Technology Adoption and Human Capital Integration

by

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DEDICATION

To my dad,

Stephen Adam Horan, Ph.D.,

originally of 61 Houghton Street in Worcester, Massachusetts,

who taught me to be curious and honest in intellectual pursuits,

to be humble and persistent in life pursuits,

to be kind,

to be coachable,

to have faith,

to look up,

and to never, ever, EVER dribble into the corner.

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Always and Forever,

Go Blue!

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ABSTRACT

In this dissertation, I examine how using an employment contract to integrate human capital affects the technology adoption process, including both the firm's decision to adopt a new technology and the subsequent implementation of a new technology. I specifically focus on the integration of the set of human capital beyond firm management who will be responsible for incorporating the new technology into a new product or process following the decision to adopt. First, I address competing predictions in the literature that create ambiguity around the effect of integrating human capital on the timing of the technology adoption decision. I show that a firm that uses an employment contract to integrate the human capital who will be responsible for implementing a new technology will adopt a new technology sooner than a firm that maintains an arm's length relationship with that set of human capital because integration raises managerial expectations of successful implementation. While the presence of influence activity may weaken this effect, I demonstrate that the extent to which influence activity arises depends on the type of technology. Second, I establish conditions under which using an employment contract to integrate human capital will facilitate the implementation of a new technology. I demonstrate why using an employment contract to integrate human capital should generally facilitate implementation, but I identify two caveats. The employment contract should be less advantageous in implementation when continuity of association is not unique to the employment relationship. Furthermore, the employment contract should be less advantageous in

implementation when the technology in question targets tasks for which human capital have greater expertise than firm management.

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CHAPTER I
Technology Adoption and Human Capital Integration

Adopting a new technology is a consequential undertaking for a firm. A firm can use a new technology to generate new or improved products or processes, both of which can lead to improvements in firm performance, but converting a new technology into the desired performance improvements can be difficult as a firm's capabilities and a technology's technical properties can hamper efforts to effectively incorporate the technology into the relevant product or process (Attewell, 1992; Edmondson, Bohmer, & Pisano, 2001; Leonard-Barton & Deschamps, 1988; Orlikowski, 2000; Szulanski, 2000). The firm's initial decision to invest in a new technology can be complex as well. In constructing the case for or against adoption, firm management may attempt to include considerations of both firm capabilities and the technical properties of the technology (Farrell & Saloner, 1985; M. L. Katz & Shapiro, 1994; Loch & Huberman, 1999; Tushman & Anderson, 1986), but firm management is nonetheless likely to face uncertainty about what the ultimate cost and the ultimate benefit of investing in the new technology will be. The time and effort that successful implementation will entail and the extent to which future market conditions will reward those efforts can each be difficult to predict, and uncertainty about the technical properties of the technology itself introduces the risk that the technology will not behave or evolve as expected (Dixit & Pindyck, 1994; Garud, Nayyar, & Shapira, 1997; Hall & Khan, 2003; Lieberman & Montgomery, 1988; McGrath, 1997). While some of this uncertainty can be resolved over time, choosing to delay the decision to adopt carries its own risks, and a firm that waits too long to invest in a new technology may find itself

losing ground to competitors and unable to catch up (Christensen & Bower, 1996; Hall & Khan, 2003; Lieberman & Montgomery, 1988; Tripsas & Gavetti, 2000; Tushman & Anderson, 1986). Thus, technology adoption—from the firm's decision to invest in the technology through the implementation process—can significantly affect firm fortunes, making both the timing of technology adoption decisions and the conditions under which technologies are successfully implemented important areas of inquiry for scholars of firm strategy and innovation.

In this dissertation, I examine how using an employment contract to integrate human capital affects the technology adoption process, including both the timing of the firm's decision to adopt a new technology and the subsequent implementation of the new technology. I specifically focus on the integration of the set of human capital beyond firm management who will be responsible for incorporating the new technology into the relevant product or process following the decision to adopt (Lanzolla & Suarez, 2012; Leonard-Barton & Deschamps, 1988; Rogers, 2003). For the firm to realize the full value of a new technology, it is critical that this set of human capital engages in adaptation efforts that may include investing time in learning to use the new technology and making any necessary adjustments to their roles and patterns of interpersonal interactions within the firm (Barley, 1986, 1990; Orlikowski, 1992; Szulanski, 2000; Tyre & Orlikowski, 1994; von Hippel, 1994). For new process technologies in particular, maximizing the value of the technology may also require human capital to participate in the process of mutual adaptation, whereby the provider of the technology can continue to modify and improve it in response to user feedback—feedback that must be provided by the set of human capital in question (Leonard-Barton, 1988; von Hippel, 1994).

As an example, consider a hospital's adoption of a new technology that allows the physicians who treat patients at the hospital to enter medical orders electronically rather than

using a pen and paper. Medical orders within a hospital include orders for medications, lab work, diagnostic testing, imaging, and other forms of care. Instead of having staff deliver a physician's written order for a medication or a diagnostic test to the relevant department, such as the pharmacy or lab, computerized physician order entry (CPOE) allows the physician to enter the order on a computer and the order is then transmitted electronically to the intended recipient. In deciding whether to invest in this technology, firm management, i.e., hospital administrators, consider the potential benefits of CPOE for the hospital, which include improving the cost and quality of patient care through the reduction of medical errors that are caused by misinterpreted handwriting. Efficiency gains are also expected via a reduction in the hospital's reliance on paper and staff to communicate medical orders, and CPOE may additionally reduce the delays in patient care that arise when, for instance, the pharmacist must track down the physician whose handwriting she cannot read. But crucially, the extent to which these benefits materialize depends on whether the physicians who treat patients at the hospital engage in the required adaptation efforts. Not only must physicians take the time to learn to use the technology, but they may need to adjust how they interact with patients or communicate with nurses and other hospital staff to ensure that the introduction of CPOE does actually lead to improvements in the quality and cost of patient care. For example, in a qualitative study of CPOE implementation, Campbell et al. (2006) find that the implementation process generates both more and new work for physicians and nursing staff, workflow issues, unexpected changes in the power structure, and changes in communication patterns and practices. Moreover, to maximize the value that the hospital ultimately extracts from the technology, the hospital may need physicians to engage with the technology producer, pointing out flaws in the technology or areas for improvement.

Thus, while often it is firm management that makes the firm's decision to invest in a new technology, a firm's ability to realize the full value of the technology typically depends on another set of human capital engaging in adaptation efforts (Lanzolla & Suarez, 2012; Leonard-Barton & Deschamps, 1988; Rogers, 2003). Prior research suggests that human capital can be reluctant to do so, however (e.g., Edmondson et al., 2001; Leonard-Barton & Deschamps, 1988). For instance, hospital administrators in 64% of U.S. hospitals cite physician cooperation as an obstacle to adopting health information technologies such as CPOE, and 25% name physician cooperation as the single-biggest obstacle.[1] In this dissertation, I examine how using an employment contract to integrate this set of human capital, as opposed to maintaining an arm's-length relationship, affects the implementation of a new technology by considering how an employment contract may or may not facilitate obtaining the required adaptation efforts from the relevant human capital. I also examine how using an employment contract to integrate this set of human capital affects the timing of a firm's decision to adopt a new technology in the first place by considering how integrating human capital may alter both the decision-making process and firm management's expectations about the likelihood of successful implementation.

To do so, I approach the strategic question of whether to use an employment contract to integrate human capital as one of firm boundaries. Consistent with theories of the firm that deem the distinguishing characteristic of the firm from the market to be the coordination of activities and resources by fiat as opposed to the price mechanism (e.g., Coase, 1937; Williamson, 1975), the distinguishing feature of an employment contract, both theoretically and legally, is the directive control conferred to firm management (Bidwell, 2004; Cappelli & Keller, 2013; Gibbons, 2005; Simon, 1951; Williamson, 1975). Unlike arm's-length contracts which specify the products or services to be provided by a worker at the outset, the employment contract leaves

[1] Percentages calculated using the 2011 American Hospital Association Annual Survey IT Supplement.

many requirements of the worker formally unspecified and instead confers to firm management directive control, which is the authority to select in the future (over the length of the contract) what tasks a worker should perform, as well as when and how the tasks should be executed (Simon, 1951; Williamson, 1975).[2] Accordingly, it has been common in the literature to view employing human capital as a form of integration (Bidwell, 2004; Davis-Blake & Uzzi, 1993; Doeringer & Piore, 1971; Wernerfelt, 1997; Williamson, Wachter, & Harris, 1975).

Despite a body of thoughtful research on the relationship between firm boundaries and innovation, however, the implications of using an employment contract to integrate human capital for technology adoption remain unclear. This is especially true for the human capital of interest in this dissertation: those responsible for implementing a new technology, particularly when they are highly skilled. To successfully implement a new technology, a firm needs the relevant human capital to be both willing to engage in the required adaptation efforts and, to the extent that the adaptation efforts involve task interdependency, able to align their actions with one another (Gulati et al., 2005). In short, the firm requires both the cooperation and the coordination of these individuals, and prior research cites the abilities to direct integrated human capital by fiat (e.g., Simon, 1951; Williamson, 1975, 1991) and to develop superior modes of communication (Arrow, 1974; Cremer, Garicano, & Prat, 2007; Kogut & Zander, 1996; Nelson & Winter, 1982) as reasons why firms that integrate human capital should be able to obtain the needed cooperation and coordination more successfully than firms that remain at arm's length with their human capital (e.g., Kapoor & Adner, 2012; Nelson & Winter, 1982; Williamson, 1975, 1985, 1991). Yet unlike the integration of physical assets, the integration of human capital

[2] Both case law and the Internal Revenue Service's (IRS) rules for classifying labor support Simon's (1951) theory of formal employment which states that directive control is what distinguishes an employment contract from any other type of contract. However, there are limits on this control, and holding the legal right to directive control implies neither that employees always comply with managerial directives, nor that non-employees never comply with managerial directives. I explore this point in greater depth in later sections.

does not confer ownership of human capital to firm management but instead merely confers greater control over their activities. Not only are there are limits on this control (Bidwell, 2004; Coff, 1997; Simon, 1951), but human capital retain voice as well. The well-documented difficulty firms have in implementing a technology-stimulated change in routines and practices testifies to the reality that, unlike what the assumption of fiat within firms would suggest (e.g., Simon, 1951; Williamson, 1975, 1991), cooperation from employees in the technology implementation process is far from automatic (e.g., Attewell, 1992; Barley, 1986; Edmondson et al., 2001; Leonard-Barton, 1988; Leonard-Barton & Deschamps, 1988; Orlikowski, 1993, 2000; Tyre & Orlikowski, 1994). Thus, under certain conditions, integrated human capital may be just as unwilling to cooperate and engage in the required adaptation efforts as non-integrated human capital. On the other hand, trends in employment also indicate that the line between an employment relationship and an arm's length relationship with human capital is blurring on dimensions such as tenure and location of work (e.g., Bidwell, 2004, 2009, 2013; Cappelli & Keller, 2013; Farber, 2008; Hollister, 2011; Kalleberg, Reskin, & Hudson, 2000), raising the possibility that, under other conditions, non-integrated human capital may be just as willing and able to engage in the implementation process as integrated human capital.

Ambiguity also surrounds the relationship between integrating human capital and the decision to adopt the new technology in the first place as competing predictions emerge from the existing literature. If integration does ultimately facilitate implementation due to the abilities of firm management to direct human capital by fiat (e.g., Simon, 1951; Williamson, 1975, 1991) and to develop superior modes of communication (Arrow, 1974; Cremer et al., 2007; Kogut & Zander, 1996; Nelson & Winter, 1982), then using an employment contract to integrate human capital may raise managerial expectations about the likelihood of successful implementation, and

firms that integrate human capital may be more likely to adopt (Kapoor & Lee, 2013). But it has also been argued that integration introduces influence activity (Kapoor & Lee, 2013; Milgrom & Roberts, 1988, 1990) and an anti-innovation bias (Kapoor & Lee, 2013; Teece, 1996; Williamson, 1975, 1985) that may lead firms that choose to use an employment contract to integrate human capital to be slower to decide to adopt a new technology (Kapoor & Lee, 2013).

My goal is to address these ambiguities by developing a more nuanced framework for evaluating the effect of integrating human capital on both the firm's decision to adopt a new technology and the implementation of a new technology. To do so, I consider three features that are typical of the employment relationship and examine how and when they may or may not facilitate the technology adoption process. The first is the legally-conferred directive control described above. This represents the sharpest distinction between an employment contract and any other type of contract with human capital (Cappelli & Keller, 2013). The second feature is continuity of association, which refers to the mutual expectation of a continued relationship between a firm and its human capital (Demsetz, 1988; Williamson, 1985), and the third feature is compensation flexibility, which refers to the alternative modes of compensation, such as bonuses and promotion, that give firm management more flexibility in when and how firm management can reward the efforts of integrated human capital relative to non-integrated human capital (Williamson, 1975, 1991).

I begin with the relationship between integration and the firm's decision to adopt a new technology in Chapter 2. I hypothesize that a firm that uses an employment contract to integrate the human capital on whom the firm will rely to implement a new technology will adopt a new technology sooner than a firm that maintains an arm's length relationship with that set of human capital because those three features of the typical employment contract—(1) legally-conferred

directive control, (2) continuity of association, and (3) compensation flexibility—raise firm management's expectations that the relevant human capital will fully engage in the required adaptation efforts and thereby raise managerial expectations that implementation will be successful. However, I hypothesize important caveats. This effect should be stronger earlier in the technology life cycle, when there is more uncertainty about what the implementation process will entail, and this effect should be weaker when continuity of association is not unique to the employment relationship. Finally, I hypothesize that the effect should be weaker when integrated human capital engage in influence activity, but that they should only engage in influence activity when the new technology targets tasks for which the relevant human capital have a sufficiently large expertise advantage over firm management. Additionally, I argue that the delaying effect associated with the anti-innovation bias of hierarchy should only materialize when integration moves the locus of decision-making for adoption from outside to inside the firm, which is not the case in my empirical context.

I consider the relationship between integration and the implementation of a new technology in Chapter 3, where I aim to enrich our understanding of the adaptive benefits of integration by hypothesizing contingencies for when using an employment contract to integrate human capital should facilitate the implementation of a new technology. I articulate why using an employment contract to integrate human capital should generally facilitate implementation, but I then identify two caveats. First, the employment contract should be less advantageous when continuity of association is not unique to the employment relationship; under this condition, non-integrated human capital are more likely to be willing and able to engage in the implementation process due to both repeated social interaction incubating identification with the firm across firm boundaries and the introduction of the "shadow of the future" into the relationship. Second, the

employment contract should be less advantageous in implementation when the technology in question targets tasks for which human capital have greater expertise than firm management. Under this condition, I argue that firm management cannot exploit the usual ability to direct integrated human capital by fiat and thereby loses the most valuable adaptive advantage that the employment contract offers.

I test these hypotheses empirically in the context of hospital adoption of new technologies. In short, hospitals may choose to employ the physicians who treat patients at their facilities, or hospitals may choose to maintain an arm's-length relationship in which the hospital and physicians remain legally separate economic entities and the physicians contract for the right to treat patients at the hospital.[3] Do hospitals that integrate physicians as employees adopt a new technology sooner or later than hospitals that maintain an arm's-length relationship with physicians? And do hospitals that integrate physicians as employees have more success in implementing new technologies?

The hospital context is an attractive empirical setting for studying technology adoption and human capital integration because not only is there significant variation across hospitals in the integration of physicians, but the presence of corporate practice of medicine laws in certain states prevents hospitals in those states from employing physicians, offering a source of exogeneity in physician integration decisions. Moreover, the healthcare industry represents nearly one-fifth of the U.S. economy (Hartman, Martin, Espinosa, Catlin, & The National Health Expenditures Account Team, 2017), and identifying the implications of using an employment

[3] The arm's length relationship between a physician and the hospital at which the physician treats patients is not that of a typical independent contractor in that cash is not the medium of exchange. While physicians do contract for the right to treat patients at the hospital, the hospital is compensated in kind; for example, in exchange for access to the hospital, a physician will agree to perform on-call duties for the hospital. Nonetheless, it is an arm's length, market exchange. In contrast, when hospitals use an employment contract to govern the relationship with a physician, that physician becomes a salaried employee of the hospital.

contract to govern a central relationship in the industry—that between hospitals and physicians—has long been an important area of inquiry (e.g., Burns & Muller, 2008; Burns & Wholey, 2000; Cuellar & Gertler, 2006).

But understanding how the contractual relationship between a firm and its human capital affects the technology adoption process is also relevant beyond the healthcare industry, as available data suggests that more firms in a variety of industries are considering whether to use employment contracts to integrate human capital. Data documenting work arrangements in the U.S. is notoriously limited, but the ranks of non-integrated human capital appear to be growing (Cappelli & Keller, 2013; L. F. Katz & Krueger, 2016). Katz and Krueger (2016) estimate that the share of U.S. workers engaging with firms through arrangements other than traditional employment contracts, such as independent contracting or temporary help, grew from 10.7% in 2005 to 15.8% in 2015, and the share of workers reporting income from self-employment to the Internal Revenue Service (IRS) reached 16.5% in 2014. Data characterizing firms' use of employment contracts versus alternative work arrangements are even more difficult to come by, but a survey of 200 firms of varying sizes conducted by the Aberdeen Group suggests that both U.S. and foreign firms use independent contracting for a significant portion of their workforces (Dwyer, 2011). A similar survey conducted by Ardent Partners suggests that a growing number of firms consider non-integrated human capital to be critical to achieving their primary goals and objectives (Dwyer, 2013). Anecdotal evidence also indicates that the trend away from employment is not restricted to low-skilled human capital. As noted above, it is not uncommon for hospitals and physicians to remain at arm's length, and firms both within and beyond the U.S. are increasingly engaging with high-skilled human capital such as consultants, managers, and lawyers as independent contractors (Miller & Miller, 2012). It is therefore important for strategy

scholars to develop a full account of the consequences of the integration choice for firm performance, including the implications for a firm's ability to adapt to technological change. I aim to contribute on this front by examining the effect of integrating human capital on the technology adoption process.

I generate hypotheses for the effect of integrating human capital on the decision to adopt a new technology in Chapter 2 and on the implementation of a new technology in Chapter 3. The question of whether and when firms adopt a new technology and the question of technology implementation each speak to their own literatures, and thus I motivated them and presented the associated hypotheses separately. But because I test these hypotheses in the same empirical setting, I present the empirical approach, results, and conclusion in a combined format. I provide more detail about the empirical context and describe the empirical approach in Chapter 4. I discuss results in Chapter 5, and I conclude in Chapter 6.

CHAPTER II
The Firm's Decision to Adopt a New Technology

Introduction

The decision to use an employment contract to integrate human capital and the decision to adopt a new technology are two important strategic choices for firm management. In this chapter, I examine how the former may influence the latter. Specifically, I focus on the integration of the set of human capital on whom a firm will rely to implement a new technology, and I ask whether firms that use an employment contract to integrate this set of human capital will make the firm's decision to adopt that technology sooner or later than firms that maintain an arm's length relationship with this set of human capital.[4] Prior literature reveals competing predictions for this relationship. Arguments suggesting integration may delay the technology adoption decision cite an anti-innovation bias associated with hierarchy that arises from slower decision-making processes and lower-powered incentives (Kapoor & Lee, 2013; Teece, 1996; Williamson, 1975, 1985). The sub-optimal decision-making that can result from employees engaging in influence activity and politicking (Milgrom & Roberts, 1988, 1990) has also been cited as a reason why firms that integrate human capital as employees will be slower to invest in a new technology (Kapoor & Lee, 2013).

On the other hand, if firm management takes into consideration expectations about the success of implementation when deciding whether to adopt a new technology, then firms that

[4] An example of an arm's length relationship with human capital would be an independent contracting relationship, which is governed by contract law rather than employment law.

integrate the human capital who will be needed to implement the new technology might be expected to decide to adopt that technology sooner rather than later (Kapoor & Lee, 2013). For example, the coordinative advantages commonly ascribed to the employment relationship based on the ability to direct human capital by fiat (e.g., Simon, 1951; Williamson, 1975, 1991) and develop superior modes of communication (Arrow, 1974; Cremer et al., 2007; Kogut & Zander, 1996; Nelson & Winter, 1982) suggest that firm management might expect integrated human capital to facilitate the implementation of a new technology. Furthermore, technology adoption may require human capital to develop firm-specific skills and knowledge in the implementation process, which again suggests that firms with integrated human capital will be more likely to invest in a new technology (e.g., Monteverde & Teece, 1982; Williamson, 1985). In this chapter, I aim to disentangle these competing predictions. By undertaking a closer examination of the mechanisms driving each prediction and considering how the operation of these mechanisms depends on the type of new technology at stake, I hypothesize conditions under which firms that use an employment contract to integrate human capital decide to adopt a new technology sooner than those that do not. Doing so is important because it has long been established that whether and when a firm decides to adopt a new technology can have important consequences for firm performance, and as the choice of whether to use an employment contract to integrate human capital appears to be becoming more relevant to more firms, strategy scholars should identify the full implications of that choice for firm performance, including a firm's ability to respond to technological change. I aim to contribute on this front by examining how integrating human capital affects the timing of the technology adoption decision.

A new technology can be used to generate new or improved products or processes that may lead to improvements in firm performance, but firm management must decide whether to

adopt a new technology under uncertainty about both the ultimate cost and the ultimate benefit that investing in the new technology will incur. The time and effort that successful implementation will entail and the extent to which future market conditions will reward those efforts can each be difficult to predict, and uncertainty about the technical properties of the technology itself introduces the risk that the technology will not behave or evolve as expected (Dixit & Pindyck, 1994; Garud, Nayyar, & Shapira, 1997; Hall & Khan, 2003; Lieberman & Montgomery, 1988; McGrath, 1997). While some of this uncertainty can be resolved over time (e.g., Anderson & Tushman, 1990; Dosi, 1982; Sahal, 1981), choosing to delay the decision to adopt carries its own risks, and a firm that waits too long to invest in a new technology may find itself losing ground to competitors and unable to catch up (Christensen & Bower, 1996; Hall & Khan, 2003; Lieberman & Montgomery, 1988; Lieberman & Montgomery, 1988; Schilling, 1998; Spence, 1981; Tripsas & Gavetti, 2000; Tushman & Anderson, 1986). Therefore, identifying the reasons for the timing of firms' technology adoption decisions has been an important area of inquiry in strategy and innovation research.[5]

Although data documenting the contractual relationships between firms and their human capital in the U.S. is notoriously limited, more firms appear to be considering whether to use employment contracts to integrate human capital (Cappelli & Keller, 2013; L. F. Katz & Krueger, 2016). Katz and Krueger (2016) estimate that the share of U.S. workers engaging with firms through arrangements other than traditional employment contracts, such as independent contracting or temporary help, grew from 10.7% in 2005 to 15.8% in 2015, and the share of

[5] For example, scholars have shown that network ties (e.g., DiMaggio and Powell, 1983; Rogers, 2003), geographic proximity to prior adopters. (e.g. Jaffe, Trajtenberg, and Henderson, 1993; Pouder and St. John, 1996; Audretsch and Feldman, 1996; Singh, 2005; Powell, Koput, and Smith-Doerr, 1996; Owen-Smith and Powell, 1994), inertial tendencies (Christensen & Bower, 1996; Christensen & Rosenbloom, 1995; Henderson & Clark, 1990; Levinthal & March, 1993; Levitt & March, 1988; Nelson & Winter, 1982), cognitive biases (Tripsas & Gavetti, 2000), absorptive capacity (Cohen & Levinthal, 1990), and a technology's compatibility with existing products or technological infrastructure (Farrell & Saloner, 1985; M. L. Katz & Shapiro, 1994) can all whether and when a firm decides to adopt a new technology.

workers reporting income from self-employment to the Internal Revenue Service (IRS) reached 16.5% in 2014, suggesting the ranks of non-integrated human capital are growing. Data characterizing firms' use of employment contracts versus alternative work arrangements are even more difficult to come by, but a survey of 200 firms of varying sizes conducted by the Aberdeen Group suggests that both U.S. and foreign firms use independent contracting for a significant portion of their workforces (Dwyer, 2011). A similar survey conducted by Ardent Partners suggests that an increasing number of firms consider non-integrated human capital to be critical to achieving their primary goals and objectives (Dwyer, 2013). Anecdotal evidence also indicates that the trend away from employment is not restricted to low-skilled human capital. Firms both within and beyond the U.S. are increasingly engaging with high-skilled human capital such as consultants, managers, and lawyers as independent contractors (Miller & Miller, 2012), and in the healthcare industry it has long been common for hospitals to choose not to use employment contracts to govern their relationship with physicians (e.g., Burns & Muller, 2008; Burns & Wholey, 2000; Cuellar & Gertler, 2006).

Accordingly, the relationship between the technology adoption decision and human capital integration has been of interest to researchers, but thus far prior research primarily focuses on the flexibility of non-integration as advantageous in responding to technological change. In this argument, firms that do not integrate human capital may decide to adopt a new technology sooner than firms that do use employment contracts to integrate human capital because non-integration facilitates resource adjustment. For example, Harrigan (1984, 1985) and Balakrishnan and Wernerfelt (1986) find that minimizing vertical integration enables greater flexibility to respond to frequent change, including technological change. Similarly, Matusik & Hill (1998) and Schilling & Steensma (2001) suggest that the flexibility of alternative work

arrangements may facilitate managing technological change. The assumption underpinning these arguments, however, is that the technological change in question renders existing relationships with human capital obsolete. Choosing not to integrate human capital can be attractive in such cases because the ease of ending relationships with non-employees relative to ending relationships with human capital governed by employment contracts enables quicker resource adjustment. But while non-integration makes it easier to break relationships with human capital that need to be broken, another important implication of the trend toward non-integration is that it becomes more likely that a valuable set of human capital—those whom firms rely upon to implement new technologies—will be outside the firm, and the argument favoring flexibility is not relevant to this case. It is important, therefore, to develop a more robust understanding of how the integration choice regarding this set of human capital affects the technology adoption decision.

Prior literature suggests that one way the contractual relationship between the firm and this set of human capital may affect whether and when firm management decides to adopt a new technology is by influencing firm management's expectations about implementation (Kapoor & Lee, 2013). In constructing the case for or against adoption, firm management must consider the likelihood of successful implementation, and the likelihood of successful implementation critically depends on the human capital who must do the work of incorporating the technology into the relevant product or process (Lanzolla & Suarez, 2012; Leonard-Barton & Deschamps, 1988; Rogers, 2003). These adaptation efforts may include investing time in learning to use the technology as well making adjustments to roles and patterns of interpersonal interactions within the firm (Barley, 1986, 1990; Orlikowski, 1992; Szulanski, 2000; Tyre & Orlikowski, 1994; von Hippel, 1994). For new process technologies in particular, maximizing the value of the

technology may also require human capital to participate in the process of mutual adaptation, whereby the provider of the technology can continue to modify and improve it in response to user feedback (Leonard-Barton, 1988; von Hippel, 1994). Using an employment contract to integrate this set of human capital may raise managerial expectations that the human capital will fully engage in these adaptation efforts due to the coordinative advantages commonly associated with an employment contract (e.g., Gibbons, 2005; Kogut & Zander, 1996; Williamson, 1975, 1991), which will in turn raise expectations that implementation will be successful. Firms that integrate human capital may then be less likely to defer adoption.

But in addition to influencing firm management's expectations about implementation, choosing to use an employment contract to integrate human capital may also alter the decision-making process itself by introducing the anti-innovation bias of hierarchy (Kapoor & Lee, 2013; Teece, 1996; Williamson, 1975, 1985) or increasing the presence of influence activity (Kapoor & Lee, 2013; Milgrom & Roberts, 1988, 1990). The competing predictions that emerge from these possibilities create ambiguity as to whether integration speeds or delays the decision to adopt a new technology. Kapoor and Lee (2013) summarize this tension as that between the "costs of organization" and the "adaptability of organization." However, rather than resolve this tension in their study of firms' technology investment decisions, Kapoor and Lee (2013) use it to argue that firms with alliance relationships with their complementors will invest in a new technology sooner than both firms that integrate their complementors and firms that maintain a market relationship with their complementors. I complement this work by building on the fact that there is an apparent tension in the literature as to the effect of integration on a firm's technology investment decisions, but rather than focus on the advantages of a hybrid relationship, my goal is to address the ambiguity around the effect of choosing integration over the market by clarifying

how and when the mechanisms underlying the competing predictions operate. Moving away from the specificity of the firm-complementor relationship, I compare the use of an employment contract versus an arm's length contract to govern a firm's relationship with human capital, and my goal is to identify conditions under which choosing integration leads a firm to adopt a new technology sooner.

Theory and Hypotheses

I follow the literature in framing firm management's technology adoption decision as the decision between adopting "now" or deferring the decision to a later date (Hall & Khan, 2003), and I consider a firm to have decided to adopt a new technology when the firm makes an initial capital investment in the technology; empirically, this will be measured as the point at which a firm contracts with a vendor for a health information technology. Following Rogers (2003), this represents the culmination of the consideration phase, which involves information gathering, conceptualizing, and planning activities, and from this culmination point onward, effort turns toward implementing the chosen technology rather than deciding whether to invest in it.

I also assume that the prospect of adoption is primarily management-led, or a "top-down" technology. In some cases, particularly within hospitals, technology adoption can be driven by the human capital; for example, physicians may drive the adoption of new medical devices that they think will improve their ability to care for patients. But in the case of the technologies I will examine empirically, while there may be variance in the degree to which different physicians support the technology, the initiative is primarily driven by hospital administrators, specifically the Chief Information Officer.

To hypothesize conditions under which firms that use an employment contract to integrate human capital will adopt a new technology sooner than firms that maintain an arm's

length relationship with human capital, I examine how using an employment contract to integrate human capital may affect both firm management's expectations about the success of implementation and the decision-making process itself. Beginning with firm management's expectations about implementation, I argue that the timing of firm management's decision to adopt the new technology depends, at least in part, on firm management's expectations about soliciting the required adaptation efforts from the relevant human capital in a timely manner. I then demonstrate how common features of the employment relationship affect those expectations.

Integration and Managerial Expectations about Implementation

Choosing whether to adopt a new technology or to defer the decision to a later date is a consequential choice for firm management, yet it is fraught with uncertainty. The time and effort that successful implementation will entail and the extent to which future market conditions will reward those efforts can each be difficult to predict, and uncertainty about the technical properties of the technology itself introduces the risk that the technology will not behave or evolve as expected (Dixit & Pindyck, 1994; Hall & Khan, 2003; Lieberman & Montgomery, 1988; McGrath, 1997). If firm management chooses to adopt the new technology in the face of such uncertainty, they risk investing in technologies that will ultimately fail to yield a positive return, regardless of the quality of their implementation efforts. For example, the process improvements that a new technology is expected to yield may prove overly optimistic (Garud, Nayyar, & Shapira, 1997), or, in cases where a dominant design emerges, a firm may find that it has invested in a losing version of the technology and now faces a significant challenge in switching course (e.g., Eggers, 2012; Schilling, 1998).

Yet while such technological and market uncertainty typically wanes over time (Anderson & Tushman, 1990; Dosi, 1982; Sahal, 1981), deferring adoption to a later date carries its own risks. For example, the knowledge and experience gained by using a new technology before competitors can allow early adopters to lead the learning curve (Spence, 1981) or to get a head-start in patent races, both of which can act as entry barriers for later would-be adopters (Lieberman & Montgomery, 1988; Schilling, 1998). But critically, any advantage in choosing not to defer adoption only materializes if the firm's human capital engage in the required adaptation efforts before their competitors can; a firm can only build an advantage with a technology if the relevant human capital make the effort to learn to use the technology and adapt their roles and interpersonal interactions within the firm as needed.

Furthermore, the firm can realize more of the technology's potential value if human capital engages in the required adaptation efforts with full enthusiasm right away. For process technologies especially, there is an important "window of opportunity" immediately following initial adoption where the technology can be modified and improved in response to user feedback (Tyre & Orlikowski, 1994). Once this window of opportunity closes, efforts to optimize the technology fade and once-temporary work-arounds become permanent (Tyre & Orlikowski, 1994), capping the value that the technology can generate for the firm. Thus, choosing to adopt a new technology without a sufficiently strong expectation that human capital will fully engage in the required adaptation efforts in a timely manner eliminates the potential rewards of choosing not to defer adoption without attenuating the risks. Firm management will therefore be more likely to defer adoption the lower their expectation that human capital will fully engage in the required adaptation efforts in a timely manner.

Three features commonly associated with an employment contract suggest that using an employment contract to integrate human capital will raise firm management's expectations that human capital will fully engage in the required adaptation efforts in a timely manner: (1) legally-conferred directive control, (2) continuity of association, and (3) compensation flexibility. I now examine each of them.

The directive control conferred to firm management by an employment contract represents the sharpest distinction between an employment contract and any other type of contract with human capital, both theoretically and legally. Directive control is the authority to select in the future what tasks a worker should perform, as well as when and how the tasks should be executed, for the length of the contract in exchange for a stated wage (Bidwell, 2004; Cappelli & Keller, 2013; Gibbons, 2005; Simon, 1951; Williamson, 1975). The concept was formalized as the distinguishing feature of an employment contract by Simon (1951) in his treatment of the employment relationship and is consistent with Coase's (1937) theory of the firm. Under an employment contract, "certain aspects of the worker's behavior are stipulated in contract terms, certain other aspects are placed within the authority of the employer, and still other aspects are left to the worker's choice," (Simon, 1951, p. 305). In contrast, under a sales contract, firm management promises a stated sum of money to an individual worker in return for the individual performing a set of tasks that are specified in full at the outset (Simon, 1951). Firm management has no right to demand changes to when and how the product or service is provided once the contract is set. Similarly, Coase asserts that the contract for an individual who is party to an integrated transaction is "…one whereby the factor [individual], for a certain remuneration (which may be fixed or fluctuating), agrees to obey the directions of an entrepreneur *within certain limits*," (Coase, 1937, p. 391)[emphasis author's], while in a market exchange between

an individual and a firm, the individual has no obligation to obey the directions of the firm beyond providing the product or service as detailed in the contract.

Simon's (1951) definition of directive control has continued to serve as the basis for defining employment in the literature (e.g., Bidwell, 2004; March & Simon, 1958; Simon, 1991; Wernerfelt, 1997; Williamson, 1975). For example, Williamson (1975) cites Simon (1951) in defining the employment contract as one in which the employer contracts in the present for "the right to select a specific x [behavior] from within an admissible set X [possible behaviors], the determination of the particular x to be deferred until the future,"(p.). Bidwell (2004) and Gibbons (2005) both build on Simon (1951) in describing the key feature that distinguishes the employment contract from the sales contract as the set of decision rights held by firm management concerning the services provided by the human capital for the firm. Under an employment contract, firm management is granted the set of decision rights regarding what tasks human capital performs and how the human capital performs them for the length of the contract. This allows the firm to "unilaterally alter the nature of the service that is provided to it [by the human capital] and how the service is provided," Bidwell (2004). Employees can choose not to comply and resign, but they do not have the right to ignore firm management's directives and continue to provide the original service for the original compensation. Under a sales contract, however, firm management gives up any decision rights regarding what tasks the human capital should perform and how they should be performed beyond what is articulated in the contract (Bidwell, 2004). Therefore, firm management may request a change in whether or how human capital performs a given task or set of tasks, but if the human capital does not wish to comply, the human capital has the right to continue to provide services and receive compensation as originally articulated in the contract.

Legally, directive control as the distinguishing feature of an employment contract is consistent with both case law and tax rules. Masten (1988) documents that U.S. case law reveals a unique set of obligations and responsibilities associated with the employment contract that are consistent with firm management having greater control over employee behavior relative to other human capital. Unlike an employee, firm management has no legal basis for directing a non-integrated worker's behavior beyond what is specified in the contract, including how to produce a desired outcome (Cappelli & Keller, 2013; Masten, 1988). Moreover, courts validate the authority of firm management over employees by typically refusing to resolve disputes between an employee and firm management, but they do agree to resolve disputes between a firm and non-integrated human capital (Cappelli & Keller, 2013; Masten, 1988). The legal basis of directive control is not limited to the U.S. either (Befort, 2003; Cappelli & Keller, 2013; Stone, 2006). The right to control the work process distinguishes an employment contract around the world, especially in developed countries in North America and Europe (Cappelli & Keller, 2013).

Furthermore, the Internal Revenue Service (IRS) in the U.S. monitors firms' categorization of their human capital as employees versus independent contractors based on the presence of directive control. According to the IRS,

> "A worker is an employee when the business has the right to direct and control the worker. The business does not have to actually direct or control the way the work is done – as long as the employer has the right to direct and control the work…The key consideration is whether the business has retained the right to control the details of a worker's performance or instead has given up that right," (Internal Revenue Service, 2018).

Firms risk legal consequences if attempting to claim that a relationship with human capital in which firm management effectively exercises directive control is an independent contracting relationship governed under contract law instead of an employment contract

governed under employment law. Thus, consistent with definitions in the literature, legally-conferred directive control is unique to the employment contract and allows firm management to choose what task an individual performs and how and when the task should be executed, giving firm management the right to unilaterally demand changes in worker behavior (Bidwell, 2004; Cappelli & Keller, 2013; Gibbons, 2005; Simon, 1951; Williamson, 1975).

Holding legally-conferred directive control over the human capital on whom the firm will rely to implement a new technology should raise firm management's expectation of obtaining the required adaptation efforts from the relevant human capital in a timely manner for two reasons. First, holding directive control eliminates the need for contract renegotiation. The details of the implementation process are typically uncertain ex ante (Dixit & Pindyck, 1994; Hall & Khan, 2003; Lieberman & Montgomery, 1988; McGrath, 1997), making it difficult to contract for the specific details of the implementation process prior to investing in a new technology.[6] It can be equally difficult to contract on the outcome of technology implementation ex ante. For example, firm management may want to ensure that human capital do not simply use the new technology but do their best to improve it by engaging the process of mutual adaptation with the technology provider (Leonard-Barton, 1988; von Hippel, 1994). Agreeing on how to define "their best" and measure success on these terms is likely to be prohibitively challenging. Therefore, contracting with non-integrated human capital prior to initiating adoption cannot adequately ensure their cooperation. Alternatively, choosing to initiate adoption and renegotiate a contract with non-integrated human capital as the needs of implementation unfold is likely to be prohibitively time-consuming and expensive, particularly if the activities involved with implementation are a

[6] Even if it were possible to specify a complete contract for the process of implementation, doing so would put the firm at risk of violating the IRS's rules for non-employees; the more detailed a firm's instructions are for how to perform an individual's job, the more likely the IRS will require the firm to instead categorize the individual as an employee and use an employment contract to govern the relationship (IRS).

significant departure from previously contracted activities (Hart & Moore, 2008; Hart & Zehnder, 2011). Moreover, there are legal constraints on the level of detail with which firms can specify how non-integrated human capital should provide a product or service; the more detailed a firm's instructions are for how to perform an individual's job, the more likely the IRS will require the firm to instead categorize the individual as an employee and use an employment contract to govern the relationship (Internal Revenue Service, 2018). An employment contract, however, allows firm management to unilaterally demand changes in what tasks human capital perform and how the tasks should be performed (Bidwell, 2004; Cappelli & Keller, 2013; Gibbons, 2005; Simon, 1951; Williamson, 1975), eliminating the need for the costly and time-consuming process of contract renegotiation either ex ante to the initiation of adoption or ex post. Instead, firm management can expect to direct human capital to adjust their activities as the needs of the implementation process unfold.

Second, holding directive control reduces the likelihood that a coordination problem will delay or prevent human capital from fully engaging in the required adaptation efforts. The implementation process requires coordination if whether and when one individual performs a task depends on whether and when another individual has completed his or her own task. To ensure smooth implementation, individuals must therefore be able to read and react to signals from each other regarding the state of completion of various tasks (Williamson, 1991); failing to do so will prohibit human capital from successfully adapting the technology even if it is their intention to perform the required adaptation efforts (Gulati, Lawrence, & Puranam, 2005; Schelling, 1960). As Nelson and Winter (1982, p. 104) write, "what is central to coordination is that individual members, knowing their jobs, correctly interpret and respond to messages they receive." But correctly identifying, interpreting, and reacting to such signals requires knowledge

of what tasks others perform and how these tasks are interdependent with one's own tasks, which can be difficult for boundedly rational individuals to achieve without the aid of some centralized coordinating figure (Gulati et al., 2005; Gulati & Singh, 1998; Williamson, 1991). Holding legally-conferred directive control facilitates coordination by allowing firm management to set rules for what tasks should be performed and when, and if decision rules prove insufficient, it allows firm management to appoint a centralized authority figure whose responsibility is to develop knowledge about how tasks among individuals are interdependent and use this knowledge to direct human capital's actions as needed (Galbraith, 1977; March & Simon, 1958; Thompson, 1967). Crucially, the success of these coordinative efforts depends on human capital allowing the centralized authority figure to direct what tasks they perform and when, and firm management cannot count on non-integrated human capital to do so.

Therefore, because holding directive control raises firm management's expectations that human capital will fully engage in the required adaptation efforts in a timely manner by eliminating the need for contract renegotiation and lowering the risk of a coordination problem, firms that integrate human capital using an employment should adopt a new technology sooner than firms that choose not to integrate human capital.

> *H1: Firms that use an employment contract to integrate the set of human capital who will implement a new technology will adopt the new technology sooner than firms that maintain an arm's length relationship with that set of human capital.*

Directive control is legally and theoretically the sharpest and most consistent distinguishing feature of an employment contract, but another feature that commonly accompanies the employment contract is continuity of association (Demsetz, 1988; Williamson,

1985), meaning employees typically work for one firm at a time and have an expectation of a continued, open-ended relationship as a opposed to a clearly defined endpoint, such as the end of a contracted project. While the post-World War II model of employment in which a person works for one company for his or her whole adult life has become much less prevalent (Farber, 2008; Hollister, 2011), the average employee still remains with one firm for several years (Farber, 2008), and expectations of a continued, longer term relationship still tend to be stronger for human capital that are party to employment contracts rather than market contracts (Cappelli & Keller, 2013). This feature raises firm management's expectations about soliciting the required adaptation efforts from human capital in a timely manner in three ways.

First, firm management may assume that the expectation of a continued, exclusive relationship with a firm increases human capital's incentives for investing in firm-specific skills. If a firm is early to adopt a new technology and there is uncertainty as to whether other firms will follow suit, or if the implementation of a new technology is idiosyncratic to the firm, then the process of implementation may require human capital to develop firm-specific knowledge or skills. The returns to adaptation efforts will then be lower for non-integrated human capital because they likely spend less time working with the firm than integrated human capital and they cannot apply the learned knowledge or skills to the other firms with which they work. To this point, as the expectation of a continued association declines, human capital become less willing to invest in firms specific-skills (Cappelli, 1999, 2008).

The firm specificity of the implementation effort may also affect managerial expectations about the success of implementation because firm-specific investments are also associated with the possibility of self-interested bargaining with non-integrated human capital that can slow-down adaptation (Williamson, 1991). As human capital engage in the required adaptation efforts

and gain the firm-specific knowledge and skills required to incorporate a given technology into a product or process, human capital may then try to renegotiate their contract with the firm opportunistically, since switching to new human capital has now become more costly for the firm (e.g., Masten, Meehan, & Snyder, 1991; Monteverde & Teece, 1982; Williamson, 1985). Integration is intended to limit this opportunistic behavior by uniting control of the transacting parties within one firm (Williamson, 1985). However, in the transaction costs perspective, control is typically conferred to the firm through the ownership of physical assets (Gibbons, 2005), and while non-integrated human capital may be able to hold up the firm as they develop firm-specific skills, choosing to integrate human capital with an employment contract does not necessarily solve the problem when the human capital's value is in their inalienable knowledge and skills—which is likely to be the case for higher-skilled human capital such as professionals and knowledge workers (Coff, 1997; Gibbons, 2005; Hart, 2017). An employment contract grants firm management greater control over human capital's behavior, but there are still limits on that control (Bidwell, 2004; Coff, 1997; Simon, 1951); moreover, human capital can still engage in opportunistic bargaining over the terms of an employment contract or threaten to leave the firm altogether. Thus, while the possibility for hold-up by human capital can have the general effect of causing firm management to defer adoption, firms with integrated human capital are not necessarily any less likely to expect hold up than firms with non-integrated human capital, especially in the case of highly-skilled human capital. But importantly, regardless of whether using an employment contract can alter expectations about hold-up, continuity of association between a firm and human capital can raise firm management's expectations that human capital will engage in the required adaptation efforts by increasing the return on investment that human capital earn for those efforts.

Second, firm management may assume that continuity of association with human capital brings the interests of human capital into greater alignment with the interests of the firm, further incentivizing human capital to engage in the required adaptation efforts in a timely manner. Both Ang and Slaughter (2001) and Bidwell (2009) provide evidence that firm management perceives contractors as exhibiting less organizational commitment, which is the "psychological attachment felt by the person for the organization," and it reflects the degree to which an individual internalizes or adopts the characteristics or perspectives of the firm (O'Reilly & Chatman, 1986, p. 493). Organizational and affective commitment can lead to discretionary organizational citizenship behaviors such as conscientiousness and organizational loyalty that involve going above and beyond the bare minimum when completing a job (Dekas, Bauer, Welle, Kurkoski, & Sullivan, 2013; Organ, 1988; Organ, Dennis W. & Ryan, 1995), which may prove useful in implementing a new technology as human capital taking initiative and using their judgment to fill gaps can smooth the uncertain process and ensure that the firm maximizes the full value of the technology. [7]

Third, continuity of association between a firm and human capital reduces the likelihood that a coordination problem will delay or prevent human capital from fully engaging in the required adaptation efforts, apart from the effect of holding legally-conferred directive control. As described previously, implementation may require coordination if there is task interdependency among individuals, yet the difficulties that individuals have in correctly identifying, interpreting, and reacting to signals from each other regarding the state of completion of various tasks can impair achieving coordination (Gulati et al., 2005; Gulati & Singh, 1998; Nelson & Winter, 1982; Williamson, 1991). A result of the continuity of

[7] Williamson (1975) calls such behavior "consummate cooperation", which stands in contrast to "perfunctory cooperation," or performing the required tasks with the minimal acceptable compliance.

association that is found in many employment relationships, however, is that integrated human capital tend to accumulate shared experiences through repeated interaction (Gulati et al., 2005; Kogut & Zander, 1996). This can engender the development of shared norms and values as human capital come to identify with the firm, which facilitates the development of procedures and heuristics for effectively coordinating behavior with each other (Akerlof & Kranton, 2005; Kogut & Zander, 1996). Repeated social interaction also enables the development of codes of communication that allow the identification and interpretation of signals from other human capital (Arrow, 1974; Cremer et al., 2007; Kogut & Zander, 1996; Nelson & Winter, 1982). Firm-specific codes of communication can be particularly valuable in facilitating "unstructured, uncodifiable, generally verbal, and often face-to-face communication," (Monteverde, 1995, p. 1629), which is likely to be required in the unpredictable, idiosyncratic process of technology implementation. Thus, while directive control represents a formal mechanism by which an employment contract facilitates coordination, the continuity of association that commonly accompanies an employment contract offers informal mechanisms that facilitate coordination as well (Gulati et al., 2005).

In sum, while directive control gives firm management the authority to ensure human capital participate in the implementation process, continuity of association raises managerial expectations that the relevant human capital will be incentivized to engage in the required adaptation efforts while also allowing for coordination to be achieved. Continuity of association therefore presents another reason why firms that use an employment contract to integrate human capital should adopt a new technology sooner than firms that choose not to integrate human capital.

However, unlike directive control, which provides a strict distinction between an employment contract and any other type of contract, continuity of association is not necessarily unique to the use of an employment contract. Even if contracts are written to cover a relatively short period, non-integrated workers may both accumulate tenure with a firm through repeated contracting and operate under an exclusive relationship with the firm. In such cases, non-integrated human capital may be just as likely to cooperate and engage the in the required adaptation efforts as human capital integrated by an employment contract. The firm-specificity of the skills human capital will acquire through the implementation process should matter less in shaping firm management's expectations. Furthermore, the "shadow of the future" encourages cooperation (Baker et al., 2002) and repeated interactions can encourage the development of trust, shared norms and values, and codes of communication that facilitate coordination across firm boundaries (Gulati et al., 2005). For similar reasons, the difference in organizational commitment and proclivities for organizational citizenship behaviors may shrink. For example, Pfeffer and Barron (1988) express skepticism as to whether employee versus contractor status influences organizational commitment in the first place, and in contrast to Ang and Slaughter (2001) and Bidwell (2009), Pearce (1993) finds no difference in the extra-role behavior exhibited by contractors versus employees and no significant difference in organizational commitment between employees and contractors. Variation in the length and exclusivity of relationships between firms and contractors may explain some of the discrepancy. Moreover, the evidence indicating that employees of a firm are more likely to exhibit organizational citizenship behaviors is in the form of statistically significant correlations (Ang & Slaughter, 2001; Bidwell, 2009; Dukerich, Golden, & Shortell, 2002; Tsui, Pearce, Porter, & Tripoli, 1997), but there are still non-employees who engage in cooperative behavior within these samples.

Therefore, one might expect that the difference in managerial expectations about human capital engaging in the required adaptation efforts to be smaller when continuity of association is not unique to the employment contract. My empirical context provides an opportunity to explore this possibility. In some local healthcare markets, there is only one hospital that physicians can feasibly use to treat their patients. In this case, physicians are likely to interact repeatedly and nearly exclusively with that hospital, regardless of their contractual relationship with the hospital. Within these markets, I expect a weaker relationship between using an employment contract to integrate human capital and the timing of the decision to adopt a new technology.

> *H2: The relationship between using an employment contract to integrate the set of human capital who will implement a new technology and the timing of technology adoption will be weaker in markets that engender continuity of association for all types of contractual relationships.*

A third feature that accompanies the employment contract is compensation flexibility. First, the employment contract typically confers directive control to firm management in exchange for a fixed wage, i.e., a salary. Salaried compensation can dampen productivity incentives relative to the incentives human capital face as independent contractors in the market by loosening the correlation between effort and reward (Teece, 1996; Williamson, 1985). However, these lower-powered incentives can work in favor of technology implementation and actually raise firm management's expectations that human capital will fully engage in the adaptation efforts in a timely manner. Engaging in the required adaptation efforts comes at the expense of productivity, and human capital who operate under the higher-powered market incentives for productivity have a higher opportunity cost associated with making that

investment and may therefore be less willing to do so. Furthermore, the employment contract also allows for other modes of compensation or reward such as bonuses and promotion that may raise managerial expectations about human capital engaging in the required adaptation efforts by enabling firm management to reward the efforts of human capital based on subjective evaluation (Williamson, 1975, 1991).

However, in my empirical context, hospitals consciously attempt to mimic the productivity incentives of the market. When integrating physicians first became common in the 1990s in response to the managed care movement (see Chapter 4), hospitals witnessed first-hand the drop in physicians' productivity when they became salaried employees. The vast majority of employed physicians now have a significant portion of their compensation tied to their productivity. Specifically, while employed physicians may have a base salary, their total compensation is tightly tied to the number of Relative Value Units (RVUs) that they produce. A number of RVUs is assigned to a given procedure or service based on the time, skill, effort, training, and stress performing the service requires, and physicians are then paid by a dollar multiple that is typically determine within an employment contract[8] (Coberly, 2015). While hospital administrators still have access to compensation flexibility, they are unlikely to exercise it during my sample period in a way that is specific to employed physicians. Therefore, while productivity incentives and the ability to flexibly reward human capital are likely to affect firm

[8] Please see Coberly (2015) for more detail: Physician procedures and services are defined by the Current Procedural Terminology (CPT) code set, which is maintained by the American Medical Association (AMA). The Centers for Medicaid and Medicare (CMS) define the RVUs and are required by Congress to update them every five years or as new procedures emerge; CMS also sets a fee structure for Medicaid and Medicare reimbursements, and this serves as the benchmark for insurers and hospital employers. For example, a diagnostic colonoscopy requires 30 minutes of prep time, 25 minutes actually performing the colonoscopy, and 15 minutes post-procedure time; the RVU is based on the physician spending 75 minutes on the procedure, as well as the skill and effort the procedure requires; he 25 minutes of time spent performing the procedure earns more RVUs than the 25 minutes of time spent in a standard office visit. In 2014, an intermediate office visit earned a physician 1.50 RVUs while diagnostic colonoscopy earned 3.69 RVUs and total hip replacement earned 20.72 RVUs. The dollar multiple in 2014 used by CMS was $35,8228.

management's expectations about human capital engaging in the required adaptation efforts generally, they are unlikely to play a strong role in this context.

To summarize, legally-conferred directive control, continuity of association, and compensation flexibility should raise firm management's expectations that the relevant human capital will engage in the adaptation efforts that successful implementation of a new technology requires in a timely manner. In my empirical context in particular, legally-conferred directive control and continuity of association should have strong effects. In turn, firms that use an employment contract to integrate the set of human capital on whom the firm relies to implement a new technology should adopt that technology sooner than firms that maintain an arm's length relationship with that set of human capital.

Yet uncertainty about what the implementation process will entail, and therefore what the nature of the required adaptation efforts will be, is likely to be higher earlier in the technology life cycle when all the flaws in the technology have yet to be worked out (Anderson & Tushman, 1990; Dosi, 1982; Sahal, 1981). A more flawed technology also suggests that the adaptation efforts themselves are likely to be more extensive earlier in the technology lifecycle, as the processes of experimentation and mutual adaptation become more involved, and so uncertainty about human capital making the required adaptation efforts is also likely to be higher earlier in the technology life cycle. Therefore, legally-conferred directive control and the incentive and coordinative benefits associated with continuity of association are likely to be of relatively more value earlier in the technology life cycle and have a greater effect on firm management's expectations about the likelihood of successful implementation. I further hypothesize that firms that use an employment contract to integrate human capital will be more likely to adopt a new technology sooner than firms with non-integrated human capital in the earlier stages of the

technology life cycle.

H3: The relationship between using an employment contract to integrate the set of human capital who will implement a new technology and the timing of technology adoption will be stronger earlier in the technology life cycle.

Integration and the Decision-making Process

While I have argued that using an employment contract to integrate the human capital on whom a firm will rely to implement a new technology will increase the likelihood of adoption by raising expectations that implementation will be successful, choosing to use an employment contract to integrate human capital may also alter the decision-making process itself by introducing the anti-innovation bias of hierarchy (Kapoor & Lee, 2013; Teece, 1996; Williamson, 1975, 1985) or increasing the presence of influence costs (Kapoor & Lee, 2013; Milgrom & Roberts, 1988, 1990). This presents the competing prediction that integration will delay the technology adoption decision. To resolve this tension, I first argue that the anti-innovation bias is unlikely to explain differences in the timing of technology adoption decisions between firms that integrate human capital and firms that do not integrate human capital. I then identify a contingency for when influence costs are likely to manifest.

A closer examination of the mechanisms underlying the argument that an anti-innovation bias associated with hierarchy delays the technology adoption decision in firms that use an employment contract to integrate human capital reveals that it is unlikely to be applicable to explaining differences in the timing of adoption between firms that integrate human capital and firms that do not. The two main mechanisms driving the anti-innovation bias are the slower decision-making processes and the lower-powered incentives associated with hierarchy that each

tend to promote the status quo at the expense of pursuing novel or uncertain projects (Teece, 1996; Williamson, 1975, 1985). However, integration does not necessarily imply a more hierarchical decision-making process, and the extent to which it does depends on the technology under consideration. If the locus of decision-making for investing in a given technology sits with the human capital in question when they are not integrated but shifts to firm management when they are integrated as employees of the firm, then integration does involve a change in the hierarchical nature of the decision-making process, and one would expect decision-making under integration to be slower. For example, within the hospital context, suppose the new technology in question is a new x-ray machine, and suppose that, as a non-integrated affiliate of the hospital, a physician would make the decision to purchase the new x-ray machine him- or her-self, but as an integrated employee of the hospital, he or she must now obtain approval from hospital administration to make such a purchase. The latter may involve having to write up a case for purchasing the technology and seeking the approval of one or more committees, and it will be weighed against other opportunities for investment across the hospital (Teece, 1996). Therefore, one might expect that adoption of the x-ray technology will be slower if physicians are integrated as employees of a hospital. But note that the comparison in such a case is between a hospital that has integrated physicians and physicians that remain independent. There is no relevant prediction for whether hospitals that integrate physicians will be slower to adopt the x-ray technology than hospitals that do not integrate physicians because the adoption decision is not relevant to hospitals that do not integrate physicians—the locus of decision-making has moved outside of the hospital to the independent physician.

Additionally, while it is argued that the lower-powered incentives facing human capital under an employment contract can inhibit incentives to innovate (Kapoor & Lee, 2013; Teece,

1996), lower-powered incentives may not necessarily delay technology adoption. Again, the effect depends on the type of technology and the locus of decision-making. Lower-powered incentives mean that the efforts of a worker are less closely tied to firm performance under an employment contract than his or her efforts would be tied to performance if he or she operated as an independent market actor (Teece, 1996; Williamson, 1985), and the concern is that employees therefore have less incentive to look for opportunities to innovate because they are less likely to be compensated in proportion to the improvement in firm performance that those efforts generate (Teece, 1996). Returning to the above example, a physician may have less incentive to push for adoption of a new x-ray machine as an employee of a hospital because he or she will receive a lower proportion of the returns to innovation than if he or she were operating independently. But for technologies for which the locus of decision-making remains with firm management, the lower-powered incentives associated with integrating human capital may even speed technology adoption. As I have already argued, the higher-powered incentives faced by physicians operating as independent market actors may make sacrificing productivity to take the time to learn to use a new technology more costly than it would be under an employment contract, and anticipating this, firm management may decide to adopt a new technology sooner if the relevant human capital is integrated as employees.

But the key is that arguments that integration will delay technology adoption due to the anti-innovation bias of hierarchy are relevant to technologies for which integration moves the locus of decision-making from outside the firm to inside the firm, but they are not suited to explaining why, all else equal, integrating human capital should affect whether and when firm management will decide to invest in a new technology when the locus of decision-making

remains with firm management in either case.[9] Within this dissertation, I focus on the latter condition in which the locus of decision-making for the firm's decision to adopt a new technology does *not* shift with the integration of human capital, and thus I do not hypothesize that a hierarchy-induced anti-innovation bias will delay the decision to adopt a new technology.

I now turn to the argument that firms that integrate human capital should be slower to invest in a new technology because influence activity and politicking within the firm result in sub-optimal decision-making (Kapoor & Lee, 2013; Milgrom & Roberts, 1988). As discussed previously, an employment contract confers directive control to firm management, allowing firm management to selectively intervene in the activities of integrated human capital and direct a change in behavior (Bidwell, 2004; Cappelli & Keller, 2013; Gibbons, 2005; Simon, 1951; Williamson, 1975). Importantly, however, unlike integrated physical assets, human capital can exercise voice, and human capital who are integrated as employees may seek to influence when and how firm management intervenes in their activities to suit their own needs (Milgrom & Roberts, 1988; Roberts, 2007; Williamson, 1985; Zenger, Felin, & Bigelow, 2011). Information asymmetries between firm management and human capital provide an opportunity to do so. Often firm management does not hold all the relevant information related to a particular decision or intervention, and the human capital within the firm that do hold the relevant information may attempt to manipulate the information set for private benefit through outright lying, suppressing unfavorable information, or putting a calculated spin on the information (Milgrom & Roberts, 1988, 1990). "Influence costs" arise from such influence activity and politicking leading to suboptimal outcomes for the firm, as well as efficiency losses due to human capital engaging in

[9] An exception would be if one can demonstrate that a given context, firms that integrate human capital also happen to have more hierarchical decision-making processes than firms that do not integrate human capital due to some other mechanism. This is not the case in the context I study for this dissertation, where hospitals consider adopting health information technologies.

those activities rather than their usual responsibilities (Milgrom & Roberts, 1988). Typical influence activities include efforts to attain promotions or to increases wages, and non-integrated human capital are less likely to be a source of influence costs because behavior and pay are set by the contract, meaning firm management has no further authority to direct behavior or alter wages (Milgrom & Roberts, 1988; Roberts, 2007; Williamson, 1985; Zenger et al., 2011).[10]

Integrated human capital may also seek to influence decision-making with respect to technology adoption. Firm management constructs the case for or against adoption under uncertainty, and often the human capital who will implement the technology have more information about the tasks targeted for change by the technology than firm management. Such an information asymmetry provides human capital an opportunity to attempt to manipulate firm management's estimates of the ultimate benefit the new technology can generate or the ultimate cost implementation will incur (Milgrom & Roberts, 1988, 1990). Unlike non-integrated human capital who have no legal obligation to change behavior to suit firm management's wishes, integrated human capital will be required by firm management to engage in the necessary adaptation efforts if firm management chooses to adopt a new technology, making the decision more consequential for integrated human capital and thereby providing greater incentive to attempt to influence the decision. However, integrated human capital are unlikely to seek to influence every technology adoption decision. Instead, I argue that integrated human capital will be more likely to engage in influence activity if the technology under consideration targets a task or a set of tasks for which the human capital are perceived to have greater expertise than firm management.

[10] For this reason, influence costs within the firm are considered analogous to the bargaining and transaction costs that arise in the market (Gibbons, 2005; Zenger et al., 2011).

The division of tasks within an organization is intended to allow for specialization, (Chandler, 1962; Lawrence & Lorsch, 1967; Thompson, 1967), and authority is then allocated to centralized decision-making figures through a hierarchical design that allows the centralized figure to accumulate the necessary information from across specialties or divisions to coordinate activities (Chandler, 1962; Galbraith, 1973; March & Simon, 1958; Marschak & Radner, 1972; Williamson, Oliver E., 1967). Thus, the decision-making authority allocated to those centralized figures, i.e., firm management, is grounded in their superior access to information about activities across the various specialties or divisions. As Barnard (1938) writes,"[a] communication has the presumption of authority when it originates at sources of organization information—a communication center—better than individual sources […] Thus men impute authority to communications from superior positions," (p. 173). In their classical works, Barnard (1938) and Simon (1947) posited that employees are more likely to accept firm management's authority to direct whether and how they perform a given task or set of tasks if they believe that firm management has the relevant information and expertise to make an effective decision, but as employees begin to question the completeness of firm management's information and the level of firm management's expertise with respect to a given task or set of tasks, firm management's authority loses legitimacy. This is consistent with more recent arguments that employees, particularly skilled employees, may be more likely to question firm management's expertise to judge a tool designed to aid a technical task as opposed to a tool designed to aid an administrative task, and that employees' perceptions of superior competence relative to their superiors decrease the legitimacy of an authority message to adopt an innovation (Leonard-Barton, 1988). It is also consistent with the argument that professionals and knowledge workers are likely to believe that firm management does not have the expertise to critique or modify their

technical tasks, which include classifying, diagnosing, and prescribing treatments for certain classes of problems (e.g., Abbott, 1988; Freidson, 2001; Gorman & Sandefur, 2011; Sharma, 1997).

Thus, human capital cede decision-making authority to firm management on the basis of firm management having access to the requisite information and holding the requisite expertise to use that information to make effective decisions. To have incentive to engage in influence activity, then, human capital must question whether firm management has the relevant information and expertise to make an effective decision and must have concern that the outcome of the decision will affect their personal interests. To have opportunity to engage in influence activity, there must be some degree uncertainty around the terms of the decision; human capital will be particularly effective in influencing the decision if there is an information asymmetry to exploit. Therefore, in the context of technology adoption, integrated human capital should be less likely to trust firm management to make the decision to adopt a new technology and more likely to seek to influence the decision if they question the completeness of information and the level of firm management's expertise with respect to the task or set of tasks targeted by the new technology. I argue that this should be the case when a new technology targets tasks for which employees are believed to have greater expertise relative to firm management, and I hypothesize that it is under this condition that influence activity conducted by integrated human capital will counteract the effect of integration on managerial expectations about successful implementation. In particular, the greater human capital's expertise advantage over firm management in the tasks targeted by a new technology, the less likely firms with integrated human capital will be to adopt a new technology sooner than firms with non-integrated human capital.

H4: The greater human capital's expertise advantage over firm management in the tasks targeted by a new technology, the less likely firms that use an employment contract to integrated human capital will be to adopt a new technology sooner than firms that do not integrate human capital.

Summary

Existing literature reveals competing predictions for whether firms that use an employment contract to integrate the human capital on whom a firm will rely to implement a new technology will adopt a new technology sooner or later than firms that maintain an arm's length relationship with this set of human capital. Choosing to use an employment contract to integrate human capital may alter the decision-making process such that firms that integrate human capital are slower to decide to adopt a new technology due to the anti-innovation bias associated with hierarchy (Kapoor & Lee, 2013; Teece, 1996; Williamson, 1975, 1985) and the presence of influence activity (Kapoor & Lee, 2013; Milgrom & Roberts, 1988, 1990). On the other hand, the adaptive advantages of integration may raise managerial expectations about the likelihood of successful implementation, suggesting that firms that integrate human capital will adopt a new technology sooner.

In this Chapter, I present the beginnings of a framework that disentangles these competing predictions. I argue that firms that use an employment contract to integrate the human capital on whom the firm will rely to implement a new technology will adopt a new technology sooner than firm's that maintain an arm's length relationship with that set of human capital because legally-conferred directive control, continuity of association, and compensation flexibility raise firm management's expectations that the relevant human capital will fully engage

in the required adaptation efforts and therefore raise expectations of successful implementation. However, there are important caveats. This effect should be stronger earlier in the technology life cycle, when there is more uncertainty about what the implementation process will entail, and this effect should be weaker when continuity of association is not unique to the employment relationship. Finally, I hypothesize that the effect should be weaker when integrated human capital engage in influence activity, but that they should only engage in influence activity when the new technology targets tasks for which the relevant human capital have a sufficiently large expertise advantage over firm management. Additionally, I argue that the delaying effect associated with the anti-innovation bias of hierarchy should only materialize when integration moves the locus of decision-making for adoption from outside to inside the firm, which is not the case in my empirical context.

CHAPTER III
The Implementation of a New Technology

Introduction

Firms adopt new technologies with the goal of generating improvements in firm performance by using the technology to create new or improved products or processes, and the success of these efforts depends on a set of human capital, typically beyond firm management, who must do the work of incorporating the technology into the relevant product or process (Lanzolla & Suarez, 2012; Leonard-Barton & Deschamps, 1988; Rogers, 2003). For the firm to realize the full value of a new technology, it is critical that this set of human capital engages in adaptation efforts that may include investing time in learning to use the new technology and making any necessary adjustments to their roles and patterns of interpersonal interactions within the firm (Attewell, 1992; Barley, 1986, 1990; Orlikowski, 1992; Szulanski, 2000; Tyre & Orlikowski, 1994; von Hippel, 1994). For new process technologies in particular, maximizing the value of the technology may also require human capital to participate in the process of mutual adaptation, whereby the provider of the technology can continue to modify and improve it in response to user feedback (Leonard-Barton, 1988; von Hippel, 1994).

In this chapter, I examine how using an employment contract to integrate this set of human capital affects the implementation of a new technology, and I specifically focus on the case where the relevant human capital are highly skilled, such as knowledge workers or professionals. Consistent with theories of the firm that deem the distinguishing characteristic of the firm from the market to be the coordination of activities and resources by fiat as opposed to

the price mechanism (e.g., Coase, 1937; Williamson, 1975), the distinguishing feature of an employment contract, both theoretically and legally, is the directive control conferred to firm management (Bidwell, 2004; Cappelli & Keller, 2013; Gibbons, 2005; Internal Revenue Service, 2018; Masten, 1988; Simon, 1951; Williamson, 1975). Unlike arm's-length, market-based contracts which specify the products or services to be provided by a worker at the outset, the employment contract leaves many requirements of the worker formally unspecified and instead confers to firm management directive control, which is the authority to select in the future (over the length of the contract) what tasks a worker should perform, as well as when and how the tasks should be executed (Simon, 1951; Williamson, 1975).[11] Accordingly, it has been common in the literature to view employing human capital as a form of integration (Bidwell, 2004; Davis-Blake & Uzzi, 1993; Doeringer & Piore, 1971; Wernerfelt, 1997; Williamson et al., 1975), and the strategic question of whether to use an employment contract to integrate human capital is one of firm boundaries.

Prior literature suggests that firms that integrate human capital should be able to implement a new technology more successfully than firms that remain at arm's length with their human capital due to the adaptive advantages commonly associated with integration (e.g., Kapoor & Adner, 2012; Nelson & Winter, 1982; Williamson, 1975, 1985, 1991). The technology implementation process can be idiosyncratic, unpredictable, and involve task interdependency among actors, and successful implementation therefore requires both the ability to obtain cooperation from the relevant human capital and the ability to coordinate their activities. Integration should facilitate each by conferring to firm management both the ability to direct integrated human capital by fiat (e.g., Simon, 1951; Williamson, 1975, 1991) and the ability to

[11] There are, of course, limits on this control, and holding the legal right to directive control implies neither that employees always comply with managerial directives, nor that non-employees never comply with managerial directives. This is a key point that explore in this paper.

develop superior modes of communication (Arrow, 1974; Cremer et al., 2007; Kogut & Zander, 1996; Nelson & Winter, 1982).

But I contend that a more nuanced framework is needed. On the one hand, non-integrated human capital may be just as willing and able to engage in the required adaptation efforts as integrated human capital. Bidwell (2004), for example, finds smaller-than-expected differences in the amount of control firm management has over employees versus contractors in IT projects, where managers reported experiencing no less control over contractors than employees in day-to-day operations. This suggests that it is possible for non-integrated independent contractors to be just as responsive to management's directives as employees, and thus there may be cases in which firm management can obtain the needed cooperation and coordination for implementation from non-integrated human capital just as they would from integrated human capital. Moreover, the shared norms and codes of communication that are cited as an important reason why integration has a coordinative advantage over non-integration even when cooperation can be obtained from both non-integrated and integrated human capital alike are incubated by continuity of association and repeated social interaction (Gulati et al., 2005; Kogut & Zander, 1996). Changes in the employment relationship, however, call into question the extent of this advantage. Traditionally, employment meant that an employee would work at the firm's physical location on a fixed schedule for a fixed wage under a mutual expectation of continued employment (Cappelli & Keller, 2013; Kalleberg et al., 2000). Yet advances in information technology have increased both the ability of employees to work off-site and the flexibility of work schedules (Cappelli & Keller, 2013). Worker tenure has also declined (Bernhardt et al., 2001; Farber, 2008a; Hollister, 2011; Neumark et al. 1999) as the presence of unions have diminished (Bidwell, 2013). At the same time, workers under non-employment contracts may work alongside employees at a firm's

location and may operate under a mutual expectation of a continued relationship with the firm on par with that of an employee (Bidwell, 2004, 2009). As the difference in continuity of association in firms' relationships with integrated versus non-integrated human capital shrinks, the coordinative advantages of the employment contract in implementing a new technology may also shrink.

On the other hand, integrated human capital may be just as *unwilling* to engage in the required adaptation efforts as non-integrated human capital. The advantages of integration in solving both the problem of cooperation and the problem of coordination lie largely in the unification of control rights, where firm management gains the ability to direct resources, including human capital, by fiat. For example, in the classical transaction costs perspective, integration is intended to solve the problem of cooperation by eliminating the potential for hold-up and costly bargaining (Williamson, 1985). As Gibbons (2005) also notes, this is primarily accomplished by removing the transacting partner's ability to manipulate physical assets to his or her own ends. Similarly, in the property rights view of the firm, control is also conferred through ownership of alienable assets, where a firm's authority over an employee derives from the firm's ability to exclude individuals from using assets to which the firm owns the residual rights (Grossman & Hart, 1986; Hart & Moore, 1990); if a firm owns the asset used by workers to produce the desired output, then the firm holds the right to exclude those workers from using the asset if they do not behave how the firm directs them to behave (Hart & Moore, 1990).

But the nature of the control that is conferred to firm management by integration is different in the case of using an employment contract to integrate high-skilled human capital such as professionals or knowledge workers whose value to the firm is principally in their inalienable knowledge and skills, which, even if firm-specific, are not specific to physical assets

(Coff, 1997; Gibbons, 2005; Hart, 2017). In this case, the manipulation of physical assets loses its power as a tool of control, and although an employment contract does grant firm management greater control over human capital's behavior than any other type of contract, there are bounds on that control—an employment contract does not confer to firm management ownership of an individual (Bidwell, 2004; Coff, 1997; Simon, 1951). The key question regarding technology implementation is whether and when the adaptation efforts required of human capital for successful implementation fall outside those bounds. Furthermore, given a firm's inability to use physical assets as a tool of manipulation, employed human capital can still engage in opportunistic bargaining over the terms of an employment contract or threaten to leave the firm altogether. Thus, non-integrated human capital may, indeed, pose both cooperation and coordination problems for firm management that will hamper efforts to implement a new technology, but choosing to integrate human capital with an employment contract may not necessarily solve the problem. This is consistent with the well-documented difficulty firms have in implementing a technology-stimulated change in routines and practices, where, unlike what fiat would suggest, compliance in engaging in the required adaptation efforts is far from automatic (e.g., Attewell, 1992; Barley, 1986; Edmondson et al., 2001; Leonard-Barton, 1988; Leonard-Barton & Deschamps, 1988; Orlikowski, 1993, 2000; Tyre & Orlikowski, 1994).

In this chapter, I aim to enrich our understanding of the adaptive benefits of integration by hypothesizing conditions under which using an employment contract to integrate human capital facilitates the implementation of a new technology. To do so, I consider when and how three features commonly associated with the employment contract confer an advantage in the degree of cooperation and quality of coordination obtained from the relevant human capital: (1) legally conferred directive control, (2) continuity of association, and (3) compensation flexibility.

I also aim to contribute the technology implementation literature. Prior research identifies numerous factors that facilitate the implementation of a new technology, such as cognitive framing, leadership, and norms. Orlikowski (1993) shows that both organizational culture and the mental model or "technological frame" through which individuals understand a technology have a significant effect on implementation. Successful implementation also requires a shift in the interpersonal "scripts," or the patterns of interaction between individuals (Barley, 1986). Managerial leadership and influence are important in motivating individuals to adapt to a new technology (Leonard-Barton & Deschamps, 1988), and Edmondson et al. (2001) find that strong leadership from within the group of individuals responsible for learning to use the new technology also facilitates implementation. A sense of psychological safety in the interpersonal climate is important as well (Edmondson et al., 2001). Wilson (2016) suggests that alignment between the required changes in behavior and professional norms will increase an individual's motivation and capacity for change.

Despite the richness of these studies, however, the employment status of the human capital implementing a new technology has received little attention, while available data suggests that the choice of whether to use an employment contract to integrate human capital is becoming relevant to more firms (Cappelli & Keller, 2013; L. F. Katz & Krueger, 2016). For example, Katz and Krueger (2016) estimate that the share of U.S. workers engaging with firms through arrangements other than traditional employment contracts grew to 15.8% in 2015, a nearly fifty percent increase from 2005, and smaller-scale surveys indicate that more firms in both the U.S. and abroad view independent contracting as crucial to achieving their primary goals and objectives (Dwyer, 2011, 2013). Moreover, in this chapter I specifically examine the effect of using an employment contract to integrate high-skilled human capital such as professionals and

knowledge workers, and anecdotal evidence indicates that firms increasingly consider whether to integrate this type of human capital as well, including lawyers, consultants, and managers (Miller & Miller, 2012). As more firms choose not to integrate human capital, it becomes more likely that the human capital on whom a firm will rely upon to implement a given new technology will be outside the firm, and therefore it is important to identify the implications of the integration choice for implementation.

This is especially important for the technology implementation literature because a common setting for studying technology implementation has been in hospitals (e.g., Barley, 1986; Black, Carlile, & Repenning, 2004; Edmondson et al., 2001, 2001; Pisano, Bohmer, & Edmondson, 2001; Tucker, Nembhard, & Edmondson, 2006; Wilson, 2016), and yet hospitals and physicians have long remained at arm's length with one another (e.g., Burns & Muller, 2008; Burns & Wholey, 2000; Cuellar & Gertler, 2006). It is critical, therefore, to develop a better understanding of how the contractual relationship between a firm and human capital affects human capital's behavior in the implementation process.

Theory and Hypotheses

For a firm to realize the full value of a new technology, it is crucial that the set of human capital who are responsible for implementing the new technology fully engage in the required adaptation efforts, which may include investing time in learning to use the new technology and making any necessary adjustments to their roles and patterns of interpersonal interactions within the firm (Attewell, 1992; Barley, 1986, 1990; Orlikowski, 1992; Szulanski, 2000; Tyre & Orlikowski, 1994; von Hippel, 1994). For new process technologies in particular, maximizing the value of the technology may also require human capital to participate in the process of mutual adaptation, whereby the provider of the technology can continue to modify and improve

it in response to user feedback (Leonard-Barton, 1988; von Hippel, 1994). To ensure that human capital do engage in these adaptation efforts, firm management must solve two problems: the problem of cooperation and the problem of coordination. The problem of cooperation is one of motivation, or aligning interests (Gulati et al., 2005); the relevant human capital need to be willing to engage in the required adaptation efforts. The problem of coordination is one of aligning actions (Gulati et al., 2005), and it is likely to arise in the implementation process if there is task interdependency among individuals, meaning whether and when one individual performs a task depends on whether and when another individual has completed his or her own task. To ensure smooth implementation in the presence of task interdependency, individuals must be able to read and react to signals from each other regarding the state of completion of various tasks (Williamson, 1991); failing to do so will prohibit human capital from successfully adapting the technology even if it is their intention to perform the required adaptation efforts (Gulati et al., 2005; Kogut & Zander, 1996; Nelson & Winter, 1982; Schelling, 1960). As Nelson and Winter (1982, p. 104) write, "what is central to coordination is that individual members, knowing their jobs, correctly interpret and respond to messages they receive." But correctly identifying, interpreting, and reacting to such signals requires knowledge of what tasks others perform and how these tasks are interdependent with one's own tasks, which can be difficult for boundedly rational individuals to achieve without the aid of some centralized coordinating figure (Gulati et al., 2005; Gulati & Singh, 1998; Williamson, 1991).

I hypothesize conditions under which using an employment contract to integrate human capital facilitates the implementation of a new technology by considering how and when three features commonly associated with the employment contract are advantageous in solving the

problems of cooperation and coordination. These features are (1) legally-conferred directive control, (2) continuity of exclusive association, and (3) compensation flexibility.

Legally-conferred directive control represents the sharpest distinction between an employment contract and any other type of contract with human capital (Cappelli & Keller, 2013). Unlike a sales contract in which firm management promises a stated sum of money to an individual worker in return for the individual performing a set of tasks that are specified in full at the outset, an employment contract confers directive control to firm management, which is the authority to select in the future what tasks a worker should perform, as well as when and how the tasks should be executed, for the length of the contract in exchange for a stated wage (Bidwell, 2004; Cappelli & Keller, 2013; Gibbons, 2005; Simon, 1951; Williamson, 1975). Initially formalized in the literature by Simon (1951) in his treatment of the employment relationship, it continues to serve as the basis for defining employment in the literature (e.g., Bidwell, 2004; March & Simon, 1958; Simon, 1991; Wernerfelt, 1997; Williamson, 1975). More recently, Bidwell (2004) and Gibbons (2005) both build on Simon (1951) in describing an employment contract as one in which firm management is granted the set of decision rights regarding what tasks human capital performs and how the human capital performs them for the length of the contract. This allows the firm to "unilaterally alter the nature of the service that is provided to it [by the human capital] and how the service is provided," Bidwell (2004). Under a sales contract, firm management has no right to demand changes to when and how the product or service is provided once the contract is set.

In practice, directive control as the distinguishing feature of an employment contract is consistent with both case law and tax rules. Masten (1988) documents that U.S. case law reveals a unique set of obligations and responsibilities associated with the employment contract that are

consistent with firm management having greater control over employee behavior relative to other human capital. Unlike an employee, firm management has no legal basis for directing a non-integrated worker's behavior beyond what is specified in the contract, including how to produce a desired outcome (Cappelli & Keller, 2013; Masten, 1988). Courts validate the authority of firm management over employees by typically refusing to resolve disputes between an employee and firm management, but they do agree to resolve disputes between a firm and non-integrated human capital (Cappelli & Keller, 2013; Masten, 1988). Furthermore, the Internal Revenue Service (IRS) in the U.S. monitors firms' categorization of their human capital as employees versus independent contractors based on the presence of directive control, where, "a worker is an employee when the business has the right to direct and control the worker," (Internal Revenue Service, 2018). Firms risk legal consequences if attempting to claim that a relationship with human capital in which firm management effectively exercises directive control is an independent contracting relationship governed under contract law instead of an employment contract governed under employment law. The legal basis of directive control is not limited to the U.S. either (Befort, 2003; Cappelli & Keller, 2013; Stone, 2006). The right to control the work process distinguishes an employment contract around the world, especially in developed countries in North America and Europe (Cappelli & Keller, 2013).

The second feature, continuity of association, refers to the mutual expectation of a continued relationship between a firm and its human capital (Demsetz, 1988; Williamson, 1985). Employees typically work for one firm at a time and have an expectation of a continued, open-ended relationship as opposed to a clearly defined endpoint, such as the end of a contracted project. While the post-World War II model of employment in which a person works for one company for his or her whole adult life has become much less prevalent (Farber, 2008; Hollister,

2011), the average employee still remains with one firm for several years (Farber, 2008), and expectations of a continued, longer term relationship still tend to be stronger for human capital that are party to employment contracts rather than market contracts (Cappelli & Keller, 2013). Although, as noted previously, declines in employee tenure (Bernhardt et al., 2001; Farber, 2008a; Hollister, 2011; Neumark et al. 1999) combined with an increase in independent contractors also operating under a mutual expectation of a continued relationship with the firm on par with that of an employee (Bidwell, 2004, 2009) suggest that continuity of association may not distinguish employment contracts from other types of contracts as sharply as it once did.

Finally, a third feature that accompanies the employment contract is compensation flexibility. The employment contract typically confers directive control to firm management in exchange for a fixed wage, i.e., a salary. Salaried compensation is associated with lower productivity incentives as it loosens the correlation between effort and reward (Teece, 1996; Williamson, 1985). But the employment contract also allows for other modes of compensation, such as bonuses and promotion, that give firm management more flexibility in when and how they reward the efforts of human capital, while compensation in other types of contracts is typically limited to the terms specified in contract at origination (Williamson, 1975, 1991).

By considering whether and how these three features of the typical employment relationship solve the problems of cooperation and coordination in the technology implementation process, I generate hypotheses for the effect of using an employment contract to integrate human capital on the speed with which a new technology is implemented. However, implementation is a complex process that can involve iterating through a trial and error process (Edmondson et al., 2001), and I acknowledge that speed is just one dimension by which the success of implementation may be evaluated. For example, Szulanski (1996, 2000) deems

implementation to have been successful when satisfactory results have been achieved and use is ongoing. Thus far, I am not hypothesizing the effect on the extent to which use is ongoing or the extent to which results are satisfactory. Instead, I leave that to future work.

To start, I articulate why each of the three features should contribute to faster implementation. I then hypothesize two conditions under which using an employment contract to integrate human capital will be less advantageous. The first is because non-integrated human capital will be just as willing to engage in the required adaptation efforts as integrated human capital, and the second because integrated human capital will be just as likely to resist engaging in the required adaptation efforts as non-integrated human capital. An assumption throughout is that the firm has already made the decision to adopt a new technology and the next step is implementation.

All three features of the typical employment relationship should allow firms that use an employment contract to integrate human capital to solve the problem of cooperation more quickly than firms that maintain an arm's length relationship with human capital. First, holding legally-conferred directive control enables firm management to unilaterally demand changes in what tasks human capital perform and how the tasks should be performed (Bidwell, 2004; Cappelli & Keller, 2013; Gibbons, 2005; Simon, 1951; Williamson, 1975), eliminating the need for time-consuming contract renegotiation. Because the details of the implementation process are typically uncertain ex ante (Dixit & Pindyck, 1994; Hall & Khan, 2003; Lieberman & Montgomery, 1988; McGrath, 1997), it is unlikely that firm management will have contracted with non-integrated human capital for the required adaptation efforts prior to the initiation of implementation. The idiosyncratic and unpredictable nature of technology implementation precludes the detailed specification of the tasks that implementation will require ex ante, and

because agreeing to the definition and measurement of successful implementation is also difficult to do ex ante (Dixit & Pindyck, 1994; Hall & Khan, 2003; Lieberman & Montgomery, 1988; McGrath, 1997), it is unlikely that firm management will have contracted with non-integrated human capital for the outcome of the technology implementation prior to the initiation of implementation. Therefore, if firm management wants to obtain the cooperation of non-integrated human capital, firm management can either attempt to renegotiate contracts with non-integrated human capital as the needs of implementation unfold or rely on non-integrated human capital deciding to cooperate on their own volition. The former is likely to be time-consuming as well as expensive, particularly if the activities involved with implementation are a significant departure from previously contracted activities (Hart & Moore, 2008; Hart & Zehnder, 2011). Moreover, there are legal constraints on the level of detail with which firms can specify how non-integrated human capital should provide a product or service; the more detailed a firm's instructions are for how to perform an individual's job, the more likely the IRS will require the firm to instead categorize the individual as an employee and use an employment contract to govern the relationship (Internal Revenue Service, 2018). The latter option can be time-consuming as well, as firm management must convince the relevant human capital that it is in their own interest to participate in the implementation process. For example, hospital administrators may try to persuade non-integrated physicians that the implementation of a new technology will improve the quality of care that physicians can provide to their patients without attempting to specify a contract requiring that they use the new technology to treat patients. I consider conditions under which the method of aligning interests may take less time later, but this path is often likely to take more time and more effort than what the employment contract offers, which is the authority to direct what tasks human capital perform and how the tasks

should be performed (Bidwell, 2004; Cappelli & Keller, 2013; Gibbons, 2005; Simon, 1951; Williamson, 1975), without the need for contract renegotiation or persuasion efforts.

While directive control enables firm management to demand that integrated human capital engage in the required adaptation efforts, continuity of association can solve the problem of cooperation by incentivizing integrated human capital to engage in the required adaptation efforts in two ways. First, the expectation of a continued relationship with a firm increases human capital's incentives for investing in firm-specific skills. If a firm is early to adopt a new technology and there is uncertainty as to whether other firms will follow suit, or if the implementation of a new technology is idiosyncratic to the firm, then the process of implementation may require human capital to develop firm-specific knowledge or skills. The returns to adaptation efforts will then be lower for non-integrated human capital because they likely spend less time working with the firm than integrated human capital and they cannot apply the learned knowledge or skills to the other firms with which they work. To this point, as the expectation of a continued association declines, human capital become less willing to invest in firms specific-skills (Cappelli, 1999, 2008).

Second, as an individual spends more time with a firm, the individual can begin to view the firm's long-term success as synonymous with his or her own (Abegglen & Stalk, 1985; Edwards, 1979; Osterman, 1988). Accordingly, Williamson (1975) suggests that employees can develop a strong commitment and sense of moral obligation to the firm, and Simon (1947, 1991) argues that when woerkers identify with the firm, they make decisions with the well-being of the firm in mind and become willing to obey commands due to the realization that doing so can be useful to the attainment of joint purpose. This belief that following the directives of firm management is in service of the organization is based on the belief that (1) firm management has

the relevant information to make an effective decision, (2) firm management the ability to use that information to make an effective decision, and (3) coordinating the worker's efforts along with the efforts of his or her coworkers is necessary to achieve the desired objective (Simon, 1947). Under these conditions, the worker will even accept commands he or she knows to be incorrect in order to avoid challenging or unsettling the system of authority that he or she believes to be beneficial to his or her aims in the long run (Barnard, 1938; Simon, 1997).

These insights relate to the psychological construct of organizational commitment, which is the "psychological attachment felt by the person for the organization," and it reflects the degree to which an individual internalizes or adopts the characteristics or perspectives of the firm (O'Reilly & Chatman, 1986, p. 493). Meyer and Allen (1997) similarly use the term "affective commitment" to describe an individual's emotional attachment to and identification with an organization. Organizational and affective commitment can lead to discretionary organizational citizenship behaviors such as conscientiousness and organizational loyalty that involve going above and beyond the bare minimum when completing a job (Dekas et al., 2013; Organ, 1988; Organ, Dennis W. & Ryan, 1995). For example, Dukerich et al. (2002) et al. provide evidence that physicians that are salaried by a healthcare system demonstrate stronger organizational identity and are more likely to engage in organizational citizenship behaviors than non-salaried physicians. Ang and Slaughter (2001) find that contractors exhibit lower extra-role behaviors relative to employees, while Tsui et al. (1997) find that perceived employment security encourages organizational citizenship behaviors. Therefore, not only may integrated human capital engage in the adaptation efforts required of implementation on their own volition because they believe that the technology is both the firm's interests and their own, but they may do so

with enthusiasm, taking initiative and using their judgment to fill gaps can smooth the uncertain process and ensure that the firm maximizes the full value of the technology.[12]

Finally, compensation flexibility further enables firm management to solve the cooperation problem by giving firm management more flexibility to reward the adaptation efforts of human capital throughout the process. Although salaried compensation is often associated with dampened productivity, (Teece, 1996; Williamson, 1985), engaging in the required adaptation efforts comes at the expense of productivity, and lower-powered incentives can work in favor of technology implementation by lowering opportunity cost associated with that investment. Additionally, while holding directive control gives firm management the ability to direct the activities of human capital, compensation flexibility gives firm management the ability to reward those who comply with the spirit and not just the letter of the directive. As Williamson (1975) observes, there is a difference between "perfunctory cooperation," in which human capital perform the required tasks with minimal acceptable compliance, and "consummate cooperation," in which human capital take initiative and use their own judgment to fill in any gaps as implementation processes. The latter is usually difficult to specify in a contract and therefore difficult to incentivize and reward through an arm's-length contract. But the other modes of compensation that are available via an employment contract, such as bonuses and promotions, enable firm management to reward the efforts of human capital based on subjective evaluation (Williamson, 1975, 1991).

Thus, legally-conferred directive control, continuity of association, and compensation flexibility are typical features of the employment relationship that are advantageous in solving the problem of cooperation. However, successful implementation typically requires not only

[12] Williamson (1975) calls such behavior "consummate cooperation", which stands in contrast to "perfunctory cooperation," or performing the required tasks with the minimal acceptable compliance.

solving the problem of cooperation but also the problem of coordination, and both legally-conferred directive control and continuity of association also make the employment contract advantageous in facilitating coordination.

Implementation requires coordination if there is task interdependency among individuals, yet the difficulties that individuals have in correctly identifying, interpreting, and reacting to signals from each other regarding the state of completion of various tasks can impair achieving coordination (Gulati et al., 2005; Gulati & Singh, 1998; Nelson & Winter, 1982; Williamson, 1991). Holding legally-conferred directive control enables firm management to solve the problem of coordination by setting rules for what tasks should be performed and when, and, should decision rules prove insufficient, by allowing firm management to appoint a centralized authority figure whose responsibility is to develop knowledge about how tasks among individuals are interdependent and use this knowledge to direct human capital's actions as needed (Galbraith, 1977; March & Simon, 1958; Thompson, 1967). Crucially, the success of these coordinative efforts, and the reason directive control is advantageous in solving the problem of coordination, depends on human capital allowing the centralized authority figure to direct what tasks they perform and when. Non-integrated human capital cannot be relied upon to do so.

Continuity of exclusive association between a firm and human capital also facilitates coordination, apart from the effect of holding legally-conferred directive control. A result of the continuity of association that is found in many employment relationships is that integrated human capital tend to accumulate shared experiences through repeated interaction (Gulati et al., 2005; Kogut & Zander, 1996). This can incubate the development of shared norms and values as human capital come to identify with the firm, which facilitates the development of procedures

and heuristics for effectively coordinating behavior with each other (Akerlof & Kranton, 2005; Kogut & Zander, 1996). Repeated social interaction also enables the development of codes of communication that allow the identification and interpretation of signals from other human capital (Arrow, 1974; Cremer et al., 2007; Kogut & Zander, 1996; Nelson & Winter, 1982). Firm-specific codes of communication can be particularly valuable in facilitating "unstructured, uncodifiable, generally verbal, and often face-to-face communication," (Monteverde, 1995, p. 1629), which is likely to be required in the unpredictable, idiosyncratic process of technology implementation. Thus, while directive control represents a formal mechanism by which an employment contract facilitates coordination, continuity of exclusive association offers an informal mechanism by which an employment contract facilitates coordination (Gulati et al., 2005).

In sum, because using an employment contract to integrate human capital enables firms to solve the problems of both cooperation and coordination more reliably and more quickly than firms that maintain an arm's length relationship with human capital, I expect firms that integrate human capital using an employment contract to implement a new technology faster. However, I hypothesize in Chapter 2 that it is because of these advantages in obtaining cooperation and coordination that firms that integrate human capital will be more likely to adopt a new technology in the first place. Moreover, I argued that firms should only adopt a new technology when they have a sufficiently high expectation that implementation will be successful, meaning they have a sufficiently high expectation that the relevant human capital will participate in the implementation process and engage in the required adaptation efforts. If a set of firms all use the same hurdle for the probability of successful implementation that must be met, then, empirically, we should expect to observe that implementation proceeds similarly, regardless of the

contractual relationship a firm has with its human capital, conditional on the timing of the firm's decision to adopt.[13] Thus, while firms that integrate human capital are more likely to adopt sooner, firms that do not integrate human capital that do adopt a new technology must have a sufficiently high expectation that non-integrated human capital are nonetheless incentivized to engage in the required adaptation efforts. For example, suppose hospital administrators expect physicians to engage in the adaptation efforts required of CPOE implementation because physicians believe that the reduction in medical error promised by CPOE will improve the quality of care provided to their patients. Physicians may have even voiced support for CPOE. But the implementation of a new technology is unpredictable and idiosyncratic. It can take more effort and be more disruptive than expected, as interdependencies among workers and tasks that were previously unknown are revealed and communication structures are altered.

CPOE itself is a prime example. The case for CPOE was as strong as they come: A study by Bates et al. (1995), which found that over 60% of all medication errors occurred at either the ordering or transcribing stage, but in a 1998 trial of an early CPOE system, Bates et al. (1998) found that placing medication orders using CPOE reduced the rate of nonintercepted serious medication errors by more than half. In a meta-analysis of 10 published studies about the effectiveness of CPOE, Radley et al. (2013) similarly concluded that CPOE use reduces the likelihood of an order error by 48%. Hospital administrators and physicians alike can see the value in that.

However, implementation of CPOE has proven to be more complex than expected. Schiff et al. (2015) find that while CPOE use results in an overall reduction of order errors, about half of the errors that do occur are due to the CPOE system itself. In a study of CPOE combined with

[13] The timing of the decision to adopt matters, as the implementation process may require more time earlier in the technology's life cycle, when it is expected to still have flaws that need to be remedied.

a form of decision support, Ranji et al. (2014) found that CPOE use reduced medication prescribing errors but found no effect on clinical adverse drug event rates (Isaac, Weissman, Davis, & et al., 2009). In a qualitative study of CPOE implementation, Campbell et al. (2006) identify nine categories of unintended consequences of CPOE implementation: (1) both more work and new work for clinicians, (2) unfavorable workflow issues, (3) never ending system demands, (4) problems related to paper persistence, (5) problematic changes in communication patterns and practices, (6) negative emotions, (7) generation of new kinds of errors, (8) unexpected changes in the power structure, and (9) overdependence on the technology.

Therefore, despite the efforts of firm management to defer adoption until successful implementation is sufficiently likely, I still expect firms that integrate human capital should implement a new technology faster. Continuity of association improves the likelihood that integrated human capital will remain incentivized to implement the technology for longer than non-integrated human capital, and directive control provides firm management a valuable fallback position from which to weather the unpredictable nature of the implementation process.

H5: Firms that use an employment contract to integrate the set of human capital who will implement a new technology should implement the new technology faster.

I now consider the possibility that firm management may be able to obtain successful implementation from non-integrated human capital in a manner on par with that obtained from integrated human capital. In other words, when might non-integrated human capital be just as likely to cooperate and engage in the adaptation efforts required by the implementation process while also being able to achieve the required coordination? I have already established that

contracting for the required adaptation efforts can be prohibitively time-consuming and expensive, and legally-conferred directive control remains a bright line in distinguishing an employment contract from any other type of contract with human capital (Cappelli & Keller, 2013), making it unavailable as a tool with which to solicit either cooperation or coordination from non-integrated human capital. Instead, the question is whether there is a condition under which non-integrated human capital voluntarily participate in the implementation process and allow firm management to coordinate their efforts.

One such condition may be when continuity of association is present in the relationship between a firm and non-integrated human capital. Continuity of association is more common in employment relationships but it is not unique to employment relationships (Bidwell, 2004, 2009; Cappelli & Keller, 2013). Even if contracts are written to cover a relatively short period, non-integrated workers may both accumulate tenure with a firm through repeated contracting and operate under an exclusive relationship with the firm; as noted previously, human capital under non-employment contracts may work alongside employees at a firm's location and may operate under a mutual expectation of a continued relationship with the firm on par with that of an employee (Bidwell, 2004, 2009).

When continuity of association is present, non-integrated human capital may be just as likely to cooperate and engage in the required adaptation efforts as human capital integrated by an employment contract because, in addition to making firm-specific investments more worthwhile, continuity of association may both foster organizational commitment in non-integrated human capital and introduce the shadow of the future to the relationship. If repeated interaction with a firm can engender feelings of identification with a firm and the view that the firm's interests are synonymous with one's own, then non-integrated human capital who

repeatedly interact with a given firm and have a mutual expectation of a continued relationship may also begin to develop feelings of identification with a firm and become willing to obey commands and coordinate with other worker's efforts due to the realization that doing so can be useful to the attainment of joint purpose (Simon, 1947, 1991). To this point, Pfeffer and Barron (1988) express skepticism as to whether employee versus contractor status influences organizational commitment, and in contrast to Ang and Slaughter (2001) and Bidwell (2009), Pearce (1993) finds no difference in the extra-role behavior exhibited by contractors versus employees and no significant difference in organizational commitment between employees and contractors. Variation in the length and exclusivity of relationships between firms and contractors may explain some of the discrepancy. Moreover, the evidence indicating that employees of a firm are more likely to exhibit organizational citizenship behaviors is in the form of statistically significant correlations (Ang & Slaughter, 2001; Bidwell, 2009; Dukerich et al., 2002; Tsui et al., 1997), but there are still non-employees who engage in cooperative behavior within these samples. The more non-integrated human capital view the interests of the firm as their own, the more likely they may be to undertake activities that improve firm performance on their own volition, such as engaging in the adaptation efforts required for the implementation of a new technology.

Furthermore, the mutual expectation of a continued relationship introduces the "shadow of the future" to the relationship, allowing the firm and human capital to establish an informal agreement by which human capital will engage in the required adaptation efforts. Although I have argued that the required adaptation efforts are not formally contractible,

> "A relational contract can be based on outcomes that are observed by only the contracting parties ex post, and also on outcomes that are prohibitively costly to specify ex ante. A relational contract thus allows the parties to utilize their

> detailed knowledge of their specific situation and to adapt to new information as it becomes available," (G. Baker, Gibbons, & Murphy, 2002, p. 40).

The only mechanism of enforcement for a relational contract stems from the value of the future relationship, and thus it is more likely to be available to firms and non-integrated human capital when there is an expectation of a future relationship. Nonetheless, in such a case, it provides a mechanism for obtaining the cooperation of human capital in the implementation process despite the absence of directive control.

Finally, the shared norms and codes of communication that are cited as an important reason why integration has a coordinative advantage over non-integration even when cooperation can be obtained from both non-integrated and integrated human capital alike are incubated by continuity of association and repeated social interaction (Gulati et al., 2005; Kogut & Zander, 1996), meaning that continuity of association can also facilitate coordination for non-integrated human capital by encouraging the development of trust, shared norms and values, and codes of communication across firm boundaries. Therefore, because continuity of association make it more likely that firm management will be able to avoid the problems of cooperation and coordination with non-integrated human capital, I expect the difference in implementation between firms that integrate human capital and firms that do not to be smaller if continuity of exclusive association also characterizes the relationship between firms and non-integrated human capital. My empirical context provides an opportunity to explore this possibility. In some local healthcare markets, there is only one hospital that physicians can feasibly use to treat their patients due to geographic constraints. In this case, physicians are likely to interact repeatedly and nearly exclusively with that hospital, regardless of their contractual relationship with the hospital. Within these markets, I expect a weaker relationship between using an employment contract to integrate human capital and the speed of implementation.

H6: The relationship between using an employment contract to integrate the set of human capital who will implement a new technology and the speed of technology implementation will be weaker in markets that enable continuity of association for all contractual relationships.

My empirical context also allows me to evaluate the firm specificity of technology implementation separately from continuity of association: I can identify whether other hospitals within a local market have adopted the same health information technology product from the same vendor. However, I do not expect firm specificity to moderate the relationship between integration and speed of implementation because while a reduction in firm specificity may increase cooperation from non-integrated human capital, there is not a mechanism by which it facilitates the coordination needed to implement the technology at a given hospital. But rather than formally hypothesize no effect, I intend to explore this possibility empirically.

Finally, while in some cases non-integrated human capital may be just as likely to engage in the adaptation efforts required for implementation as integrated human capital, the well-documented difficulty that many firms have in getting their employees to successfully implement new technologies (e.g., Attewell, 1992; Barley, 1986; Edmondson et al., 2001; Leonard-Barton, 1988; Leonard-Barton & Deschamps, 1988; Orlikowski, 1993, 2000; Tyre & Orlikowski, 1994) suggests that there may also be instances where integrated human capital are just as unwilling to engage in the adaptation efforts required for implementation as non-integrated human capital. To generate my final hypothesis, I explore when this might occur by taking a closer look at the directive control that is conferred to firm management by an employment contract.

The presence of legally-conferred directive control in the employment relationship does not mean that every action taken by an employee is dictated by a boss or firm management. In theoretical terms, directive control has only been exercised if an employee complies with a directive from firm management "irrespective of his own judgment as to the merits of that decision," (Simon, 1997, p. 31). If an employee only follows the directive because the worker's own evaluation of the decision produced the same conclusion, then the worker has not accepted authority over his or her behavior (Barnard, 1938; Simon, 1951, 1997). Thus, employees may choose to engage in the adaptation efforts required of implementation without the exercise of directive control, and, as I have argued, continuity of association and compensation flexibility are two additional features common to the employment contract that allow firm management to incentivize cooperation in the implementation process without having to exercise directive control.

However, legally-conferred directive control remains an important fallback position for firms that integrate human capital (Bidwell, 2004). In cases where continuity of association or compensation flexibility do not suffice in incentivizing the cooperation of the relevant human capital in the implementation process, directive control represents a stark and key advantage for firms that use an employment contract to integrate human capital over those that do not. Yet there are still bounds on the directive control firm management can exercise over human capital (Bidwell, 2004; Cappelli & Keller, 2013; Gibbons, 2005; Internal Revenue Service, 2018; Masten, 1988; Simon, 1951; Williamson, 1975), and an employment contract will lose its advantage in soliciting the cooperation of human capital when the tasks associated with the required adaptation efforts fall outside those bounds.

I argue that this more likely to occur when the technology targets a task or a set of tasks for which the human capital are perceived to have greater expertise than firm management. This is consistent with arguments that employees, particularly skilled employees, may be more likely to question firm management's expertise to judge a tool designed to aid a technical task as opposed to a tool designed to aid an administrative task, and that employees' perceptions of superior competence relative to their superiors decrease the legitimacy of an authority message to adopt an innovation (Leonard-Barton, 1988). Similarly, professionals and knowledge workers are likely to believe that firm management does not have the expertise to critique or modify their technical tasks, which include classifying, diagnosing, and prescribing treatments for certain classes of problems (e.g., Abbott, 1988; Freidson, 2001; Gorman & Sandefur, 2011; Sharma, 1997). But my argument is also grounded in Simon's original formalization of the employment relationship that continues to be the basis for defining employment today (e.g., Bidwell, 2004; Gibbons, 2005).

Simon (1951, 1991) provides a convenient term for discussing whether the tasks associated with the required adaptation efforts fall inside or outside the bounds on directive control: the zone of acceptance. In his (1951) formalization of the employment contract, an individual's *behavior* is the collection of specific actions that the employee performs on a job, such as typing letters, operating a machine, or laying bricks, and a behavior pattern consists of a given set of tasks to be performed in a particular order at a particular rate with a particular level of accuracy. He supposes that there is a set of all possible behavior patterns X from which each element x represents one possible behavior pattern, and he asserts that the boss exercises *authority* over the employee if the employee permits the boss to select x. The employee will

accept authority if the selected x is within a particular subset of X that Simon calls "the zone of acceptance."

Simon (1951) draws directly from Barnard (1938) in defining the zone of acceptance, although Barnard uses the term "zone of indifference":

> "If all orders for actions reasonably practicable be arranged in the order of their acceptability to the person affected, it may conceive that there are a number which are clearly unacceptable, that is, which certainly will not be obeyed; there is another group somewhat more or less on the neutral line, that is, either barely acceptable or barely unacceptable; and a third group unquestionably acceptable. This last group lies within the 'zone of indifference.' The person affected will accept orders lying within this zone and is relatively indifferent as to what the order is so far as the question of authority is concerned. Such an order lies within the range that in a general way was anticipated at the time of undertaking the connection with the organization. For example, if a soldier enlists, whether voluntarily or not, in an army in which the men are ordinarily moved about within a certain broad region, it is a matter of indifference whether the order be to go to A or B, C or D, and so on; and goings to A, B, C, D, etc., are in the zone of indifference." (Barnard, 1938, p. 169).

Hence, for Barnard (1938), the zone of indifference represents a set of potential behavior patterns for which the choice of one alternative over another is of little importance to the employee. Simon's (1951) zone of acceptance similarly includes the set of potential behavior patterns to which the employee is indifferent, but notes that the zone of acceptance also includes potential behavior patterns for which the employee may not be truly indifferent but for which sanctions are strong enough to induce the employee to carry out anyway (Simon, 1991). Barnard (1938) and Simon (1951, 1991) each emphasize that authority is only established when the employee accepts the directive of firm management, and furthermore, authority is established only if the employee's criterion for deciding which behavior alternative to follow is the receipt of a command or signal from firm management (Simon, 1997). If an employee only follows a directive because the employee's own evaluation of the decision produced the same conclusion, then the employee has not accepted authority over his or her behavior.

Baseline conditions for whether a task or a set of tasks falls inside an employee's zone of acceptance include the employee understanding what the task or set of tasks entails, the employee having the physical and mental capability of executing the task or set of tasks as directed, and completing the task cannot, on net, compromise his or her own interests (Barnard, 1938). But most importantly, employees must believe that firm management has the relevant information and the relevant expertise to use that information, to make an effective decision regarding whether or how the task or set of tasks should be performed (Simon, 1947). Employees cede authority on that basis to firm management, whose higher position within a firm's hierarchy affords them superior access to the information needed to coordinate activities within the firm across specialties or divisions (Chandler, 1962; Galbraith, 1973; March & Simon, 1958; Marschak & Radner, 1972; Williamson, Oliver E., 1967). Barnard (1938) similarly argues that superior access to information is a source of authority, writing that,"[a] communication has the presumption of authority when it originates at sources of organization information—a communication center—better than individual sources […] Thus men impute authority to communications from superior positions," (p. 173). Therefore, tasks which fall inside the zone of acceptance are those for which employees believe firm management has the requisite information and expertise to effectively choose whether and how employees should perform them. Tasks for which employees do not believe firm management has the relevant information and expertise to make an effective decision are more likely to fall outside the zone of acceptance.[14]

[14] Although there can be cases where if inducements are strong enough, such as through sufficiently high compensation, employees may comply with tasks for which employees do not believe firm management holds the requisite information and expertise to effectively choose whether and how employees should perform them (Simon, 1991).

In the context of technology implementation, integrated human capital should be less likely to accept firm management's directives to implement a new technology if they question the completeness of information and the level of firm management's expertise with respect to the task or set of tasks targeted by the new technology. I argue that this is more likely to occur when a new technology targets tasks for which employees are believed to have greater expertise relative to firm management, and that in such cases the advantage in implementing a new technology associated with the employment contract weakens as compliance cannot be obtained through directive control. Firm management may still be able to obtain cooperation from integrated human capital by convincing them that it is in their own interest to participate in the implementation process, but with firm management's expertise called into question, an employment contract does not confer an inherent advantage; even if integrated human capital exhibit organizational commitment, they will then question whether firm management's decision-making is in the best interests of the organization. Furthermore, negotiating sufficient compensation to solicit cooperation from integrated human capital who question the expertise and authority of firm management's decision-making is not necessarily any less time-consuming than negotiating with non-integrated human capital, and while sanctioning is another means by which to obtain compliance despite the loss of directive control (Simon, 1991), doing so risks alienating valuable human capital, particularly in the case of highly-skilled human capital. Therefore, I hypothesize that the greater human capital's expertise advantage over firm management in the tasks targeted by a new technology, the less likely firms with integrated human capital will be to implement a new technology sooner than firms with non-integrated human capital.

H7: The greater human capital's expertise advantage over firm management in the tasks targeted by a new technology, the less likely firms that use an employment contract to integrated human capital will be to implement a new technology faster than firms that do not integrate human capital.

Summary

Prior literature suggests that firms that integrate human capital should be able to implement a new technology more successfully than firms that remain at arm's length with their human capital due to the adaptive advantages commonly associated with integration (e.g., Kapoor & Adner, 2012; Nelson & Winter, 1982; Williamson, 1975, 1985, 1991), such as the ability to direct integrated human capital by fiat (e.g., Simon, 1951; Williamson, 1975, 1991) and the ability to develop superior modes of communication (Arrow, 1974; Cremer et al., 2007; Kogut & Zander, 1996; Nelson & Winter, 1982). However, I argue that a more nuanced framework is needed, especially in the case where the human capital in question are highly skilled, such as professionals and knowledge workers. On the one hand, trends in employment suggest that the line between an employment relationship and an arm's length relationship with human capital is blurring (e.g., Bidwell, 2004, 2009, 2013; Cappelli & Keller, 2013; Farber, 2008; Hollister, 2011; Kalleberg et al., 2000), meaning non-integrated human capital may be just as willing and able to engage in the implementation process as integrated human capital. On the other hand, integrated human capital may be just as *unwilling* to engage in the required adaptation efforts as non-integrated human capital, as the well-documented difficulty firms have in implementing a technology-stimulated change in routines and practices (e.g., Attewell, 1992; Barley, 1986; Edmondson et al., 2001; Leonard-Barton, 1988; Leonard-Barton & Deschamps,

1988; Orlikowski, 1993, 2000; Tyre & Orlikowski, 1994) indicates that, unlike what fiat would suggest, compliance from employees in the technology implementation process is far from automatic.

In this chapter, I aim to enrich our understanding of the adaptive benefits of integration by hypothesizing conditions under which using an employment contract to integrate human capital facilitates the implementation of a new technology. To do so, I consider when and how three features commonly associated with the employment contract confer an advantage in the degree of cooperation and quality of coordination obtained from the relevant human capital: (1) legally conferred directive control, (2) continuity of association, and (3) compensation flexibility. I articulate why using an employment contract to integrate human capital should generally facilitate implementation, but I then identify two caveats. First, the employment contract should be less advantageous when continuity of association is not unique the employment relationship; under this condition, non-integrated human capital are more likely to be willing and able to engage in the implementation process due to both repeated social interaction incubating identification with the firm across firm boundaries and the introduction of the "shadow of the future" into the relationship. Second, the employment contract should be less advantageous in implementation when the technology in question targets tasks for which human capital have greater expertise than firm management. Under this condition, I argue that firm management cannot exploit the usual ability to direct integrated human capital by fiat and thereby loses the most valuable adaptive advantage that the employment contract can offer.

CHAPTER IV
Empirical Approach

In this chapter, I introduce the context in which I test the hypotheses develop in Chapters 2 and 3, I review prior literature outside of strategy and management literatures that studies the relationship between hospital-physician integration and technology adoption, I describe the datasets I use, and I articulate my econometric approach.

Context

I test the hypotheses developed in Chapters 2 and 3 in the context of hospital adoption of a new technology, where physicians are the relevant human capital who must make an adaptation investment for the hospital to realize the full value of the technology. I specifically study non-federal, general acute care hospitals in the United States, which are defined as those hospitals that provide "…inpatient medical care and other related services for surgery, acute medical conditions or injuries (usually for a short-term illness or condition)."[15] In the U.S., physicians typically provide outpatient care to their patients in outpatient facilities. When a patient requires surgery or treatment for acute medical conditions, physicians admit the patient to this type of hospital, using the hospital's facilities, resources, and support staff to provide the relevant inpatient medical care.[16]

I examine hospital adoption of two technologies. The first is *computerized physician order entry* (CPOE), which enables physicians to place medical orders electronically rather than

[15] Glossary at Medicare.gov https://www.medicare.gov/HospitalCompare/Resources/Glossary.html
[16] Hospitals do not receive patients directly but rely on physicians to bring in and treat patients. The emergency department is a notable exception: hospitals do not rely on physicians for emergency room patients. However, physicians decide whether to admit emergency room patients into the hospital for inpatient care.

using a pen and paper. Medical orders within a hospital include orders for medications, lab work and other diagnostic testing, imaging, and other forms of care. Instead of having staff deliver a physician's written order for a medication or a diagnostic test to the relevant department such as the pharmacy or lab, CPOE allows the physician to enter the order on a computer and the order is then transmitted electronically to the intended recipient. The order is usually completed at a desktop, which can be bedside, at a workstation, or in the physician's office; in more recent years, handheld devices enable CPOE use. The potential benefits of CPOE for the hospital include improving the cost and quality of patient care through the reduction of medical errors that are caused by misinterpreted handwritten orders. A study by Bates et al. (1995) found that over 60% of all medication errors occurred at either the ordering or transcribing stage, but in a 1998 trial of an early CPOE system, Bates et al. (1998) found that placing medication orders using CPOE reduced the rate of non-intercepted serious medication errors by more than half. In a meta-analysis of 10 published studies about the effectiveness of CPOE, Radley et al. (2013) similarly concluded that CPOE use reduces the likelihood of an order error by 48%. Efficiency gains are also expected via a reduction in the hospital's reliance on paper and staff to communicate prescription and diagnostic needs, and CPOE may additionally reduce the delays in patient care that arise when, for instance, the pharmacist must track down the physician whose handwriting she cannot read.

The second technology is *decision support technology*; specifically, I examine the adoption of physician documentation products in which physicians enter patient information electronically in structured templates and the system responds with guidelines for diagnoses and testing, as well as recommended care pathways. Like CPOE, the potential benefits of decision support technology include the reduction of medical error through the reduction of mistakes

attributed to physicians or nursing staff misreading physician notes in a patient's file. Efficiency gains are also expected via a reduction in the hospital's reliance on paper, and decision support technology may additionally reduce the delays in patient care that arise when hospital staff or physicians must track down a physician whose notes cannot be read. But decision support technology is also intended to improve the process of diagnosing and selecting treatment for patients by alerting physicians to best practices and clinical guidelines in response to the information the physician enters in the structured templates. For example, a physician may enter that a patient is experiencing lower back pain along with some additional contextual information. The technology then issues an alert that a non-contrast lumbar MRI is recommended.

While there are many different technologies and products that together contribute to a health IT system in a hospital, focusing on CPOE and decision support technology is attractive because each requires a physician to directly interact with the technology and these interactions with the technologies are recorded. Notably, physicians are required to enter the medical orders via CPOE themselves unless the hospital has hired approved scribes (which will be noted in my data). If a nurse logs in as a physician to place the order for the physician, the physician will be held liable if the nurse enters the order incorrectly. It is also noteworthy that case law has established that hospitals can be held liable for the medical errors committed by non-integrated physicians under a principle known as either apparent authority or ostensible agency, depending on the state.[17]

Importantly, the decision to invest in these types of technologies is led by hospital administrators, especially Chief Information Officers, and is largely led by hospital administrators. It is a top-down technology, which is unlike many other types of technologies

[17] The specifics vary by state, but documentation of this principle in case law can be found easily. For example, https://www.plaintiffmagazine.com/item/when-is-a-hospital-liable-for-a-physician-s-malpractice, last accessed June 1, 2018.

that a hospital may consider investing in, such as new medical instruments, that may be led by physicians even if it is hospital administrators who make the final call.

To test hypotheses in which I expect the effect of integration on either the decision to adopt a new technology or the implementation of a new technology to depend on whether the technology targets tasks for which human capital have greater expertise than firm management, I argue that physicians' expertise advantage over hospital administrators in the tasks targeted by decision support technology is greater than in the tasks targeted by CPOE. To make this distinction, I leverage the fact that physicians are high-skilled professionals. Organizational theorists classify the processes of classifying, diagnosing, and determining the treatment of a problem as the technical work for which professionals rely on their training and expertise (e.g., Abbott, 1988; Freidson, 2001; Gorman & Sandefur, 2011). Because decision support technology targets the technical work of physicians by attempting to modify how physicians classify, diagnose, and select treatment for their patients, I argue that physicians' expertise advantage is greater in the tasks targeted by decision support technology relative to CPOE. Rather than a technical task, CPOE merely targets an administrative task—that of placing a medical order.

As noted previously, the physicians who treat patients at hospitals are the human capital of interest in this setting; they are integrally responsible for the implementation of both CPOE and decision support technology and they must engage in adaptation efforts to ensure successful implementation. Importantly, there is significant variation in the contractual relationships between hospitals and these physicians. A hospital may maintain an arm's length relationship with physicians, where physicians operate their own outpatient practices and contract for admitting privileges at one or more hospitals in order to provide inpatient care. Alternatively, a hospital may choose to integrate physicians, where physicians provide both outpatient and

inpatient care as salaried employees of the hospital. There are also several alternative types of hospital-physician relationships that can be considered "quasi-integration" in which hospitals do not employ physicians but may own some of their tangible assets, provide administrative services, or formally engage in joint bargaining with payer (Cuellar & Gertler, 2006). But the majority of hospitals pursue either full integration or full non-integration, and I focus on the comparison of these two contractual relationships in this dissertation. Please see Appendix B for more detail about the quasi-integration alternatives. As I turn now to explaining hospitals' strategic motivations for choosing to integrate physicians or not, it may also be helpful have an understanding of the context in which hospitals and physicians operate, specifically how they get paid and by whom. Please see Appendix A for this information.

In the traditional hospital-physician relationship, hospitals and physicians remain separate economic entities, where individual physicians contracted with hospitals for admitting privileges. This allows individual physicians to maintain their own private practice while using hospital facilities and staff as needed to treat patients with acute issues. This arrangement is not typical of the independent contractor relationship in that cash is often not the medium of exchange. While physicians do contract for the right to treat patients at the hospital, the hospital is typically compensated in kind: in exchange for admitting privileges, physicians provide services such as on-call availability for the emergency room. Nonetheless, this is an arm's-length, market exchange, and physicians may transact with many partners, i.e., obtain admitting privileges at multiple hospitals. Because hospitals rely on physicians admitting patients to their facilities for income, hospitals in the same market compete for physicians through marketing activities showcasing the quality of their facilities and staff (Burns & Muller, 2008).

However, many hospitals began to integrate physicians as employees in the 1980s and 1990s. In what is described as an *Integrated Salary Model* (ISM), a hospital hires physicians, including both primary care physicians and specialists, as salaried employees, by either contracting individually or by purchasing an entire practice (L. C. Baker, Bundorf, Devlin, & Kessler, 2016). The move toward integration was largely in response to the managed care movement. Managed care organizations selectively contract with physicians and hospitals in order to negotiate lower prices, shift payment risk to providers, and to form provider networks that appeal to their enrollees (Cuellar & Gertler, 2006), thus acting as gatekeepers to revenue-generating patients. Hospitals and physicians began to develop new relationships with each other largely to counteract the bargaining power of managed care organizations (Cuellar & Gertler, 2006; Gal-Or, 1999; Gaynor & Haas-Wilson, 2000). While some scholars have suggested that hospitals began developing non-market relationships with physicians in order to achieve efficiency gains through superior coordination with physicians and the exploitation of economies of scale (e.g., Robinson, 1997; Robinson & Casalino, 1996), Cueller and Gertler (2006), find little evidence of efficiency gains but do find strong support for the bargaining power explanation, which includes integrated hospitals having higher prices than standalone hospitals and the differences in prices being larger for exclusive arrangements and in less competitive markets. They also find that hospital-physician integration is significantly higher in markets with high managed care penetration than in markets with low managed care penetration.

Although hospital-physician integration increased in the 1990s, it stagnated and even retreated in the early 2000s as managed care plans moved away from capitation payment models to fee-for-service models, reducing the need for hospitals and physicians to join forces in the name of bargaining power. But recently, integration has been revived, and Burns and Muller

(2008) suggest a number of factors causing this resurgence of integration. Bargaining power is once again a motivator, although for a different reason. As managed care plans push toward pay-for-performance models, hospitals may integrate physicians in an effort to better demonstrate improvements in quality and efficiency that can justify higher reimbursement rates. Hospitals may also integrate in order to improve physician loyalty; a key challenge for hospitals is to woo "splitters," or those physicians who have admitting privileges at more than one hospital. Physicians are also more interested in becoming salaried employees of hospitals as they have seen their office overhead costs skyrocket in recent years while reimbursements for services have declined; the stability of income and predictability of shift work that are associated with employment have therefore become more attractive, particularly for overburdened primary care physicians.

Thus, the evidence does not suggest that integration decisions are directly related to the decision to adopt CPOE or decision support technology other than through the mechanisms that I have identified. Nonetheless, an attractive feature of the hospital-physician context is the existence of corporate practice of medicine laws in some states that prohibit hospitals from employing physicians. This allows me to exploit variation in state law as a source of exogeneity in the decision to integrate physicians.

State corporate practice of medicine laws prohibit corporations from practicing medicine or employing physicians who provide medical services. The rationale is based on the following public policy concern, as summarized by the American Medical Association,

> "(1) allowing corporations to practice medicine or employ physicians will result in the commercialization of the practice of medicine, (2) a corporation's obligation to its shareholders may not align with a physician's obligation to his patients, and (3) employment of a physician by a corporation may interfere with the physician's independent medical judgment," (American Medical Association, 2015).

While many states allow an exception for hospitals, several states do not. Lammers (2013) surveyed state laws for all 50 states to establish that Arkansas, California, Ohio, and Texas prohibit both for-profit and non-profit hospitals from employing physicians, and Michigan, Nevada, North Carolina, Ohio, South Carolina, Washington, and West Virginia prohibit for-profit hospitals from employing physicians. Please see Appendix C for a reprinting

Prior Literature Studying the Context

While there is a very large literature studying the adoption and implementation of various products and technologies related to health information technology, especially those related to electronic health record (EHR) systems, few have considered the effect role of firm boundaries in either the decision-making or implementation processes. McCullough and Snir (2010) study hospital-physician integration and the adoption of three types of health IT, physician monitoring, clinical data repository (CDR), and utilization review. Arguing that these technologies are monitoring technologies that the hospital can use to monitor physician behavior, their goal is to understand whether monitoring technologies are substitutes or complements to hospital-physician integration. They find that integrated hospitals are more likely to adopt monitoring technologies, and they conclude that for hospitals, physician integration and monitoring technologies are complements. However, McCullough and Snir assume that implementation of the technology would be equally successful regardless of the hospital-physician relationship, and they fail to consider how the integration choice may affect either managerial expectations about the success of implementation or the decision-making process itself. By taking these possibilities under consideration, I am able to hypothesize contingencies for when firms that integrate physicians should be more or less likely to adopt a new technology sooner.

Lammers (2013) studies the effect of hospital-physician integration on CPOE adoption specifically. Using a one-year cross-section of data, Lammers finds no effect of hospital-physician integration on CPOE adoption in the naïve regression but does find a positive effect of hospital-physician integration when he uses state corporate practice of medicine laws as an instrument for integration. Unlike Lammers, I examine adoption over time, enabling me to develop a richer, more accurate understanding of the factors that influence whether and when a hospital adopts CPOE.

Finally, neither McCullough and Snir (2010) nor Lammers (2013) consider the effect of hospital-physician integration on the implementation of health information technology.

Data

I combine multiple datasets to test my hypotheses. I use the American Hospital Association's annual survey to obtain information about hospital-physician relationships and hospital characteristics. In particular, the AHA survey provides information about the number of physicians affiliated with the hospital who are engaged in each of the following types of hospital-physician relationships: independent practice association, group practice without walls, open physician-hospital organization, closed physician-hospital organization, management service organization, foundation, and integrated salary model (i.e., employment). I then combine two additional datasets with the AHA survey data to obtain technology adoption information.

The second dataset is actually compiled from three sub-datasets: the Dorenfest 3000+ Databases, Dorenfest Integrated Healthcare Delivery System Databases, and HIMSS Analytics databases to measure CPOE and decision support technology adoption in U.S. hospitals from 2003-2013. These three databases are available from The Dorenfest Institute for Health Information at the HIMSS Foundation. The HIMSS Foundation is the philanthropic of the

Healthcare Information and Management Systems Society (HIMSS), a not-for-profit organization that works to advance improvement in health care through information technology and management systems. The Dorenfest Institute was formed in 2005 to facilitate research in health IT thanks to a donation from Sheldon Dorenfest and The Dorenfest Group, a leading consultant and source of market knowledge in health IT. The Dorenfest Group also donated its historical data assets, including the Dorenfest 3000+ Databases and the Dorenfest Integrated Healthcare Delivery System Databases, which provide expansive data on the adoption and usage of health IT products in U.S. hospitals from 1986-2004. I append these Dorenfest databases to the HIMSS Analytics database, which covers 2005-2014. HIMSS Analytics, a wholly owned subsidiary of HIMSS, is a global health care research and advisory firm who provides market research provides the health care industry with market intelligence solutions and guidance in managing health information technology. HIMSS Analytics donates its annual market research data to the Dorenfest Institute with a three-to four-year lag. Going forward, I will refer to the combination of the Dorenfest databases and the HIMSS Analytics databases as the "HIMSS data."

The third dataset is the AHA Technology Supplement, which is a survey of hospital technology adoption that started being administered in conjunction with the AHA annual survey in 2008. It provides detail about the CPOE and decision support technology functionality that hospitals have adopted, as well as the stages adoption for each technology, from 2008-2015.

Combining the HIMSS data and the AHA Survey data, I assemble a panel data set spanning the years 2003-2013 in which observations are at the hospital-year level. I use this as the primary dataset, with which I model the time to adoption for each technology. Because the AHA Technology Supplement is only available from 2008-2015, I use this dataset to conduct

robustness checks for the findings with the HIMSS data. The AHA Technology Supplement also allows me to test whether firms with integrated human capital are less likely to list physician cooperation as an anticipated obstacle to health information technology implementation. Finally, I use Lammers's (2013) compilation of state corporate practice of medicine laws—some of which restrict hospitals from employing physicians—to create an instrument for physician integration (see Appendix C).

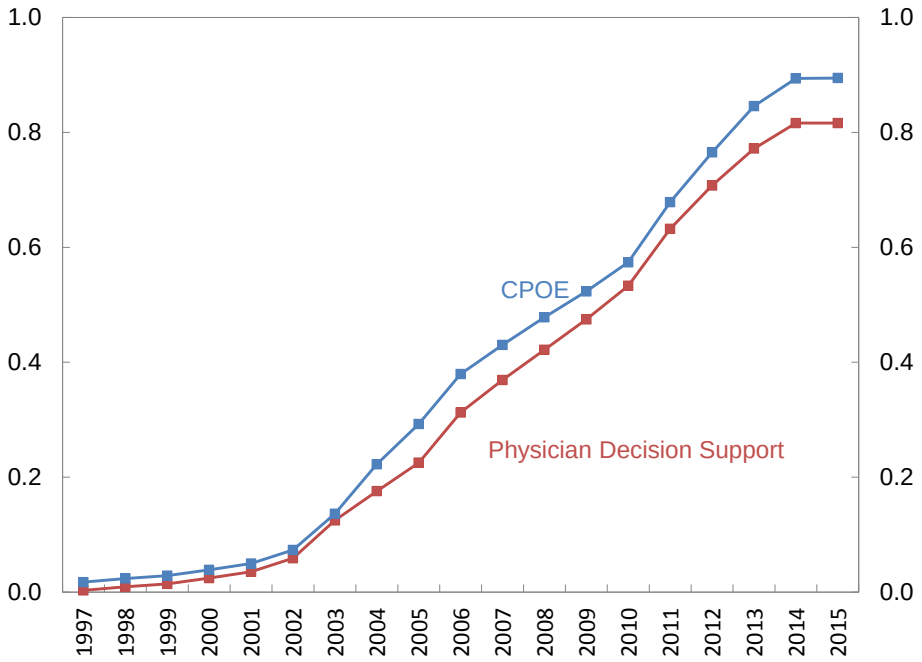
Measures

Because I use many of the same variables to test the hypotheses for both the decision to adopt a new technology and the implementation of a new technology, I describe all the variables here. Dependent variables are constructed from the HIMMS database unless otherwise noted. All independent variables are constructed from the AHA annual survey. Please see Table IV.1. For a summary of variable definitions and data sources.

Dependent Variable: Firm's Decision to Adopt a New Technology

To test the hypotheses in Chapter 2 about the effect of integrating human capital on the technology adoption decision, I model the time to initial adoption of a new technology. Adoption is defined as the first year in which a hospital contracts for a CPOE or decision support technology, which I obtain from the HIMSS database. The cumulative adoption of each of these technologies by U.S. general acute care hospitals is illustrated in Figure IV.1. I test whether firms with a greater share of integrated human capital are likely to adopt a technology sooner than firms with a smaller share of integrated human capital.

Figure IV.1 Cumulative Adoption of New Technologies in U.S. General Acute Care Hospitals, 1997-2015



Dependent Variable: Implementation of a New Technology

To test the hypotheses in Chapter 3 about the effect of integrating human capital on the speed of implementation of a new technology, I define two dependent variables for each technology. The first is installation, where the variable is equal to 0 if the technology has been contracted but not yet fully installed and equal to 1 if it is the first year in which the technology has been fully installed. The second is the percentage of physicians using each technology a year after implementation. Both variables are provided by the HIMSS database.

Integration

I use two measures of integration: (1) an indicator variable for whether the hospital employs physicians, which is known in the healthcare industry as using an *integrated salary model* (ISM), and (2) the ratio of the number of physicians employed under an integrated salary model to the number of inpatient days. Importantly, I measure the integration of primary care and specialist physicians combined. These are physicians who see patients in both outpatient and

inpatient settings. Hospitalists, who specialize in the treatment of hospitalized patients, are not included; please see the definition of the control, *No Hospitalists*, for a more detailed explanation.

In the AHA survey, hospitals report whether they utilize any form of integration or quasi-integration for primary care and specialist physicians: (1) integrated salary model, (2) foundation model, (3) closed hospital-physician organization, (4) open hospital-physician organization, (5) group practice without walls, (6) equity model, or (7) independent provider organization. It is common practice among researchers who use the AHA survey to identify those hospitals that do not indicate any of these seven models as hospitals that exclusively use an eighth and final model, (8) the market model in which hospital's remain at arm's length with all of their physicians. Please see the prior section as well as Appendix B for more detailed descriptions of each model.

I define *Integrated Salary Model* to be an indicator variable equal to one if the hospital reports using it and zero otherwise. I include indicator controls for each of the quasi-integration models, thus the baseline comparison is always the market model.

An important limitation of the AHA survey is the survey's failure to ask directly about hospitals' use of the market model. For models (1)-(7), the AHA survey asks hospitals to indicate whether they use each model and to list how many physicians are governed under each model. Most commonly, hospitals indicate that they use only one of the seven, but some hospitals indicate more than one.[18] However, because the AHA survey does not ask directly about hospitals' use of the market model, it is not possible to know (1) whether a hospital that indicates it uses an integrated salary model also uses the market model for some of its

[18] In my data, only 11% of hospitals who indicated that they use an integrated salary model also indicated that they use on of the other seven models.

physicians, or (2) how many of its physicians are governed by the market model. For example, if a hospital does not indicate that it uses any of the first seven models, then it is accepted to assume that the hospital exclusively uses the market model. Therefore, it is also accepted to assume that 100% of the hospitals physicians are governed by the market model. However, suppose a hospital indicates that 25 of its physicians are governed by the integrated salary model. The hospital indicates that 0 of its physicians are governed by models (2)-(7). It is not accurate to assume that 100% of the hospitals physicians are integrated as employees because we do not know whether the hospital also uses the market model for some of its physicians. In other words, the logical denominator for measuring the share of employed physicians cannot be calculated.

However, I proxy for the percentage of primary care and specialist physicians that are salaried employees of the hospital with the ratio of the number of physicians employed under an integrated salary model to the number of inpatient days. The number of inpatient days should be closely correlated to the number of physicians treating patients at the hospital; within the data, the correlation is 0.71. But because the correlation is noisy, I create two indicator variables. *ISM Ratio < 75th percentile* is equal to one if the hospital uses an integrated salary model but is less than the 75th percentile in the ratio of number of integrated physicians to inpatient days, and *ISM Ratio < 75th percentile* is equal to one if the hospital uses an integrated salary model and is at the 75th percentile or higher in the ratio of number of integrated physicians to inpatient days.

Continuity of Association

In both Chapter 2 and Chapter 3, I hypothesize that the effect of integrating human capital on the technology adoption process can be moderated in markets where continuity of association is present for all contract types. I proxy use the indicator *Single Hospital HSA* to

identify local markets in which there is only one general acute care hospital, meaning physicians are more likely to treat patients regularly, and likely exclusively, at one hospital.

Table IV.1 Measures

Construct	Variable	Description	Dataset
Time of firm's decision to adopt	Decision to Adopt	The year T in which a given hospital contracted for the technology	HIMSS
Speed of implementation	Years to Full Implementation	The number of years from the initial contracting to the hospital reporting that th	HIMSS, AHA IT Supplement
	Physician Usage Percentage	The percent of physicians using the technology in the year (and year after) the	HIMSS, AHA IT Supplement
Integration	Integrated Salary Model (yes=1)	The hospital employs primary care and specialist physicians via an integrated s	AHA Annual
	ISM Ratio < 75th percentile	Uses an ISM but is less than the 75th percentile in the ratio of number of physc	AHA Annual
	ISM Ratio >= 75th percentile	At least the 75th percentile in the ratio of number of physcians employed under	AHA Annual
Governance	For-profit (yes=1)	The hospital is for-profit.	AHA Annual
Firm characteristics	Teaching hospital (yes=1)	The hospital hosts a medical school or is affiliated with a university.	AHA Annual
	Critical access hospital (yes=1)	A Centers for Medicaid and Medicare designation; must be in a rural location a	AHA Annual
	Rural (yes=1)	Rural location as designated by the CBSA.	AHA Annual
	Size: 25 beds max	Indicator variable for hospitals with at most 25 beds.	AHA Annual
	Size: 26-50 beds	Indicator variable for hospitals with 26-50 beds.	AHA Annual
	Size: 51-100 beds	Indicator variable for hospitals with 51-100 beds.	AHA Annual
	Size: 101-250 beds	Indicator variable for hospitals with 101-250 beds.	AHA Annual
	Size: 251-500 beds	Indicator variable for hospitals with 251-500 beds.	AHA Annual
	Size: Over 500 beds	Indicator variable for hospitals with over 500 beds.	AHA Annual
	System Membership (yes=1)	Hospital is a member of a multi-hospital system.	AHA Annual
	Single-hospital health service area (yes	Local health care markets (HSA) with only one general acute care hospital.	AHA Annual
	No hospitalists (yes=1)	Indicator variable for whether the hospital uses hospitalists.	AHA Annual
Competitive conditions	ln(Market Share) by HRR	Hospital's percentage of beds in the health referral region.	AHA Annual
	ln(Market Share) by HSA	Hospital's percentage of beds in the health service area.	AHA Annual
	ln(Competition) by HRR	Herfindahl Index characterizing the level of competition in the health referral reg	AHA Annual
	ln(Competition) by HSA	Herfindahl Index characterizing the level of competition in the health service are	AHA Annual
Government leverage	% Inpatient days Medicare	Percentage of inpatient days that are reimbursed by Medicare or Medicaid.	AHA Annual

Control Variables

I include a number of controls to account for hospital characteristics and the competitive dynamics of local healthcare markets. I proxy for the *Propensity to adopt new technology* by including the predicted probability that a firm had adopted clinical data repository technology by the end of the year 2000. A clinical data repository is a centralized database that allows hospitals to collect, store, and access clinical, administrative, and/or financial information from across information technology applications within the organization, and about forty-one percent of general acute care hospitals had contracted for this technology by the end of the year 2000. Importantly, physicians do not interact with this technology. See Table IV.8 for estimation. I also include the *Years since adopting CDR*. I following the healthcare literature in measure hospital *Size* as the number of beds. I also include an indicator for whether the hospital is a *Teaching* hospital and an indicator for whether the hospital is *For-profit*. Hospital revenue data is not disclosed in the AHA survey, but to account for financial constraints that may affect the hospital's ability to invest in a new technology, I include an indicator for whether a hospital is CBSA-designated R*ural* and an indicator for whether a hospital is a C*ritical Access Hospital*. Critical access hospitals are rural hospitals with no more than 25 beds that receive more favorable Medicare and Medicaid reimbursements in order to reduce their financial vulnerability.

I follow standard practice by measuring a hospital's market share, *ln(Market Share) by HSA*, as the log of its share of total beds in its health service area. I measure market competition, *ln(Market Competition) by HSA*, by calculating the Herfindahl-Hirschman Index (HHI) based on market shares in a health service area and taking the log. For robustness, I also include measures of market share, *ln(Market Share) by HRR*, and market competition , *ln(Market Competition) by*

HRR, based on the health referral region rather than the health service area; the health referral region is larger.

I include the percent of inpatient days for which the hospital receives *Medicare reimbursement* as a control for the extent to which a hospital is likely to respond to government recommendations and incentives to invest in a new technology. In particular, the HITECH Act was passed in 2009, creating subsidies for healthcare providers to adopt health information technologies. Incentives are provided by manipulating Medicare reimbursements.

I include an indicator for whether a hospital is part of a healthcare system, *System Member*. In some parts of my analysis, I exclude those hospitals who have indicated in the AHA Technology Supplement that they coordinate their technology adoption systems with the system's central organization. Where I do not exclude them, I include an indicator variable to account for this.

Finally, I include an indicator for whether the hospital utilizes hospitalists, *No Hospitalists*. According to the Society of Hospital Medicine, a hospitalist is a physician "whose primary professional focus is the general medical care of hospitalized patients…activities include patient care, teaching, research, and leadership related to hospital medicine," (Pantilat, 2006). In my analyses, the independent variable of interest is whether primary care and specialist physicians are integrated as employees of a hospital. Hospitalists represent a different set of physicians.

To explain, consider the following example. Traditionally, a primary care physician will both conduct a routine physical in an outpatient setting and provide care for a patient who has pneumonia in the hospital. When a primary care physician's patient is in the hospital, the primary care physician remains in charge of caring for the patient and coordinating the patient's

care; the primary care physician will make daily rounds in which he or she is physically at the hospital. However, hospitals can use hospitalists to relieve primary care and specialist physicians from the burden of having to make these daily visits to the hospital. Instead of primary care physicians continuing to make daily trips to the hospital to treat and coordinate the care for a patient, the patient is "handed off" to hospitalist physicians at the hospital who take charge of treatment and coordination of care. Once the patient has recovered and no longer requires hospitalization, the patient is then "handed back" to the primary care physician. In the case of a specialist, a cardiologist performs the cardiac surgery, but then the treatment and coordination of care for the patient after surgery is handed off to a hospitalist.

Hospitalists are typically compensated as salaried employees of a hospital, although in some cases the hospital may contract with a hospitalist practice. Some hospitals began using hospitalists in the 1990s in response to increases in hospital patients arriving through the emergency department; it became more and more difficult to rely solely on community physicians to meet the needs of these patients (Wachter & Goldman, 2016). Moreover, community physicians were happy to cede many of their hospital-based duties to hospitalists because community physicians received little compensation for non-procedural inpatient care (Wachter & Goldman, 2016). In turn, hospitals found that they could realize cost savings as well as improvements in patient care through the use of hospitalists and thus became more willing to employ them (Wachter & Goldman, 2016).

For my purposes, what is important is that hospitalists take over many of the tasks that primary care and specialist physicians typically perform at a hospital, and hospitalists reduce the amount of time that primary care and specialist physicians physically spend at a hospital. For example, one of the technologies whose adoption and implementation I am evaluating in this

dissertation is computerized physician order entry (CPOE), which allows physicians to place medical orders for prescriptions, diagnostic testing, lab work, etc., electronically rather than using a pen and paper. Traditionally, in hospitals without hospitalists, primary care and specialist physicians place medical orders at the hospital for their patients and therefore would be integral to the successful implementation of CPOE at the hospital. However, at a hospital with hospitalists, primary care and specialist physicians spend significantly less time at the hospital because care for hospitalized patients is now transferred to hospitalists. This means primary care and specialist physicians are much less likely to be placing medical orders on a routine basis at the hospital. Instead, that task has been transferred to hospitalists, and successful implementation of a technology like CPOE now depends on usage by hospitalists rather than primary care and specialist physicians from the community.

Therefore, the theoretical arguments I have put forth thus far for why hospitals that integrate primary care and specialist physicians should be more likely to adopt a new technology sooner than hospitals that maintain an arm's length relationship with physicians apply to hospitalists as well. I expect hospitals that use hospitalists will be faster to adopt a new technology such as CPOE than hospitals that do not use hospitalists because as employees of the hospital, the hospital administrators can expect greater control over hospitalists than non-integrated physicians and they can expect hospitalists to be more inclined to use CPOE on their own volition. As Lee Goldman, M.D., who has written extensively on the rise of the hospitalist notes,

> "Hospitalists, because they are there all the time, became experts in all the ways that a hospital works on a daily basis. Then you throw in the electronic medical record, and the hospitalists learned how to use it and make it helpful, whereas the individual physician coming from the office found it to be a burden," (Goldman, 2016).

Moreover, if managerial expectations about physician cooperation matter in the decision to adopt a new technology such as CPOE, then managerial expectations about the cooperation of primary care and specialist physicians should matter more for hospitals that do not use hospitalists than hospitals that do use hospitalists. Hospitals that do not use hospitalists rely on primary care and specialist physicians to use CPOE in order for implementation to be successful. But hospitals that do use hospitalists are more likely to rely on hospitalists than primary care and specialist physicians to use CPOE for successful implementation, since primary care and specialist physicians are less likely to be placing medical orders at the hospital in the first place. I use this fact as a way to empirically explore the mechanisms underlying my hypotheses.

Beginning in 2003, the AHA asks hospitals to indicate whether they use hospitalists. Therefore, I define *No Hospitalists* to be equal to 1 if the hospital does not use hospitalists and equal to 0 otherwise. To include the year 2000 in my analyses, I also define hospitals that did not use hospitalists in 2003 as not using hospitalists in 2000. This is a conservative measure, as there are likely hospitals that used hospitalists in 2003 that did not use them in 2000.

Sample

I limit my sample to 2,631 non-federal, general acute care hospitals. I include both independent hospitals and hospitals that are members of health systems, but I exclude those hospitals that indicate that they must coordinate their technology adoption decisions with the system. Please see Tables IV.3-6 for summary statistics.

Econometric Approach: A Firm's Decision to Adopt a New Technology

To test the hypotheses developed in Chapter 2, I model the time to adoption of a new technology. Let T represent the time of adoption, measured as the first year in which a hospital contracted with a vendor for the technology. The decision to adopt a given technology can occur

at any time (i.e., on any given day), suggesting an underlying continuous-time process where the goal should be to estimate the hazard:

$$h(t) = \lim_{s \to t} \frac{\Pr(t < T_{CPOE} < s | T_{CPOE} \geq t)}{s - t}$$

However, the time of adoption is recorded as the year in which a new technology was adopted, making the measure of time large relative to the period of observation and the rate of adoption occurrence. This results in a large number of "ties," where many hospitals have the same time-to-adoption. Under these circumstances, the continuous time assumption is inappropriate (Allison, 2009). Instead, I proceed with a discrete-time model as recommended by Allison (2009) in which time t is measured as discrete $t = 1,2,3,$ ... years. T is an integer-valued random variable giving the year in which a given hospital contracted for the technology. The probability that adoption occurs at time t given that adoption has not already occurred is given:

$$P_t = \Pr(T = t | T \geq t)$$

Let $\boldsymbol{x}_{it}$ be the vector of explanatory variables observed for hospital i at time t. For my main analysis, I estimate a logit model:

$$\log\left[\frac{P_{it}}{1 - P_{it}}\right] = \alpha_t + \boldsymbol{\beta x}_{it}$$

where $0 \leq P_t \leq 1$. I allow for arbitrary changes in the hazard with time, such that each α_t is a constant for year t.

However, for robustness, I also estimate a complementary log-log model, which assumes that that the data were generated by an underlying proportional hazards model in continuous time:

$$\log[-\log(1 - P_{it})] = \alpha_t + \boldsymbol{\beta x}_{it}$$

The coefficients in this model are exactly equivalent to the coefficients in the underlying proportional hazards model (Allison, 2009).

I estimate these models using the maximum likelihood method. In my data, I have hospital-year observations. The dependent variable is coded 1 if adoption occurs during that year and is coded as zero if adoption has not yet occurred. Independent and control variables take on whatever value occurs during the relevant time unit.

Both left censoring and right censoring are present in the data, where some firms already adopted the technology when observation began (left-censoring) while others never adopted the technology (right-censoring). I plan to understand the left-censoring observations by estimating a probit model for whether hospitals have adopted by year one. For the right-censored observations, I plan to extend the dataset in the future; I recently gained access to the 2014 HIMSS dataset.

In an effort to provide evidence of a treatment effect of integration on technology adoption, I conduct a number of different analyses that I describe in more detail in the results section. But for a list of possible obstacles to establishing a treatment effect and my strategies for addressing them, please see Table IV.2.

Econometric Approach: Implementation of a New Technology

To test the hypotheses developed in Chapter 3, I evaluate two dimensions of the "speed" of implementation. First, I estimate the time to installation. The dependent variable is equal to 1 if it is the first year in which the hospital achieves full installation and 0 if the technology has been contracted but full installation has not yet been achieved. Once again, there are many ties in the data, and so I use the same discrete time model as described above, where time t is measured as discrete $t = 1,2,3,$ ... years. T is an integer-valued random variable giving the year

in which a given hospital first achieves full installation of the new technology. The probability that the hospital achieves full installation at time t given that full installation has not already been achieved is given:

$$P_t = \Pr(T = t | T \geq t)$$

Let $\boldsymbol{x}_{it}$ be the vector of explanatory variables observed for hospital i at time t. I estimate a logit model:

$$\log\left[\frac{P_{it}}{1 - P_{it}}\right] = \alpha_t + \boldsymbol{\beta}\boldsymbol{x}_{it}$$

where $0 \leq P_t \leq 1$. I allow for arbitrary changes in the hazard with time, such that each α_t is a constant for year t. I estimate this model using the maximum likelihood method.

I also model the percentage of physicians using the technology at the end of full implementation. I estimate an ordered probit model because these percentages are reported in ordered categories (1-25%, 26-50%, 51-75%, 76-100%).

Table IV.2 Strategies for Identifying a Treatment Effect

Problem	Strategy
Potential omitted variable: Hospital resources	I control for: •Hospital size (# beds) •For-profit status •System membership •Critical access hospital •Rural hospital
Potential omitted variable: Market competition	I control for: •Local market competition •Market share
Potential omitted variable: Government pressure to adopt	I control for: •Medicare reimbursements
Potential omitted variable: Physician age	I control for: •Teaching hospital •Critical access hospital •Rural hospital
Potential omitted variable: Physician specialty	Limit sample to general acute care hospitals Control for: •Teaching hospital •Critical access hospital •Rural hospital
Potential omitted variable: (Unidentified)	I include a variable accounting for the hospital's propensity to adopt a new technology. The first is the propensity to have been an earlier adopter of clinical data repository technology. This is a technology that does not require physicians to interact with it, and most hospitals adopt a CDR technology prior to adopting CPOE or Physician Decision Support. Use state corporate practice of medicine laws as an instrument as a source of exogeneity in integration decisions. Conduct both matching and instrumental variables analyses.
Proposed mechanisms are not directly observed.	I include an indicator for whether the hospital utilizes hospitalists. Hospitalists take over many of the tasks that a primary care or specialist physician complete in the hospital setting, including coordinating care and placing medical orders. Hospitalists therefore minimize the extent to primary care or specialist physicians have to complete the tasks associated with CPOE and decision support technology at the hospital. If hospital administrators weigh expectations about the cooperation of physicians in deciding whether to implement a new technology, then the cooperation of the physicians actually integrated (or not) under the ISM should matter less for hospitals that use hospitalists and matter more for hospitals that do not use hospitalists. Test whether hospital administrators are more likely to cite physicians as an obstacle to information technology adoption if physicians are not integrated using the AHA Health IT Survey.

Table IV.3 Summary Statistics

Variable	N	Mean	SD	Min	p5	p10	p25	p50	p75	p90	p95	Max
Integrated salary model (yes=1)	20271	0.318	0.466	0	0	0	0	0	1	1	1	1
Market model (yes=1)	20263	0.422	0.494	0	0	0	0	0	1	1	1	1
Quasi-integration: MSO model (yes=1)	20274	0.060	0.238	0	0	0	0	0	0	0	1	1
Quasi-integration: Foundation model (yes=1)	20272	0.027	0.162	0	0	0	0	0	0	0	0	1
Quasi-integration: CPHO model (yes=1)	20273	0.040	0.197	0	0	0	0	0	0	0	0	1
Quasi-integration: OPHO model (yes=1)	20273	0.137	0.344	0	0	0	0	0	0	1	1	1
Quasi-integration: GPWW model (yes=1)	20272	0.029	0.168	0	0	0	0	0	0	0	0	1
Quasi-integration: IPA model (yes=1)	20271	0.122	0.327	0	0	0	0	0	0	1	1	1
No hospitalists (yes=1)	16655	0.542	0.498	0	0	0	0	1	1	1	1	1
For-profit (yes=1)	24803	0.107	0.309	0	0	0	0	0	0	1	1	1
Teaching hospital (yes=1)	24785	0.197	0.398	0	0	0	0	0	0	1	1	1
Critical access hospital (yes=1)	24803	0.278	0.448	0	0	0	0	0	1	1	1	1
Rural (yes=1)	24605	0.328	0.469	0	0	0	0	0	1	1	1	1
Size: 25 beds max	24803	0.233	0.423	0	0	0	0	0	0	1	1	1
Size: 26-50 beds	24803	0.150	0.357	0	0	0	0	0	0	1	1	1
Size: 51-100 beds	24803	0.187	0.390	0	0	0	0	0	0	1	1	1
Size: 101-250 beds	24803	0.251	0.433	0	0	0	0	0	1	1	1	1
Size: 251-500 beds	24803	0.131	0.337	0	0	0	0	0	0	1	1	1
Size: Over 500 beds	24803	0.048	0.214	0	0	0	0	0	0	0	0	1
ln(Market Share) by HRR	23878	-3.586	1.237	-7.529	-5.585	-5.207	-4.452	-3.634	-2.750	-1.910	-1.433	0
ln(Competition) by HRR	23878	-2.306	0.733	-4.214	-3.338	-3.226	-2.919	-2.287	-1.741	-1.342	-1.150	0
ln(Market Share) by HSA	23878	-0.666	1.220	-7.011	-3.570	-2.746	-0.806	0	0	0	0	0
ln(Competition) by HSA	23878	-0.374	0.664	-3.260	-1.873	-1.356	-0.632	0	0	0	0	0
% Inpatient days Medicare	24803	0.503	0.198	0	0.097	0.193	0.407	0.522	0.633	0.735	0.799	1
System Membership (yes=1)	24803	0.473	0.499	0	0	0	0	0	1	1	1	1

Table IV.4 Variable Averages by Year

Variable	2000	2003	2004*	2005	2006	2007	2008	2009	2010	2011	2012	2013
Integrated salary model (yes=1)	0.220	0.263	0.263	0.282	0.306	0.321	0.345	0.346	0.358	0.376	0.379	0.405
Market model (yes=1)	0.461	0.426	0.426	0.422	0.415	0.406	0.402	0.410	0.420	0.425	0.428	0.407
Quasi-integration: MSO model (yes=1)	0.081	0.066	0.066	0.063	0.062	0.061	0.057	0.061	0.055	0.053	0.047	0.042
Quasi-integration: Foundation model (yes=1)	0.028	0.022	0.022	0.025	0.025	0.028	0.029	0.027	0.030	0.029	0.029	0.032
Quasi-integration: CPHO model (yes=1)	0.050	0.042	0.042	0.043	0.040	0.046	0.045	0.040	0.039	0.035	0.030	0.030
Quasi-integration: OPHO model (yes=1)	0.185	0.160	0.160	0.149	0.137	0.130	0.125	0.125	0.117	0.110	0.113	0.112
Quasi-integration: GPWW model (yes=1)	0.031	0.027	0.027	0.030	0.027	0.031	0.028	0.029	0.029	0.029	0.029	0.033
Quasi-integration: IPA model (yes=1)	0.149	0.149	0.149	0.138	0.138	0.130	0.115	0.109	0.104	0.091	0.080	0.084
No hospitalists (yes=1)	.	0.742	0.742	0.648	0.601	0.554	0.513	0.479	0.445	0.421	0.368	0.352
For-profit (yes=1)	0.084	0.089	0.089	0.121	0.109	0.104	0.115	0.115	0.118	0.118	0.114	0.104
Teaching hospital (yes=1)	0.160	0.185	0.185	0.199	0.197	0.199	0.199	0.196	0.208	0.206	0.221	0.219
Critical access hospital (yes=1)	0.000	0.230	0.230	0.308	0.289	0.322	0.324	0.322	0.332	0.334	0.340	0.344
Rural (yes=1)	0.325	0.323	0.323	0.317	0.322	0.329	0.330	0.330	0.331	0.334	0.337	0.336
Size: 25 beds max	0.110	0.159	0.159	0.228	0.245	0.251	0.261	0.263	0.274	0.286	0.292	0.300
Size: 26-50 beds	0.202	0.177	0.177	0.142	0.133	0.136	0.137	0.139	0.136	0.135	0.141	0.138
Size: 51-100 beds	0.208	0.203	0.203	0.189	0.188	0.186	0.186	0.183	0.178	0.175	0.169	0.173
Size: 101-250 beds	0.300	0.274	0.274	0.260	0.253	0.240	0.239	0.239	0.236	0.230	0.231	0.220
Size: 251-500 beds	0.135	0.143	0.143	0.139	0.135	0.139	0.127	0.125	0.127	0.121	0.115	0.114
Size: Over 500 beds	0.045	0.044	0.044	0.042	0.047	0.048	0.049	0.051	0.049	0.053	0.052	0.055
ln(Market Share) by HRR	-3.509	-3.521	-3.521	-3.545	-3.575	-3.603	-3.618	-3.616	-3.622	-3.643	-3.633	-3.649
ln(Competition) by HRR	-2.400	-2.346	-2.346	-2.324	-2.318	-2.324	-2.307	-2.287	-2.274	-2.264	-2.230	-2.225
ln(Market Share) by HSA	-0.682	-0.623	-0.623	-0.664	-0.654	-0.685	-0.688	-0.698	-0.675	-0.692	-0.652	-0.658
ln(Competition) by HSA	-0.423	-0.375	-0.375	-0.392	-0.380	-0.382	-0.378	-0.375	-0.363	-0.365	-0.336	-0.333
% Inpatient days Medicare	0.491	0.490	0.490	0.511	0.496	0.497	0.505	0.506	0.504	0.516	0.511	0.522
System Membership (yes=1)	0.494	0.495	0.495	0.491	0.486	0.475	0.472	0.462	0.463	0.454	0.445	0.439

* I did not have access to 2004 data from the American Hospital Association Survey, so I ran regressions that exclude 2004 data, use 2003 data in place of 2004 data, and use 2005 data in place of 2004 data.

Table IV.5 Variable Averages by Contractual Relationship with Physicians

Variable	Integrated Salary Model	Market Model
No hospitalists (yes=1)	0.510	0.578
For-profit (yes=1)	0.030	0.136
Teaching hospital (yes=1)	0.265	0.140
Critical access hospital (yes=1)	0.335	0.270
Rural (yes=1)	0.351	0.340
Size: 25 beds max	0.229	0.245
Size: 26-50 beds	0.116	0.180
Size: 51-100 beds	0.190	0.183
Size: 101-250 beds	0.235	0.252
Size: 251-500 beds	0.155	0.109
Size: Over 500 beds	0.076	0.031
ln(Market Share) by HRR	-3.358	-3.740
ln(Competition) by HRR	-2.235	-2.344
ln(Market Share) by HSA	-0.485	-0.682
ln(Competition) by HSA	-0.330	-0.348
% Inpatient days Medicare	0.487	0.509
System Membership (yes=1)	0.447	0.491

Table IV.6 Correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 Integrated salary model (yes=1)																								
2 Market model (yes=1)	-0.58																							
3 Quasi-integration: MSO model (yes=1)	-0.01	-0.20																						
4 Quasi-integration: Foundation model (yes=1)	-0.06	-0.14	0.02																					
5 Quasi-integration: CPHO model (yes=1)	-0.06	-0.17	0.06	0.02																				
6 Quasi-integration: OPHO model (yes=1)	-0.06	-0.32	0.07	-0.01	-0.05																			
7 Quasi-integration: GPWW model (yes=1)	-0.03	-0.14	0.00	0.01	-0.01	0.00																		
8 Quasi-integration: IPA model (yes=1)	-0.10	-0.30	0.03	0.05	0.05	-0.04	0.03																	
9 No hospitalists (yes=1)	-0.04	0.05	-0.08	-0.03	-0.07	-0.09	-0.01	0.02																
10 For-profit (yes=1)	-0.11	0.12	-0.01	-0.02	-0.03	-0.03	-0.03	0.01	0.02															
11 Teaching hospital (yes=1)	0.08	-0.14	0.06	0.08	0.05	0.08	0.06	0.06	-0.31	-0.08														
12 Critical access hospital (yes=1)	0.08	0.03	-0.12	-0.02	-0.06	-0.17	-0.01	-0.01	0.40	-0.08	-0.29													
13 Rural (yes=1)	0.03	0.04	-0.10	-0.03	-0.08	-0.14	-0.01	0.00	0.42	-0.06	-0.30	0.55												
14 Size: 25 beds max	0.02	0.06	-0.09	-0.02	-0.06	-0.15	0.00	0.00	0.31	0.03	-0.24	0.67	0.40											
15 Size: 26-50 beds	-0.05	0.05	-0.04	-0.02	-0.04	-0.04	0.03	-0.02	0.15	0.05	-0.16	0.00	0.20	-0.21										
16 Size: 51-100 beds	0.01	0.00	-0.01	0.00	0.00	0.01	-0.04	-0.02	0.10	0.00	-0.15	0.00	0.06	-0.25	-0.18									
17 Size: 101-250 beds	-0.04	0.01	0.03	-0.02	0.01	0.07	0.00	-0.02	-0.16	0.01	0.02	-0.32	-0.28	-0.32	-0.23	-0.27								
18 Size: 251-500 beds	0.02	-0.07	0.09	0.02	0.06	0.09	-0.01	0.01	-0.27	-0.07	0.29	-0.27	-0.28	-0.23	-0.16	-0.20	-0.25							
19 Size: Over 500 beds	0.06	-0.08	0.05	0.09	0.05	0.05	0.04	0.06	-0.21	-0.05	0.40	-0.16	-0.17	-0.14	-0.10	-0.12	-0.15	-0.11						
20 ln(Market Share) by HRR	0.09	-0.14	0.10	0.04	0.06	0.18	0.02	-0.03	-0.36	-0.14	0.39	-0.43	-0.38	-0.53	-0.20	-0.06	0.20	0.40	0.34					
21 ln(Competition) by HRR	0.06	-0.06	0.01	-0.01	-0.02	0.09	0.02	-0.07	-0.03	-0.06	-0.01	0.03	0.01	0.06	0.05	-0.02	-0.08	-0.01	0.03	0.56				
22 ln(Market Share) by HSA	0.06	-0.04	0.03	0.00	0.00	0.03	-0.04	-0.08	0.05	-0.32	-0.14	0.10	0.16	-0.06	0.02	0.11	0.03	-0.05	-0.07	0.08	0.05			
23 ln(Competition) by HSA	0.02	0.02	-0.01	-0.04	-0.03	-0.02	-0.04	-0.08	0.19	-0.21	-0.36	0.24	0.27	0.14	0.10	0.15	-0.01	-0.22	-0.27	-0.15	0.15	0.81		
24 % Inpatient days Medicare	-0.05	0.03	0.02	0.00	-0.01	0.05	0.00	-0.03	-0.02	0.03	-0.06	-0.03	-0.03	0.29	0.03	-0.16	-0.06	-0.06	-0.10	-0.19	0.08	0.07	0.14	
25 System Membership (yes=1)	-0.04	0.04	0.05	0.01	-0.02	0.06	-0.01	-0.01	-0.20	0.11	0.12	-0.21	-0.22	-0.15	-0.05	-0.06	0.10	0.10	0.09	0.14	0.02	-0.07	-0.13	0.07

CHAPTER V

Results

I present and discuss the results first for the firm's decision to adopt a new technology and then for the implementation of the technology. Please see Tables IV.3-IV.6 for summary statistics.

Firm's Decision to Adopt

In Chapter 2 I hypothesize that firms that use an employment contract to integrate human capital will adopt a new technology sooner than firms that maintain an arm's length relationship with human capital (H1). I test this hypotheses by estimating a discrete time-to-adoption model for CPOE, and I present the results in Table V.1. The three main variables of interest are *Integrated Salary Model*, *ISM Ratio* $< 75^{th}$ *percentile*, and *ISM Ratio* $>= 75^{th}$ *percentile*. In columns (1) and (2), none of these is significant. However, an important feature of some hospitals is the use of hospitalist physicians. In this analysis, I am testing whether hospitals that integrate primary care and specialist physicians as salaried employees adopt a new technology sooner or later than hospitals that do not integrate primary care and specialist physicians. Hospitalist physicians represent a different set of physicians. Hospitalist physicians are typically employed as full-time, salaried employees by the hospitals that use them, and they specialize in the treatment and coordination of care of hospitalized patients. Traditionally, a primary care physician would both conduct a routine physical in an outpatient setting and care for a patient

who has pneumonia in an inpatient setting, i.e., a hospital. When a primary care physician's patient is in the hospital, the primary care physician remains in charge of treating the patient and coordinating the patient's care; the primary care physician will make daily rounds in which he or she is physically at the hospital, and it is in this context that the physician conducts the tasks associated with the technologies in question: placing medical orders and documentation. However, hospitals can use hospitalists to relieve primary care and specialist physicians from the burden of having to make these daily visits to the hospital, regardless of whether the primary care and specialist physicians are integrated as employees. Instead of primary care physicians continuing to make daily trips to the hospital to treat and coordinate the care for a patient, the patient is "handed off" to hospitalist physicians at the hospital who take charge of treatment and coordination of care. Once the patient has recovered and no longer requires hospitalization, the patient is then "handed back" to the primary care physician. In the case of a specialist, a cardiologist performs the cardiac surgery, but then the treatment and coordination of care for the patient after surgery is handed off to a hospitalist.

Thus, at a hospital with hospitalists, regardless of whether the primary care and specialist physicians are integrated as employees of the hospital, the primary care and specialist physicians spend significantly less time at the hospital because care for hospitalized patients is now transferred to hospitalists. This means primary care and specialist physicians are much less likely to be placing medical orders on a routine basis at the hospital. Instead, that task has been transferred to hospitalists, and successful implementation of a technology like CPOE now depends on usage by hospitalists rather than primary care and specialist physicians from the community. Therefore, if managerial expectations about physician cooperation matter in the decision to adopt a new technology such as CPOE, then managerial expectations about the

cooperation of primary care and specialist physicians should matter more for hospitals that do not use hospitalists than hospitals that do use hospitalists. Hospitals that do not use hospitalists rely on primary care and specialist physicians to use CPOE in order for implementation to be successful. But hospitals that do use hospitalists are more likely to rely on hospitalists than primary care and specialist physicians to use CPOE for successful implementation, since primary care and specialist physicians are less likely to be placing medical orders at the hospital in the first place.

The results in columns (4) and (6) support this, where hospitals that employ primary care and specialist physicians under an integrated salary model adopt CPOE sooner if they do not use hospitalists, but the integration of primary care and specialist physicians does not seem to matter if the hospital does use hospitalists. Moreover, the main effect on *No Hospitalists* suggests that hospitals that employ hospitalists are more likely to adopt CPOE faster than hospitals that do not employ hospitalists. This is expected because hospitalists are themselves employees of the hospital, and therefore firm management can expect to have more control over hospitalists and expect hospitalists to be more willing to use CPOE on their own volition. As Lee Goldman, MD, who has researched the use of hospitalists extensively over the past twenty years writes, "…you throw in the electronic medical record, and the hospitalists learned how to use it and make it helpful, whereas the individual physician coming from the office found it to be a burden," (2016).

In Table V.2, I present the results related to (H2) in Chapter 2, where I hypothesize that the relationship between integrating human capital and the time to adoption should be weaker in markets where continuity of association is present regardless of contract type. To test this, I test whether the relationship between integration and time to adoption is weaker single-hospital

markets, where non-integrated human capital are more likely to regularly interact with one particular hospital and have a stronger mutual expectation of a continued relationship with the hospital. However, I find evidence of the opposite effect, where hospitals that employ physicians under an integrated salary model are even more likely to adopt CPOE sooner than firms that maintain an arm's length relationship with physicians.

I also hypothesize that the relationship between integration and time to adoption will be stronger earlier in the technology life cycle because greater uncertainty and more intensive adaptation efforts make integration more valuable. To proxy for stage in the technology life cycle, I interacted the year indicator variables for the years 2000, 2003, and 2004 with the integration variables because uncertainty should be highest when only 1-25% of hospitals have adopted the new technology; over time, as more hospitals use the new technology and the technology is refined, technological uncertain resides. Yet the results in columns (5) and (6) did not provide support for this hypothesis.

However, the estimates presented in Tables V.1 and V.2 do not account for the potential endogeneity associated with the choice to integrate human capital and the choice to invest in a new technology, and thus the results in these tables may be biased (in either direction). Rather than providing a single solution to this issue, I take a number of approaches and provide a portfolio of results. I first use state corporate practice of medicine laws banning the employment of physicians by hospitals in certain states as an instrument in a two-stage least squares analysis. I also conduct a matching analysis that exploits these laws. Thus far, I have limited the sample to hospitals that make the decision of whether to adopt a new technology at the establishment level, but I also show that within multi-hospital systems that coordinate the adoption of CPOE across hospitals, adoption is more likely to be initiated at establishments that integrate physicians under

an employment contract. Finally, I also show that hospital administrators are less likely to cite physician cooperation as an obstacle to adoption at hospitals that employ physicians.

Table V.1 Decision to Adopt CPOE: Discrete Time Estimates, Part 1

	(1)	(2)	(3)	(4)	(5)	(6)
Integrated salary model (yes=1)	0.070		0.012	-0.181		
	(0.072)		(0.075)	(0.118)		
ISM Ratio <75th percentile		0.056			0.005	-0.191
		(0.077)			(0.080)	(0.127)
ISM Ratio >= 75th percentile		0.221			0.116	-0.036
		(0.142)			(0.146)	(0.221)
No hospitalists (yes=1)			-0.204*	-0.311***	-0.201*	-0.305***
			(0.080)	(0.091)	(0.080)	(0.091)
Integrated salary model x No Hospitalists				0.345*		
				(0.148)		
ISM Ratio <75th percentile x No Hospitalists						0.351*
						(0.160)
ISM Ratio >= 75th percentile x No Hospitalists						0.274
						(0.280)
For-profit (yes=1)	-0.762***	-0.768***	-0.626***	-0.621***	-0.624***	-0.618***
	(0.141)	(0.142)	(0.159)	(0.159)	(0.160)	(0.159)
Teaching hospital (yes=1)	0.246*	0.239*	0.232*	0.242*	0.225*	0.233*
	(0.102)	(0.103)	(0.105)	(0.104)	(0.105)	(0.105)
Critical access (yes=1)	-0.169	-0.166	-0.129	-0.135	-0.131	-0.137
	(0.109)	(0.109)	(0.116)	(0.116)	(0.116)	(0.117)
Rural (yes=1)	-0.372***	-0.370***	-0.327***	-0.334***	-0.324***	-0.330***
	(0.084)	(0.084)	(0.091)	(0.092)	(0.091)	(0.092)
Size: 26-50 beds	-0.041	-0.018	-0.010	-0.009	-0.002	-0.002
	(0.130)	(0.132)	(0.141)	(0.141)	(0.142)	(0.142)
Size: 51-100 beds	0.181	0.213	0.288+	0.296+	0.292+	0.300+
	(0.160)	(0.161)	(0.171)	(0.172)	(0.172)	(0.173)
Size: 101-250 beds	0.545**	0.594**	0.645**	0.649**	0.668**	0.674**
	(0.205)	(0.205)	(0.216)	(0.217)	(0.217)	(0.219)
Size: 251-500 beds	0.776**	0.833**	0.854**	0.871**	0.878**	0.899**
	(0.254)	(0.256)	(0.269)	(0.271)	(0.271)	(0.273)
Size: Over 500 beds	0.972**	1.032**	1.053**	1.054**	1.078**	1.085**
	(0.320)	(0.322)	(0.337)	(0.339)	(0.339)	(0.343)
ln(Market Share HRR)	-0.041	-0.052	-0.091	-0.090	-0.091	-0.091
	(0.079)	(0.079)	(0.084)	(0.085)	(0.085)	(0.085)
ln(Market Competition HRR)	0.002	0.009	0.040	0.039	0.038	0.038
	(0.097)	(0.097)	(0.103)	(0.103)	(0.103)	(0.104)
ln(Market Share HSA)	-0.072	-0.072	-0.056	-0.057	-0.058	-0.060
	(0.060)	(0.060)	(0.064)	(0.064)	(0.064)	(0.064)
ln(Market Competion (HSA)	0.084	0.091	0.077	0.082	0.086	0.091
	(0.124)	(0.125)	(0.133)	(0.133)	(0.133)	(0.133)
% Inpatient Days Medicare	0.012	-0.006	-0.108	-0.092	-0.113	-0.095
	(0.182)	(0.184)	(0.189)	(0.189)	(0.190)	(0.191)
System membership	0.215**	0.237***	0.183*	0.177*	0.193**	0.187*
	(0.069)	(0.069)	(0.073)	(0.073)	(0.073)	(0.073)
Quasi-integration: MSO	0.084	0.084	0.084	0.087	0.084	0.088
	(0.141)	(0.141)	(0.145)	(0.145)	(0.145)	(0.146)
Quasi-integration: Foundation	-0.032	0.002	-0.020	-0.019	0.017	0.016
	(0.169)	(0.170)	(0.175)	(0.176)	(0.175)	(0.176)
Quasi-integration: CPHO	0.355*	0.354*	0.327*	0.332*	0.328*	0.334*
	(0.143)	(0.143)	(0.148)	(0.148)	(0.148)	(0.148)
Quasi-integration: OPHO	0.058	0.045	0.030	0.029	0.029	0.028
	(0.101)	(0.101)	(0.104)	(0.104)	(0.104)	(0.104)
Quasi-integration: GPWW	-0.216	-0.187	-0.170	-0.157	-0.140	-0.127
	(0.196)	(0.196)	(0.193)	(0.193)	(0.195)	(0.194)
Quasi-integration: IPA	-0.065	-0.042	-0.085	-0.083	-0.077	-0.075
	(0.104)	(0.104)	(0.106)	(0.107)	(0.106)	(0.108)
N	11442	11360	10036	10036	10012	10012

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001 Standard errors clustered by hospital

Table V.2 Decision to Adopt CPOE: Discrete Time Estimates, Part 2
Testing Continuity of Association and Life-Cycle Hypotheses

	(1)	(2)	(3)	(4)	(5)	(6)
Integrated salary model (yes=1)	0.010	-0.348*			-0.035	
	(0.075)	(0.143)			(0.087)	
ISM Ratio <75th percentile			0.004	-0.323*		-0.041
			(0.081)	(0.156)		(0.095)
ISM Ratio >= 75th percentile			0.114	-0.359		0.064
			(0.146)	(0.266)		(0.153)
No hospitalists (yes=1)	-0.203*	-0.205*	-0.201*	-0.202*	-0.203*	-0.199*
	(0.080)	(0.080)	(0.080)	(0.080)	(0.080)	(0.080)
Single-hospital health service area	-0.155	-0.336*	-0.154	-0.326*		
	(0.145)	(0.151)	(0.146)	(0.151)		
Integrated salary model x Single-hospital HSA		0.515**				
		(0.165)				
ISM Ratio <75th percentile x Single-hospital HSA				0.465**		
				(0.179)		
ISM Ratio >= 75th percentile x Single-hospital HSA				0.717*		
				(0.310)		
Integrated salary model x Year 2000					-0.033	
					(0.301)	
Integrated salary model x Year 2003					0.169	
					(0.225)	
Integrated salary model x Year 2004					0.298	
					(0.229)	
ISM Ratio <75th percentile x Year 2000						-0.072
						(0.326)
ISM Ratio >= 75th percentile x Year 2000						0.365
						(0.633)
ISM Ratio <75th percentile x Year 2003						0.129
						(0.238)
ISM Ratio >= 75th percentile x Year 2003						0.456
						(0.501)
ISM Ratio <75th percentile x Year 2004						0.328
						(0.238)
ISM Ratio >= 75th percentile x Year 2004						0.013
						(0.627)
For-profit (yes=1)	-0.635***	-0.678***	-0.632***	-0.680***	-0.626***	-0.624***
	(0.160)	(0.161)	(0.160)	(0.162)	(0.159)	(0.160)
Teaching hospital (yes=1)	0.222*	0.232*	0.214*	0.229*	0.231*	0.222*
	(0.105)	(0.105)	(0.106)	(0.106)	(0.105)	(0.105)
Critical access (yes=1)	-0.134	-0.154	-0.136	-0.160	-0.127	-0.127
	(0.116)	(0.117)	(0.116)	(0.117)	(0.116)	(0.116)
Rural (yes=1)	-0.323***	-0.315***	-0.320***	-0.310***	-0.328***	-0.325***
	(0.091)	(0.092)	(0.092)	(0.092)	(0.091)	(0.091)
Size: (Bed Indicators)	Y	Y	Y	Y	Y	Y
ln(Market Share HSA)	-0.024	-0.010	-0.026	-0.020	-0.056	-0.059
	(0.069)	(0.070)	(0.070)	(0.070)	(0.064)	(0.064)
ln(Market Competion (HSA)	0.109	0.101	0.117	0.116	0.078	0.089
	(0.138)	(0.138)	(0.138)	(0.138)	(0.133)	(0.133)
% Inpatient Days Medicare	-0.120	-0.142	-0.125	-0.157	-0.105	-0.109
	(0.189)	(0.189)	(0.190)	(0.190)	(0.189)	(0.190)
System membership	0.181*	0.177*	0.190**	0.190**	0.182*	0.191**
	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)
Quasi-integration model controls	Y	Y	Y	Y	Y	Y
N	10036	10036	10012	10012	10036	10012

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001 Standard errors clustered by hospital

As described in the prior chapter, certain states prohibit hospitals from employing physicians under corporate practice of medicine laws, thus providing a source of exogeneity in the decision to integrate physicians. I use Lammers's (2013) survey of state laws for all 50 states to construct an instrument for banned employment. Arkansas, California, Ohio, and Texas prohibit both for-profit and non-profit hospitals from employing physicians, and Michigan, Nevada, North Carolina, Ohio, South Carolina, Washington, and West Virginia prohibit for-profit hospitals from employing physicians. I have reprinted Lammers's summary of the survey results in Appendix C.

Unfortunately, it is not appropriate to perform a two-stage analysis in a logit model where the endogenous regressor (in this case, *Integrated Salary Model*) is also binary (Angrist & Pischke). Therefore, I instead estimate a linear probability model for the endogenous regression and then perform a two-stage OLS instrumental variable analysis; the results are presented in Table V.3. Thus, it is important to view these results cautiously. Nonetheless, I find support for the hypothesis that hospitals that integrate physicians adopt CPOE sooner in columns (3) and (6).

Because the instrumental variable approach requires that I rely on a linear probability model, I also performed a propensity score matching analysis for additional robustness. In this approach, I first estimated the likelihood of using an integrated salary model in the sample excluding the states where employment of physicians is banned. I then use this to estimate the predicted likelihood of adoption for all hospitals, including those in states with employment banned. I then used a kernel matching method to match "treated" hospitals in states that do not ban employment with "untreated" hospitals in states that do ban employment based on the predicted likelihood of integrating physicians. Results are presented in Table V.4. Across the

Table V.3 Decision to Adopt CPOE: Two-Stage OLS

	Endogenous Adoption (1)	1st Stage ISM (2)	2nd Stage Adoption (3)	Endogenous Adoption (4)	1st Stage ISM (5)	2nd Stage Adoption (6)
Integrated salary model (yes=1)	0.007		0.134*	0.001		0.111+
	(0.007)		(0.056)	(0.007)		(0.057)
Instrument: CPOM law bans employing physicians		-0.140***			-0.144***	
		(0.019)			(0.021)	
No hospitalists (yes=1)				-0.026**	-0.019	-0.024**
				(0.008)	(0.017)	(0.009)
For-profit (yes=1)	-0.069***	-0.100***	-0.048***	-0.059***	-0.094***	-0.042**
	(0.010)	(0.023)	(0.014)	(0.012)	(0.026)	(0.015)
Teaching hospital (yes=1)	0.028*	0.094***	0.016	0.027*	0.087***	0.017
	(0.011)	(0.023)	(0.014)	(0.012)	(0.024)	(0.014)
Critical access (yes=1)	-0.025**	0.094***	-0.038***	-0.022*	0.087**	-0.031**
	(0.009)	(0.025)	(0.011)	(0.009)	(0.027)	(0.011)
Rural (yes=1)	-0.028***	0.012	-0.031***	-0.024**	0.014	-0.026**
	(0.007)	(0.022)	(0.008)	(0.007)	(0.024)	(0.008)
Size: 26-50 beds	-0.001	-0.048+	0.005	0.002	-0.043	0.007
	(0.010)	(0.028)	(0.011)	(0.011)	(0.031)	(0.012)
Size: 51-100 beds	0.017	-0.022	0.021	0.027+	-0.024	0.031*
	(0.013)	(0.036)	(0.015)	(0.014)	(0.039)	(0.016)
Size: 101-250 beds	0.051**	-0.066	0.064**	0.059**	-0.074	0.072***
	(0.018)	(0.047)	(0.020)	(0.019)	(0.050)	(0.021)
Size: 251-500 beds	0.075**	-0.079	0.088***	0.081**	-0.084	0.093***
	(0.023)	(0.060)	(0.026)	(0.024)	(0.064)	(0.027)
Size: Over 500 beds	0.102**	-0.044	0.122***	0.108**	-0.038	0.126***
	(0.032)	(0.075)	(0.035)	(0.035)	(0.080)	(0.037)
ln(Market Share HRR)	-0.006	0.054**	-0.014+	-0.011	0.049*	-0.018+
	(0.007)	(0.020)	(0.009)	(0.008)	(0.021)	(0.009)
ln(Market Competition HRR)	0.004	-0.024	0.010	0.007	-0.013	0.012
	(0.008)	(0.025)	(0.010)	(0.009)	(0.026)	(0.010)
ln(Market Share HSA)	-0.005	0.023	-0.009	-0.004	0.022	-0.007
	(0.006)	(0.015)	(0.006)	(0.006)	(0.016)	(0.006)
ln(Market Competion (HSA)	0.006	-0.030	0.012	0.006	-0.030	0.011
	(0.012)	(0.027)	(0.013)	(0.014)	(0.029)	(0.014)
% Inpatient Days Medicare	-0.003	-0.010	0.002	-0.012	-0.020	-0.007
	(0.015)	(0.038)	(0.016)	(0.016)	(0.041)	(0.017)
System membership	0.020**	-0.023	0.020**	0.017*	-0.030+	0.018*
	(0.006)	(0.017)	(0.007)	(0.007)	(0.018)	(0.007)
Quasi-integration model controls	Y	Y	Y	Y	Y	Y
N	11442	19445	11442	10036	17506	10036

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001 Standard errors clustered by hospital

Table V.4 Decision to Adopt CPOE: Matching

	(1)	(2)	(3)	(4)	(5)	(6)
2000	.	0.041	0.042	0.054	0.059	0.010
2003	0.037	0.030	0.057	0.059	0.027	0.090
2004	0.024	0.031	0.047	-0.004	0.025	0.017
2005	-0.006	-0.001	0.036	-0.214	0.028	-0.031
2006	0.026	0.025	0.027	0.033	0.039	0.013
2007	0.020	0.019	0.002	0.073	-0.010	0.109
2008	0.005	0.001	0.029	-0.034	0.023	-0.040
2009	0.042	0.042	-0.010	0.123	0.012	0.161
2010	-0.018	-0.017	-0.111	0.160	-0.033	0.010
2011	0.027	0.040	0.132	0.006	0.035	0.049
2012	-0.200	-0.206	-0.151	-0.283	-0.134	-0.397
Total	0.011	0.012	0.022	0.015	0.015	0.026
N	1825	2023	1493	476	1525	415
t-test p-value	0.140	0.107	0.004	0.407	0.047	0.143
Diffusion < 25%	0.031	0.033	0.050	0.040	0.035	0.041
N	466	625	502	94	454	144
Diffusion >=25%	0.004	0.002	0.008	0.009	0.007	0.018
N	1359	1398	991	382	1071	271
p-value for diffusion comparison	0.126	0.047	0.010	0.493	0.107	0.548

The table displays the estimated percentage point increase in the probability of adopting CPOE in a given year that integrating physicians as employees yields. The estimates are displayed for each year. The p-values are bootstrapped from a t-test for whether the estimates in the Total row are statistically different from zero. The diffusion estimates allows for a comparison as to whether the effects of employment are stronger earlier in the technology life cycle The following is a key to the columns:

(1) *No Hospitalists* is not available in the year 2000.

(2) Included *No Hospitalists* for 2000 by assuming that hospitals that did not have hospitalists in 2003 do not have hospitalists in 2000.

(3) Estimates for hospitals that do not use hospitalists.

(4) Estimates for hospitals that do use hospitalists.

(5) Estimates for hospitals in single-hospital markets.

(6) Estimates for hospitals in multi-hospital markets.

sample, the results indicate that integration has a statistically significant effect and raises the likelihood of adopting CPOE in any given year by 1.1 to 2.5 percentage points. However, the effect is also significantly larger in earlier years, which also supports (H3). Columns (3) and (4) allow for the comparison of the effects of integration in hospitals that do not use hospitalists (3) and those that do (4). Columns (5) and (6) allow the comparison of hospitals that are in single-hospital markets with those in multi-hospital markets.

Thus far, the sample has been limited to those hospitals that make the decision to adopt at the establishment level. However, in Table V.5 I present results for hospitals that coordinate the adoption decision across a multi-hospital system. I test whether such systems are more likely to initiate adoption in hospitals that integrate physicians than hospitals that do not integrate physicians, when that choice is available. I find strong support for this relationship.

Finally, the 2011 AHA IT Supplement survey, hospital administrators identify various obstacles to integration. These include, physician resistance, staff resistance, upfront capital costs, security/liability for privacy breaches, uncertainty about certification processes, lack of or limited vendor capacity, lack of adequate IT personnel, and ongoing costs of maintenance. I estimate the likelihood of reporting each obstacle in Tables V.6 and V.7. Consistent with (H1), I find that hospitals that are in the 75^{th} percentile of the integrated salary model ratio, i.e. those that integrate a higher percentage of physicians, are less likely to cite physician cooperation as an obstacle to adoption while integration has no effect on the likelihood of citing staff resistance, upfront capital costs, uncertainty about certification process, or lack of adequate IT personnel as obstacles to adoption.

Table V.5 Decision to Adopt CPOE: Multi-hospital System

	(1)	(2)	(3)
Integrated salary model (yes=1)	1.105**	1.013*	
	(0.394)	(0.437)	
ISM Ratio <75th percentile			0.495
			(0.506)
ISM Ratio >= 75th percentile			2.547***
			(0.637)
No hospitalists (yes=1)		-0.707	-0.619
		(0.844)	(0.862)
Number of hospitals in system	0.029	0.009	0.022
	(0.034)	(0.026)	(0.028)
Years since initial contracting	0.182	0.189	0.186
	(0.144)	(0.153)	(0.158)
For-profit (yes=1)	-1.244		
	(1.200)		
Teaching hospital (yes=1)	-0.066	-0.156	-0.212
	(0.512)	(0.516)	(0.566)
Critical access (yes=1)	-1.808	-1.637	-1.396
	(1.740)	(1.753)	(1.914)
Rural (yes=1)	-0.551	-0.555	-0.770
	(0.864)	(0.881)	(1.042)
Size: 26-50 beds	-3.286+	-3.107+	-2.984+
	(1.781)	(1.588)	(1.623)
Size: 51-100 beds	-1.529	-1.564	-1.647
	(2.320)	(2.313)	(2.450)
Size: 101-250 beds	-3.368	-3.689+	-3.991+
	(2.303)	(2.201)	(2.311)
Size: 251-500 beds	-3.679	-4.154	-4.412
	(2.881)	(2.762)	(2.889)
Size: Over 500 beds	-3.168	-3.620	-4.052
	(3.200)	(3.032)	(3.180)
ln(Market Share HRR)	1.650+	1.684*	1.980*
	(0.842)	(0.785)	(0.849)
ln(Market Competition HRR)	-1.603+	-1.747*	-2.182*
	(0.884)	(0.768)	(0.872)
ln(Market Share HSA)	-0.484	-0.407	-0.537
	(0.336)	(0.342)	(0.378)
ln(Market Competion (HSA)	0.713	0.667	0.820
	(0.762)	(0.772)	(0.824)
% Inpatient Days Medicare	1.875	2.114	1.875
	(1.656)	(1.637)	(1.681)
Quasi-integration model controls	Y	Y	Y
N	11442	19445	11442

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
Standard errors clustered by hospital

Table V.6 Obstacles to Health IT Adoption Cited by Administrators, Part 1

	Physician Resistance		Staff Resistance		Upfront Capital Costs		Security/Liability for Privacy Breaches	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Integrated salary model (yes=1)	-0.144		-0.119		0.128		-0.229+	
	(0.100)		(0.109)		(0.098)		(0.128)	
ISM Ratio <75th percentile		-0.081		-0.158		0.194+		-0.184
		(0.111)		(0.121)		(0.108)		(0.140)
ISM Ratio >= 75th percentile		-0.318*		-0.022		-0.067		-0.335
		(0.160)		(0.174)		(0.162)		(0.211)
No hospitalists (yes=1)	0.217	0.199	0.003	0.020	0.076	0.050	-0.060	-0.085
	(0.132)	(0.133)	(0.143)	(0.144)	(0.131)	(0.132)	(0.171)	(0.173)
For-profit (yes=1)	-0.712***	-0.712***	-0.441*	-0.430*	0.101	0.081	-0.206	-0.208
	(0.183)	(0.183)	(0.217)	(0.218)	(0.176)	(0.176)	(0.232)	(0.233)
Teaching hospital (yes=1)	-0.371**	-0.351**	0.075	0.080	-0.201	-0.187	0.015	0.020
	(0.134)	(0.135)	(0.146)	(0.147)	(0.134)	(0.134)	(0.168)	(0.168)
Critical access (yes=1)	-0.696***	-0.693***	-0.042	-0.039	-0.099	-0.101	0.138	0.170
	(0.199)	(0.200)	(0.212)	(0.213)	(0.192)	(0.192)	(0.253)	(0.253)
Rural (yes=1)	-0.080	-0.067	-0.020	-0.004	0.453**	0.461**	0.288	0.261
	(0.147)	(0.148)	(0.157)	(0.157)	(0.143)	(0.144)	(0.189)	(0.187)
Size: 26-50 beds	-0.405+	-0.444+	-0.058	-0.032	0.129	0.066	0.113	0.117
	(0.239)	(0.242)	(0.267)	(0.271)	(0.236)	(0.238)	(0.308)	(0.310)
Size: 51-100 beds	-0.427+	-0.486+	0.072	0.088	0.489*	0.422+	0.066	0.065
	(0.252)	(0.255)	(0.275)	(0.279)	(0.248)	(0.250)	(0.316)	(0.318)
Size: 101-250 beds	-0.745*	-0.805*	-0.245	-0.198	0.319	0.248	0.451	0.437
	(0.318)	(0.321)	(0.362)	(0.367)	(0.312)	(0.315)	(0.408)	(0.409)
Size: 251-500 beds	-0.962*	-1.051**	-0.140	-0.122	0.407	0.313	0.594	0.588
	(0.397)	(0.401)	(0.439)	(0.444)	(0.387)	(0.390)	(0.498)	(0.499)
Size: Over 500 beds	-1.365**	-1.457**	-0.327	-0.289	0.306	0.204	0.438	0.431
	(0.465)	(0.468)	(0.515)	(0.520)	(0.455)	(0.460)	(0.598)	(0.598)
ln(Market Share HRR)	0.315**	0.327**	0.119	0.121	-0.347**	-0.336**	-0.045	-0.050
	(0.122)	(0.122)	(0.136)	(0.137)	(0.119)	(0.120)	(0.161)	(0.161)
ln(Market Competition HRR)	-0.276+	-0.289+	-0.085	-0.090	0.437**	0.416**	0.108	0.108
	(0.151)	(0.151)	(0.171)	(0.171)	(0.150)	(0.150)	(0.202)	(0.202)
ln(Market Share HSA)	0.188*	0.189*	0.082	0.071	0.097	0.102	0.033	0.035
	(0.092)	(0.093)	(0.109)	(0.108)	(0.092)	(0.092)	(0.121)	(0.121)
ln(Market Competion (HSA)	-0.075	-0.090	0.040	0.062	-0.233	-0.247	-0.095	-0.097
	(0.164)	(0.165)	(0.192)	(0.192)	(0.165)	(0.166)	(0.213)	(0.214)
% Inpatient Days Medicare	0.496+	0.502+	0.184	0.185	-0.451	-0.430	0.501	0.544
	(0.286)	(0.287)	(0.327)	(0.328)	(0.281)	(0.282)	(0.373)	(0.372)
System membership	-0.165	-0.150	-0.024	-0.014	-0.255*	-0.242*	-0.479**	-0.479**
	(0.119)	(0.120)	(0.131)	(0.132)	(0.115)	(0.116)	(0.148)	(0.149)
System makes adoption decision	0.079	0.066	0.106	0.101	0.238*	0.225*	0.552***	0.559***
	(0.110)	(0.110)	(0.121)	(0.121)	(0.107)	(0.108)	(0.143)	(0.144)
Quasi-integration: MSO	0.535*	0.536*	0.515*	0.520*	-0.122	-0.127	0.075	0.071
	(0.243)	(0.244)	(0.228)	(0.228)	(0.220)	(0.221)	(0.282)	(0.282)
Quasi-integration: Foundation	-0.037	-0.070	-0.440	-0.410	0.626*	0.583*	-0.208	-0.197
	(0.274)	(0.276)	(0.324)	(0.325)	(0.273)	(0.275)	(0.359)	(0.359)
Quasi-integration: CPHO	-0.224	-0.223	-0.360	-0.358	0.288	0.292	-0.065	-0.064
	(0.236)	(0.236)	(0.278)	(0.278)	(0.242)	(0.244)	(0.305)	(0.305)
Quasi-integration: OPHO	0.210	0.190	-0.099	-0.099	0.172	0.181	-0.091	-0.077
	(0.153)	(0.154)	(0.163)	(0.164)	(0.147)	(0.148)	(0.190)	(0.190)
Quasi-integration: GPWW	0.158	0.152	-0.325	-0.318	-0.085	-0.089	-0.092	-0.096
	(0.310)	(0.310)	(0.334)	(0.334)	(0.282)	(0.284)	(0.360)	(0.359)
Quasi-integration: IPA	0.022	0.017	-0.190	-0.186	0.038	0.032	0.089	0.083
	(0.179)	(0.179)	(0.198)	(0.198)	(0.168)	(0.168)	(0.213)	(0.214)
N	1893	1883	1893	1883	1893	1883	1893	1883

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table V.7 Obstacles to Health IT Adoption Cited by Administrators, Part 2

	Uncertainty about Certification Process		Lackof or Limited Vendor Capacity		Lack of Adequate IT Personnel		Ongoing Costs of Maintenance & Upgrades	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Integrated salary model (yes=1)	0.120		0.240*		0.009		-0.009	
	(0.117)		(0.113)		(0.101)		(0.098)	
ISM Ratio <75th percentile		0.183		0.265*		0.045		0.130
		(0.127)		(0.122)		(0.111)		(0.107)
ISM Ratio >= 75th percentile		-0.078		0.188		-0.097		-0.430**
		(0.199)		(0.187)		(0.161)		(0.164)
No hospitalists (yes=1)	-0.270+	-0.285+	-0.204	-0.206	0.034	0.033	0.071	0.034
	(0.159)	(0.160)	(0.157)	(0.159)	(0.133)	(0.134)	(0.130)	(0.131)
For-profit (yes=1)	-0.046	-0.054	-0.193	-0.197	-0.672***	-0.667***	-0.323+	-0.330+
	(0.216)	(0.216)	(0.220)	(0.221)	(0.177)	(0.178)	(0.181)	(0.182)
Teaching hospital (yes=1)	0.097	0.118	0.064	0.068	0.042	0.059	-0.175	-0.136
	(0.151)	(0.152)	(0.144)	(0.144)	(0.135)	(0.136)	(0.134)	(0.135)
Critical access (yes=1)	0.385	0.405+	-0.119	-0.137	-0.221	-0.208	-0.015	0.024
	(0.239)	(0.239)	(0.240)	(0.241)	(0.193)	(0.194)	(0.190)	(0.191)
Rural (yes=1)	0.096	0.053	-0.045	-0.046	0.135	0.118	0.492***	0.482***
	(0.179)	(0.179)	(0.173)	(0.173)	(0.145)	(0.145)	(0.143)	(0.143)
Size: 26-50 beds	0.550+	0.544+	0.451	0.425	-0.032	-0.031	0.282	0.231
	(0.304)	(0.308)	(0.314)	(0.318)	(0.238)	(0.241)	(0.233)	(0.234)
Size: 51-100 beds	0.662*	0.638*	0.574+	0.548+	0.189	0.186	0.416+	0.331
	(0.312)	(0.316)	(0.308)	(0.311)	(0.249)	(0.251)	(0.245)	(0.247)
Size: 101-250 beds	1.092**	1.053**	0.751+	0.719+	0.055	0.038	0.734*	0.635*
	(0.392)	(0.397)	(0.395)	(0.399)	(0.313)	(0.315)	(0.309)	(0.311)
Size: 251-500 beds	1.252**	1.194*	1.088*	1.042*	0.164	0.131	0.886*	0.768*
	(0.480)	(0.487)	(0.478)	(0.482)	(0.389)	(0.392)	(0.383)	(0.386)
Size: Over 500 beds	0.816	0.761	0.683	0.639	0.312	0.288	0.960*	0.831+
	(0.558)	(0.566)	(0.555)	(0.559)	(0.462)	(0.465)	(0.450)	(0.454)
ln(Market Share HRR)	-0.124	-0.119	-0.149	-0.148	0.038	0.039	-0.309**	-0.302*
	(0.143)	(0.144)	(0.143)	(0.143)	(0.118)	(0.118)	(0.118)	(0.119)
ln(Market Competition HRR)	-0.045	-0.047	0.247	0.258	-0.192	-0.192	0.326*	0.310*
	(0.178)	(0.179)	(0.177)	(0.176)	(0.148)	(0.148)	(0.149)	(0.150)
ln(Market Share HSA)	-0.014	-0.016	0.292*	0.294*	0.055	0.054	0.101	0.107
	(0.114)	(0.115)	(0.122)	(0.122)	(0.093)	(0.093)	(0.090)	(0.090)
ln(Market Competion (HSA)	-0.017	-0.018	-0.365+	-0.371+	-0.064	-0.069	-0.284+	-0.316+
	(0.191)	(0.192)	(0.202)	(0.202)	(0.171)	(0.172)	(0.162)	(0.163)
% Inpatient Days Medicare	0.761*	0.782*	0.959**	0.923**	0.385	0.409	-0.165	-0.100
	(0.356)	(0.355)	(0.342)	(0.342)	(0.287)	(0.289)	(0.280)	(0.281)
System membership	-0.252+	-0.271+	-0.425**	-0.433**	-0.109	-0.126	-0.375**	-0.359**
	(0.140)	(0.141)	(0.132)	(0.133)	(0.119)	(0.120)	(0.115)	(0.115)
System makes adoption decision	-0.096	-0.071	0.036	0.049	0.270*	0.278*	0.128	0.125
	(0.132)	(0.133)	(0.123)	(0.124)	(0.110)	(0.111)	(0.107)	(0.108)
Quasi-integration: MSO	-0.121	-0.128	-0.212	-0.215	0.157	0.157	-0.288	-0.289
	(0.258)	(0.258)	(0.251)	(0.252)	(0.231)	(0.231)	(0.222)	(0.221)
Quasi-integration: Foundation	0.394	0.408	0.526+	0.558*	-0.569*	-0.612*	0.287	0.227
	(0.288)	(0.289)	(0.283)	(0.285)	(0.259)	(0.261)	(0.267)	(0.268)
Quasi-integration: CPHO	0.106	0.101	0.233	0.225	0.151	0.154	0.089	0.093
	(0.270)	(0.270)	(0.242)	(0.242)	(0.256)	(0.257)	(0.238)	(0.238)
Quasi-integration: OPHO	0.379*	0.379*	-0.141	-0.174	-0.219	-0.203	-0.119	-0.114
	(0.165)	(0.167)	(0.171)	(0.173)	(0.148)	(0.149)	(0.148)	(0.148)
Quasi-integration: GPWW	-0.218	-0.227	-0.112	-0.120	0.399	0.392	-0.017	-0.032
	(0.368)	(0.366)	(0.345)	(0.345)	(0.313)	(0.313)	(0.277)	(0.281)
Quasi-integration: IPA	-0.007	-0.011	0.253	0.250	0.124	0.125	0.165	0.154
	(0.202)	(0.202)	(0.187)	(0.188)	(0.173)	(0.173)	(0.169)	(0.171)
N	1893	1883	1893	1883	1893	1883	1893	1883

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001 Robust standard errors in parentheses

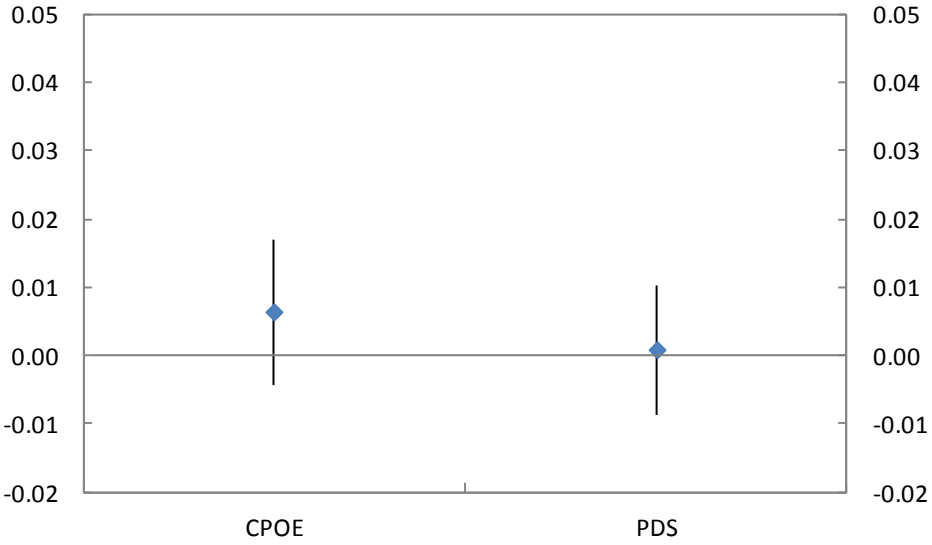
Lastly, in the fourth hypothesis in Chapter 2, I hypothesize that the relationship between integration and the timing of technology adoption will be weaker when the technology in question targets tasks for which the relevant human capital have a sufficiently large expertise advantage over firm management. I argued in the prior chapter that CPOE targets an administrative task and is therefore less likely to elicit resistance from integrated human capital than physician decision support (PDS) technology, which targets the tasks most associated with physicians' expertise, the process of diagnosing and selecting treatment for patients.

To test this, I ran the same analyses for PDS as I did for CPOE. In short, the relationship between integration and PDS adoption is weaker than the relationship between integration and CPOE, but it is not clear that it is significantly so. For example, Figures V.1 and V.2 show the estimated mean finite differences in the probability of adopting CPOE and PDS due to integration (from the discrete time estimates in Table V.1 and Table V.8), and while the effect is smaller for PDS than CPOE, their 90% confidence intervals largely overlap.Integration is insignificant in both the instrumental variable analysis (Table V.10) and the estimates for multi-hospital systems for PDS (Table V.12). Yet the matching analysis produces estimates for PDS adoption on par with those of CPOE (Table V.11).

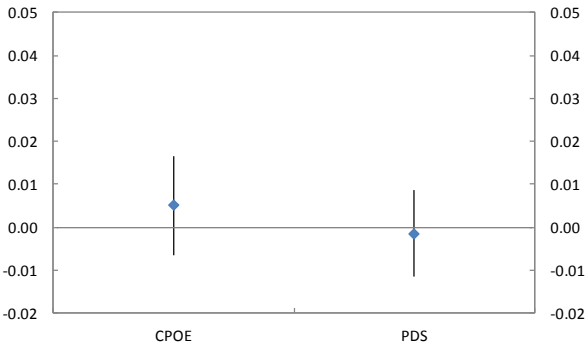
In sum, I find support for the hypothesis that hospitals that integrate physicians adopt a new technology sooner (H1) in the endogenous time to adoption estimates, the instrumental variable analysis, the matching analysis, and the multi-hospital system analysis. I find no support for the hypothesis that the relationship between integration and single-hospital markets will be weaker (H2); in fact, I produce evidence that it is stronger. I find support for the hypothesis that the relationship between integration and adoption will be stronger earlier in the technology life cycle (H3) in the matching analysis but not in the endogenous time to adoption estimates.

Finally, while the estimates are in the predicted direction, I do not find conclusive evidence of a weaker relationship between integration and adoption when the technology in question targets tasks for which human capital have greater expertise than firm management (H4).

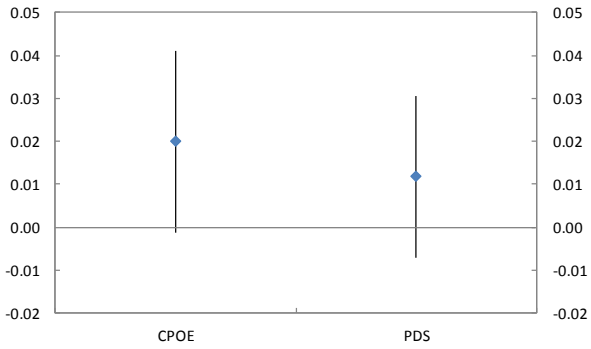
Figure V.1 Decision to Adopt a New Technology: Mean Finite Differences Due to Integration
Discrete Time Estimates, without Accounting for Hospitalists



Integrated Salary Model

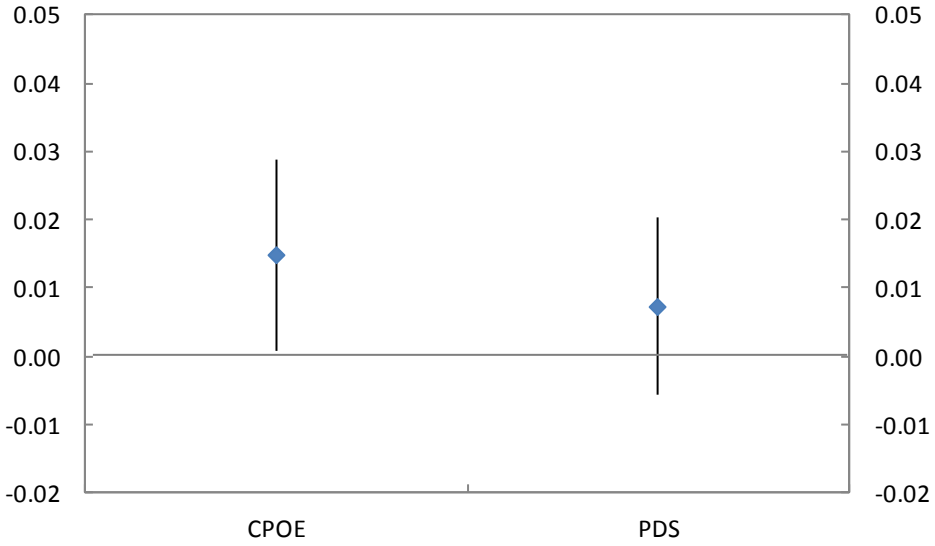


ISM Ratio < 75th percentile

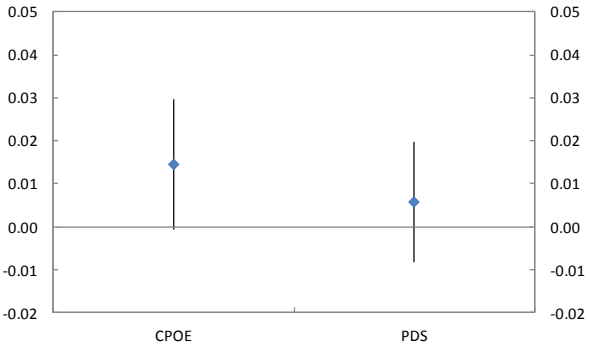


ISM Ratio >=75th Percentile

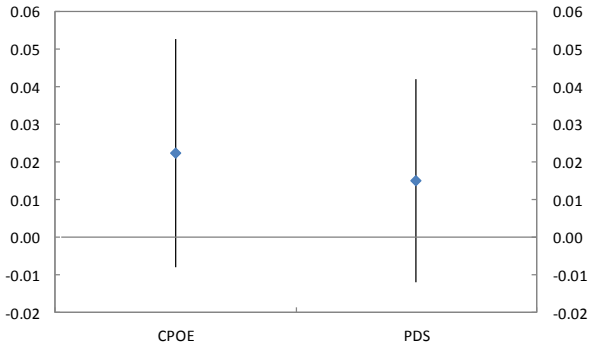
Figure V.2 Decision to Adopt a New Technology: Mean Finite Differences Due to Integration
Discrete Time Estimates for Hospitals that Do Not Use Hospitalists



Integrated Salary Model



ISM Ratio < 75th percentile



ISM Ratio >=75th Percentile

Table V.8 Decision to Adopt PDS: Discrete Time Estimates, Part 1

	(1)	(2)	(3)	(4)	(5)	(6)
Integrated salary model (yes=1)	0.010		-0.005	-0.106		
	(0.071)		(0.074)	(0.108)		
ISM Ratio <75th percentile		-0.018			-0.016	-0.111
		(0.077)			(0.079)	(0.116)
ISM Ratio >= 75th percentile		0.146			0.053	-0.074
		(0.142)			(0.145)	(0.212)
No hospitalists (yes=1)			-0.103	-0.168+	-0.102	-0.166+
			(0.083)	(0.096)	(0.083)	(0.096)
Integrated salary model x No Hospitalists				0.196		
				(0.143)		
ISM Ratio <75th percentile x No Hospitalists						0.182
						(0.155)
ISM Ratio >= 75th percentile x No Hospitalists						0.251
						(0.275)
For-profit (yes=1)	-0.590***	-0.584***	-0.522**	-0.520**	-0.509**	-0.506**
	(0.153)	(0.154)	(0.172)	(0.172)	(0.172)	(0.173)
Teaching hospital (yes=1)	0.079	0.073	0.076	0.080	0.077	0.081
	(0.098)	(0.098)	(0.101)	(0.100)	(0.101)	(0.101)
Critical access (yes=1)	-0.102	-0.105	-0.078	-0.082	-0.079	-0.084
	(0.114)	(0.114)	(0.123)	(0.123)	(0.123)	(0.123)
Rural (yes=1)	-0.323***	-0.313***	-0.279**	-0.282**	-0.272**	-0.275**
	(0.091)	(0.091)	(0.099)	(0.099)	(0.099)	(0.099)
Size: 26-50 beds	-0.108	-0.081	-0.069	-0.072	-0.065	-0.067
	(0.137)	(0.139)	(0.151)	(0.152)	(0.153)	(0.153)
Size: 51-100 beds	0.164	0.180	0.223	0.218	0.218	0.214
	(0.162)	(0.164)	(0.174)	(0.174)	(0.175)	(0.175)
Size: 101-250 beds	0.547**	0.575**	0.649**	0.642**	0.655**	0.647**
	(0.209)	(0.211)	(0.221)	(0.222)	(0.223)	(0.223)
Size: 251-500 beds	0.708**	0.734**	0.787**	0.784**	0.795**	0.790**
	(0.265)	(0.267)	(0.281)	(0.281)	(0.283)	(0.283)
Size: Over 500 beds	0.918**	0.958**	1.020**	1.018**	1.029**	1.025**
	(0.315)	(0.317)	(0.332)	(0.332)	(0.334)	(0.334)
ln(Market Share HRR)	0.008	0.009	-0.023	-0.019	-0.019	-0.014
	(0.083)	(0.083)	(0.088)	(0.088)	(0.088)	(0.088)
ln(Market Competition HRR)	0.016	0.011	0.041	0.037	0.035	0.030
	(0.101)	(0.101)	(0.107)	(0.107)	(0.107)	(0.107)
ln(Market Share HSA)	-0.098+	-0.101+	-0.104+	-0.107+	-0.107+	-0.109+
	(0.059)	(0.059)	(0.063)	(0.063)	(0.063)	(0.063)
ln(Market Competion (HSA)	0.083	0.099	0.129	0.135	0.142	0.147
	(0.116)	(0.116)	(0.123)	(0.123)	(0.124)	(0.124)
% Inpatient Days Medicare	-0.060	-0.049	-0.177	-0.173	-0.166	-0.167
	(0.183)	(0.184)	(0.190)	(0.190)	(0.191)	(0.191)
System membership	0.087	0.081	0.066	0.062	0.063	0.059
	(0.071)	(0.071)	(0.074)	(0.074)	(0.074)	(0.074)
Quasi-integration: MSO	0.237+	0.244+	0.279*	0.281*	0.285*	0.286*
	(0.126)	(0.126)	(0.130)	(0.130)	(0.130)	(0.130)
Quasi-integration: Foundation	-0.099	-0.087	-0.120	-0.118	-0.106	-0.104
	(0.200)	(0.204)	(0.208)	(0.209)	(0.210)	(0.210)
Quasi-integration: CPHO	0.052	0.058	0.082	0.090	0.087	0.094
	(0.154)	(0.155)	(0.156)	(0.156)	(0.156)	(0.156)
Quasi-integration: OPHO	0.050	0.075	0.029	0.032	0.045	0.047
	(0.098)	(0.098)	(0.101)	(0.100)	(0.100)	(0.100)
Quasi-integration: GPWW	0.071	0.074	0.047	0.052	0.052	0.056
	(0.178)	(0.178)	(0.181)	(0.181)	(0.182)	(0.182)
Quasi-integration: IPA	-0.112	-0.094	-0.136	-0.135	-0.131	-0.129
	(0.104)	(0.104)	(0.109)	(0.109)	(0.109)	(0.109)
N	12432	12354	10968	10968	10945	10945

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001 Standard errors clustered by hospital

Table V.9 Decision to Adopt PDS: Discrete Time Estimates, Part 2
Testing Continuity of Association and Life-Cycle Hypotheses

	(1)	(2)	(3)	(4)	(5)	(6)
Integrated salary model (yes=1)	-0.005	-0.075			0.039	
	(0.074)	(0.130)			(0.088)	
ISM Ratio <75th percentile			-0.015	-0.103		0.036
			(0.079)	(0.144)		(0.096)
ISM Ratio >= 75th percentile			0.054	0.004		0.072
			(0.145)	(0.227)		(0.156)
No hospitalists (yes=1)	-0.103	-0.104	-0.102	-0.103	-0.103	-0.100
	(0.083)	(0.083)	(0.083)	(0.083)	(0.083)	(0.083)
Single-hospital health service area	0.030	-0.013	0.028	-0.022		
	(0.132)	(0.144)	(0.133)	(0.145)		
Integrated salary model x Single-hospital HSA		0.105				
		(0.154)				
ISM Ratio <75th percentile x Single-hospital HSA				0.128		
				(0.168)		
ISM Ratio >= 75th percentile x Single-hospital HSA				0.077		
				(0.290)		
Integrated salary model x Year 2000					-0.239	
					(0.277)	
Integrated salary model x Year 2003					0.079	
					(0.288)	
Integrated salary model x Year 2004					0.166	
					(0.268)	
ISM Ratio <75th percentile x Year 2000						-0.196
						(0.290)
ISM Ratio >= 75th percentile x Year 2000						-1.037
						(1.059)
ISM Ratio <75th percentile x Year 2003						-0.033
						(0.312)
ISM Ratio >= 75th percentile x Year 2003						0.732
						(0.561)
ISM Ratio <75th percentile x Year 2004						0.099
						(0.286)
ISM Ratio >= 75th percentile x Year 2004						0.642
						(0.564)
For-profit (yes=1)	-0.522**	-0.532**	-0.508**	-0.519**	-0.519**	-0.504**
	(0.172)	(0.174)	(0.172)	(0.174)	(0.172)	(0.172)
Teaching hospital (yes=1)	0.077	0.078	0.079	0.079	0.080	0.081
	(0.101)	(0.101)	(0.101)	(0.101)	(0.101)	(0.101)
Critical access (yes=1)	-0.077	-0.083	-0.078	-0.084	-0.080	-0.078
	(0.123)	(0.123)	(0.123)	(0.123)	(0.123)	(0.123)
Rural (yes=1)	-0.280**	-0.278**	-0.273**	-0.271**	-0.279**	-0.273**
	(0.099)	(0.099)	(0.099)	(0.099)	(0.099)	(0.099)
Size: (Bed Indicators)	Y	Y	Y	Y	Y	Y
ln(Market Share HSA)	-0.110	-0.107	-0.113+	-0.107	-0.104	-0.104
	(0.068)	(0.069)	(0.069)	(0.069)	(0.063)	(0.063)
ln(Market Competion (HSA)	0.122	0.121	0.136	0.135	0.127	0.134
	(0.128)	(0.128)	(0.129)	(0.129)	(0.123)	(0.125)
% Inpatient Days Medicare	-0.174	-0.177	-0.164	-0.166	-0.179	-0.165
	(0.190)	(0.190)	(0.191)	(0.191)	(0.190)	(0.191)
System membership	0.067	0.066	0.063	0.063	0.066	0.063
	(0.074)	(0.074)	(0.074)	(0.074)	(0.074)	(0.075)
Quasi-integration model controls	Y	Y	Y	Y	Y	Y
N	10968	10968	10945	10945	10968	10945

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001 Standard errors clustered by hospital

Table V.10 Decision to Adopt PDS: Instrumental Variable

	Endogenous Adoption (1)	1st Stage ISM (2)	2nd Stage Adoption (3)	Endogenous Adoption (4)	1st Stage ISM (5)	2nd Stage Adoption (6)
Integrated salary model (yes=1)	0.002		0.059	0.001		0.056
	(0.006)		(0.046)	(0.006)		(0.048)
Instrument: CPOM law bans employing physicians		-0.140***			-0.144***	
		(0.019)			(0.021)	
No hospitalists (yes=1)				-0.013+	-0.019	-0.012
				(0.008)	(0.017)	(0.008)
For-profit (yes=1)	-0.046***	-0.100***	-0.036**	-0.042***	-0.094***	-0.032*
	(0.010)	(0.023)	(0.012)	(0.011)	(0.026)	(0.013)
Teaching hospital (yes=1)	0.007	0.094***	0.002	0.007	0.087***	0.002
	(0.009)	(0.023)	(0.011)	(0.010)	(0.024)	(0.011)
Critical access (yes=1)	-0.014+	0.094***	-0.020*	-0.011	0.087**	-0.017+
	(0.008)	(0.025)	(0.009)	(0.009)	(0.027)	(0.010)
Rural (yes=1)	-0.021***	0.012	-0.022***	-0.018*	0.014	-0.019*
	(0.006)	(0.022)	(0.007)	(0.007)	(0.024)	(0.007)
Size: 26-50 beds	-0.004	-0.048+	-0.001	-0.000	-0.043	0.002
	(0.009)	(0.028)	(0.010)	(0.010)	(0.031)	(0.011)
Size: 51-100 beds	0.013	-0.022	0.015	0.017	-0.024	0.020
	(0.012)	(0.036)	(0.012)	(0.013)	(0.039)	(0.014)
Size: 101-250 beds	0.044**	-0.066	0.050**	0.052**	-0.074	0.059**
	(0.016)	(0.047)	(0.017)	(0.017)	(0.050)	(0.019)
Size: 251-500 beds	0.061**	-0.079	0.069**	0.067**	-0.084	0.076**
	(0.021)	(0.060)	(0.023)	(0.023)	(0.064)	(0.025)
Size: Over 500 beds	0.090**	-0.044	0.096***	0.099***	-0.038	0.105***
	(0.027)	(0.075)	(0.029)	(0.030)	(0.080)	(0.031)
ln(Market Share HRR)	0.001	0.054**	-0.004	-0.001	0.049*	-0.006
	(0.007)	(0.020)	(0.008)	(0.007)	(0.021)	(0.008)
ln(Market Competition HRR)	0.001	-0.024	0.005	0.002	-0.013	0.006
	(0.008)	(0.025)	(0.009)	(0.008)	(0.026)	(0.009)
ln(Market Share HSA)	-0.007	0.023	-0.009+	-0.008	0.022	-0.009+
	(0.005)	(0.015)	(0.005)	(0.005)	(0.016)	(0.005)
ln(Market Competion (HSA)	0.008	-0.030	0.009	0.013	-0.030	0.014
	(0.010)	(0.027)	(0.011)	(0.011)	(0.029)	(0.011)
% Inpatient Days Medicare	-0.004	-0.010	-0.002	-0.012	-0.020	-0.010
	(0.013)	(0.038)	(0.013)	(0.014)	(0.041)	(0.015)
System membership	0.008	-0.023	0.008	0.006	-0.030+	0.007
	(0.006)	(0.017)	(0.006)	(0.006)	(0.018)	(0.006)
Quasi-integration model controls	Y	Y	Y	Y	Y	Y
N	12432	19445	12432	10968	17506	10968

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001 Standard errors clustered by hospital

Table V.11 Decision to Adopt PDS: Matching

	(1)	(2)	(3)	(4)	(5)	(6)
2000	.	0.005	0.010	0.003	0.009	0.021
2003	0.038	0.038	.	0.125	0.030	0.057
2004	0.040	0.041	.	0.176	0.033	0.080
2005	0.062	0.062	.	0.110	0.032	0.155
2006	0.050	0.049	.	0.074	0.039	0.083
2007	0.050	0.050	.	0.141	0.018	0.125
2008	0.000	-0.001	.	0.032	0.002	0.029
2009	-0.032	-0.031	.	0.079	-0.070	0.092
2010	0.035	0.033	.	0.092	0.039	-0.024
2011	0.017	0.016	.	-0.198	0.048	-0.125
2012	0.048	0.044	.	-0.016	0.091	-0.127
Total	0.032	0.030	0.010	0.055	0.021	0.053
N	2012	2250	127	580	1630	493
t-test p-value	0.000	0.000	0.644	0.001	0.003	0.001
Diffusion < 25%	0.047	0.039	0.010	0.100	0.027	0.082
N	705	865	127	157	627	209
Diffusion >=25%	0.024	0.024	.	0.038	0.017	0.032
N	1307	1385	0	423	1003	284
p-value for diffusion comparison	0.106	0.259		0.081	0.475	0.124

The table displays the estimated percentage point increase in the probability of adopting CPOE in a given year that integrating physicians as employees yields. The estimates are displayed for each year. The p-values are bootstrapped from a t-test for whether the estimates in the Total row are statistically different from zero. The diffusion estimates allows for a comparison as to whether the effects of employment are stronger earlier in the technology life cycle The following is a key to the columns:

(1) *No Hospitalists* is not available in the year 2000.

(2) Included *No Hospitalists* for 2000 by assuming that hospitals that did not have hospitalists in 2003 do not have hospitalists in 2000.

(3) Estimates for hospitals that do not use hospitalists.

(4) Estimates for hospitals that do use hospitalists.

(5) Estimates for hospitals in single-hospital markets.

(6) Estimates for hospitals in multi-hospital markets.

Table V.12 Decision to Adopt PDS: Multi-hospital Systems

	(1)	(2)	(3)
Integrated salary model (yes=1)	-0.304	-0.323	
	(0.434)	(0.458)	
ISM Ratio <75th percentile			-0.905
			(0.556)
ISM Ratio >= 75th percentile			0.715
			(0.781)
No hospitalists (yes=1)		0.193	0.215
		(0.795)	(0.804)
Number of hospitals in system	0.064***	0.065**	0.078***
	(0.019)	(0.020)	(0.018)
Years since initial contracting	-0.090	-0.091	-0.086
	(0.079)	(0.078)	(0.079)
For-profit (yes=1)	19.710***	19.814***	18.646***
	(0.631)	(0.650)	(1.047)
Teaching hospital (yes=1)	-0.028	-0.054	-0.016
	(0.402)	(0.439)	(0.444)
Critical access (yes=1)	-0.223	-0.237	-0.457
	(2.038)	(1.996)	(1.829)
Rural (yes=1)	-1.198	-1.277	-1.266
	(1.049)	(1.140)	(1.095)
Size: 26-50 beds	-1.033	-0.976	-0.935
	(1.663)	(1.718)	(1.679)
Size: 51-100 beds	-2.136	-2.094	-2.311
	(1.916)	(1.877)	(1.873)
Size: 101-250 beds	-2.857	-2.787	-2.860
	(2.134)	(2.096)	(2.069)
Size: 251-500 beds	-2.477	-2.386	-2.402
	(2.742)	(2.659)	(2.696)
Size: Over 500 beds	-3.239	-3.057	-3.024
	(2.556)	(2.443)	(2.422)
ln(Market Share HRR)	1.066	1.021	1.059
	(0.864)	(0.858)	(0.916)
ln(Market Competition HRR)	-1.353	-1.224	-1.198
	(1.099)	(1.044)	(1.124)
ln(Market Share HSA)	-0.421	-0.396	-0.510
	(0.480)	(0.483)	(0.466)
ln(Market Competion (HSA)	0.694	0.593	0.709
	(0.733)	(0.710)	(0.678)
% Inpatient Days Medicare	0.547	0.646	0.664
	(1.531)	(1.543)	(1.603)
Quasi-integration model controls	Y	Y	Y
N	208	205	204

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
Standard errors clustered by hospital

Implementation

In Chapter 3, I develop hypotheses about the effect of using an employment contract on implementation. Here I present results for two measures of implementation. The first is the time to installation from the year in which the technology was first contracted. The second is the percentage of physicians using the technology in the year in which full implementation is reported. The data comes from the HIMSS database.

Table V.13 presents results for the years to installation for CPOE. I find support for (H5) that firms that integrate human capital will implement a new technology sooner in columns (1) and (3), where there is a significantly positive coefficient on *Integrated Salary Model*. Although the effect is insignificant on the *ISM Ratio* > 75^{th} *Percentile*, this is likely due to the fact that there is a very small number of these firms in the sample. Interestingly, the interactions with *No Hospitalists* are insignificant, which is something I plan to examine more closely in the future. Figure V.3 further demonstrates the support for (H5).

I also hypothesize that the relationship between integration and adoption will be weaker in single-hospital markets because such markets promote continuity of association regardless of contract type (H6). The results illustrated in Figure V.3 do not support this hypothesis, as the mean finite differences due to integration are not significantly smaller in single-hospital markets.

Lastly, I hypothesize that the relationship between integration and implementation will be weaker if the technology in question targets tasks for which human capital have greater expertise than firm management (H7). I find weak support for this hypothesis, as demonstrated in Table V.14 and Figure V.4. The effect of integration is negative, but not significantly different from zero.

In Tables V.15 and V.16, I present the results of an ordered probit estimation of the percentage of physician usage at the time full implementation is achieved. Integration increases physician usage in hospitals that do not use hospitalists, providing support for (H5). Furthermore, this effect only holds for CPOE, supporting (H7). Hypothesis 6 is not supported in the usage estimates.

In sum, these results suggest support for (H5) and (H7), but not (H6). I discuss this further in the next chapter.

Table V.13 CPOE Implementation: Time to Installation
Discrete Time Estimates

	(1)	(2)	(3)	(4)
Integrated salary model (yes=1)	0.376***		0.391**	
	(0.097)		(0.123)	
ISM Ratio <75th percentile		0.404***		0.396**
		(0.109)		(0.136)
ISM Ratio >= 75th percentile		0.247		0.318
		(0.164)		(0.203)
No hospitalists (yes=1)	-0.215+	-0.213+	-0.200	-0.208
	(0.120)	(0.121)	(0.140)	(0.142)
Integrated salary model x No Hospitalists			-0.039	
			(0.198)	
ISM Ratio <75th percentile x No Hospitalists				0.025
				(0.220)
ISM Ratio >= 75th percentile x No Hospitalists				-0.156
				(0.318)
For-profit (yes=1)	0.010	0.042	0.010	0.038
	(0.294)	(0.292)	(0.294)	(0.293)
Teaching hospital (yes=1)	0.019	0.027	0.018	0.024
	(0.141)	(0.141)	(0.141)	(0.142)
Critical access (yes=1)	0.009	0.006	0.009	0.008
	(0.172)	(0.172)	(0.172)	(0.172)
Rural (yes=1)	0.032	0.036	0.034	0.039
	(0.131)	(0.131)	(0.131)	(0.131)
Size: 26-50 beds	0.563**	0.559**	0.564**	0.556**
	(0.204)	(0.204)	(0.204)	(0.205)
Size: 51-100 beds	0.167	0.140	0.168	0.139
	(0.255)	(0.258)	(0.255)	(0.258)
Size: 101-250 beds	0.257	0.233	0.259	0.238
	(0.314)	(0.318)	(0.313)	(0.317)
Size: 251-500 beds	0.415	0.390	0.416	0.401
	(0.388)	(0.393)	(0.388)	(0.394)
Size: Over 500 beds	0.328	0.301	0.328	0.318
	(0.479)	(0.484)	(0.479)	(0.486)
ln(Market Share HRR)	-0.230+	-0.230+	-0.231+	-0.233+
	(0.127)	(0.126)	(0.126)	(0.127)
ln(Market Competition HRR)	0.207	0.207	0.208	0.210
	(0.151)	(0.151)	(0.151)	(0.152)
ln(Market Share HSA)	0.139	0.130	0.139	0.132
	(0.087)	(0.087)	(0.088)	(0.088)
ln(Market Competion (HSA)	-0.402*	-0.393*	-0.404*	-0.397*
	(0.178)	(0.178)	(0.178)	(0.179)
% Inpatient Days Medicare	-0.183	-0.180	-0.187	-0.166
	(0.294)	(0.295)	(0.295)	(0.300)
System membership	-0.099	-0.100	-0.099	-0.101
	(0.114)	(0.114)	(0.114)	(0.114)
Quasi-integration controls	Y	Y	Y	Y
Product controls	Y	Y	Y	Y
N	2651	2647	2651	2647

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
Standard errors clustered by product.

Figure V.3 CPOE Implementation: Mean Finite Differences Due to Integration for Time to Installation

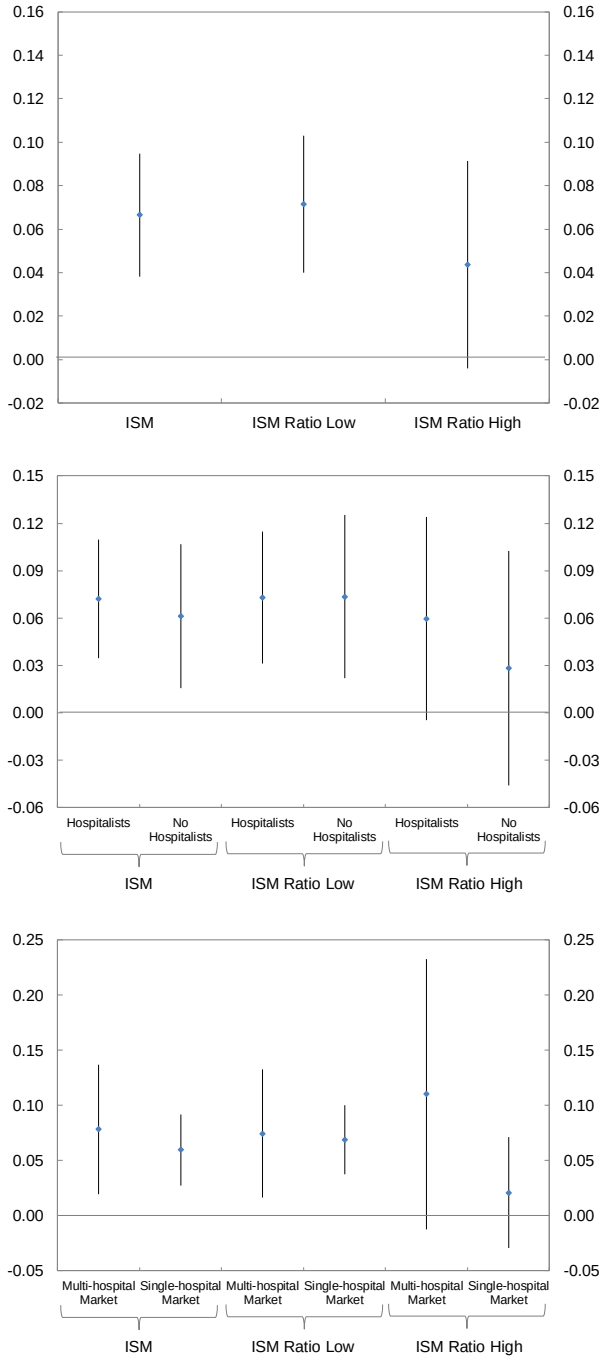


Table V.14 PDS Implementation: Time to Installation
Discrete Time Estimates

	(1)	(2)	(3)	(4)
Integrated salary model (yes=1)	-0.019		-0.186	
	(0.120)		(0.154)	
ISM Ratio <75th percentile		0.006		-0.164
		(0.135)		(0.173)
ISM Ratio >= 75th percentile		-0.107		-0.291
		(0.193)		(0.258)
No hospitalists (yes=1)	-0.083	-0.076	-0.227	-0.226
	(0.144)	(0.146)	(0.170)	(0.171)
Integrated salary model x No Hospitalists			0.403+	
			(0.240)	
ISM Ratio <75th percentile x No Hospitalists				0.424
				(0.280)
ISM Ratio >= 75th percentile x No Hospitalists				0.408
				(0.346)
For-profit (yes=1)	0.235	0.228	0.252	0.245
	(0.274)	(0.274)	(0.273)	(0.273)
Teaching hospital (yes=1)	-0.124	-0.126	-0.110	-0.111
	(0.160)	(0.161)	(0.159)	(0.160)
Critical access (yes=1)	0.120	0.121	0.139	0.140
	(0.212)	(0.213)	(0.211)	(0.213)
Rural (yes=1)	-0.187	-0.187	-0.218	-0.221
	(0.157)	(0.157)	(0.160)	(0.160)
Size: 26-50 beds	0.426+	0.421+	0.431+	0.424+
	(0.246)	(0.249)	(0.246)	(0.249)
Size: 51-100 beds	0.057	0.045	0.066	0.050
	(0.296)	(0.301)	(0.295)	(0.299)
Size: 101-250 beds	0.114	0.112	0.129	0.124
	(0.397)	(0.400)	(0.394)	(0.396)
Size: 251-500 beds	0.110	0.130	0.140	0.158
	(0.494)	(0.498)	(0.491)	(0.495)
Size: Over 500 beds	0.636	0.642	0.665	0.669
	(0.568)	(0.571)	(0.567)	(0.571)
ln(Market Share HRR)	0.074	0.068	0.066	0.059
	(0.150)	(0.150)	(0.150)	(0.150)
ln(Market Competition HRR)	-0.231	-0.229	-0.225	-0.222
	(0.182)	(0.182)	(0.181)	(0.181)
ln(Market Share HSA)	0.112	0.111	0.112	0.111
	(0.096)	(0.096)	(0.094)	(0.095)
ln(Market Competion (HSA)	-0.217	-0.225	-0.207	-0.216
	(0.194)	(0.194)	(0.193)	(0.193)
% Inpatient Days Medicare	0.682*	0.686*	0.715*	0.722*
	(0.343)	(0.344)	(0.342)	(0.347)
System membership	-0.109	-0.107	-0.119	-0.119
	(0.127)	(0.128)	(0.127)	(0.128)
Quasi-integration controls	Y	Y	Y	Y
Product controls	Y	Y	Y	Y
N	1937	1933	1937	1933

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
Standard errors clustered by product.

Figure V.4 PDS Implementation: Mean Finite Differences Due to Integration for Time to Installation

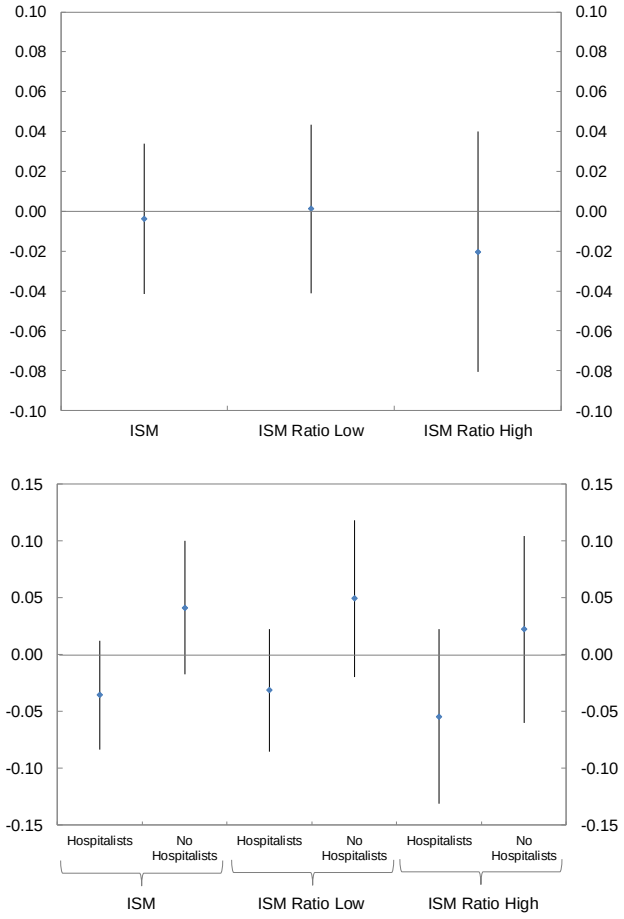


Table V.15 Technology Implementation: % Physician Usage at Full Implementation, Part 1
Pooled Ordered Probit

	(1)	(2)	(3)	(4)
CPOE (yes=1)	0.797***	0.801***	0.798***	0.802***
	(0.081)	(0.080)	(0.082)	(0.080)
Integrated salary model (yes=1)	0.036	-0.024		
	(0.067)	(0.068)		
ISM Ratio <75th percentile			0.022	-0.049
			(0.064)	(0.070)
ISM Ratio >= 75th percentile			0.065	0.038
			(0.106)	(0.101)
No hospitalists (yes=1)	-0.089	-0.183	-0.092	-0.186
	(0.141)	(0.144)	(0.143)	(0.145)
Integrated salary model x No Hospitalists		0.244*		
		(0.120)		
ISM Ratio <75th percentile x No Hospitalists				0.288*
				(0.117)
ISM Ratio >= 75th percentile x No Hospitalists				0.106
				(0.232)
For-profit (yes=1)	-0.029	-0.035	-0.028	-0.035
	(0.134)	(0.134)	(0.133)	(0.132)
Teaching hospital (yes=1)	0.051	0.057	0.051	0.055
	(0.081)	(0.082)	(0.083)	(0.083)
Critical access (yes=1)	0.073	0.068	0.072	0.068
	(0.158)	(0.156)	(0.157)	(0.155)
Rural (yes=1)	-0.052	-0.051	-0.050	-0.046
	(0.119)	(0.119)	(0.119)	(0.120)
Size: 26-50 beds	0.267	0.274+	0.268	0.269+
	(0.164)	(0.158)	(0.166)	(0.158)
Size: 51-100 beds	0.290	0.296	0.295	0.301
	(0.199)	(0.195)	(0.204)	(0.198)
Size: 101-250 beds	0.114	0.127	0.116	0.135
	(0.202)	(0.198)	(0.210)	(0.205)
Size: 251-500 beds	0.119	0.130	0.125	0.145
	(0.237)	(0.233)	(0.246)	(0.242)
Size: Over 500 beds	0.208	0.227	0.214	0.245
	(0.229)	(0.226)	(0.231)	(0.229)
ln(Market Share HRR)	-0.007	-0.008	-0.006	-0.012
	(0.078)	(0.079)	(0.077)	(0.077)
ln(Market Competition HRR)	0.033	0.039	0.034	0.045
	(0.100)	(0.102)	(0.100)	(0.100)
ln(Market Share HSA)	0.015	0.013	0.015	0.015
	(0.060)	(0.061)	(0.059)	(0.059)
ln(Market Competion (HSA)	-0.188+	-0.187+	-0.187+	-0.188+
	(0.099)	(0.101)	(0.099)	(0.099)
% Inpatient Days Medicare	0.139	0.133	0.135	0.141
	(0.252)	(0.249)	(0.250)	(0.250)
System membership	-0.042	-0.043	-0.039	-0.041
	(0.081)	(0.081)	(0.081)	(0.082)
Quasi-integration controls	Y	Y	Y	Y
Product controls	Y	Y	Y	Y
N	1523	1523	1520	1520

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
Standard errors clustered by product

Table V.16 Technology Implementation: % Physician Usage at Full Implementation, Part 2
Pooled Ordered Probit

	(1)	(2)	(3)	(4)
CPOE (yes=1)	0.798***	0.798***	0.767***	0.766***
	(0.081)	(0.081)	(0.077)	(0.078)
Integrated salary model (yes=1)	-0.007		-0.011	
	(0.099)		(0.098)	
ISM Ratio <75th percentile		-0.069		0.062
		(0.104)		(0.102)
ISM Ratio >= 75th percentile		0.115		-0.189
		(0.149)		(0.162)
No hospitalists (yes=1)	-0.092	-0.097	-0.088	-0.093
	(0.139)	(0.142)	(0.141)	(0.143)
Single-hospital health service area	0.023	0.014		
	(0.119)	(0.121)		
Integrated salary model x Single-hospital HSA	0.077			
	(0.135)			
ISM Ratio <75th percentile x Single-hospital HSA		0.160		
		(0.158)		
ISM Ratio >= 75th percentile x Single-hospital HSA		-0.104		
		(0.189)		
Integrated salary model x CPOE			0.069	
			(0.102)	
ISM Ratio <75th percentile x CPOE				-0.058
				(0.120)
ISM Ratio >= 75th percentile x CPOE				0.390*
				(0.168)
For-profit (yes=1)	-0.028	-0.025	-0.028	-0.028
	(0.139)	(0.138)	(0.133)	(0.133)
Teaching hospital (yes=1)	0.053	0.046	0.051	0.048
	(0.083)	(0.086)	(0.081)	(0.084)
Critical access (yes=1)	0.069	0.067	0.072	0.082
	(0.156)	(0.154)	(0.158)	(0.157)
Rural (yes=1)	-0.053	-0.057	-0.050	-0.047
	(0.119)	(0.114)	(0.117)	(0.116)
Size: 26-50 beds	0.261+	0.254	0.267	0.290+
	(0.158)	(0.160)	(0.164)	(0.168)
Size: 51-100 beds	0.280	0.267	0.289	0.309
	(0.195)	(0.204)	(0.200)	(0.207)
Size: 101-250 beds	0.104	0.084	0.113	0.137
	(0.196)	(0.207)	(0.203)	(0.212)
Size: 251-500 beds	0.111	0.097	0.121	0.149
	(0.232)	(0.249)	(0.238)	(0.251)
Size: Over 500 beds	0.203	0.186	0.209	0.250
	(0.228)	(0.236)	(0.229)	(0.236)
ln(Market Share HRR)	0.002	0.004	-0.007	-0.011
	(0.077)	(0.078)	(0.078)	(0.078)
ln(Market Competition HRR)	0.029	0.030	0.033	0.037
	(0.099)	(0.100)	(0.101)	(0.100)
ln(Market Share HSA)	0.006	0.017	0.015	0.012
	(0.068)	(0.065)	(0.060)	(0.063)
ln(Market Competion (HSA)	-0.202*	-0.212*	-0.187+	-0.182+
	(0.103)	(0.097)	(0.099)	(0.102)
% Inpatient Days Medicare	0.147	0.145	0.137	0.117
	(0.252)	(0.247)	(0.251)	(0.247)
System membership	-0.035	-0.029	-0.042	-0.033
	(0.079)	(0.078)	(0.082)	(0.082)
Quasi-integration controls	Y	Y	Y	Y
Product controls	Y	Y	Y	Y
N	1523	1520	1523	1520

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001 Standard errors clustered by product

CHAPTER VI
Discussion and Conclusions

Discussion of Results

Consider the picture drawn by the results of examining both the firm's decision to adopt a new technology and the implementation of that technology. First, integrating primary care and specialist physicians as employees appears to matter more for both the decision and the implementation of a new technology if the hospital does not use hospitalist physicians. This reflects the role of hospitalists, which is to take over many of the tasks that primary care and specialist physicians perform at the hospital's facilities, including those targeted by the technologies I evaluated. Hospitals that do not use hospitalists rely on primary care and specialist physicians to regularly perform tasks related to medical orders and patient documentation, and I show that within these hospitals, integrating primary care and specialist physicians as employees raises the likelihood of adopting a new technology sooner rather than later and results in both a faster installation process and a higher percentage of physicians actually using the technology once implemented.

I now take stock of the three features commonly associated with the employment relationship that I used to motivate the hypotheses in Chapter 2 and Chapter 3: (1) legally-conferred directive control, (2) continuity of association, and (3) compensation flexibility. As I have noted, hospital administrators are unlikely to utilize compensation flexibility as a primary tool for motivating physicians to implement a new technology. Moreover, some of their most commonly used tools of flexible compensation are related to scheduling, such as access to the

operating room or on-call rounds, and these tools can be used for both integrated and non-integrated physicians.

I attempt to proxy for continuity of association in hospital relationships with non-integrated physicians using an indicator for single-hospital healthcare markets. Admittedly, this is a bit blunt and introduces the possibility that single-hospital healthcare markets may be subject to other characteristics that make integration matter more, but continuity of association did not appear to be a driving force in either the decision to adopt a new technology or the implementation of a new technology; it only performed as hypothesized in the estimates for the number of years to full implementation.

Formal integration, however, and the legally-conferred directive control that comes with it did drive the results. In the decision to adopt, this suggests that hospital administrators expect formal employment to be important in either giving them the control needed to demand cooperation and coordination or in properly incentivizing physicians—or both. In the implementation process, integration was associated with both faster installation and greater usage. Nonetheless, I find evidence that not even formal employment can elicit usage when human capital fundamentally questions the authority message of firm management to use the technology; integration only yielded higher usage for the more administrative CPOE as opposed to PDS, which targets tasks directly in the domain of physicians' expertise.

Going Forward

There are important limitations in this study that I plan to address going forward. First, I plan to extend the dataset farther back; I have been evaluating adoption of these technologies starting when they have already diffused to at least 10% of the market. I particularly want to explore the interaction between integration and technology adoption in the earliest phases of the

technology life cycle. Second, these initial results suggest that integration benefits the speed of implementation, but the next question is whether and how integration affects the quality of implementation. I plan to explore the potential for a tradeoff in more detail. One possibility is looking at any differences in how these technologies affect the rate of malpractice suits (for CPOE quality) or adherence to evidence-based process measures from the Centers for Medicaid and Medicare Services (for PDS quality) (Everson, Lee, & Adler-Milstein, 2016). Third, I am working on building a dataset of physician-level data that would allow me to more precisely capture continuity of association as well as physician movements in response to technology adoption. With this data, I intend to evaluate how additional types of technologies affect the competition for physicians among hospitals. For example, in this dissertation, I have focused only on health information technologies that are introduced in a top-down fashion and, for many physicians, the value of adopting these technologies was not clear. But the relationship between technology adoption and integration may differ for medical technologies that are identified and promoted in a more grassroots fashion by physicians themselves.

Conclusion

My goal in this dissertation is to bring greater clarity to questions of how and when using an employment contract to integrate human capital should affect the technology adoption process. Regarding the firm's decision to adopt a new technology, there is a tension in the literature between the "costs of organization," which should delay adoption, and the superior "adaptability of organization," which should hasten adoption (Kapoor & Lee, 2013). Moreover, the well-documented difficulty firms have in implementing a technology-stimulated change in routines and practices (e.g., Attewell, 1992; Barley, 1986; Edmondson et al., 2001; Leonard-Barton, 1988; Leonard-Barton & Deschamps, 1988; Orlikowski, 1993, 2000; Tyre & Orlikowski,

1994)—a difficulty that has been particularly acute for hospitals implementing new technologies that require physician cooperation (AHA IT Supplement, 2011)—calls into question the adaptive and coordinative advantages associated with integration that are at the root of assumptions about the superior "adaptability of organization." These cases suggest that integrated human capital can be just as unwilling to participate in the implementation process as non-integrated human capital. At the same time, trends in employment indicate that the line between an employment relationship and an arm's length relationship with human capital is blurring on dimensions such as tenure and location of work (e.g., Bidwell, 2004, 2009, 2013; Cappelli & Keller, 2013; Farber, 2008; Hollister, 2011; Kalleberg et al., 2000), further underscoring the question: what does an employment contract really get firm management in the context of technology adoption?

I approach these questions by considering three features that typically distinguish the employment relationship from other types of contractual relationships with human capital: (1) legally-conferred directive control, (2) continuity of association, and (3) compensation flexibility. I examine how and when each may or may not facilitate the technology adoption process and use them to build the beginnings of a framework for resolving the tension between the superior "adaptability of organization" and the "costs of organization" with respect to a firm's decision to adopt a new technology. Theoretically and empirically, I identify conditions under which firms that use an employment contract to integrate human capital adopt a new technology sooner than firms that do not integrate human capital due to superior adaptability. In doing so, I also provide conditions under which the "costs of organization" should surface, arguing that integrated human capital should only engage in influence activity when the new technology targets tasks for which the relevant human capital have a sufficiently large expertise advantage over firm management. Additionally, I argue that the delaying effect associated with

the anti-innovation bias of hierarchy should only materialize when integration moves the locus of decision-making for adoption from outside to inside the firm. Thus, the extent to which the "costs of organization" arise depends on the nature of the technology itself.

I also use these three features to generate predictions for when and how integration should facilitate implementation. I find that firms that integrate human capital are both faster to install a new technology and see greater usage after installation unless the technology in question targets tasks for which human capital have sufficiently greater expertise than firm management, thus showing that the effect of integrating human capital on implementation also depends on the type of technology.

Through these analyses, I demonstrate the importance of examining when and how the micro-mechanisms underlying common predictions about the adaptive advantages of integration actually operate, whether in the context of technology adoption or some other form of organizational change. I show that considering how and when legally-conferred directive control, continuity of association, and compensation flexibility affect firm management's ability to secure the needed cooperation and coordination from human capital can be a useful framework for evaluating when and how integration will facilitate adaptation, emphasizing that it is important to avoid both the assumption that integration will necessarily hamper a firm's ability to recognize and respond to changes in the environment and the assumption that integration will necessarily facilitate the process of adaptation.

I emphasize that this is especially true in the case of higher-skilled human capital such as knowledge workers and professionals whose value lies in their intangible, inalienable knowledge and skills. The traditional modes of control and coordination that are commonly argued to make integration advantageous relative to the market in responding to change are predicated on

integration unifying the control rights over resources, including human capital. While firm managers never had complete control over workers, owning valuable physical assets prevented workers from being able to "hold up" the firm (e.g., Williamson, 1985), and the firm was able to use the ability to exclude workers from using physical assets as a means of control within the firm (Grossman & Hart, 1986; Hart, 2017; Hart & Moore, 1990). Yet while high-skilled knowledge workers and professionals can still gain an advantageous position with the firm and engage in self-interested bargaining, physical assets lose their utility as a tool of manipulation (Gibbons, 2005). Instead, the only control firm management has over such an employee is the control conferred by an employment contract, and, crucially, this control is bounded. Understanding what the bounds of control are for a given employment relationship, how those bounds are set, and how and when continuity of association and compensation flexibility can be used to obtain cooperation and coordination from high-skilled human capital when control is not present is therefore critically important for identifying conditions under which integrating high-skilled human capital will earn firm management the superior cooperation and coordination they seek. Lacking this understanding leaves firm management susceptible to overestimating the advantage of employment in responding to technological change. Indeed, many hospital administrators who expected employing physicians to facilitate the adoption of new health information technologies have learned this lesson first-hand (Rasayon, 2015); as Dr. Kenneth Cohn observes, "Physicians are a bit like tenured professors; I've heard a number of deans say that just because you pay somebody doesn't mean they put you at the top of their list," (Becker's Hospital Review, 2011). My hope is that the approach and results put forth in this dissertation will serve as a useful foundation for continuing to explore these questions and providing firm

management better frameworks for evaluating the benefits and costs of choosing to use an employment contract to integrate human capital.

APPENDICES

APPENDIX A

Payment Models and Payers in Health Care

For efficiency, I will call both hospitals and physicians *providers* of healthcare, but I will make note of where there are differences between hospital and physician payment. While *patients* seek and receive care and treatment from providers in exchange for payment, typically the payment is subsidized by a third-party, which can be either a private insurance company or a government program such as Medicaid and Medicare. I treat such third parties as the relevant *payers*. In this section, I review the primary payment structures by which payers determine the value of payments and discuss the different insurance products payers offer to patients and their implications for providers.

Payment Structure

There are two categories of payer payment structures. Retrospective structures pay for services after they have been rendered, while prospective structures pay a pre-determined fee for all services to be rendered. The most common form of retrospective payment—and the most common form of all healthcare payments—is the *fee-for-service* model in which a provider receives payment for each service rendered. Services may include appointments, treatments, overnight stays, medical procedures, imaging, and laboratory tests. For example, payers may use the Current Procedural Terminology (CPT) to assign fees to each service. The CPT is a medical code that assigns to each clinical task a unique identifier, and the payers then use the Resource-

Based Relative Value Scale (RBRVS) assigns a dollar amount to each task in the CPT (Robinson, 2001).

Fee-for-service models pay for the quantity of services rendered, but an emerging set of retrospective payment models known as *pay-for-performance* (P4P) models aim to reward not the quantity of services provided but the quality. Payers are currently experimenting with different versions of pay-for performance, but a common theme is providing financial incentives to meet a predetermined set of quality and efficiency criteria (Lischko, 2008). For example, Medicare introduced a pay-for-performance initiative in 2005 called The Medicare Physician Group Practice. In addition to traditional fee-for-service payments, physicians receive bonuses for meeting certain quality measures.

While retrospective payment structures award payment based on the quantity or quality of services rendered after-the-fact, prospective payment structures essentially pre-pay for provider services and involve some form of capitation. In the traditional *full-capitation* model, payers pay a regular, periodic fee to cover some or all services rendered by all providers for all conditions affecting a patient. For example, in a primary care setting, a physician receives a fixed payment for each patient, typically on a per-month basis. The fixed payment may vary across patients based on factors such as age and sex, but the payment does not vary with the quantity or quality of services provided for a given patient.

The *episode-of-care* (EOC) model is a version of capitation that is more likely to be found in hospitals. In this case, the provider receives a fixed, pre-determined payment covering all services rendered during a single episode of care. For instance, if a patient is admitted to a hospital for a heart attack, a single, pre-determined payment is awarded to the hospital for all services rendered while the patient is in the hospital. The EOC model may also be used with

specialty physicians; a surgeon would receive a single payment for all services associated with an episode of care as opposed to receiving separate fees for the surgery and follow-up care (Miller, 2007). In some cases, two or more providers may be paid jointly in a single EOC payment. For example, instead of a hospital receiving an EOC payment covering the services rendered at the hospital and a home health provider receiving an EOC payment covering the services received after the patient is discharged from the hospital, the payer may award one bundled EOC payment to be split by the hospital and home health provider that treats the hospital stay and the home health care as two steps in a single episode of care (Miller, 2007).

Another form of capitation that is very similar to the EOC payment model is the *condition-specific capitation* model. The provider receives a regular, periodic payment to cover the services rendered in treating a patient's specific condition over time, like a chronic disease. Finally, in some cases, the payer may employ providers in a *salary* model, where providers earn a regular salary that is set independent of how many or what type of patients a provider treats.

Each model alters the incentives for how providers approach care. Retrospective models incentivize physician productivity and reward physicians for treating sicker patients. However, the fee-for service model can also incentivize over-treatment of patients, such as ordering superfluous lab work or imaging services (Miller, 2007; Robinson, 2001). Prospective models, on the other hand, incentivize providers to be more cost-conscious and to innovate ways to improve the cost-efficiency of care. Yet providers may respond to such incentives by under-treating patients or avoiding the sickest patients altogether (Robinson, 2001). With the fee-for-service model at one end of the spectrum and the full-capitation and salary models at the other end, in between are models that experiment with the tradeoffs between incentivizing productivity and treatment of sick individuals with incentivizing cost efficiency. The goal of EOC and

condition-specific capitation models is to award larger payments for more expensive medical procedures while maintaining the cost efficiency incentives of capitation. P4P models aim to balance the incentives for productivity and treating sick patients associated with the fee-for-service model with financial incentives for meeting quality and efficiency objectives.

Payer Products

There are five main types of insurance products offered by payers. The first is traditional *indemnity* health insurance, and it is used only in conjunction with the fee-for-service payment model. Providers treat patients and charge a fee for each service rendered, and then the patient submits a claim to the payer and receives a reimbursement. Indemnity health insurance was the primary form of health insurance product following World War II and remained popular until the 1980s when other insurance products emerged; in 2003, indemnity insurance products represented only 5% of health plan enrollment among covered workers, and by 2016, indemnity insurance represented only 1% (Claxton et al., 2016).

Managed care health plans replaced indemnity insurance products beginning in the 1970s and 1980s and today remains the dominant type of insurance product. While indemnity insurance plans allow patients to see the provider of the patient's choosing, managed care plans put limitations on the providers for whose services the payer will pay. In managed care plans, the payer creates networks of providers with whom they negotiate lower payments in exchange for providers receiving preferential access to the payers' set of patients. Within the category of managed care, there are five types.

A health maintenance organization (HMO) limits coverage to care from doctors who work for, or contract with, the HMO.[19] An HMO plan requires patients to choose an in-network

[19] Definitions of managed care plans are from https://www.healthcare.gov/choose-a-plan/plan-types/ . Accessed May 31, 2017.

primary care provider (PCP) who coordinates care; for example, a patient requires a referral from the designated PCP in order to see a specialist. Furthermore, an HMO plan will not pay for provider services outside of the network. A preferred provider network (PPO) does not require patients to designate a PCP and allows patients to see providers outside of the PPO network for an additional cost.

Point-of-service (POS) plans and exclusive provider organization (EPO) plans combine different elements of HMO plans and PPO plans. A POS plan requires patients to choose an in-network PCP to coordinate care like HMO plans, but patients can see out-of-network providers for an additional cost like PPO plans. An EPO plan does not require patients to designate a PCP but also does not pay for out-of-network service.

The fifth managed care product is the high-deductible health plan (HDHP), which is typically paired with a health savings account (HSA). The HDHP plan can be structured like an HMO or like a PPO, but the key distinguishing feature is the higher deductible compared to typical managed care plans. A HSA allows patients to save their pre-tax income for qualified medical expenses. Thus, the patient pays for expenses out-of-pocket using the HSA savings until the higher deductible is met.

Managed care plans make up the overwhelming majority of health plans in the U.S. PPO plans are the most popular; in 2003, 54% of covered workers held PPO plans, and in 2016 48% held PPO plans. HMO plans have been losing popularity since the 1990s, dropping from 24% of covered workers in 2003 to 15% in 2016. On the other hand, HDHP/HSA plans have grown from 17% of covered workers in 2003 to 29% in 2016.[20]

[20] All stats from https://www.jec.senate.gov/public/_cache/files/50b582c2-bfeb-49e1-9ace-9079b9725d27/hsas-032217.pdf

Most managed care plans operate with a fee-for-service payment structure for providers. In the 1990s as managed care plans were emerging, full-capitation payment structures became more popular. HMOs in particular mostly operated with a capitation payment structure. However, backlash against full-capitation developed and today fee-for-service is the most common payment structure with EOC or condition-specific capitation used in specific cases. P4P models are emerging and in limited use. Salary models are rare.

The key implication of managed care for providers was the need to be able to negotiate with payers over payments, whether in a fee-for-service payment structure or in a capitation paymentstructure. As managed care grew in the 1990s, providers began developing different arrangements both among physicians and among hospitals as well as across physicians and hospitals.

APPENDIX B

Alternative Hospital-Physician Relationships

First, an *Independent Practice Association* (IPA) is a loose contractual network of physicians with a hospital whose purpose is to obtain managed care contracts (Cuellar & Gertler, 2006). The physicians in IPAs typically have solo practices, and they have no affiliation with each other or with hospitals other than to jointly bargain with managed care organizations (L. C. Baker et al., 2016; Cuellar & Gertler, 2006).

Second, an *Open Physician-Hospital Organization* (OPHO) is a joint venture between a hospital and physicians which facilitates managed care contracting, provides administrative services to physicians, and manages any ambulatory care facilities where the physicians work (Cuellar & Gertler, 2006). In an OPHO, physicians continue to have autonomy over their own practices, and physicians may have admitting privileges at multiple hospitals (L. C. Baker et al., 2016; Cuellar & Gertler, 2006). Burns et al. (2000) identified only a moderate degree of joint planning and clinical integration between physician practices and hospitals in OPHOs.

Third, *Closed Physician-Hospital Organizations* (CPHOs) are OPHOs in which the hospital forms exclusive relationships with physicians (Cuellar & Gertler, 2006). CPHOs selectively contract with physicians based on criteria for cost effectiveness and/or quality (L. C. Baker et al., 2016; Cuellar & Gertler, 2006).

Fourth, a *Management Services Organization* (MSO) is similar to a CPHO except the MSO purchases the physical assets of the participating physicians (L. C. Baker et al., 2016;

Cuellar & Gertler, 2006). The physical assets are leased back to physician practices as part of a full-service management agreement in which the MSO employs all non-physician staff and provides all supplies and administrative systems for a fee (L. C. Baker et al., 2016).

Finally, in an *Integrated Salary Model* (ISM), the hospital hires physicians as salaried employees, purchasing the entire practice (L. C. Baker et al., 2016).

Table B.1 modifies a similar table from Cuellar and Gertler (2006), summarizing these five physician-hospital relationships in terms of five key characteristics: (1) whether the hospital and physicians jointly contract with managed care plans, (2) whether the hospital provides administrative services, (3) whether physicians have exclusive relationships with the hospital, (4) whether the hospital owns the physical assets of a physician practice, and (5) whether physicians are salaried.

Table B.1 Characteristics of Hospital-Physician Relationships

	Market	Independent Practice Association	Open Physician Hospital Organization	Closed Physician Hospital Organization	Management Services Organization	Fully Integrated Organization
Contracting w/ managed care plans		x	x	x	x	x
Administrative services			x	x	x	x
Physicians exclusive to hospital				x	x	x
Physical asset ownership					x	x
Physicians salaried						x

Note: Categories based on Cuellar and Gertler's (2006, p. 7) Table 1.

APPENDIX C

State Corporate Practice of Medicine Laws

Here I reprint Eric Lammers's (2013) detailed survey of state corporate practice of medicine laws in the United States.[21]

Alabama

Rule: Hospital employment of physicians is explicitly tolerated in Alabama. Although there have been no recent statements of binding law on the issue, the Alabama Attorney General,[22] the Alabama Medical Licensure Commission, and the Alabama Board of Medical Examiners[23] all agree that for-profit and non-profit corporations may employ physicians, as long as the corporation does not control the physicians' medical judgment.

Alaska

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

Arizona

Rule: Hospital employment of physicians is tolerated in Arizona. In 2008 a state appeals court strongly indicated (although it did not hold as a matter of binding law) that hospitals may employ physicians.[24] Evidence suggests this has been the informally-accepted practice for many years, despite two old cases that held CPOM to be the law in Arizona. [25]

Summary of the 2008 case:

[21] Lammers, Eric. 2013. The effect of hospital-physician integration on health information technology adoption. *Health Economics*, 22(10): 1215-1229.
[22] Opinion of the Attorney General of Alabama, No. 2001-089 (Feb. 1, 2001) ["We note that many hospitals in Alabama are owned and operated by for-profit business corporations"].
[23] See joint declaratory ruling by the Alabama Board of Medical Examiners (Oct. 21, 1992) and the Alabama Medical Licensure Commission (Oct. 28, 1992), and declaratory ruling by the Medical Licensure Commission (Nov. 6, 1995).
[24] See Midtown Med. Group, Inc. v. State Farm Mut. Auto. Ins. Co., 220 Ariz. 341 (Ariz. Ct. App. 2008).
[25] See Funk Jewelry Co. v. State ex rel. La Prade, 46 Ariz. 348, 50 P.2d 945 (1935); State Ex. Rel. Board of Optometry v. Sears Roebuck & Co., 102 Ariz. 175, 427 P2d. 126 (1967).

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

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

- The court held that corporations and other entities may apply for licenses to become "health care institutions," a term which includes by definition outpatient treatment centers, **hospitals**, and other types of healthcare facilities.[26]

- The court also held that physician licensing statutes do not prevent corporations and other lay-controlled business from employing physicians.[27]

- The court discussed the prior CPOM cases at length. It did not overturn these cases (as it does not have the authority to do so, being an appeals court),[28] but it discussed numerous reasons why these cases were inapplicable and did not prevent physicians from being employed by health care institutions. Below are a few of these reasons:

    - In the prior cases, the licensing authorities had been of the opinion that corporations may not employ licensed practitioners. Today, however, the licensing authorities were on the side of the corporations – the party pushing to invalidate the employment arrangement was an insurance company that was trying to avoid reimbursement payments.[29]

    - The statutory framework governing health care institutions is completely different today than it was when the prior cases were decided. Now, for example, applicable statutes provide that corporations, in operating health care institutions, may provide medical services "by physician."[30]

Arkansas

Rule: hospitals may not employ physicians.

No recent cases or statutes address CPOM in Arkansas, but an AG opinion stated that the CPOM doctrine allows only three categories of entities to employ physicians.[31] Hospitals are not listed as one of these exceptions.

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

Note that there is an exception for "hospital service corporations," which are nonprofit organizations regulated as a type of insurance provider. These entities may hire physicians as independent contractors, but not as employees.[32] Hospital service corporations are defined as:

> … corporations organized under the laws of this state for the purpose of establishing, maintaining, and operating nonprofit hospital service or medical service plans, or combination of plans, whereby hospital, medical, and related services may be provided by hospitals, physicians, or others with which the corporations have contracted for the purposes, to such of the public as become subscribers to the corporations under contracts which entitle each subscriber to certain hospital or medical services or benefits, or both.[33]

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

California

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

General Rule

- In 1980 Cal Bus & Prof Code § 2400 became law, codifying the general rule, taken from a line of court cases, [34] that California hospitals may not employ physicians. This basic rule remains in the same statutory language today, and courts have continued to interpret it to prevent hospitals from employing physicians.

Exceptions (in rough temporal order):

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

- **Professional medical or podiatry corporations**: Section 2402 provides that professional medical corporations may employ physicians. Note that such corporations must meet certain requirements laid out in subsequent sections, including the rule that the shareholders must be physicians.

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

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

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

- **County Hospitals**: A state appellate court held that county hospitals are exempt from California's corporate practice of medicine laws.[35]

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

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

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

- **State university medical schools and hospitals**: A state appellate court indicated that state university medical schools and hospitals are exempt from the ban on hospital employment of physicians.[36]

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

> In 1979, the Board of Medical Quality Assurance (the agency then charged with the enforcement of section 2400 et seq.) advised the Legislature that, in the Board's view, the University of California could employ physicians because the University is "exempt from the corporate practice restrictions as [a] unit of government." This view

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

> is entitled to great weight [*citation* omitted], and the Legislature's subsequent addition of sections 2400 and 2401 without overturning the exemption are strong evidence of its agreement with the Board's interpretation [*citation omitted*].[37]

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

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

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

    - In 1996, a California appellate court[38] held that health care districts established pursuant to The Local Health Care District Law[39] may hire doctors only as *independent contractors*, but not as *employees*.

    - In response, in 2003 the California legislature amended Section 2401 by adding subsection (d), which provides for a temporary pilot program in which health care districts would be permitted to hire physicians as employees, subject to certain requirements.[40]

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

    - However, this exception may be renewed. As of the time of writing, a bill had been introduced before the California State Assembly that would renew and extend The Local Health Care District Law.[41] This bill would extend the basic purpose of the pilot program, with modifications, until December 31, 2022. For more information, and to track the progress of this bill, go to: <www.aroundthecapitol.com/Bills/AB_1360/20112012/>

[37] Id at 553 (Cal. Ct. App. 2000).
[38] Conrad v. Med. Bd. of California, 48 Cal. App. 4th 1038 (Cal. Ct. App. 1996).
[39] California Health and Safety Code § 32000 et al.
[40] Bus. & Prof. Code, Section 2401, subsection (d) (2003).
[41] California Assembly Bill No. 1360

NOT an Exception

- **Nonprofit corporations**: The California Attorney General issued an opinion that nonprofit corporations are not, as a general proposition, allowed to employ physicians.[42] (However, note that nonprofit corporations falling into one of the exceptions discussed above presumably would be permitted to employ physicians.)

Colorado

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

- Hospitals may not limit or control physicians' medical decisions.
- No fee-splitting between hospitals and physicians.
- Hospitals cannot discriminate, with regard to staff privileges, between physicians who are employees of the hospitals and those who are not.
- Hospitals must give a yearly report of the number of physicians employed.[43]

Note, however, that even though hospitals may employ physicians, victims of medical malpractice may not sue hospitals for the negligent acts of physicians.[44]

Connecticut

Rule: Non-profit hospital employment of physicians is tolerated, due to an opinion of the Attorney General of Connecticut which stated that although the practice of medicine and surgery is restricted to individuals and does not include corporations, non-profit charitable hospitals are exempted.[45] (It is not clear how the AG interpreted "charitable" at the time.) The attorney who wrote the Connecticut section of the AHLA 50 State Survey seems quite convinced that CPOM is almost non-existent in the state, and that even for-profit hospitals are also free to employ physicians.[46]

Delaware

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

[42] 83 Op. Cal. Atty. Gen. 170, fn. 2 (2000); see also California Physicians' Service v. Aoki Diabetes Research Institute, 163 Cal.App.4th 1506 (App. 1 Dist. 2008).
[43] Colorado Revised Statutes § 25-3-103.7 (2011).
[44] Estate of Harper ex rel. Al-Hamim v. Denver Health & Hosp. Auth., 140 P.3d 273 (Colo. Ct. App. 2006).
[45] Opinion of the Attorney General of Connecticut, No. 28-248 (1954).
[46] AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).

There is no case law, and there are no AG opinions, on CPOM in Delaware. The state does have a statute indicating the CPOM doctrine exists in some form,[47] but there is also another statute suggesting hospitals may employ physicians.[48]

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

Florida

Rule: Hospitals very likely may employ physicians.

Despite a 1955 opinion of the Attorney General of Florida stating that a corporation may not employ physicians to practice medicine,[49] today it appears that Florida hospitals may employ physicians. Similar to Delaware, no legal authority explicitly allows it, but a state statute indirectly approves it. However, the Florida statute provides a stronger endorsement of hospital employment of physicians than its counterpart in Delaware. A relevant section of this statute reads:

> Every hospital or teaching hospital employing or utilizing the services of a resident physician, assistant resident physician, house physician, intern, or fellow in fellowship training registered under this section shall designate a person who shall, on dates designated by the board, in consultation with the department, furnish the department with a list of such hospital's employees and such other information as the board may direct.[50]

And also:

> A person registered as a resident physician under this section may in the normal course of his or her employment prescribe medicinal drugs described in schedules set out in chapter 893 when:
>
> (a) The person prescribes such medicinal drugs through use of a Drug Enforcement Administration number issued to the hospital or teaching hospital by which the person is employed or at which the person's services are used;
>
> …

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

See also a case from 1967,[51] although its holding is very narrow and not illustrative of the state of the CPOM doctrine in Florida.

Finally, the attorney who researched the AHLA 50 State Survey indicates that hospitals in Florida employ physicians in practice.[52]

Georgia

Rule: Hospitals very likely may employ physicians.

Up until 1982, the CPOM doctrine was codified in a Georgia statute which banned general business corporations from employing physicians, but the statute contained an explicit exception allowing hospitals to employ physicians. In 1982, however, the entire statutory section was repealed. Since then some courts have suggested that the CPOM framework under the repealed statute may still be in force despite the repeal,[53] but no courts have ruled explicitly on whether hospitals may still employ physicians.

Hawaii

- **Rule**: Hospital employment of physicians is tolerated, due to a lack of law on the subject and an apparent pattern of acceptance.[54]

However, it appears that all of Hawaii's hospitals are currently non-profits.[55] In 2007, for the first time, a non-profit hospital system in Hawaii (St. Francis Healthcare Systems) became for-profit, but it has now reclaimed non-profit status. I can find no evidence to suggest that this hospital system was challenged under the CPOM doctrine while it operated as a for-profit entity.

Idaho

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

Although old Idaho case law lays out a CPOM doctrine,[56] less formal evidence suggests that CPOM generally is not enforced in Idaho.[57] Evidence suggests that Idaho hospitals routinely

[51] Rush v. City of St. Petersburg, 205 So.2d 11 (Fla. 1967).
[52] AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[53] See e.g. Sherrer v. Hale, 248 Ga. 793, 285 S.E.2d 714 (1982); Clower v. Orthalliance, Inc., 337 F. Supp. 2d 1322 (N.D. Ga. 2004).
[54] The AHLA 50 State Survey indicates that hospitals in Florida do employ physicians. See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[55] <http://www.statehealthfacts.org/profileind.jsp?cat=5&sub=68&rgn=13>
[56] Worlton v. Davis, 249 P.2d 810 (Idaho S.Ct. 1952); see also Idaho Op. Att'y Gen. (May 26, 1954).

employ physicians, and that the Idaho Board of Medicine only ever invokes CPOM with regard to non-hospital compensation arrangements.[58] In short, Idaho's CPOM doctrine appears to be unenforced.

Illinois

Summary

Rule: Hospitals may employ physicians, subject to certain requirements.[59]

Summary of Requirements:[60]

- If the hospital/affiliate has a medical staff, then the physician must be a member of the staff.
- The quality of the medical services of the employed physician must periodically be reviewed by "independent" physicians who are not employed.
- The hospital/affiliate and the physician must both sign a statement that the hospital/affiliate will not unreasonably control or interfere with the physician's exercise of medical judgment.
- The hospital/affiliate and physician establish and agree to an independent review process by which the physician can seek review of alleged violations of these requirements.
- The statute also extended the right to employ physicians to "hospital affiliates":[61]

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

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[57] "We have been advised by Idaho health law counsel that the corporate practice doctrine generally is not enforced in Idaho." Corporate Practice of Medicine: 50-State Survey, AHLA-PAPERS P06059630 (June 5, 1996).
[58] <http://www.hteh.com/Documents%20and%20Settings/8/Site%20Documents/PDFs/March%20Alert.pdf>
[59] Illinois Statutes Ch. 210, § 85/10.8 (effective Sept. 30, 2001; current through P.A. 96-1555 of the 2010 Reg. Sess.)
[60] Illinois Statutes Ch. 210 § 88/10.8, subsection (a).
[61] Illinois Statutes Ch. 210 § 88/10.8, subsection (b).

health maintenance organization regulated under the Health Maintenance Organization Act.

The Supreme Court of Illinois acknowledged and enforced this statute shortly after its passage.[62]

Indiana

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

Indiana is one of the rare states which has codified the hospital exemption from the CPOM doctrine. Two statutory sections serve to exempt hospitals from the doctrine,[63] and another explicitly provides that hospitals may employ physicians, provided that the entity does not direct or control independent medical acts, decisions, or judgment of licensed physicians.[64] These statutes became law in 1989. A court case in 1996 acknowledged them.[65]

Iowa

General Rule: Hospitals may employ physicians, provided that the hospital does not "control" the physician's relationship with the patient.[66]

A 1991 opinion by the Iowa Attorney General evaluates case law to determine that a hospital may not control the physician's relationship with the patient.[67] This determination is to be made on a case-by-cases basis by examining the degree to which the hospital had the right or ability to in effect become the "practitioner." This rule applies equally to both for-profit and non-profit corporations, although the AG opinion suggests that non-profit status may be considered as one factor indicating less control by the hospital (thus making it more likely that the relationship is acceptable). The type of contract at issue – whether an employment or independent contractor contract – is not determinative; more important is a detailed factual review of the hospital's level of control over the physician-patient relationship.

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

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

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

- **Radiologists and Pathologists**.[68] The AG decision determined that there was essentially no patient-physician relationship which the corporate employer could control, so it was not necessary to apply the CPOM doctrine to radiologists or pathologists.
- **Student Interns**.[69]

Kansas

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

In 1994 the Supreme Court of Kansas ruled clearly and conclusively that hospitals, both for-profit and non-profit, may employ physicians as employees or independent contractors.[70] The Supreme Court reaffirmed this decision in 1999.[71]

Kentucky

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

A case back in 1938 held that hospitals may employ physicians; unfortunately, it did so based upon the vague distinction that "hospital services" are different from "medical or surgical services."[72] The court did not explain what this means, and no recent authority exists on the matter.

According to several 50 State Surveys,[73] in 1993 the Kentucky Board of Medical Licensure issued a letter to a physician saying that hospitals may employ physicians (I have been unable to find a copy of this letter). The letter is said to rely on an AMA opinion that was a result of a federal case in which the AMA was ordered to stop issuing rules to enforce CPOM. This case was decided under antitrust law, on the reasoning that the AMA was interfering with physician employment contracts.

Louisiana

[68] Idem; see also Iowa Code § 135B.26 (2011).
[69] Christensen v. Des Moines Still Coll. of Osteopathy & Surgery, 248 Iowa 810, 814 (1957) [citing Frost v. Des Moines Still College of Osteopathy and Surgery (1957); Moeller v. Hauser, 237 Minn. 368, 376 (1952); St. Paul-Mercury Indemnity Co. v. St. Joseph's Hosp., 212 Minn. 558 (1942); 41 Am.Jur., Physicians and Surgeons, § 116, page 227; 26 Am.Jur., Hosp. and Asylums, § 14, page 595].
[70] St. Francis Reg'l Med. Ctr., Inc. v. Weiss, 254 Kan. 728, 869 P.2d 606 (1994).
[71] In re Univ. of Kansas Sch. of Med.-Wichita Med. Practice Ass'n from a Decision of Dist. Court of Shawnee County, Kansas, 266 Kan. 737, 762, 973 P.2d 176, 193 (1999).
[72] Johnson v. Stumbo, 277 Ky. 301, 126 S.W.2d 165 (1938).
[73] AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996); Dobbins, D. Cameron, "Survey of State Laws Relating to the Corporate Practice of Medicine," ABA Health Law Section, HeinOnline 9 Health Law. 21 (1996).

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

> … structured to shield the physician's relationship with patients and his exercise of independent medical judgment from corporate intrusion, where employment termination and ownership of and access to records provisions are shaped to provide for continuity of patient care and to ensure continuing patient freedom of choice, and where patient confidentiality and personal professional accountability are safeguarded.[74]

This rule is articulated in a statement of position by the Louisiana State Board of Medical Examiners, which has authority to issue regulations under the Medical Practices Act.[75]

Maine

Rule: hospital employment of physicians is tolerated, as indicated by a non-binding opinion letter issued on November 2, 1992 by the state Board of Licensure in Medicine.[76]

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

Maine repealed a statute which stated that optometrists could not associate themselves with people or entities in way that allowed an unregistered person or entity to practice medicine.[77]

Finally, the AHLA 50 State Survey indicates Maine's former Health Care Finance Commission would regularly sign off on health care entity structures that involved physician employees.[78]

Maryland

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

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[74] Statement of Position, Louisiana State Board of Medical Examiners (Sept. 24, 1992; reviewed March 21, 2001).
[75] See La. Rev. Stat. Ann. § 37:1271.
[76] See reference in AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[77] See 32 Maine Revised Statutes § 2452 (repealed); Small v. Maine Bd. of Registration & Examination in Optometry, 293 A.2d 786, 789 (Me. 1972) [this case took place before the creation of the Board of Licensure in Medicine].
[78] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996); see e.g. Osteopathic Hospital of Maine, Health Care Finance Commission, Case No. 89-133 (January 19, 1990); Maine Medical Center, Health Care Finance Commission, Case No. 88-89 (August 19, 1988).

No court in Maryland has ruled explicitly on hospital employment of physicians, but some cases have mentioned it without disapproval.[79]

In addition, the AHLA 50 State Survey suggests that the Board of Physicians provides informal opinions to practitioners indicating that CPOM is not an enforcement priority, that no physician has ever been disciplined for being employed by a corporation, and that enforcement is only likely in situations where the employer is interfering with the physician's medical judgment.[80]

Massachusetts

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

A case from 1937 prevents hospitals from employing physicians.[81] Statutory authority for this decision was based on Massachusetts General Law, chapter 112, section 6. However, a 50-State Survey[82] and a survey by the DHHS[83] and indicate that the state does not enforce its CPOM doctrine to prevent hospitals from employing physicians.

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

- Validly-licensed clinics[84] (but NOT clinics that are "conducted by hospitals"[85]).
- Medical Service Corporations[86]

Michigan

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

An opinion by the Attorney General of Michigan states that non-profit hospitals may employ physicians.[87] In addition, a statute appears to permit county hospitals to employ physicians, although it does not explicitly grant such permission.[88]

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[79] See e.g. Dvorine v. Castleberg Jewelry Corp., 170 Md. 661, 185 A. 562 (1936); Backus v. County Bd. of Appeals, 224 Md. 28, 166 A.2d 241 (1960).
[80] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[81] See McMurdo v. Getter, 298 Mass. 363 (1937).
[82] AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[83] "State Prohibitions on Hospital Employment of Physicians," Department of Health and Human Services, Office of Inspector General (Nov. 1991).
[84] See Mass. Gen. Laws, ch. 111, §51; and 105 Mass. Code Regs., § 140.000 et seq. For a definition of "clinic" see 105 Mass. Code Regs., § 140.020.
[85] See 105 Mass. Code Regs., § 140.020.
[86] See Mass. Gen. Laws, ch. 176B & 176C.
[87] Opinion of the Attorney General of Michigan, 1993 No. 6770 (Sept. 17, 1993).
[88] Mich. Comp. Laws chapter 331.

Minnesota

Rule: Hospital employment of physicians is tolerated, due to an opinion by the state Attorney General[89] and a favorable – although vague – decision by the state Supreme Court.[90]

In 1936, the Supreme Court held that the state's CPOM doctrine prevents for-profit hospitals from employing physicians.[91] It did not rule on non-profit hospitals. In 1955 the state Attorney General declared that a non-profit corporation that employs a physician but which does not undertake to control the manner in which the physician attends to his or her patients does not raise corporate practice of medicine concerns.[92]

Almost seventy years after the Supreme Court had last ruled on CPOM, the court held that the CPOM doctrine still applies in the state (applying it against a chiropractor).[93] However, the court also admitted that a number of exceptions exist, both in MN and in other states, and that some of the original policy rationale for applying CPOM no longer applies. The court explicitly mentioned hospitals and nonprofit corporations as being "common" exceptions to CPOM, without ruling on whether those exceptions apply in MN.[94]

Mississippi

Rule: According to the Mississippi State Board of Medical Licensure, hospitals may employ physicians if they meet the following requirements:[95]

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

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

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

[89] Op. Atty. Gen. No. 92-B-11 (Oct. 5, 1955) (reversing, in part, Op. Atty. Gen. No. 92-B-11 (Aug. 8, 1939) which held that the corporate practice doctrine could apply to nonprofit corporations).
[90] Isles Wellness, Inc. v. Progressive N. Ins. Co., 703 N.W.2d 513 (Minn. 2005), aff'd Isles Wellness, Inc. v. Progressive N. Ins. Co., 725 N.W.2d 90 (Minn. 2006).
[91] People, by Kerner, v. United Med. Serv., 362 Ill. 442, 454, 200 N.E. 157, 163 (1936).
[92] Op. Atty. Gen. No. 92-B-11 (Oct. 5, 1955).
[93] Isles Wellness, Inc. v. Progressive N. Ins. Co., 703 N.W.2d 513 (Minn. 2005), aff'd Isles Wellness, Inc. v. Progressive N. Ins. Co., 725 N.W.2d 90 (Minn. 2006).
[94] Id. at 518 (Minn. 2005).
[95] I could find no court cases directly endorsing this rule.

however, the manner of billing and the amount of fees and expenses charged to a patient for medical services rendered shall be left solely to the discretion of the licensed physician.

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

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

- Free choice of physicians and hospitals is a right of every individual. One may select and change at will one's physician or hospital or may choose a medical care plan such as that provided by a closed panel or group practice or health maintenance organization (HMO) or service organization (PPO). While it is recognized that the choosing to subscribe to an HMO or PPO or accepting treatment in a particular hospital will result in the patient accepting limitations upon freedom of choice of medical services, all physicians must recognize that situations will exist where patients will be best served by physicians or hospitals outside such contractual arrangements. If the HMO or PPO contract or other business arrangement does not permit referral to a non-contracting medical specialist, diagnostic or treatment facility or hospital, and the physician believes that the patient's best interest will be served by a specialist, facility or hospital outside of the contractual relationship, the physician has an ethical and contractual obligation to inform the patient of this fact. The physician should so inform the patient so that the patient may decide whether to accept the outside referral at his or her own expense or confine herself or himself to the services available within the HMO, PPO or other business arrangement.

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

- Pursuant to Miss. Code Ann. Section 79-10-31, shareholders of a professional corporation rendering medical services shall only be licensed physicians.[96]

Missouri

Rule: hospitals may employ physicians.

[96] Opinion of the Mississippi State Board of Medical Licensure, revised on May 16, 1996, and September 20, 2001.This policy statement was adopted utilizing language set forth in the current opinions of the Council on Ethical and Judicial Affairs of the American Medical Association (Sections 8.13 and 9.06).

Missouri is one of the few states which never adopted the Corporate Practice of Medicine.[97]

Montana

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

The AHLA 50 State Survey suggests that hospitals employ physicians in practice.[98]

Nebraska

Rule: hospitals may employ physicians.

Nebraska courts have interpreted the state's CPOM doctrine in a way that it does not prevent any corporations from employing physicians.[99]

Nevada

Rule: For-profit hospitals may not employ physicians, according to a 1977 opinion by the state Attorney General.[100] However, non-profit hospital employment of physicians appears to be tolerated, because the opinion did not address non-profit organizations. Note also that, in 2008, a statute became effective which lays out explicit exceptions to the CPOM doctrine. It allows private non-profit medical schools and non-profit medical research institutions to operate clinics and to employ physicians as faculty at the clinics.[101] The section below ("The 2008 Law") contains more details on the scope of this law. It is unclear to what extent, if at all, this law affects the ability of non-profit hospitals to employ physicians as a general matter.

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

> … [Some] hospitals act on the belief that licensed hospitals have a yet-unrecognized, inherent exception from the corporate practice prohibition. These hospitals either employ physicians directly or form partnerships and limited

[97] See State ex inf. Sager v. Lewin, 128 Mo. App. 149, 106 S.W. 581 (Mo. Ct. App. 1907); Missouri Attorney General Opinion No. 8 (Mar. 15, 1962).
[98] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[99] See State Electro-Medical Institute v. Platner, 74 Neb. 23, 103 N.W. 1079 (1905); State Electro-Medical Institute v. State, 74 Neb. 40, 103 N.W.__(1905); Nebraska Revised Statute § 38-2024.
[100] Opinion of the Attorney General of Nevada, No. 40 (1977).
[101] Nev. Rev. Stat. Ann. § 630.365 (effective Jan 1, 2008; current through the 2009 75th Regular Session and the 2010 26th Special Session of the Nevada Legislature and technical corrections received from the Legislative Counsel Bureau (2010)).

liability partnerships with licensed physicians, which partnerships own medical delivery assets and employ physicians.

…

State authorities appear unconcerned over technical violations of the corporate practice prohibition so long as lay persons do not direct medical treatment and the public is not deceived.[102]

The 2008 Law

- A statute which became law in 2008 allows private non-profit medical schools and non-profit medical research institutions to operate clinics and to employ physicians to staff the clinics, provided that the physicians are both:
    - (1) Licensed pursuant to this chapter or chapter 633 of NRS, respectively; and
    - (2) Members of the faculty of the school or institution.[103]
- The statute defines "private nonprofit medical schools" as the following: "As used in this section, 'private nonprofit medical school' means a private nonprofit medical school that is licensed by the Commission on Postsecondary Education and approved by the Liaison Committee on Medical Education of the American Medical Association and the Association of American Medical Colleges."[104]
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- This statute does not define "nonprofit medical research institution" or "clinics," and I have found no court decisions interpreting this section.

New Hampshire

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

The AHLA 50 State Survey suggests that hospitals employ physicians in practice.[105]

New Jersey

[102] AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[103] Nev. Rev. Stat. Ann. § 630.365, subsection 1.
[104] Id. at subsection 2.
[105] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).

Rule: Both for-profit and non-profit hospitals may employ physicians under New Jersey state statute. However, any hospital employing physicians is subject to the following provisions:[106]

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

This statute is set to expire. A readoption of the statute is currently proposed, with minor updates that do not detract from the ability of hospitals to employ physicians.[107]

New Mexico

Rule: Hospitals may employ physicians. A 1987 opinion by the Attorney General of New Mexico stated that any corporation may employ physicians in the state.[108] This opinion has not been questioned. Further, statutory authority suggests that, at a minimum, public hospitals may employ physicians.[109] Combined, these authorities strongly suggest any hospital may employ physicians in New Mexico.

New York

Rule: Hospitals may employ physicians.[110]

North Carolina

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[106] See N.J. Administrative Code § 13:35-6.16, subsection (f)(4).
[107] See 2010 NJ REG TEXT 229065 (NS).
[108] Opinion of the Attorney General of New Mexico, No. 87-39 (1987).
[109] N.M. Stat. Ann. § 23-1-1 (current through all 2010 legislation) [bolding added].
[110] See People v. John H. Woodbury Dermatological Inst., 192 N.Y. 454, 456-57, 85 N.E. 697, 698 (1908); Albany Medical College v. McShane, 66 N.Y.2d 982 489 N.E.2d 1278, 499 N.Y.S.2d 376 (N.Y. 1985); Odrich v. Trustees of Columbia Univ. in City of New York ("Odrich"), 193 Misc. 2d 120, 747 N.Y.S.2d 342 (N.Y. Sup. Ct. 2002) aff'd, 308 A.D.2d 405, 764 N.Y.S.2d 448 (N.Y. App. Div. 2003).

Rule: Hospital employment of physicians is tolerated for non-profit hospitals and public hospitals, pursuant to an opinion by the Attorney General of North Carolina.[111] For-profit hospitals may not employ physicians.[112]

Note that the North Carolina Medical Board may consider independent contractor relationships between lay corporations and physicians to constitute violations of the CPOM doctrine; [113] this raises the concern that the Board would also consider independent contractor relationships between for-profit hospitals and physicians to violate the CPOM doctrine.

North Dakota

Rule: Hospitals may employ physicians.[114]

Ohio

Rule: Two exceptions exist to Ohio's CPOM doctrine: (1) Non-profit and public hospitals that are located in districts defined by statute as "rural" may employ physicians, provided that they follow certain rules (see below);[115] and (2) Teaching hospitals may employ faculty physicians.[116] These are the only two exceptions to Ohio's CPOM law.[117]

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

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

[111] Idem.
[112] Opinion of the Attorney General of North Carolina, No. 33-43 (1955) [citing Seawell v. Carolina Motor Club, 209 N.C. 624, 184 S.E. 540 (1936)].
[113] See Jimison, Marcus. "The Corporate Practice of Medicine." Prognosis, Vol. 23, No. 1 (November 2006).
[114] N.D. Cent. Code § 43-17-42 (1993).
[115] Ohio Rev. Code § 4731.31 (2011).
[116] Ohio Rev. Code § 4731.291 (2011); see also the DHHS report "State Prohibitions on Hospital Employment of Physicians."
[117] See Albain v. Flower Hosp., 50 Ohio St. 3d 251 (1990) [overruled on a different issue by Clark v. Southview Hosp. & Family Health Ctr., 68 Ohio St. 3d 435 (1994)]; Schelling v. Humphrey, 123 Ohio St. 3d 387, 390, 916 N.E.2d 1029, 1033.

- Require that a physician be employed by the hospital or facility as a condition of granting the physician privileges to practice within the hospital or facility.[118]

Oklahoma

Rule: Both for-profit and non-profit hospitals may employ physicians, as permitted by statute.[119]

Oregon

Rule: hospital employment of physicians is tolerated, due to a non-binding opinion by the Attorney General of Oregon.[120]

The AHLA 50 State Survey suggests that hospitals employ physicians in practice.[121]

Pennsylvania

Rule: Hospitals may employ physicians, as permitted by statute.[122]

Rhode Island

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

South Carolina

Rule: Hospital employment of physicians is tolerated for "charitable" hospitals and public hospitals.[123] The definition of a "charitable" hospital is unclear, as the attorney general opinion that lays out this exception does not define the term.

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

[118] Ohio Revised Code § 4731.31.
[119] See Oklahoma Statutes title 59, § 492 and title 63, § 1-701 (1999).
[120] Opinion of the Attorney General of Oregon 37-963 (1975).
[121] See AHLA-Papers P06059630, American Health Lawyers Association, AHLA Seminar Materials: Health Law Update and Annual Meeting (June 5, 1996).
[122] See 35 Pa. Stat. Ann. § 448.817, subsection (a) and § 448.802, subsection (a) (current through end of the 2010 Regular and First Special Session).
[123] Op. Atty. Gen. S. C. (Sept. 8, 1982) [citing Op. Atty. Gen. S. C. No. 645 at 145 (1958-1959)].

First, in 1999 the South Carolina Supreme Court reaffirmed that the state does indeed have a CPOM doctrine.[124]

Second, the Supreme Court (in a footnote) stated that a hospital cannot itself "practice medicine."[125] However, the court did not outline the contours of the doctrine, nor did it mention whether CPOM prevents the employment of physicians.

Third, in a case from 2010, a federal district court applying SC law indicated that the CPOM doctrine may prevent hospitals from employing physicians directly.[126] However, because of the procedural stance of the case, the court did not actually decide this issue. The employer at issue in the 2010 case – OrthAlliance, Inc. – was a for-profit corporation, but the court did not draw any distinction between public or nonprofit (or charitable) hospitals on the one hand, and private for-profit hospitals and corporations on the other.

South Dakota

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

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

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

- Remain effective for a period of more than three years, after which it may be renewed by both parties annually.[127]

I have found no cases which have interpreted this statute.

Tennessee

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

1. Only research hospitals may employ radiologists, anesthesiologists, pathologists, or emergency physicians; non-research hospitals may not employ them.[128]

[124] Baird v. Charleston County, 333 S.C. 519 (1999).
[125] McMillan v. Durant, 312 S.C. 200, 439 S.E.2d 829, note 2 (1993).
[126] OrthAlliance, Inc. v. McConnell, CIV.A. 8:08-2591-RBH, 2010 WL 1344988 (D.S.C. Mar. 30, 2010).
[127] S.D. Codified Laws § 36-4-8.1.

- "Research hospital" is defined as a hospital at which fifty percent (50%) or more of the inpatients treated during the previous calendar year were treated pursuant to research protocols.[129]

- This rule is subject to one exception: any hospital may employ a physician to provide emergency medical services if such physician is employed to provide other medical services.[130]

- Note that the definition of "emergency physician" is rather specific.[131]

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

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

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

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

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

        - The employing entity discloses any such restrictions to the patient.[132]

Texas

Rule: Two types of health organization may employ physicians in Texas: (1) nonprofit public interest health organizations,[133] and (2) nonprofit federally-recognized migrant, community, or homeless health centers.[134] The term "nonprofit public interest health organization" is defined below.

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

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

- (1) is a nonprofit corporation under Texas law

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

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

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

- (4) has as its directors and trustees persons who are both:
    - (A) licensed physicians; and
    - (B) actively engaged in the practice of medicine.[135]

Utah

Rule: Hospitals may employ physicians.[136]

Vermont

Rule: Hospital employment of physicians is tolerated, at least for non-profits. There is very little guidance on the subject; the only authority I found was a case in which a non-profit corporation was permitted to employ physicians.[137] It is unclear whether a court would take a different view of for-profit hospitals.

Virginia

[135] Texas Occupations Code § 162.001(b).
[136] Utah Code § 58-67-802; see also Golding v. Schubach Optical Co., 93 Utah 32, 70 P.2d 871, 875 (1937).
[137] LoPresti v. Rutland Reg'l Health Services, Inc., 2004 VT 105, 177 Vt. 316, 321, 865 A.2d 1102, 1107 (2004).

Rule: Medical schools and state-managed or state-controlled hospitals are explicitly permitted by statute to employ physicians.[138] In addition, according to opinions by the Virginia Attorney General, both non-profit[139] and for-profit[140] hospitals may employ physicians, so long as physicians retain control of patient care.

Additional state statutes make references to, but do not explicitly provide for, the employment of physicians by hospitals,[141] as well as by local health departments, federally funded comprehensive primary care clinics, and nonprofit health care clinics or programs.[142]

Washington State

Rule: Hospitals may not employ physicians.[143]

Washington's CPOM doctrine is based on case law, not statute, but the courts draw their authority to enforce CPOM from certain sections in the Business and Professions Code.[144] Among these sections is a long list of exceptions to the law[145] most of which – aside from the common exceptions for medical students, interns, and residents – do not pertain to hospitals.

Practitioners should also note a potential trend: the statute from which courts draw their authority to enforce the CPOM doctrine[146] has recently come under attack for being unconstitutionally overbroad. The argument, in short, is that the law's regulation of the practice of medicine is so broad that it impairs free speech rights. Two times now courts in Washington have shown some sympathy to this argument, but due to the procedural posture of the cases the court did not rule on the issue.[147] This argument has also been made, unsuccessfully, in Michigan.[148]

West Virginia

Rule: Hospital employment of physicians is tolerated so long as the relationship passes a multi-factorial test, as described in an opinion by the West Virginia Board of Medicine.[149]

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[138] Virginia Code § 54.1-2941.
[139] Virginia Attorney General Opinion, Dec. 7, 1992.
[140] Virginia Attorney General Opinion, May 22, 1995.
[141] Virginia Code § 54.1-2918.
[142] Virginia Code § 54.1-2957.01.
[143] Columbia Physical Therapy, Inc., P.S. v. Benton Franklin Orthopedic Associates, P.L.L.C., 168 Wash. 2d 421 (2010); see also Morelli v. Ehsan, 110 Wn.2d 555 (1988); State v. Boren, 36 Wn.2d 522 (1950) appeal dismissed per curium, 340 U.S. 881 (1950); State ex rel. Standard Optical Co. v. Superior Court, 17 Wn.2d 323 (1943).
[144] Revised Code of Washington § 18.71.011.
[145] Wash. Rev. Code § 18.71.030.
[146] Revised Code of Washington § 18.71.011.
[147] Washington State Dept. of Health Unlicensed Practice Program v. Yow, 146 Wash. App. 1075 (Wash. Ct. App. 2008) [referring to State v. Pacific Health Center, Inc. 135 Wn.App. 149 (2006)].
[148] People v. Rogers 249 Mich.App. (2001).
[149] Statement of Public Policy, State of West Virginia Board of Medicine (originally adopted May 8, 1995, amended May 10, 2010).

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

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

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

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

- (4) Is the structure a for profit structure or a non profit structure?[150]

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

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

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

Wisconsin

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

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

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

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

3. Establishes the remuneration of the physician.[151]

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

> "Hospital" means an institution providing 24-hour continuous service to patients confined therein which is primarily engaged in providing facilities for diagnostic and therapeutic services for the surgical and medical diagnosis, treatment and care, of injured or sick persons, by or under the supervision of a professional staff of physicians and surgeons, and which is not primarily a place of rest for the aged, drug addicts or alcoholics, or a nursing home … [152]

Note that an Attorney General opinion also remarked that hospitals are exempt from the state's CPOM doctrine.[153]

Wyoming

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

Wyoming court cases have not ruled explicitly on hospital employment of physicians, but they have held that optometry constitutes the practice of medicine, and that although corporations may not practice medicine, the key is not the form of the employment relationship but the amount of control the corporation has over the professional.[154] The courts have not provided detailed guidance as to what constitutes excessive control.

The AHLA survey suggests that hospitals employ physicians in practice.[155]

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

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