

Moral Hazard and Hospital Physician Integration

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A dissertation
submitted in partial fulfillment of the
requirements for the degree of

Doctor of Philosophy

University of Washington
2015

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Program Authorized to Offer Degree:
Business Administration

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Abstract

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Despite the importance of the hospital physician relationship, little is known about hospital physician integration. In this dissertation, I examine how integration solves moral hazard problems in a principal-agent relationship in the context of the hospital physician integration continuum. I build on the idea in agency theory that trade-offs between the cost of measuring behavior and the cost of transferring risk to the agent influence compensation contracts and integration. I review theories on vertical integration in the strategy and economics literature and explore the existing empirical literature on hospital physician integration. The empirical portion of this dissertation is split into two studies. In Study 1, I focus on the circumstances that account for variations in hospital physician integration. Using a double-sided moral hazard model, where both the principal and agent contribute to production, I hypothesize that hospital effort and level of malpractice risk increases the degree of hospital physician integration, whereas

physician effort decreases the degree of integration. I find partial support for the impact of hospital effort on hospital physician integration, and positive support for the impact of physician effort and risk on integration. The results suggest that integration occurs when risk is high and depends on the relative marginal contributions to production. In Study 2, I investigate the impact of hospital physician integration on hospital performance. Specifically, I hypothesize that integration will have a positive impact on hospital financial performance and health care quality. Additionally, I hypothesize that organizational factors, including coordination investment, physician leadership, physician governance, and quality improvement investment, positively moderate the impact of integration on performance. The results partially support my predictions. I do not find a significant direct impact of integration on financial performance, inpatient quality, or patient safety. However, I find evidence that coordination and physician governance are positive moderators of the relationship between integration and performance. The results also indicate that coordination investment, quality improvement investment, and physician leadership have direct positive impacts on inpatient quality. At the same time, these factors have a negative impact on patient safety. These results raise many questions and provide fodder for future research opportunities.

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1 Introduction

In this dissertation, I examine how vertical integration solves moral hazard problems in a principal-agent relationship. In particular, I focus on the circumstances that account for variations in compensation structures and investigate the impact of integration on performance and quality outcomes. Strategy scholars and economists have made great progress toward understanding how agency relationships shape firm boundaries and payment contracts. For example, Eisenhardt (1988) demonstrates that retailers use salary compensation when task programmability and managerial span of control are low, and outcome uncertainty is high. Strategy scholars have also examined the impact of integration and incentive contracts on firm performance and the competitiveness of markets (Masten, Meehan Jr, & Snyder, 1991; Poppo & Zenger, 1998; Bloom & Milkovich, 1998; Miller, Wiseman, & Gomez-Mejia, 2002), albeit with mixed empirical evidence. I build on the idea in agency theory that trade-offs between the cost of measuring behavior and the cost of transferring risk to the agent influence compensation contracts, and thereby vertical integration. However, instead of using a one-sided principal agent model, I focus instead on a double-sided moral hazard model, where both the principal and agent contribute to production. Additionally, instead of solely focusing on performance outcomes of integration (Cuellar & Gertler, 2006; Ciliberto & Dranove, 2006), I also turn attention to the organizational factors that moderate the relationship between integration and performance.

I test these ideas in the context of the hospital physician integration continuum. The percentage of physician practices that are hospital-owned has increased from 22% in 2002, to 53% in 2008 (Kocher & Sahni, 2010), and is expected to

rise even further (Cantlupe, 2010). The resulting variation in vertical integration¹ both between and within hospitals is thus not only a timely topic but also makes for an attractive empirical setting for research on firm boundaries. The changing nature of organizational relations between physicians and hospitals will undoubtedly impact the future of health care in the United States. In 2011, U.S. hospital expenditures were \$850 billion, accounting for approximately a third of total health care spending, and 6% of national GDP (CMS, 2013). The hospital physician relationship is a critical factor in the problems facing the U.S. healthcare system: high and rapidly rising costs, lapses in quality, and inefficiencies in the delivery system. Many scholars have argued that the current structure of hospital physician relationships are a source of misaligned incentives and poor care coordination in the delivery system (Burns & Muller, 2008; Cutler, 2012). Consequently, vertical integration of hospitals and physicians has been promoted as a method for increasing efficiency and quality of care. For example, as a step in this direction, the Patient Protection and Affordable Care Act (2010) created a voluntary program for Accountable Care Organizations (ACOs), which is designed to encourage the US health care system towards more integrated care delivery.

Despite the importance of the hospital physician relationship for policy applications, little is known about hospital physician integration. Drawing on the strategy, economics, and health services literatures, I address two basic questions concerning hospital physician integration. First, under what circumstances are we likely to observe vertical integration of hospitals and physicians? Second, what is the impact of integration on financial performance and health care outcomes?

¹Not technically vertical integration, even though there are inputs that the hospital provides for physicians. But to stay consistent with literature will continue to use vertical integration.

In order to address these questions, I start by forming a theoretical background in the relevant strategy and microeconomic theories on vertical integration. I also review the empirical literature on the determinants and consequences of vertical integration in both the strategy and health services literatures. Then, the empirical research is split into two studies. In Study 1, I build a double-sided moral hazard model of hospital physician integration that examines the antecedents of hospital physician integration. I hypothesize that hospital effort and level of malpractice risk increases the degree of hospital physician integration, whereas physician effort decreases the degree of integration. I find partial support for the impact of hospital effort on hospital physician integration, and positive support for the impact of physician effort and risk on integration. The results suggest that integration occurs when risk is high and depends on the relative marginal contributions to production. In Study 2, I investigate the impact of hospital physician integration on financial performance and health care quality. Specifically, I hypothesize that integration will have a positive impact on hospital financial performance and health care quality. Additionally, I hypothesize that organizational factors, including coordination investment, physician leadership, physician governance, and quality improvement investment, positively moderate the impact of integration on performance. I use both qualitative and quantitative methods to explore these relationships. The quantitative results partially support my predictions. I do not find a significant direct impact of integration on financial performance, inpatient quality, or patient safety. However, I find evidence that coordination and physician governance are positive moderators of the relationship between integration and performance. The results also indicate that coordination investment, quality improvement investment, and physician leadership have direct positive impacts

on inpatient quality. At the same time, these factors have a negative impact on patient safety. These findings were supported by the results of the qualitative data. At the same time, these organizational factors have a negative impact on patient safety. To my knowledge, there are no studies that examine the relationship between patient safety and inpatient quality. Thus, these results raise many questions and provide much fodder for future research opportunities.

2 Literature Review

2.1 Theories of Vertical Integration

Both transaction cost and agency theories have been used to explain firm boundaries. In the past half-century, transaction cost theory has developed into the predominant framework for explaining variations in organizational boundaries in the strategy literature (Williamson, 1975a, 1985). To a lesser extent, moral hazard principal agent models have also been used to explain forward integration (Lafontaine & Slade, 2007) and the structure of payment contracts (Gomez-Mejia & Balkin, 1992; Makri, Lane, & Gomez-Mejia, 2006; Stroh, Brett, Bauman, & Reilly, 1996). In both theories, competitive market forces are assumed to push organizations toward efficiency, resulting in the conclusion that organizations that integrate under the right circumstances will perform well. There is also a different set of implications in oligopoly markets. Theory suggests that vertical integration can also change the competitive structure of the market, which can result in high performance for firms with market power but adverse welfare consequences (Hart & Tirole, 1990). In the following section, I review what each of these theories and

existing empirical literature say about the circumstances in which firms integrate and the performance and competitive consequences of integration.

2.1.1 Transaction Cost Theory

The question of firm boundaries was famously posed by Coase in 1937. Coase (1937) suggested that competitive forces would ensure that successful organizations economized on transaction costs, which differs for each transaction under the alternative governance structures of markets or hierarchies (firm). The fundamental insight that transaction attributes that cause high transaction costs determine governance choice, is the foundation of present day transaction cost economics (Williamson, 1975b, 1985). Williamson (1975b) spurred a flurry of empirical work, which tests the relationship between transaction costs and make-or-buy decisions, when he defined three observable and measurable dimensions of transactions: asset specificity, uncertainty, and frequency.

According to transaction cost theory, when assets are specific to a transaction and cannot be effectively redeployed outside the particular transaction, a potential hold-up problem exists (Williamson, 1975b, 1985). The potential hold-up problem becomes an actual problem when performance or contract compliance is uncertain, or difficult to evaluate. An increase in the asset specificity and/or uncertainty of a transaction raises the cost of transaction, increasing the preference for vertical integration over market governance in order to avoid a hold-up problem. Williamson (1985) also argues that when a transaction occurs in the market with increased frequency, such as a relatively standard transaction, the likelihood of integration also increases. The rationale is that the bureaucratic costs of governance within a firm become more cost effective as transaction frequency increases.

TCE theory has been primarily used to explain backward vertical integration decisions, otherwise known as make-or-buy decisions, in a variety of industries such as mining, automobile, and trucking (Geyskens, Steenkamp, & Kumar, 2006; Joskow, 1985; Klein, 2005; Masten, 1984; Masten & Meehan, 1989; Monteverde & Teece, 1982; Ohanian, 1994; Pirrong, 1993; Walker & Weber, 1984). There has only been one study to my knowledge that explores forward integration decisions from a TCE lens (Anderson 1984; 1985). But for the most part, due to the need for measurability at the transaction level and the preferences by researchers, TCE explanations have fit better when a product or specific service is exchanged. For example, Bigelow and Argyres (2008) construct an index of uniqueness for every make-or-buy decision for engines in every U.S. auto firm from 1917-1933 and test the impact of uniqueness on make-or-buy decisions. The results confirm that asset specificity significantly increased make choices. Recent review articles have concluded that the empirical evidence largely supports the predictions of transaction cost theory on firm boundaries, with particularly strong results for asset specificity and uncertainty (Williamson, 2010; Carter & Hodgson, 2006; David & Han, 2004; Geyskens, Steenkamp, & Kumaret, 2006; Klein, 2005; Lafontaine & Slade, 2007; Shelanski & Klein, 1995).

2.1.2 Agency Theory

Another approach to understanding vertical integration and firm boundaries is agency theory. Instead of transactions, the primary relationship of interest is between the principal and an agent, who is delegated tasks by the principal. Agency or incentive problems arise when there is both a conflict in desires or goals between the principal and agent, and incomplete information. Agency problems can

be categorized into two types of situations: adverse selection² and moral hazard. In the case of moral hazard, agents choose actions that affect the performance of the principal, meanwhile the principal has incomplete information about the actions of the agent. For example, the effort exerted by an agent may be hard or impossible to verify and uncertainty makes outcomes only a noisy indication of the agent's effort. Principals can attempt to induce high effort by aligning the incentives of agents or by investing in monitoring the actions of agents. With formal principal agent models, researchers attempt to identify the optimal second-best contract, which would induce a high effort from the agent by transferring some of the risk to agent.

Eisenhardt (1989) provides an overview of agency theory in the strategy literature, separating formal principal agent models from positivist agency theory. The application of positivist agency theory has been generally limited to the agency problem existing between the owners of the corporation and management,³ and focused on describing governance mechanisms, such as Board of Directors and the use of stock options to limit agency (Fama & Jensen, 1983; Jensen & Meckling, 1976; Nyberg, Fulmer, Gerhart, & Carpenter, 2010). The availability of data on CEOs, Board of Directors, and financial performance makes empirical work focused on these relationships attractive. Additionally, the resulting corporate governance prescriptions are especially useful to strategy academics in classrooms and other real world settings. However, many have criticized this line of research claiming

²Adverse selection models are used when there is incomplete information about the type of agent. I will address the potential of adverse selection to influence the proposed model below.

³Berle and Means (1932) famously framed the relationship between owners of a corporation and managers as a principal agent relationship and much of the following positivist agency literature uses this framework to focus on governance mechanisms that would align managers' interests with those of owners.

that these very prescriptions create detrimental effects on managers, proposing alternative models of governance (Ghoshal, 2005; Perrow, 1986; Davis, Schoorman, & Donaldson, 1997).

As Eisenhardt (1989) notes, formal principal agent models, which elucidate circumstances in which integration is likely to occur (much like TCE), are relatively underutilized in the strategy literature. In the strategy literature, principal agent models have not been used to explain the circumstances surrounding vertical integration, concentrating instead on managerial incentives and the choice of compensation structures, such as pay for performance. In some early work, Eisenhardt (1988) uses agency theory to derive predictions about the relationship between task programmability, span of control, and outcome uncertainty on the structure of payment contracts among retail stores. Eisenhardt shows that an increase in any of these three factors, as measured by a survey administered to store managers, increases the likelihood of salary-based pay, as opposed to commission-based pay. Using principal agent models to predict the circumstances of vertical integration would be a logical extension of the work on payment structures due to the parallels between behavior-based pay (salary) and integration, and performance-based pay (commission) and markets.

Although there has been some interest in agency theory as a complementary approach in the strategy literature, it is economists who have primarily developed moral hazard principal agent models, and empirically tested the circumstances in which integration occurs (Lafontaine & Slade, 2007). The empirical setting for these studies is franchising, where the variable of interest is forward integration by outlet. Increasing importance of the agent's (franchisee) input and effort (measured by proxies such as location, labor intensity, and level of service) low-

ers the likelihood of integration (Brickley, Linck, & Smith, 2003; Slade, 1996; Woodruff, 2002). Conversely, when inputs, such as brand, provided by the principal (franchisor) are more important, the likelihood of vertical integration increases (Lafontaine, 1992; Lafontaine & Shaw, 2005; Minkler & Park, 1994; Nickerson & Silverman, 2003; Penard, Raynaud, & Saussier, 2003; Thompson, 1994). For example Lafontaine and Shaw (2005) show that franchisors with high brand name value, measured by major media expenditures and other proxies, have high rates of company ownership. They argue that franchisors want to exert more control and protect their brands from adverse franchisee behaviors. Many studies also test the effect of the ease of monitoring on integration and find that monitoring behavior and monitoring outcomes have contradicting effects on integration. When behavior monitoring or control mechanisms are more costly or less effective, firms are less likely to integrate. On the other hand, when outcome monitoring is more costly and complicated, the likelihood of vertical integration increases (Baker & Hubbard, 2003; Brickley, Linck, & Smith, 2003; Carney & Gedajlovic, 1991; Kehoe, 1996; Lafontaine & Shaw, 2005; Scott, 1995).

2.1.3 Impact of Vertical Integration

What are the consequences of integration on the performance of firms and the competitive landscape of the market? According to transaction cost and agency theories, firms that are integrated are likely to have done so in response to high transaction costs or agency problems. Thus they are more likely to survive because they were properly aligned with the conditions that prompted the integration. Efficiency is the underlying rationale for both theories, with agency theory more focused on the relationship between principal and agent, and transaction cost

focused on the transaction level. Therefore many previous studies have not been able to identify the effect of integration on performance due to the endogeneity of the integration decision and sample selection bias. Integration may be endogenous if the decision to integrate or not integrate is correlated with unobservables that affect performance. For instance, if less capable workers are more likely to integrate and therefore have lower performance outcomes *ceteris paribus*, then failure to control for this correlation will yield an estimated integration effect on performance that is biased. Another issue is sample selection bias, which refers to problems where the dependent variable is observed only for a restricted, nonrandom sample. This happens when you can only observe performance for successful firms.

Recent empirical work that accounts for sample selection bias using two stage models and panel data has confirmed the effects of transaction cost efficiency on firm performance (Masten, Meehan Jr, & Snyder, 1991; Poppo & Zenger, 1998). Additionally, other outcomes such as innovation (Forman & Gron, 2009; Klein, 2007) and survival (Bigelow & Argyres, 2008; Silverman, Nickerson, & Freeman, 1997) have also been shown to be positively impacted by transaction cost efficiency. However, there is also a body of research that points to the costs of bureaucracy, which could lead to negative performance outcomes. Managerial inefficiencies, incentive degradation, and the complexity of internal coordination have all been cited as problems with vertical integration (Harrigan, 1984; Hill & Hoskisson, 1987; Jones & Hill, 1988; Williamson, 1985). Thus, the overall consensus in the strategy literature is that vertical integration will increase the performance of firms to a point.

There is also a stream of research in strategy focusing on the efficacy of incentive pay for aligning agent behavior in various organizational contexts (Gerhart &

Milkovich, 1990; Gomez-Mejia & Balkin, 1992; Makri, Lane, & Gomez-Mejia, 2006; Roth & O'Donnell, 1996; Stroh, Brett, Bauman, & Reilly, 1996). If we recast increases in incentive pay to represent a compensation structure more akin to contract pay instead of a salaried model, then the evidence from this stream of literature may also inform the potential impacts of integration on performance. For example, Gerhart and Milkovich (1990) show that increases in performance bonus and incentive pay predicts positive firm market performance. However, there are also several studies that show that there are potential negative performance consequences for incentive pay (Beatty & Zajac, 1994; Bloom & Milkovich, 1998; Miller, Wiseman, & Gomez-Mejia, 2002; Zajac & Westphal, 1994). Some scholars argue that pay for performance can encourage agents to attempt to reduce personal risk by playing it safe and thus not maximizing firm performance. Indeed the role of risk on the efficacy of pay for performance is important. Bloom and Milkovich (1998) find that high performing firms with higher risk place less emphasis on short-term incentives, concluding that incentive pay is not good for performance in high-risk situations. All together, the evidence in the strategy literature on the performance effects of outcome-based incentives is mixed.

The performance of individual firms is the primary focus in the strategy literature. However, studies in economics not only examine profits, prices, quantities, and costs, but also the societal benefits (losses) and who gains (loses). Under the efficiency rationale of transaction cost and agency theories, the welfare effects would be positive. However, there are many theoretical market power reasons that firms would want to integrate. There are two market power based rationales, double marginalization and vertical foreclosure, which each have different theoretical predictions for consumer welfare. Double marginalization occurs when firms

at each stage in the supply chain extract monopoly profits, resulting in multiple mark-ups and large price increases for consumers (Greenhut & Ohta, 1979; Spengler, 1950). Under a vertically integrated firm, the upstream firm no longer extracts monopoly profits, and consumer prices are predicted to be lower price than in the case where the consumer has to pay for multiple markups. Thus, even though a firm may integrate in order to gain market power, the reduction of double marginalization will increase consumer welfare. Vertical foreclosure is the second potential market power motive for vertical integration. Foreclosure is when integration forecloses entry by competitors, causes competitors to exit, or disadvantages competitors in some manner. For example, a vertically integrated firm with market power can deny access to an upstream supplier or downstream buyer thereby unduly disadvantaging its competitors. As modeled by economists, the theoretical predictions on the welfare effects of foreclosure are equivocal (Hart & Tirole, 1990; Ordover, Saloner, & Salop, 1990; Salinger, 1988). The models show that although integration can raise prices through entry barriers, the elimination of double marginalization, can cause prices to fall. Therefore, the outcome of these models depends on the specification of parameters and economic theory is not clear about the effects of integration when the drive for market power is behind integration. The empirical work in this area also suffers from the same endogeneity issues as before, making it difficult to isolate the effect of integration, as there are no counterfactuals and valid instruments are difficult to find. Recently, the use of panel data, better control variables, event studies, and simulations have allowed researchers to better assess the trade off between foreclosure and efficiency gains of integration (Lafontaine & Slade, 2007). Both Mullin and Mullin (1997), and Chipty (2001) find that the efficiency gains from integration outweigh the negative

effects of foreclosure in the steel and cable television industries. Lafontaine and Slade (2007) review other studies on the consequences of vertical integration and show that the one consistent finding among these studies is that the overall welfare effects seem to be positive. Therefore, the empirical evidence is supportive of the welfare efficiency of vertical integration, even in the presence of increased market power.

In order to elucidate the circumstances in which hospital physician integration occurs, it appears that the principal-agent model is the most useful, due to the focus on the relationship between the two parties. The moral hazard model suggests that factors such as risk, agent effort, principal effort, and monitoring costs will influence the likelihood of vertical integration. Additionally, the relevant strategy and economics literature strongly suggests that in theory, integration under high transaction costs or agency problems will result in higher performance for firms and overall welfare increases, even with increased market power. In order to add more detail on the hospital physician integration, in the following section I turn attention to the health services literature.

2.2 Hospital Physician Integration

The hospital physician relationship has been characterized as an agency relationship, along with many other relationships in healthcare (Gaynor & Gertler, 1995; McLean, 1989; Pontes, 1995; Robinson, 2001; Smith, Stepan, Valdmanis, & Verheyen, 1997). For example, the patient-physician relationship is described by Arrow (1963) as a principal-agent relationship due to the specialized training of physicians and resulting information asymmetry. The agent (physician) makes

decisions and suggestions for the (principal) patient although he/she may have incentives to deviate from what is in the best interest of the patient. Similarly, in the hospital physician relationship, physicians make the majority of decisions about patient care that is delivered in the hospital, even though these decisions affect the quality, costs, and financial performance of the hospital. Research by Burns, Chilingerian, and Wholey (1994) shows that the individual impact of physicians on hospital efficient use of resources is quite large even after controlling differences in patients and conditions. Accordingly, due to the different expertise of each party and the interdependence of their activities, the hospital physician relationship has been characterized by an agency relationship in the literature (McCullough & Snir, 2010; McGuire, 2000).

Traditionally, the hospital physician relationship is based on the voluntary or independent medical staff model. Physicians perform procedures and provide services in hospitals that they cannot provide in other settings. Hospitals provide technology and support services for physicians, and in return physicians voluntarily serve on hospital committees, provide on call coverage to the emergency department, and refer their patients to the facility, and teach at hospitals with teaching programs. Physicians maintain independence and hospitals compete for referrals and admissions. There are no formal incentives for physicians to achieve operational targets for costs, quality, efficiencies, and patient satisfaction because reimbursement for the technical portion of services rendered is separate from the reimbursement for physician services. The fee-for-service payment system incentivizes both hospitals and physicians to increase the volume of care. However, a swing in the early 1990's towards managed care and the widespread belief that capitation would become the dominant payment system brought a wave of hos-

pital and physician integration. Hospitals purchased primary care practices and hired physicians, but as the capitation model failed to become prevalent, hospitals divested from primary care at the end of the decade as they were losing money (Casalino, November, Berenson, & Pham, 2008).

Nonetheless, another wave of integration has occurred during the past decade due to increased cost efficiency pressures and does not show signs of slowing down. A plethora of integrated arrangements evolved that vary on the coordination intensity of business and clinical operations, degree of exclusive rights over patient care, and the level of investments made to acquire assets (Cuellar & Gertler, 2006). These arrangements include Physician Hospital Organizations (open and closed PHOs), Independent Practice Association (IPAs), Management Service Organizations (MSOs), and fully integrated systems (Burns, Bazzoli, Dynan, & Wholey, 2000; Cuellar & Gertler, 2006; Gaynor & Haas-Wilson, 1999; Snail & Robinson, 1998). Both IPAs and open PHOs are arrangements that represent a minimal level of integration and only coordinate contracting with managed care plans. Physicians still have a lot of autonomy over business and clinical operations and a relatively low level of joint investments is required. In the closed PHO and MSO models, physicians are exclusive to the hospital, and costs are shared, as well as administrative, coordination, and marketing resources. Fully integrated organizations include both medical foundations and salary models. Physicians are hired as employees and are often consolidated into centralized locations. In these organizations, employment can include all physicians, or can vary by specialty and within specialty.

Even though many have pointed to the need for research on integration in health care and the resulting impacts on competition and efficiency (Gaynor &

Haas-Wilson, 1999; Goes & Zhan, 1995; Robinson, 1997; Robinson & Casalino, 1996) there is little empirical research in this area. Existing empirical research on hospital physician integration has focused on price differences before and after integration. Cuellar and Gertler (2006) examine price changes in Arizona, Wisconsin, and Florida and find that integration is associated with an increase in prices without efficiency or quality gains, concluding that hospital physician integration is anticompetitive. In contrast, Ciliberto and Dranove (2006) find that increased vertical integration in California hospitals did not change prices, concluding that integration is not anticompetitive. In a recent study of privately insured patients, Baker et al. (2014) find that increased hospital physician integration is associated with higher hospital prices and spending and is only offset by a small reduction in the frequency of hospital admissions. These results provide a negative picture of integration from the perspective of the consumer. In a treatment specific study, Madison (2004) investigates the relationship between hospital physician affiliation and patient treatments, expenditure, and outcomes using data on Medicare heart attack patients and finds no evidence of any impacts of hospital physician relationships on outcomes. Perhaps the inconsistent empirical results can be attributed to differences in samples and aggregation of integration at the hospital level. Addressing these conflicting empirical results, Gaynor (2006) argues that researchers need to uncover the specific processes that are at work when hospitals and physicians integrate.

Using theories from the management literature, researchers have hypothesized how increased hospital physician integration will positively benefit health care and hospital outcomes. Proponents argue that integration will lead to better coordination, less complications, and more collaboration. Robinson and Casalino (1996)

examine increased vertical integration patterns on hospitals in California. They argue that vertically integrated organizations through fiat control can focus their subunits on the same goals and strategies, although they do not empirically test this. They also argue that integration of hospitals and physicians will create the unity of purpose and performance for delivery systems that incorporate primary care, specialty panels, and hospitals. Similarly, Kocher and Sahni (2010) predict that under increased integration there will be more standardization of practice, and increased use of evidence for choosing cost-effective devices and processes. However, none of these hypotheses have been empirically tested, although it is likely that integration will result in increased availability of data and potential for monitoring.

Healthcare researchers have begun to draw attention to the fact that benefits of vertical integration on performance outcomes may not be entirely straightforward. Burns and Muller (2008) find that when hospitals and physicians integrate, economic integration does not necessarily imply clinical integration. They suggest that not only do financial incentives need to be in place, but internal changes to clinical operations need to be made in order to reap the benefits of integration. This resonates with the management literature, which suggests that organizational structure and culture have direct effects on the work activities of individuals and groups (Mintzberg, 1979; Scott, 2003).

Likewise, prior literature on the effect of physician payment incentives on quality of care, costs, and efficiency is also mixed. Health services researchers argue that in theory fee-for-service encourages volume and capitation discourages resource use, while productivity based pay encourages efficiency and salaried compensation undermines productivity (Hellinger, 1996). However, the empirical re-

sults are mixed. Conrad et al. (1998) find that physician compensation method has no impact on the use and cost of health services, and that other patient and physician factors were the prime determinants of utilization and cost of health services. In another study, Krawlewski et al. (2000) finds a significant relationship between salary compensation and higher costs. In a recent study, Shafrin (2010) shows that when specialists are paid through a fee for service system versus capitation basis, surgery rates increase 78%. Thus, the payment literature does not provide a guide for what the impact of integration on financial performance and quality may be.

A review of the hospital physician integration literature shows that although hospital physician integration is increasing nationwide and integration differs between specialties, there has not been a systematic assessment of the determinants of integration. No studies have examined this question, even at the regional level. Additionally, while many policymakers and health services researchers are proponents for hospital physician integration, as it is arguably a simple solution to aligning incentives, the empirical evidence for this claim does not exist.

3 Study 1: Hospital Physician Integration

3.1 Moral Hazard model

In this section, I build a double-sided moral hazard principal agent model of hospital physician integration in order to derive testable hypotheses about the circumstances in which integration is likely to occur. In reality, the hospital physician relationship is only one strand in the web of relationships that exist in healthcare.

Many of these relationships can be characterized from a moral hazard perspective. Principal-agent models have been used to model the patient-physician relationship, the insurer-hospital relationship, and in some cases multiple parties (hospital, insurer, physicians). However, in this study, I want to isolate the hospital physician relationship in order to focus on the integration relationship, while still recognizing that the insurer and patient relationships exist and may also have some bearing in the real world. The basic model is adapted from the principal agent models by Laffont and Martimort (2002) and Lafontaine and Slade (2007) in order to reflect the hospital physician relationship. For a complete derivation, please see Appendix A.

A double-sided moral hazard model is used in situations where both the principal and agent contribute to the production of goods or services (Bhattacharyya & Lafontaine, 1995). Although traditional moral hazard models have been used to describe the hospital physician relationship (McCullough & Snir, 2010; McGuire, 2000), a double-sided model is appropriate because of the joint nature of production of patient care. The role of physicians in the production of patient care is clear. Physicians admit and discharge patient, perform procedures, prescribe pharmaceuticals, and many cases serve on committees that oversee care. The role of hospitals in patient care production is important, especially for inpatient care. Hospitals not only supply the physical facilities, but also provide nursing and other support staff, coordination, and management that are essential for complex patient care. In this model, the principal is the hospital (H) while the agent is the physician (P) and the perspective of the hospital is adopted. Even though it is plausible that physician groups could buy hospital facilities and thus become the locus of integration, this has not been the traditional arrangement and contrary to

empirical evidence on integration arrangements between hospitals and physicians.

Let $R(e_H, e_P, \epsilon)$ represent the revenue from providing patient care, which is a function of the effort of both parties, the hospital (e_H), the physician (e_P), and a random disturbance term $\epsilon \sim (0, N)$. The marginal products of the hospital and physician for one unit of effort are represented by a_H and a_P , respectively. The effort of both parties is required, otherwise, $R(e_H, e_P, \epsilon) = 0$. The production cost of providing care is represented by $C(e_H, e_P, \theta)$, where $\theta \sim (0, N)$ is a random disturbance term and c_H and c_P are the respective marginal cost of effort, which can represent the fact that there are material costs with providing additional patient care in the form of disposable equipment and staff.

$$R(e_P, e_H, \epsilon) = a_P e_P + a_H e_H + \epsilon \quad (1)$$

$$C(e_P, e_H, \theta) = c_P e_P + c_H e_H + \theta \quad (2)$$

The cost function is separated out instead of subsuming it in the productivity terms in R because only the hospital faces the material costs that are associated with hospital and physician effort. This is largely an accurate representation of a common situation in which a physician decides to perform a procedure and the hospital bears the material cost associated with the procedure. Additionally, the private marginal costs of exerting effort are represented by $v(e_i) = \frac{e_i^2}{2}$, α represents the share of revenue that is paid to the physician, and w is a fixed wage that is paid regardless. When $\alpha = 0$, this represents a fully salaried contract with no added incentive pay, and as α increases, the strength of incentive pay increases. Therefore, for the agent (physician) the net income from patient care is a function of the effort exerted by the hospital and the physician according to Equation

(3), and the maximization problem for the hospital is represented by Equation (4). This is a reasonable approximation of how hospitals are reimbursed under Medicare and insurance contracts.

$$y_P = \alpha(R(e_P, e_H, \epsilon)) + w - \frac{e_P^2}{2} \quad (3)$$

$$y_H = \alpha(R(e_P, e_H, \epsilon)) - C(e_P, e_H, \theta) - w - \frac{e_H^2}{2} \quad (4)$$

I assume an exponential utility, or a constant risk aversion utility function (CARA) for the agent such that $U(y) = 1 - e^{-ry}$ where r is the risk factor for the agent. Therefore, the agent chooses e_P in order to maximize expected utility, where $E(U(y)) = E(y) - \frac{r}{2}Var(y)$.

Assuming that neither party can observe the effort of the other party perfectly, and due to the presence of the disturbance terms, it is also difficult to infer effort levels from the outcome, the contracting solution is found by recognizing that depending on the payment scheme, the agent will choose a level of effort in order to maximize expected income and the principal will also choose effort to maximize his/her own income. Solving the first order conditions, we find that the agent will choose a level of effort equal to the marginal product multiplied by the incentive pay rate. The principal also chooses a level of effort in order to maximize its income. This gives us:

$$e_P = \alpha a_P \quad (5)$$

$$e_H = (1 - \alpha)(a_H - c_H) \quad (6)$$

In the second-best solution, the levels of effort by both the principal and agent

are relatively less than the solutions in the first-best world. This is consistent with the basic moral hazard premise that both parties will tend to shirk. Moreover, the amount of revenue sharing affects the incentive to shirk. When α increases, the level of effort by the physician increases and effort by the hospital falls. As expected, the material cost of physician effort is not taken into account by the physician, whereas the material cost of hospital effort is taken into account when the hospital chooses its level of effort. Knowing this, the principal chooses the level of incentive pay α to maximize surplus given these levels of effort, and thus we find that α^* is:

$$\alpha^* = \frac{a_P^2 - a_P c_P}{a_P^2 + a_H^2 + r\sigma^2} \quad (7)$$

From Equation (7), we see that the model predicts that α increases with the marginal product of physician effort a_P , and decreases with the marginal product of hospital effort a_H , risk σ^2 , and the material marginal cost of physician effort c_P . Thus, leaving it as is, this is a model predicting the strength of incentive pay for agents. In order to use this model to predict the likelihood of vertical integration, we transform this equation by looking at the difference in expected profit for the principal under vertical integration ($\alpha = 0$) and fully contract pay ($\alpha = 1$). Then we can find an equation that represents the probability of vertical integration P_{VI} as a function of these other parameters, where T represents the transaction cost of the contract.

$$P_{VI} = F\left(\frac{2T}{a_P^2} - \frac{a_P^2 - a_P c_P}{a_P^2 + a_H^2 + r\sigma^2}\right) \quad (8)$$

Equation (8) can be used to predict both the probability of vertical integration where $\alpha = 0$ and also the strength of incentive pay if $\alpha > 0$. Using this likelihood equation, there are a number of predictions involving hospital and physician effort and risk parameters that parallel the predictions above from Equation (7).

3.2 Principal Effort

The first set of predictions from the double-sided moral hazard model developed above, center on the effort of the hospital. In Equation (7) and (8) we see that an increase in the marginal product of hospital effort a_H decreases α , the strength of internal incentive pay, while increasing P_{VI} , the probability of integration. In other words, there is a higher probability of integration as the marginal product of hospital effort increases. The more important the contribution of hospitals is to patient care and profits, the larger the share of control and profits that hospitals will want to keep. While the theoretical predictions are relatively straightforward, the product of medical care is composed of many complex outcomes, many without direct measures. In order to test these predictions, I proxy for marginal productivity of hospital effort using measures that directly assess the quality of the hospital's contribution to patient care and reputation measures that capture a perceived quality.

The quality of nursing staff and hospital investment in improving facilities and equipment are the measures I use to represent the hospital's quality of contribution to patient care. One of the hospitals' most important direct contributions towards patient care is the nursing staff. Nursing care is inextricably tied to patient care. A higher proportion of hours of nursing care provided by registered nurses and the

number of hours of care by registered nurses per day have been shown to lead to better patient outcomes (Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002). Despite the proven link to patient care, the quality and quantity of nursing care varies across hospitals. In a survey of registered nurses, Lucero, Lake, and Aiken (2009) find that there is a wide range across hospitals in the proportion of registered nurses who report leaving nursing care needs unfinished. After accounting for demographic factors, the authors conclude that variation in nursing care quality is predominately driven by the quality environment in hospitals. Thus, one of the most important ways that hospitals contribute to patient care is through the management of nursing staff. Following the argument that as the marginal product of hospital effort increases, the probability of integration increases and the strength of incentive pay decreases, I would expect that the more effort the hospital contributes to patient care in the form of nursing staff, the degree of hospital physician integration will increase. Similarly, another area where hospitals directly contribute to patient care is through facilities and equipment. Levitt (1994) find that investment in property, plant, and equipment in hospitals predicts certain dimensions of quality of care. Thus, as another proxy for the marginal productivity of hospital effort, I use hospital investment in facility and equipment standardized to hospital size, and predict that higher investment is associated with a higher degree of integration.

H1: Increases in a hospital's nursing quality will lead to a higher degree of hospital physician integration.

H2: Increases in a hospital's facility and equipment investment will lead to a higher degree of hospital physician integration.

Reputation-based measures can also proxy for the marginal product of hospital effort. Lafontaine and Shaw (2005) use high brand name value to represent principal effort among franchisors. They argue that franchisors want to protect their brands and thus are more likely to integrate. Managers at hospitals invest in building reputation and signal to stakeholders their efforts to provide high quality care in order to bolster reputations. Firms have been shown to compete for reputational status by signaling key characteristics to stakeholders (Fombrun & Shanley, 1990). Thus, although reputation is a perceived quality, it is likely that the underlying characteristics are in part accurately reflected in reputations. A high status reputation is desirable for several reasons. Hospitals with high reputations can attract patients and increase revenue. Pope (2009) estimates the effect of the US News and World Report Best Hospital rankings on both patient volume and hospital revenues and find that an improvement in a given hospital-specialties rank leads to a significant increase in both the number of non-emergency patients treated and the total revenue generated from non-emergency patients in that specialty. Moreover, reputation rankings are increasingly being used to seek more patients. Rosenthal, Chren, Lasek, and Landefeld (1996) find survey evidence that over 85% of hospital CEOs are aware of and have used the US News and World Report Best Hospital rankings for advertising purposes.

Although individual physicians can disproportionately form and affect perceptions of the quality of care provided at a hospital, reputation is more likely to be associated with the hospital or a type of service (such as cancer care) than individual physicians. There are two reasons for this. First, when patients are admitted they are in essence purchasing a bundle of goods and services. Thus, they may have difficulty evaluating discrete contributions and are likely to attribute the

experience and quality to the hospital as it is the unifying locus of care. Secondly, there is evidence that management matters in hospitals. Good management and the organization of care have been shown to increase performance in intensive care units (Shortell, Zimmerman, Rousseau, Gillies, Wagner, Draper, Knaus, & Duffy, 1994) and reduce adverse outcomes (Mitchell & Shortell, 1997). Thus, reputation is likely to reflect hospital differences in management and the perceived quality of the bundle of care received. Nonetheless, if patients impute a physician's reputation for the hospital's, this would only bolster the argument that if hospitals have invested heavily in their reputation, that they will be more likely to seek deeper integration with physicians.

H3: Hospitals with a higher reputation will have a higher degree of hospital physician integration.

3.3 Agent Effort

The second set of predictions derived from this model concern the effect of the marginal product of physician effort a_P on the strength of internal incentive pay α provided by the hospital and the probability of vertical integration P_{VI} . In general, the predictions are in the opposite direction of those in the previous section. From Equation (7) and (8), we see that an increase in the marginal product of physician effort a_P increases α , while lowering P_{VI} . In other words, as the importance of physician effort to providing patient care and generating revenue increases, the less likely that the physician will want to give up control. Ultimately, the structure of physician compensation reflects the marginal productivity of the physician. Thus, we would expect to see less hospital physician integration when

the marginal product of physician effort is relatively high.

Unfortunately, a direct measure of marginal product of physician effort is difficult to obtain. However, similar to above, I use several approximations of marginal productivity. The specialty of a physician's practice area is a natural method of distinguishing among physicians due to differences in the type of care provided, and knowledge and skills needed. To proxy for the marginal productivity by specialty, I use the length of training required to practice in the specialty and the median annual reported work Relative Value Unit (RVU) by specialty. Training is one of the most important ways that physicians make effort to provide patient care. In general, the more specialized that a physician is, the more years of education and training is required. The length of training for residencies, which is the minimum number of years of postgraduate training required for board certification, can range from three years for family practice to seven years for neurological surgery. Moreover, many specialties require an additional one to three years in the form of fellowships. Assuming that additional years of training are required in order to increase experience and develop more specialized skills and knowledge, the number of years of required residency training by specialty is used as a proxy for the marginal product for physicians by specialty.

H4: The length of residency training required for a medical specialty is negatively related to the degree of hospital physician integration in that specialty.

The second measure I use is a more direct measures of physician productivity by specialty. I approximate for the marginal productivity of physicians in a specialty by the median national work Relative Value Unit (RVU) by medical specialty.

Every procedure and visit is assigned a physician work RVU by the Centers for Medicare & Medicaid Services (CMS). The work RVU accounts for the time, technical skill and effort, mental effort and judgment, and stress to provide a service. The CMS is responsible for maintaining and refining the methodology for estimating RVUs and works with the American Medical Association/Specialty Society Relative Value Scale Update Committee to improve the accuracy of estimates. The organization determines RVUs for new services and updates RVUs to reflect current practices and the latest technologies (Ginsberg & Berenson, 2007). Since private insurance companies also use the work RVU in order to determine physician payments, all physicians track RVUs for work done. Consequently, I would expect that physicians in medical specialties that report higher RVUs would want to keep control and a larger share of revenues, lowering the likelihood of integration.

H5: Median physician work Relative Value Unit (RVU) reported in a medical specialty is negatively related to the degree of hospital physician integration in that specialty.

3.4 Risk

The double-sided moral hazard model also predicts that an increase in risk σ^2 will increase the probability of vertical integration. As the level of uncertainty increases for the agent, so does the desirability of vertical integration. Malpractice liability and changes in the Medicare physician fee schedule are two major sources of uncertainty for physicians. Physicians' concerns about malpractice risk are pervasive (Carrier, Reschovsky, Mello, Mayrell, & Katz, 2010). In a survey of physicians, Carrier et. al. (2010) find that concerns about malpractice risk vary

across specialties and are higher in specialties that are generally thought to be at higher risk for malpractice claims. Indeed, malpractice risk varies among specialties in several different ways. In a study using physician-level malpractice claims obtained from a large professional liability insurer, Jena, Seabury, Lakdawalla, & Chandra (2011) characterized the proportion of physicians facing a malpractice claim in a given year, the proportion of physicians making an indemnity payment, and the size of this payment. There was significant variation across specialties in the probability of facing a claim, ranging annually from 19.1% in neurosurgery, and 18.9% in thoracic–cardiovascular surgery, to 5.2% in family medicine, and 2.6% in psychiatry. However, high risk specialties were not always the specialties in which paid indemnity claims or the highest average payment size were most prevalent. For example, the average payment for neurosurgeons (\$344,811) was less than the average payment for pathologists (\$383,509) or for pediatricians (\$520,924), even though neurosurgeons were several times more likely to face a claim in a year. Physicians in specialties that perceive a high risk of malpractice may want to insure against this uncertainty by becoming more tightly integrated with a hospital. Moreover, the actual cost and hassle of maintaining malpractice insurance may also push physicians towards integration. On the other hand, hospitals may be better able to pool malpractice insurance risk and negotiate better insurance rates. In many cases, hospitals also face malpractice claims in conjunction with a physician. Therefore, hospitals also face strong incentives to integrate and have more control over physicians in order to mitigate malpractice risks.

H6: In medical specialties where physicians are at a higher malpractice risk there will be a higher degree of hospital physician integration.

3.5 Data and Methods

Sample and Data

The data for this study are from the population of short-term, acute care, general hospitals in the state of California. These hospitals have an average length of stay of less than 30 days and provide a comprehensive range of services. The data were acquired from state-mandated annual hospital disclosure reports provided to the California Office Statewide Health Planning and Development (OSHPD). Data includes financial and utilization data by payer, income, expenses, cost center data, employee information, hospital and non-hospital based medical staff by specialty, and governance information. Kaiser and Shriner hospitals were omitted from the sample as they are not required to submit all financial information by state statute. The empirical analysis for Study 1 covers the eighteen year period 1994-2011 and includes 5,061 hospital-year observations. The average number of hospitals in any year is $n=333$ and ranges from 296 to 397 hospitals.

Dependent Variable

Degree of Vertical Integration: I measure the degree of vertical integration as the percent of hospital-based physicians out of the total number of physicians with hospital privileges. OSHPD defines a hospital-based physician as a physician who spends the predominant part of his practice time within one or more hospitals instead of in an office setting. Such physicians have a financial arrangement (salary or contract) under which they are compensated by or through a hospital for in-patient and/or outpatient services. A non-hospital-based physician refers to a physician other than hospital-based that is on the hospital's active medical staff

and has staff privileges (OSHPD, 2003).

The mean percentage of all hospital-based physicians increased from 24% to 31% from 1994-2011. This positive trend is not driven by changes in only select hospitals. The variance of hospital-based physicians within a hospital over time is only slightly less than the variance across hospitals. Additionally, the overall trend masks differences in the percentage of hospital-based physicians by specialty. For example, the percentage of internal medicine physicians that are hospital-based increases in the second half of the time period (2003-2011), whereas the percentage of hospital-based thoracic surgeons falls over the same period.

Explanatory Variables

Hospital Effort: I approximate hospital effort using measures in three areas. The first is the quality of nursing staff. In order to measure the quality of nursing, I use the percent of personnel who are registered nurses employed in the performance of direct nursing care to patients and the nurse to patient ratio as reported in the OSHPD data. These measures are also available at the medical specialty level. The second measure I use to approximate hospital effort is investment in hospital facilities. To measure this, I use the annual facilities and equipment investment scaled by hospital size, which is also obtained from the OSHPD data. The third measure is a reputation-based measure from the US News and World Report Rankings. I use a binary measure that takes the value of one if the hospital is mentioned in the top 50 hospitals for any specialty. The rankings have been shown to largely represent subjective reputations (Sehgal, 2010) and are thus well suited to represent another dimension of hospital effort.

Physician Effort: I measure physician effort using two measures at the level

of medical specialty. The first measure is the length of residency by medical specialty, which is collected from the Graduate Medical Education Directory from the American Medical Association (AMA). The second measure is the historical median relative value unit (RVU) by medical specialty, which is compiled yearly from annual survey data and reports from the Medical Group Management Association (MGMA) and American Medical Group Association (AMGA). Data is only available for 2005-2011.

Risk: I construct a measure of overall malpractice risk using data reported by Jena, Seabury, Lakdawalla, & Chandra (2011) and Carrier et al. (2010) in order to identify high risk medical specialties. The measure is a product of the proportion of physicians facing a malpractice claim, the proportion of physicians making an indemnity payment, and the size of this payment. This measure accounts for the fact that physicians who are more likely to face a claim may not necessarily make large payments or be required to make payments at all.

Control Variables

Hospital size: Larger hospitals may be more able to take advantage of economies of scope and scale and thus have better health care outcomes and financial performance. Hospital size has been a significant predictor of hospital financial performance in the literature (Graeff, 1980). Following other studies of the hospital industry (Ketchen, Thomas & Snow, 1993) I use the number of licensed beds as a proxy for organization size.

Teaching hospital: The dual missions of providing health care to a market as well as providing graduate education may put academic hospitals at a distinct competitive disadvantage to their nonacademic counterparts (Blumenthal, Campbell,

and Weissman, 1997). Therefore, it is important to acknowledge these different organizational missions and control for teaching status.

Type of control: Hospital type (non-profit, for-profit, district, city/county) has been shown to have a significant influence on performance (Graeff, 1980). A for-profit hospital will likely have different organizational goals from those of the non-profit hospital (Zajac and Shortell, 1989).

Market Rivalry: The Herfindahl-Hirschman Index (HHI) is used as a measure of market rivalry in each hospital market. The HHI has been used extensively in the strategy literature as a measure for market rivalry (Boyd, 1990) and to characterize competition in hospital markets (Zwanzigler & Melnick, 1988). Prior literature (Gruber, 1994; Duggan, 2002; Douglas & Ryman 2003) has found that increased competition changes the behavior and impacts the performance of hospitals. Local hospital markets are defined using Health Service Area (HSAs), which are calculated by the CDC. A HSA is relatively self-contained with respect to the provision of routine hospital care and reflects current travel patterns between counties for hospital care (CDC, 1991).

Network: Hospitals that are part of a network may be able to take advantages of both economies of scope and scale and thus have better health care outcomes and financial performance. Hospitals that are part of a network may also be in a better position to bargain with insurance companies and physician group practices, and thus affect the degree of hospital physician integration.

Year: I control for the upward trend in hospital physician integration by adding in a variable for the year.

Model

In order to test these hypotheses, I run models using hospital level data and models at the medical specialty level. I use hospital panel data models to investigate the effect of hospital effort on hospital physician integration. There are challenges to using a linear regression model when the dependent variable is a proportion, and thus limited to values between 0 and 1 (Gujarati, 1995). Therefore, I first estimate the models with hospital physician integration using panel linear regression and robust standard errors. Then, following common econometric practice (Greene, 2003), I also estimated models with a log-odds transformation of hospital physician integration.⁴ Following new research on panel data methods with fractional response variables (Papke & Wooldridge, 2005), I estimate models using a generalized estimating equation approach (GEE) in which I specified a probit link function and an exchangeable correlation matrix and computed robust errors. I compare results from these three alternative specifications.

Both hospital fixed effects or random effects can be used to control for unobserved heterogeneity, such as organizational culture or differences in practices across hospitals (Greene, 2003). I used Hausman tests to confirm that fixed effects models are preferable to random effects models. I tested for heteroscedasticity using the Breusch-Pagan test (Greene, 2003) and report White robust standard errors. Additionally, I lagged explanatory variables one year in order to reduce concerns of reverse causality and simultaneity. Finally, I checked for first-order autocorrelation and higher-order correlations using the Durbin-Watson statistic

⁴The transformed variable is as follow: $\ln(integration/1-integration)$. Because the transformation is undefined when integration is equal to 0 or 1, I recoded these values as follows: 0=0.0001 and 1= 0.9999.

and the Breusch-Godfrey tests (Greene, 2003).

For physician effort and risk which are collected on the medical specialty level, I use multivariate regression models with clustered standard errors at the hospital level. I do not run fixed effect models because a specialty-level fixed effect model does not allow for time-invariant explanatory variables and for specialties within a hospital to be grouped. Since specialties are nested within a hospital, it is expected that those specialties' outcomes will be correlated. Thus, I use panel linear regression with Huber clustered sandwich standard errors, which relaxes the assumption of independence of observations.

3.6 Results

Table 1 reports descriptive statistics and correlations for hospital level variables. The panel was unbalanced and consisted of 397 hospitals and 5,016 hospital-year observations covering the period 1994-2011. Table 2 presents the results of the hospital level fixed effects panel regression analysis used to test Hypotheses 1-3. I estimated these models using hospital fixed effects in order to control for unobserved heterogeneity and because Hausman specification tests supported the use of fixed effects. Table 3 reports descriptive statistics and correlations for specialty level variables. The specialty level dataset consisted of 397 hospitals and 30,138 specialty-year observations covering the period from 1994-2011. For Model 5, due to limited data availability for mean physician RVU, the sample consisted of 316 hospitals and 10,255 specialty-year observations covering the period from 2005-2011. The specialties that I was able to collect data for and join with hospital physician integration data were: anesthesiology, cardiovascular diseases, gas-

troenterology, general surgery, obstetrics and gynecology, and psychiatry. Table 4 presents the results of the multivariate regression analysis used to test hypotheses 4-6.

For ease of interpretation, the results reported in Table 2 and 4 are for untransformed hospital physician integration. These results are consistent with the results using a logit transformation and those from GEE estimation (See Appendix C for logit transformation and GEE results). Huber-White (or clustered) robust standard errors are reported, and all significance levels are for two-tailed tests. None of the models reported have problems with multicollinearity. The variance inflation factor (VIF) for all variables in each model are below recommended values (Greene, 2003).

Hypothesis 1 predicts a positive relationship between quality of nursing staff and hospital physician integration. The results of the hospital level fixed-effects panel analysis in Table 2 do not support this hypothesis. On the contrary, there is evidence for an inverse relationship. Model 2 in Table 2 shows that an increase in the nurse to patient ratio results in lower hospital physician integration. Models 2-4 with specialty level data reported in Table 4 support this result. The registered nurse share has a significant negative relationship with hospital physician integration. Hypothesis 2 predicts that increases in a hospital's facility and equipment investment leads to a higher degree of hospital physician integration. Model 3 in Table 2 provides support for this hypothesis. A 1% increase in facilities investment leads to a 3% increase in hospital physician integration. Models with specialty level data reported in Table 4 show a similar effect size and are also statistically significant. Hypothesis 3 predicts that hospitals with higher reputation will have a higher degree of hospital physician integration. Model 4 in Table 2 does not lend

support for Hypothesis 3 at the hospital level. However, at the specialty level, all models in Table 4 provide support for a positive relationship between hospital reputation and integration. Therefore, with the exception of nursing quality, the positive effect of hospital effort on hospital physician integration is supported by the data.

Hypothesis 4 predicts that increased physician effort, as proxied by the length of residency training, is negatively related to integration. Physician residency length exhibits a negative and significant effect on hospital physician integration in that medical specialty in Model 4 (Table 4). Hypothesis 5 predicts a negative relationship between median physician RVU by specialty and integration. The effect of physician RVU is not significant in Model 5. Finally, Hypothesis 6 predicts that increased malpractice risk will be positively related to hospital physician integration. Model 4-6 in Table 4 show that the impact of increased malpractice risk in a specialty on hospital physician integration is positive and significant. Regarding control variables, city and county hospitals and teaching hospitals also increase integration. In sum, there is partial support for the impacts of hospital effort and physician effort on hospital physician integration, and positive support for the impact of risk on integration. A summary of Study 1 results is shown in Table 5. The Wald statistics at the bottom of Table 2 and 4 indicate that each model provide significant improvement in fit relative to the baseline model.

Table 1 – Hospital-Level Descriptive Statistics and Correlations^a

	mean	sd	min	max	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Hospital Physician Integration	0.31	0.34	0	1													
2. Nurse to patient ratio	0.39	0.26	0	9.8	0.03												
3. Registered nurse proportion	0.64	0.17	0	1	-0.01	0.12											
4. Facilities investment ^b	12.64	1.06	4.3	15.3	0.09	0.01	0.37										
5. Reputation	0.03	0.18	0	1	0.18	0.06	0.14	0.19									
6. Size	225.4	182.7	10	2045	0.04	-0.05	0.26	0.26	0.41								
7. Teaching	0.07	0.25	0	1	0.20	0.03	0.14	0.19	0.51	0.50							
8. Rural	0.18	0.38	0	1	0.12	-0.01	-0.33	-0.04	-0.08	-0.39	-0.12						
9. Network	0.38	0.48	0	1	-0.08	-0.04	0.19	0.11	-0.09	0.05	-0.10	-0.16					
10. Non-profit	0.54	0.50	0	1	-0.03	0.00	0.19	0.37	0.10	0.22	0.06	-0.09	0.07				
11. Investor	0.27	0.44	0	1	-0.17	0.06	0.05	-0.43	-0.10	-0.21	-0.16	-0.20	0.19	-0.66			
12. District	0.13	0.34	0	1	0.10	-0.06	-0.34	0.01	-0.07	-0.19	-0.10	0.43	-0.23	-0.41	-0.24		
13. Market Rivalry	0.07	0.04	0.02	0.18	0.08	-0.01	0.06	0.26	-0.01	-0.11	0.01	0.16	0.01	0.17	-0.30	0.11	
14. Year	2002	5.2	1994	2002	0.06	0.07	0.04	0.34	0.02	0.05	0.02	0.04	0.08	0.01	-0.03	0.03	0.14

^a $n(\text{hospitals}) = 397$; $n(\text{observations}) = 5016$ ^b Logarithm

Table 2 – Results of Fixed-Effects Panel Linear Regression Analysis Predicting Hospital Physician Integration^a

Variables	Model 1		Model 2		Model 3		Model 4	
Constant	0.45***	(0.10)	0.49***	(0.13)	0.20	(0.16)	0.20	(0.16)
Size	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Network	0.00	(0.02)	-0.02	(0.02)	-0.03	(0.02)	-0.03	(0.02)
Non-profit	-0.39***	(0.09)	-0.36***	(0.12)	-0.34***	(0.12)	-0.34***	(0.12)
Investor	-0.41***	(0.09)	-0.43***	(0.11)	-0.41***	(0.11)	-0.41***	(0.12)
District	-0.26**	(0.11)	-0.31**	(0.14)	-0.29**	(0.13)	-0.29**	(0.14)
Market rivalry	1.09	(0.72)	0.98	(0.69)	0.90	(0.68)	0.90	(0.68)
Year	0.00**	(0.00)	0.00**	(0.00)	0.00*	(0.00)	0.00*	(0.00)
Nurse to patient ratio			-0.13***	(0.02)	-0.13***	(0.02)	-0.13***	(0.02)
Registered nurse share			0.05	(0.07)	0.04	(0.07)	0.04	(0.07)
Facilities investment ^b					0.03***	(0.01)	0.03***	(0.01)
Reputation							-0.01	(0.02)
R^2	0.62		0.66		0.67		0.67	
Wald χ^2			17.32***		15.61***		11.79***	

^a $n(\text{hospitals}) = 397$; $n(\text{observations}) = 5016$. Huber-White sandwich robust standard errors in parentheses.

^b Logarithm

Two-tailed tests. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Table 3 – Specialty-Level Descriptive Statistics and Correlations^a

	Mean	sd	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Hospital Physician	0.19	0.38	0	1																
Integration																				
2. Nurse to patient ratio	4.8	139	0	10283	-0.01															
3. Registered nurse share	0.84	0.20	0	1	-0.09	0.02														
4. Facilities investment ^b	13	1.16	5.3	15.3	0.11	0.00	0.13													
5. Reputation	0.05	0.21	0	1	0.16	0.00	0.07	0.19												
6. Risk	0.7	0	1	18.90	0.05	0.02	0.38	0.00	0.00	-										
7. Physician Effort	5.42	0.90	4	6.7	-0.12	0.01	0.10	0.00	0.00	0.03										
8. Physician RVU ^b	8.8	0.22	8.1	9.0	0.06	0.01	0.36	0.00	0.00	0.00	0.46									
9. Size	278	190	10	1395	0.16	0.01	0.24	0.26	0.41	0.00	0.00	0.00								
10. Network	0.45	0.48	0	1	-0.01	-0.01	0.09	0.11	-0.10	0.00	0.00	0.00	0.05							
11. Teaching	0.10	0.30	0	1	0.20	0.01	0.09	0.19	0.52	0.00	0.00	0.00	0.52	-0.11						
12. Rural	0.12	0.32	0	1	-0.08	0.00	-0.16	-0.04	-0.09	0.00	0.00	0.00	-0.40	-0.17	-0.13					
13. Non-profit	0.59	0.50	0	1	0.02	0.00	0.10	0.37	0.11	0.00	0.00	0.00	0.22	0.09	0.06	-0.09				
14. Investor	0.25	0.43	0	1	-0.07	0.00	-0.02	-0.43	-0.09	0.00	0.00	0.00	-0.19	0.19	-0.16	-0.20	-0.65			
15. District	0.10	0.29	0	1	-0.06	-0.01	-0.12	0.01	-0.07	0.00	0.00	0.00	-0.19	-0.24	-0.11	0.44	-0.42	-0.23		
16. Market Rivalry	0.07	0.04	0.02	0.17	0.02	0.00	-0.02	0.26	-0.01	0.00	0.00	0.00	-0.11	0.01	0.01	0.16	0.18	-0.26	0.07	
17. Year	2002	5.18	1994	2012	0.03	0.01	0.01	0.23	0.02	0.00	0.00	0.05	0.05	0.08	0.02	0.05	0.01	-0.03	0.03	0.13

^a $n(\text{hospitals}) = 397$; $n(\text{observations}) = 30138$.

^b Logarithm

Alternative Explanations and Robustness Checks

I considered several alternative explanations and assessed the robustness of the results. First, I added year-dummies to all models to control for the possibility that there were shocks in certain years. The results were similar to those obtained with a time trend. Next, I considered the potential simultaneity of hospital effort and hospital physician integration. Perhaps increased hospital physician integration causes hospitals to make larger investments in facilities and equipment and the quality of nursing staff. The ideal solution approach to rule out endogeneity would be to find an instrument that is correlated with hospital effort but is not related to hospital physician integration. Unfortunately, a good instrument is not available in my dataset. Instead, I run models testing the effect of hospital physician integration (lagged by either one or two years) on the quality of nursing staff and investment in facilities and equipment and find no significant effects of reverse causality.

At the specialty level, a parallel endogeneity problem is that greater hospital physician integration would lead to changes in physician effort variables. However, I would expect these effects to take place over a period of time longer than the study length. The length of physician residencies by specialty did not change from 2005-2011. Even though there have been calls for lengthening the family medicine residency to four years since the early 2000's (Saultz & David, 2004) pilot programs to explore the possibility were only launched in 2013. I run reverse causality models and find no significant effects.

Table 4 – Results of Fixed-Effects Panel Linear Regression Analysis Predicting Hospital Physician Integration^a

Variables	Model 1	Model 2	Model 3	Model 4	Model 5 ^c
Constant	0.33*** (0.07)	0.13 (0.13)	-0.02 (0.13)	0.26** (0.13)	0.49* (0.28)
Size	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Network	0.02 (0.02)	0.02 (0.02)	0.03 (0.02)	0.03 (0.02)	0.01 (0.03)
Teaching	0.20** (0.08)	0.14* (0.07)	0.14* (0.07)	0.14** (0.07)	0.21** (0.09)
Rural	-0.04 (0.03)	-0.05 (0.03)	-0.05 (0.03)	-0.05 (0.03)	-0.02 (0.04)
Non-profit	-0.23*** (0.06)	-0.24*** (0.06)	-0.23*** (0.06)	-0.24*** (0.06)	-0.32*** (0.08)
Investor	-0.25*** (0.07)	-0.25*** (0.07)	-0.25*** (0.07)	-0.25*** (0.07)	-0.37*** (0.09)
District	-0.23*** (0.07)	-0.26*** (0.07)	-0.26*** (0.07)	-0.26*** (0.07)	-0.32*** (0.09)
Market	0.12 (0.31)	0.03 (0.32)	0.03 (0.32)	0.03 (0.32)	-0.07 (0.46)
Rivalry					
Year	0.0** (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.01 (0.00)
Nurse to patient ratio		-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00** (0.00)
Registered nurse share		-0.13*** (0.02)	-0.18*** (0.02)	-0.17*** (0.02)	0.02 (0.02)
Facilities Investment ^b		0.03*** (0.01)	0.03*** (0.01)	0.03*** (0.01)	0.02* (0.01)
Reputation		0.20*** (0.07)	0.20** (0.07)	0.20** (0.07)	0.20* (0.10)
Risk ^b			0.03*** (0.00)	0.03*** (0.00)	0.02*** (0.01)
Physician effort				-0.05*** (0.00)	-0.003 (0.00)
Physician RVU ^b					-0.02 (0.03)
R^2	0.06	0.09	0.10	0.11	0.14
Wald χ^2		22.8***	33.75***	55.87***	5.83***

^a $n(hospitals) = 397$; $n(observations) = 30138$. Huber-White sandwich robust standard errors in parentheses.

^b Logarithm

^c Due to data availability for RVU (only available 2005-2011) $n(hospitals) = 316$; $n(observations) = 10255$

Two-tailed tests. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Table 5 – Summary of Study 1 Results Predicting Hospital Physician Integration

	Hypothesized relationship	Results
<u>Hospital effort</u>		
H1 Quality of nursing	+	–
H2 Facilities and equipment investment	+	✓
H3 Reputation	+	✓
<u>Physician effort</u>		
H4 Residency length	–	✓
H5 Median RVU	–	×
<u>Risk</u>		
H6 Risk	+	✓
<u>Controls</u>		
City/County		+
Teaching		+

3.7 Discussion

This study was motivated by both the lack of research on the circumstances leading to hospital physician integration and the limited application of agency theory to explain vertical integration. The strategy literature on vertical integration largely takes a transaction cost approach, forgetting formal agency models. Meanwhile, the literature on hospital physician integration has focused on the benefits of integration, with little consideration to the determinants of integration. Without examining the circumstances leading to integration, studies that explore the impact of integration on financial performance and health care quality may be biased. Hospitals may be responding to circumstances to integrate. Indeed, this research has produced inconclusive empirical results regarding the impact of integration.

This study addressed these limitations by using a moral hazard approach to investigate the circumstances that may lead to vertical integration of hospitals

and physicians. The moral hazard theoretical framework suggested hospital effort, physician effort, and risk play different roles in hospital physician integration. Regarding hospital effort, I drew on the double-sided moral hazard model to predict that the marginal productivity of hospital effort has a positive relationship with hospital physician integration. When hospitals contribute relatively more to patient care and profits in terms of facilities and equipment investment, the quality of nursing staff, and reputation, hospital physician integration increases. Hospitals want a larger share of control and profits, while physicians may be more attracted to integration in these circumstances. Regarding physician effort, the double-sided nature of the moral hazard model generated parallel predictions in the opposite direction. I predict that increases in the marginal productivity of physician effort have a negative relationship with hospital physician integration. In other words, as the importance of physician effort to providing patient care and generating revenue increases, the less likely that the physician will integrate with hospitals. Regarding risk, the double-sided moral hazard model predicts that an increase in risk will increase the probability of vertical integration. As the level of uncertainty increases for the agent, so does the desirability of vertical integration. Together, these three predictions bring light onto the circumstances surrounding hospital physician integration by characterizing the hospital physician relationship as a principal agent relationship.

The empirical results are consistent with the predictions of the theoretical framework. I predicted a positive relationship between hospital effort and integration, yet depending on the measure of hospital effort I find different results. When hospital effort is represented by the quality of nursing staff I find evidence of a negative relationship with integration. On the other hand, when I use facilities

and equipment investment and reputation to represent hospital effort I find evidence that hospital effort strengthens hospital physician integration. I speculate on the quality of nursing staff result below. I also find positive support for the effect of hospital reputation on integration. Reputation is used as a proxy for the marginal productivity of hospital effort since hospitals with high reputations can attract patients and increase revenues. Additionally, hospitals with high reputations might be more inclined to integrate in order to retain more control. I also found partial support for the effect of physician effort on integration. Physician residency length exhibits a negative and significant effect on hospital physician integration. However, physician RVU by specialty does not show a statistically significant relationship with integration. Finally, the results show that the impact of risk on hospital physician integration is positive and significant. The results do not seem to be biased by endogeneity and are robust to the use of many hospital level controls, alternative specification and estimation routines, and firm fixed effects.

Although I predicted a positive effect of hospital effort, I found a negative relationship between the nurse to patient ratio and integration. There is one likely possible explanation for this result: nursing care is a partial substitute for physician care. Indeed, Laurant, Reeves, Hermens, Braspenning, Grol, and Sibbald (2005) review the literature on the shift of the provision of patient care from doctors to nurses. They find that nurses act as substitutes for physicians and are able to provide a quality of care comparable to physicians at a lower cost. This argument suggests that the parameter estimates for nurse to patient ratio might be biased. Perhaps hospitals increase the nurse to patient ratio in order to avoid integrating additional physicians. In the absence of a instrumental variable, I tested additional

models that controlled for the physician to patient ratio and find similar results to those without this additional control. Although a detailed investigation into the complex relationship between nursing staff, physician staff, and the production of patient care is an important topic for future research, it is beyond the scope of this study.

This study is the first step in understanding hospital physician integration. First, this study contributes to the strategy literature by using a formal moral hazard model to address vertical integration. Using a principal agent model to predict the circumstances of vertical integration extends the use of agency theory in strategy beyond explaining payment structures and corporate governance (Eisenhardt, 1988). Questions of firm boundaries or “make or buy” decisions in the strategy literature have usually been examined using a transaction cost approach. This study shows that agency theory may be a better fit to explaining employment relationships when two parties are working together to produce a service or product. Many firms are making decisions on whether or not to hire contract workers whom will work with employees to jointly produce a product or service. Using agency theory may help researchers understand these types of firm boundary decisions.

Secondly, this study contributes to the literature on hospital physician integration. This literature has solely focused on outcomes without addressing possible antecedents. Existing research does not explore the circumstances in which hospitals integrate with physicians. The results of this study suggest that there may be factors that drive hospitals physician integration. Hospital effort, physician effort, and risk are all important circumstances that affect when integration occurs. These findings should be considered in conjunction with studies that study

the impact of integration on quality and financial performance such as in Study 2. Prior conflicting findings on the impact of integration may be confounded by ignoring the circumstances that systematically drive integration (Ciliberto & Dranove, 2006; Cuellar & Gertler, 2006). The findings of this study suggest that the circumstances surrounding integration should be taken into account.

Finally, the results of this study have managerial implications. The findings confirm that differing circumstances both on the hospital and physician level affect vertical integration. The theory and results point to integration as a way to solve a moral hazard problem. This implies that integration should be done in the correct circumstances and may not be a one size fits all solution. Managers should understand these larger economic forces and remember them when evaluating their choices about integrating with physicians. For example, integrating with physicians in specialties that require more training may require higher levels of hospital effort and contributions to patient care. Although this may seem commonsense to hospital managers, moving to a larger understanding of the dynamics of hospital physician integration can sensitize managers to the importance of understanding their relationships with physicians.

The results and contributions of this study should be considered in light of its limitations. First, I use proxies for the marginal productivity of hospital and physician effort instead of the more complicated route of calculating a production equation for patient care. Production functions in health care are complicated and attaining a measure for the true marginal contributions of hospital and physician to patient care is difficult. Therefore, the measures I use for hospital effort and physician effort are second best.

Secondly, the way I have measured hospital physician integration is rooted in

the way hospital-based physicians are defined in the OSHPD reports. The definition of hospital-based physicians does not take into account the nature of financial arrangements between hospitals and physicians. For example, some hospitals pay physicians a salary, some bill jointly for physicians and pay all expenses, whereas some physicians are completely independent of hospital costs and revenues. The OSHPD dataset has limited information on the nature of these financial arrangements for some medical specialties. These data show that contracted financial arrangements are increasing, where the physician may pay any or all expenses and the hospital bills patients for the services provided and remits a fee to the physician. On the other hand, independent or separate financial arrangements, where no costs or revenues are received is becoming less predominant. Thus the measure I use for hospital physician integration may not fully capture true integration of hospitals and physicians, since there are no details on the financial arrangements of hospital based physicians.

Third, the data at the physician level is not as complete as I desired. The data on median RVU by physician specialty was only available for the six year period 2005-2011, instead of the entire study period (1994-2011). By matching data at the level of medical specialties across the different data sources, I lost observations on specialties that did not match. In addition, I was not able to collect annual data on risk by physician specialty. If I used fixed effects models at the hospital-specialty level, I would lose the ability to include my measure of risk as a variable. Similarly, the physician residency lengths did not change during this time period, which would have also been omitted in fixed effects analyses. Thus, the analysis at the physician level is not as robust as I would have liked.

Finally, the archival data used in this study cannot provide direct evidence of

the causal processes that I hypothesized. My data do not allow me to observe the process by which hospitals and physicians decide to integrate. Indeed one of the hypotheses about the nurse to patient ratio was the opposite of my theoretical predictions. A better understanding of what underlies hospital physician integration decisions and negotiations is needed to validate the causal inferences of this study.

3.8 Conclusion

The question of under what circumstances are we likely to observe vertical integration of hospitals and physicians is fundamental to understanding the future of healthcare. For strategy researchers, using a principal agent relationship to explain organizational boundaries can help understand how organizations adapt, thrive, and survive. This study confirms that agency theory is a useful lens for examining hospital physician integration. Studying the impact of hospital physician integration without addressing antecedents is half of the picture. In particular, the results suggest that integration occurs when risk is high and depends on the relative marginal contributions of both parties to joint production. In Study 2, I investigate the impact of hospital physician integration on financial performance and quality of care, taking into account the circumstances that lead to integration at the hospital level.

4 Study 2: Impact of Vertical Integration

Having considered the factors that lead to hospital physician integration, I explore the effects of vertical integration on financial performance and health care quality. First, taking into account both efficiency and market power arguments, I investigate the impact of vertical integration on hospital financial performance. Next, I examine the impact of vertical integration on health care quality. The attention to both financial performance and health care outcomes is important in order to account for any tradeoffs that are made between quality and financial performance. Prior literature shows that quality and financial outcomes are inversely related (Bazzoli, Chen, Zhao, Lindrooth, 2007; Encinosa, Bernard, 2005; Burstin, Lipsitz, Udvarhelyi, & Troyen, 1993). Moreover accounting for both quality and financial performance allows an understanding of when vertical integration is more likely to benefit consumers, which is key to any public policy discussion. Finally, in order to better understand the processes that are at work and eliminate alternative explanations, I explore organizational moderators that affect the relationship between integration and financial and health care outcomes.

4.1 Financial performance

What is the impact of hospital physician integration on hospital financial performance? This research question follows directly from the focus in Study 1 on the antecedents to integration. According to both agency and transaction cost theory, integration happens as a result of efficiency pressures. These efficiency based theories suggest that due to competitive pressures, firms integrate until the efficiency benefits are offset by the cost of integration, such as incentive degradation and inef-

iciencies in internal coordination (Harrigan, 1984; Hill & Hoskisson, 1987; Jones & Hill, 1988; Williamson, 1985). The moral hazard model proposed in Study 1 is an efficiency-based model. The model and results suggest that integration solves the moral hazard problem. Physicians (agent) incentives are brought into alignment with the hospital (principal). Indeed, in the hospital physician relationship literature, researchers have long pointed to the discrepancy in physician and hospital incentives under a fee-for-service model as a source of inefficiency and high costs in health care. Burns and Muller (2008) summarize the health services literature on how hospital physician integration could potentially align incentives, increase care coordination, and result in more efficient resource use. The moral hazard model implies that productivity and profit should increase while costs should decrease now that hospitals and physician are on the same team. Additionally, the more efficient integrated organizations would be able to offer lower prices and compete more effectively. Thus we would expect that integration would lead to increased financial performance.

The creation and exploitation of market power is also another potential driving force behind integration. In this case, hospitals with significant market power could bargain for higher reimbursement rates with payers or bargain with physicians for services. The two market-power theories on integration are double marginalization and vertical foreclosure (Hart & Tirole, 1990; Ordoover, Saloner, & Salop, 1990; Salinger, 1988). Double marginalization occurs when firms at each stage in the supply chain extract monopoly profits, resulting in multiple mark-ups and large price increases for consumers (Greenhut & Ohta, 1979; Spengler, 1950). Thus, when a firm integrates, even with the motive to gain market power, the reduction of double-marginalization results in lower consumer prices and larger profits. I

would expect that in smaller or isolated geographic markets where physicians also have significant market power, that double marginalization would be likely and that integration would likely lower prices and increase hospital profits. This effect on financial performance parallels the effect of increased efficiency and would be difficult to distinguish empirically.

On the other hand, the theoretical prediction of vertical foreclosure is an increase in prices. Foreclosure occurs when integration reduces access between sellers and buyers. Foreclosure can disadvantage competitors or potential competitors in a manner that prevents entry and exit from sustaining a perfectly competitive market. For example, hospitals could integrate with the bulk of physicians in the area, making it difficult for other hospitals to enter the market. This would especially be true if the minimum efficient scale is reached at larger output levels (Gaynor, Kleiner, & Vogt, 2014). There is evidence that hospitals do not operate in a perfectly competitive environment and that indeed market power influences hospital decision-making. Researchers have shown that when hospitals have relatively greater market power, hospitals have the ability to negotiate higher prices and earn higher profit (Melnick, Shen, & Wu, 2011).⁵ Likewise, results from Study 1 (Table 2) show that increased market rivalry leads to greater hospital physician integration. Thus using this reasoning, we would expect that greater hospital physician integration leads to price increases and increased profits.

Taken together, the theories above are unclear what the effect of integration is on prices. Correspondingly, the empirical results concerning this relationship are mixed. Cuellar and Gertler (2006) find that integration is associated with an

⁵Higher prices from payers does not necessarily translate to higher consumer prices in health care since by in large payers are the government or insurance companies.

increase in prices, while Ciliberto and Dranove (2006) find that increased vertical integration in California hospitals did not change prices. However, the efficiency based theories and market-power theories predict that integrated hospitals will show increased financial performance.

H1: Hospital physician integration leads to increased financial performance.

4.2 Health Care Outcomes

In this section I turn attention from monetary-based measures of performance to the quality of care provided to patients. It is possible that as prices fall, productivity increases, or profits rise, the quality of patient care declines. This may especially be the case in the United States, as payers are typically not the patient.⁶ Despite the lack of empirical evidence that hospital physician integration will lead to improved health care quality, there is broad support for this idea (Kochner & Sahni, 2010). The enthusiasm for integration is largely based on aligning incentives between the hospital and physician. There are also additional benefits to integration, such as physical proximity and the ability to access the same information systems that can have a positive impact on the quality of care.

There are many challenges associated with measuring the quality of health care. The subject is the focus of much academic research (Campbell and Roland, and Buetow, 2000; McGlynn, 1997; Brook, McGlynn, and Cleary, 1996; Donabedian, 1988) and the mission of the Agency for Healthcare Research and Quality (AHRQ), a branch of the U.S. Department of Health and Human Services.

⁶Ideally, patient care business models are not completely divorced from the improved health care of patients, but the two do not always go hand in hand.

Quality of care can be evaluated on the basis of outcome or process. Outcome measures are based on health status and improvement in patients after care (e.g., improvement in symptoms). Process measures assess the degree to which health care adheres to processes that are proven by scientific evidence and professional consensus to affect outcomes (e.g., proper tests ordered). The relative merits of these types of measures has led to vigorous debate over the past decade (Rubin, Pronovost, & Diette, 2001). The AHRQ uses process measures when assessing the performance of provider care. Process measures are highly acceptable to providers because they demonstrate clearly how providers can improve their outcomes. Additionally, physicians are more accountable for the process of care than for the outcomes, which can be affected by many other things such as nutrition, environment, lifestyle, and socioeconomic status. Many process measures are quite robust, with tight, evidence-based links between process performance and patient outcomes. For example, a process measure with strong medical backing is that eligible patients with acute myocardial infarction should received a beta-blocker at hospital discharge (Brand, Newcomer, Freiburger, and Tian, 1995).

These types of process based measures of quality are appropriate when examining the impact of integration. Hospitals and physicians can arguably work together more effectively to ensure that quality processes are followed. The other random factors that affect the patient health outcomes will not affect this analysis. I measure quality of care using two sets of indicators developed by AHRQ. The Inpatient Quality Indicators (IQI) are a set of measures that use hospital discharge records to assess the quality of care inside hospitals. I also use the Patient Safety Indicators (PSI), which are calculated for medical conditions and surgical procedures that have been shown to have complication/adverse event rates that vary

substantially across institutions and for which evidence suggests that high complication/adverse event rates may be associated with deficiencies in the quality of care. Healthcare researchers have suggested that the integration of hospitals and physicians will lead to better care (Kocher & Sahni, 2010; Robison & Casalino, 1996). As the nature of providing health care is complex and unpredictable, integration may address these difficulties by eliminating the need for care coordination across firm boundaries and reducing the opportunities for lapses in quality of care to occur. Thus, I predict that hospital physician integration leads to an increase inpatient quality and patient safety.

H2: Hospital physician integration leads to an increase in the quality of health care.

H3: Hospital physician integration leads to an increase in patient safety.

The moral hazard model developed in Study 1 is based on the idea that competitive market forces push organizations toward efficiency. This leads to the conclusion that organizations that integrate under the right circumstances will outperform other organizations. Without taking into account the circumstances that lead to integration, the estimated integration effect on performance could be biased. Therefore, I investigate the impact of integration, controlling for hospital effort variables from Study 1.

4.3 Organizational Factors

Due to the conflicting empirical results in the literature on the effect of integration on prices (Baker, Bundorf, & Kessler, 2014; Cuellar & Gertler, 2006; Ciliberto & Dranove, 2006), Gaynor (2006) suggests that in order to understand the true

effects of hospital physician integration, researchers need to uncover the specific processes that are at work when hospitals and physicians integrate. In this section, I hypothesize several organizational factors that moderate the relationship between hospital physician integration and financial performance and health care outcomes. Integration is not just about aligning incentives, but about the other processes, programs, and structures that hospitals can implement to leverage integration for positive outcomes (Burns and Muller, 2008). In other words, the use of organizational design is just as important as the financial integration of hospitals and physicians. I use the organizational design framework developed by Nadler and Tushman (1997) to develop moderator hypotheses. The organizational design framework includes five components: structure, controls/incentives, processes, human capital, and organizational cultures. Due to the lack of available data, I do not measure each of these components, but am able to capture many of the most important ones. The organizational factors that I suggest are coordination of care investment, physician leadership, physician governance, and the implementation of quality improvement processes and programs.

The delivery of health care commonly spans many different providers, often in several locations. Fragmentation of care can lead to patients not getting the care they need, receiving duplicative care, and increasing the risk for poor quality of care and medical errors. For example, if a patient is discharged from the hospital after surgery, often follow up care is with the patient's primary care provider. This follow up care can be crucial to preventing complications and subsequent readmissions. Specific technologies, such as electronic health records (EHR/EMR), computerized clinical decision support systems, and computerized physician order entry, and more general technological capabilities such as data

processing and telecommunications have been cited as methods to increase care coordination and quality of care (Cebul, Love, Jain, & Hebert, 2011; GAO, 2010; Garg, Adhikari, McDonald, Rosas-Arellano, Devereaux, Beyene, Sam, & Haynes, 2005; Kaushal, Shojania, Bates, 2003; Gaynes & Solomon, 1996). An essential tool that has been found to facilitate care coordination is the electronic health record (EHR/EMR). The EHR is an electronic collection of information about the health of an individual or the care provided, such as patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory and imaging data (GAO, 2010). For example, EHRs have been shown to increase the quality of diabetes care (Cebul, Love, Jain, & Hebert, 2011; McCullough, Casey, Moscovice, & Prasad, 2010; Himmelstein, Wright, & Woolhandler, 2010). Improved data processing and telecommunications has been shown to reduce hospital acquired infections (Gaynes & Solomon 1996), reduce medication error rates (Kaushal, Shojania, Bates, 2003), and improve patient outcomes (Garg, Adhikari, McDonald, Rosas-Arellano, Devereaux, Beyene, Sam, & Haynes, 2005). Thus, I expect that investment in care coordination technologies by hospitals will maximize the positive outcomes resulting from integration.

H4: Investment in care coordination technologies positively moderates the effect of hospital physician integration on financial performance and health care outcomes.

The next organizational factors concern the presence of physician leadership and governance in hospital management. Although there are increasing expectations that hospitals and physicians will collaborate to solve many problems that the health system is facing, in many markets the willingness and ability for hospi-

tals and physicians to work together is actually eroding as cost pressures increase (Berenson, Ginsburg, & May, 2007). In the face of these mounting challenges, there are renewed calls for physician managers and physician CEOs (Falcone and Satiani, 2008) to create a climate of collaboration and interdependence (Cohn, Gill, & Schwartz 2005). Physician leadership and involvement in governance are seen as additional ways to align incentives and improve communication and processes that span hospital employees and the physician medical staff. The limited empirical evidence supports the link between physician leadership and governance and quality outcomes. Goodall (2011) finds a strong positive relationship between the USNWR rankings of hospitals and hospitals with physician CEOs. Similarly, there is evidence that physician participation on the board also enhances operational performance and measures of clinical involvement and quality (Molinari, Alexander, Morlock, & Lyles, 1995; Weiner, Shortell, & Alexander, 1997). Thus, I expect that physician leadership and physician governance in hospitals will maximize the positive outcomes resulting from integration.

H5: Physician leadership positively moderates the effect of hospital physician integration on economic and health care outcomes.

H6: Physician governance positively moderates the effect of hospital physician integration on economic and health care outcomes.

The final organizational factor that I consider is the investments in quality improvement processes and programs. Physicians are trained and deeply rooted in the tradition of providing the best treatment and care for patients. At times, this has been seen to be at odds with the efficiency pressures facing hospitals. Research indicates that physicians are essential to increasing the focus on quality

in hospital settings (Weiner, Shortell, & Alexander, 1997). However, the limited research on the impact of quality programs on outcomes is mixed (Shortell, Jones, Rademaker, Gillies, Dranove, Hughes, Budetti, Reynolds, & Huang 2000; Shortell, O'Brien, Carman, Foster, Hughes, Boerstler, O'Connor, 1995). In an early study, Shortell et al. (1995) find that quality improvement implementation was positively associated with greater perceived patient outcomes. Therefore, I hypothesize that quality improvement processes and programs in hospitals will maximize the positive financial and health care outcomes resulting from integration.

H7: Investment in quality improvement processes and programs positively moderates the effect of hospital physician integration on financial performance and health care outcomes

4.4 Qualitative Data and Results

The purpose of this study is to test the effects of hospital physician integration on hospital financial performance and health care outcomes. I plan to use both qualitative and quantitative methods. The goal of combining methods is to increase the validity of measures through triangulation and to generate greater understanding of the mechanisms underlying quantitative results (Edmonson & McManus, 2007). The qualitative data is used to confirm measures of organizational factors that moderate the effect of integration on performance.

4.4.1 Qualitative Methods

I conducted in-depth field interviews with 15 hospital executives. These interviews allowed me to better understand hospital physician integration and how it

could influence performance and quality. It is especially important in the complicated context of health care to get inside the organization in order to truly understand the dynamics of the relationship between hospitals and physicians. Furthermore, since there is limited empirical evidence on the relationship between the organizational factors proposed and outcomes, the qualitative data is essential in establishing validity. Finally, since there are a multitude of processes and external factors that affect performance outcomes, the process of gathering qualitative data helps narrow the measures chosen in the quantitative portion of this study and identify opportunities for future studies.

I contacted a total of 20 hospital and physician's group executives, including CEOs, chief medical officers (CMOs), and other C-level executives (e.g. chief nursing officer, chief operating officer) in both California and Washington for interviews. These semi-structured interviews followed the interview protocol in Appendix B. The focus of each interview was the respondent's experience with hospital physician integration and their experience managing physicians in order to achieve hospital performance goals. The protocol was designed to be flexible in order to enhance the flow of conversation and to allow respondents the time and scope to talk about their unique experiences and voice their opinions.

I used content analysis in order to reduce the amount of data and organize responses to identify trends (Weber, 1990). After the interviews, the notes and transcripts were transcribed. The unit of analysis is an idea. I classify each data unit into a set of pre-determined and emergent categories. Next, the data are reduced through a count of responses and the creation of composite responses. This process aggregated the data, generalized findings with similarities, and identified exceptions among respondents. This enabled me to confirm the moderators pro-

posed for the quantitative analysis as well as assess what unexpected relationships or issues might emerge from the data. This process also resulted in ideas and propositions to be developed for further study.

4.4.2 Results of Qualitative Analysis

Table 5 reports the most prevalent ideas, along with example quotes and summaries of interview content. The 15 hospital executives that were interviewed included: 7 Chief Medical Officers (CMO or Medical Director), 4 Chief Executive Officers (CEO), and 4 Other Executive Administrators (Director of Nursing, Chief Operating Officer, Medical Executive, Senior VP for physician alignment). Each interview lasted approximately 1 hour and occurred between June and October 2012. To prepare for each interview, I familiarized myself with the history and management structure of each hospital using material attained from hospital websites and news articles about the hospitals.

The most prevalent idea in the qualitative data collected was the importance of care coordination in both increasing the quality of care and improving the financial performance of hospitals. Types of care coordination discussed included EHR/EMR systems, health IT systems, care conferences, and increased communication among teams of physicians and other types of healthcare providers (e.g. nurses, social workers). Interviewees detailed efforts they made in order to better coordinate care. They also shared ideas and future plans to increase care coordination. Physician governance and physician leadership were also very prevalent ideas that surfaced during the interviews. Hospital executives talked about the need to have physicians involved in self-governance and take leadership roles in order for integration to have beneficial effects, or in some cases in place of for-

Table 6 – Summary of In-Depth Field Interviews^a

Ideas	Quotes and Summaries
Care Coordination	<ul style="list-style-type: none"> - <i>“Need to move to a team structure of healthcare professionals of all sorts, not just physicians.”</i> - <i>“Integrated physicians are connected and have incentives to go to meetings where decisions are made.”</i> - <i>“Care coordination is key to prevent readmissions and also to reduce preventable admissions.”</i> - Technology integration is essential, but not straight-forward. Many departments and physician practices are on different systems without access to information on other systems. Takes time to migrate to a similar system.
Physician Governance	<ul style="list-style-type: none"> - <i>“Physicians need to be included at the administrative level. They need to attend the same meetings.”</i> - <i>“Physicians need to have a voice.”</i> - <i>“Guidelines need to be developed by a group of affiliated physicians and the agreement (between hospital and physician) is built into the system.”</i> - <i>“Self-governance is crucial.”</i>
Physician Leadership	<ul style="list-style-type: none"> - <i>“Now with the new environment, you need physicians who are in leadership roles.”</i> - <i>“Physician leaders who are accountable to the hospital and have a broader perspective is key to a more patient centered culture.”</i> - <i>“Cannot do provider integration without provider education. Must be done in parallel. Need a formal program of physician leadership.”</i>
Importance of history	<ul style="list-style-type: none"> - Physician integration is highly dependent on past relationships with physician groups, historical affiliations, and existing contracts. - Culture is also highly dependent on history as well, and takes time to change.
Patient centered culture	<ul style="list-style-type: none"> - <i>“Physicians need to be stewards.”</i> - <i>“Cultural integration is just as important.”</i> - <i>“Need to reorient culture from a silo and tribal identity (departments) to a patient-centered approach.”</i>
Quality and Utilization Management	<ul style="list-style-type: none"> - <i>“Quality measures need to be developed by physicians.”</i> - <i>“They owned it (quality metrics) and took a lot of pride in it.”</i> - <i>“Quality is achieved through culture.”</i> - <i>“Safety and quality are team based approaches.”</i>
Financial integration	<ul style="list-style-type: none"> - <i>“Ultimate integration needs to happen with payors.”</i> - Financial contracts (salary, productivity pay) important in determining behavior and access to healthcare.

^a Interview subjects: 7 Chief Medical Officers, 4 Chief Executive Officers, 4 Other Administrators (Director of Nursing, Chief Operating Officer, Medical Executive, Senior VP for physician alignment)

mal integration. To this end, many of the hospitals had formal programs for physician leadership and governance. For example, a CMO who was interviewed mentioned the importance of compensating for physicians for their time in leadership roles and governing committees, so that the physicians are accountable to the hospital. Another one of the most prevalent ideas was the importance of history. Every hospital executive emphasized how historical relationships between the hospital and physician groups in the area influenced their integration with physicians. They also emphasized how the history of these relationships and the history of the hospital in the community affects the culture at the hospital. The next most frequently mentioned idea is the importance of a patient-centered culture. According to respondents, having a patient-centered culture is just as important as formal integration or quality metrics to align incentives between hospitals and physicians. Interviewees mentioned history, physician governance, and leadership as things that can change the culture to be more patient-centered. Lastly, interviewees mentioned quality metrics and financial integration as important variables in determining outcomes and physician behaviors. For example, several executives mentioned that physician contracts that combined salary with RVU scaled pay were the most effective at motivating access to care while also aligning physician with hospital efficiency objectives.

The qualitative portion of this study was motivated by a desire to better understand hospital physician integration from within the organization. The results of the interviews confirm the moderator hypotheses 4-7 that predict that care coordination, physician leadership, physician governance, and quality improvement programs will positively moderate the relationship between integration and financial performance and health care outcomes. The perspective of the majority of

interviewees was that financial integration of physicians was just the first step. True integration with positive health care benefits would not occur without coordination, physician governance, and physician leadership. Additionally, since hospitals are complex organizations that balance quality of care with the need to survive financially, it was especially informative to get insider perspectives. Indeed, research on the effects of hospital physician integration (Cuellar & Gertler, 2006; Ciliberto & Dranove, 2006) has produced conflicting empirical results, suggesting that a more nuanced approach is needed. The results support the hypotheses that predict that care coordination, physician governance, physician leadership, and quality improvement programs affect the relationship between integration and financial performance and health care outcomes.

4.5 Quantitative Data and Results

4.5.1 Quantitative Methods

Design and Sample

The data for this study are from the population of short-term, acute care, general hospitals in the state of California from 2001-2011. These hospitals have an average length of stay of less than 30 days and provide a comprehensive range of services. The financial and managerial data were acquired from state-mandated annual hospital disclosure reports provided to the California Office Statewide Health Planning and Development (OSHPD). Kaiser and Shriner hospitals were omitted from the sample as they are not required to submit all financial information by state statute. Due to hospital openings, closings, and mergers, the panel is unbalanced with the total number of hospitals ranging from $n=296$ to $n=330$ hospitals in any given year.

The health outcomes data is from the California State Inpatient Database (SID), which was developed as part of the Healthcare and Utilization Project (HCUP). The database includes inpatient discharge records for all patients, regardless of payer from 2003-2011. Each year of data contains on average 3.1 million usable discharge abstracts, for a total of approximately 28 million records. There are 12 hospitals that do not match between the SID database and the OSHPD data and were dropped. Thus the final sample is a total of 2648 hospital years, with the total number of hospitals in any year ranging from n=293 to n=330 hospitals.

Dependent Variables

Health Care Outcomes: In order to compare health care outcomes across hospitals, I calculate inpatient quality indicators (IQI) and patient safety indicators (PSI) that have been defined by the Agency for Healthcare Research and Quality (AHRQ). These indicators are then combined into composite measures that have been developed by the AHRQ and endorsed by the National Quality Forum, a not-for-profit organization created to develop and implement a national strategy for health care quality measurement and reporting.

The Inpatient Quality Indicators (IQI) are a set of measures that use hospital discharge records to assess quality of care inside the hospital. These indicators reflect quality of care inside hospitals and include inpatient mortality indicators for medical conditions and surgical procedures that have been shown to vary substantially across institutions and for which evidence suggests that high mortality may be associated with deficiencies in the quality of care. These indicators are measured as rates, the number of deaths divided by the number of admissions for the procedure or condition. These rates are then risk-adjusted, which removes the

confounding influence of patient mix (different profiles of risk that are not related to care). This allows for useful comparisons among hospitals. I use the inverse of rates so that a higher indicator represents an improvement in inpatient quality.

The Patient Safety Indicators (PSI) are calculated for medical conditions and surgical procedures that have been shown to have complication/adverse event rates that vary substantially across institutions and for which evidence suggests that high complication/adverse event rates may be associated with deficiencies in the quality of care. These indicators are measured as rates: the number of complications/adverse events divided by the number of admissions for the procedure or condition. The provider-level indicators include only those cases where a secondary diagnosis code flags a potentially preventable complication. All indicators used are risk-adjusted for patient mix to allow for useful comparisons. I use the inverse of rates so that a higher indicator represents an improvement in patient safety.

Financial Performance: I use operating margin, total margin, and return on assets (ROA) to measure the financial performance of hospitals. These measures are commonly used in health services and economic research to assess hospital financial performance (Zeller, Stanko, Cleverly, 1996; Goes & Zhan, 1995; Bazzoli, Chen, Zhao, & Lindrooth, 2008). Even though 54% of hospitals in the sample are non-profit, the ability of hospitals to generate revenue from patient services is essential to their mission of providing care and overall financial viability. Therefore, hospitals may not be organized to make a profit, but profit is nonetheless a primary factor (Zeller, Stanko, & Cleverly 1996).

Table 7 – Descriptive Statistics and Correlations^a

	mean	sd	min	max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Inpatient Quality	1.14	0.21	0.55	3.42															
2. Patient Safety	0.88	0.28	0.22	2.50	-0.18														
3. Operating Margin	-0.01	0.18	-4.47	0.54	-0.06	-0.01													
4. Hospital Physician Integration	0.32	0.34	0	1	-0.03	0.04	0.00												
5. Nurse to patient ratio	0.41	0.18	0	4.76	-0.15	0.14	0.01	0.08											
6. Facilities investment ^b	12.83	1.14	5.31	15.33	0.12	0.16	0.15	0.14	0.14										
7. Physician Leadership	0.07	0.27	0	2	-0.07	0.05	-0.04	-0.02	0.03	0.00									
8. Physician Governance	0.27	0.20	0	1	-0.05	-0.11	0.08	-0.24	0.00	-0.24	0.14								
9. Quality improvement	0.02	0.01	0	0.07	-0.16	0.00	0.03	-0.19	-0.03	-0.08	0.08	0.10							
10. Coordination investment	0.07	0.03	0	0.20	-0.08	0.10	0.03	0.12	0.15	0.33	0.03	-0.17	0.08						
11. Network	0.41	0.49	0	1	0.01	-0.05	0.12	-0.08	-0.03	0.07	0.01	0.19	0.20	-0.07					
12. Non-profit	0.54	0.50	0	1	0.08	0.03	0.19	0.00	0.06	0.44	-0.02	-0.19	0.02	0.14	0.17				
13. Investor	0.25	0.44	0	1	-0.14	-0.05	-0.03	-0.21	0.02	-0.53	0.09	0.53	0.19	-0.31	0.13	-0.64			
14. District	0.14	0.35	0	1	0.07	0.01	-0.10	0.09	-0.10	0.01	-0.09	-0.20	-0.20	0.10	-0.26	-0.44	-0.24		
15. Size	231.74	183.62	10	1395	0.10	0.07	0.07	0.04	-0.01	0.24	0.06	-0.05	0.00	0.06	0.05	0.21	-0.17	-0.21	
16. Market Rivalry	0.07	0.04	0.02	0.18	0.15	0.15	0.08	0.08	0.00	0.31	0.01	-0.17	-0.05	0.10	0.05	0.20	-0.34	0.11	-0.10

^a $n(\text{hospitals}) = 330$; $n(\text{observations}) = 2648$

^b Logarithm

Independent Variables

Degree of Vertical Integration: I measure the degree of vertical integration as the percent of hospital-based physicians out of the total number of physicians with hospital privileges. A hospital-based physician is a physician who spends the predominant part of his practice time within one or more hospitals instead of in an office setting. Such physicians have a financial arrangement (salary or contract) under which he/she is compensated by or through a hospital for inpatient and/or outpatient services. A non-hospital-based physician refers to a physician other than hospital-based that is on the hospital's active medical staff and has staff privileges (OSHPD, 2003).

Coordination: I measure coordination expenditures as the sum of hospital expenditures on communications, data processing, and medical records. This does not include expenditures on fiscal services, such as billing and accounting. Communication costs include expenses incurred in operating the communications systems within and outside the hospital. Data processing covers costs incurred in the operation of the hospital's electronic data processing system. Medical records includes the maintenance of a records system for the use, transcription, retrieval, storage, and disposal of patient medical records, and the production of indexes, abstracts, and statistics for hospital management and medical staff uses. Included as direct expenses are: salaries and wages, employee benefits, professional fees, supplies, purchased services, equipment depreciation/leases/rentals, other direct expenses, and transfers.

Physician Leadership: Physician leadership is a dummy variable that takes the value of one when the CEO of the hospital is a physician (MD or DO) or the

chairman of the board is a physician (MD or DO). This variable is coded from the managerial data acquired from the OSHPD financial data.

Physician Governance: Physician involvement in hospital governance is measured as the proportion of all board members who were physicians (MD or DO). This variable is coded from the managerial data acquired from the OSHPD financial data.

Quality Improvement: I measure quality improvement as hospital expenditures on utilization management. Utilization management includes those activities involved in the monitoring and improvement of patient care. Costs typically include utilization review, quality assurance, infection control, and risk management. Each of these activities involves screening some aspect of patient care, analyzing patient care data, implementing corrective action when required, monitoring care to determine whether issues have been resolved. Included as direct expenses are: salaries and wages, employee benefits, professional fees, supplies, purchased services, equipment depreciation/leases/rentals, other direct expenses, and transfers.

Controls

Hospital size: Larger hospitals may be more able to take advantage of economies of scope and scale and thus have better health care outcomes and financial performance. Hospital size has been a significant predictor of hospital financial performance in the literature (Graeff, 1980). Following other studies of the hospital industry (Ketchen, Thomas & Snow, 1993) I use the number of licensed beds as a proxy for organization size.

Teaching hospital: The dual missions of providing health care to a market as well as providing graduate education may put academic hospitals at a distinct com-

petitive disadvantage to their nonacademic counterparts (Blumenthal, Campbell, and Weissman, 1997). Therefore, it is important to acknowledge these different organizational missions and control for teaching status.

Type of control: Hospital type (non-profit, for-profit, district, city/county) has been shown to have a significant influence on performance (Graeff, 1980). A for-profit hospital will likely have different organizational goals from those of the non-profit hospital (Zajac and Shortell, 1989).

Market Rivalry: The Herfindahl-Hirschman Index (HHI) is used as a measure of market rivalry in each hospital market. The HHI has been used extensively in the strategy literature as a measure for market rivalry (Boyd, 1990) and to characterize competition in hospital markets (Zwanzigler & Melnick, 1988). Prior literature (Gruber, 1994; Duggan, 2002; Douglas & Ryman 2003) has found that increased competition changes the behavior and impacts the performance of hospitals. Local hospital markets are defined using Health Service Area (HSAs), which are calculated by the CDC. A HSA is relatively self-contained with respect to the provision of routine hospital care and reflects current travel patterns between counties for hospital care (CDC, 1991).

Network: Hospitals that are part of a network may be able to take advantages of both economies of scope and scale and thus have better health care outcomes and financial performance.

Model

I use hospital panel data models to investigate the effect of hospital physician integration on financial performance and health care outcomes. Both hospital fixed effects or random effects can be used to control for unobserved heterogeneity, such

as cultural factors or differences in business practices across hospitals (Greene, 2003). I used Hausman tests to confirm that fixed effects models are preferable to random effects models. For each outcome of interest (operating margin, inpatient quality, and patient safety) I run a baseline control model (Model 1). Model 2 adds the direct effect of integration on outcomes. Model 3 includes the direct effect of the hypothesized moderators. In order to test the moderator hypotheses (Hypotheses 4-7), I use panel data models that include interaction terms between each moderator and the degree of vertical integration (Model 4). For significant interaction terms, I perform a significance test for slope differences (Greene, 2003). I tested for heteroscedasticity using the Breusch-Pagan test (Greene, 2003) and report White robust standard errors. Additionally, I lagged integration and hospital effort variables two years in order to reduce concerns of reverse causality and simultaneity. Finally, I checked for first-order autocorrelation and higher-order correlations using the Durbin-Watson statistic and the Breusch-Godfrey tests (Greene, 2003).

4.5.2 Results of Quantitative Analysis

Table 7 reports descriptive statistics and correlations for all variables. The panel was unbalanced and consisted of 330 hospitals and 2648 hospital-year observations covering the period 2002-2011. Results for the impact of financial performance are presented in Table 8 for operating margin. Similar results were obtained for models using total margin and return on assets as measures of financial performance (See Appendix C). Results obtained for health care outcomes of inpatient quality and patient safety are shown in Tables 9 and 10, respectively. I estimated these models using hospital fixed effects in order to control for unobserved heterogeneity and because Hausman specification tests supported the use of fixed effects. Huber-

Table 8 – Results of Fixed-Effects Panel Linear Regression Analysis Predicting Operating Margin^a

	Model 1	Model 2	Model 3	Model 4
Constant	-0.04 (0.07)	0.37*** (0.13)	0.46** (0.21)	0.43** (0.22)
Patient Safety (t-1)	-0.01 (0.01)	-0.02** (0.01)	-0.02** (0.01)	-0.02* (0.01)
Inpatient Quality (t-1)	0.03 (0.02)	0.03 (0.02)	0.03 (0.03)	0.03 (0.03)
Size	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Network	0.02 (0.02)	0.04 (0.03)	0.04 (0.03)	0.04 (0.03)
Non-profit	-0.01 (0.04)	-0.01 (0.04)	-0.15 (0.14)	-0.15 (0.13)
Investor	-0.04** (0.02)	-0.04* (0.03)	-0.16 (0.14)	-0.17 (0.13)
District	0.01 (0.02)	0.01 (0.02)	-0.08 (0.12)	-0.08 (0.11)
Market Rivalry	-0.62 (0.41)	-0.44 (0.43)	-0.55 (0.42)	-0.55 (0.42)
<u>Study 1 Variables</u>				
Integration (I)		0.00 (0.02)	-0.00 (0.01)	0.11 (0.12)
Nurse to patient ratio		-0.03 (0.02)	0.03 (0.04)	0.03 (0.04)
Facilities Investment ^b		-0.03*** (0.01)	-0.03*** (0.01)	-0.03*** (0.01)
<u>Moderators</u>				
Coordination ^b (C)			0.00 (0.02)	-0.01 (0.02)
Physician Leadership (PL)			0.02 (0.03)	0.01 (0.03)
Physician Governance (PG)			0.03 (0.02)	0.03 (0.03)
Quality Improvement ^b (QI)			-0.01 (0.01)	-0.01 (0.01)
<u>Two way interactions</u>				
C x I				0.03 (0.04)
PL x I				0.03 (0.03)
PG x I				-0.01 (0.08)
QI x I				0.00 (0.02)
R^2	0.62	0.62	0.63	0.63
Wald χ^2		3.48**	3.22***	2.36***

^a $n(\text{hospitals}) = 330$; $n(\text{observations}) = 2648$. Huber-White sandwich robust standard errors in parentheses.

^b Logarithm

Two-tailed tests. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Table 9 – Results of Fixed-Effects Panel Linear Regression Analysis Predicting Inpatient Quality^a

	Model 1	Model 2	Model 3	Model 4
Constant	2.09*** (0.19)	1.74*** (0.18)	2.33*** (0.23)	2.31*** (0.24)
Patient Safety	-0.18*** (0.02)	-0.13*** (0.02)	-0.11*** (0.02)	-0.11*** (0.02)
Operating margin (t-1)	-0.01 (0.03)	0.01 (0.03)	0.01 (0.04)	0.01 (0.04)
Size	0.00*** (0.00)	0.00*** (0.00)	0.00*** (0.00)	0.00*** (0.00)
Network	0.00 (0.02)	-0.01 (0.03)	-0.02 (0.03)	-0.02 (0.03)
Non-profit	-0.10 (0.08)	-0.09 (0.09)	-0.19** (0.08)	-0.17** (0.08)
Investor	-0.03 (0.05)	-0.03 (0.06)	-0.11* (0.06)	-0.08 (0.06)
District	-0.06 (0.05)	-0.06 (0.05)	-0.13*** (0.03)	-0.12*** (0.03)
Market Rivalry	6.39 (0.77)	6.14 (0.77)	4.90*** (0.67)	4.81*** (0.66)
<u>Study 1 Variables</u>				
Integration (I)		-0.01 (0.03)	-0.03 (0.03)	0.00 (0.00)
Nurse to patient ratio		0.16 (0.11)	0.48*** (0.08)	0.48*** (0.08)
Facilities Investment ^b		0.02 (0.01)	0.01 (0.01)	0.01 (0.01)
<u>Moderators</u>				
Coordination ^b (C)			0.05** (0.03)	0.03 (0.03)
Physician Leadership (PL)			0.08*** (0.02)	0.10*** (0.03)
Physician Governance (PG)			-0.03 (0.04)	-0.03 (0.05)
Quality Improvement ^b (QI)			0.08*** (0.02)	0.10*** (0.03)
<u>Two way interactions</u>				
C x I				0.09* (0.05)
PL x I				-0.07 (0.04)
PG x I				-0.01 (0.10)
QI x I				-0.04 (0.03)
R^2	0.57	0.58	0.62	0.62
Wald χ^2		1.75	13.76***	9.33***

^a $n(\text{hospitals}) = 330$; $n(\text{observations}) = 2648$. Huber-White sandwich robust standard errors in parentheses.

^b Logarithm

Two-tailed tests. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Table 10 – Results of Fixed-Effects Panel Linear Regression Analysis Predicting Patient Safety^a

	Model 1	Model 2	Model 3	Model 4
Constant	2.86*** (0.00)	3.43*** (0.00)	2.68*** (0.00)	2.69*** (0.00)
Inpatient Quality	-0.41*** (0.05)	-0.39*** (0.05)	-0.29*** (0.05)	-0.29*** (0.05)
Operating margin (t-1)	0.02 (0.05)	0.04 (0.06)	0.05 (0.07)	0.06 (0.07)
Size	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Network	-0.04* (0.02)	-0.03 (0.03)	-0.01 (0.03)	-0.01 (0.03)
Non-profit	0.03 (0.04)	0.03 (0.05)	0.09 (0.07)	0.11 (0.07)
Investor	0.06 (0.03)	0.05 (0.04)	0.11* (0.06)	0.12 (0.06)
District	-0.03 (0.03)	-0.03 (0.03)	0.04 (0.04)	0.04 (0.04)
Market Rivalry	-4.56*** (1.02)	-4.28*** (1.00)	-3.73*** (1.06)	-3.83*** (1.04)
<u>Study 1 Variables</u>				
Integration (I)		-0.03 (0.03)	-0.03 (0.03)	0.00 (0.00)
Nurse to patient ratio		-0.10 (0.06)	-0.27*** (0.10)	-0.27*** (0.10)
Facilities Investment ^b		-0.05*** (0.02)	-0.04** (0.02)	-0.04** (0.02)
<u>Moderators</u>				
Coordination ^b (C)			-0.07** (0.37)	-0.08*** (0.05)
Physician Leadership (PL)			-0.08** (0.04)	0.02 (0.05)
Physician Governance (PG)			-0.07 (0.05)	-0.12* (0.10)
Quality Improvement ^b (QI)			-0.06*** (0.02)	-0.05** (0.02)
<u>Two way interactions</u>				
C x I				0.05 (0.07)
PL x I				-0.33*** (0.09)
PG x I				0.25* (0.14)
QI x I				-0.03 (0.04)
R^2	0.44	0.45	0.46	0.46
Wald χ^2		3.51**	7.08***	6.78***

^a $n(\text{hospitals}) = 330$; $n(\text{observations}) = 2648$. Huber-White sandwich robust standard errors in parentheses.

^b Logarithm

Two-tailed tests. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

White (or clustered) robust standard errors are reported, and all significance levels are for two-tailed tests. The Wald statistics at the bottom of each table reports incremental improvement in fit relative to the baseline Model 1. None of the models reported have problems with multicollinearity. The variance inflation factor (VIF) for all variables in each model are below recommended values (Greene, 2003).

Hypothesis 1 predicts a positive relationship between hospital physician integration and financial performance. The results of the fixed-effects panel analysis in Table 8 do not support this hypothesis. Hypothesis 2 predicts that increases in hospital physician integration will lead to improvements in inpatient quality. Model 2 in Table 9 does not support this hypothesis. Similarly, Hypothesis 3 predicts that increases in integration will lead to improvements in patient safety. Likewise, there is no empirical evidence in Table 10 to support this hypothesis. In sum, there is no evidence of the direct effects of integration on hospital performance.

The results for organizational factors that positively moderate the relationship between integration and performance are shown in Tables 8, 9, and 10. Model 3 tests the direct effects of coordination, physician leadership, physician governance, and quality improvement on performance. Model 4 includes the interaction terms with the degree of hospital physician integration for each moderator. Hypothesis 4 predicts that hospitals with larger care coordination investments are better able to reap the benefits of integration, thus increasing financial and health care performance. There is partial support for this hypothesis. The interaction of integration and coordination in Model 4 (Table 9) predicting inpatient quality is significant. To better interpret the significant interaction, I plot the results in Figure 1, using one and two standard deviations above and below the mean for coordination investments. The differences in slopes for the values of coordination shown are sig-

nificant ($p < 0.05$). As shown in Figure 1, the lines depict an increasingly positive relationship between integration and inpatient safety as coordination increases. This is consistent with my prediction that coordination positively moderates the relationship between integration and inpatient quality. As shown in Model 4 (Table 8 and Table 10), the interaction effects of integration and coordination on operating margin and patient safety are not significant. However, Models 3 and 4 (Table 10) show that coordination investments have a direct negative direct on patient safety.

Hypothesis 5 predicts that physician leadership will positively moderate the relationship between integration and performance. The results from Model 4 do not support this hypothesis, instead showing that physician leadership is a negative moderator of the relationship. The interaction of physician leadership and integration in Model 4 (Table 10) predicting patient safety is significant and negative. I plot the effect of integration on patient safety for hospitals with and without physician CEOs in Figure 2. The dashed line depicts a strongly negative relationship between integration and patient safety when the hospital CEO is a physician. In contrast, the relationship is near zero under conditions of non-physician CEOs. Lastly, there is evidence from Models 3 and 4 (Table 9) that physician leadership has a positive direct effect on inpatient quality.

Hypothesis 6 predicts that physician governance will positively moderate the relationship between integration and performance. The results from Model 4 (Table 10) partially support this hypothesis for patient safety. The interaction of physician governance and integration is significant and positive. I plot the results in Figure 3, using one standard deviation above and below the mean for physician governance. The lines show a positive relationship between integration and patient

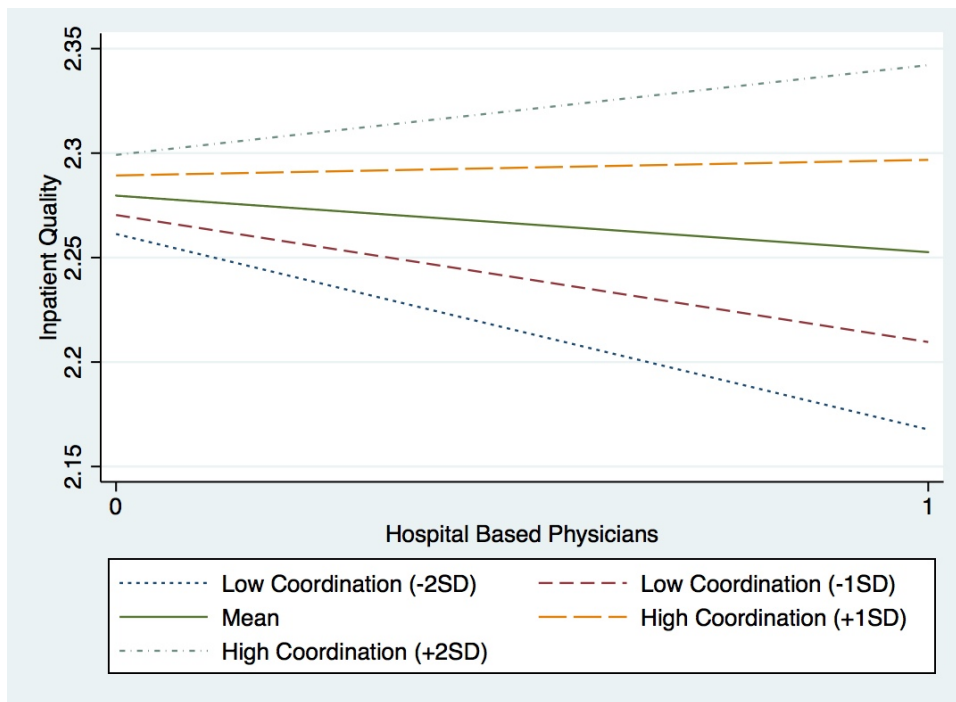
safety under high levels of physician governance. In contrast, under low levels of physician governance, the relationship between integration and patient safety is negative.

Lastly, Hypothesis 7 predicts that quality improvement will positively moderate the relationship between integration and performance. The interactions with integration in Model 4 are not significant. However, there is a significant direct relationship between quality improvement and health care outcomes. Quality improvement has a large positive and significant effect on inpatient quality, and a large negative effect on patient safety. Table 11 summarizes the results of Study 2 predicting hospital financial performance, inpatient quality, and patient safety.

Other additional relationships of note that were not hypothesized are also summarized in Table 11. Regarding control variables, increased market rivalry is shown to have a significant and positive effect on inpatient quality, and a negative relationship with patient safety. Additionally, the hospital effort variables from Study 1 are included in order to control for hospitals that are likely to integrate. The nurse to patient ratio and facilities and equipment investment have a positive effect on inpatient quality, and a negative effect on patient safety. Finally, the inpatient quality and patient safety have a strong and significant inverse relationship. This relationship between inpatient quality and patient safety permeates the results and will be discussed below.

Overall, there is no support for the direct impacts of hospital physician integration on performance. However, there is compelling support that physician governance and coordination investments positively moderate the relationship between integration and health care outcomes. There is also strong support for the positive direct impact of coordination investment, quality improvement programs,

Figure 1 – Inpatient Quality: Integration and Coordination Interaction



and physician leadership on inpatient quality. On the other hand, the data show that physician leadership is a negative moderator of the relationship between integration and patient safety. At the same time, there is also significant evidence for the negative impact of coordination investments, quality improvement, and physician leadership on patient safety. The Wald statistics at the bottom of each table indicate that models 2-4 provide significant improvement in fit relative to the baseline models.

Alternative Explanations and Robustness Checks

I considered several alternative explanations and assessed the robustness of the results. First, I added year-dummies to all models to control for the possibility that there are spikes in certain years that could affect these results. The results

Figure 2 – Patient Safety: Integration and Physician Leadership Interaction

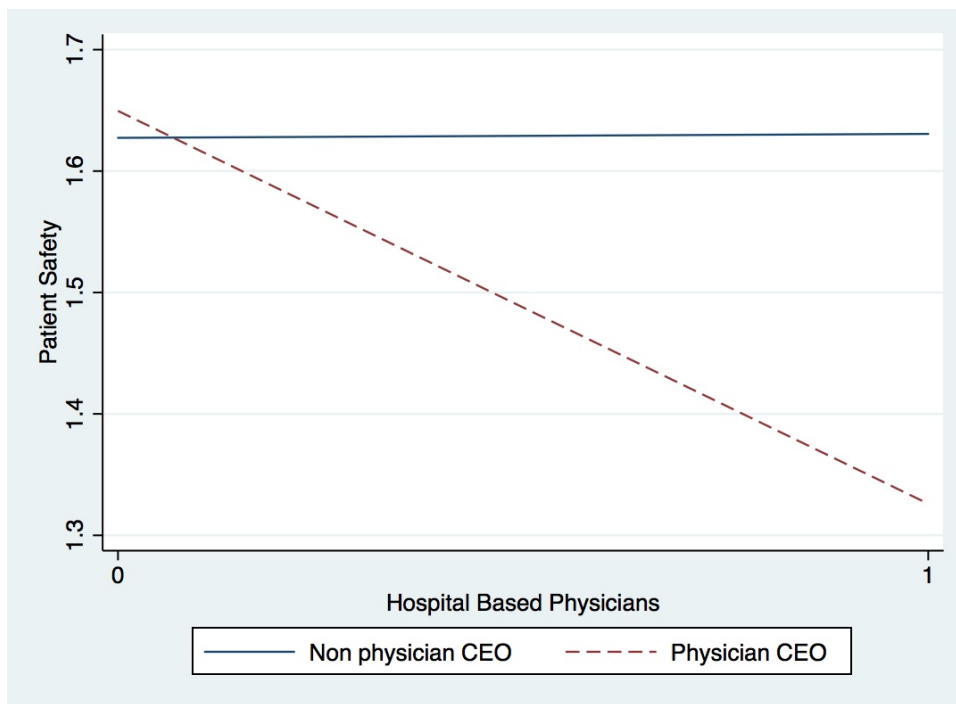
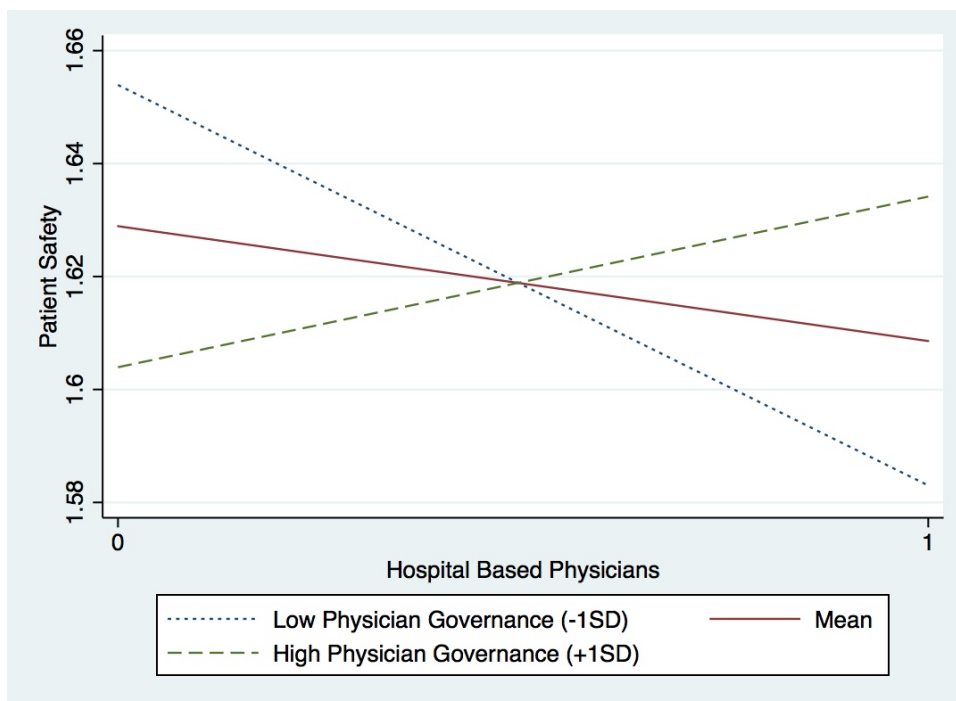


Figure 3 – Patient Safety: Integration and Physician Governance Interaction



were similar to those obtained without year dummies. I also added in a year variable to all models to control for time trends. The results were similar to those obtained without a time trend. Next, I considered the interaction of hospital effort measures with hospital physician integration and organizational moderators. These specifications did not produce compelling results I also considered models that considered a three way interaction of organizational moderators with hospital physician integration and hospital effort measures. The results were also not compelling, did not allow for useful interpretations, and the average marginal effects were similar.

Table 11 – Summary of Study 2 Results Predicting Hospital Performance

	Operating Margin Hypothesized Relationship	Operating Margin Results	Inpatient Quality Hypothesized Relationship	Inpatient Quality Results	Patient Safety Hypothesized Relationship	Patient Safety Results
<u>Hospital Physician Integration</u>						
H1: VI and Financial Performance	+	×	+	×	+	×
H2: VI and Inpatient Quality	+	×	+	×	+	×
H3: VI and Patient Safety	+	×	+	×	+	×
H4: Control for Hospital Effort	+	×	+	√	+	–
<u>Moderators</u>						
H5: Coordination	+	×	+	√	+	×
H6: Physician Leadership	+	×	+	×	+	–
H7: Physician Governance	+	×	+	×	+	√
H8: Quality Improvement	+	×	+	×	+	×
<u>Controls and Other Relationships</u>						
Market Rivalry				+		–
Physician Leadership Direct Effect				+		–
Quality Improvement Direct Effect				+		–
Coordination Direct Effect				+		–
Patient Safety and Inpatient Quality		–				

4.6 Discussion

This study was motivated by the lack of research on the effects of hospital physician integration on hospital financial performance and health care outcomes. Both efficiency based theories of integration and market-powered theories predict that integration will result in increased financial performance. However, the studies that investigate the effects of integration on prices are inconclusive (Baker, Bundorf, & Kessler, 2014; Cuellar & Gertler, 2006; Ciliberto & Dranove, 2006). The health services literature cites the potential of hospital physician integration to align incentives, increase care coordination, and result in more efficient resource use, but there is limited empirical evidence. Additionally, without examining the circumstances leading to integration, studies that explore the impact of integration on financial performance and health care quality may be biased.

This study attempted to address these limitations by investigating the impact of vertical integration on hospital financial performance, inpatient quality, and patient safety indicators. Each model controls for both financial performance and health care outcomes in order to account for tradeoffs that are made between quality and financial performance. The relationship between quality and financial performance has been established and thus cannot be ignored (Bazzoli, Chen, Zhao, Lindrooth, 2007; Encinosa, Bernard, 2005; Burstin, Lipsitz, Udvarhelyi, & Troyen, 1993). Finally, in order to better understand the processes that are at work and eliminate alternative explanations, I explore organizational moderators that affect the relationship between integration and financial and health care outcomes and were confirmed by the qualitative results above.

The quantitative results in do not support my predictions for a direct rela-

tionship between integration and performance. I predicted a positive relationship between hospital physician integration and financial performance and health care outcomes. Yet, I do not find a significant impact of integration on performance. There are two several likely possible explanations for this lack of results. The first is that in California, the largest increases in hospital physician integration occurred in the 1990s. For example, the mean hospital based physicians increased from 24% in 1994 to 30% in 2000, while there was little to no change in the average during the 2000s. Ideally, I would have health care outcome data from the 1990s and be better able to analyze this relationship when integration was changing. I was unable to obtain health care quality data previous to 2003 for this study.

The second possible explanation for the lack of relationship between hospital physician integration and performance concerns the measurement of the degree of hospital physician integration. I use the reported share of hospital-based physicians in the OSHPD financial database. The definition of hospital based physician used does not reflect the financial contract between the hospital and physician. Therefore, physicians that are under contract, bill jointly, or are paid a salary by the hospital, could still be counted as non hospital-based physicians. Previous studies that examine hospital physician integration measure integration by identifying organizational forms, which ranges from Independent Physicians Associations (IPAs) to Fully Integrated Organizations (OPHOs). These data are taken from the American Hospital Association surveys and were not available for this study. Ideally, I would like to reanalyze the data with these organizational forms as another measure of degree of vertical integration. However, even these measures of organizational forms may not accurately represent the degree of hospital physician integration. Many hospitals participate in several types of organizational forms

for different service lines, and even within a type of organizational form, there is much variation in the actual integration of clinical and financial systems. Perhaps in future studies measuring aspects of hospital physician integration, such as health IT system integration, scheduling, referral systems, payment management, and physician involvement in hospital management, may provide a measure of hospital physician integration that is both comparable across hospitals and truly represents meaningful integration.

The second set of predictions in this study concern organizational factors including care coordination investment, physician leadership, physician governance, and quality improvement. These results support the hypotheses that physician governance and coordination investments positively moderate the relationship between integration and health care outcomes. Thus there is partial support for Hypotheses 5 and 7. Investments in care coordination help hospitals take advantage of the quality benefits of hospital physician integration. Having a physician leader may facilitate clinical integration and thus increase the positive effects of integration on quality. There is also strong support for the positive direct impact of coordination investment, quality improvement programs, and physician leadership on inpatient quality. At the same time, the data show that physician leadership is a negative moderator of the relationship between integration and patient safety. Moreover, there is also significant evidence for the negative impact of coordination investments, quality improvement, and physician leadership on patient safety.

There are two things important to discuss. The first is that there is a direct impact of these variables on health care outcomes without an associated impact on financial performance. The evidence on impacts of coordination investments, quality improvement programs, and physician leadership is limited. Thus, these direct

relationships could be fruitful areas for future papers to focus on. The second thing to note is the inverse relationship between patient safety and inpatient quality, and the disparate effects of organizational factors on these two types of outcomes. Patient safety and inpatient quality are significant negatively correlated for the years 2003-2007, but then have a positive correlation from 2008- 2012. Patient safety improves over this entire time period as well. One possible explanation for the improvement in patient safety may be the increased attention paid to patient safety following the release of an Institute of Medicine report in 2000 that estimated that 98,000 die in hospitals each year as a result of medical errors (Kohn, Corrigan, & Donaldson, 2000). This report received a lot media attention and hospitals came under pressure to respond to gaps in patient safety. Perhaps this focus on patient safety came at the cost of less focus on inpatient quality. To my knowledge, there is no research on the relationship between inpatient quality and patient safety. Although a detailed investigation into the complex relationship between inpatient quality and patient safety is an important topic for future research, it is beyond the scope of this study.

The results from this study shed some light on the impact of hospital physician integration on performance. Organizational factors, such as physician governance and coordination investments are critical for hospitals to reap the quality benefits of hospital physician integration. However, the results bring up further questions for investigation, particularly about the relationship between inpatient quality and safety and the importance of organizational factors such as quality improvement, coordination, physician involvement in management. Another intriguing result is that physician leadership is a negative moderator to the relationship between integration and patient safety. Perhaps physicians do not make good managers,

or there are other factors such as organizational structure that physician managers perform better under. With the combined OSHPD financial and SID health outcomes database, I hope to further investigate some of these relationships.

The results and contributions of this study should be considered in light of its limitations. First, I use proxies for hospital and physician effort instead of the more complicated route of calculating a production equation for patient care. I also do not calculate productivity measures for hospital production. Likewise, I do not create a price index for hospitals. Measuring prices for hospital procedures and treatment is quite complicated and was outside of the scope of this study. However, linking economic indicators, such as productivity and prices, to the existing financial and health outcomes data would be a fruitful area for future research.

Secondly, the way I have measured hospital physician integration is rooted in the way hospital-based physicians are defined in the OSHPD reports. Thus the measure I use for hospital physician integration may not fully capture true integration of hospitals and physicians, since there are no details on the financial arrangements of hospital based physicians. Since there are endless variation of financial arrangements, perhaps measuring aspects of hospital physician integration, such as physician involvement in management, may provide a measure of hospital physician integration that is both comparable across hospitals and truly represents meaningful integration.

Finally, the archival data used in this study cannot provide direct evidence of the causal processes that I hypothesized. My data do not allow me to observe how integration and organizational factors affect financial performance and health care outcomes.

4.7 Conclusion

Taken together, the findings from Study 1 and Study 2 are a step towards further understanding hospital physician integration. This study contributes to the strategy literature by using a formal moral hazard model to address vertical integration. Using a principal agent model to predict the circumstances of vertical integration extends the use of agency theory in strategy beyond explaining payment structures and corporate governance (Eisenhardt, 1988). Secondly, this dissertation also contributes to the literature on hospital physician integration. The health services literature has not explored the circumstances in which hospitals integrate with physicians. Prior conflicting findings on the impact of integration may be confounded by ignoring the circumstances that systematically drive integration (Ciliberto & Dranove, 2006; Cuellar & Gertler, 2006). The results of this study suggest that hospital effort, physician effort, and risk are all important circumstances that affect when integration occurs.

There are several important contributions that result from this research. The first is that organizational factors such as physician governance and coordination investments are important moderators of the relationship between integration and quality. Secondly, organizational factors such as coordination investments, quality improvement, and physician leadership are shown to positively impact inpatient quality. Moreover, I measure these organizational factors from expenditure information available through hospital financial statements. Existing research has shown the positive impact of health IT adoption (McCullough, Casey, Moscovice, & Prasad, 2010; Himmelstein, Wright, & Woolhandler, 2010), while the research on quality programs has been mixed (Pham, Coughlan, O'Malley, 2006; Shortell,

Jones, Rademaker, Gillies, Dranove, Hughes, Budetti, Reynolds, & Huang 2000; Shortell, O'Brien, Carman, Foster, Hughes, Boerstler, O'Connor, 1995). However, this research has relied on limited samples or cross-sectional survey data. By using expenditure data from hospital financial statements to measure these organizational factors, the results I obtain are more robust. Using the dataset collected, I plan on conducting future research on the direct effects of these organizational factors on health care outcomes.

Another important contribution from this study is that the results show a strong inverse relationship between patient safety and inpatient quality. To my knowledge, there are no studies that examine the relationship between patient safety and inpatient quality. Thus, these results point to a gap in the literature that I hope to explore with this data in a future study as well.

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5 Appendix A: Model Derivation

Production and Cost Functions:

R is the revenue function, C is the cost function, e_P is physician effort, e_H is hospital effort, a_i is the marginal productivity, c_i is the marginal cost of effort, and ϵ and θ are random disturbances distributed $(0, N)$.

$$R(e_P, e_H, \epsilon) = a_P e_P + a_H e_H + \epsilon$$

$$C(e_P, e_H, \theta) = c_P e_P + c_H e_H + \theta$$

Agent (Physician) Income and Utility:

y is the effective income for the agent, α is the share of revenue paid to the agent, w is the salary paid regardless, and $\frac{e_P^2}{2}$ is the private cost of effort.

$$y = \alpha(R(e_P, e_H, \epsilon)) + w - \frac{e_P^2}{2}$$

$$U(y) = 1 - e^{-ry}$$

$$E(U(y)) = E(y) - \frac{r}{2} \text{Var}(y)$$

Agent (Physician) chooses effort to maximize utility:

$$E(U(y)) = \alpha(a_P e_P + a_H e_H) + w - \frac{e_P^2}{2} - \frac{r}{2} \alpha^2 \sigma_\epsilon^2$$
$$\frac{\partial E(U(y))}{\partial e_P} = \alpha a_P - e_P = 0$$

$$e_P = \alpha a_P$$

Principal (Hospital) chooses effort to maximize expected profit:

$$\begin{aligned}\pi &= (1 - \alpha)(a_P e_P + a_H e_H + \epsilon) - (c_P e_P + c_H e_H + \theta) - \frac{e_H^2}{2} - w \\ E(\pi) &= (1 - \alpha)(a_P e_P + a_H e_H) - (c_P e_P + c_H e_H) - \frac{e_H^2}{2} - w - (1 - \alpha)^2 \sigma_\epsilon^2 - \sigma_\theta^2 \\ \frac{\partial E(\pi)}{\partial e_H} &= (1 - \alpha)a_H - c_H - e_H = 0 \\ e_H &= (1 - \alpha)a_H - c_H\end{aligned}$$

Principal (Hospital) chooses α knowing e_H and e_P :

$$\begin{aligned}Max_\alpha \quad & a_P e_P + a_H e_H - c_P e_P - c_H e_H - \frac{e_P^2}{2} - \frac{e_H^2}{2} - \frac{r}{2} \alpha^2 \sigma^2 \\ & a_P(\alpha a_P) + a_H((1 - \alpha)a_H - c_H) - c_P(\alpha a_P) - c_H((1 - \alpha)a_H - c_H) - \\ & \quad \frac{(\alpha a_P)^2}{2} - \frac{((1 - \alpha)a_H - c_H)^2}{2} - \frac{r}{2} \alpha^2 \sigma^2 \\ FOC : \quad & a_P^2 - a_P c_P - \alpha(a_P^2 + a_H^2 + r\sigma^2) = 0 \\ \alpha^* &= \frac{a_P^2 - a_P c_P}{a_P^2 + a_H^2 + r\sigma^2}\end{aligned}$$

6 Appendix B: Interview Protocol

I. INTRODUCTION

I am writing my dissertation on hospital physician integration. I am interested in what circumstances lead to hospital physician integration and what impact this integration might have on economic and health care outcomes. In today's interview, I hope to get a better understanding of the research setting by hearing your experiences and sharing your individual perspective. I will treat your answers as confidential. I will not include your name or any other information that could identify you, unless explicit permission is given.

II. CONTEXT

1. *What was your background before coming to_____ ? What other places have you worked and in what capacity?*
2. *How long have you been with _____ , and in what capacities? Could you please tell me a bit more about your responsibilities as (role)?*
3. *Can you give me a brief history of (organization), including any changes _____ has undergone?*

III. HOSPITAL PHYSICIAN INTEGRATION

[resume]

1. *Could you describe the typical hospital physician relationship at _____?*
2. *Has _____ sought closer economic integration with physicians? In what ways?*
3. *How were the decisions to integrate made?*

4. *Can you give me more details on the employment contracts of physicians?
Are they salaried? Or on a productivity basis?*
5. *Are there additional incentives or bonuses built into these employment contracts?*
6. *Are there differences in the work behaviors and incentives facing non-integrated and integrated physicians? Are these physicians managed differently? If so, how? Could you give me an example?*
7. *What types of investments in systems, structures, and assets are important in order to facilitate integration?*
8. *What are some other ways in which _____ has sought closer integration with physicians?*

IV. QUALITY

[resume]

1. *How is patient care coordinated among inpatient/outpatient and between services? Does integration affect care coordination?*
2. *What are some special initiative or guidelines that have been put into place? How are decisions to undergo these taken? What are some of the tensions in making these decisions?*
3. *How does the hospital work with physicians to implement new guidelines, programs, or initiatives? Can you give me an example?*
4. *Does the hospital have certain monitoring of outcomes or quality in place? How are physicians involved?*

V. WRAP-UP

[resume]

1. *What are some challenges to the future of hospital physician integration?
How do you plan to deal with these challenges?*
2. *What is your personal opinion on the hospital physician integration in the
context of healthcare reform in the US?*
3. *Are there other areas that we have not covered that you feel are important?*

7 Appendix C: Additional Results

Table 12 – Study 1- Results of Fixed-Effects Panel Linear Regression Analysis Predicting Hospital Physician Integration (logit transformation)^a

Variables	Model 1		Model 2		Model 3		Model 4	
Constant	0.76	(1.48)	1.30	(1.82)	-3.03	(2.45)	-3.05	(2.46)
Size	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Network	0.05	(0.32)	-0.34	(0.31)	-0.44	(0.31)	-0.44	(0.31)
Non-profit	-4.82***	(1.38)	-4.33***	(1.62)	-4.09**	(1.59)	-4.09**	(1.59)
Investor	-4.73***	(1.33)	-5.03***	(1.53)	-4.59***	(1.50)	-4.59***	(1.5)
District	-2.82*	(1.58)	-3.71**	(1.79)	-3.50**	(1.73)	-3.49**	(1.73)
Market rivalry	15.78	(11.16)	13.89	(10.18)	12.81	(10.03)	12.73	(10.03)
Year	0.05**	(0.03)	0.05*	(0.03)	0.04	(0.03)	0.04	(0.03)
Nurse to patient ratio			-2.53***	(0.34)	-2.57***	(0.31)	-2.57***	(0.31)
Registered nurse share			0.78	(1.20)	0.69	(1.20)	0.70	(1.21)
Facilities investment ^b					0.37**	(0.16)	0.37***	(0.16)
Reputation							-0.19	(0.40)
R^2	0.58		0.62		0.62		0.62	
Wald χ^2			28.78***		25.07***		19.06***	

^a $n(\text{hospitals}) = 397$; $n(\text{observations}) = 5016$. Huber-White sandwich robust standard errors in parentheses.

^b Logarithm

Two-tailed tests. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Table 13 – Study 2- Results of Fixed-Effects Panel Linear Regression Analysis Predicting Return on Assets^a

	Model 1	Model 2	Model 3	Model 4
Constant	-0.03 (0.74)	0.48*** (0.01)	0.50 (0.11)	0.54** (0.11)
Patient Safety (t-1)	0.00 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Inpatient Quality (t-1)	0.03 (0.02)	0.03 (0.02)	0.04* (0.02)	0.04* (0.02)
Size	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Network	0.01 (0.02)	0.03 (0.02)	0.03 (0.02)	0.03 (0.02)
Non-profit	0.05 (0.04)	0.07 (0.09)	-0.12 (0.26)	-0.12 (0.27)
Investor	-0.07 (0.02)	-0.06 (0.03)	-0.23 (0.14)	-0.22 (0.26)
District	0.01 (0.06)	0.02 (0.06)	-0.10 (0.22)	-0.09 (0.23)
Market Rivalry	-0.24 (0.52)	-0.03 (0.55)	-0.06 (0.54)	-0.08 (0.55)
<u>Study 1 Variables</u>				
Integration (I)		0.01 (0.03)	0.01 (0.01)	0.10 (0.15)
Nurse to patient ratio		0.01 (0.03)	0.06 (0.05)	0.06 (0.05)
Facilities Investment ^b		-0.04*** (0.01)	-0.04*** (0.01)	-0.04*** (0.01)
<u>Moderators</u>				
Coordination ^b (C)			-0.02 (0.02)	-0.01 (0.03)
Physician Leadership (PL)			0.03 (0.02)	0.04 (0.03)
Physician Governance (PG)			0.05 (0.07)	0.03 (0.07)
Quality Improvement ^b (QI)			-0.02 (0.01)	-0.01 (0.02)
<u>Two way interactions</u>				
C x I				0.03 (0.04)
PL x I				-0.04 (0.04)
PG x I				0.07 (0.11)
QI x I				-0.02 (0.03)
R^2	0.55	0.56	0.58	0.58
Wald χ^2		3.63***	3.98***	2.83***

^a $n(\text{hospitals}) = 330$; $n(\text{observations}) = 2648$. Huber-White sandwich robust standard errors in parentheses.

^b Logarithm

Two-tailed tests. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Table 14 – Study 2- Results of Fixed-Effects Panel Linear Regression Analysis Predicting Operating Margin^a

	Model 1	Model 2	Model 3	Model 4
Constant	-0.06 (0.48)	0.28** (0.05)	0.37** (0.10)	0.37* (0.12)
Patient Safety (t-1)	0.01 (0.01)	0.00 (0.01)	0.00 (0.01)	0.02 (0.01)
Inpatient Quality (t-1)	0.03 (0.02)	0.03 (0.02)	0.03 (0.03)	0.03 (0.03)
Size	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Network	0.02 (0.02)	0.04 (0.03)	0.04 (0.03)	0.04 (0.03)
Non-profit	0.05 (0.06)	0.05 (0.07)	-0.11 (0.17)	-0.11 (0.17)
Investor	-0.04 (0.03)	-0.03 (0.04)	-0.16 (0.17)	-0.16 (0.17)
District	0.06* (0.03)	0.06* (0.03)	-0.04 (0.14)	-0.03 (0.14)
Market Rivalry	-0.50 (0.43)	-0.34 (0.45)	-0.52 (0.41)	-0.52 (0.41)
<u>Study 1 Variables</u>				
Integration (I)		0.02 (0.02)	-0.00 (0.01)	0.01 (0.12)
Nurse to patient ratio		-0.00 (0.02)	0.03 (0.04)	0.05 (0.04)
Facilities Investment ^b		-0.03** (0.01)	-0.03** (0.01)	-0.03** (0.01)
<u>Moderators</u>				
Coordination ^b (C)			0.00 (0.02)	-0.01 (0.02)
Physician Leadership (PL)			0.02 (0.03)	-0.00 (0.03)
Physician Governance (PG)			0.03 (0.02)	0.03 (0.04)
Quality Improvement ^b (QI)			-0.01 (0.01)	-0.01 (0.01)
<u>Two way interactions</u>				
C x I				0.02 (0.04)
PL x I				0.02 (0.03)
PG x I				0.01 (0.08)
QI x I				-0.00 (0.02)
R^2	0.56	0.57	0.59	0.59
Wald χ^2		2.25*	2.49***	1.88**

^a $n(\text{hospitals}) = 330$; $n(\text{observations}) = 2648$. Huber-White sandwich robust standard errors in parentheses.

^b Logarithm

Two-tailed tests. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$