Essays on Information Technology and Organizational Form in the Health Care Industry

by

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ABSTRACT

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Employment of physicians by hospitals can confer greater administrative control to hospitals over physicians' actions and resources and thereby enable efficiency gains, including implementation of enterprise-wide initiatives, such as health information technology (IT), that can improve quality and contain cost growth. It can also reduce other costs, and improve coordination of pricing inpatient and outpatient services. On the other hand, hospital-physician integration, may have anti-competitive and cost increasing effects that harm social welfare.

I test for the relationship between hospital employment of physicians and hospitals' propensity to adopt health IT. I use state laws that prohibit hospital employment of physicians as an instrument to mitigate potential bias from the endogenous relationship with hospital IT adoption. Employment of physicians is associated with significant increases in the probability of hospital health IT adoption. Therefore subsidization of health IT among hospitals not employing physicians may be less beneficial. Furthermore, state laws prohibiting hospitals from employing physicians may inhibit adoption of health IT, thus working against policy initiatives aimed at promoting use of the technology.

Participation in health information exchange (HIE), in which unaffiliated providers in a community leverage the capabilities of health IT to share patient data with one another, potentially slows cost growth and improves quality by reducing redundant diagnostic procedures.

Emergency departments (ED) are an important test case for the claimed benefits of health IT and HIE since enhanced speed of access to patient information can have great value in EDs. In an analysis of panel data on ED discharges in California and Florida, I find robust evidence of a reduction in repeat diagnostic imaging procedures due to health IT adoption and HIE participation.

This dissertation's final analysis considers competitive and cost effects of hospital-physician integration. Findings of a positive effect of hospital-physician integration on average revenue and average inpatient days among rural hospitals only suggests that integration intensifies inpatient service provision in rural areas but does not adversely impact competition. Given no evidence of price increases in non-rural areas, integration should not raise concern on anti-trust grounds in most markets and may yield benefits like hastening adoption of innovations.

Chapter 1

Introduction: The organization of health care delivery and consequences for information technology adoption, quality and costs

Providing health care, particularly to patients with the greatest need like those with chronic conditions, requires considerable coordination between a variety of often unaffiliated professionals and organizations. The Institute of Medicine (IOM), in its influential report *Crossing the Quality Chasm* (2001), identified weaknesses in the coordination of care that are attributable, in part, to the decentralized structure of care provision, and the failure to implement advanced capabilities of information technology (IT) to enhance communication among providers and with patients. The IOM authors observed that, currently, care is often delivered by teams of providers, but that the effectiveness of these teams is limited by tendencies toward protection of "professional prerogatives and separate roles," which result in "lost continuity [for patient care], redundancy, excess costs, and miscommunication." The report further asserts that, "each doctor gets what he or she wants, but at the cost of introducing enormous complexity and possible error into the system (I.O.M., 2001)."

The United States federal government has enacted several policy initiatives to address these weaknesses in the organization of care delivery and improve coordination towards better quality and efficiency. The health reform legislation passed in 2010 includes provisions for Medicare to contract with networks of providers, including hospitals, physicians and others self-organized into Accountable Care Organizations (ACOs) with the goal of improving quality and reducing costs. Under this initiative, Medicare will enact incentive mechanisms, such as bundled payments to groups of providers for episodes of care, to encourage more intensive coordination. These payment mechanisms are intended to present incentives for more cost-effective care by tracking measures of performance and allowing for any cost savings to be shared with the providers (Merils, 2010).

Achieving widespread adoption and effective use of health IT may also contribute to the goal of improving coordination among providers. Two reports have estimated projected savings due to avoided unnecessary tests and other efficiency improvements on the order of tens of billions of dollars over a ten to fifteen year period. Hillestad and colleagues (2005) projected annual savings of over $81 billion, with $1.7 billion from efficiencies in outpatient imaging procedures. Walker and colleagues (2005) focused particularly on projected benefits of health information exchange (HIE) and interoperability and estimated $78 billion in annual net value, with up to $26 billion coming from avoided tests and improved efficiencies. While these proposed savings from widespread health IT adoption are simply educated guesses, they encapsulate the conventional wisdom on the promise of health IT to make health care more efficient and safer for patients. The Unites States federal government has bet on this potential with a thirty billion dollar investment in the national health IT infrastructure through the HITECH Act portion of the 2009 American Recovery and Reinvestment Act. Chapter 4 of this dissertation examines some claimed benefits of health IT and HIE in emergency departments (ED)—a setting where the technology may reduce redundant diagnostic tests that patients often undergo in multiple visits to providers. I find evidence of a reduction in repeat diagnostic imaging procedures among patients who visit multiple EDs due to health IT adoption and HIE participation

The pathologies of misaligned incentives and coordination failures among providers, identified in generality by the IOM, have previously been described in microcosmic form in Jeffrey Harris' seminal paper on the internal organization of hospitals (1977). Harris highlighted the tension that exists between physicians, who serve as their patients' agents in procuring hospital resources and hospital administrators who supply the necessary inputs for care while attempting to minimize the costs of excess capacity. He also describes the allocation of hospital resources among the various services provided by members of the medical staff as being determined by " loosely enforced standards, rules of thumb, side bargains, cajoling, negotiations, special contingency plans, and in some cases literally shouting and screaming." Harris draws the conclusion that physicians' and hospital administrators' pursuits of different objectives, and regulation that focuses solely on the supplying (administrative) side of the firm, results in an expansion of utilization and hospital capacity. This favors innovations that increase the amount of resources used per patient over efficiency-enhancing innovations that lead to fewer resources per case. Certainly, fee for service payment also contributes to this phenomenon.

It is noteworthy that Harris developed his model during a time (the late 1970s) of predominantly loose affiliation between hospitals and physicians in which physicians served their patients using hospital resources but received separate reimbursement from payers and usually did not have direct financial ties to the hospitals in which they worked. The introduction of prospective payment, capitation, per-diems, case rate payment and other innovations aimed at limiting costs prompted hospitals and physicians to experiment with tighter affiliations, including direct employment of physicians by hospitals (Burns et al., 2000, Cuellar and Gertler, 2006). Economizing on transactions costs, such as costs of coordination between hospitals and physicians and costs of motivating physicians to align their actions with hospital interests or vice versa, provides a rationale for integration. Transacting in complex circumstances, combined with the cognitive limitations of human actors (bounded rationality), and small numbers bargaining between potential participants in contracts combined with the human propensity to behave opportunistically, influences the relative costs of different organizational forms (Williamson, 1975). Harris' description of the internal organization of hospitals makes apparent that all of these factors (complexity, small numbers bargaining, opportunistic behavior, etc.) are present to a significant degree in the hospital setting. Given these conditions and the resulting hazards of incomplete contracts, transaction cost economics emphasizes advantages of authority in a vertically integrated firm compared to coordination among looser affiliates. These advantages derive from the ability of managers to reallocate resources in the face of uncertainty without the necessity of negotiation, to deploy a more extensive set of monitoring and control mechanisms, to have better alignment of incentives among the parties housed in one firm, to jointly maximize profit, and to spread cognitive costs over a more diverse set of agents (Menard, 2005, Williamson, 1975).

Two of the research papers composing this dissertation examine effects of the vertical integration between hospitals and physicians. In Chapter 2, I examine the effect on hospital adoption of health IT—technology that is regarded as having the potential to introduce significant efficiency in the sense of fewer resources used per patient. This technology can enhance efficiency by lowering the costs of communicating patient information among providers, extending their cognitive capabilities (for example, by reminding clinicians to provide scientifically indicated services tailored to specific patient attributes), and by enabling greater monitoring of clinician adherence to protocols and use of hospital resources. To be sure, the effects of health IT are not exclusively in the direction of using fewer resources per patient, but as I show in Chapter 3, health IT can produce significant reductions in utilization of diagnostic procedures. In Chapter 2, I present evidence that hospitals directly employing physicians are more likely to have adopted health IT applications.

Chapter 4 considers the balance between potential anti-competitive effects of hospital-physician integration and potential efficiency gains. By integrating with a large physician group or several such groups operating in its market, a hospital may foreclose rival hospitals from the market for physician services, thereby inducing higher operating costs among rivals. The integrated hospital may then be able to exert market power, either unilaterally or by coordinating with competitors. Because rivals are disadvantaged by increased costs resulting from the vertical merger, these hospitals may be induced into involuntary coordination with the vertically merged hospital. In this manner, a vertically integrated firm can achieve the power to raise or maintain price above marginal cost (Gaynor, 1998, Riordan and Salop, 1995). Without high market concentration, however, this potential anticompetitive effect becomes less likely. On the other hand, hospital-physician integration may produce efficiencies from economies of scope in the provision of hospital and physician services, or from better coordination of pricing across these services. I find no evidence of an anti-competitive effect nor a cost efficiency effect from integration. I do, however, find indirect evidence that integration may induce more intensive inpatient services in these hospitals through greater inpatient days per discharge. The results presented in Chapter 4 suggest that fears of anti-competitive effects from the formation of Accountable Care Organizations (as voiced in the study by Berenson and colleagues (2010), for example) may be unfounded, at least with respect to direct employment of physicians by hospitals.

1.1 References for Chapter 1

Berenson, R. A., Ginsburg, P. B. & Kemper, N. (2010) Unchecked provider clout in California foreshadows challenges to health reform. *Health Aff (Millwood),* 29**,** 699-705.

Burns, L. R., Bazzoli, G. J., Dynan, L. & Wholey, D. R. (2000) Impact of HMO market structure on physician-hospital strategic alliances. *Health Serv Res,* 35**,** 101-32.

Cuellar, A. E. & Gertler, P. J. (2006) Strategic integration of hospitals and physicians. *J Health Econ,* 25**,** 1-28.

Gaynor, M., Deborah Haas-Wilson (1998) Vertical Relations in Health Care Markets. IN Morrisey, M. A. (Ed.) *Managed care & changing health care markets.* Washington, D.C., AEI Press.

Harris, J. E. (1977) The Internal Organization of Hospitals: Some Economic Implications. *The Bell Journal of Economics,* 8**,** 467-482.

Hillestad, R., Bigelow, J., Bower, A., Girosi, F., Meili, R., Scoville, R. & Taylor, R. (2005) Can electronic medical record systems transform health care? Potential health benefits, savings, and costs. *Health Aff (Millwood),* 24**,** 1103-17.

I.O.M. (2001) Crossing the quality chasm : a new health system for the 21st century. IN America., C. O. Q. O. H. C. I. (Ed.). Washington, D.C., National Academy Press.

Menard, C. (2005) A new institutional approach to organization. IN Menard, C., Shirley, M. M. & Springerlink (Eds.) *Handbook of New Institutional Economics.* Boston, MA, Springer.

Merils, M. (2010) Health Policy Brief: Accountable Care Organizations. *Health Affairs.*

Riordan, M. H. & Salop, S. C. (1995) Evaluating vertical mergers: a post-Chicago approach. *Antitrust L.J.,* 63**,** 513-568.

Walker, J., Pan, E., Johnston, D., Adler-Milstein, J., Bates, D. W. & Middleton, B. (2005) The value of health care information exchange and interoperability. *Health Aff (Millwood),* Suppl Web Exclusives**,** W5-10-W5-18.

Williamson, O. E. (1975) *Markets and hierarchies, analysis and antitrust implications: a study in the economics of internal organization,* New York, Free Press.

Chapter 2

The Effect of Hospital-Physician Integration on Health Information Technology Adoption

2.1 Introduction

In 2009, the United States (U.S.) Congress passed the American Recovery and Reinvestment Act which appropriates funds to promote the adoption and use of health information technology (IT). The Medicare and Medicaid insurance programs are distributing these funds as rewards to providers for meeting various criteria for implementation and use of health IT with the goal of improving quality and cost-efficiency of care (Blumenthal and Tavenner, 2010). A prominent health IT application emphasized by the program is computerized provider order entry (CPOE). CPOE helps providers to create and manage orders for patients' services and medication and has been promoted as an important component in improving patient safety (IOM, 2001). In theory CPOE can reduce errors due to illegible handwriting, and with the aid of alerts, decision support, and detailed clinical information about a patient contained in an electronic medical record (EMR), it can help avoid adverse events from drug-drug interactions and known drug allergies. It can also enable faster delivery times to the pharmacy and may be less subject to errors caused by similar drug names and incorrect drug choices (Koppel et al., 2005).

This study contributes evidence regarding the relationship between vertical integration in health care and hospital use of clinical IT applications. It enhances our understanding of the organizational determinants of health IT adoption. Various cross-sectional and longitudinal studies have identified determinants of health IT adoption, including system affiliation, size, urban location, multihospital system membership, network effects, and not-for-profit ownership (Kazley and Ozcan, 2007, McCullough, 2008, Cutler et al., 2005, Miller and Tucker, 2009). Previous research on the relationship between IT and firm size and firm boundaries in other industries has found that increases in IT capital are associated with a decline in average firm size, consistent with case analyses and theoretical arguments suggesting that IT lowers the costs of coordinating externally with suppliers, thus leading to less vertical integration (Brynjolfsson et al., 1994, Hitt, 1999). However, evidence from the introduction of on-board computers in the trucking industry indicates that this technology, serving as a monitoring device in that context, altered incentives related to ownership of trucks and thereby induced more vertical integration in that industry (Baker and Hubbard, 2004). Thus, findings in non-healthcare industries do not show a consistent relationship between IT and firm boundaries. In the health care context, McCullough and Snir (2010) find evidence of a positive relationship between exclusive hospital-physician affiliations and hospital use of IT applications that enhance monitoring of physician activities, including utilization review software and clinical data repositories.

Hospital-physician organizational arrangements come in various forms with functions intended to align hospitals' and physicians' economic and strategic interests (Alexander et al., 1996, Cuellar and Gertler, 2006, Morrisey et al., 1996). The traditional medical staff model, by far the most common arrangement prior to the managed care era, involves only the granting of admitting privileges by a hospital to its physicians without direct financial ties between the two. During the managed care era, many hospitals entered into various arrangements with physicians, including at one extreme, direct employment of physicians. While the era of tight managed care has passed, hospitals still face pressures from payers via negotiated payment rates, per diem or case rate payments and Medicare's prospective payment system to control costs. Thus coordination with physicians continues to be a concern for hospitals. Cuellar and Gertler (2006) provide a detailed discussion of other organizational arrangements between hospitals and physicians aside from employment.

In this study, I restrict the definition of hospital-physician integration to hospital employment of physicians and examine if this organizational form displays significantly different health IT adoption patterns relative to other looser hospital-physician affiliations. This restricted definition is warranted since employment is the most common form of integration between hospitals and physicians reported in the AHA survey and has risen during the past decade while other forms have declined (Gaynor, 2011). This evidence is corroborated by recent independent research revealing that hospital employment of physicians, both specialists and primary care, is increasing nationwide (Casalino et al., 2008, O'Malley et al., 2011). Since the trend toward physician employment by hospitals coincides with increasing interest in stimulating health IT use, understanding any interactions between these two hospital strategies will inform both policies intended to influence health IT adoption and policies focused on hospital-physician relations, including anti-trust regulation and initiatives fostering the development of Accountable Care Organizations.

2.2 Conceptual Model

Because much benefit from health IT follows from reduced costs of communicating and managing patient information across multiple settings and over different episodes of care (Hillestad et al., 2005), providers' use of, or failure to use, the technology imposes an externality on other providers and the patients they serve (Miller and Tucker, 2009). Since the costs and benefits of investment in information systems do not accrue to a single provider, a public goods problem arises in which each agent has inadequate incentives to privately invest in the necessary technology.

While many factors other than the coordination of information system investments contribute to hospital and physician decisions about whether to integrate, those hospitals that do employ their medical staff can more readily internalize the externality stemming from availability of patient data in electronic form. Without an exclusive hospital-physician affiliation, building necessary interfaces between inpatient and ambulatory information systems can be problematic due to the threat of regulatory actions under the federal Stark and anti-kickback laws prohibiting hospitals from offering financial incentives to independent physicians in return for referrals. Even with amendments to these laws in 2006 that were designed to facilitate hospital financing of IT implementation in physician practices, independent physicians must still contribute a substantial portion of the funds required for the technology (Grossman and Cohen, 2008). Hospitals that own physician practices face no such legal barriers to financing information systems that exchange patient data between settings of care, thus allowing them to capture greater benefit from these investments.

Furthermore, hospital employment of physicians confers advantages in the face of uncertainty, such as potential future changes in payment systems (e.g. movement by payers to impose greater risk-bearing or pay-for-performance on providers). Integration does this by centralizing control of hospital resources, including the medical staff and associated practice assets, under the authority of hospital administrators. Transaction cost economics, which I adopt as the framework for understanding the relative performance of physician employment versus looser arrangements, emphasizes advantages of authority compared to coordination among looser affiliates. These advantages flow from the ability of managers to reallocate resources in the face of uncertainty without the necessity of negotiating (Menard, 2005, Williamson, 1975). In the context of this study, we may understand hospital implementation of health information technology as an adaptive response to the hospital's environment that requires cooperation from physicians. Integration between hospitals and physicians confers greater control to hospitals over physicians' actions and resources and thus enables more beneficial implementation of the new technology.

I also draw on Jeffrey Harris' (1977) model of the internal organization of hospitals. Because of the uncertainty surrounding human disease processes, Harris highlights the importance to hospitals of rapid adaptation to "changing circumstances and new information" while determining the appropriate short-term allocation of resources. In theory, health IT can improve information management and communication in hospitals, thus enabling more efficient use of resources. These considerations contribute to hospital demand for health IT. However, as Harris points out, a tension exists between physicians, who serve as their patients' agents in procuring hospital resources, and hospital administrators, who must supply the necessary inputs for care without carrying too much excess capacity. This tension contributes to hospital administrators' desire for greater control over physician actions, thus leading to alignment strategies, such as directly employing physicians. Conditions for physician participation include compensation that meets or exceeds a minimum threshold determined by physician risk-preferences and the profitability of owning an independent practice.

Furthermore, IT enhances the capability of hospitals to monitor the actions of affiliated physicians and structure incentives accordingly (McCullough and Snir, 2010). As noted by Masten (1988), certain legal requirements, such as employer liability for the actions of employees, enhance incentives to monitor employee activities more carefully relative to independent contractors' activities. When hospitals employ physicians, they assume malpractice liability that they would not otherwise have to bear for physicians (Cebul et al., 2008). This liability may motivate use of IT for monitoring purposes within tightly integrated health systems relative to hospitals more loosely affiliated with their medical staffs.

Alternatively, hospital use of health IT can substitute for direct employment of physicians by allowing hospitals to attract independent physicians through conveniences associated with health IT, such as ready access to inpatient information through physician internet portals, or through a reputation effect as a sign of prestige. Since the relationship between physician employment and health IT may involve both complementarity and substitutability, empirical research can illuminate the relative magnitudes of these effects. In this study I test for a relationship between hospital employment of physicians and the probability that hospitals adopt two prominent health IT applications—EMR and CPOE.

2.3 Data and Methods

2.3.1 Data Sources

The Health Information Management Systems Society (HIMSS) Analytics database for 2008 provides information on hospital use of health IT applications for over 4800 non-federal acute care hospitals in the U.S.—a near census of such hospitals. Included in the database are variables indicating hospital use of enterprise-wide EMR and CPOE. Respondents to this survey report if they have an operational system or not. The American Hospital Association (AHA) annual survey for 2008 provides information on hospital characteristics, including employment of physicians, for over 6,000 hospitals, including 4,678 nonfederal general hospitals. I merged the HIMSS Analytics database with the AHA data using various hospital identifiers common to both datasets, including the hospitals' Medicare provider numbers, names, and addresses. After merging these datasets, the sample consists of 4,502 non-federal general hospitals observed in 2008. The 2008 Area Resource File provides data on county-level demographics.

For part of the analysis, I use data regarding state corporate practice of medicine (CPM) laws. The CPM doctrine, which has been defined primarily through case law interpretations of state medical practice acts, prohibits unlicensed entities (non-physicians) from employing medical doctors (Kim, 2007). In some states, this doctrine has been extended to prohibit the employment of physicians by hospitals. Some states only prohibit for-profit hospitals. Prior research substantiates the premise that these laws present a binding constraint for many hospitals subject to them. A 1991 Department of Health and Human Services study involving a random sample survey of hospital administrators found that the laws impose "legal, recruitment or administrative costs," and “make it more difficult to staff medical services” (Yessian et al., 1991). A recent analysis of California’s CPM doctrine notes that, despite availability of alternative integrated arrangements between hospitals and physicians, “the complexity and costs of such efforts may preclude smaller, financially weaker, and rural hospitals from pursuing them (Draper et al., 2009).”

A research assistant did comprehensive searches of state and federal statutes and case law and consulted state medical societies and prior CPM studies in order to identify states that apply the doctrine to hospital employment of physicians. Figure 2.1 shows states that were found to enforce CPM against hospital employment of physicians in two groups: 1) those restricting both not-for-profit and for-profit hospitals, and 2) those restricting only for-profits. All unlisted states were not found to have a CPM law that prohibits hospital employment of physicians. Within those states that apply the CPM doctrine to not-for-profit hospitals, there are exceptions for particular classes of hospitals (Draper et al., 2009). The exceptions to CPM in those states that apply the law to hospitals are described in an appendix. From these data, I constructed a hospital-level indicator for binding CPM restrictions against employing physicians. To the extent that exempt hospitals are identifiable with the AHA survey (e.g. because of non-profit or government ownership or teaching status in some states), the indicator variable for CPM takes into account the various exceptions within those states that apply the restriction.

Table 2.1 provides summary statistics for the variables used in the estimations described below. I report results and summary statistics only for the sample with non-missing data. These summary statistics are also presented with stratification according to whether the hospital is bound by corporate practice of medicine restrictions and p-values from t-tests of differences in means. In the case of for-profit status and teaching status, differences between hospitals bound by the law and those not bound follow obviously from differential application of the law between for-profits and non-profits and academic versus non-academic hospitals in some states. Because there are a number of significant differences in observed characteristics between hospitals bound by the law and those not bound by the law, in the regression analyses I control for a rich set of observed hospital characteristics on the assumption the law is validly excluded as a predictor of health IT adoption conditional on the observed hospital characteristics.

In 2008, thirty-five percent of the sample reported having an employment arrangement with their physicians. As expected, a substantially larger proportion of hospitals that are not bound by CPM laws report employment of physicians. Although the laws technically prohibit integration as defined in this paper, they imperfectly (but strongly) predict non-integration due to some exempt hospitals that cannot be identified with the available data, possible variation in enforcement practices, and reporting error regarding integration in the survey. The problem of reporting error is mitigated by the instrumental variable strategy used in this study.

For comparison, I also examined hospital use of several administrative IT applications, including business intelligence software, financial modeling, and financial data warehousing. These computer-based applications are designed to provide performance data for business and financial measures to support management decision making. They were in use by proportions of hospitals similar to those using the clinical applications in this study. By ruling out a strong association between these applications and hospital-physician integration, I establish further evidence that the effect of integration on health IT is due to a complementary relationship between physician employment and the technology as described in my conceptual model and not due to another mechanism.

Relevant hospital characteristics are included as control variables. In particular, membership in the council of teaching hospitals, for-profit, not-for-profit, and government ownership, and the proportion of patients insured by government payers (Medicare and Medicaid) are included in the estimates. As a measure of the managed care environment faced by hospitals, the Medicare managed care penetration rate is also included. Linear splines for total admissions are included as a measure of hospital size. In order to improve the fit of the models, I tested for differences in the coefficients of spline segments and combined those that were not found to be significantly different from one another. This procedure resulted in two segments for total admissions in the CPOE estimation, four in the EMR estimation, and four in the comparison technology regressions. Competition among hospitals is measured using the Herfindahl-Hirschman Index (HHI) for which higher values indicate more concentrated markets. For this study, a market is a hospital referral region (HRR), defined by the Dartmouth Atlas as a regional market for tertiary care based around hospitals that provide major cardiovascular procedures and neurosurgery (Dartmouth Medical, 1998).

2.3.2 Empirical Model

I estimated the probability that a hospital has a particular health IT application (EMR and in a separate regression, CPOE) cross-sectionally as a function of hospital-physician integration using probit. However, because hospitals make decisions about health IT and physician employment with consideration for the same sets of circumstances, unobserved hospital characteristics can contribute to bias in estimating the relationship between these two variables. For example, higher costs of maintaining an independent physician practice in some markets may lead to substantially more hospital-based employment. Previous research using consulting reports, surveys, and case studies documents rising overhead costs in independent practice as contributing to more physicians accepting hospital employment in recent years (Burns and Muller, 2008). These costs of maintaining independent physician practices will be correlated with local costs of adopting health IT, such as labor costs for professionals needed to support use of the new technology. These costs, in turn, reduce hospital propensity to adopt health IT even though an employed physician staff reduces other organizational impediments to adoption. Thus, correlation between unobserved physician practice costs and unobserved labor costs for IT will bias coefficient estimates toward zero in a single equation estimation of the relationship between hospital-physician integration and hospital propensity to use health IT.

In order to mitigate bias from the endogeneity of hospital-physician integration, I use information about whether or not hospitals are prohibited by state laws from directly employing physicians as an instrumental variable in a bivariate probit regression. Because these state laws have remained static during the period over which EMR and CPOE have diffused, I estimated a single period cross-sectional regression for 2008—the latest year for which data was available, and also the year during which there is the greatest variation in hospital use of the technology and hospital employment of physicians so far. Having substantial variation in these two hospital characteristics is, of course, necessary for the purpose of estimating the relationship of interest.

The model is presented in the following equations:

$$T_h{}^* = \beta_0 + \beta_1 I_h + \beta_2 \boldsymbol{HOSPITAL}_h + \beta_3 \boldsymbol{MARKET}_h + \varepsilon_T \qquad (1)$$

$$T_h = 1(T_h{}^* > 0)$$

$$I_h{}^* = \theta_0 + \theta_1 RESTRICTIONS_h + \theta_2 \boldsymbol{HOSPITAL}_h + \theta_3 \boldsymbol{MARKET}_h + \varepsilon_I \qquad (2)$$

$$I_h = 1(I_h{}^* > 0)$$

Hospital *h's* adoption of health IT (T) is a function of an unobserved latent index variable (T *) which represents hospital *h's* propensity to adopt health IT. T * in turn is a linear function of integration with physicians (I)—a dichotomous variable—a vector of hospital characteristics ($\boldsymbol{HOSPITAL}$) and a vector of hospital market characteristics ($\boldsymbol{MARKET}$). Integration status is treated as endogenous, while all other hospital and market characteristics are regarded as exogenous. Integration status (I) is modeled as a function of state laws prohibiting physician employment ($RESTRICTIONS$) as well as vectors of hospital characteristics ($\boldsymbol{HOSPITAL}$) and hospital market characteristics ($\boldsymbol{MARKET}$). This strategy produces consistent estimates of the coefficient on hospital employment of physicians in (1) from which I calculate the incremental effect of hospital-physician integration on the probability of health IT adoption. The key identifying assumptions in terms of this model are that $RESTRICTIONS$ affects integration, and only influences T (with adjustment for other observed variables) through its effect on I and is therefore uncorrelated with ε_T. The error terms in the two latent index functions, ε_T and ε_I, are modeled as having a bivariate normal distribution. Because of the crucial role of state-level policies in the identification strategy, all regressions allow for correlation in the error components among hospitals in the same state.

2.4 Results

Probit estimates of the effect of physician employment on hospital use of health IT yield insignificant positive results. Table 2.2 displays the average marginal effects from the probit estimates for EMR and CPOE. Significant predictors of health IT use include teaching status, total admissions, and metropolitan location. For-profit status has a significant negative relationship with both forms of health IT relative to private non-profit hospitals, while government ownership has a significant negative relationship only for EMRs relative to private non-profits. Median household income has a significant positive relationship with CPOE, but not with standalone EMR systems.

Table 2.3 reports average marginal effects calculated from results of univariate probit estimation of the reduced form equation in which the indicator for a binding CPM law replaces the integrated salary model indicator. The results show significant reductions in the probability of health IT use attributed to binding state restrictions prohibiting hospital employment of physicians. Chernozhukov and Hansen (2008) point out that, assuming the exclusion restriction holds, testing the significance of the coefficient estimates for excluded instruments in the reduced form equation provides a test for the parameters of interest that is robust to weak instrument bias. Furthermore, as contextual information for interpreting the reduced form results, the treatment effect of interest (i.e. the effect of integration on the probability of hospital IT use) is approximately the ratio of the reduced form coefficient estimate and the first stage coefficient estimate in an exactly identified two-stage least squares regression with a single endogenous regressor. Thus it is the case here, using probit and bivariate probit, that the average marginal effects estimated for the reduced form, first stage, and structural equation are proportionally related.

Furthermore, I estimated the probability of health IT use as a function of integration status, other hospital characteristics and market/county characteristics using recursive bivariate probit with state corporate practice of medicine laws as an instrument for hospital-physician integration. Bhattacharya and colleagues (2006) document evidence on the advantages of recursive bivariate probit relative to other instrumental variables (IV) strategies for estimating treatment effects when both outcome and treatment variables are dichotomous. They find, in particular, that recursive bivariate probit estimates are more robust to departures from normality in the data generating process than alternative IV strategies.

Table 2.4 reports average marginal effects from the estimate of the probability of hospital-physician integration (the first stage equation of the bivariate probit regression). Consistent with expectations, binding CPM laws produce a significant twenty-four percentage point decline in the probability of employing physicians. Other results from estimating the probability of hospital-physician integration indicate that for-profit hospitals are significantly less likely to employ physicians than non-profits. Operating in a more concentrated market is associated with a higher probability of employing physicians. Among larger hospitals, total admissions is positively associated with the probability of integration.

Table 2.5 reports average marginal effects on the marginal probability of health IT use ($\partial\Phi(T)/\partial x$) from the health IT bivariate probit regressions. Standard errors for the average marginal effect estimates from these regressions were calculated using the delta method. The average marginal effects indicate a significant positive relationship between physician employment and the use of both EMR and CPOE. Here I find that integration is associated with a twenty-four percentage point increase in the probability of CPOE use, and a thirty-nine percentage point increase in the probability of EMR use. Teaching status and metropolitan location remain significant positive predictors of both health IT applications. Total patient admissions, within some ranges, is significantly and positively associated with the probability of both forms of health IT. Although the marginal effect of for-profit status remains a significant negative predictor of the probability of EMR use, it is not statistically significant in the CPOE regression, contrary to the univariate probit results. It does, however, have a negative direct effect as with univariate probit. These results suggest that much of the negative effect of for-profit status on CPOE use comes indirectly through its negative effect on integration.

A test of the strength of the excluded instrument produces a chi-square test statistic of twenty-four, indicating a reasonably strong instrument (see Table 2.5). The other requirement which an instrument must satisfy to be valid is an exclusion restriction—in this case, CPM laws should only influence the probability of health IT adoption through hospital-physician integration and not through any unobserved variable. Because the CPM laws predate the adoption of modern information systems and have remained static with respect to hospitals ever since, these laws are plausibly uncorrelated with EMR and CPOE adoption by hospitals except through their effect on hospital-physician integration. Furthermore, I find evidence that employment of physicians is endogenous with respect to hospital health IT use via a Wald test of the hypothesis that rho = 0 in both health IT bivariate probit regressions (see Table 2.6). This test indicates that there is substantial correlation between hospital health IT use and employment of physicians after observed factors have been accounted for. Thus, the coefficient estimate for integration in a single equation probit model will be inconsistent, and use of an instrumental variables strategy is warranted.

2.4.1 Robustness

I tested the effect of integration on other hospital administrative IT applications for which, a priori, we would not expect a relationship with hospital-physician integration. In particular, if aligning physicians with implementation of hospital health IT and improving communication of patient data between hospitals and physician practices are reasons why greater health IT adoption is attributable to physician employment, then there should be no relationship between employment of physicians and other information technology applications that do not share these properties. I estimated the effect of integration on the probability that hospitals use administrative information technology applications, including business intelligence applications, financial modeling software and financial data warehousing systems. All of these applications are intended to provide data analysis on firm performance to hospital administrative decision makers. Both the probit results (Table 2.6) and the bivariate probit results (Table 2.7) indicate no significant relationship between hospital-physician integration and these applications. The null results of this falsification exercise provide some reassurance that results from the main health IT analysis constitute evidence in favor of the hypothesized relationship between physician employment and health IT.

A critical assumption for the identification of hospital-physician integration's effect on health IT adoption is that CPM laws only affect health IT adoption through physician employment by hospitals. I examine the robustness of the findings to this assumption by testing the bivariate probit models without any covariates. If association between the instrument and unobserved variables is similar to the association between the instrument and observed variables, then obtaining similar results without any covariates suggests the main findings are not biased by unobserved factors. In fact, I find almost no change in the effect of hospital-physician integration (see columns 4 and 5 of Table 2.8) when all covariates are excluded (although, unsurprisingly, the estimates with covariates are more precise). While this is reassuring, the possibility always remains that unobserved cultural and institutional factors may influence both the preservation of CPM laws and adoption of health IT, thus biasing the IV strategy.

Because the identification strategy depends on cross-sectional variation in state CPM regulations, I am unable to estimate models with state fixed effects. Alternatively, I estimated separate models that include indicators for state electronic discovery laws and privacy protection laws in place during 2008 as covariates. Miller and Tucker (2009) and (2011a) have demonstrated that these two types of laws have significant effects on hospital adoption of EMR. Estimations that control for these other state regulations (in columns 6 and 7 of table 2.8) show slight increases in the effect of integration with no changes in statistical significance.

Furthermore, I estimated a "placebo" version of the reduced form equation among only hospitals that do not face CPM restrictions. Thirteen percent of hospitals that do not face CPM restrictions are located in CPM enforcing states (see Table 2.1). While the marginal effects are negative for both EMR and CPOE, they are not significantly so (see last two columns of Table 2.8). The results of these tests provides some reassurance that CPM laws are not correlated with unobserved state-level variables that may be driving the main findings.

2.5 Discussion

This study examines the relationship between hospital employment of physicians and hospital use of health IT applications. While a probit estimation of this relationship finds no significant effect of physician employment on the probability that hospitals use health IT, an instrumental variables analysis reveals a significant positive relationship between the two hospital strategies. These results suggest that unobserved factors, such as local costs of running independent physician practices and costs of IT adoption, influence hospitals' actions for both types of acquisitions. Measurement error in the integration variable may also contribute to a bias toward zero (as it always does when present) in the single equation estimates. Fortunately, instrumental variables, uncorrelated with the measurement error, still produce consistent estimates in this circumstance (Angrist and Krueger, 2001). Moreover, the findings provide evidence in favor of the hypothesis of a complementary relationship between integration and health IT and suggest that hospitals with employed physicians may perceive greater net benefit from use of health IT compared to hospitals without employed physicians. This supports the transaction cost interpretation of vertical integration in that integration confers greater adaptability to the organization by lowering costs of coordinating with physicians to implement new enterprise-wide technology. Further research is needed to understand more precisely how hospital employment of physicians interacts with health IT to affect quality, outcomes, and costs of care.

A limitation regarding the generalizability of the IV results in this study should be noted. The effect of physician employment on hospital health IT adoption is identified using variation in state laws that prohibit hospitals from employing physicians. Therefore, we can only interpret the estimated impact of integration on IT adoption as the average effect among those hospitals that are bound by the laws but would have otherwise chosen to employ physicians, rather than as the average effect of physician employment among all hospitals nationwide. This is the local average treatment effect interpretation of an instrumental variables analysis (Angrist and Pischke, 2009).

While incentive payments to hospitals, such as those through the Medicare and Medicaid Meaningful Use programs, may reduce some monetary costs faced by hospitals in acquiring the technology, other organizational costs may still inhibit its effective implementation by providers. Inability to capture some benefits of IT, such as easier exchange of patient data among providers in an integrated health system, may reduce the technology's value to hospitals that do not employ any of their physician staff. Also, provider resistance to accompanying changes in work practices may continue to slow implementation—at least in the near term until generational turnover in the medical workforce produces more cohorts of physicians primarily trained in health IT-enabled environments. CPOE in particular has been noted for engendering strong resistance (Poon et al., 2004). Some concerns on the part of providers regarding reduced productivity and new forms of error may be warranted as the work of Koppel and colleagues (2005) suggests. Regardless of risks associated with this particular technology, hospitals that employ their physicians may more easily coordinate with their medical staff to implement innovations that require substantial organizational change.

Lower rates of adoption among non-integrated hospitals may also indicate a lower return from the public subsidies being given to these hospitals, thus calling into question the wisdom of subsidizing IT adoption by such hospitals. Alternatively, health IT in non-integrated settings may still produce some value, but such hospitals may require greater incentives to support its adoption. Further research is needed to identify more precisely the relative value of the technology in integrated and non-integrated settings. Also, from a social welfare perspective, if health IT improves quality of care (some compelling evidence for this has been produced by Miller and Tucker (2011b) who find lower rates of neonatal mortality attributable to EMR adoption), hospital-physician integration may enhance its ability to do so. These benefits must, however, be weighed against possible costs to society if hospital-physician integration also confers greater bargaining power with payers or leads to induced demand for profitable but unnecessary medical services. Finally, the findings of this study indicate that continued enforcement of the corporate practice of medicine restrictions on hospital employment of physicians in some states inhibit hospital adoption of health IT and therefore work against policy initiatives intended to increase adoption.

2.6 References for Chapter 2

Alexander, J. A., Vaughn, T., Burns, L. R., Zuckerman, H. S., Andersen, R. M., Torrens, P. & Hilberman, D. W. (1996) Organizational approaches to integrated health care delivery: a taxonomic analysis of physician-organization arrangements. *Med Care Res Rev,* 53**,** 71-93.

Angrist, J. D. & Krueger, A. B. (2001) Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments. *The Journal of Economic Perspectives,* 15**,** 69-85.

Angrist, J. D. & Pischke, J.-S. (2009) *Mostly harmless econometrics: an empiricist's companion,* Princeton, Princeton University Press.

Baker, G. P. & Hubbard, T. N. (2004) Contractibility and Asset Ownership: On-Board Computers and Governance in U. S. Trucking. *The Quarterly Journal of Economics,* 119**,** 1443-1479.

Bhattacharya, J., Goldman, D. & Mccaffrey, D. (2006) Estimating probit models with self-selected treatments. *Statistics in Medicine,* 25**,** 389-413.

Blumenthal, D. & Tavenner, M. (2010) The "Meaningful Use" Regulation for Electronic Health Records. *N Engl J Med*.

Brynjolfsson, E., Malone, T. W., Gurbaxani, V. & Kambil, A. (1994) Does Information Technology Lead to Smaller Firms? *MANAGEMENT SCIENCE,* 40**,** 1628-1644.

Burns, L. R. & Muller, R. W. (2008) Hospital-physician collaboration: landscape of economic integration and impact on clinical integration. *Milbank Q,* 86**,** 375-434.

Casalino, L. P., November, E. A., Berenson, R. A. & Pham, H. H. (2008) Hospital-physician relations: two tracks and the decline of the voluntary medical staff model. *Health Aff (Millwood),* 27**,** 1305-14.

Cebul, R. D., Rebitzer, J. B., Taylor, L. J. & Votruba, M. E. (2008) Organizational Fragmentation and Care Quality in the U.S. Healthcare System. *Journal of Economic Perspectives,* 22**,** 93-113.

Chernozhukov, V. & Hansen, C. (2008) The reduced form: A simple approach to inference with weak instruments. *Economics Letters,* 100**,** 68-71.

Cuellar, A. E. & Gertler, P. J. (2006) Strategic integration of hospitals and physicians. *J Health Econ,* 25**,** 1-28.

Cutler, D. M., Feldman, N. E. & Horwitz, J. R. (2005) U.S. adoption of computerized physician order entry systems. *Health Aff (Millwood),* 24**,** 1654-63.

Dartmouth Medical, S. (1998) The Dartmouth atlas of health care 1998. Chicago, Ill., American Hospital Publishing.

Draper, D. A., Berenson, R. A. & November, E. A. (2009) A Tighter Bond: California Hospitals Seek Stronger Ties with Physicians. *California Health Care Almanac.* Oakland, CA, California HealthCare Foundation.

Gaynor, M. (2011) Health Industry Consolidation. *Ways and Means Health Subcommittee.* Washington, D.C.

Grossman, J. M. & Cohen, G. (2008) Despite regulatory changes, hospitals cautious in helping physicians purchase electronic medical records. *Issue Brief Cent Stud Health Syst Change***,** 1-4.

Harris, J. E. (1977) The Internal Organization of Hospitals: Some Economic Implications. *The Bell Journal of Economics,* 8**,** 467-482.

Hillestad, R., Bigelow, J., Bower, A., Girosi, F., Meili, R., Scoville, R. & Taylor, R. (2005) Can electronic medical record systems transform health care? Potential health benefits, savings, and costs. *Health Aff (Millwood),* 24**,** 1103-17.

Hitt, L. M. (1999) Information Technology and Firm Boundaries: Evidence from Panel Data. *Information Systems Research,* 10**,** 134-149.

Iom (2001) Crossing the quality chasm : a new health system for the 21st century. IN America., C. O. Q. O. H. C. I. (Ed.). Washington, D.C., National Academy Press.

Kazley, A. S. & Ozcan, Y. A. (2007) Organizational and environmental determinants of hospital EMR adoption: a national study. *J Med Syst,* 31**,** 375-84.

Kim, A. (2007) The Corporate Practice of Medicine Doctrine. California State Library.

Koppel, R., Metlay, J. P., Cohen, A., Abaluck, B., Localio, A. R., Kimmel, S. E. & Strom, B. L. (2005) Role of computerized physician order entry systems in facilitating medication errors. *JAMA,* 293**,** 1197-203.

Masten, S. E. (1988) A Legal Basis for the Firm. *Journal of Law, Economics, & Organization,* 4**,** 181-198.

Mccullough, J. S. (2008) The adoption of hospital information systems. *Health Econ,* 17**,** 649-64.

Mccullough, J. S. & Snir, E. M. (2010) Monitoring technology and firm boundaries: physician-hospital integration and technology utilization. *J Health Econ,* 29**,** 457-67.

Menard, C. (2005) A new institutional approach to organization. IN Menard, C., Shirley, M. M. & Springerlink (Eds.) *Handbook of New Institutional Economics.* Boston, MA, Springer.

Miller, A. R. & Tucker, C. (2009) Privacy Protection and Technology Diffusion: The Case of Electronic Medical Records. *Management Science,* 55**,** 1077-1093.

Miller, A. R. & Tucker, C. (2011a) Electronic Discovery and the Adoption of Information Technology. *SSRN eLibrary*.

Miller, A. R. & Tucker, C. E. (2011b) Can Health Care Information Technology Save Babies? *Journal of Political Economy,* 119**,** 289-324.

Morrisey, M. A., Alexander, J., Burns, L. R. & Johnson, V. (1996) Managed care and physician/hospital integration. *Health Aff (Millwood),* 15**,** 62-73.

O'malley, A. S., Bond, A. M. & Berenson, R. A. (2011) Rising hospital employment of physicians: better quality, higher costs? *Issue Brief Cent Stud Health Syst Change***,** 1-4.

Poon, E. G., Blumenthal, D., Jaggi, T., Honour, M. M., Bates, D. W. & Kaushal, R. (2004) Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals. *Health Aff (Millwood),* 23**,** 184-90.

Williamson, O. E. (1975) *Markets and hierarchies, analysis and antitrust implications: a study in the economics of internal organization,* New York, Free Press.

Yessian, M. R., Kvaal, M. B. & Hereford, R. W. (1991) State prohibitions on hospital employment of physicians. IN Department of Health and Human Services, O. O. I. G. (Ed.). Washington, DC, Department of Health and Human Services, Office of Inspector General.

Figure 2.1 States that have a corporate practice of medicine statute or case law prohibiting some hospitals from employing physicians.

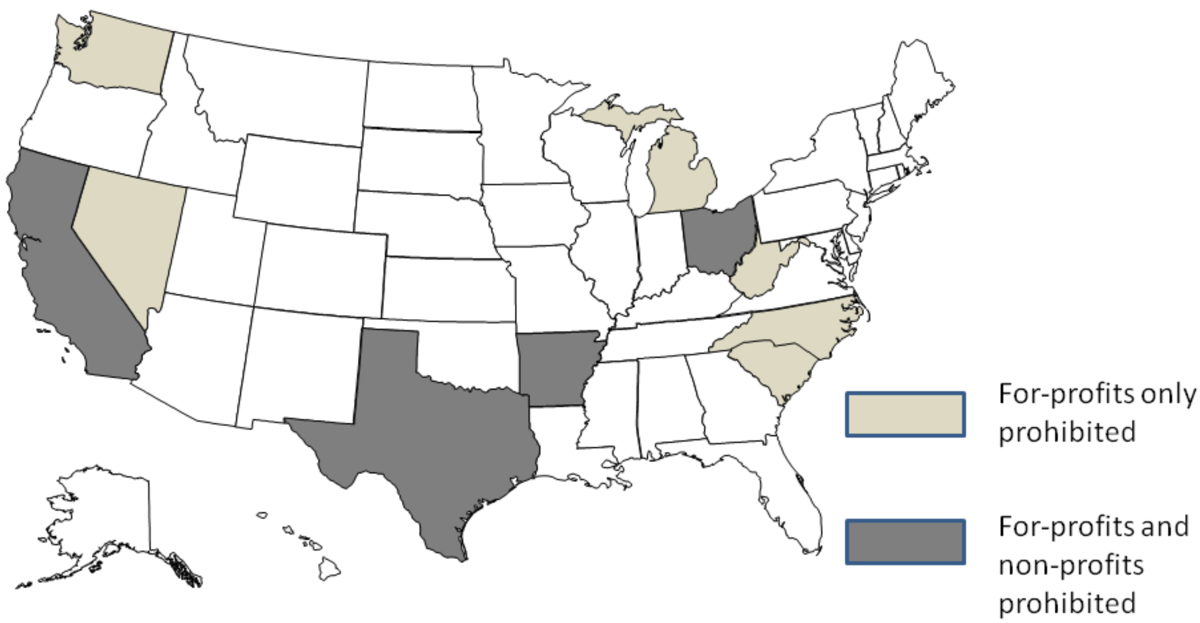

Table 2.1 Descriptive statistics for general hospitals in 2008 stratified by state laws restricting the corporate practice of medicine

Variable	All hospitals (n=3493) Mean	Bound by state restrictions on physician employment (n=616) Mean	Not bound by state restrictions on physician employment (n=2877) Mean	P value from t-test of difference in means
Dependent variables				
CPOE	0.24	0.19	0.25	0.002
EMR	0.48	0.37	0.51	< 0.001
Comparison technologies				
Business Intelligence	0.27	0.32	0.26	0.003
Data Warehousing	0.28	0.30	0.28	0.34
Financial Modeling	0.29	0.30	0.28	0.49
Organizational arrangement with physicians				
Employs physicians (Integrated salary model)	0.36	0.15	0.40	< 0.001
Hospital characteristics				
Member of the council of teaching hospitals	0.072	0.005	0.09	< 0.001
Government owned (non-federal)	0.24	0.23	0.25	0.35
Nonprofit ownership	0.64	0.53	0.66	< 0.001
For profit ownership	0.12	0.24	0.09	< 0.001
Total admissions	8,154	7,424	8,310	0.0163
Member of a multi-hospitalhealth care system	0.55	0.61	0.53	< 0.001
Percent Medicare discharges	0.49	0.48	0.50	< 0.001
Percent Medicaid discharges	0.16	0.17	0.16	0.09
Geographic and market characteristics				
Metropolitan CBSA	0.55	0.66	0.52	< 0.001
Herfindahl-Hirschman Index (HHI) by HRR for total admissions	3,263	2,860	3,350	< 0.001
Median household income in county	$48,252	$48,842	$48,126	0.22
Medicare managed care penetration in the county	0.18	0.19	0.17	0.003
Located in a state with corporate practice of medicine restrictions	0.28	1	0.13	< 0.001
Other state regulations				
Electronic discovery laws (circa 2007)	0.32	0.50	0.29	< 0.001
Privacy protection laws (circa 2002)	0.49	0.77	0.43	< 0.001
Instrument				
Bound by law prohibiting hospital employment of physicians	0.18	1	0	

Table 2.2 Average marginal effects from naïve probit estimation of CPOE and EMR use as a function of integration status in 2008

Variables	Electronic medical records	Computerized provider order entry
	$\partial\Phi(T)/\partial X_{EMR}$	$\partial\Phi(T)/\partial X_{CPOE}$
Endogenous variable		
Integrated salary model	0.014 (0.020)	.014 (0.019)
Hospital characteristics		
Member of the council of teaching hospitals	0.123*** (0.045)	0.122*** (0.035)
For profit	-0.325*** (0.047)	-0.055** (0.028)
Government owned (non-federal)	-0.060** (0.026)	-0.005 (0.023)
Member of a health care system	0.037* (0.023)	0.026 (0.017)
Percent Medicare discharges	-0.052 (0.090)	-0.157** (0.065)
Percent Medicaid discharges	-0.08 (0.14)	-0.12 (0.12)
Total admissions (1000s) splines		
< 1.34		0.101*** (0.029)
> 1.34		0.00397*** (0.00083)
< 0.43	0.36* (0.20)	
0.43 – 2.23	0.124*** (0.020)	
2.23 – 8.63	0.0125*** (0.0049)	
> 8.63	0.0005 (0.0015)	
Geographic and market characteristics		
Metropolitan or Division CBSA	0.044* (0.024)	0.071*** (0.017)
Herfindahl Hirschman Index (rescaled by 1000) by HRR	0.009 (0.010)	0.003 (0.011)
Median household income in county (in $10,000s)	0.0085 (0.011)	0.0202** (0.0083)
Medicare managed care penetration in county	0.036 (0.093)	0.131* (0.069)
N	3493	3493

Notes: Standard errors calculated by the delta method are reported in parentheses. Estimates allow for correlation in the error terms within states. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 2.3 Average marginal effects from probit estimations of the reduced form equations for CPOE and EMR use as a function of corporate practice of medicine status in 2008

Variables	Electronic Medical Record	Computerized Provider Order Entry
	$\partial \Phi (T)/ \partial X_{EMR}$	$\partial \Phi (T)/ \partial X_{CPOE}$
Instrumental variable		
Corporate practice of medicine restrictions	-0.105*** (0.018)	-0.051** (0.023)
Hospital characteristics		
Member of the council of teaching hospitals	0.097** (0.047)	0.111*** (0.037)
For profit	-0.310*** (0.047)	-0.049* (0.029)
Government owned (non-federal)	-0.059** (0.026)	-0.0048 (0.024)
Member of a health care system	0.039* (0.023)	0.028 (0.017)
Percent Medicare discharges	-0.063 (0.092)	-0.162** (0.066)
Percent Medicaid discharges	-0.06 (0.12)	-0.11 (0.12)
Total admissions (1000s) splines		
< 1.34		0.098*** (0.030)
> 1.34		0.00403*** (0.00084)
< 0.43	0.347* (0.197)	
0.43 – 2.23	0.120*** (0.020)	
2.23 – 8.63	0.0125*** (0.0047)	
> 8.63	0.0006 (0.0015)	
Geographic and market characteristics		
Metropolitan or Division CBSA	0.054** (0.024)	0.075*** (0.018)
Herfindahl Hirschman Index (rescaled by 1000) by HRR	0.000 (0.010)	-0.001 (0.011
Median household income in county (in $10,000s)	0.0077 (0.0096)	0.0197** (0.0078)
Medicare managed care penetration in county	0.04 (0.08)	-0.13 (0.31)
N	3493	3493

Notes: Standard errors calculated by the delta method are reported in parentheses. Estimates allowed for correlation in the error terms within states. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 2.4 Average marginal effects on the marginal probability of hospital-physician integration (the first stage) from recursive bivariate probit estimation of CPOE and EMR probabilities using state corporate practice of medicine laws as an instrument for employment of medical staff in 2008

Variables	Hospital-physician integration	
	$\partial \Phi(I) / \partial X_{EMR}$	$\partial \Phi(I) / \partial X_{CPOE}$
Hospital characteristics		
Member of the council of teaching hospitals	0.019 (0.055)	0.021 (0.053)
For profit	-0.150*** (0.034)	-0.149*** (0.034)
Government owned (non-federal)	-0.039* (0.022)	-0.036 (0.023)
Member of a health care system	-0.0057 (0.021)	-0.006 (0.021)
Percent Medicare discharges	0.016 (0.076)	0.023 (0.078)
Percent Medicaid discharges	-0.082 (0.093)	-0.097 (0.093)
Total admissions (1000s) splines		
< 1.34		-0.066** (0.028)
> 1.34		0.0062*** (0.0015)
< 0.43	-0.24** (0.11)	
0.43 – 2.23	-0.027* (0.015)	
2.23 – 8.63	0.0078* (0.0043)	
> 8.63	0.0062*** (0.0019)	
Geographic and market characteristics		
Metropolitan or Division CBSA	-0.022 (0.025)	-0.019 (0.023)
Herfindahl Hirschman Index (rescaled by 1000) by HRR	0.0018 (0.013)	0.002 (0.013)
Median household income in county (in $10,000s)	-0.0133 (0.0091)	-0.0142 (0.0092)
Medicare managed care penetration in county	-0.11 (0.31)	-0.05 (0.11)
Instrumental variable		
Hospital bound by laws prohibiting physician employment	-0.241*** (0.048)	-0.243*** (0.047)
Chi-square test of strength of instrument	23.67	24.44
p-value from chi-square test	0.000	0.000
N	3493	3493

Notes: Standard errors calculated by the delta method are reported in parentheses. Estimates allow for correlation in the error terms within states. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 2.5 Average marginal effects on probability of health IT use from recursive bivariate probit estimation of CPOE and EMR probabilities using state corporate practice of medicine laws as an instrument for employment of medical staff in 2008

Variables	Electronic Medical Record	Computerized Provider Order Entry
	$\frac{\partial \Phi(T)}{\partial X}$	$\frac{\partial \Phi(T)}{\partial X}$
Endogenous variable		
Integrated salary model	0.391***	0.241***
	(0.030)	(0.053)
Hospital characteristics		
Member of the council of teaching hospitals	0.053*	0.093***
	(0.032)	(0.031)
For profit	-0.188***	-0.019
	(0.039)	(0.033)
Government owned (non-federal)	-0.025	0.0050
	(0.022)	(0.022)
Member of a health care system	0.034**	0.028
	(0.017)	(0.016)
Percent Medicare discharges	-0.053	-0.156**
	(0.079)	(0.066)
Percent Medicaid discharges	-0.015	-0.08
	(0.10)	(0.12)
Total admissions (1000s) splines		
< 1.34		0.107***
		(0.027)
> 1.34		0.0022**
		(0.0011)
< 0.43	0.35**	
	(0.16)	
0.43 – 2.23	0.100***	
	(0.016)	
2.23 – 8.63	0.0060	
	(0.0038)	
> 8.63	-0.0022*	
	(0.0013)	
Geographic and market characteristics		
Metropolitan or Division CBSA	0.049***	0.074***
	(0.018)	(0.015)
Herfindahl Hirschman Index (rescaled by 1000) by HRR	-0.0014	-0.001
	(0.0073)	(0.010)
Median household income in county (in $10,000s)	0.0102	0.0212***
	(0.0075)	(0.0076)
Medicare managed care penetration in county	0.048	0.136**
	(0.065)	(0.064)
Tests		
Chi-square test of instrument strength	23.67	24.44
rho	-0.70	-0.52
	(0.09)	(0.12)
p-value from test of rho =0	0.0000	0.0003
N	3493	3493

Notes: Standard errors calculated by the delta method are reported in parentheses. Estimates allow for correlation in the error terms within states. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 2.6 Average marginal effects from naïve probit estimation of non-clinical IT applications as a function of hospital characteristics in 2008

Variables	Business intelligence	Financial modeling	Data warehousing
	$\frac{\partial\, \Phi\,(T)}{\partial X}$	$\frac{\partial\, \Phi\,(T)}{\partial X}$	$\frac{\partial\, \Phi\,(T)}{\partial X}$
Endogenous variable			
Integrated salary model	-0.020	0.0062	-0.015
	(0.020)	(0.016)	(0.016)
Hospital characteristics			
Member of the council of teaching hospitals	-0.031	-0.029	0.017
	(0.032)	(0.036)	(0.031)
For profit	0.076**	0.015	-0.063
	(0.038)	(0.041)	(0.053)
Government owned (non-federal)	-0.056*	-0.041	-0.056**
	(0.032)	(0.027)	(0.026)
Member of a health care system	0.088***	0.086***	0.080***
	(0.025)	(0.024)	(0.024)
Percent Medicare discharges	-0.091	-0.124	-0.165*
	(0.095)	(0.089)	(0.094)
Percent Medicaid discharges	-0.01	0.00	-0.05
	(0.12)	(0.11)	(0.14)
Total admissions (1000s) splines			
< 0.43	0.68***	0.34**	0.22
	(0.14)	(0.16)	(0.17)
0.43 – 12.8	0.0115***	0.0117***	0.0068***
	(0.0030)	(0.0032)	(0.0025)
12.8– 19	-0.0108**	-0.0039	0.0013
	(0.0052)	(0.0057)	(0.0056)
> 19	0.0037***	0.0009	0.0013
	(0.0012)	(0.0017)	(0.0016)
Geographic and market characteristics			
Metropolitan or Division CBSA	0.058***	0.058**	0.094***
	(0.017)	(0.026)	(0.015)
Herfindahl Hirschman Index (rescaled by 1000) by HRR	-0.011	-0.006	0.002
	(0.011)	(0.012)	(0.011)
Median household income in county (in $10,000s)	-0.0018	0.0076	-0.0099
	(0.0098)	(0.0084)	(0.0068)
Medicare managed care penetration in county	0.141*	0.077	0.006
	(0.076)	(0.083)	(0.065)
N	3493	3493	3493

Notes: Standard errors calculated by the delta method are reported in parentheses. Estimates allow for correlation in the hospital error terms within states. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 2.7 Average marginal effects on probability of non-clinical IT applications from recursive bivariate probit estimation using state corporate practice of medicine laws as an instrument for employment of medical staff in 2008

Dependent Variables	Business intelligence	Financial modeling	Data warehousing
	$\frac{\partial\, \Phi\,(T)}{\partial X}$	$\frac{\partial\, \Phi\,(T)}{\partial X}$	$\frac{\partial\, \Phi\,(T)}{\partial X}$
Endogenous variable			
Integrated salary model	0.04	0.17	0.06
	(0.10)	(0.15)	(0.11)
Hospital characteristics			
Member of the council of teaching hospitals	-0.035	-0.038	0.011
	(0.036)	(0.041)	(0.032)
For profit	0.085*	0.043	-0.051
	(0.046)	(0.049)	(0.053)
Government owned (non-federal)	-0.053	-0.032	-0.052*
	(0.033)	(0.030)	(0.027)
Member of a health care system	0.089***	0.084***	0.080***
	(0.025)	(0.022)	(0.024)
Percent Medicare discharges	-0.094	-0.135	-0.168*
	(0.095)	(0.085)	(0.095)
Percent Medicaid discharges	0.00	0.012	-0.04
	(0.12)	(0.11)	(0.14)
Total admissions (1000s) splines			
< 0.43	0.70***	0.37**	0.24
	(0.15)	(0.16)	(0.17)
0.43 – 12.8	0.0113***	0.0107***	0.0066**
	(0.0030)	(0.0031)	(0.0026)
12.8– 19	-0.0115**	-0.0059	0.0003
	(0.0054)	(0.0063)	(0.0064)
> 19	0.0034***	-0.0001	0.0008
	(0.0013)	(0.0018)	(0.0016)
Geographic and market characteristics			
Metropolitan or Division CBSA	0.060***	0.065***	0.097***
	(0.018)	(0.025)	(0.016)
Herfindahl Hirschman Index (rescaled by 1000) by HRR	-0.013	0.0060	0.001
	(0.012)	(0.0061)	(0.012)
Median household income in county (in $10,000s)	-0.0012	0.0091	-0.0090
	(0.0098)	(0.0082)	(0.0072)
Medicare managed care penetration in county	0.145**	0.086	0.011
	(0.073)	(0.078)	(0.066)
Tests			
Chi-square test of instrument strength	23.77	22.82	25.00
rho	-0.04	-0.33	-0.12
	(0.20)	(0.30)	(0.23)
P-value from test of rho =0	0.84	0.32	0.62
N	3493	3493	3493

Notes: Standard errors calculated by the delta method are reported in parentheses. Estimates allow for correlation in the error terms within states. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 2.8 Robustness: average marginal effects on probability of health IT use

	Original IV models		IV models without covariates		IV models with other state regulations affecting health IT use		Probit with only hospitals exempt from CPM restrictions	
Dependent variable	EMR	CPOE	EMR	CPOE	EMR	CPOE	EMR	CPOE
Integrated salary model	0.391*** (0.030)	0.241*** (0.053)	0.389*** (0.064)	0.24* (0.13)	0.411*** (0.021)	0.271*** (0.061)		
Covariates Included	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Electronic discovery laws (circa 2007)					-0.005 (0.019)	0.021 (0.019)		
Privacy protection laws (circa 2002)					0.060*** (0.018)	0.018 (0.020)		
Located in a state enforcing CPM restriction							-0.012 (0.034)	-0.039 (0.029)
	Significance of instruments in first stage							
Chi-square test of instrument strength	24	24	28	28	19	18		
N	3493	3493	3493	3493	3493	3493	2877	2877

Notes: Standard errors calculated by the delta method are reported in parentheses. Estimates allow for correlation in the error terms within states. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Chapter 3

The Effect of Interoperable Health Information Technology on Use of Diagnostic Imaging in Emergency Departments

3.1 Introduction and Previous Literature

Health information technology (IT) holds great promise for enabling more effective use of patient information at the point of care. Paper-based medical information systems involve redundancy in information storage and costly communication as the same patient may have multiple medical records across different, often unaffiliated, sites for receiving care. Thus, one proposed manner in which health IT can improve efficiency in medical care is by reducing redundant diagnostic tests that patients may undergo in multiple visits to providers (Bates et al. 1999; Orszag 2008). Emergency Departments stand out as a site of care where these technological advantages may have a noticeable effect on diagnostic imaging use, and I identify several reasons behind this conjecture. First, emergency department services are often time-sensitive, such that speed of access to relevant information about patients and their presenting problems may be of great value. Patients often present in the ED with acute symptoms, or with conditions of unknown severity, such that clinicians must assume any delay in care may result in adverse long-term consequences for the patient's health. Second, ED patients sometimes come in a condition of limited or no ability to communicate. Third, unlike providers who serve as their patients' usual source of care, such as primary care physicians, ED providers are less likely to have prior experience with their patients. Thus, obtaining access to other sources of information about a patient's condition or history, including relevant tests from prior episodes, often has greater value in EDs than in other sites of care. Furthermore, EDs are legally mandated to provide care to patients regardless of ability to pay, and it is therefore unsurprising that a substantial and growing proportion of patients presenting in EDs lack insurance (Newton et al. 2008). Therefore, much of the care provided to uninsured patients in an ED goes unreimbursed (Irvin, Fox, and Pothoven 2003). These financial considerations should incentivize EDs to use health IT to reduce identifiable redundant care that is not reimbursed.

In this study, I focus on utilization of three particular types of imaging procedures as outcomes: computed tomography (CT), radiography (x-rays), and ultrasound. CT scans, in particular, have become a key diagnostic tool in emergency medicine during the recent past, replacing a number of other imaging procedures for certain clinical situations (Broder, and Warshauer 2006; Kocher et al. 2011). However, concerns about over-utilization have arisen, and with those come concerns about unnecessary expenditures on care and undue exposure of patients to radiation. CT constitutes the largest medical source of exposure to ionizing radiation in the United States (Larson et al. 2011). Additionally, insurance reimbursement for CT scans are considerable, ranging from $400 for cervical spine CT to $1400 for CT of the abdomen and pelvis (Broder, and Warshauer 2006). Thus health plans, the Medicare Payment Advisory Commission, the Government Accountability Office, and academic studies have raised concerns about the appropriateness of current usage levels for CT scans (Iglehart 2009).

Furthermore, imaging services are leading examples of "gray area medicine" for which there is often no well-articulated medical theory or scientific evidence guiding usage (Chandra, Cutler, and Song 2011). Thus there is significant scope for other factors, including availability of previous test results and idiosyncratic clinician beliefs about the value of additional testing, to contribute to image ordering. For example, the desire to avoid malpractice lawsuits and their attendant costs may prompt clinicians to practice "defensive medicine"—to order tests of questionable value for a patient only for the sake of reducing the physicians' risk of being sued (Baicker, Fisher, and Chandra 2007; Danzon 2000). Health IT, which enables easier access to previous test results, and in some cases reminders to clinicians of the existence of these results, may also influence test ordering decisions. Availability of earlier test results, with sufficient notice given to a clinician, may mitigate some of the reasons for additional testing when these previous results are absent. If clinicians at different sites of care have information systems in place that can readily exchange patient data, these interoperable systems can allow for more efficient services across the various unaffiliated providers from whom patients may seek care (Frisse 2005; Walker et al. 2005). To illustrate the relevance of electronic health information exchange in EDs in one community, Frisse and Holmes (2007) used a database query of a health information exchange in Memphis, TN, to identify 44 patients who had visited more than one ED within a two week period. A "back of the envelope" calculation based on these data indicated costs of over $1000 per patient attributable to duplicate (and possibly redundant) radiology tests among this small group of repeat ED patients.

Two studies have estimated projected savings due to avoided unnecessary tests and other efficiency improvements on the order of tens of billions of dollars over a ten to fifteen year period. Hillestad and colleagues (2005) projected annual savings of over $81 billion, with average annual savings of $1.7 billion from efficiencies in outpatient imaging procedures. Walker and colleagues (2005) focused particularly on projected benefits of health information exchange and interoperability and estimated $78 billion in annual net value, with up to $26 billion coming from avoided tests and improved efficiencies.

However research on the impact of health IT provides mixed evidence that it can contribute to decreased rates of utilization of potentially redundant or inappropriate care (Bates et al. 1999; Chaudhry et al. 2006). Bates and colleagues found that computerized provider order entry (CPOE) with the capability to remind clinicians of redundancies in their orders can change clinician behavior and lead to fewer redundant tests. On the other hand, Agha, more recently, found a positive effect of health IT on the probability of two or more electrocardiogram test orders during a thirty day window in a national longitudinal sample of Medicare beneficiaries (Agha 2011). McCormick and colleagues (2012) examined the impact of health IT in physician office-based settings and found evidence of an increase in image ordering associated with computerized access to images or image reports.

The present study makes a significant contribution to our understanding of the effects of health IT by examining its impact on the ordering of image procedures in EDs. To the best of my knowledge, this is the first longitudinal analysis of health IT's impact on utilization of diagnostic procedures in a panel of EDs. And furthermore, I believe it is the first study to estimate the impact of health information exchange on diagnostic procedures in EDs. After accounting for unobserved ED characteristics via ED fixed effects, I find that health IT, significantly increases the likelihood of repeat CT scans, repeat chest X-rays, and repeat ultrasounds among patients who visit two different EDs during a thirty day period. However, I also find that this effect is counteracted by HIE participation, such that hospitals with a clinical information system (IS) in the ED who engage in HIE with outside providers experience no net change in repeat imaging rates. These findings provide evidence that health IT improves access to images from previous episodes of care and can help reduce repeat procedures, some of which may be redundant and unnecessary. I find scant evidence that health IT affects repeat imaging procedures among patients revisiting the same ED, suggesting that EDs have other effective mechanisms, besides computers, for avoiding such duplication among repeat visitors to the same institution.

3.2 Conceptual Model

For patients presenting in emergency departments, the severity of their conditions is often greater, or surrounded by greater uncertainty, than that of patients in other settings. Thus, to the degree that they are influenced by concern for the patient's well-being, emergency department providers have an incentive to quickly obtain relevant information about patients. This is often done by ordering tests after the patient comes to the ED (Newton et al. 2008). However, test results from separate prior episodes of care can sometimes inform ED providers about a patient's conditions, and can help avoid redundant testing. Various factors can influence the response of clinicians to prior test access. Some mechanisms may weigh against additional testing when previous results are readily available. For instance, concerns about the impact of additional testing on patient health may lead clinicians to limit testing if the previous test result is sufficiently informative. Also, access to previous test results that bear on a patient's presenting circumstances may diminish the risk of lawsuits and curb a clinician's incentive toward defensive test ordering. Furthermore, the ED may attempt to limit services provided to uninsured patients who lack ability to pay. From the hospital's perspective, the net cost of serving such patients is much higher than for insured patients, and this may result in less than the optimal amount of diagnostic imaging (from society's perspective). In contrast, the socially optimal amount of diagnostic imaging is influenced to a greater extent by the net impact of these procedures on patient health and welfare, and thus society may be better off with more testing of ED patients.

Increasing access to previous test results may, on the other hand, lead to additional test ordering as the value of such additional testing can increase in light of prior findings. For example, if results of a previous test show significant indication of a condition that should be watched over time, a clinician with access to that test may be more likely to follow up with additional tests when a patient revisits the ED, even if the revisit is for a different problem. Thus, access to a patient's test result history may induce subsequent follow-up testing by ED clinicians. Or if the test was taken at another institution, clinicians may be less willing to rely on the findings than if the test results came from their own institutions due to greater trust in the home institution. Furthermore, increasing speed and convenience in the ordering process and receiving results may increase the value of additional diagnostic images from the clinician's perspective, thus resulting in an increase in diagnostic procedures. From the ED's perspective, additional testing of patients paid for on a fee for service basis, may be profitable, and prompt EDs to encourage greater diagnostic imaging for such patients.

Health information technology potentially opens or enhances two information channels for an ED. The first channel is to previous instances of care in the same ED (i.e. the same patient visits the same ED on at least two separate occasions). By storing information in electronic form, as opposed to paper, an ED can leverage the capabilities of this technology in information management to avoid lost or misfiled paperwork and to automate retrieval of data from prior services at the same site if a patient revisits. The second possible channel is from previous instances of care received by the patient in unaffiliated institutions. Opening or enhancing this channel requires that the ED use an interoperable IS and participate in an active health information exchange (HIE) initiative. Exchange of test and imaging results among unaffiliated hospitals and other providers is a basic function of existing HIE initiatives (Adler-Milstein, Bates, and Jha 2011).

Patients' ability to pay can be especially relevant to the amount and types of services received in the ED. Given the ED's special legal obligations to provide services to all patients in need regardless of ability to pay (Irvin et al. 2003), cost-saving measures that limit any unnecessary care to uninsured individuals can protect an ED's financial well-being. These legal obligations may make EDs more sensitive to costs and more responsive to information on prior tests than providers in other settings of care, all of whom do not contend with such legal requirements. Improving management of patient information via health IT has been prominently proposed as a means of reducing costs resulting from redundant procedures (Orszag 2008).

With consideration for the factors affecting repeat imaging outlined above, I model the probability of a repeat diagnostic imaging procedure being performed in ED *h* on revisiting patient *i* during year *t* as a function of various patient and provider characteristics:

$$Image_{iht} = f(chronic\ conditions_{iht}, insurance_{iht}, HIT_{ht}, chronic\ conditions_{iht} \times HIT_{ht},\ insurance_{iht} \times HIT_{ht}, \boldsymbol{X}_{iht}, Year_t, ED_h\ |Image\ during\ prior\ visit\ to\ an\ ED) \quad (1)$$

where $Image_{iht}$ is an indicator of a repeat image within thirty days of the same image procedure at either the same or a different ED, $chronic\ conditions_{iht}$ is a count of the number of chronic conditions the patient was diagnosed with at the previous ED visit, $insured_{iht}$ indicates whether the patient is insured or self-paying, $\boldsymbol{X}_{iht}$ is a vector of other patient characteristics, including age, sex, and race, $Year_t$ is a series of year fixed effects that account for common shocks to repeat imaging across all EDs within the given years, and ED_h is a series of ED fixed effects accounting for unobserved time-invariant ED characteristics affecting repeat imaging. The main variable of interest is HIT_{ht}, a vector of one or three variables indicating the use of an ED information system and, in some specifications, indicators for hospital participation in HIE and an interaction between ED IS and HIE. HIT is interacted with $chronic\ conditions$ in order to test for the possibility that the effect of HIT on repeat imaging is mediated by patient conditions that develop or occur over longer periods of time, as opposed to acute trauma conditions for which there may be little utility from available prior images. Furthermore, I interact HIT with $insured$ in order to test for a mediating effect of patient ability to pay given the special legal obligations of EDs to provide services regardless of ability to pay.

3.3 Empirical Methods

3.3.1 Data Construction

I used emergency department discharge data over the six year period 2005 to 2010 from two states: California, and Florida. Discharge data from these states and years were the only data available through the Agency for Healthcare Research and Quality's (AHRQ) Healthcare Cost and Utilization Project (HCUP) that allowed analysis of patient revisits to an ED. Patients receiving CT scans, chest radiographs, and ultrasound imaging were identified using the Clinical Classification Software (CCS) provided by HCUP. In particular, I identified patients who received CT scans of the head, abdomen, chest, or spine; ultrasounds of the abdomen, pelvic area, kidneys or extremity veins; and radiographs of the chest (see Figure 3.1). Only patients who received one of these types of images in the given body regions during an initial ED visit were used in the analysis. The estimation sample consists only of discharge information from patients during their second visit to an ED within a thirty day period. Potentially redundant imaging among revisiting patients was identified by comparing CCS classifications and Current Procedural Terminology (CPT) codes for diagnostic imaging procedures performed in consecutive visits on the same patient. If the same imaging procedure was performed on the same body region (as identified by CCS category or, in some cases, CPT code) in consecutive ED visits, an indicator variable for a repeat test has a value of one for the later visit and is otherwise zero. Any significant reduction in the probability of such repeat procedures, during consecutive visits, that is attributable to health IT would likely indicate a reduction in redundant procedures.

Data on health IT use in EDs comes from the Health Information Management Systems Society (HIMSS) Analytics database. The main explanatory variable is an indicator for whether or not the ED has a live and operational emergency department information system (ED IS). HIMSS defines the ED IS as "an application that assists [ED] clinicians and staff in the…task of managing patients quickly and efficiently; directs each step of the patient management/patient flow and patient documentation process, including triage, tracking, nursing and physician charting" (HIMSS 2011). HIMSS also collects data on hospital participation in health information exchange (HIE) initiatives, intended to foster better communication of patient data among unaffiliated providers. Because HIE involving ED patient data is highly unlikely without an operational computer-based patient record in the ED, I consider only those EDs that report both an IS and that affiliate with a hospital participating in a named HIE organization as using *interoperable* health IT in the emergency department.

Furthermore, because the introduction of new technology often requires some time for workers to learn how to optimally use it (Borzekowski 2009; Bresnahan et al. 1996), I lag the health IT explanatory variables by one year. Previous research has identified significant effects of health IT with such a lag structure (Borzekowski 2009; McCullough et al. 2010). I also tested alternative lag periods for the health IT variables and find similar results, but the limited time period for which I have data—especially on HIE participation—hinders extensive examination of a relationship between time and health IT on clinician test ordering in EDs. While data on health IT use in EDs is available for all six years in the sample, data on HIE participation is only available for four of those years, and only twenty-eight EDs in the sample switched HIE status during the study period. Figure 3.2 displays the upward trend in hospital adoption of ED-specific clinical information systems (IS) and participation in HIE in my sample. ED IS use rose from 64 percent in 2005 to 78 percent in 2009 in this sample. HIE participation rose from 9 percent to 16 percent between 2006 (the first year for which such data was available) and 2009. Combined IS use and HIE participation rose from 3 percent of the sample in 2006 to 10 percent in 2009.

The ED discharge data and HIMSS data were merged using American Hospital Association (AHA) identification numbers, Medicare provider numbers, hospital names and addresses. The dataset used for analysis consists of discharges only from hospital-based EDs and does not include any from stand-alone facilities since HIMSS does not report HIT data for these. While the merged dataset represented nearly 600 EDs in the states of Arizona, California, and Florida, I found that a substantial number of EDs reported no use of CT scans, ultrasounds or radiographs for any patient in a given year. The fact that 39 percent of the hospitals in the sample report no CT scans on any patient, while at least 70 percent of these same EDs belong to hospitals that, in the AHA survey, report having CT scanners, suggests that many EDs in the sample fail to report actual imaging procedures that took place. Other research on CT scans in the ED find higher rates of use than is found in the HCUP discharge data that I analyze. Using the National Hospital Ambulatory Medical Care Survey, Kocher and colleagues (2011) find that 13.9 percent of ED encounters in 2007 involved a CT scan, while my data indicates only 5.4 percent of all ED encounters in Arizona, California and Florida involved a CT scan. However, I do find rates of CT use closer to the findings of Kocher and colleagues when excluding those EDs that report no imaging procedures. Because many EDs do not report use of the imaging procedures that serve as dependent variables in this study, inclusion of hospital fixed effects produces perfect prediction of the outcomes among these EDs. Thus, only 355 EDs out of an initial sample of 585 ultimately contribute information on repeat imaging to the analyses.

Table 3.1 provides descriptive statistics from the earliest year of available data for the included EDs with means stratified by HIT switching status during the study period. Eighty-five EDs switched IS status during the five year period, and twelve EDs switched interoperable HIT status during the three years of available data. On average, interoperable HIT switchers have more annual discharges and more patients revisiting within 30 days than other EDs in the sample. The average annual discharges among interoperable HIT switchers is thirty percent greater than the complete sample average, and the average number of patients with a recent previous image at another ED is notably larger at interoperable HIT switchers. These characteristics of HIT switchers begs the question of whether these EDs were inclined to adopt interoperable HIT in response to these larger numbers of patients with previous diagnostic procedures at different EDs. However, the average proportions of repeat imaging procedures within EDs are similar at baseline across switching categories. IS switchers had slightly lower proportions of repeat CT scans and chest X-rays relative to interoperable HIT switchers and the overall average. Both IS switchers and interoperable HIT switchers had greater proportions of repeat ultrasounds than the sample average, with interoperable HIT switchers having the highest proportion at 14.5 percent relative to the overall sample average of 10.2 percent.

I also include a number of patient-level demographic characteristics, including age, sex, race (black/not black), and uninsured status, in order to control for any associations between such factors and a patient's propensity to receive repeat diagnostic procedures. These characteristics have similar means across EDs with different HIT switching statuses. However, interoperable HIT switchers serve a notably larger proportion of black patients (56 percent more than the average proportion in the overall sample). The average proportion of uninsured patients in the sample is nearly identical, at 21 percent, across switching statuses.

For an analysis of ED IS alone, I restricted the sample to only those patients who received an imaging procedure of interest during an earlier visit to the same ED or another ED in the same hospital system within the past 30 days of the same calendar year. I consider the effect of IS among patients visiting two different hospitals within the same system, because this is an important case in which information technology may reduce costs of communicating patient data within an organization. For the analysis of interoperable HIT, I restricted the sample to only those patients who received an imaging procedure in another ED within the previous 30 days of the same calendar year. Performing these separate analyses allows more direct examinations of the two scenarios outlined above: 1) health IT improves information management within EDs and 2) health IT enables better communication between a given ED and other EDs serving the same patients.

3.3.2 Empirical Estimation Strategy

In order to estimate the relationship between health IT use in EDs and repeat diagnostic images, I employed the following regression model with ED fixed effects:

$$RepeatImage_{iht} = \beta_1 IS_{ht} + \beta_2 IS_{ht} \times Uninsured_{iht} + \beta_3 IS_{ht} \times PriorDiagnoses_{iht} + \boldsymbol{\theta X}_{iht} + \tau_t Year_t + \gamma_h ED_h + \varepsilon_{iht} \quad (1)$$

The variable $RepeatImage_{iht}$ whether or not patient *i* received a repeat image in year *t*. The model controls for a vector of patient-level characteristics, $\boldsymbol{X}$, which includes age, sex, race (black or not black), uninsured status and number of chronic conditions observed in the previous ED visit. Unobserved heterogeneity between EDs that is correlated with adoption of health IT and the propensity to use radiology imaging procedures can produce inconsistent estimates of the coefficient on IS. The ED fixed effects, with ED-specific parameters represented as γ_h, control for any unobserved ED-level variation that does not change over time, and thus, produces estimates of the effect of health IT on repeat imaging that is identified off of changes in IS adoption status within EDs. Because the ED fixed effects regressions constitute my main models, I do not control for other ED-level characteristics. A set of year dummies $Year_t$ are also included to control for any trend in image utilization common to all EDs in the sample. Using fixed effects is not a perfect solution to the endogeneity problem, as any unobserved characteristics that also change over time and are correlated with both IS adoption and use of imaging technology will also contribute to inconsistent estimates. In a separate set of analyses, I test the robustness of the fixed effects results by including ED-specific trend variables to control for unobserved time-varying ED characteristics associated with image ordering.

For the analyses of interoperable HIT, I estimate the following model that includes a right-hand side variable indicating use of a clinical IS in the ED, and another indicating the combination of clinical IS in the ED and hospital participation in an HIE initiative.

$$RepeatImage_{iht} = \delta_1 IS_{ht} + \delta_2 HIE_{ht} + \delta_3 IS_{ht} \times HIE_{ht} + \delta_4 IS_{ht} \times HIE_{ht} \times Uninsured_{iht} + \delta_5 IS_{ht} \times Uninsured_{iht} + \delta_6 HIE_{ht} \times Uninsured_{iht} + \delta_7 IS_{ht} \times HIE_{ht} \times PriorDiagnoses_{iht} + \delta_8 IS_{ht} \times PriorDiagnoses_{iht} + \delta_9 HIE_{ht} \times PriorDiagnoses_{iht} + \boldsymbol{\theta X}_{iht} + \tau_t Year_t + \gamma_h ED_h + \varepsilon_{iht} \quad (2)$$

I use this latter variable, $IS_{ht} \times HIE_{ht}$, as an indicator of interoperable health IT use in EDs. I test this model only on the subset of patients who had visits to two different EDs within 30 days and had an image of interest in the initial ED visit. I hypothesize that the combination of both a clinical IS in the ED and participation in HIE is more likely to produce a change in repeat diagnostic procedures for such patients than clinical IS alone. This change in imaging could go in either direction given the reasons outlined in the conceptual model. However, possessing a clinical IS even without participation in a formal HIE organization may enable exchange of data between two different EDs within the same hospital system or even among unaffiliated institutions if some neighboring EDs enter into bilateral arrangements outside of an identified community HIE. Hospital participation in HIE without an operational clinical IS in the ED should not produce an effect ($\delta_2 \approx 0$), as there is no obvious mechanism for ED clinicians to retrieve information about a patient from unaffiliated EDs in this case. Only two hospitals in the sample switched HIE status without also having an IS in their EDs.

Given the potential cost-savings associated with health IT and the legal obligation to provide services to patients regardless of ability to pay, I hypothesize that the interaction effect between health IT and uninsured status should be negative ($\beta_2 < 0$ in equation 1 and $\delta_4 < 0$ in equation 2), as EDs will be more cost-sensitive when serving uninsured patients, and therefore more responsive to the availability of prior image results. Furthermore, I hypothesize that ED clinicians are more responsive to available prior image reports for patients diagnosed with chronic conditions during previous ED visits. These conditions may serve as the impetus for repeat visits to EDs thus increasing the value of access to data from prior episodes of care. In some cases, however, access to prior images may increase the value of additional testing, while in other cases the available prior report precludes the need for additional testing. Hence, I hypothesize that the signs of the coefficients β_3 in equation1 and δ_7 in equation 2 are indeterminate, but may be significant in either direction.

Many of the explanatory variables of interest in the regression models are interaction terms between IS and HIE and between these two variables and patient characteristics. As Ai and Norton (2003) point out, the sign and significance of interaction terms in nonlinear regression models cannot be determined reliably from inspection of the coefficient estimates as they can be in linear models. For this reason, I use linear probability models for estimation.

Because patients receiving care in the same ED are subject to many of the same environmental factors (e.g. the same physician practice styles), patient error terms were assumed correlated within EDs but independent across different EDs and are estimated accordingly.

3.4 Results

3.4.1 Health Information Technology and patient revisits to the same ED

I report estimated effects of clinical IS on the probability of repeat images. In the base specification (column 1 of Table 3.2), I find an significant increase of 1.3 percentage points in the probability of a repeat CT scan associated with clinical IS. The inclusion of ED fixed effects (columns 2 of Table 3.2) reveals a positive effect of clinical IS on repeat CT scans that is smaller in magnitude but still statistically significant. The significance of the effect of IS is not robust, however, as I find in estimates with ED-specific time trends and fixed effects (columns 4 and 5 of Table 3.2). Contrary to hypothesized effects among uninsured and chronically ill patients, I find no significant interactions between IS and uninsured status and number of prior diagnoses (column 3 of Table 3.2). I test the robustness of the fixed effect results by controlling for ED-specific trends in repeat CT scans. Here, I find that neither IS nor its interactions with uninsured status and number of prior diagnoses (column 5 of Table 3.2) are significant.

In an examination of repeat chest X-rays, I find no significant relationship between health IT and repeat images upon revisit to the same ED (Tables 3.3) in the base model. The effect of IS is found to be significantly greater zero with inclusion of ED fixed effects (column 2 of Table 3.3) but not with ED-specific trends (columns 4 and 5 of Table 3.3). The interaction between IS and uninsured status is barely significantly positive at the ten percent level. I find a negative interaction effect of IS and number of diagnoses beyond five during the prior visit.

I find a similarly insignificant relationship between IS and repeat ultrasounds in the base model for these imaging procedures (column 1 of Table 3.4). With the inclusion of fixed effects, I find no significant effect of IS (column 2 of Table 3.4). When ED-specific time trends are included, the effect of IS remains insignificant (column 4 of Table 3.4). The interaction term of IS with number of previous diagnoses beyond 5 remains significant. Taken as a whole, these findings provide little evidence of a significant average effect of health IT on repeat imaging for patients visiting the same ED twice within a thirty day period. However, there is some significant evidence that health IT reduces the likelihood of repeat chest imaging for patients with greater numbers of diagnoses in a previous ED visit.

3.4.2 Health Information Exchange and patient visits to two different EDs

I also examined the effect of clinical IS in combination with hospital participation in health information exchange (HIE), to which I refer as *interoperable* health IT, on repeat images for the subset of patients that visit an ED within thirty days of a prior visit to another ED. For these cases, I report the effect of clinical IS in the ED, hospital participation in HIE, and the interaction effect of these two elements of interoperable health IT. In the base regression model for CT, I find a significant 2.9 percentage point increase in the probability of repeat CT scans associated with clinical IS and no significant relationship between interoperable health IT and repeat CT (column 1 of Table 5). HIE alone is not significant. However, the base model does not control for unobserved heterogeneity among EDs. When ED fixed effects are included to control for time-invariant unobserved ED characteristics, I find a -8 percentage point interaction effect of IS x HIE on repeat CT scans (column 2 of Table 3.5). The direct effect of IS on repeat CT scans remains positive and significant ($p < 0.01$). These results are robust to the inclusion of ED-specific time trends (columns 4 and 5 of Table 3.5). An F-test that the sum of the coefficients for IS, HIE and their interaction equals zero fails to reject the null. In those EDs that both adopt an IS and participate in HIE, the net effect on repeat imaging appears to be zero, while it is positive in those EDs with only an IS. These findings suggest that clinical IS alone increases the rate of repeat imaging among patients who had prior visits to other EDs, but HIE participation mitigates this effect of health IT.

The base model estimates of the relationship between health IT and repeat chest X-rays shows a significant increase in repeat images associated with clinical IS alone, while there is a significant decrease associated with the interaction term, IS x HIE and no relationship with HIE alone (column 1 of Table 3.6). With ED fixed effects, the effect of IS is an increase in the probability of a repeat image of 5.3 percentage points. The interaction effect of IS and HIE is -10.8 percentage points, significant at the 1 percent level (column 2 of Table 3.6). Again, I find no significant effect of HIE alone on repeat chest X-rays. With inclusion of ED-specific time trends, the IS x HIE interaction effect is -14.5 percentage points and is significant at the 1 percent level (column 4 of Table 3.6). While the interaction term for HIE and uninsured is significantly positive at the 10 percent level, an F-test of the sum of interaction terms for IS and HIE with uninsured status does not reject the null hypothesis. Similarly, an F-test of the sum of interaction terms of IS and HIE with number of prior diagnoses does not reject the null hypothesis (column 5 of Table 3.6).

The estimated interaction effect of IS x HIE on repeat ultrasounds for patients who visit two different EDs in a thirty day period is negative but not significant in the base model (column 1 of Table 7). When I estimate with fixed effects (columns 2 and 3 of Table 3.7), the IS x HIE interaction effect is significantly negative ($p < 0.01$). The effect of IS alone is significantly positive, as is the effect of HIE alone in the fixed effects regressions. The effect of HIE alone, however, becomes non-significant with ED-specific trends included, while the effect of IS alone remains significantly positive and the interaction effect IS x HIE remains significantly negative. The magnitude of the interaction effect grows slightly to -14.9 percentage points with the inclusion of ED-specific trends (columns 4 of Table 3.7). As with the other two types of image procedures examined, I find no significant cumulative effect of IS and HIE interacted with uninsured status or number of prior diagnoses (column 5 of Table 3.6).

3.4.3 Alternative specifications

Given that HIE alone is not expected to have an effect on repeat imaging aside from its interaction with IS in the ED, as well as concerns about multi-collinearity among the health IT variables, I have estimated alternative specifications that include the IS x HIE interaction term but exclude the direct HIE variable. In the fixed effects models for CT and ultrasound, the IS term remains significantly positive, while the interaction term is negative but not significant. In the fixed effects model for chest X-rays, the interaction term is significantly negative and the IS term is again significantly positive. An F-test of the sum of IS and IS x HIE interaction term fails to reject the null hypothesis that the cumulative effect is no change in repeat testing in all fixed effects models for all types of images. These findings, combined with the robust finding of a positive effect of IS on repeat testing, indicate that HIE participation mitigates an average increase in repeat testing that results from health IT adoption.

3.5 Discussion

I find a significant positive effect of clinical IS on repeat diagnostic procedures among patients visiting multiple EDs within a thirty day period. This positive effect, however, is significantly reduced among those hospitals participating in a health information exchange organization with other providers, such that the cumulative effect among health IT and HIE participation is not significantly different from zero. This same positive effect of health IT and negative interaction effect with HIE was found for all three of the image procedures I examined. I am unable to identify whether the additional repeat tests are redundant, but the negative interaction effect of IS with HIE suggests that some of the observed repeat procedures due to IS adoption represent services that would otherwise be unnecessary if clinicians have access to patients' medical records from other providers. Furthermore, I find little evidence of a similar effect on repeat procedures among patients visiting the same ED multiple times within thirty days. While the fixed effects results for IS adoption are significantly positive among patients revisiting the same ED, the fact that the results are no longer statistically significant with the inclusion of ED-specific trends, suggests that rates of repeat testing were already increasing among these hospitals prior to their adoption of a clinical IS. These findings suggest that health IT, as most commonly used in EDs, currently has little effect on the number of repeat diagnostic procedures taking place for patients revisiting the same ED. It is likely the case that other mechanisms, not restricted to the use of electronic patient records, provide effective means for limiting redundant procedures and mitigating any positive effect health IT may have on repeat testing among patients revisiting the same ED. Meanwhile, the robust findings of a positive effect of IS on repeat testing and a negative interaction effect of IS and HIE participation on repeats of all three types of images among patients visiting multiple EDs indicate that the technology is enhancing communication among participants in HIE initiatives.

The findings in this study of a positive effect of IS on imaging among patients with visits to a new ED are consistent with some other recent research findings on health IT and test ordering practices. Some rigorously executed studies accounting for unobserved heterogeneity among providers have found increased diagnostic testing attributable to health IT adoption. However, results of other studies employing cross-sectional designs without controlling for unobserved confounders (often due to inherent data limitations) have been interpreted as evidence that health IT causes clinicians to order more tests. This may or may not be true in different settings of care, but the findings of this study indicate that unobserved factors do influence the relationship between health IT and image ordering in EDs. Therefore finding positive associations between IT and test ordering without accounting for these unobservables should not constitute convincing evidence of a causal relationship.

The findings regarding health IT's interaction with uninsured status indicate that health IT's effect on repeat imaging is not mediated by patients' ability to pay. Other considerations, such as unobserved (to the econometrician) presenting problems and the availability of relevant prior image reports, play a larger role than payment ability in determining repeat imaging. I find some evidence of a negative interaction between health IT and the number of recent prior diagnoses for chest X-rays and ultrasounds among patients revisiting the same ED. These findings indicate that health IT may be a more effective aid for managing patient information of sicker patients or more complex cases than among patients with fewer conditions.

Taken as a whole, the findings of this study suggest that HIE is a critical component in any policy efforts aimed at leveraging health IT to reduce utilization of expensive and potentially unnecessary services. Therefore, incentives to support use of the technology should motivate use of HIE features of health IT and continued development of regional HIE initiatives that foster communicating patient data between unaffiliated providers. HIE initiatives will likely have a crucial role in the realization of health IT's cost-saving potential. However, the findings also suggest that health IT in the absence of HIE participation increases the rate at which diagnostic procedures are used. At present any decrease in utilization due to HIE among some patients may be offset by increased rates of utilization among others. It is important to recognize that while health IT use may prompt additional testing by providers, at least some of this additional testing may be to the benefit of the patient. Furthermore, it is important to recognize that while HIE participation results in a cumulative impact of no change in testing, the findings do indicate that some testing that would otherwise occur due to adoption of health IT is being avoided. Using rough assumptions that the average cost of a CT scan is $1000, for example, the findings suggest that the average hospital participating in HIE in the sample saved as much as $31,000 in the year after initiating HIE through reductions in CT scans in the ED that would have otherwise occurred (in part due to the use of clinical IS).[1]

[1] I base this calculation on an annual average of 233 patients visiting another ED within the preceding 30 days who are also at risk for a repeat image as reported in the summary statistics (Table 3.1). Given the findings of the ED fixed effects and ED time trends analysis of an IS*HIE interaction effect of -0.134, the estimated reduction in costs amounts to 0.134 x 233 x $1000 = $31,222.

While these savings may seem rather modest, consideration for all the different types of diagnostic procedures performed in the ED would add substantially to the total savings.

The findings show that, at least in the context of emergency departments, available prior image results can overcome the financial incentives of fee-for-service payment to reduce intensity of services among frequent visitors to EDs. Particular features of the ED environment, such as greater uncertainty regarding presenting problems, may be especially salient here and therefore some caution is warranted about generalizing the findings to other settings of care. Future research should attempt to determine the generalizability of the findings to other settings of care. Furthermore, interoperable health IT use in this sample remained relatively low, even in the final year, at only 10 percent. Assuming the continued expansion and maturation of HIE participation, future research will be needed to determine if it becomes more effective at reducing redundant procedures and ultimately results in a net reduction in repeat testing and imaging.

3.6 References for Chapter 3

Adler-Milstein, J., D. W. Bates, and A. K. Jha. 2011. "A survey of health information exchange organizations in the United States: implications for meaningful use." *Ann Intern Med* 154(10): 666-71.

Agha, L. 2011. "The effects of health information technology on the costs and quality of medical care." Boston, MA: National Bureau of Economic Research; School of Management, Boston University.

Ai, C. and E. C. Norton. 2003. "Interaction terms in logit and probit models." *Economics Letters* 80(1): 123-29.

Baicker, K., E. S. Fisher, and A. Chandra. 2007. "Malpractice liability costs and the practice of medicine in the Medicare program." *Health Aff (Millwood)* 26(3): 841-52.

Bates, D. W., G. J. Kuperman, E. Rittenberg, J. M. Teich, J. Fiskio, N. Ma'luf, A. Onderdonk, D. Wybenga, J. Winkelman, T. A. Brennan, A. L. Komaroff, and M. Tanasijevic. 1999. "A randomized trial of a computer-based intervention to reduce utilization of redundant laboratory tests." *Am J Med* 106(2): 144-50.

Borzekowski, R. 2009. "Measuring the cost impact of hospital information systems: 1987-1994." *J Health Econ* 28(5): 938-49.

Bresnahan, T., S. Greenstein, D. Brownstone, and K. Flamm. 1996. "Technical Progress and Co-Invention in Computing and in the Uses of Computers." *Brookings Papers on Economic Activity. Microeconomics* 1996: 1-83.

Broder, J. and D. M. Warshauer. 2006. "Increasing utilization of computed tomography in the adult emergency department, 2000-2005." *Emerg Radiol* 13(1): 25-30.

Chandra, A., D. Cutler, and Z. Song. 2011. "Chapter Six - Who Ordered That? The Economics of Treatment Choices in Medical Care." In *Handbook of Health Economics*, edited by T. G. M. Mark V. Pauly and P. B. Pedro, pp. 397-432: Elsevier.

Chaudhry, B., J. Wang, S. Wu, M. Maglione, W. Mojica, E. Roth, S. C. Morton, and P. G. Shekelle. 2006. "Systematic review: impact of health information technology on quality, efficiency, and costs of medical care." *Ann Intern Med* 144(10): 742-52.

Danzon, P. M. 2000. "Liability for medical malpractice." In *Handbook of Health Economics*, pp. 1339-404: Elsevier.

Frisse, M. E. 2005. "State and community-based efforts to foster interoperability." *Health Aff (Millwood)* 24(5): 1190-6.

Frisse, M. E. and R. L. Holmes. 2007. "Estimated financial savings associated with health information exchange and ambulatory care referral." *J Biomed Inform* 40(6 Suppl): S27-32.

Hillestad, R., J. Bigelow, A. Bower, F. Girosi, R. Meili, R. Scoville, and R. Taylor. 2005. "Can electronic medical record systems transform health care? Potential health benefits, savings, and costs." *Health Aff (Millwood)* 24(5): 1103-17.

HIMSS. 2011. “HIMSS Analytics definitions - sorted by term.” Chicago, IL: HIMSS Analytics.

Iglehart, J. K. 2009. “Health insurers and medical-imaging policy--a work in progress.” *N Engl J Med* 360(10): 1030-7.

Irvin, C. B., J. M. Fox, and K. Pothoven. 2003. “Financial impact on emergency physicians for nonreimbursed care for the uninsured.” *Ann Emerg Med* 42(4): 571-6.

Kocher, K. E., W. J. Meurer, R. Fazel, P. A. Scott, H. M. Krumholz, and B. K. Nallamothu. 2011. “National trends in use of computed tomography in the emergency department.” *Ann Emerg Med* 58(5): 452-62 e3.

Larson, D. B., L. W. Johnson, B. M. Schnell, S. R. Salisbury, and H. P. Forman. 2011. “National trends in CT use in the emergency department: 1995-2007.” *Radiology* 258(1): 164-73.

McCormick, D., D. H. Bor, S. Woolhandler, and D. U. Himmelstein. 2012. “Giving office-based physicians electronic access to patients' prior imaging and lab results did not deter ordering of tests.” *Health Aff (Millwood)* 31(3): 488-96.

McCullough, J. S., M. Casey, I. Moscovice, and S. Prasad. 2010. “The effect of health information technology on quality in U.S. hospitals.” *Health Aff (Millwood)* 29(4): 647-54.

Newton, M. F., C. C. Keirns, R. Cunningham, R. A. Hayward, and R. Stanley. 2008. “Uninsured adults presenting to US emergency departments: assumptions vs data.” *JAMA* 300(16): 1914-24.

Orszag, P. 2008. “Evidence on the Costs and Benefits of Health Information Technology.” Washington, D.C.

Walker, J., E. Pan, D. Johnston, J. Adler-Milstein, D. W. Bates, and B. Middleton. 2005. “The value of health care information exchange and interoperability.” *Health Aff (Millwood)* Suppl Web Exclusives: W5-10-W5-18.

Figure 3.1 Types of image procedures by body region

Computed Tomography Scans	**Ultrasounds**	**Radiographs**
head	abdomen	chest
abdomen	extremity veins	
chest	Pelvis	
spine	kidneys	

Figure 3.2 Proportion of EDs in California and Florida with ED health IT and HIE, 2005-2009

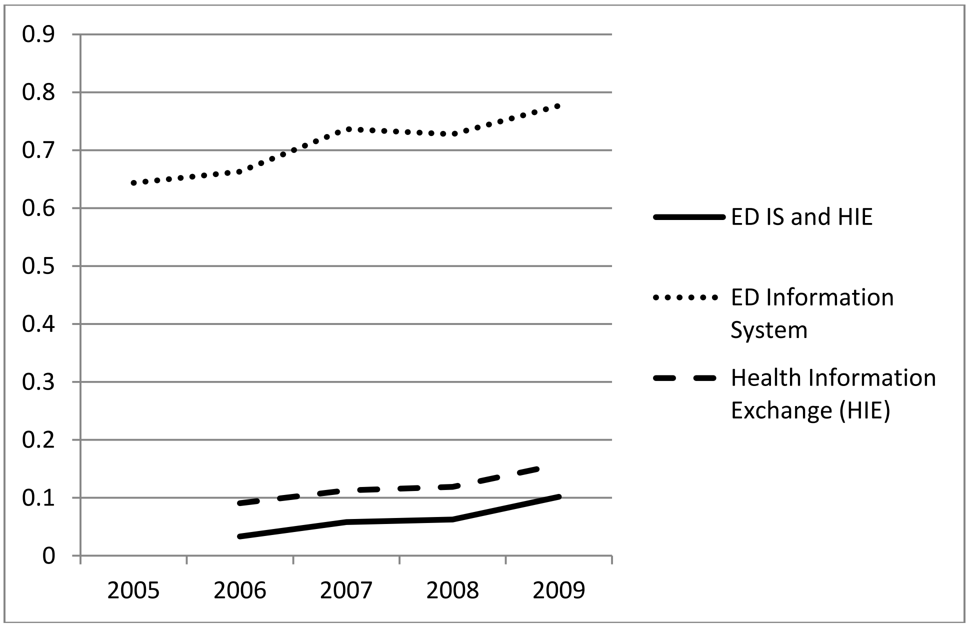

Table 3.1 Means for hospital-based emergency departments (ED) during baseline year, stratified by Health Information Technology and Health Information Exchange switching during the study period

	Information System Switchers	Interoperable HIT Switchers	All EDs
Sample Size:			
Number of hospitals	85	12	355
Annual discharges per ED	25,824	36,296	27,875
Repeat image procedures			
ED average revisiting same ED within 30 days who had image procedure during earlier visit	374	655.5	578.1
ED average revisiting different ED within 30 days who had image procedure during earlier visit	101	233.4	162.7
Proportion of 30 day revisits receiving same CT scan as previously	0.12	0.13	0.13
Proportion of 30 day revisits receiving repeat chest X-ray	0.23	0.24	0.24
Proportion of 30 day revisits receiving same ultrasound as previously	0.12	0.15	0.10
Hospital characteristics:			
ED Information System	0.38	0.42	0.71
Hospital participates in regional health information exchange	0.05	0.08	0.03
Member of council of teaching hospitals	0.04	0	0.05
Multi-hospital system	0.84	0.58	0.75
Private not for profit	0.72	0.92	0.56
For profit	0.16	0	0.30
Government owned	0.12	0.08	0.14
Has advanced multi-slice CT scanner	0.53	0.86	0.74
Patient characteristics:			
Mean Age	39.6	36.5	39.6
Female proportion	0.56	0.55	0.56
Black race proportion	0.12	0.21	0.14
Uninsured proportion	0.21	0.21	0.21

Table 3.2 Treatment effects for repeat CT scans during revisit within 30 days to same ED

	Base model	ED Fixed Effects		ED Fixed Effects with ED trends	
	1	2	3	4	5
Standalone Info. System	0.0129*** (0.0042)	0.0075** (0.0032)	0.0051 (0.0045)	0.0030 (0.0049)	0.0013 (0.0059)
IS x Uninsured			-0.0033 (0.0038)		-0.0031 (0.0037)
IS x No. Previous Diagnoses (1-5)			0.0011 (0.0012)		0.0010 (0.0013)
IS x No. Previous Diagnoses (6-25)			-0.0005 (0.0015)		-0.0010 (0.0015)
Race (black)	-0.0380*** (0.0021)	-0.0330*** (0.0022)	-0.0330*** (0.0022)	-0.0329*** (0.0022)	-0.0329*** (0.0022)
Female	-0.0139*** (0.0013)	-0.0160 (0.0012)	-0.0160*** (0.0012)	-0.0162*** (0.0012)	-0.0162*** (0.0012)
No. Previous Diagnoses (1-5)	0.00048 (0.00088)	-0.00146*** (0.00055)	-0.0024** (0.0011)	-0.00146*** (0.00055)	-0.0023** (0.0011)
No. Previous Diagnoses (6-25)	0.00164* (0.00088)	0.00050 (0.00056)	0.0010 (0.0014)	0.00050 (0.00057)	0.0014 (0.0015)
Uninsured	-0.0136*** (0.0018)	-0.0127*** (0.0017)	-0.0100*** (0.0033)	-0.0128*** (0.0017)	-0.0102*** (0.0032)
P-value from joint F-test of IS interacted with previous diagnoses			0.651		
Year Fixed Effects	5	5	5	5	5
Hospital Fixed Effects		405	405	405	405
Observations	563,938	563,938	563,938	563,938	563,938

Notes: Standard errors, clustered by ED, are reported in parentheses. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level. Patient age splines included but not reported.

Table 3.3 Treatment effects for repeat chest X-rays during revisit within 30 days to same ED

	Base model	ED Fixed Effects		ED Fixed Effects with ED trends	
	1	2	3	4	5
Standalone Info. System	0.0082 (0.0067)	0.0086** (0.0042)	0.0126* (0.0064)	0.0012 (0.0064)	0.0027 (0.0078)
IS x Uninsured			0.0093* (0.0053)		0.0088* (0.0052)
IS x No. Previous Diagnoses (1-5)			-0.0013 (0.0017)		-0.0006 (0.0017)
IS x No. Previous Diagnoses (6-25)			-0.0041** (0.0020)		-0.0035* (0.0021)
Race (black)	0.0253*** (0.0048)	0.0239*** (0.0023)	0.0239*** (0.0023)	0.0247*** (0.0023)	0.0246*** (0.0023)
Female	-0.01643 (0.0017)	-0.0191*** (0.0015)	-0.0191*** (0.0015)	-0.0191*** (0.0015)	-0.0191*** (0.0015)
No. Previous Diagnoses (1-5)	0.0048*** (0.0014)	0.00103 (0.00075)	0.0021 (0.0015)	0.00103 (0.00075)	0.0015 (0.0015)
No. Previous Diagnoses (6-25)	0.0119*** (0.0016)	0.0107*** (0.0011)	0.0143*** (0.0017)	0.0108*** (0.0011)	0.0138*** (0.0018)
Uninsured	-0.0296*** (0.0032)	-0.0275*** (0.0024)	-0.0353*** (0.0046)	-0.0276*** (0.0024)	-0.0349*** (0.0046)
P-value from joint F-test of IS interacted with previous diagnoses			0.037		
Year Fixed Effects	5	5	5	5	5
Hospital Fixed Effects		394	394	394	394
Observations	705,513	705,513	705,513	705,513	705,513

Notes: Standard errors, clustered by ED, are reported in parentheses. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level. Patient age splines included but not reported.

Table 3.4 Treatment effects on repeat ultrasound during revisit within 30 days to same ED

	Base model	ED Fixed Effects		ED Fixed Effects with ED trends	
	1	2	3	4	5
Standalone Info. System	0.019 (0.013)	0.0078 (0.0063)	0.0182** (0.0088)	-0.0026 (0.0067)	0.0055 (0.0090)
IS x Uninsured			0.0026 (0.0088)		0.0013 (0.0086)
IS x No. Previous Diagnoses (1-5)			-0.0042** (0.0021)		-0.0034 (0.0022)
IS x No. Previous Diagnoses (6-25)			-0.0105*** (0.0028)		-0.0102*** (0.0031)
Race (black)	0.0207*** (0.0055)	0.0074** (0.0037)	0.0074** (0.0037)	0.0076** (0.0037)	0.0076** (0.0037)
Female	0.1155*** (0.0052)	0.1070*** (0.0046)	0.1070*** (0.0046)	0.1072*** (0.0047)	0.1071*** (0.0047)
No. Previous Diagnoses (1-5)	-0.0142*** (0.0018)	-0.0153*** (0.0012)	-0.0117*** (0.0021)	-0.0156*** (0.0012)	-0.0128*** (0.0022)
No. Previous Diagnoses (6-25)	-0.0028*** (0.0010)	-0.0037*** (0.0013)	0.0057** (0.0028)	-0.0039** (0.0013)	0.0052* (0.0032)
Uninsured	-0.0179*** (0.0056)	-0.0233*** (0.0041)	-0.0255*** (0.0081)	-0.0228*** (0.0039)	-0.0239*** (0.0082)
P-value from joint F-test of IS interacted with previous diagnoses			< 0.01		
Year Fixed Effects	5	5	5	5	5
Hospital Fixed Effects		392	392	392	392
Observations	265,682	265,682	265,682	265,682	265,682

Notes: Standard errors, clustered by ED, are reported in parentheses. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level. Patient age splines included but not reported.

Table 3.5 Treatment effects on repeat CT scans within 30 days of a CT scan at another ED

	Base model	ED Fixed Effects		ED Fixed Effects with ED trends	
	1	2	3	4	5
Standalone Info. System	0.0292***	0.060***	0.062***	0.049***	0.046**
	(0.0084)	(0.012)	(0.013)	(0.017)	(0.019)
HIE	-0.012	0.030	0.023	0.036	0.017
	(0.016)	(0.024)	(0.026)	(0.064)	(0.063)
IS x HIE	-0.006	-0.082***	-0.086***	-0.134***	-0.126***
	(0.020)	(0.028)	(0.029)	(0.043)	(0.043)
IS x HIE x Uninsured			-0.024**		-0.018
			(0.012)		(0.012)
HIE x Uninsured			0.0184*		0.0134
			(0.0096)		(0.0099)
IS x Uninsured			0.0085*		0.0045
			(0.0051)		(0.0049)
IS x HIE x No. Previous Diagnoses (1-5)			0.0042		-0.0006
			(0.0039)		(0.0036)
IS x No. Previous Diagnoses (1-5)			-0.0011		0.0006
			(0.0018)		(0.0016)
HIE x No. Previous Diagnoses (1-5)			0.0006		0.0051*
			(0.0028)		(0.0028)
IS x HIE x No. Previous Diagnoses (6-25)			-0.0038		-0.0050
			(0.0051)		(0.0053)
IS x No. Previous Diagnoses (6-25)			-0.0002		0.0008
			(0.0026)		(0.0022)
HIE x No. Previous Diagnoses (6-25)			-0.0005		0.0014
			(0.0044)		(0.0046)
No. Previous Diagnoses (1-5)	-0.00269***	-0.00290***	-0.0025*	-0.00296***	-0.0041***
	(0.00098)	(0.00078)	(0.0015)	(0.00078)	(0.0013)
No. Previous Diagnoses (6-25)	-0.00202***	-0.00248***	-0.0019	-0.00273***	-0.0031
	(0.00092)	(0.00080)	(0.0023)	(0.00081)	(0.0020)
Uninsured	-0.0029	-0.0030	-0.0100**	-0.0014	-0.0051
	(0.0025)	(0.0023)	(0.0042)	(0.0021)	(0.0041)
P-values from F-tests:					
IS+HIE+IS*HIE=0		0.85		0.33	
Cumulative interaction effect of HIT and uninsured			0.69		0.981
Cumulative interaction effect of HIT 1-5 diagnoses			0.27		0.0467
Cumulative interaction effect of HIT and >5 diagnoses			0.22		0.377
Year Fixed Effects	3	3	3	3	3
Hospital Fixed Effects		497	497	497	497
Observations	171,400	171,400	171,400	171,400	171,400

Notes: Standard errors, clustered by ED, are reported in parentheses. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level
Patient age splines, race, and sex indicators included but not reported.

Table 3.6 Treatment effects on repeat chest X-rays within 30 days of a chest X-ray at another ED

	Base model	ED Fixed Effects		ED Fixed Effects with ED trends	
	1	2	3	4	5
Standalone Info. System	0.057***	0.053***	0.062***	0.041**	0.047**
	(0.015)	(0.013)	(0.015)	(0.019)	(0.020)
HIE	0.007	0.012	0.028	-0.014	-0.004
	(0.021)	(0.023)	(0.027)	(0.060)	(0.062)
IS x HIE	-0.071**	-0.108***	-0.123***	-0.145***	-0.155***
	(0.034)	(0.027)	(0.030)	(0.049)	(0.051)
IS x HIE x Uninsured			-0.015		-0.003
			(0.012)		(0.012)
HIE x Uninsured			0.018*		0.0124
			(0.010)		(0.011)
IS x Uninsured			0.0023		-0.0057
			(0.0069)		(0.0070)
IS x HIE x No. Previous Diagnoses (1-5)			0.0078		0.0054
			(0.0053)		(0.0053)
IS x No. Previous Diagnoses (1-5)			-0.0028		-0.0016
			(0.0026)		(0.0024)
HIE x No. Previous Diagnoses (1-5)			-0.0077*		-0.0057
			(0.0046)		(0.0048)
IS x HIE x No. Previous Diagnoses (>5)			-0.0095*		-0.0106**
			(0.0049)		(0.0047)
IS x No. Previous Diagnoses (>5)			-0.0005		0.0009
			(0.0028)		(0.0023)
HIE x No. Previous Diagnoses (>5)			0.0075*		0.0085**
			(0.0045)		(0.0040)
No. Previous Diagnoses (1-5)	-0.0033***	-0.00312***	-0.0006	0.00333***	-0.0018
	(0.0012)	(0.00086)	(0.0023)	(0.00083)	(0.0021)
No. Previous Diagnoses (>5)	0.0061***	0.00569***	0.0060*	0.00545***	0.0046**
	(0.0014)	(0.00092)	(0.0025)	(0.00091)	(0.0019)
Uninsured	-0.0160***	-0.0136***	-0.0164***	-0.0118***	-0.0085
	(0.0038)	(0.0027)	(0.0059)	(0.0027)	(0.0060)
P-values from F-tests					
IS+HIE+IS*HIE=0		0.29		< 0.01	
Cumulative interaction effect of HIT and uninsured			0.50		0.641
Cumulative interaction effect of HIT 1-5 prior diagnoses			0.46		0.544
Cumulative interaction effect of HIT and >5 prior diagnoses			0.61		0.773
Year Fixed Effects	3	3	3	3	3
Hospital Fixed Effects		499	499	499	499
Observations	188,839	188,839	188,839	188,839	188,839

Notes: Standard errors, clustered by ED, are reported in parentheses. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level. Patient age splines, race, and sex indicators included but not reported.

Table 3.7 Treatment effects on repeat ultrasounds within 30 days of an ultrasound at another ED

	Base model	ED Fixed Effects		ED Fixed Effects with ED trends	
	1	2	3	4	5
Standalone Info. System	0.060***	0.070***	0.095***	0.043*	0.063***
	(0.017)	(0.019)	(0.021)	(0.022)	(0.024)
HIE	-0.050**	0.093**	0.072*	0.054	0.019
	(0.025)	(0.038)	(0.040)	(0.089)	(0.086)
IS x HIE	-0.029	-0.136***	-0.138***	-0.149**	-0.135**
	(0.038)	(0.038)	(0.053)	(0.061)	(0.066)
IS x HIE x Uninsured			-0.008		0.012
			(0.031)		(0.030)
HIE x Uninsured			0.036		0.017
			(0.022)		(0.019)
IS x Uninsured			0.009		-0.0046
			(0.014)		(0.0089)
IS x HIE x No. Previous Diagnoses (1-5)			0.002		-0.006
			(0.011)		(0.010)
IS x No. Previous Diagnoses (1-5)			-0.0102***		-0.0071**
			(0.0038)		(0.0034)
HIE x No. Previous Diagnoses (1-5)			0.0048		0.0124
			(0.0104)		(0.0093)
IS x HIE x No. Previous Diagnoses (6-25)			0.002		-0.003
			(0.010)		(0.011)
IS x No. Previous Diagnoses (6-25)			-0.0030		0.0002
			(0.0052)		(0.0056)
HIE x No. Previous Diagnoses (6-25)			-0.0016		0.003
			(0.0096)		(0.010)
No. Previous Diagnoses (1-5)	-0.0147***	-0.0132***	-0.0056*	-0.0134***	-0.0085***
	(0.0017)	(0.0013)	(0.0034)	(0.0013)	(0.0029)
No. Previous Diagnoses (>5)	-0.0071**	-0.0066***	-0.0041	-0.0074***	-0.0077
	(0.0016)	(0.0017)	(0.0049)	(0.0016)	(0.0053)
Uninsured	-0.0261***	-0.0274***	-0.038***	0.0837***	-0.0245***
	(0.0056)	(0.0044)	(0.013)	(0.0066)	(0.0077)
P-values from F-tests					
IS+HIE+IS*HIE=0		0.64		0.43	
Cumulative interaction effect of HIT and uninsured			0.16		0.28
Cumulative interaction effect of HIT 1-5 diagnoses			0.57		0.84
Cumulative interaction effect of HIT and >5 diagnoses			0.62		0.90
Year Fixed Effects	3	3	3	3	3
Hospital Fixed Effects		492	492	492	492
Observations	78,032	78,032	78,032	78,032	78,032

Notes: Standard errors, clustered by ED, are reported in parentheses. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level. Patient age splines, race, and sex indicators included but not reported.

Chapter 4

The Effect of Hospital-Physician Integration on Hospital Inpatient Revenue From Private Payers

4.1 Introduction and Previous Literature

Integration between hospitals and physicians, in which physicians are directly employed under the same ownership as a hospital system, may confer greater bargaining power to providers when negotiating over payment rates with private payers. (Public payers Medicare and Medicaid unilaterally set payment rates for their covered individuals). Alternatively, hospital-physician integration may enable more cost-efficient care, and to the extent that there is price competition in health care, efficiencies resulting from integration may be passed on to payers in the form of lower prices. Another line of reasoning holds that when one or both parties in a vertical relationship have market power, vertical integration, by reducing two profit margins to one in the newly integrated entity, can facilitate coordinated pricing and possibly lead to a reduction in prices even as profits rise (Viscusi, Harrington, and Vernon 2005).

Esther Gal-Or (1999) provides theoretical results indicating increased prices may follow from hospital-physician integration when both hospitals and physicians face comparable degrees of competition in their respective markets. In cases where the degree of competition between the two markets differs significantly, only the party in the more competitive market benefits from higher payment rates resulting from the merger.

While payment systems in health care remain generally fee for service, hospitals often face cost-containment pressures from payers via negotiated payment rates, per diem or case rate payments and Medicare's prospective payment system (Casalino, and Robinson 2003). Thus coordination with physicians to implement various strategies for navigating payment systems is a concern for hospitals. Previous survey and case study research finds that hospitals report entering into integrated arrangements with physicians for reasons that include bargaining jointly with payers, securing sources of admissions and saving in costs of hospital care under full or shared-risk contracting with payers (Berenson, Ginsburg, and Kemper 2010; Burns, and Muller 2008; Casalino, and Robinson 2003).

Economizing on transaction costs also provides an important motive for firms to vertically integrate (Williamson 1975, 1985). This efficiency-enhancing quality of vertical integration can outweigh anti-competitive effects. Williamson points out that such efficiency-enhancing effects have become increasingly accepted in antitrust enforcement concerning vertical mergers. While the 1968 Vertical Merger Guidelines reflected the view that "even the slightest degree of monopoly power was thought to be responsible for decisions to integrate," the 1982/1984 Vertical Merger Guidelines "reflect a genuine sensitivity to transaction cost features—and are much more permissive than their predecessors as a consequence" (Williamson 1985). The Vertical Merger Guidelines have not been revised since 1984.

Two previous empirical economic studies have examined the effect of hospital-physician integration on hospital inpatient prices. Ciliberto and Dranove (2006) examined changes in price over time in California as a function of various types of hospital-physician alliances using a hospital fixed effects model. They found no effect of integration on price. Cuellar and Gertler (2006) also examined the effect of integration on prices in Arizona, Florida, and Wisconsin, and found increases in price attributable to certain forms of hospital-physician affiliation that involve exclusive relationships but not direct employment of physicians. To be precise, Cuellar and Gertler did not find an effect of direct physician employment on hospital price while they did find a positive effect of other types of hospital-physician affiliation. In an editorial accompanying these two research papers, Martin Gaynor cited these works as "opening up a new area of inquiry with intriguing and important results," and he called for more research on this topic (Gaynor 2006). The present paper addresses the same question using a larger national sample of hospitals over a recent period of increasing direct employment of physicians by hospitals. Furthermore, I use an instrumental variables strategy to identify the effect of integration, while employing a novel instrument—state corporate practice of medicine laws, which prohibit direct employment of physicians by hospitals in some states. With the recent increase in the prevalence of physician employment by hospitals, which is now the dominant form of integration, the present research provides important and timely new evidence on the competitive effect of this organizational form.

4.2 Conceptual Framework

In constructing a framework for examining the competitive effects of hospital-physician integration, I draw largely on the analysis of Gaynor and Haas-Wilson (1998), who apply lessons from the general economics literature on vertical relations to the particular features of health care firms. They, along with other economists (Riordan, and Salop 1995; Viscusi et al. 2005; Williamson 1975) who have done prior work on these issues, identify two broad types of effects that can motivate integration between vertically related firms. On the one hand, integration may generate efficiencies in the coordination of upstream (physicians) and downstream (hospital) firms in the production process. On the other hand, increased market power may result from a raising rivals cost (RRC) effect or by increasing hospital and physician bargaining power with private payers. Gaynor and Haas-Wilson (1998) conclude that there is no consensus on the competitive effects of vertical integration, and this conclusion is reiterated by Gaynor (2006).

4.2.1 Efficiency Gains from Vertical Integration

Several mechanisms may account for efficiency gains when hospitals and physicians integrate. The costs to hospitals of coordinating with physicians and motivating physician actions toward alignment with hospital interests represent types of transaction costs. Elimination of such costs may provide substantial motivation for integration. In particular, mergers may ensure an adequate supply of inputs (in this case, physicians) to the downstream firm (the hospital). For example, many hospitals rely on specialist physicians in the community to take call coverage responsibilities for their emergency departments (Berenson, Ginsburg, and May 2007). Thus, hospital-physician integration can ensure that the hospital has adequate ED coverage by physicians, reducing costs associated with uncertainty of demand fluctuations. Furthermore, integration may better align incentives faced by physicians and hospitals, resulting in a more efficient use of the integrated firm's resources. Jeffrey Harris' model of the internal organization of hospitals (1977) highlights the tension between physicians, who serve as their patients' agents in procuring hospital resources, and hospital administrators, who must supply the necessary inputs for care without carrying too much excess capacity. This tension motivates hospital administrators to try to achieve greater control over physician actions, thus leading to monitoring and alignment strategies such as direct employment of physicians.

There may also be economies of scope, since physicians work both within and outside of hospitals, and economies of scale associated with hospital-physician integration. Integration can allow for more efficient coordination of outpatient and inpatient services than is otherwise possible with a loosely affiliated medical staff, thus lowering costs. Becoming employed by a larger organization can relieve physicians of non-clinical administrative duties outside of their core competencies. Furthermore, changes in medical technology have led to greater provision of medical care in outpatient settings and hence substitution of care in ambulatory settings for inpatient care (Burns, and Muller 2008). Vertical integration may allow for better coordination of pricing these different services, which in some cases complement one another and in other cases can substitute for one another. Such coordination has an indeterminate effect on inpatient prices and quantities.

4.2.2 Anticompetitive Effects of Vertical Integration

By integrating with a large physician group or several such groups operating in its market, a hospital may foreclose rival hospitals from the market for physician services, thereby inducing higher operating costs among rival hospitals. Furthermore, the integrated hospital may then be able to exert market power, either unilaterally or by coordinating with competitors. Because rivals are disadvantaged by increased costs resulting from the vertical merger (i.e. assuming scale economies or fixed costs spread over fewer customers), these hospitals may, in a sense, be induced into involuntary coordination with the vertically merged hospital. In this manner, a vertically integrated firm can achieve the power to raise or maintain prices above marginal cost (Gaynor 1998). This scenario, described in terms of hospital-physician integration, corresponds to the general phenomenon of input foreclosure, which is identified and discussed in the literature on antitrust (Riordan 2008; Riordan, and Salop 1995).

Similarly, in concentrated markets, integration may raise barriers to entry by foreclosing the input market to potential entrants, or necessitating that any entrants also be vertically merged (Riordan 2008; Williamson 1975). A hospital merging with a large physician group may foreclose the market for physician services and thereby raise barriers to potential hospital entrants or vice versa. This may in turn allow for the exercise of monopoly power by incumbent hospitals. Without high market concentration, however, this potential anticompetitive effect becomes less likely. Hence, the effects of foreclosure resulting from vertical integration become most salient for competition when there is preexisting market power on the part of either hospitals or physicians integrating with one another (Gaynor 2006). A dominant hospital merging with physicians will more likely disadvantage independent rival physicians than if the integrating hospital is one of many similar firms in a competitive market. A dominant physician group that becomes exclusively aligned with one hospital through integration will more likely disadvantage rival hospitals than if a small (relative to the size of the market) physician group becomes exclusively aligned with a hospital.

The effects of hospital-physician integration on the market for physician services can affect the degree to which a vertically integrated hospital exerts market power. Furthermore, integration also affects costs of coordination between hospitals and physicians and costs of producing patient care. Because there are both efficiency gains and anti-competitive effects theoretically attributable to vertical mergers, the effect on prices, costs, and the quantity of services provided is indeterminate. Empirical work can help uncover the relative magnitude of these countervailing effects. I test for a general effect of integration on average hospital revenue. I also examine possible mechanisms for an effect of integration on revenue through operating expenditures and quantity of services. If efficiency gains or economies from integration predominate, then prices and average revenue, as well as costs or quantity of services per patient, may fall as a result of hospital employment of physicians.

4.3 Empirical Methods

4.3.1 Data Construction

Previous studies on the effects of hospital mergers have constructed a measure of hospital price based on variables reported in the Centers for Medicare and Medicaid Services' (CMS) Hospital Cost Report Information System (HCRIS) (Connor, Dowd, and Feldman 1998; Dafny 2009). These measures of price essentially consist of average revenue per patient. I have constructed a measure of average revenue based on hospital inpatient revenue from non-Medicare sources per non-Medicare discharge (excluding swing/skilled nursing facility revenue).[1] Average revenue[2] is a function of price and

[1] In terms of CMS HCRIS data, I use this formula: Average private revenue = [(hospital inpatient routine service charges + hospital intensive care charges + hospital inpatient ancillary charges) x discount factor –

quantity of services per discharge—roughly R=P*Q. Hospital-physician integration can, therefore, affect average revenue either by influencing the negotiated prices (P) or the amount of services provided to each patient (Q). Because hospitals are price-takers with respect to Medicare, these revenues and patients are excluded.

The main explanatory variable of interest consists of salaries paid to physicians other than resident and interns averaged over the number of all hospital inpatients (including Medicare beneficiaries) discharged over a year. I use the scaled salary variable to account for differences in hospital size that would otherwise obscure comparisons of total salaries paid across hospitals. This measure accounts for the degree to which each inpatient receives services rendered by hospital-employed physicians as opposed to independent physicians. Payments made to independent contractor physicians are not included in the measure. In a supporting regression analysis, I examine the effect of salaries paid to employed physicians on average inpatient costs. These costs consist of five *Inpatient Routine Service Cost Centers* as identified in the CMS healthcare cost report information system: 1) adults and pediatrics (general inpatient routine care); 2) intensive care unit 3) coronary care unit; 4) burn intensive care unit; and 5) surgical intensive care unit. These five cost centers correspond on a one-to-one basis with the five revenue centers used for the average revenue analysis. However, I am unable to distinguish costs that are attributable to privately covered patients from those costs

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Medicare primary payor amounts –Medicare total amount payable]/[(total discharges excluding swing/skilled nursing facility –total Medicare discharges excluding swing/skilled nursing facility)]. This formula differs from that used by Dafny (2009) only in that she also divides by the Medicare case mix index (CMI). Doing so reduces the number of observations by nearly half in my sample. Instead of including CMI in the main analysis, I check the robustness of my findings to inclusion of Medicare CMI.

[2] To be precise regarding the revenue counted in the dependent variable, I follow Dafny by using revenue totals from five significant hospital inpatient revenue centers as reported in the HCRIS: 1) general inpatient routine care services; 2) intensive care unit; 3) coronary care unit; 4) burn intensive care unit; and 5) surgical intensive care unit.

attributable to publicly insured patients. Therefore, I use routine inpatient care costs averaged over all discharges, regardless of payer type, as the dependent variable in this secondary analysis. This is a reasonable plan of analysis given that it is unlikely that any efficiencies achieved due to hospital-physician integration would affect only patients with private insurance and not patients from other payer categories.

Due to the endogenous relationship between hospital salary payments to employed physicians and revenue, costs and quantities of services, I use an instrumental variable strategy to mitigate the problem of inconsistent estimation. In particular, I use a hospital-level indicator for a binding corporate practice of medicine restriction against employing physicians as an instrument for physician salaries. Assuming that CPM restrictions are validly excluded from the regression models for average inpatient revenue, average inpatient costs, and average inpatient days per discharge, estimation using two-stage least squares will recover consistent coefficient estimates for average physician payments per discharge. See section 2.3 of Chapter 2 and Appendix A in this dissertation for more details on the CPM laws and how data about these laws were constructed.

Previous studies have found that the hospital-physician alliances increase in prevalence with the number of HMOs in the market (Burns et al. 2000; Cuellar, and Gertler 2006). Payer market structure also plays a critical role in determining reimbursement rates to hospitals (Chernew et al. 1998; Zwanziger, Melnick, and Bamezai 1994). It is therefore important to control for the proportion of hospital services that are subject to capitation or other cost-sharing mechanisms (as opposed to fee for service), and the number of payers operating in a given provider market. While data limitations prohibit the inclusion of more direct measures of competition among payers, I am able to incorporate data on Medicare managed care penetration (at the county level) and the number of health maintenance organization (HMO) and preferred provider organization (PPO) contracts that each hospital possesses. I summed the number of HMO and PPO contracts to create a count of managed care organization (MCO) contracts at the hospital level.

Because of the importance of provider market competition in determining the effect of vertical merger on provider bargaining power with payers, I incorporate a measure of competition among hospitals using the Herfindahl-Hirschman Index (HHI) for which higher values indicate more concentrated markets. The definition of a market for this study is a county. I calculated this index while accounting for hospitals in the same county under the same ownership as one unit since such hospitals are assumed not to compete with one another. In particular, I summed total admissions for each hospital in the same system and the same market and divided this system-market total by total admissions among all hospitals in the county to obtain the hospital system's market share. I then summed the squares of the market shares for all hospital systems and stand-alone hospitals in the same county to obtain the HHI. I also control for individual hospital market shares since this may also influence hospital pricing, costs and quantity of services separately from market concentration.

Because the state CPM laws have remained static during the period for which I have data, I estimated a single period cross-sectional regression for 2009—the latest year for which data was available, and also the year during which there is the greatest variation in hospital employment of physicians so far. I also separately estimated the regression models using 2007 and 2008 data and find nearly identical results with only small variations in magnitude in the explanatory variable's effects.

4.3.2 Empirical Estimation Strategy

I identify the effect of hospital-physician integration on average inpatient revenue using cross-sectional variation among hospitals and with an instrumental variable to mitigate bias due to the endogeneity of hospital-physician integration. I focus on examining the effect of direct employment since this has become the dominant form of hospital-physician integration during the past decade while other forms have declined in prevalence (Casalino et al. 2008; Gaynor 2011), and it is at the extreme end of the continuum of hospital-physician organizational arrangements (see Cuellar and Gertler (2006) for a more detailed description of such arrangements). Figure 1 shows the changes in proportions of hospitals reporting the most commonly reported organizational forms in the AHA survey from 2000 to 2009. We can see from this that direct employment of physicians has become the most prevalent arrangement with physicians during this decade.

I estimate the following instrumental variables (IV) regression model to determine the effect of a change in integration status on average private revenue obtained by hospitals.

$$\ln(\overline{LogRevenue}_{ht}) = \beta_{IV} \ln{(SalaryPerDischarge)_{ht}} + \boldsymbol{\theta HOSPITAL}_{ht} + \boldsymbol{\gamma MARKET}_{ht} + \varepsilon_{ht} \qquad (1)$$

$$\ln\,(SalaryPerDischarge_{ht}) = \alpha_{FS}1(CPM_{ht}) \; +$$

$$\boldsymbol{\pi HOSPITAL}_{ht} \; + \; \boldsymbol{\lambda MARKET}_{ht} \; + \; \mu_{ht} \qquad (2)$$

The specification presented in equation (1) has the log of average revenue for hospital *h* at time *t* as a linear function of the log of physicians' salary-per-discharge (for only salaries paid by hospitals). The regression model also includes a vector of hospital characteristics, $\boldsymbol{HOSPITAL}$, a vector of market characteristics, $\boldsymbol{MARKET}$. The vectors of hospital and market characteristics contains log transformations of continuous variables: total admissions, registered nurses per bed, Medicaid discharge share, Medicare discharge share; and market characteristics: Medicare managed care penetration, and HHI. Equation (2) represents the first stage in which log physicians' salary-per-discharge is modeled as a function of state CPM restrictions on hospital employment of physicians as well as the same hospital and market covariates that appear in the structural equation (1).

Because IV results may be biased due to a weak first stage, I also estimated the reduced form regression equation, in which the endogenous variable is replaced with the excluded instrument. Chernozhukov and Hansen (2008) point out that, assuming the exclusion restriction holds, testing the significance of the coefficient estimates for excluded instruments in the reduced form equation provides a test for the parameters of interest that is robust to weak instrument bias. The reduced form is depicted in the following equation:

$$\ln\,(\overline{LogRevenue}_{ht}) = \omega_{RF}1(CPM_{ht}) + \boldsymbol{\omega HOSPITAL}_{ht} +$$

$$\boldsymbol{\psi MARKET}_{ht} + \; \upsilon_{ht} \qquad (3)$$

The reduced form parameter for the excluded instrument is proportionally related to the parameter on the endogenous variable in the structural equation (1) such that $\beta_{IV} \approx \omega_{RF}/\alpha_{FS}$.

Because the outcome variable of interest—average inpatient revenue—may be affected by changes in quantity of services or costs or changes in market power, I subsequently examined measures of related variables: 1) log of operating expenditures per inpatient discharge; 2) log of average inpatient days per admission; and 3) log total discharges. Examining average costs per discharge provides a test of the theories of vertical integration that emphasize efficiency-enhancing effects. If there are significant economies of scope associated with hospital-physician integration, average costs of inpatient services would likely decrease due to integration. However, other types of costs affected by vertical integration (i.e. transaction costs as opposed to production costs) may not be reflected in the data on operating expenditures. Furthermore, while the number of inpatient days per admission does not account for all the variation in quantity of services that a patient may receive during a hospital visit, changes in length of stay can contribute to changes in costs and revenue per admission. Therefore, if hospitals face cost-sharing incentives for more efficient care from payers, and if integration allows better monitoring or control of physician activities, then I expect a decrease in the quantity of services provided per patient. On the other hand, if providers face a largely fee for service payment environment and integration facilitates better control over physician behavior, then I expect to find an increase in quantity of services provided per patient. For the same reasons, I would also expect integration to increase inpatient discharges.

4.4 Results

I estimated the average revenue per discharge model first using OLS (see table 4.2). Here I find a significant negative relationship between physician salaries and average revenue. Because physician location decisions are associated with large transaction costs that render them less responsive to changes in market conditions, and because rural areas tend to have lower physician to population ratios than non-rural areas (Nicholson, and Propper 2011), I estimated each model separately for rural and non-rural areas to allow for a different effect of integration between these two types of markets. The magnitude of the relationship is significantly larger among hospitals in rural counties, as each additional physician salary dollar per discharge is associated with a 3 percent decrease in average private revenue, whereas in non-rural counties, each additional salary dollar per discharge is associated with only a 0.4 percent decrease in average private revenue.

Other hospital and market characteristics also have significant relationships with average private revenue. Larger hospitals have lower average revenue, perhaps reflecting scale economies. A larger share of Medicaid patients is associated with lower average revenue, likely reflecting the lower reimbursement rates of Medicaid. Government ownership is associated with lower private revenue, while teaching hospital status is associated with significantly greater average private revenue, perhaps reflect more complex cases seen in academic medical centers. Hospitals in more concentrated markets have lower average revenue. This finding is not consistent with the hypothesis that greater market concentration produces greater prices. Greater median household income is associated greater average revenue. This finding is interesting as it suggests the possibility that hospitals may be able to engage in price discrimination by charging greater prices in wealthier markets. Managed care penetration is associated with lower average revenue, while the interaction of managed care penetration with the number of managed care contracts positively offsets the direct effect of penetration. This latter finding is consistent with the idea that greater competition in the payer market erodes the monopsony power of managed care organizations (MCOs).

Table 4.3 depicts results from the regression of the log of physician salaries per discharge on binding state CPM laws. This regression constitutes the first stage of the two stage least squares analysis (2SLS). Consistent with expectations of the instrument, binding CPM restrictions have a significant negative effect on physician salaries paid by hospitals. An F-test of the strength of the instrument in the first stage produces a test statistic of 9 in the full sample. This is close to but below the rule of thumb value of 10 for sufficiently strong instrument. The F-test statistic is 13 among non-rural hospitals in the sample. Since the test statistic is below 10 in the full sample, I also report results of the reduced form analysis, in which the excluded instrument replaces the endogenous variable in the structural model, as an additional test of the effect of integration that is robust to weak instrument bias.

Estimates of the first stage regression among the subset of rural hospitals reveals that the instrument is quite weak among this group of hospitals. Therefore, I omit an IV analysis of hospital-physician integration effects among rural hospitals, but I still report reduced form estimates for rural hospitals, since these results cannot be subjected to a weak instrument critique.

Table 4.4 presents the IV results from the average revenue analysis. Here, I find that physician salaries per discharge are no longer significantly negative. Nor can we reject the null hypothesis in a positive direction. This suggest that there are unobserved variables biasing the OLS estimates of physician salarys' effect in a negative direction.

Table 4.5 presents results from the reduced form analysis. Consistent with the IV analysis, I find no effect of physician salary on average revenue for the full sample and the non-rural subsample. However, I do find a negative effect of binding CPM laws on average revenue among rural hospitals. Assuming that CPM laws decrease the level or likelihood of integration, this result indicates a positive effect of integration on average private revenue among rural hospitals. I explore this relationship further with an analysis of integration's effect on inpatient operating expenditures and inpatient days per discharge below.

Because the outcome variable of interest—average inpatient revenue—may be affected by changes in costs or quantity of services, I subsequently estimated models with measures of these variables as outcomes: log of routine inpatient operating expenditures per discharge and log of average inpatient days per admission. While the number of inpatient days does not account for all the variation in quantity of services that a patient may receive during a hospital visit, changes in length of stay can contribute to changes in costs and revenue per admission. The results of OLS estimation of log average operating expenditures as a function of log physician salaries per discharge are given in Table 4.6. Here I find no relationship between physician salaries and average operating expenditures. The IV estimates presented in table 4.7, and the reduced form estimates presented in table 4.8 reinforce the null findings of the OLS estimates. There does not appear to be any substantial effect of physician employment by hospitals on operating expenditures.

When I regress log average inpatient days per admission on log physician salary per discharge, I find a significant negative relationship (Table 4.9). However, the IV estimates reveal some evidence of a significant positive effect of physician salaries on quantity of inpatient days per discharge (see Table 4.10). The IV estimates among non-rural hospitals does not indicate a significant effect in this subsample (Table 4.10). The reduced form regression of inpatient days per discharge confirms the IV analysis findings of a significant effect of physician salaries, and furthermore indicates that the bulk of this effect is attributable to integration among rural hospitals. This finding in conjunction with the significant negative effect of physician salaries on average revenue among rural hospitals suggests that at least some portion of a positive effect of hospital-physician integration on average revenue comes through an increase in average inpatient days. Thus integration may produce greater intensity of inpatient services among rural hospitals.

As an additional test of the effect of integration on quantity of services, I regressed log inpatient discharges on log physician salary per discharge. In an OLS analysis, I find a positive relationship between physician salary and inpatient volume. This positive relationship is statistically significant in both rural and non-rural areas (see Table 4.12). However, the IV estimates indicate no significant effect of physician salaries on inpatient volume in the whole sample as well as among non-rural hospitals (Table 4.13). An OLS analysis of the reduced form equation in the full sample and the non-rural subsample finds not effect of CPM laws on inpatient volume (Table 4.14). But for rural hospitals, CPM laws significantly increase the volume of inpatients by 36 percent (Table

4.14). Thus, assuming that the laws are validly excluded from the structural equation and since CPM significantly decreases the likelihood of integration, these findings indicate that integration decreases inpatient volume in rural hospitals. This means that the naïve OLS results are upwardly biased.

4.5 Discussion

Many health care industry participants claim that hospital-physician integration increases monopoly power and allows the extraction of higher payment rates from insurers (Berenson et al. 2010; O'Malley, Bond, and Berenson 2011). With recent initiatives, supported in part by health reform legislation, to create Accountable Care Organizations that involve substantial coordination among providers and bundled payments to groups of providers, concerns about a negative impact on competition from such arrangements have been raised. However, I find little evidence in a national sample of hospitals that the increasing prevalence of hospital employment of physicians has produced higher private prices. There is some evidence indicating that hospitals in rural counties that directly employ physicians have an increase in private average revenue that is accompanied by an increase in average inpatient days but not accompanied by any change in expenditures. Rather than indicating the exercise of market power to raise price, this more likely indicates increased intensity of physician services among vertically integrated hospitals. This may be due to a shift in patient mix resulting from new service line capabilities enabled by tighter integration with physicians.

I also find evidence that rural hospitals experience a decrease in inpatient volume attributable to integration, while non-rural hospitals do not experience any volume effect due to integration. This may be due to substitution toward outpatient care and away from inpatient care that is enabled by directly employed physicians.

The instrumental variables findings do not support a causal interpretation of the significant negative relationship between physician salary and average private payer revenue, nor the negative relationship between physician salary and average inpatient days per discharge, nor the positive relationship between physician salary and inpatient volume found in the OLS analyses. This discrepancy suggests that unobserved factors are correlated with revenue, inpatient length of stay, inpatient volume, and physician salaries and contribute to bias in the OLS estimates. One possibility is that declining revenue due to less intensive service provision in a fee for service environment prompts hospitals to pursue integration with physicians as a means of bolstering profits. Thus it may be the low average revenue and the low quantity of services provided that induces some hospitals to pursue integration. Such a reverse causation scenario would account for the discrepancy between the OLS findings and IV findings in the average revenue and average inpatient days analyses. Similarly, since changes in medical technology are enabling greater provision of care on an outpatient basis, hospitals serving larger volumes of inpatients may be more likely to integrate in order to shift care toward lower-cost and more profitable outpatient services. This could account for the discrepancy in the OLS and IV findings for inpatient volume.

The present findings do not constitute strong evidence of anti-competitive effects of hospital-physician integration nor of any cost efficiency effect. The findings of a negative effect of binding CPM laws on average private revenue and a negative effect of CPM on average inpatient days among rural hospitals suggests that integration may induce more intensive inpatient services in these hospitals. (This interpretation follows from the fact that CPM laws reduce the prevalence of integration between physicians and hospitals. Given the proportional relationship of IV estimates to reduced form and first stage parameter estimates of the excluded instrument, a negative estimate for CPM in both the reduced form model and the first stage model implies a positive effect of integration in the structural equation.) Furthermore, the finding of a positive effect of CPM laws on inpatient volume in rural hospitals suggests that integration produces lower inpatient admissions in these hospitals.

If more intensive service provision but fewer inpatient admissions results from integration in rural areas, these effects may or may not be welfare enhancing for patients. Further investigation of the impact of integration in rural areas is warranted for this reason and because, in comparison to urban areas, these markets tend to have fewer hospital beds and physicians relative to population size. Prior research on physician location decisions provides evidence that large transaction costs associated with relocating a physician practice contribute to low responsiveness of physician location decisions when market conditions change, such as when physician fees exogenously increase or decrease (Nicholson, and Propper 2011). Given these large costs associated with physician location decisions, hospital-physician integration may allow hospitals in rural or low physician per capita areas to more readily adapt their mix of services to changes in medical technology and changes in demand for outpatient and inpatient services. Further research along these lines would provide valuable information about the consequences of hospital-physician integration rural markets and markets with fewer physicians per capita. Findings on this topic may well help to inform medical workforce policy for rural and underserved areas.

4.6 References for Chapter 4

Berenson, R. A., P. B. Ginsburg, and N. Kemper. 2010. “Unchecked provider clout in California foreshadows challenges to health reform.” *Health Aff (Millwood)* 29(4): 699-705.

Berenson, R. A., P. B. Ginsburg, and J. H. May. 2007. “Hospital-physicians relations: cooperation, competition, or separation?” *Health Aff (Millwood)* 26(1): w31-43.

Burns, L. R., G. J. Bazzoli, L. Dynan, and D. R. Wholey. 2000. “Impact of HMO market structure on physician-hospital strategic alliances.” *Health Serv Res* 35(1 Pt 1): 101-32.

Burns, L. R. and R. W. Muller. 2008. “Hospital-physician collaboration: landscape of economic integration and impact on clinical integration.” *Milbank Q* 86(3): 375-434.

Casalino, L. and J. C. Robinson. 2003. “Alternative models of hospital-physician affiliation as the United States moves away from tight managed care.” *Milbank Q* 81(2): 331-51, 173-4.

Casalino, L. P., E. A. November, R. A. Berenson, and H. H. Pham. 2008. “Hospital-physician relations: two tracks and the decline of the voluntary medical staff model.” *Health Aff (Millwood)* 27(5): 1305-14.

Chernew, M. E., R. A. Hirth, S. S. Sonnad, R. Ermann, and A. M. Fendrick. 1998. “Managed care, medical technology, and health care cost growth: a review of the evidence.” *Med Care Res Rev* 55(3): 259-88; discussion 89-97.

Chernozhukov, V. and C. Hansen. 2008. “The reduced form: A simple approach to inference with weak instruments.” *Economics Letters* 100(1): 68-71.

Ciliberto, F. and D. Dranove. 2006. “The effect of physician-hospital affiliations on hospital prices in California.” *J Health Econ* 25(1): 29-38.

Connor, R. A., B. E. Dowd, and R. D. Feldman. 1998. “The effects of market concentration and horizontal mergers on hospital costs and prices.” *International Journal of the Economics of Business* 5: 159+.

Cuellar, A. E. and P. J. Gertler. 2006. “Strategic integration of hospitals and physicians.” *J Health Econ* 25(1): 1-28.

Dafny, L. 2009. “Estimation and Identification of Merger Effects: An Application to Hospital Mergers.” *Journal of Law and Economics* 52(3): 523-50.

Gal-Or, E. 1999. “The profitability of vertical mergers between hospitals and physician practices.” *J Health Econ* 18(5): 623-54.

Gaynor, M. 2006. “Is vertical integration anticompetitive? Definitely maybe (but that's not final).” *J Health Econ* 25(1): 175-80.

Gaynor, M. 2011. “Health Industry Consolidation.” *Ways and Means Health Subcommittee.* Washington, D.C.

Gaynor, M., Deborah Haas-Wilson. 1998. “Vertical Relations in Health Care Markets.” In *Managed care & changing health care markets,* edited by M. A. Morrisey, pp. 140-63. Washington, D.C.: AEI Press.

Harris, J. E. 1977. “The Internal Organization of Hospitals: Some Economic Implications.” *The Bell Journal of Economics* 8(2): 467-82.

Nicholson, S. and C. Propper. 2011. “Medical Workforce.” In *Handbook of Health Economics,* edited by T. G. M. Mark V. Pauly and P. B. Pedro, pp. 873-925: Elsevier.

O'Malley, A. S., A. M. Bond, and R. A. Berenson. 2011. “Rising hospital employment of physicians: better quality, higher costs?” *Issue Brief Cent Stud Health Syst Change*(136): 1-4.

Riordan, M. H. 2008. “Competitive Effects of Vertical Integration.” In *Handbook of Antitrust Economics,* edited by P. Buccirossi. Cambridge, MA, USA: MIT Press.

Riordan, M. H. and S. C. Salop. 1995. “Evaluating vertical mergers: a post-Chicago approach.” *Antitrust L.J.* 63(2): 513-68.

Viscusi, W. K., J. E. Harrington, and J. M. Vernon. 2005. *Economics of regulation and antitrust*. Cambridge, Mass.: MIT Press.

Williamson, O. E. 1975. *Markets and hierarchies, analysis and antitrust implications: a study in the economics of internal organization*. New York: Free Press.

Williamson, O. E. 1985. *The economic institutions of capitalism: firms, markets, relational contracting*. New York : London: Free Press ; Collier Macmillan.

Zwanziger, J., G. A. Melnick, and A. Bamezai. 1994. “Costs and price competition in California hospitals, 1980-1990.” *Health Aff (Millwood)* 13(4): 118-26.

Figure 4.1: 2000-2009 Proportions of U.S. hospitals involved in organizational arrangements with physicians. Source: AHA Annual Survey

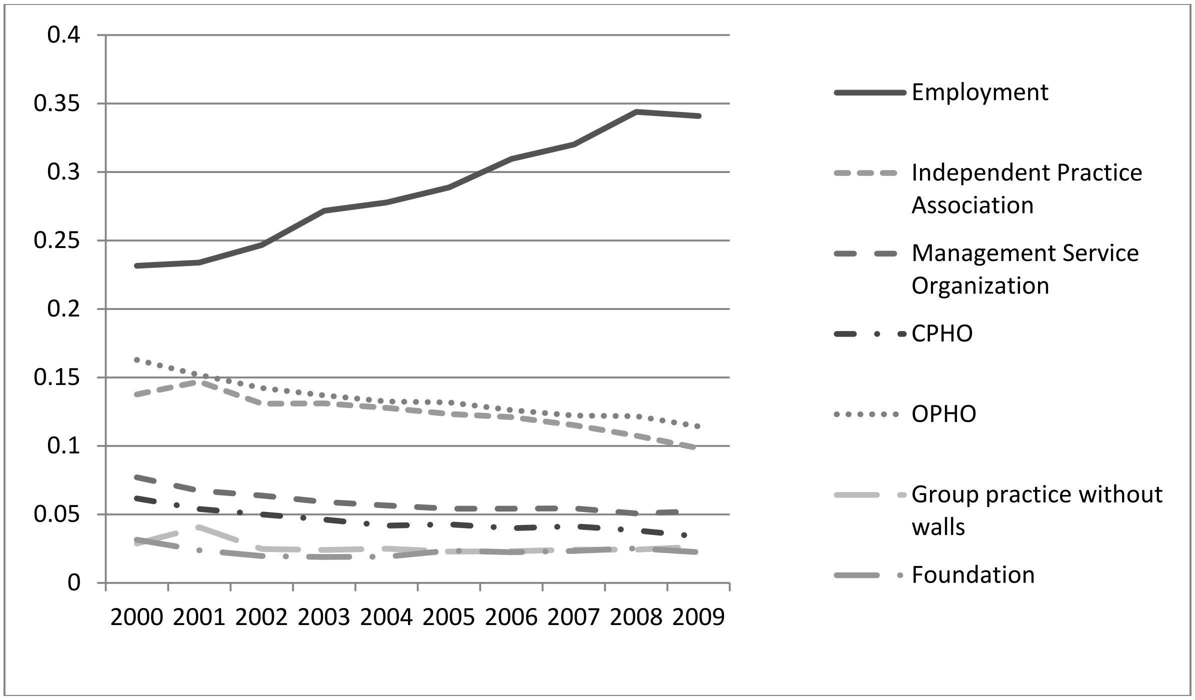

Table 4.1 Descriptive statistics of sample means given for variables in 2009

	All Hospitals	Hospitals with positive physician salary payments
Dependent Variables:		
Average revenue per private pay inpatient ($)	38,278.42	9,678.86
Average routine inpatient cost per discharge ($)	3,633.61	1,958.52
Average inpatient days per discharge	6.11	4.39
Independent Variable:		
Physician salaries paid by hospital per discharge ($)	242.52	709.19
Instrument		
Bound by state laws prohibiting hospital employment of physicians (%)	21.71	10.53
Hospital Characteristics		
Total admissions	7,118.16	12,004.40
Registered nurses per bed	1.39	1.58
Medicaid share of discharges (%)	16.26	19.14
Medicare share of discharges (%)	49.28	45.30
Non-profit (%)	60.70	79.02
For profit (%)	17.77	4.24
Government owned	21.53	16.74
Teaching (%)	7.05	13.33
Number of Managed care contracts	34.61	25.51
Market Characteristics		
Medicare managed care penetration (%)	19.57	21.66
Inpatient HHI by county	5911.80	5,435.89
Inpatient market share by county (%)	52.94	53.41
Median household income by county ($)	47,333.33	49,256.95
Rural county (%)	22.25	9.92
N	3,860	1,320

Table 4.2 Result from naïve OLS regressions of log hospital inpatient average revenue on hospital salary to employed physicians

	Base	Non-rural only	Rural only
Log physician salaries per discharge	-0.0096***	-0.0044*	-0.0317***
	(0.0022)	(0.0023)	(0.0086)
Log of total admissions	-0.182***	-0.159***	-0.281***
	(0.018)	(0.019)	(0.050)
Log of nurses per bed	-0.058	-0.111	0.054
	(0.058)	(0.086)	(0.049)
Log of Medicare discharge proportion	0.011	-0.009	0.130**
	(0.049)	(0.049)	(0.053)
Log of Medicaid discharge proportion	-0.212***	-0.221***	-0.123***
	(0.028)	(0.029)	(0.029)
Log of number of managed care organization (MCO) contracts	0.010	0.034*	-0.019
	(0.016)	(0.017)	(0.035)
For profit	-0.072	-0.042	-0.20
	(0.065)	(0.068)	(0.13)
Government owned	-0.173***	-0.176**	-0.21**
	(0.072)	(0.066)	(0.10)
Teaching hospital	0.720***	0.690***	
	(0.047)	(0.052)	
Market (County) Characteristics			
Log of county HHI	-0.105**	-0.105**	-0.07
	(0.041)	(0.049)	(0.12)
Log of county market share	-0.064*	-0.068	0.046
	(0.037)	(0.044)	(0.054)
Log of median household income	0.35***	0.25**	0.80***
	(0.12)	(0.12)	(0.18)
Log of county Medicare managed care (MMC) penetration	-.057***	-0.097**	-0.019
	.021	(0.047)	(0.015)
Log MMC penetration x Log No. of MCO contracts	0.0141**	0.029*	-0.0014
	(0.0058)	(0.014)	(0.0095)
Rural	-0.18		
	(0.12)		
Number of hospitals observed	3860	3001	859

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.3 Result from the first stage regression of physician salaries scaled by inpatient discharges on state restrictions against hospital employment of physicians

	Base	Non-rural only
Instrument		
Hospital bound by laws prohibiting physician employment	-2.35***	-3.20***
	(0.78)	(0.87)
Log of total admissions	2.17***	2.07***
	(0.26)	(0.31)
Log of nurses per bed	-0.48*	-0.29
	(0.24)	(0.28)
Log of Medicare discharge proportion	0.39***	0.42***
	(0.11)	(0.12)
Log of Medicaid discharge proportion	-0.078	-0.14
	(0.098)	(0.12)
For profit	-4.73***	-4.82***
	(0.54)	(0.62)
Government owned	-0.55	-0.77
	(0.42)	(0.59)
Teaching hospital	0.39	0.29
	(0.65)	(0.62)
Log of number of managed care organization (MCO) contracts	-0.27	-0.30
	(0.18)	(0.24)
Market (County) Characteristics		
Log of county HHI	0.71	0.65
	(0.50)	(0.47)
Log of county market share	-0.23*	-0.20
	(0.14)	(0.15)
Log of median household income	-0.25	0.32
	(0.93)	(1.00)
Log of county Medicare managed care (MMC) penetration	0.18	0.19
	(0.24)	(0.38)
Log MMC penetration x Log No. of MCO contracts	-0.087	-0.08
	(0.093)	(0.13)
Rural	-1.15**	
	(0.50)	
First stage test statistic		
F-test of instrument strength	9.00	13.38
Number of hospitals observed	3860	3001

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.4 Result from IV regressions of log hospital inpatient average revenue on log of hospital employment of physicians

	Base	Non-rural only
Log physician salaries per discharge	0.025	-0.009
	(0.058)	(0.031)
Log of total admissions	-0.26**	-0.149**
	(0.12)	(0.067)
Log of nurses per bed	-0.042	-0.112
	(0.044)	(0.079)
Log of Medicare discharge proportion	-0.002	-0.007
	(0.064)	(0.056)
Log of Medicaid discharge proportion	-0.212***	-0.222***
	(0.027)	(0.028)
Log of number of managed care organization (MCO) contracts	0.022	0.032
	(0.019)	(0.024)
For profit	0.11	-0.07
	(0.29)	(0.15)
Government owned	-0.149**	-0.180***
	(0.060)	(0.059)
Teaching hospital	0.685***	0.695
	(0.058)	(0.044)
Market (County) Characteristics		
Log of county HHI	-0.140*	-0.100
	(0.082)	(0.067)
Log of county market share	-0.055	-0.069
	(0.048)	(0.047)
Log of median household income	0.35***	0.25*
	(0.13)	(0.13)
Log of county Medicare managed care (MMC) penetration	-0.064**	-0.096**
	(0.029)	(0.048)
Log MMC penetration x Log No. of MCO contracts	0.0173*	0.029*
	(0.0091)	(0.015)
Rural	-0.137	
	(0.098)	
First stage test statistic		
F-test of instrument strength	9.00	13.38
Number of hospitals observed	3860	3001

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.5 Result from OLS estimation of the reduced form model of log hospital inpatient average revenue regressed on binding CPM restrictions

	Base	Non-rural only	Rural only
Excluded instrument			
Hospital bound by laws prohibiting physician employment	-0.06	0.03	-0.45**
	(0.12)	(0.10)	(0.18)
Log of total admissions	-0.203***	-0.168***	-0.353***
	(0.016)	(0.018)	(0.044)
Log of nurses per bed	-0.054	-0.109	0.071
	(0.060)	(0.087)	(0.045)
Log of Medicare discharge proportion	0.007	-0.011	0.134**
	(0.050)	(0.049)	(0.052)
Log of Medicaid discharge proportion	-0.214***	-0.220***	-0.131***
	(0.032)	(0.031)	(0.033)
Log of number of managed care organization (MCO) contracts	0.015	-0.097*	-0.003
	(0.014)	(0.047)	(0.034)
For profit	-0.009	-0.024	-0.05
	(0.053)	(0.066)	(0.15)
Government owned	-0.163**	-0.173**	-0.166**
	(0.066)	(0.066)	(0.063)
Teaching hospital	0.695***	0.692***	
	(0.044)	(0.043)	
Market (County) Characteristics			
Log of county HHI	-0.122**	-0.106*	-0.05
	(0.053)	(0.054)	(0.11)
Log of county market share	-0.061	-0.067	0.038
	(0.039)	(0.044)	(0.053)
Log of median household income	0.34**	0.25*	0.82***
	(0.14)	(0.13)	(0.23)
Log of county Medicare managed care (MMC) penetration	-0.059**	-0.097**	-0.020
	(0.023)	(0.047)	(0.017)
Log MMC penetration x Log No. of MCO contracts	0.0151**	0.029**	-0.000
	(0.0059)	(0.014)	(0.011)
Rural	-0.17		
	(0.12)		
Number of hospitals observed	3860	3001	859

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.6 Result from naïve OLS regressions of log hospital routine inpatient costs on log of hospital salary to employed physicians

	Base	Non-rural only	Rural only
Log physician salaries per discharge	0.0003	0.0006	0.0010
	(0.0016)	(0.0019)	(0.0026)
Log of total admissions	-0.236***	-0.187***	-0.477***
	(0.017)	(0.015)	(0.050)
Log of nurses per bed	0.003	0.014	0.057
	(0.032)	(0.052)	(0.038)
Log of Medicare discharge proportion	-0.055**	-0.058*	-0.124**
	(0.027)	(0.031)	(0.055)
Log of Medicaid discharge proportion	-0.086***	-0.091***	-0.015
	(0.015)	(0.019)	(0.015)
Log of number of managed care organization (MCO) contracts	0.036***	0.021	0.020
	(0.013)	(0.013)	(0.024)
For profit	-0.294***	-0.284***	-0.231***
	(0.038)	(0.047)	(0.085)
Government owned	0.009	0.004	-0.045
	(0.026)	(0.032)	(0.030)
Teaching hospital	0.495***	0.427***	
	(0.045)	(0.044)	
Market (County) Characteristics			
Log of county HHI	-0.122***	-0.077*	-0.002
	(0.042)	(0.046)	(0.074)
Log of county market share	-0.048	-0.073*	-0.043
	(0.033)	(0.037)	(0.043)
Log of median household income	0.395***	0.316***	0.61***
	(0.086)	(0.087)	(0.11)
Log of county Medicare managed care (MMC) penetration	-0.033**	-0.001	-0.010
	(0.015)	(0.026)	(0.018)
Log MMC penetration x Log No. of MCO contracts	0.0203***	0.0147*	0.0104
	(0.0047)	(0.0085)	(0.0076)
Rural	-0.152**		
	(0.058)		
Number of hospitals observed	3860	3001	859

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.7 Result from IV regressions of log hospital routine inpatient costs on log of hospital salary to employed physicians

	Base	Non-rural only
Log physician salaries per discharge	-0.009	-0.015
	(0.033)	(0.025)
Log of total admissions	-0.214**	-0.152**
	(0.084)	(0.063)
Log of nurses per bed	-0.002	0.009
	(0.027)	(0.045)
Log of Medicare discharge proportion	-0.051	-0.051
	(0.035)	(0.038)
Log of Medicaid discharge proportion	-0.086***	-0.091***
	(0.014)	(0.019)
Log of number of managed care organization (MCO) contracts	0.033*	0.014
	(0.017)	(0.018)
For profit	-0.35**	-0.37***
	(0.16)	(0.11)
Government owned	0.003	-0.010
	(0.030)	(0.033)
Teaching hospital	0.504***	0.443***
	(0.040)	(0.039)
Market (County) Characteristics		
Log of county HHI	-0.112*	-0.060
	(0.059)	(0.060)
Log of county market share	-0.050	-0.077*
	(0.036)	(0.040)
Log of median household income	0.394***	0.325***
	(0.080)	(0.088)
Log of county Medicare managed care (MMC) penetration	-0.031**	0.003
	(0.016)	(0.026)
Log MMC penetration x Log No. of MCO contracts	0.0194***	0.0130
	(0.0058)	(0.0097)
Rural	-0.162***	
	(0.048)	
First stage test statistic		
F-test of instrument strength	9.31	13.49
Number of hospitals observed	3860	3001

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.8 Result from OLS estimation of the reduced form model of log hospital routine inpatient costs regressed on binding CPM restrictions

	Base	Non-rural only	Rural only
Excluded instrument			
Hospital bound by laws prohibiting physician employment	0.022 (0.085)	0.049 (0.088)	-0.070 (0.061)
Log of total admissions	-0.235*** (0.017)	-0.185*** (0.014)	-0.474*** (0.053)
Log of nurses per bed	0.003 (0.032)	0.014 (0.051)	0.055 (0.038)
Log of Medicare discharge proportion	-0.055** (0.027)	-0.058* (0.030)	-0.122** (0.055)
Log of Medicaid discharge proportion	-0.085*** (0.016)	-0.089*** (0.021)	-0.015 (0.015)
Log of number of managed care organization (MCO) contracts	0.035*** (0.012)	0.019 (0.013)	0.022 (0.024)
For profit	-0.300*** (0.034)	-0.298*** (0.045)	-0.224** (0.092)
Government owned	0.008 (0.025)	0.001 (0.032)	-0.040 (0.031)
Teaching hospital	0.501*** (0.038)	0.440*** (0.038)	
Market (County) Characteristics			
Log of county HHI	-0.119** (0.046)	-0.070 (0.048)	-0.004 (0.074)
Log of county market share	-0.048 (0.033)	-0.074* (0.037)	-0.045 (0.043)
Log of median household income	0.397*** (0.092)	0.322*** (0.090)	0.59*** (0.11)
Log of county Medicare managed care (MMC) penetration	-0.033** (0.015)	0.000 (0.026)	-0.010 (0.018)
Log MMC penetration x Log No. of MCO contracts	0.0203*** (0.0046)	0.0143 (0.0087)	0.0106 (0.0075)
Rural	-0.152** (0.058)		
Number of hospitals observed	3860	3001	859

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.9 Result from naïve OLS regressions of log hospital inpatient days per admission on log of hospital salary to employed physicians

	Base	Non-rural only	Rural only
Log physician salaries per discharge	-0.0060***	-0.0057***	-0.0048*
	(0.0016)	(0.0014)	(0.0027)
Log of total admissions	0.073***	0.097***	-0.059
	(0.024)	(0.024)	(0.061)
Log of nurses per bed	-0.263***	-0.306***	-0.128**
	(0.054)	(0.076)	(0.049)
Log of Medicare discharge proportion	-0.008	-0.009	-0.064
	(0.016)	(0.017)	(0.053)
Log of Medicaid discharge proportion	-0.103***	-0.105***	-0.059
	(0.015)	(0.017)	(0.036)
Log of number of managed care	0.007	0.002	0.015
organization (MCO) contracts	(0.013)	(0.017)	(0.026)
For profit	-0.071	-0.066	-0.16
	(0.068)	(0.071)	(0.10)
Government owned	-0.031	-0.047	-0.033
	(0.031)	(0.029)	(0.056)
Teaching hospital	0.240***	0.231***	
	(0.027)	(0.033)	
Market (County) Characteristics			
Log of county HHI	0.061**	0.074*	0.10
	(0.029)	(0.040)	(0.10)
Log of county market share	-0.125***	-0.132***	-0.094
	(0.027)	(0.036)	(0.079)
Log of median household income	-0.088*	-0.121**	-0.01
	(0.049)	(0.046)	(0.12)
Log of county Medicare managed care	-0.042***	-0.034	-0.041**
(MMC) penetration	(0.015)	(0.025)	(0.017)
Log MMC penetration x Log No. of	0.0103*	0.0080	0.0114
MCO contracts	(0.0055)	(0.0077)	(0.0090)
Rural	-0.050		
	(0.058)		
Number of hospitals observed	3860	3001	859

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.10 Result from IV regressions of log hospital inpatient days per admission on log of hospital salary to employed physicians

	Base	Non-rural only
Endogenous variable		
Log physician salaries per discharge	0.021*	0.0077
	(0.011)	(0.0079)
Hospital characteristics		
Log of total admissions	0.013	0.0686535
	(0.042)	(0.036)
Log of nurses per bed	-0.250***	-0.302***
	(0.054)	(0.077)
Log of Medicare discharge proportion	-0.019	-0.015
	(0.017)	(0.017)
Log of Medicaid discharge proportion	-0.103***	-0.105***
	(0.014)	(0.016)
Log of number of managed care organization (MCO) contracts	0.017	0.008
	(0.012)	(0.017)
For profit	0.071	0.008
	(0.081)	(0.089)
Government owned	-0.012	-0.035
	(0.033)	(0.033)
Teaching hospital	0.213***	0.216***
	(0.029)	(0.029)
Market (County) Characteristics		
Log of county HHI	0.033	0.059
	(0.033)	(0.039)
Log of county market share	-0.119***	-0.128***
	(0.028)	(0.035)
Log of median household income	-0.090	-0.130***
	(0.056)	(0.046)
Log of county Medicare managed care (MMC) penetration	-0.047***	-0.038
	(0.016)	(0.026)
Log MMC penetration x Log No. of MCO contracts	0.0128**	0.0092
	(0.0057)	(0.0076)
Rural	-0.019	
	(0.062)	
First stage test statistic		
F-test of instrument strength	9.00	13.38
Number of hospitals observed	3860	3001

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.11 Result from OLS estimation of the reduced form model of log hospital inpatient days per admission regressed on binding CPM restrictions

	Base	Non-rural only	Rural only
Excluded instrument			
Hospital bound by laws prohibiting physician employment	-0.050**	-0.025	-0.150***
	(0.019)	(0.023)	(0.033)
Log of total admissions	0.059**	0.085***	-0.070
	(0.022)	(0.023)	(0.056)
Log of nurses per bed	-0.260***	-0.304***	-0.127**
	(0.054)	(0.077)	(0.048)
Log of Medicare discharge proportion	-0.011	-0.012	-0.062
	(0.016)	(0.017)	(0.053)
Log of Medicaid discharge proportion	-0.104***	-0.106***	-0.061*
	(0.015)	(0.017)	(0.036)
Log of number of managed care organization (MCO) contracts	0.011	0.005	0.021
	(0.013)	(0.017)	(0.026)
For profit	-0.029	0.029	-0.123
	(0.059)	(0.065)	(0.090)
Government owned	-0.024	-0.041	-0.020
	(0.030)	(0.029)	(0.054)
Teaching hospital	0.221***	0.219***	
	(0.025)	(0.030)	
Market (County) Characteristics			
Log of county HHI	0.048	0.064	0.10
	(0.030)	(0.040)	(0.10)
Log of county market share	-0.124***	-0.130***	-0.098
	(0.028)	(0.036)	(0.081)
Log of median household income	-0.095*	-0.128***	-0.02
	(0.050)	(0.046)	(0.12)
Log of county Medicare managed care (MMC) penetration	-0.043***	-0.036	-0.041**
	(0.015)	(0.026)	(0.018)
Log MMC penetration x Log No. of MCO contracts	0.0110*	0.0086	0.0117
	(0.0055)	(0.0077)	(0.0092)
Rural	-0.044		
	(0.059)		
Number of hospitals observed	3860	3001	859

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.12 Result from naïve OLS regressions of log inpatient discharges on log of hospital salary to employed physicians

	Base	Non-rural only	Rural only
Log physician salaries per discharge	0.0075***	0.0050***	0.0153**
	(0.0013)	(0.0012)	(0.0062)
Log of total beds	0.996***	1.013***	0.896***
	(0.025)	(0.025)	(0.066)
Log of nurses per bed	0.787***	0.723***	0.884***
	(0.044)	(0.039)	(0.072)
Log of Medicare discharge proportion	0.062	0.072*	-0.071*
	(0.038)	(0.042)	(0.042)
Log of Medicaid discharge proportion	0.077***	0.068***	0.162***
	(0.014)	(0.018)	(0.024)
Log of number of managed care organization (MCO) contracts	0.005	0.018	0.011
	(0.016)	(0.017)	(0.031)
For profit	0.318	0.266***	0.452***
	(0.033)	(0.028)	(0.095)
Government owned	-0.141***	-0.151***	-0.098*
	(0.030)	(0.032)	(0.055)
Teaching hospital	-0.202***	-0.174	
	(0.047)	(0.049)	
Market (County) Characteristics			
Log of county HHI	-0.256***	-0.259***	-0.32***
	(0.036)	(0.038)	(0.11)
Log of county market share	0.154***	0.157***	0.269***
	(0.026)	(0.028)	(0.060)
Log of median household income	-0.075	0.030	-0.53***
	(0.076)	(0.067)	(0.17)
Log of county Medicare managed care (MMC) penetration	0.038	-0.006	0.026
	(0.027)	(0.033)	(0.025)
Log MMC penetration x Log No. of MCO contracts	-0.0104*	-0.0027	-0.0074
	(0.0052)	(0.0096)	(0.0088)
Rural	-0.266***		
	(0.046)		
Number of hospitals observed	3860	3001	859

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.13 Result from IV regressions of log inpatient discharges on log of hospital salary to employed physicians

	Base	Non-rural only
Endogenous variable		
Log physician salaries per discharge	-0.039	-0.003
	(0.040)	(0.014)
Hospital characteristics		
Log of total beds	1.12***	1.036***
	(0.10)	(0.038)
Log of nurses per bed	0.855***	0.734***
	(0.072)	(0.043)
Log of Medicare discharge proportion	0.089	0.078
	(0.059)	(0.048)
Log of Medicaid discharge proportion	0.083***	0.069
	(0.017)	(0.018)
Log of number of managed care	-0.012	0.015
organization (MCO) contracts	(0.019)	(0.018)
For profit	0.11	0.224***
	(0.18)	(0.064)
Government owned	-0.184***	-0.161***
	(0.051)	(0.039)
Teaching hospital	-0.203**	-0.173***
	(0.081)	(0.054)
Market (County) Characteristics		
Log of county HHI	-0.218***	-0.251***
	(0.052)	(0.041)
Log of county market share	0.150***	0.156***
	(0.029)	(0.029)
Log of median household income	-0.085	0.035
	(0.095)	(0.068)
Log of county Medicare managed care	0.050	-0.0047
(MMC) penetration	(0.033)	(0.034)
Log MMC penetration x Log No. of	-0.0163*	-0.004
MCO contracts	(0.0086)	(0.010)
Rural	-0.321***	
	(0.068)	
First stage test statistic		
F-test of instrument strength	6.04	12.36
Number of hospitals observed	3860	3001

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Table 4.14 Result from OLS estimation of the reduced form model of log inpatient discharges regressed on binding CPM restrictions

	Base	Non-rural only	Rural only
Excluded instrument			
Hospital bound by laws prohibiting physician employment	0.082	0.011	0.36***
	(0.061)	(0.042)	(0.10)
Log of total beds	1.019***	1.027***	0.986***
	(0.022)	(0.026)	(0.075)
Log of nurses per bed	0.800***	0.730***	0.937***
	(0.044)	(0.039)	(0.076)
Log of Medicare discharge proportion	0.067*	0.076*	-0.063
	(0.040)	(0.042)	(0.039)
Log of Medicaid discharge proportion	0.080***	0.069***	0.161***
	(0.016)	(0.019)	(0.027)
Log of number of managed care organization (MCO) contracts	-0.000	0.016	0.000
	(0.014)	(0.017)	(0.026)
For profit	0.265***	0.239***	0.374***
	(0.030)	(0.026)	(0.098)
Government owned	-0.153***	-0.157***	-0.121**
	(0.033)	(0.033)	(0.054)
Teaching hospital	-0.183***	-0.171***	
	(0.062)	(0.057)	
Market (County) Characteristics			
Log of county HHI	-0.238***	-0.253***	-0.32***
	(0.039)	(0.039)	(0.10)
Log of county market share	0.152***	0.157***	0.272***
	(0.027)	(0.029)	(0.059)
Log of median household income	-0.067	0.034	-0.55***
	(0.079)	(0.068)	(0.16)
Log of county Medicare managed care (MMC) penetration	0.040	-0.005	0.025
	(0.026)	(0.033)	(0.023)
Log MMC penetration x Log No. of MCO contracts	-0.0116**	-0.0033	-0.0079
	(0.0051)	(0.0097)	(0.0086)
Rural	-0.273***		
	(0.050)		
Number of hospitals observed	3860	3001	859

Notes: Standard errors are reported in parentheses and are clustered by state. * Statistically significant at the 10% level. ** Statistically significant at the 5% level. *** Statistically significant at the 1% level.

Chapter 5

Conclusion: A summary of the findings and implications for future research

The findings described in the preceding chapters provide some reasons for optimism about recently enacted policies to motivate adoption of health IT and spur greater coordination among previously unaffiliated providers. Chapter 2 presents evidence that direct employment of physicians by hospitals, which has been growing in prevalence recently, may promote adoption of health IT by these hospitals. To the extent that health IT has the significant quality-enhancing or cost-containing properties its proponents hope for, integration may contribute to social welfare in this regard by overcoming the barriers to implementation that are otherwise endemic in a fragmented delivery system. While I have found evidence consistent with a hypothesized complementary relationship between hospital-physician integration and health IT, future research should try to determine the relative value of health IT, in terms of quality, outcomes and costs of care, in integrated versus non-integrated health systems.

While providing substantial arguments in support of the efficiency-enhancing qualities of vertical integration in general, economic theory also provides some reasons for concern as vertical mergers may, under conditions of pre-existing market power, harm competition. The findings presented in Chapter 4 that hospital-physician integration does not increase average private revenue, provides evidence against an anti-competitive effect attributable to integration. Furthermore, the findings of a negative effect of binding CPM laws on average private revenue and a negative effect of CPM on average inpatient days among rural hospitals suggests that integration may induce more intensive inpatient services in these hospitals. And the finding of a positive effect of CPM laws on inpatient volume in rural hospitals suggests that integration produces lower inpatient admissions in these hospitals. These results suggest that further examination of the effects of hospital-physician integration in rural areas and areas with fewer physicians per capita could be a fruitful line of new research. For example, do hospitals in rural areas with an employed physician staff offer more or substantially different services relative to hospitals in similar regions without employed physicians? Does more intensive service provision to patients in rural hospital positively impact their health and well-being? Answers to these questions could inform policies aimed at workforce supply in rural and underserved regions.

In Chapter 3, I find a significant positive effect of standalone information systems and a significant negative effect of interoperable health IT on repeat diagnostic procedures, including CT scans—a significant source of patient exposure to ionizing radiation—among patients visiting multiple EDs within a thirty day period. These findings provide evidence of a welfare improvement for patients from provider adoption of interoperable health IT. However, the findings should be interpreted cautiously, as I do not perform an analysis that takes into account the costs of adopting health IT and participating in HIE or the costs to tax-payers of subsidizing these activities. While the ED is an important setting of care in which to study effects of health IT, it is also a setting with idiosyncratic features that may make it particularly likely to enjoy efficiency and patient safety benefits from health IT adoption. Future research should try to determine if the results reported here are generalizable to other settings of care. The special legal obligations of EDs to serve all patients regardless of ability to pay may also make it a setting that is especially cost-sensitive and therefore likely to make better use of the information exchange capabilities of health IT. While I do not find any difference in the effect of health IT and HIE on uninsured patients relative to the insured, EDs may not be able to discriminate at the patient level in their use of health IT and their response to patient data obtained through HIE. However, it is interesting that sharing of patient data among EDs does seem to produce a negative effect on imaging even among insured patients, since ED services are typically reimbursed on a fee for service basis. This suggests that clinicians' ethical inhibitions against unnecessary testing, combined with ready access to prior results, may counteract any financial incentives towards redundant services in EDs.

Furthermore, the effect of health IT on diagnostic imaging may have implications for use of other resources. A question that readily follows is whether health IT use in the ED influences subsequent admission of patients to the hospital since these inpatient cases will incur much greater costs than those who are discharged from the ED without an inpatient stay.

Appendix A

Corporate Practice of Medicine Doctrine: Hospital Employment of Physicians
50 State Survey

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Disclaimer

This 50 state survey of the corporate practice of medicine ("CPOM") doctrine is for general informational purposes only. The author, Jack Albers, hopes that the survey will be helpful as background material, but he cannot make any warranties as to the content. Circumstances may have changed after the author initially researched the topics covered, and circumstances may change in the future. The CPOM doctrine in many states is unresolved, ambiguous, or contradictory; thus, the survey is by necessity general in nature, and it may not apply to particular factual or legal circumstances. In any event, the survey does not constitute legal advice and should not be relied on as such. Any attorneys and law firms who may have assisted with the survey render legal advice only after compliance with certain procedures for accepting clients and when it is legally and ethically permissible to do so. Readers seeking to act upon any of the information contained in this survey are urged to seek their own legal advice.

Introduction

This survey addresses a particular aspect of the corporate practice of medicine doctrine: whether hospitals in a state are permitted to employ physicians. Before reading the survey, please note a few preliminary issues:

- "Hospitals" means a healthcare facility that provides 24-hour in-patient care. This memo does not address outpatient clinics. This memo indicates when state law has different rules for non-profit vs. for-profit hospitals.

- "Employ" is defined as full employment. If this memo states that a jurisdiction allows the employment of physicians, then unless otherwise noted the hospital may hire the physician as a full-time employee.

- In nearly every state it appears to be legal for hospitals to employ doctors-in-training, such as medical residents. This memo does not address that issue.

- In every state in the U.S. it is legal for professional service corporations and HMOs (and usually professional LLCs) to employ physicians. This memo excludes these entities, addressing only hospitals.

- Most states restrict the ability of non-physician entities, such as hospitals, from controlling the professional medical judgment of physicians. This memo only mentions such rules when they are tied directly to the jurisdiction's CPOM law.

To use this survey, refer first to the "key" below. This explains how the various state laws are categorized.

Key

Symbol	Meaning
"Y" / "Y limited"	The law in the jurisdiction affirmatively allows all ("Y") or some ("Y limited)" hospitals to employ physicians. Some jurisdictions require hospitals to meet additional requirements to employ physicians.
"Y tolerated"	No legally binding law in the jurisdiction affirmatively allows hospitals to employ physicians, but it is tolerated in practice due to either: (1) a complete lack of law on the subject, (2) an opinion by non-binding legal authority, (3) an informal indication of non-enforcement of CPOM laws, or (4) an established practice. There are no signs that this situation will change in the near future.
"N"	"No," hospitals may not employ physicians. The law in the jurisdiction affirmatively bans all hospitals from employing physicians.

Figure A.1 Summary

State	May Hospitals Employ Physicians?	Which hospitals may employ physicians?	Which hospitals may NEVER employ physicians?
CA	Y limited	• State and county hospitals • State university medical school hospitals • Nonprofit university medical school hospitals • Hospitals providing free services • Local health care district hospitals (pilot program ended)	
MA	Y tolerated	• All	
TX	Y limited	• Only two very specific types of nonprofit hospitals: (1) nonprofit public interest health organizations, and (2) nonprofit federally-recognized migrant, community, or homeless health centers.	• For-profit hospitals
ID	Y tolerated	• All	
SC	Y tolerated	• Public hospitals • "Charitable" hospitals (unclear definition)	
ND	Y	• All	
SD	Y	• All, so long as: (1) the employment relationship does NOT affect the physician's independent judgment or result in increased patient fees; and (2) so long as the employment contract is for no longer than 3 years (then it can be renewed).	
WA	N	• None	
DC	Y limited	• Nonprofit hospitals	• For-profit hospitals
MI	Y limited	• Nonprofit hospitals • County hospitals	• For-profit hospitals
MN	Y tolerated	• All	
NV	Y tolerated	• Nonprofit hospitals	• For-profit hospitals
NC	Y tolerated	• Nonprofit hospitals • Public hospitals	• For-profit hospitals
WV	Y	• Any hospital, if it "in large measure" meets the following criteria:	

		(1) Structure of arrangement provides or attempts to provide a benefit to the public in terms of enhancing the quality and accessibility of care and in decreasing the cost of health care (2) Corporate structure permits physician autonomy in medical decision-making (3) Corporate structure limits the likelihood that non-physician shareholders may be construed to be making medical judgments, and corporate bylaws provide protection for independent medical judgments by physicians (4) Corporate structure is non-profit (5) Shareholder agreements exist which protect physicians from suits for breach of fiduciary duties where decisions are made by them in the best interests of medicine which may erode the profitability of the corporation	
WI	Y	• Any hospital, if the employment contract meets 3 statutory requirements: (1) Makes physician a member of, or subject to approval by, the hospital medical staff (2) Prevents supervision of or interference with physician's professional judgment (3) Establishes physician's remuneration	
OH	Y limited[1]	• Nonprofit and public hospitals that are located in rural districts, as defined by statute • Teaching hospitals may employ faculty physicians	
PA	Y	• All	
IL	Y	• Any hospital, so long as 4 rules are met: (1) If the hospital/affiliate has a medical staff, then the physician must be a member of the staff.	

[1] Note that despite the seemingly clear law that only the listed Ohio hospitals may employ physicians, some attorneys indicate that in practice a wide range of hospitals ignore Ohio's CPOM law and employ physicians.

		(2) The quality of the medical services of the employed physician must periodically be reviewed by "independent" physicians who are not employed. (3) The hospital/affiliate and the physician must both sign a statement that the hospital/affiliate will not unreasonably control or interfere with the physician's exercise of medical judgment. (4) The hospital/affiliate and physician establish and agree to an independent review process by which the physician can seek review of alleged violations of these requirements.	
AZ	Y tolerated	• All	
FL	Y	• All	
GA	Y tolerated	• All	
AL	Y tolerated	• All	
AK	Y tolerated	• All	
AR	N	• None	
CO	Y	• All, so long as 4 rules are met: (1) Hospitals may not limit or control physicians' medical decisions. (2) No fee-splitting between hospitals and physicians (3) Hospitals cannot discriminate, with regard to staff privileges, between physicians who are employees of the hospitals and those who are not. (4) Hospitals must give a yearly report of the number of physicians employed	
CT	Y tolerated	• All	
DE	Y tolerated	• All	
HI	Y tolerated	• All	
IN	Y	• All, provided that the hospital does not direct or control independent medical acts, decisions, or judgment of licensed physicians.	
IA	Y	• All, provided that the employing entity does not interfere with the physician's independent medical judgment.	
KS	Y	• All	
KY	Y	• All	
LA	Y	• All, so long as the following rules are met:	

		(1) The employment relationship is structured to shield the physician's relationship with patients and his exercise of independent medical judgment from corporate intrusion, (2) Employment termination and ownership of and access to records provisions are shaped to provide for continuity of patient care and to ensure continuing patient freedom of choice, and (3) Patient confidentiality and personal professional accountability are safeguarded.	
ME	Y tolerated	• All	
MD	Y	• All	
MS	Y	• All, provided that the hospital meet requirements set out by the Board of Medical Licensure.	
MO	Y	• All	
MT	Y tolerated	• All	
NE	Y	• All	
NH	Y tolerated	• All	
NJ	Y	• All	
NM	Y	• All	
NY	Y	• All	
OK	Y	• All	
OR	Y tolerated	• All	
RI	Y tolerated	• All	
TN	Y	• All except 4 specialties (listed to the right), so long as the hospital does not interfere with medically appropriate diagnostic or treatment decisions and only restricts physician referrals in limited circumstances.	Radiologists, anesthesiologists, pathologists, emergency physicians (EXCEPT that research hospitals may employ them)
UT	Y	• All	
VT	Y tolerated	• All	
VA	Y	• All	
WY	Y	• All, provided that the hospital does not have too much control over the physician.	

Full Memo

Alabama

Rule: Hospital employment of physicians is explicitly tolerated in Alabama. Although there have been no recent statements of binding law on the issue, the Alabama Attorney General,[2] the Alabama Medical Licensure Commission, and the Alabama Board of Medical Examiners[3] all agree that for-profit and non-profit corporations may employ physicians, as long as the corporation does not control the physicians' medical judgment.

Alaska

Rule: Hospital employment of physicians is not banned in Alaska. The state offers no legal guidance on the corporate practice of medicine ("CPOM") doctrine.

Arizona

Rule: Hospital employment of physicians is tolerated in Arizona. In 2008 a state appeals court strongly indicated (although it did not hold as a matter of binding law) that hospitals may employ physicians.[4] Evidence suggests this has been the informally-accepted practice for many years, despite two old cases that held CPOM to be the law in Arizona. [5]

Summary of the 2008 case:

- The express holding of this case allowed **outpatient treatment centers** (1) to be wholly owned by non-physician entities, including corporations, and (2) to employ physicians.

- However, the court's reasoning almost inevitably extends the same rules to hospitals.

[2] Opinion of the Attorney General of Alabama, No. 2001-089 (Feb. 1, 2001) ["We note that many hospitals in Alabama are owned and operated by for-profit business corporations"].
[3] See joint declaratory ruling by the Alabama Board of Medical Examiners (Oct. 21, 1992) and the Alabama Medical Licensure Commission (Oct. 28, 1992), and declaratory ruling by the Medical Licensure Commission (Nov. 6, 1995).
[4] See Midtown Med. Group, Inc. v. State Farm Mut. Auto. Ins. Co., 220 Ariz. 341 (Ariz. Ct. App. 2008).
[5] See Funk Jewelry Co. v. State ex rel. La Prade, 46 Ariz. 348, 50 P.2d 945 (1935); State Ex. Rel. Board of Optometry v. Sears Roebuck & Co., 102 Ariz. 175, 427 P2d. 126 (1967).

- The court held that corporations and other entities may apply for licenses to become "health care institutions," a term which includes by definition outpatient treatment centers, **hospitals**, and other types of healthcare facilities.[6]

- The court also held that physician licensing statutes do not prevent corporations and other lay-controlled business from employing physicians.[7]

- The court discussed the prior CPOM cases at length. It did not overturn these cases (as it does not have the authority to do so, being an appeals court),[8] but it discussed numerous reasons why these cases were inapplicable and did not prevent physicians from being employed by health care institutions. Below are a few of these reasons:

  - In the prior cases, the licensing authorities had been of the opinion that corporations may not employ licensed practitioners. Today, however, the licensing authorities were on the side of the corporations – the party pushing to invalidate the employment arrangement was an insurance company that was trying to avoid reimbursement payments.[9]

  - The statutory framework governing health care institutions is completely different today than it was when the prior cases were decided. Now, for example, applicable statutes provide that corporations, in operating health care institutions, may provide medical services "by physician."[10]

Arkansas

Rule: hospitals may not employ physicians.

No recent cases or statutes address CPOM in Arkansas, but an AG opinion stated that the CPOM doctrine allows only three categories of entities to employ physicians.[11] Hospitals are not listed as one of these exceptions.

Note that there is an exception for "hospital service corporations," which are nonprofit organizations regulated as a type of insurance provider. These entities may hire

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[6] Midtown Med. Group, Inc. v. State Farm Mut. Auto. Ins. Co., 220 Ariz. 341, 343-44, 206 P.3d 790, 792-93 (Ariz. Ct. App. 2008) [citing Arizona Administrative Code R9-10-101(39), R9-10-102(A)(16), R9-10-101(43), and Arizona Revised Statutes § 1-215(29) (Supp. 2008)].
[7] Midtown Med. Group, Inc. v. State Farm Mut. Auto. Ins. Co., 220 Ariz. 341, 347-48, 206 P.3d 790, 796-97 (Ariz. Ct. App. 2008).
[8] Idem.
[9] Idem.
[10] Id [citing A.R.S. § 36-401(A)(28)].
[11] Attorney General of Arkansas, No. 94-204 (Aug. 17, 1994).

physicians as independent contractors, but not as employees.[12] Hospital service corporations are defined as:

> … corporations organized under the laws of this state for the purpose of establishing, maintaining, and operating nonprofit hospital service or medical service plans, or combination of plans, whereby hospital, medical, and related services may be provided by hospitals, physicians, or others with which the corporations have contracted for the purposes, to such of the public as become subscribers to the corporations under contracts which entitle each subscriber to certain hospital or medical services or benefits, or both.[13]

Note that this survey does not address whether Arkansas hospitals may hold ownership interests in hospital service corporations.

California

California Business and Professions Code section 2400 (1980) (hereafter "Bus & Prof Code") lays out the general principle which California courts have interpreted to mean that hospitals may not employ physicians. Other statutory provisions and courts have recognized a number of exceptions or exemptions to the general rule.

General Rule

- In 1980 Cal Bus & Prof Code § 2400 became law, codifying the general rule, taken from a line of court cases, [14] that California hospitals may not employ physicians. This basic rule remains in the same statutory language today, and courts have continued to interpret it to prevent hospitals from employing physicians.

Exceptions (in rough temporal order):

- **Free Services by Licensed Charitable Institutions**: Section 2400 describes the first exception to the general rule. It provides that the Osteopathic Medical Board of California may grant licensed charitable institutions the right to employ physicians on a salary basis, provided that the physicians' services be rendered **free of charge**.

- **Professional medical or podiatry corporations**: Section 2402 provides that professional medical corporations may employ physicians. Note that such

[12] Idem.
[13] Ark. Code § 23-75-101[current through end of 2010 Fiscal Sess.].
[14] The seminal California Supreme Court case is People v. Pacific Health Corp., 12 Cal.2d 156 (1938); see also Conrad v. Med. Bd. of California, 48 Cal. App. 4th 1038 (Cal. Ct. App. 1996).

corporations must meet certain requirements laid out in subsequent sections, including the rule that the shareholders must be physicians.

- **Corporate health care service plans**: Health & Safety Code § 1395, subsection (b), provides that corporate health care service plans enacted pursuant to the Knox-Keene Health Care Service Plan Act of 1975 may employ physicians.
  - **Explanation**: this exception is primarily to allow **HMOs** to employ physicians.

- **Outpatient Clinics**: California Health & Safety Code § 1206, subsection (d), allows outpatient clinics to employ physicians.

- **County Hospitals**: A state appellate court held that county hospitals are exempt from California's corporate practice of medicine laws.[15]

- **Nonprofit university medical school clinics**: Section 2401, subsection (a) provides that public or private nonprofit university medical school clinics "may charge for professional services rendered to teaching patients by licensees [i.e. physicians] who hold academic appointments on the faculty of the university, if the charges are approved by the physician and surgeon in whose name the charges are made."

- **Nonprofit Clinics**: Section 2401, subsection (b) allows nonprofit clinics created pursuant to California Health and Safety Code § 1206, subsection (p), to employ physicians. Note that these clinics are sometimes referred to as "medical foundations."

- **Rationale for excepting the nonprofit university medical school clinics and nonprofit clinics**: These exceptions were enacted primarily to encourage research in new health science technology by small, freestanding, nonprofit research institutes. These appear to be entities separate from hospitals. The legislature found that these small, freestanding, nonprofit research institutes were important in transferring new health science technology to the public, and that they were overly burdened by the ban on hiring physicians.

- **State university medical schools and hospitals**: A state appellate court indicated that state university medical schools and hospitals are exempt from the ban on hospital employment of physicians.[16]

  - **Caveat**: This exception, while widely accepted in California, has not been the core holding of any cases, nor is it embodied in any statute. As one court explained:

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[15] Community Memorial Hospital v. County of Ventura, 49 Cal.App.4th 527 (App. 2 Dist. 1996).
[16] California Med. Ass'n, Inc. v. Regents of Univ. of California, 79 Cal.App.4th 542 (App. 2 Dist. 2000).

> In 1979, the Board of Medical Quality Assurance (the agency then charged with the enforcement of section 2400 et seq.) advised the Legislature that, in the Board's view, the University of California could employ physicians because the University is "exempt from the corporate practice restrictions as [a] unit of government." This view is entitled to great weight [*citation* omitted], and the Legislature's subsequent addition of sections 2400 and 2401 without overturning the exemption are strong evidence of its agreement with the Board's interpretation [*citation omitted*].[17]

In short, there is "strong evidence" that state university medical schools and hospitals should be allowed to employ physicians, and as a matter of practice they do employ physicians, but **this exception is not as firmly established under the law as the other exceptions**. Thus, under California law an argument could be made that university medical schools and hospitals should not be allowed to employ physicians, but it would almost certainly fail.

- **Narcotics treatment programs**: Section 2401, subsection (c) allows narcotics treatment programs established pursuant to section 11876 of California Health and Safety Code § 11876 to employ physicians. This exception explicitly allows the narcotics treatment programs to charge fees for service rendered.

- **Temporary Pilot Program for Local Health Care Districts**:

    - In 1996, a California appellate court[18] held that health care districts established pursuant to The Local Health Care District Law[19] may hire doctors only as *independent contractors*, but not as *employees*.

    - In response, in 2003 the California legislature amended Section 2401 by adding subsection (d), which provides for a temporary pilot program in which health care districts would be permitted to hire physicians as employees, subject to certain requirements.[20]

    - This pilot program **expired as of January 1, 2011**. Thus, as of the time this paper was written, local health care district hospitals were not permitted to employ physicians except as independent contractors.

[17] Id at 553 (Cal. Ct. App. 2000).
[18] Conrad v. Med. Bd. of California, 48 Cal. App. 4th 1038 (Cal. Ct. App. 1996).
[19] California Health and Safety Code § 32000 et al.
[20] Bus. & Prof. Code, Section 2401, subsection (d) (2003).

- However, this exception may be renewed. As of the time of writing, a bill had been introduced before the California State Assembly that would renew and extend The Local Health Care District Law.[21] This bill would extend the basic purpose of the pilot program, with modifications, until December 31, 2022. For more information, and to track the progress of this bill, go to: <www.aroundthecapitol.com/Bills/AB_1360/20112012/>

NOT an Exception

- **Nonprofit corporations**: The California Attorney General issued an opinion that nonprofit corporations are not, as a general proposition, allowed to employ physicians.[22] (However, note that nonprofit corporations falling into one of the exceptions discussed above presumably would be permitted to employ physicians.)

Colorado

Rule: Hospitals may employ physicians, provided that they follow certain rules:

- Hospitals may not limit or control physicians' medical decisions.
- No fee-splitting between hospitals and physicians.
- Hospitals cannot discriminate, with regard to staff privileges, between physicians who are employees of the hospitals and those who are not.
- Hospitals must give a yearly report of the number of physicians employed.[23]

Note, however, that even though hospitals may employ physicians, victims of medical malpractice may not sue hospitals for the negligent acts of physicians.[24]

Connecticut

Rule: Non-profit hospital employment of physicians is tolerated, due to an opinion of the Attorney General of Connecticut which stated that although the practice of medicine and surgery is restricted to individuals and does not include corporations, non-profit charitable hospitals are exempted.[25] (It is not clear how the AG interpreted "charitable" at the time.) The attorney who wrote the Connecticut section of the AHLA 50 State Survey seems quite convinced that CPOM is almost non-existent in the state, and that even for-profit hospitals are also free to employ physicians.[26]

[21] California Assembly Bill No. 1360
[22] 83 Op. Cal. Atty. Gen. 170, fn. 2 (2000); see also California Physicians' Service v. Aoki Diabetes Research Institute, 163 Cal.App.4th 1506 (App. 1 Dist. 2008).
[23] Colorado Revised Statutes § 25-3-103.7 (2011).
[24] Estate of Harper ex rel. Al-Hamim v. Denver Health & Hosp. Auth., 140 P.3d 273 (Colo. Ct. App. 2006).
[25] Opinion of the Attorney General of Connecticut, No. 28-248 (1954).
[26] AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).

Delaware

- **Rule**: Hospital employment of physicians is tolerated; no legal authority explicitly allows it, but a state statute indirectly approves it.

There is no case law, and there are no AG opinions, on CPOM in Delaware. The state does have a statute indicating the CPOM doctrine exists in some form,[27] but there is also another statute suggesting hospitals may employ physicians.[28]

This second statute does not explicitly endorse hospital employment of physicians, but it implies that such a relationship is allowed. It deals with physicians who are exempt from taking the state's professional examination to become licensed physicians. One of these exemptions is for physicians who are "employed" in an accredited hospital or a public hospital or government institution.

Florida

Rule: Hospitals very likely may employ physicians.

Despite a 1955 opinion of the Attorney General of Florida stating that a corporation may not employ physicians to practice medicine,[29] today it appears that Florida hospitals may employ physicians. Similar to Delaware, no legal authority explicitly allows it, but a state statute indirectly approves it. However, the Florida statute provides a stronger endorsement of hospital employment of physicians than its counterpart in Delaware. A relevant section of this statute reads:

> Every hospital or teaching hospital employing or utilizing the services of a resident physician, assistant resident physician, house physician, intern, or fellow in fellowship training registered under this section shall designate a person who shall, on dates designated by the board, in consultation with the department, furnish the department with a list of such hospital's employees and such other information as the board may direct.[30]

And also:

> A person registered as a resident physician under this section may in the normal course of his or her employment prescribe medicinal drugs described in schedules set out in chapter 893 when:

[27] Del. Code tit. 8, § 603 (current through 78 Laws 2011, chs. 1 – 12).
[28] Del. Code tit. 24, § 1722 (Current through 78 Laws 2011, chs. 1 – 12).
[29] Opinion of the Attorney General of Florida, No. 055-71 (Mar. 25, 1955).
[30] Fla. Stat. § 458.345, subsection (3) [effective July 1, 2005; current with chapters in effect from the 2011 First Regular Session of the Twenty-Second Legislature through March 29, 2011].

(a) The person prescribes such medicinal drugs through use of a Drug Enforcement Administration number issued to the hospital or teaching hospital by which the person is employed or at which the person's services are used;

…

See also a case from 1967,[31] although its holding is very narrow and not illustrative of the state of the CPOM doctrine in Florida.

Finally, the attorney who researched the AHLA 50 State Survey indicates that hospitals in Florida employ physicians in practice.[32]

Georgia

Rule: Hospitals very likely may employ physicians.

Up until 1982, the CPOM doctrine was codified in a Georgia statute which banned general business corporations from employing physicians, but the statute contained an explicit exception allowing hospitals to employ physicians. In 1982, however, the entire statutory section was repealed. Since then some courts have suggested that the CPOM framework under the repealed statute may still be in force despite the repeal,[33] but no courts have ruled explicitly on whether hospitals may still employ physicians.

Hawaii

- **Rule**: Hospital employment of physicians is tolerated, due to a lack of law on the subject and an apparent pattern of acceptance.[34]

However, it appears that all of Hawaii's hospitals are currently non-profits.[35] In 2007, for the first time, a non-profit hospital system in Hawaii (St. Francis Healthcare Systems) became for-profit, but it has now reclaimed non-profit status. I can find no evidence to suggest that this hospital system was challenged under the CPOM doctrine while it operated as a for-profit entity.

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[31] Rush v. City of St. Petersburg, 205 So.2d 11 (Fla. 1967).
[32] AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[33] See e.g. Sherrer v. Hale, 248 Ga. 793, 285 S.E.2d 714 (1982); Clower v. Orthalliance, Inc., 337 F. Supp. 2d 1322 (N.D. Ga. 2004).
[34] The AHLA 50 State Survey indicates that hospitals in Florida do employ physicians. See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[35] <http://www.statehealthfacts.org/profileind.jsp?cat=5&sub=68&rgn=13>

Idaho

- **Rule**: Hospital employment of physicians is tolerated, due to an apparent pattern of acceptance.

Although old Idaho case law lays out a CPOM doctrine,[36] less formal evidence suggests that CPOM generally is not enforced in Idaho.[37] Evidence suggests that Idaho hospitals routinely employ physicians, and that the Idaho Board of Medicine only ever invokes CPOM with regard to non-hospital compensation arrangements.[38] In short, Idaho's CPOM doctrine appears to be unenforced.

Illinois

Summary

Rule: Hospitals may employ physicians, subject to certain requirements.[39]

Summary of Requirements:[40]

- If the hospital/affiliate has a medical staff, then the physician must be a member of the staff.

- The quality of the medical services of the employed physician must periodically be reviewed by "independent" physicians who are not employed.

- The hospital/affiliate and the physician must both sign a statement that the hospital/affiliate will not unreasonably control or interfere with the physician's exercise of medical judgment.

- The hospital/affiliate and physician establish and agree to an independent review process by which the physician can seek review of alleged violations of these requirements.

- The statute also extended the right to employ physicians to "hospital affiliates":[41]

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[36] Worlton v. Davis, 249 P.2d 810 (Idaho S.Ct. 1952); see also Idaho Op. Att'y Gen. (May 26, 1954).
[37] "We have been advised by Idaho health law counsel that the corporate practice doctrine generally is not enforced in Idaho." Corporate Practice of Medicine: 50-State Survey, AHLA-PAPERS P06059630 (June 5, 1996).
[38] <http://www.hteh.com/Documents%20and%20Settings/8/Site%20Documents/PDFs/March%20Alert.pdf>
[39] Illinois Statutes Ch. 210, § 85/10.8 (effective Sept. 30, 2001; current through P.A. 96-1555 of the 2010 Reg. Sess.)
[40] Illinois Statutes Ch. 210 § 88/10.8, subsection (a).
[41] Illinois Statutes Ch. 210 § 88/10.8, subsection (b).

> "Hospital affiliate" means a corporation, partnership, joint venture, limited liability company, or similar organization, other than a hospital, that is devoted primarily to the provision, management, or support of health care services and that directly or indirectly controls, is controlled by, or is under common control of the hospital. "Control" means having at least an equal or a majority ownership or membership interest. A hospital affiliate shall be 100% owned or controlled by any combination of hospitals, their parent corporations, or physicians licensed to practice medicine in all its branches in Illinois. "Hospital affiliate" does not include a health maintenance organization regulated under the Health Maintenance Organization Act.

The Supreme Court of Illinois acknowledged and enforced this statute shortly after its passage.[42]

Indiana

- **Rule**: hospitals are exempt from the CPOM doctrine and may employ physicians, provided that the hospital does not direct or control independent medical acts, decisions, or judgment of licensed physicians.

Indiana is one of the rare states which has codified the hospital exemption from the CPOM doctrine. Two statutory sections serve to exempt hospitals from the doctrine,[43] and another explicitly provides that hospitals may employ physicians, provided that the entity does not direct or control independent medical acts, decisions, or judgment of licensed physicians.[44] These statutes became law in 1989. A court case in 1996 acknowledged them.[45]

Iowa

General Rule: Hospitals may employ physicians, provided that the hospital does not "control" the physician's relationship with the patient.[46]

A 1991 opinion by the Iowa Attorney General evaluates case law to determine that a hospital may not control the physician's relationship with the patient.[47] This determination is to be made on a case-by-cases basis by examining the degree to which

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[42] Carter-Shields, M.D. v. Alton Health Inst., 201 Ill. 2d 441, 777 N.E.2d 948 (2002).
[43] Ind. Code Ann. § 25-22.5-1-2(a)(21) & 2(a)(22) [approved May 5, 1989; current through 2011 Public Laws approved and effective through 4/6/2011].
[44] Ind. Code Ann. § 25-22.5-1-2 [approved May 5, 1989; current through 2011 Public Laws approved and effective through 4/6/2011].
[45] Mukhtar v. Castleton Serv. Corp., 920 F. Supp. 934, 941-42 (S.D. Ind. 1996).
[46] Iowa Op. Att'y Gen. No. 91-7-1 (June 12, 1991).
[47] Idem.

the hospital had the right or ability to in effect become the "practitioner." This rule applies equally to both for-profit and non-profit corporations, although the AG opinion suggests that non-profit status may be considered as one factor indicating less control by the hospital (thus making it more likely that the relationship is acceptable). The type of contract at issue – whether an employment or independent contractor contract – is not determinative; more important is a detailed factual review of the hospital's level of control over the physician-patient relationship.

Beyond this meager guidance, it is not clear exactly what "control" means.

Exceptions: There are three groups which may be employed by hospitals:

- **Radiologists and Pathologists**.[48] The AG decision determined that there was essentially no patient-physician relationship which the corporate employer could control, so it was not necessary to apply the CPOM doctrine to radiologists or pathologists.
- **Student Interns**.[49]

Kansas

- **Rule**: hospitals may employ physicians.

In 1994 the Supreme Court of Kansas ruled clearly and conclusively that hospitals, both for-profit and non-profit, may employ physicians as employees or independent contractors.[50] The Supreme Court reaffirmed this decision in 1999.[51]

Kentucky

- **Rule**: hospitals very likely may employ physicians.

A case back in 1938 held that hospitals may employ physicians; unfortunately, it did so based upon the vague distinction that "hospital services" are different from "medical or surgical services."[52] The court did not explain what this means, and no recent authority exists on the matter.

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[48] Idem; see also Iowa Code § 135B.26 (2011).
[49] Christensen v. Des Moines Still Coll. of Osteopathy & Surgery, 248 Iowa 810, 814 (1957) [citing Frost v. Des Moines Still College of Osteopathy and Surgery (1957); Moeller v. Hauser, 237 Minn. 368, 376 (1952); St. Paul-Mercury Indemnity Co. v. St. Joseph's Hosp., 212 Minn. 558 (1942); 41 Am.Jur., Physicians and Surgeons, § 116, page 227; 26 Am.Jur., Hosp. and Asylums, § 14, page 595].
[50] St. Francis Reg'l Med. Ctr., Inc. v. Weiss, 254 Kan. 728, 869 P.2d 606 (1994).
[51] In re Univ. of Kansas Sch. of Med.-Wichita Med. Practice Ass'n from a Decision of Dist. Court of Shawnee County, Kansas, 266 Kan. 737, 762, 973 P.2d 176, 193 (1999).
[52] Johnson v. Stumbo, 277 Ky. 301, 126 S.W.2d 165 (1938).

According to several 50 State Surveys,[53] in 1993 the Kentucky Board of Medical Licensure issued a letter to a physician saying that hospitals may employ physicians (I have been unable to find a copy of this letter). The letter is said to rely on an AMA opinion that was a result of a federal case in which the AMA was ordered to stop issuing rules to enforce CPOM. This case was decided under antitrust law, on the reasoning that the AMA was interfering with physician employment contracts.

Louisiana

Rule: Hospital employment of physicians is not per se a violation of the state's Medical Practice Act, provided that the employment relationship is:

> … structured to shield the physician's relationship with patients and his exercise of independent medical judgment from corporate intrusion, where employment termination and ownership of and access to records provisions are shaped to provide for continuity of patient care and to ensure continuing patient freedom of choice, and where patient confidentiality and personal professional accountability are safeguarded.[54]

This rule is articulated in a statement of position by the Louisiana State Board of Medical Examiners, which has authority to issue regulations under the Medical Practices Act.[55]

Maine

Rule: hospital employment of physicians is tolerated, as indicated by a non-binding opinion letter issued on November 2, 1992 by the state Board of Licensure in Medicine.[56]

There is no binding legal authority on the subject, but the Board of Licensure in Medicine's opinion letter, mentioned above, states that doctors are held to certain personal and professional standards regardless of their work situation. However, in the same letter the Board stated that it has no authority to regulate corporate form matters.

Maine repealed a statute which stated that optometrists could not associate themselves with people or entities in way that allowed an unregistered person or entity to practice medicine.[57]

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[53] AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996); Dobbins, D. Cameron, "Survey of State Laws Relating to the Corporate Practice of Medicine," ABA Health Law Section, HeinOnline 9 Health Law. 21 (1996).
[54] Statement of Position, Louisiana State Board of Medical Examiners (Sept. 24, 1992; reviewed March 21, 2001).
[55] See La. Rev. Stat. Ann. § 37:1271.
[56] See reference in AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).

Finally, the AHLA 50 State Survey indicates Maine's former Health Care Finance Commission would regularly sign off on health care entity structures that involved physician employees.[58]

Maryland

Rule: Hospital employment of physicians is tolerated, as indicated by court cases and unofficial opinions by the Board of Physicians.

No court in Maryland has ruled explicitly on hospital employment of physicians, but some cases have mentioned it without disapproval.[59]

In addition, the AHLA 50 State Survey suggests that the Board of Physicians provides informal opinions to practitioners indicating that CPOM is not an enforcement priority, that no physician has ever been disciplined for being employed by a corporation, and that enforcement is only likely in situations where the employer is interfering with the physician's medical judgment.[60]

Massachusetts

Rule: Hospital employment of physicians is tolerated, as indicated by established practice.

A case from 1937 prevents hospitals from employing physicians.[61] Statutory authority for this decision was based on Massachusetts General Law, chapter 112, section 6. However, a 50-State Survey[62] and a survey by the DHHS[63] and indicate that the state does not enforce its CPOM doctrine to prevent hospitals from employing physicians.

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[57] See 32 Maine Revised Statutes § 2452 (repealed); Small v. Maine Bd. of Registration & Examination in Optometry, 293 A.2d 786, 789 (Me. 1972) [this case took place before the creation of the Board of Licensure in Medicine].

[58] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996); see e.g. Osteopathic Hospital of Maine, Health Care Finance Commission, Case No. 89-133 (January 19, 1990); Maine Medical Center, Health Care Finance Commission, Case No. 88-89 (August 19, 1988).

[59] See e.g. Dvorine v. Castleberg Jewelry Corp., 170 Md. 661, 185 A. 562 (1936); Backus v. County Bd. of Appeals, 224 Md. 28, 166 A.2d 241 (1960).

[60] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).

[61] See McMurdo v. Getter, 298 Mass. 363 (1937).

[62] AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).

[63] "State Prohibitions on Hospital Employment of Physicians," Department of Health and Human Services, Office of Inspector General (Nov. 1991).

Note that there are several types of organizations (none of the hospitals) which are permitted by statute to employ physicians:

- Validly-licensed clinics[64] (but NOT clinics that are "conducted by hospitals"[65]).
- Medical Service Corporations[66]

Michigan

Rule: Employment of physicians by non-profit hospitals and county hospitals is tolerated.

An opinion by the Attorney General of Michigan states that non-profit hospitals may employ physicians.[67] In addition, a statute appears to permit county hospitals to employ physicians, although it does not explicitly grant such permission.[68]

Minnesota

Rule: Hospital employment of physicians is tolerated, due to an opinion by the state Attorney General[69] and a favorable – although vague – decision by the state Supreme Court.[70]

In 1936, the Supreme Court held that the state's CPOM doctrine prevents for-profit hospitals from employing physicians.[71] It did not rule on non-profit hospitals. In 1955 the state Attorney General declared that a non-profit corporation that employs a physician but which does not undertake to control the manner in which the physician attends to his or her patients does not raise corporate practice of medicine concerns.[72]

Almost seventy years after the Supreme Court had last ruled on CPOM, the court held that the CPOM doctrine still applies in the state (applying it against a chiropractor).[73] However, the court also admitted that a number of exceptions exist, both in MN and in other states, and that some of the original policy rationale for applying CPOM no longer applies. The court explicitly mentioned hospitals and nonprofit corporations as being

[64] See Mass. Gen. Laws, ch. 111, §51; and 105 Mass. Code Regs., § 140.000 et seq. For a definition of "clinic" see 105 Mass. Code Regs., § 140.020.
[65] See 105 Mass. Code Regs., § 140.020.
[66] See Mass. Gen. Laws, ch. 176B & 176C.
[67] Opinion of the Attorney General of Michigan, 1993 No. 6770 (Sept. 17, 1993).
[68] Mich. Comp. Laws chapter 331.
[69] Op. Atty. Gen. No. 92-B-11 (Oct. 5, 1955) (reversing, in part, Op. Atty. Gen. No. 92-B-11 (Aug. 8, 1939) which held that the corporate practice doctrine could apply to nonprofit corporations).
[70] Isles Wellness, Inc. v. Progressive N. Ins. Co., 703 N.W.2d 513 (Minn. 2005), aff'd Isles Wellness, Inc. v. Progressive N. Ins. Co., 725 N.W.2d 90 (Minn. 2006).
[71] People, by Kerner, v. United Med. Serv., 362 Ill. 442, 454, 200 N.E. 157, 163 (1936).
[72] Op. Atty. Gen. No. 92-B-11 (Oct. 5, 1955).
[73] Isles Wellness, Inc. v. Progressive N. Ins. Co., 703 N.W.2d 513 (Minn. 2005), aff'd Isles Wellness, Inc. v. Progressive N. Ins. Co., 725 N.W.2d 90 (Minn. 2006).

“common” exceptions to CPOM, without ruling on whether those exceptions apply in MN.[74]

Mississippi

Rule: According to the Mississippi State Board of Medical Licensure, hospitals may employ physicians if they meet the following requirements:[75]

- The physician employed or associated with the entity is licensed by the Board.

- The method and manner of patient treatment and the means by which patients are treated are left to the sole and absolute discretion of the licensed physician. The provision of medical services and the exercise of sound medical judgment at all times shall be exercised solely in the discretion of the licensed physician and he or she shall not be subject to any influence, direct or indirect, to the contrary.

- The manner of billing and the amount of fees and expenses charged to a patient for medical services rendered shall be left solely to the discretion of the licensed physician. It is recognized that when physicians choose to affiliate with an HMO, PPO or other managed care entity, some discretion as to fees and expenses is lost. Whenever possible, however, the manner of billing and the amount of fees and expenses charged to a patient for medical services rendered shall be left solely to the discretion of the licensed physician.

- At no time shall a physician enter into any agreement or arrangement whereby consideration or compensation is received as an inducement for the referral of patients, referral of medical services or supplies or for admissions to any hospital.

- The business arrangement and the actions of the physician in relation thereto, cannot be contrary to or be in violation of the Medicare or Medicaid Payment and Program Protection Act of 1987, 42 U.S.C. Section1320 (a-7)(b), commonly known as the "Medicare Anti-Kickback Statute"; the Anti-Kickback Act of 1986, 41 U.S.C. Section 5158, and related statutes, rules and regulations.

- Free choice of physicians and hospitals is a right of every individual. One may select and change at will one's physician or hospital or may choose a medical care plan such as that provided by a closed panel or group practice or health maintenance organization (HMO) or service organization (PPO). While it is recognized that the choosing to subscribe to an HMO or PPO or accepting treatment in a particular hospital will result in the patient accepting limitations upon freedom of choice of medical services, all physicians must recognize that situations will exist where patients will be best served by physicians or hospitals

[74] Id. at 518 (Minn. 2005).
[75] I could find no court cases directly endorsing this rule.

outside such contractual arrangements. If the HMO or PPO contract or other business arrangement does not permit referral to a non-contracting medical specialist, diagnostic or treatment facility or hospital, and the physician believes that the patient's best interest will be served by a specialist, facility or hospital outside of the contractual relationship, the physician has an ethical and contractual obligation to inform the patient of this fact. The physician should so inform the patient so that the patient may decide whether to accept the outside referral at his or her own expense or confine herself or himself to the services available within the HMO, PPO or other business arrangement.

- Licensed physicians shall have the sole responsibility for approval of any and all public communications or advertisements, and these communications and/or advertisements must be in full compliance at all times with Board requirements relating to Physician Advertisements.

- Pursuant to Miss. Code Ann. Section 79-10-31, shareholders of a professional corporation rendering medical services shall only be licensed physicians.[76]

Missouri

Rule: hospitals may employ physicians.

Missouri is one of the few states which never adopted the Corporate Practice of Medicine.[77]

Montana

Rule: hospital employment of physicians is tolerated, as there is a complete lack of law on the subject.

The AHLA 50 State Survey suggests that hospitals employ physicians in practice.[78]

Nebraska

Rule: hospitals may employ physicians.

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[76] Opinion of the Mississippi State Board of Medical Licensure, revised on May 16, 1996, and September 20, 2001.This policy statement was adopted utilizing language set forth in the current opinions of the Council on Ethical and Judicial Affairs of the American Medical Association (Sections 8.13 and 9.06).
[77] See State ex inf. Sager v. Lewin, 128 Mo. App. 149, 106 S.W. 581 (Mo. Ct. App. 1907); Missouri Attorney General Opinion No. 8 (Mar. 15, 1962).
[78] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).

Nebraska courts have interpreted the state's CPOM doctrine in a way that it does not prevent any corporations from employing physicians.[79]

Nevada

Rule: For-profit hospitals may not employ physicians, according to a 1977 opinion by the state Attorney General.[80] However, non-profit hospital employment of physicians appears to be tolerated, because the opinion did not address non-profit organizations. Note also that, in 2008, a statute became effective which lays out explicit exceptions to the CPOM doctrine. It allows private non-profit medical schools and non-profit medical research institutions to operate clinics and to employ physicians as faculty at the clinics.[81] The section below ("The 2008 Law") contains more details on the scope of this law. It is unclear to what extent, if at all, this law affects the ability of non-profit hospitals to employ physicians as a general matter.

The AHLA 50-State Survey makes the following observations (note that this was written before the 2008 statute was enacted):

> … [Some] hospitals act on the belief that licensed hospitals have a yet-unrecognized, inherent exception from the corporate practice prohibition. These hospitals either employ physicians directly or form partnerships and limited liability partnerships with licensed physicians, which partnerships own medical delivery assets and employ physicians.
>
> …
>
> State authorities appear unconcerned over technical violations of the corporate practice prohibition so long as lay persons do not direct medical treatment and the public is not deceived.[82]

The 2008 Law

- A statute which became law in 2008 allows private non-profit medical schools and non-profit medical research institutions to operate clinics and to employ physicians to staff the clinics, provided that the physicians are both:
  - (1) Licensed pursuant to this chapter or chapter 633 of NRS, respectively; and

[79] See State Electro-Medical Institute v. Platner, 74 Neb. 23, 103 N.W. 1079 (1905); State Electro-Medical Institute v. State, 74 Neb. 40, 103 N.W.__(1905); Nebraska Revised Statute § 38-2024.
[80] Opinion of the Attorney General of Nevada, No. 40 (1977).
[81] Nev. Rev. Stat. Ann. § 630.365 (effective Jan 1, 2008; current through the 2009 75th Regular Session and the 2010 26th Special Session of the Nevada Legislature and technical corrections received from the Legislative Counsel Bureau (2010)).
[82] AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).

- (2) Members of the faculty of the school or institution.[83]

- The statute defines "private nonprofit medical schools" as the following: "As used in this section, 'private nonprofit medical school' means a private nonprofit medical school that is licensed by the Commission on Postsecondary Education and approved by the Liaison Committee on Medical Education of the American Medical Association and the Association of American Medical Colleges."[84]
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- This statute does not define "nonprofit medical research institution" or "clinics," and I have found no court decisions interpreting this section.

New Hampshire

Rule: hospital employment of physicians appears to be tolerated, as there is a complete lack of law on the subject.

The AHLA 50 State Survey suggests that hospitals employ physicians in practice.[85]

New Jersey

Rule: Both for-profit and non-profit hospitals may employ physicians under New Jersey state statute. However, any hospital employing physicians is subject to the following provisions:[86]

> A licensee may offer health care services as an employee of a general business corporation in this State only in one or more of the following settings. Any such setting shall have a designated medical director licensed in this State who is regularly on the premises and who (alone or with other persons authorized by the State Department of Health, if applicable) is responsible for licensure credentialing and provision of medical services.
>
> 1. The corporation is licensed by the New Jersey Department of Health as a health maintenance organization, hospital, long or short-term care facility, ambulatory care facility or other type of health care facility or health care provider such as a diagnostic imaging facility. The above may include a licensed facility which

[83] Nev. Rev. Stat. Ann. § 630.365, subsection 1.
[84] Id. at subsection 2.
[85] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[86] See N.J. Administrative Code § 13:35-6.16, subsection (f)(4).

> is a component part of a for-profit corporation employing or otherwise remunerating licensed physicians.

…

This statute is set to expire. A readoption of the statute is currently proposed, with minor updates that do not detract from the ability of hospitals to employ physicians.[87]

New Mexico

Rule: Hospitals may employ physicians. A 1987 opinion by the Attorney General of New Mexico stated that any corporation may employ physicians in the state.[88] This opinion has not been questioned. Further, statutory authority suggests that, at a minimum, public hospitals may employ physicians.[89] Combined, these authorities strongly suggest any hospital may employ physicians in New Mexico.

New York

Rule: Hospitals may employ physicians.[90]

North Carolina

Rule: Hospital employment of physicians is tolerated for non-profit hospitals and public hospitals, pursuant to an opinion by the Attorney General of North Carolina.[91] For-profit hospitals may not employ physicians.[92]

Note that the North Carolina Medical Board may consider independent contractor relationships between lay corporations and physicians to constitute violations of the CPOM doctrine; [93] this raises the concern that the Board would also consider independent contractor relationships between for-profit hospitals and physicians to violate the CPOM doctrine.

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[87] See 2010 NJ REG TEXT 229065 (NS).
[88] Opinion of the Attorney General of New Mexico, No. 87-39 (1987).
[89] N.M. Stat. Ann. § 23-1-1 (current through all 2010 legislation) [bolding added].
[90] See People v. John H. Woodbury Dermatological Inst., 192 N.Y. 454, 456-57, 85 N.E. 697, 698 (1908); Albany Medical College v. McShane, 66 N.Y.2d 982 489 N.E.2d 1278, 499 N.Y.S.2d 376 (N.Y. 1985); Odrich v. Trustees of Columbia Univ. in City of New York ("Odrich"), 193 Misc. 2d 120, 747 N.Y.S.2d 342 (N.Y. Sup. Ct. 2002) aff'd, 308 A.D.2d 405, 764 N.Y.S.2d 448 (N.Y. App. Div. 2003).
[91] Idem.
[92] Opinion of the Attorney General of North Carolina, No. 33-43 (1955) [citing Seawell v. Carolina Motor Club, 209 N.C. 624, 184 S.E. 540 (1936)].
[93] See Jimison, Marcus. "The Corporate Practice of Medicine." Prognosis, Vol. 23, No. 1 (November 2006).

North Dakota

Rule: Hospitals may employ physicians.[94]

Ohio

Rule: Two exceptions exist to Ohio's CPOM doctrine: (1) Non-profit and public hospitals that are located in districts defined by statute as "rural" may employ physicians, provided that they follow certain rules (see below);[95] and (2) Teaching hospitals may employ faculty physicians.[96] These are the only two exceptions to Ohio's CPOM law.[97]

In order for a hospital to qualify under the "rural district" exception (#1 above), it must meet the following requirements (summarized and simplified):

- The hospital must be non-profit or public;
- The county in which the hospital is located must have a population of fewer than 125,000; and
- The hospital must not:
    - Control the professional clinical judgment exercised within accepted and prevailing standards of practice of a physician employed pursuant to this section in rendering care, treatment, or professional advice to an individual patient; or
    - Require that a physician be employed by the hospital or facility as a condition of granting the physician privileges to practice within the hospital or facility.[98]

Oklahoma

Rule: Both for-profit and non-profit hospitals may employ physicians, as permitted by statute.[99]

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[94] N.D. Cent. Code § 43-17-42 (1993).
[95] Ohio Rev. Code § 4731.31 (2011).
[96] Ohio Rev. Code § 4731.291 (2011); see also the DHHS report "State Prohibitions on Hospital Employment of Physicians."
[97] See Albain v. Flower Hosp., 50 Ohio St. 3d 251 (1990) [overruled on a different issue by Clark v. Southview Hosp. & Family Health Ctr., 68 Ohio St. 3d 435 (1994)]; Schelling v. Humphrey, 123 Ohio St. 3d 387, 390, 916 N.E.2d 1029, 1033.
[98] Ohio Revised Code § 4731.31.
[99] See Oklahoma Statutes title 59, § 492 and title 63, § 1-701 (1999).

Oregon

Rule: hospital employment of physicians is tolerated, due to a non-binding opinion by the Attorney General of Oregon.[100]

The AHLA 50 State Survey suggests that hospitals employ physicians in practice.[101]

Pennsylvania

Rule: Hospitals may employ physicians, as permitted by statute.[102]

Rhode Island

Rule: hospital employment of physicians is tolerated, due to a complete lack of law on the subject.

South Carolina

Rule: Hospital employment of physicians is tolerated for "charitable" hospitals and public hospitals.[103] The definition of a "charitable" hospital is unclear, as the attorney general opinion that lays out this exception does not define the term.

CPOM has come up several times in recent court cases, but no court has ruled on the attorney general opinion above. Instead, recent cases have held the following:

First, in 1999 the South Carolina Supreme Court reaffirmed that the state does indeed have a CPOM doctrine.[104]

Second, the Supreme Court (in a footnote) stated that a hospital cannot itself "practice medicine."[105] However, the court did not outline the contours of the doctrine, nor did it mention whether CPOM prevents the employment of physicians.

Third, in a case from 2010, a federal district court applying SC law indicated that the CPOM doctrine may prevent hospitals from employing physicians directly.[106] However,

[100] Opinion of the Attorney General of Oregon 37-963 (1975).
[101] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[102] See 35 Pa. Stat. Ann. § 448.817, subsection (a) and § 448.802, subsection (a) (current through end of the 2010 Regular and First Special Session).
[103] Op. Atty. Gen. S. C. (Sept. 8, 1982) [citing Op. Atty. Gen. S. C. No. 645 at 145 (1958-1959)].
[104] Baird v. Charleston County, 333 S.C. 519 (1999).
[105] McMillan v. Durant, 312 S.C. 200, 439 S.E.2d 829, note 2 (1993).
[106] OrthAlliance, Inc. v. McConnell, CIV.A. 8:08-2591-RBH, 2010 WL 1344988 (D.S.C. Mar. 30, 2010).

because of the procedural stance of the case, the court did not actually decide this issue. The employer at issue in the 2010 case – OrthAlliance, Inc. – was a for-profit corporation, but the court did not draw any distinction between public or nonprofit (or charitable) hospitals on the one hand, and private for-profit hospitals and corporations on the other.

South Dakota

Rule: A corporation (including a hospital) may enter into an employment agreement with a licensed physician if the employment relationship does NOT do any of the following:

- In any manner, directly or indirectly, supplant, diminish or regulate the physician's independent judgment concerning the practice of medicine or the diagnosis and treatment of any patient;

- Result in profit to the corporation from the practice of medicine itself, such as by the corporation charging a greater fee for the physician's services than that which he would otherwise reasonably charge as an independent practitioner, except that the corporation may make additional charges reasonably associated with the services rendered, such as facility, equipment or administrative charges; and

- Remain effective for a period of more than three years, after which it may be renewed by both parties annually.[107]

I have found no cases which have interpreted this statute.

Tennessee

Rules: Tennessee has two distinct rules regarding hospital employment of physicians:

1. Only research hospitals may employ radiologists, anesthesiologists, pathologists, or emergency physicians; non-research hospitals may not employ them.[108]

    - "Research hospital" is defined as a hospital at which fifty percent (50%) or more of the inpatients treated during the previous calendar year were treated pursuant to research protocols.[109]

    - This rule is subject to one exception: any hospital may employ a physician to provide emergency medical services if such physician is employed to provide other medical services.[110]

[107] S.D. Codified Laws § 36-4-8.1.
[108] Tennessee Code § 63-6-204, subsection (a); see § 63-6-204, subsection (f) for definitions.
[109] Tennessee Code § 63-6-204, subsection (f)(7).

- Note that the definition of "emergency physician" is rather specific.[111]

2. Subject to the first rule, all hospitals may employ any licensed physician, provided that all the following requirements are met:

    - Employing entities shall not restrict or interfere with medically appropriate diagnostic or treatment decisions; and

    - Employing entities shall not restrict or interfere with physician referral decisions unless all the following requirements are met:

        - The physician so employed has agreed in writing to the specific restrictions at the time that the contract is executed;

        - The restriction does not, in the reasonable medical judgment of the physician, adversely affect the health or welfare of the patient; and

        - The employing entity discloses any such restrictions to the patient.[112]

Texas

Rule: Two types of health organization may employ physicians in Texas: (1) nonprofit public interest health organizations,[113] and (2) nonprofit federally-recognized migrant, community, or homeless health centers.[114] The term "nonprofit public interest health organization" is defined below.

A Nonprofit Public Interest Health Organization may employ physicians if it meets all the following requirements (summarized and simplified):

- (1) is a nonprofit corporation under Texas law

- (2) is organized for one of the following purposes:

[110] Tennessee Code § 63-6-204, subsection (a)(6)(A).
[111] "… a physician who has either completed a residency in emergency medicine, or practiced emergency medicine full time for a three year period, and whose practice is limited to emergency medicine. "Emergency physician" does not include, however, a physician who has been previously employed to provide nonemergent medical services who, over a period of twelve (12) months or more, becomes a full time emergency physician and who remains employed by mutual agreement." Tennessee Code § 63-6-204, subsection (f)(7).
[112] Idem.
[113] Texas Occupations Code § 162.001(b).
[114] Texas Occupations Code § 162.001(c).

- (A) conduct scientific research and research projects in the public interest in the field of medical science, medical economics, public health, sociology, or a related area;
    - (B) support medical education in medical schools through grants and scholarships;
    - (C) improve and develop the capabilities of individuals and institutions studying, teaching, and practicing medicine;
    - (D) deliver health care to the public; or
    - (E) instruct the general public in medical science, public health, and hygiene and provide related instruction useful to individuals and beneficial to the community;

- (3) is organized and incorporated solely by licensed physicians; and

- (4) has as its directors and trustees persons who are both:
    - (A) licensed physicians; and
    - (B) actively engaged in the practice of medicine.[115]

Utah

Rule: Hospitals may employ physicians.[116]

Vermont

Rule: Hospital employment of physicians is tolerated, at least for non-profits. There is very little guidance on the subject; the only authority I found was a case in which a non-profit corporation was permitted to employ physicians.[117] It is unclear whether a court would take a different view of for-profit hospitals.

Virginia

Rule: Medical schools and state-managed or state-controlled hospitals are explicitly permitted by statute to employ physicians.[118] In addition, according to opinions by the Virginia Attorney General, both non-profit[119] and for-profit[120] hospitals may employ physicians, so long as physicians retain control of patient care.

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[115] Texas Occupations Code § 162.001(b).
[116] Utah Code § 58-67-802; see also Golding v. Schubach Optical Co., 93 Utah 32, 70 P.2d 871, 875 (1937).
[117] LoPresti v. Rutland Reg'l Health Services, Inc., 2004 VT 105, 177 Vt. 316, 321, 865 A.2d 1102, 1107 (2004).
[118] Virginia Code § 54.1-2941.
[119] Virginia Attorney General Opinion, Dec. 7, 1992.
[120] Virginia Attorney General Opinion, May 22, 1995.

Additional state statutes make references to, but do not explicitly provide for, the employment of physicians by hospitals,[121] as well as by local health departments, federally funded comprehensive primary care clinics, and nonprofit health care clinics or programs.[122]

Washington State

Rule: Hospitals may not employ physicians.[123]

Washington's CPOM doctrine is based on case law, not statute, but the courts draw their authority to enforce CPOM from certain sections in the Business and Professions Code.[124] Among these sections is a long list of exceptions to the law[125] most of which – aside from the common exceptions for medical students, interns, and residents – do not pertain to hospitals.

Practitioners should also note a potential trend: the statute from which courts draw their authority to enforce the CPOM doctrine[126] has recently come under attack for being unconstitutionally overbroad. The argument, in short, is that the law's regulation of the practice of medicine is so broad that it impairs free speech rights. Two times now courts in Washington have shown some sympathy to this argument, but due to the procedural posture of the cases the court did not rule on the issue.[127] This argument has also been made, unsuccessfully, in Michigan.[128]

West Virginia

Rule: Hospital employment of physicians is tolerated so long as the relationship passes a multi-factorial test, as described in an opinion by the West Virginia Board of Medicine.[129]

The Board stated that corporate employment of physicians is not a per se violation of the West Virginia Medical Practices Act. The Board asserted that"insofar as it is within [the Board's] authority to interpret the provisions of W. Va. Code § 30-3-15," the Board

[121] Virginia Code § 54.1-2918.
[122] Virginia Code § 54.1-2957.01.
[123] Columbia Physical Therapy, Inc., P.S. v. Benton Franklin Orthopedic Associates, P.L.L.C., 168 Wash. 2d 421 (2010); see also Morelli v. Ehsan, 110 Wn.2d 555 (1988); State v. Boren, 36 Wn.2d 522 (1950) appeal dismissed per curium, 340 U.S. 881 (1950); State ex rel. Standard Optical Co. v. Superior Court, 17 Wn.2d 323 (1943).
[124] Revised Code of Washington § 18.71.011.
[125] Wash. Rev. Code § 18.71.030.
[126] Revised Code of Washington § 18.71.011.
[127] Washington State Dept. of Health Unlicensed Practice Program v. Yow, 146 Wash. App. 1075 (Wash. Ct. App. 2008) [referring to State v. Pacific Health Center, Inc. 135 Wn.App. 149 (2006)].
[128] People v. Rogers 249 Mich.App. (2001).
[129] Statement of Public Policy, State of West Virginia Board of Medicine (originally adopted May 8, 1995, amended May 10, 2010).

would apply the following five factors to determine whether a corporation is engaged in a per se violation of the West Virginia Medical Practices Act:

- (1) Does the structure of the arrangement provide or attempt to provide a benefit to the public in terms of enhancing the quality and accessibility of care and in decreasing the cost of health care?

- (2) Is there a corporate structure which permits physician autonomy in medical decision-making?

- (3) Is there a corporate structure which limits the likelihood that non-physician shareholders may be construed to be making medical judgments and corporate bylaws which provide protection for independent medical judgments by physicians?

- (4) Is the structure a for profit structure or a non profit structure?[130]

- (5) Do shareholder agreements exist which protect physicians from suits for breach of fiduciary duties where decisions are made by them in the best interests of medicine which may erode the profitability of the corporation?

The Board goes on to say that not all of the questions above need be answered affirmatively for a hospital to be allowed to employ physicians, but "it is important that in large measure they be answered affirmatively." If they are "in large measure" answered affirmatively, then the Board will conclude that employment of physicians by the corporation is not per se violative of the West Virginia Medical Practices Act.

I have found no court decisions ruling on the validity of the Board's test, nor have I found record of disciplinary cases in which the Board applied the test.

Wisconsin

Rule: Hospitals may employ physicians, provided that the contract of employment between the hospital and physician meets all the following requirements:

1. Requires the physician to be a member of or acceptable to and subject to the approval of the medical staff of the hospital or medical education and research organization;

2. Permits the physician to exercise professional judgment without supervision or interference by the hospital or medical education and research organization;

3. Establishes the remuneration of the physician.[131]

[130] Note that this is just one of the 5 factors; thus, the mere fact that a hospital is non-profit, absent other conditions, is unlikely to qualify the hospital to employ physicians under this policy statement.

For the purposes of this rule, the term "hospital" is defined as the following:

> "Hospital" means an institution providing 24-hour continuous service to patients confined therein which is primarily engaged in providing facilities for diagnostic and therapeutic services for the surgical and medical diagnosis, treatment and care, of injured or sick persons, by or under the supervision of a professional staff of physicians and surgeons, and which is not primarily a place of rest for the aged, drug addicts or alcoholics, or a nursing home … [132]

Note that an Attorney General opinion also remarked that hospitals are exempt from the state's CPOM doctrine.[133]

<u>Wyoming</u>

Rule: Hospitals may employ physicians, so long as they do not exercise excessive control over the physicians' practice.

Wyoming court cases have not ruled explicitly on hospital employment of physicians, but they have held that optometry constitutes the practice of medicine, and that although corporations may not practice medicine, the key is not the form of the employment relationship but the amount of control the corporation has over the professional.[134] The courts have not provided detailed guidance as to what constitutes excessive control.

The AHLA survey suggests that hospitals employ physicians in practice.[135]

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[131] Wis. Stat. § 448.08, subsection 5(a).
[132] Wis. Stat. § 448.08, subsection 1(a).
[133] Opinion of Attorney General of Wisconsin dated September 8, 1986 (OAG 31-86).
[134] See Lieberman v. Connecticut State Board of Examiners in Optometry, 130 Conn. 344, 34 A.2d 213 (1943); Wyoming State Bd. of Examiners of Optometry v. Pearle Vision Ctr., Inc., 767 P.2d 969, 985 (Wyo. 1989).
[135] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).