *30-Day Emergency Room Visit Rate after Medical Discharge*, which measures the percentage of medical patients who visited the emergency room within 30 days of discharge. The final two events are *30-Day Readmission Rate after Surgical Discharge* and *30-Day Emergency Room Visit Rate after Surgical Discharge*, which capture the percentage of Medicare patients who underwent a "surgical" procedure and were readmitted within 30 days of discharge and the percentage that visited the emergency room within 30 days of discharge, respectively.

Hospital-level data for those five indicators are available from the Dartmouth Atlas Project for the years 2011–2013. The data were collected from CMS's Medicare Provider Analysis and Review File. Patients included in the case mix were Medicare fee-for-service beneficiaries with full Medicare Part A and Part B coverage during the study period. Patients who left against medical advice, who were discharged to hospice care, or who died while in the hospital were excluded from the sample. The rates were adjusted for age, gender, and race. For more detail about how this measure was constructed, see Goodman, Fisher, and Chang (2011).

We also analyze a second set of indicators that became available in 2013, when CMS began calculating a number of composite quality measures meant to be better indicators of

[7] For a list of conditions and procedures categorized as "medical" and "surgical," see CMS (2008a).

hospital performance across a class of metrics. These include an all-cause hospital readmissions rate and a composite rate of complications after surgery. Hospital-level data for these two indicators were available from Hospital Compare for the years 2013–2015.

The *Hospital-Wide 30-Day Readmission Rate* (READM-30-HOSP-WIDE) is a summary rate of unplanned readmissions within 30 days of discharge for all medical, surgical, cardiorespiratory, cardiovascular, and neurological conditions and procedures. According to Rosen et al. (2016), these five patient cohorts represent almost 90 percent of all hospital admissions. Patients included are from the Medicare fee-for-service population age 65 and older who were discharged from any nonfederal, short-stay, acute-care hospital or critical-access hospital (Horwitz et al. 2011). Like the other CMS readmission and mortality rates used in this study, the all-causes readmission rate is risk standardized to take into account an individual hospital's case mix. The all-causes readmission rate also adjusts for each hospital's patients' primary diagnosis to take into account variations in conditions and procedures, allowing for comparison across heterogeneous providers. For more detail about how this measure is constructed, see CMS (2015).

The *Aggregate Patient Safety Indicator* (PSI #90) is meant to capture how well a hospital prevents complications after surgery compared to other hospitals with a similar case mix. This measure is a weighted average of the hospital's performance on the following complications: pressure ulcer, iatrogenic pneumothorax, central venous catheter–related bloodstream infection, postoperative hip fracture, postoperative hemorrhage or hematoma, postoperative physiologic and metabolic derangement, postoperative respiratory failure, postoperative pulmonary embolism or deep vein thrombosis, postoperative sepsis, postoperative wound dehiscence, and accidental puncture or laceration (note that the composite measure does not include deaths from serious complications after surgery). The resulting composite ratio is scaled to an expected score of 1, given a hospital's individual case mix. A score of more than 1 indicates that the hospital had more complications than other hospitals with a similar case mix, whereas a score of less than 1 indicates fewer complications than hospitals with a similar case mix. For more detail about how this measure is constructed, see AHRQ (2010).

Table 11 contains summary statistics of these measures. Panel A compares these aggregate quality measures in CON and non-CON states, and panel B compares the indicators at hospitals in the subsample of HRRs that cross the border between CON and non-CON states. As in the previous robustness checks, the results of the pooled regression model with fixed effects when using these aggregate quality measures are largely consistent with our original model. In general, we find that hospitals in CON states perform either worse or the same as non-CON hospitals on these additional quality measures, although not all differences are statistically significant at conventional levels.

Table 12 contains the results for the pooled panel regression with HRR fixed effects using these new aggregate quality indicators. We find that the *14-Day Ambulatory Visit Rate after Medical Discharge* is almost 1.5 percentage points higher at CON hospitals than non-CON hospitals and that this result is statistically significant at (at least) the 10 percent level. We also find that the *30-Day Emergency Room Visit Rate after Medical Discharge* and the *30-Day Readmission Rate after Surgical Discharge* are, respectively, 0.71 and 0.84 percentage points higher at CON hospitals. These estimates are statistically significant at (at least) the 5 percent level. The differences in the *30-Day Readmission Rate after Medical Discharge* and the *30-Day Emergency Room Visit Rate after Surgical Discharge* are not significantly different from zero. Similarly, the *Hospital-Wide 30-Day Readmission Rate* and the *Aggregate Patient Safety Indicator* are not significantly different from zero.

Table 11. Difference-in-Means Tests—Aggregate Quality Measures

Panel A: All CON states versus all non-CON states	Non-CON states	CON states	Difference	Clustered *t* statistic	Observations
30-day readmission rate after medical discharge (percentage points)	15.0	15.5	−0.5	7.05	9,341
14-day ambulatory visit rate after medical discharge (percentage points)	63.8	64.2	−0.4	1.32	11,811
30-day emergency room visit rate after medical discharge (percentage points)	19.3	20.1	−0.9	9.26	10,163
30-day readmission rate after surgical discharge (percentage points)	11.2	12.0	−0.8	6.41	5,387
30-day emergency room visit rate after surgical discharge (percentage points)	15.0	15.8	−0.8	6.69	6,150
Hospital-wide 30-day readmission rate (percentage points)	15.4	15.7	−0.3	13.42	13,235
Aggregate patient safety indicator (ratio)	0.75	0.75	0.0	−0.51	9,815
Panel B: HRRs in both CON and non-CON states	**HRRs in non-CON states**	**HRRs in CON states**	**Difference**	**Clustered *t* statistic**	**Observations**
30-day readmission rate after medical discharge (percentage points)	15.1	15.4	−0.3	1.67	1,600
14-day ambulatory visit rate after medical discharge (percentage points)	62.2	63.8	−1.7	2.02	2,215
30-day emergency room visit rate after medical discharge (percentage points)	19.3	19.9	−0.6	2.78	1,774
30-day readmission rate after surgical discharge (percentage points)	11.2	11.5	−0.2	0.74	877
30-day emergency room visit rate after surgical discharge (percentage points)	14.9	15.4	−0.5	1.62	988
Hospital-wide 30-day readmission rate (percentage points)	15.4	15.6	−0.1	3.01	2,735
Aggregate patient safety indicator (ratio)	0.77	0.77	0.0	−1.53	1,690

Note: CON = certificate of need; HRRs = hospital referral region. Rates of readmissions, ambulatory visits, and emergency room visits are from the Dartmouth Atlas of Health Care for the years 2011–2013 (Dartmouth Atlas Project 2016). The hospital-wide readmission rate and aggregate patient safety indicator are from Hospital Compare for the years 2013, 2014 and 2015 (Hospital Compare Data Archive 2013, 2014, 2015). The unit of analysis is the individual hospital. Data are collected at the individual hospital level. All rates except the aggregate patient safety indicator are calculated using data from Medicare patients only. All *t* statistics are clustered at the individual provider level.

Sources: CMS (2014); Hospital Compare Data Archive (2013, 2014, 2015); Dartmouth Atlas Project (2016); American FactFinder (2016).

Table 12. Regression Results for Aggregate Quality Measures

Measure name	Coefficient on CON	Observations
30-day readmission rate after medical discharge, 2011–2013 (percentage points)	0.22 (0.22) Adj R^2 = 0.21	1,253
14-day ambulatory visit rate after medical discharge, 2011–2013 (percentage points)	1.42* (0.82) Adj R^2 = 0.45	1,371
30-day emergency room visit rate after medical discharge, 2011–2013 (percentage points)	0.71** (0.33) Adj R^2 = 0.15	1,295
30-day readmission rate after surgical discharge, 2011–2013 (percentage points)	0.84** (0.37) Adj R^2 = 0.44	774
30-day emergency room visit rate after surgical discharge, 2011–2013 (percentage points)	0.61 (0.49) Adj R^2 = 0.31	871
Hospital-wide 30-day readmission rate, 2013–2015 (percentage points)	0.13 (0.08) Adj R^2 = 0.36	1,435
Aggregate patient safety indicator, 2013–2015 (ratio)	−0.01 (0.02) Adj R^2 = 0.39	1,457

Note: CON = certificate of need. Rates on readmissions, ambulatory visits, and emergency room visits are from the Dartmouth Atlas of Health Care for the years 2011–2013 (Dartmouth Atlas Project 2016). The hospital-wide readmission rate and aggregate patient safety indicator are from Hospital Compare for the years 2013–2015 (Hospital Compare Data Archive 2013, 2014, 2015). The unit of analysis is the individual provider. Clustered standard errors by provider are in parentheses. Controls for percent over age 65, percent nonwhite, percent with no high school diploma, percent uninsured, and per capita income are the average from the provider's zip code. Controls for the number of patient days and Medicare patient days as a share of total patient days are from the individual provider. Controls also include year dummy variables. All rates except the aggregate patient safety indicator are calculated using data from Medicare patients only. ** statistically significant at (at least) the 5% level. * statistically significant at (at least) the 10% level.

Sources: CMS (2014); Hospital Compare Data Archive (2013, 2014, 2015); Dartmouth Atlas Project (2016); American FactFinder (2016).

Conclusion

As of 2015, 36 states and the District of Columbia had some form of regulation requiring healthcare providers to demonstrate a need for their medical services before building new facilities, expanding existing facilities, or offering new procedures.

Theoretically, the effect of CON regulations on the quality of health care supplied by providers is ambiguous. Supporters claim that CON laws increase equilibrium quality by restricting the number of providers and ensuring that each provider supplies a higher volume of patients than the provider otherwise would, making such providers more proficient. Opponents of CON regulations argue that healthcare providers, as with providers of other goods and services, compete with each other on a variety of margins and that quality of care is one margin on which they compete. Thus, by artificially restricting the number of providers in a market, CON laws reduce the competitive pressures for incumbent providers, which in turn results in lower-quality services.

Empirical research on the effect of CON laws on the quality of health care generally finds no significant differences between providers in states with and without these regulations. However, most of these studies suffer from two drawbacks: the lack of a measure that captures the overall quality of a hospital's medical services and an inability to isolate the causal effect of CON laws on hospital quality.

We develop an empirical framework that allows us to estimate the effect of the presence of CON laws on the quality of hospitals. Analyzing nine quality indicators and estimating the effect of CON laws on the basis of only how hospital quality varies within the same healthcare market, we find no evidence that CON laws increase the quality of care. Instead, we find evidence consistent with the hypothesis that limiting entry results in lower hospital quality.

For example, we find that mortality rates are statistically significantly higher at hospitals in CON states than in non-CON states. Our findings show that the estimated average 30-day mortality rate for patients discharged with pneumonia, heart failure, or heart attack from hospitals in CON states is between 2.5 and 5 percent higher than the average mortality rate for all hospitals in our subsample of HRRs that contains providers in both CON and non-CON states, depending on the illness. These findings are largely robust to a variety of alternative samples and quality measures.

One caveat to our empirical approach is the potential that, within each of our border-crossing healthcare markets, hospitals on the CON side of a border may compete with hospitals on the non-CON side. Hospitals in CON states might improve the quality of their care because they face competition with potentially higher-quality hospitals in non-CON states. Given that our approach still finds a quality differential despite this caveat, hospitals in CON states outside HRR market areas may provide even worse quality than hospitals in CON states that are competing with hospitals in non-CON states in the same market. Future research might explore this aspect of nonprice competition.

References

AHPA (American Health Planning Association). 2005. "The Federal Trade Commission & Certificate of Need Regulation: An AHPA Critique." http://www.ahpanet.org/files /AHPAcritiqueFTC.pdf.

AHRQ (Agency for Healthcare Research and Quality). 2010. "AHRQ Quality Indicators: Composite Measures User Guide for the Patient Safety Indicators (PSI)." http://www.qualityindicators.ahrq.gov/Downloads/Modules/PSI/V42/Composite_User _Technical_Specification_PSI.pdf.

American FactFinder. 2016. United States Census Bureau. Accessed September 14. https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

CDC (Centers for Disease Control and Prevention). 2016. "Healthcare-Associated Venous Thromboembolism." February 17. http://www.cdc.gov/ncbddd/dvt/ha-vte.html.

Cimasi, Robert James. 2005. *The U.S. Healthcare Certificate of Need Sourcebook*. Frederick, MD: Beard Books.

CMS (Centers for Medicare & Medicaid Services). 2007. "Frequently Asked Questions (FAQs): Implementation and Maintenance of CMS Mortality Measures for AMI & HF." June 19. https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments /HospitalQualityInits/downloads/HospitalMortalityAboutAMI_HF.pdf.

———. 2008a. "List of Diagnosis Related Groups (DRGs), FY2008." Accessed August 26, 2016. https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and -Reports/MedicareFeeforSvcPartsAB/downloads/DRGdesc08.pdf.

———. 2008b. "Mode and Patient-Mix Adjustment of the CAHPS® Hospital Survey (HCAHPS)." April 30. http://www.hcahpsonline.org/files /DescriptionHCAHPSModeandPMAwithBottomBoxModeApr_30_08.pdf.

———. 2012. "Frequently Asked Questions (FAQs): CMS 30-Day Risk-Standardized Readmission Measures for Acute Myocardial Infarction (AMI), Heart Failure (HF), and Pneumonia." May 1. http://www.ihatoday.org/uploadDocs/1/cmsreadmissionfaqs.pdf.

———. 2014. "Cost Reports by Fiscal Year." November 12. https://www.cms.gov /Research-Statistics-Data-and-Systems/Downloadable-Public-Use-Files/Cost-Reports /Cost-Reports-by-Fiscal-Year.html.

———. 2016a. "The HCAHPS Survey—Frequently Asked Questions." Accessed March 4, 2016. https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment -Instruments/HospitalQualityInits/Downloads/HospitalHCAHPSFactSheet201007.pdf.

———. 2016b. “Hospital Compare.” May 4. https://www.cms.gov/medicare/quality-initiatives-patient-assessment-instruments/hospitalqualityinits/hospitalcompare.html.

———. 2016c. “Readmissions Reduction Program (HRRP).” April 18. https://www.cms.gov/medicare/medicare-fee-for-service-payment/acuteinpatientpps/readmissions-reduction-program.html.

Cutler, David M., Robert S. Huckman, and Jonathan T. Kolstad. 2009. “Input Constraints and the Efficiency of Entry: Lessons from Cardiac Surgery.” NBER Working Paper No. 15214. National Bureau of Economic Research, Cambridge, MA.

Dartmouth Atlas Project. 2016. Dartmouth Atlas of Health Care (database). The Dartmouth Institute for Health Policy and Clinical Practice, Lebanon, NH. http://www.dartmouthatlas.org/.

Gaynor, Martin, and Robert J. Town. 2011. “Competition in Health Care Markets.” NBER Working Paper No. 17208. National Bureau of Economic Research, Cambridge, MA.

Goodman, David C., Elliott S. Fisher, and Chiang-Hua Chang. 2011. “After Hospitalization: A Dartmouth Atlas Report on Post-Acute Care for Medicare Beneficiaries.” http://www.dartmouthatlas.org/downloads/reports/Post_discharge_events_092811.pdf.

Halm, Ethan A., Clara Lee, and Mark R. Chassin. 2002. “Is Volume Related to Outcome in Health Care? A Systematic Review and Methodologic Critique of the Literature.” *Annals of Internal Medicine* 137 (6): 511–20.

Ho, Vivian, Meei-Hsiang Ku-Goto, and James G. Jollis. 2009. “Certificate of Need (CON) for Cardiac Care: Controversy over the Contributions of CON.” *Health Services Research* 44 (2, pt.1): 483–500.

Horwitz, Leora, Chohreh Partovian, Zhenqiu Lin, Jeph Herrin, Jacqueline Grady, Mitchell Conover, Julia Montague, et al. 2011. “Hospital-Wide (All-Condition) 30-Day Risk-Standardized Readmission Measure.” Prepared for Centers for Medicare & Medicaid Services, Baltimore, MD. https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/downloads/MMSHospital-WideAll-ConditionReadmissionRate.pdf.

Hospital Compare Data Archive. Multiple years. Data.Medicare.gov. https://data.medicare.gov/data/archives/hospital-compare.

Lorch, S. A., P. Maheshwari, and O. Even-Shoshan. 2011. “The Impact of Certificate of Need Programs on Neonatal Intensive Care Units.” *Journal of Perinatology* 32 (1): 39–44.

Medicare.gov. 2016. “What Is Hospital Compare?” Accessed September 1. https://www.medicare.gov/hospitalcompare/About/What-Is-HOS.html.

NCSL (National Conference of State Legislatures). 2016. "CON: Certificate of Need State Laws." NCSL, Washington, DC. August 25. http://www.ncsl.org/research/health/con-certificate-of-need-state-laws.aspx.

Page, Leigh. 2010. "5 Most Common Hospital Acquired Conditions Based on Total Costs." *Becker's Hospital Review*. http://www.beckershospitalreview.com/hospital-management-administration/5-most-common-hospital-acquired-conditions-based-on-total-costs.html.

Paul, Jomon Aliyas, Huan Ni, and Aniruddha Bagchi. 2014. "Effect of Certificate of Need Law on Emergency Department Length of Stay." *Journal of Emergency Medicine* 47 (4): 453–61.

Piper, Thomas R. 2003. "Certificate of Need: Protecting Consumer Interests." PowerPoint presentation before a joint Federal Trade Commission–Department of Justice hearing on health care and competition law and policy. Washington, DC, June 10. http://www.ahpanet.org/files/PiperFTCDOJpresFINAL.pdf.

Polsky, Daniel, Guy David, Jianing Yang, Bruce Kinosian, and Rachel M. Werner. 2014. "The Effect of Entry Regulation in the Health Care Sector: The Case of Home Health." *Journal of Public Economics* 110: 1–14.

QualityNet. 2016. "Measure Methodology Reports: Readmission Measures." https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier4&cid=1219069855841.

Rosen, Amy K., Qi Chen, Michael Shwartz, Corey Pilver, Hillary J. Mull, Kamal F. M. Itani, and Ann Borzecki. 2016. "Does Use of a Hospital-Wide Readmission Measure versus Condition-Specific Readmission Measures Make a Difference for Hospital Profiling and Payment Penalties?" *Medical Care* 54 (2): 155–61.

Rosenthal, Gary E., and Mary V. Sarrazin. 2001. "Impact of State Certificate of Need Programs on Outcomes of Care for Patients Undergoing Coronary Artery Bypass Surgery." Report to the Florida Hospital Association. https://www.vdh.virginia.gov/Administration/documents/COPN/Jamie%20Baskerville%20Martin/Rosenthal%20et%20al.pdf.

South Carolina Health Planning Committee. 2015. *South Carolina Health Plan*. Columbia, SC: South Carolina Department of Health and Environmental Control. http://www.scdhec.gov/Health/docs/FinalSHP.pdf.

Steen, John. 2016. "Regionalization for Quality: Certificate of Need and Licensure Standards." American Health Planning Association. Accessed February 2, 2016. http://www.ahpanet.org/files/Regionalization for Quality.pdf.

Thomas, Richard K. 2015. "AHPA Perspective: Certificate of Need Regulation." PowerPoint presentation prepared for Virginia Department of Health by the American Health Planning Association, Falls Church, VA. http://slideplayer.com/slide/7468203/.

Vaughan-Sarrazin, Mary S., Edward L. Hannan, Carol J. Gormley, and Gary E. Rosenthal. 2002. "Mortality in Medicare Beneficiaries following Coronary Artery Bypass Graft Surgery in States with and without Certificate of Need Regulation." *JAMA* 288 (15): 1859–66.

Virginia Department of Health. 2015. "Certificate of Public Need Workgroup—Final Report." Report Document No. 467. https://www.vdh.virginia.gov/Administration/documents/COPN/Final%20Report.pdf.

Werner, Rachel M., and Eric T. Bradlow. 2006. "Relationship between Medicare's Hospital Compare Performance Measures and Mortality Rates." *JAMA* 296 (22): 2694–702.

Zuckerman, Rachael. 2016. "Reducing Avoidable Hospital Readmissions to Create a Better, Safer Health Care System." US Department of Health and Human Services, Washington, DC. http://www.hhs.gov/blog/2016/02/24/reducing-avoidable-hospital-readmissions.html.

Zuckerman, Rachael B., Steven H. Sheingold, E. John Orav, Joel Ruhter, and Arnold M. Epstein. 2016. "Readmissions, Observation, and the Hospital Readmissions Reduction Program." *New England Journal of Medicine* 374 (16): 1543–51.