Health Information Technology in U.S. Hospitals: How Much, How Fast?

Research-in-Progress

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Abstract

Hospitals are now faced with delivering value-based care (high quality patient care at a reduced cost) rather than volume-based care. To investigate the impact of IT on value-creation in health care, we identify and theorize how the extent of use and rate of growth in use for three HIT capabilities (Clinical Process Management, Patient Engagement, and Patient Transition) may independently and jointly affect cost and patient quality outcomes in the context of the U.S. health care industry. Our empirical data is based on multiple archival sources from 2008-2013, including data on implementation and use of HIT functionalities, hospital characteristics, quality of patient care outcomes, and cost of care outcomes. We identify measures for our constructs and propose analysis methods to test our model and hypotheses. We seek to contribute to our understanding of how portfolios of HIT capabilities and associated complementarities may contribute to the delivery of value-based care.

Keywords: Health Information Technology, IT Capabilities, Value-Based Care
Introduction

Health information technology (HIT) is defined as “the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making” (Thompson and Brailer 2004). HIT has been touted as a way to “improve quality and convenience of patient care, increase patient participation in their care, improve accuracy of diagnoses and health outcomes, improve care coordination, and increase practice efficiencies and cost savings” (ONC 2013). In response to the rising cost of health care (13.8% of GDP in 2000 to 17.9% of GDP in 2009, (CMS 2014)) and the promise of HIT to reduce such costs (and improve health benefits) (Hillestad et al. 2005), the U.S. government passed the Health Information Technology for Economic and Clinical Health (HITECH) Act, a component of the American Recovery and Reinvestment Act of 2009. The Office of the National Coordinator for Health Information Technology (ONC), created under HITECH, allocated billions of dollars in incentives through the Centers of Medicare & Medicaid Services (CMS) to hospitals and physicians to adopt Electronic Medical Records (EMRs)/Electronic Health Records (EHRs) and achieve their ‘meaningful use’ (Blumenthal and Tavenner 2010). These incentives have resulted in a dramatic increase in HIT implementation and use throughout the U.S. (DesRoches et al. 2013; Wright et al. 2013). However, while implementation and usage rates of HIT have increased, the debate regarding HIT impacts is ongoing.

U.S. hospitals face significant tensions between delivering high quality patient care and improving health outcomes while simultaneously reducing the cost of care (Berwick et al. 2008). Yet even more challenging is meeting these goals while also implementing various HIT resources in a timely and effective manner. While a number of studies have examined the impacts of HIT on the cost and quality of patient care (e.g., Appari et al. 2013; Buntin et al. 2011; Jamal et al. 2009; Wu et al. 2006), variations in significance and direction of these effects have been observed and debated. It has been suggested that these variations may be because of HIT implementation practices and the contexts of use (Jones et al. 2014). In fact, a recent update in *Health Affairs* reported that earlier estimates of potential HIT cost and efficiency gains (Hillestad et al. 2005) had to be revised significantly downward due to: initially slow HIT adoption rates, complications associated with usage factors, and a lack of complementary process reengineering when adopting HITs (Kellermann and Jones 2013). In short, the impact of HIT on performance remains mixed and inconclusive, with a void in understanding about how the extent of use (how much) and the rate of growth (how fast) of HIT capabilities impacts outcomes (Agarwal et al. 2010; Kazley and Ozcan 2008; Lester et al. 2008).

Overall, our research seeks to address this research gap and to significantly contribute to IT business value, IT capabilities, and HIT research in a context where the consumer is a key constituent for value creation processes. Value-based care is defined as delivering the highest quality of patient care at the lowest possible cost (Porter 2009; Porter and Lee 2013). We propose that the health care industry provides an excellent context in which to study the complexities of value creation in a heterogeneous, multi-stakeholder environment. Of particular interest are questions as to how portfolios of HIT capabilities within hospitals are impacting cost and quality of patient care outcomes. While systematic reviews of the impact of HIT use on outcomes have been conducted (Jones et al. 2014), results have been mixed with particular lack of research regarding: 1) how the extent of use of HIT capabilities impacts both patient quality and cost outcomes, 2) how the rate of usage growth over time of HIT capabilities impacts both patient quality and cost outcomes, and 3) how complementarities between the extent of use and the rate of growth of different HIT capabilities jointly impact patient quality and cost outcomes. The extent to which HIT capabilities are used is likely to significantly impact outcomes, but, even further, the rate at which usage levels increase, individually and in combination with complementary capabilities, is likely to have significant impacts on short-term and long-term outcomes. The rate of growth of HIT use serves as a proxy for incremental vs. radical change, which has been shown to have variable impacts on outcomes, depending on the associated learning costs and ability to stabilize complex processes (Fichman 2000; Orlikowski 1993).

Prior studies on the IT-to-performance relationship in health care have examined health care quality using broad measures, such as mortality rates (Amarasingham et al. 2009; Devaraj and Kohli 2000; Devaraj and Kohli 2003), while others have focused on similarly broad measures of health care cost efficiency and financial performance (Ayal and Seidmann 2009; Menon and Lee 2000). Similar trends have been observed in information systems (IS) business value research that focuses on the impact of IT.
investment on firm performance (Bharadwaj et al. 1999; Brynjolfsson 1996; Brynjolfsson and Hitt 2000; Santhanam and Hartono 2003). However, such studies often lump IT spending under a single coarse category, such as IT capital or IT investment (Devaraj and Kohli 2000). Although these are useful measures, they do not disaggregate the impact of specific IT capabilities and functionalities, nor do they enable investigation of how the functionalities can be effectively combined. More comprehensive models often link IT capabilities to organizational performance in a more granular fashion by elaborating the IT capabilities in a given context (e.g., Melville et al. 2004; Rai and Tang 2010). We seek to provide a more comprehensive model that enumerates the impact of HIT capabilities on outcomes specific to value creation (health care cost and patient quality of care).

We elaborate the concept of HIT capabilities in the context of patient care processes, which are defined as "health care-related activities performed for, on behalf of, or by a patient” (AHRQ 2014). Following Rai et al. (2012), we define HIT capability as “the ability to implement and use [H]IT assets ([H]IT functionalities) in combination with other resources to execute [clinical and related patient care] processes.” In general, IT capabilities that contribute to value creation in complex processes typically span multiple phases of activities, where the phases are not necessarily sequential (see, for example, Pavlou and El Sawy (2010)’s conceptualization of IT capabilities for new product development). Drawing on this view, we consider a hospital’s overall portfolio of HIT capabilities as capturing the use of HIT functionalities along three phases in providing care to a patient. First, a hospital’s clinical process management (CPM) capability involves the use of HIT functionalities to execute core, clinical processes. Second, a hospital’s patient engagement (PE) capability entails the use of HIT functionalities to support how patients are engaged and empowered in the clinical care process in a patient-centric manner. Third, a hospital’s patient transition (PT) capability encompasses the use of HIT functionalities when transferring patients and their information from one provider or facility to another. Collectively, these HIT capabilities encompass the three main phases of providing care to a patient: (1) core clinical processes in the care of a patient, (2) patient-centricity in engaging the patient in their care, and (3) coordinating patient care beyond a particular hospital or provider over multiple care providers. Motivated by this background and the identified research gaps, we ask:

How do HIT capabilities, (extent of use and rate of growth) individually and in combination, affect quality of patient care and cost of patient care outcomes in U.S. hospitals?

Our empirical study is set in the context of the U.S. health care industry and is based on multiple sources of rich, archival data from 2008–2013, including data on the implementation and use of HIT functionalities, quality of patient care, cost of care, and resource and governance characteristics of hospitals. Our data is drawn from the American Hospital Association (AHA) Survey and IT Supplement as well as meaningful use and cost of care (charge) data from the CMS. Leveraging these longitudinal datasets, we empirically assess the impacts of HIT capabilities on U.S. hospital cost and patient quality outcomes at both the process level (i.e., at the Diagnosis Related Group, DRG, level) and at the organizational (hospital level). These capabilities are assessed over a time period that includes a major governmental intervention—meaningful use—that seeks to incentivize HIT adoption and use. By examining portfolios of HIT capabilities, we seek to contribute a more nuanced view of how IT capabilities impact outcomes. Our data gives us the unique opportunity to observe these impacts before and after the government intervention, thereby representing a quasi-natural experiment. Our approach seeks to develop our understanding of IT capabilities and business value in the patient care context by investigating the extent to which and pace with which specific HIT capabilities need to be developed to achieve multiple outcomes.

Model and Hypotheses

We theorize that a hospital’s HIT capabilities enable care processes, which impact patient quality of care and costs of care (Figure 1).
Conceptualizing HIT Capabilities: Extent of Use and Rate of Growth in Use

We adopt the view that a hospital’s HIT capabilities are formed by the implementation and use of HIT functionalities in combination with other resources. Elaborating, IT capabilities are defined as “the ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities” (Bharadwaj 2000). This definition draws on the resource-based view where IT capabilities are established over time by combining firm and IT assets through practices and competencies (Aral and Weill 2007). While IT functionalities may be generic in nature, especially prior to implementation, IT capabilities are embedded within a firm and it is this firm-specific implementation and use with other resources that make IT capabilities valuable (Bharadwaj 2000; Zhu and Kraemer 2002). Therefore, IT functionalities are the tools/resources that are designed to support business processes, while IT capabilities refer to the ability to execute business processes (use). In our context, HIT capabilities are created through the use of various HIT functionalities in combination with other resources to execute processes. We focus on those HIT capabilities that span multiple phases of the patient care process as we now elaborate.

We conceptualize HIT capabilities as Clinical Process Management (CPM), Patient Engagement (PE), and Patient Transition (PT) to represent a hospital’s overall portfolio of HIT capabilities for clinical and patient care processes (Table 1). These are key clinical and patient-related capabilities that HITECH intended to develop through an initial wave of incentives (2011-2013) followed by a wave of reimbursement level penalties for lack of compliance with standards (starting in 2014). In order to qualify for an incentive payment through the EHR Incentive Program, hospitals must attest to meaningful use objectives. These objectives are divided into three stages and we are currently in the attestation period of Stage 2 (data not yet reported). Meaningful Use Stage 1 objectives include meeting 14 core objectives and 5 of 10 menu objectives as set down by CMS. The core and menu objectives for each of these capabilities are shown in Table 1.

CPM capabilities are core to health care value creation and include patient care activities, ranging from adhering to the mapped processes to addressing heterogeneous patient needs to diagnosing and treating acute and chronic conditions. Therefore, CPM encompasses a wide-range of activities, which in turn can have a broad effect on various outcomes, from lessening paper work (EHRA 2009) to alerting clinicians to actions that could potentially harm a patient. The goals of implementing CPM are to reduce readmissions, eliminate preventable hospital-acquired conditions, reduce clinical errors, and eliminate unnecessary testing, all of which influence quality and cost of care. We choose to focus on CPM, as the associated activities are core to how a hospital creates value for a patient.

In a multi-phase conceptualization of how a hospital provides care to patients, health care providers not only execute clinical processes to provide care to patients, but also engage patients as well as transition their care to other health care providers. In the case of PE, patient-facing functionalities are used to provide a technological means for patients to actively participate in their care (Baird et al.
Baird et al. 2013; Emont 2011). PE is a necessary component of a multi-phased value creation process in that it facilitates the involvement of patients and their families in health care decision-making processes as well as in a patient’s management of their own health. PE capabilities allow the hospital to capture and act on patient-reported information, such as preferences, desired outcomes, and experiences, as well as improve patients’ understanding of their health and related conditions so that they can take a more active role in their health care. Patients who are well informed of their medical condition(s) are more likely to comply with their recommended course of treatment and are better able to communicate important health information with their providers.

Value for patients is also generated when transitions of care provide useful information to patients (and caregivers) about how to continue patients’ care after leaving the hospital. PT allows for continuity of care, which can reduce miscommunications and enhance coordination, especially when considering health information exchange functionalities (Furukawa et al. 2013; Walker et al. 2005). In particular, PT facilitates the coordination and communication of medical information from one provider or facility to another. The use of these functionalities help maintain patient continuity as well as facilitate information exchange across medical practices and settings, such as the initiating, communicating, and tracing of referrals, and consultations.

<table>
<thead>
<tr>
<th>HIT Capability</th>
<th>Use of HIT Functionalities</th>
</tr>
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<tbody>
<tr>
<td><strong>Clinical Process Management (CPM)</strong></td>
<td>Core Objectives: • CPOE, Medication Allergy List, CDS Rule, Drug Interaction Checks, Record Demographics, Maintain Problem List, Record Vital Signs, e-Prescribing, Record Smoking Status, Active Medication List, Clinical Quality Measures Menu Objectives: • Drug Formulary Checks, Clinical Lab Test Results, Patient List, Patient Advance Directives</td>
</tr>
<tr>
<td><strong>Patient Engagement (PE)</strong></td>
<td>Core Objectives: • Electronic Copy of Health Information, Electronic Copy of Discharge Instructions Menu Objectives: • Patient Specific Education Resources</td>
</tr>
<tr>
<td><strong>Patient Transition (PT)</strong></td>
<td>Core Objectives: • Electronic Exchange of Clinical Information Menu Objectives: • Medication Reconciliation, Transition of Care Summary</td>
</tr>
</tbody>
</table>

Table 1: HIT Capabilities and Associated Use of HIT Functionalities

Overall, such HIT capabilities are likely to improve core processes, increase patient engagement, and improve coordination (Jones et al. 2014). Following the logic that the underlying HIT functionalities must be used to build HIT capabilities, we propose that higher the extent of use of HIT functionalities implies superior HIT capabilities. Therefore, we hypothesize, ceteris paribus:

**H1a:** Quality of patient care is positively associated with the extent of use of (a) CPM, (b) PE, and (c) PT.

HIT capabilities also hold great promise to provide cost-effective care. The Agency for Healthcare Research and Quality (AHRQ) did an extensive review on the impact of HIT on the medication management process and found that several studies showed that over time a net benefit was accrued based on cost reductions stemming from lower adverse drug events, drug costs, and laboratory test usage (McKibbon et al. 2011). In regard to specific HIT capabilities, CPM can facilitate shorter hospital stays, which can ultimately reduce costs (Newby et al. 2000). The goal of PE is to allow patients to take a more active role in their health care, such as being able to receive and keep better track their recommended care, which in turn reduces costs as patients’ health outcomes may improve as a result. As seen before, PT facilitates the communication between multiple providers, potentially reducing miscommunications and unnecessary testing, therefore reducing costs. Therefore, we hypothesize, ceteris paribus:

**H1b:** Cost of patient care is negatively associated with the extent of use of (a) CPM, (b) PE, and (c) PT.

While beneficial outcomes associated with early levels of usage are not likely to be immediate (i.e., dips or negative effects may occur initially), rapid rates of growth may have different impacts on short-term and long-term outcomes than incremental rates of growth (Fichman 2000; Orlikowski 1993). Therefore, we introduce these rates of growth hypotheses as non-linear and, more specifically, as an
inverted U relationship between rate of growth and positive benefits. Our rationale is that these functionalities cannot just be used “out of the box.” Clinicians must carry out a variety of activities (many of which are complex, costly, and time-consuming) to complement the new technologies as capability building occurs (Miller and Sim 2004). Moreover, complementary changes are critical for generating benefits from the use of new technology (Brynjolfsson and Hitt 2000). Specifically, if CPM functionalities are implemented too rapidly without providing sufficient time to integrate with the supporting infrastructure, such as vendor support or staff training, then patient quality of care can suffer due to increased inefficiency in the clinical care process. Furthermore, if PE functionalities are rolled out before clinicians have a chance to learn how to effectively use these systems, patients may not have the opportunity to realize benefits. The same holds true for PT functionalities. Implemented too quickly and hospitals risk increased readmissions, miscommunications, and discontinuities. Accordingly, as hospitals move past an intermediate rate of growth in the use of HIT functionalities, the adverse consequences resulting from not providing the time to assimilate them effectively will outweigh the costs. This leads us to hypothesize curvilinear relationships between rate of growth and the outcomes, where the benefits increase to a certain level of rate of growth and then decrease.

**H2a:** Quality of patient care has a curvilinear (inverted-U shaped) relationship with the rate of growth in use of (a) CPM, (b) PE, and (c) PT.

**H2b:** Cost of patient care has a curvilinear (U-shaped) relationship with the rate of growth in use of (a) CPM, (b) PE, and (c) PT.

**Complementarities of HIT Capabilities: Extent of Use and Rate of Growth**

Previous research has shown that there are substantial variations in the returns to IT across firms (Brynjolfsson and Hitt 2000), with presence/absence of complementary resources being a factor that explains why firms realize differential returns from a given IT resource (Ray et al. 2005). Complementarities represent the enhancement of one resource’s value in the presence of another resource (Milgrom and Roberts 1995). Individually, resources can be duplicated across firms, yet context-specific resource configurations of technologies are more difficult to reproduce. In our context, we expect HIT capabilities to yield very different results based on whether or not complementary HIT capabilities are established.

We expect that hospitals will realize greater benefits (i.e., increased quality of patient care and decreased cost of care) from CPM capabilities if combined with PE and PT capabilities. The health care industry is becoming increasingly patient-centric and the business of health care is now more than ever characterized by high interdependence between patients and health care providers. This unique context results in the need to coordinate clinical process management, patient engagement, and patient transitions across complex systems. Given these arguments, we propose the following hypotheses:

**H3a:** The marginal return to quality of patient care from the extent of use of CPM increases with complementary increases in the extent of use of (a) PE, (b) PT, and (c) PE and PT.

**H3b:** The marginal return to cost of patient care from the extent of use of CPM decreases with complementary increases in the extent of use of (a) PE, (b) PT, and (c) PE and PT.

We also expect that the rate of growth in the use of CPM will interact with the rate of growth in the use of PE and PT to affect outcomes. Our rationale is that while there are greater benefits to be gained from the complementarities of CPM with PE and PT, there are also greater learning and change management costs associated with implementing and using HIT functionalities across three diverse processes. On the benefits side, a faster rate of growth of PE and PT creates greater marginal benefits than the rate of growth of CPM because of the synergies in coordinating across these related processes. However, there is the tension of “too much” change that sets in when PE and PT use are ramped up at a very fast speed that will decrease the marginal benefits from CPM use. In sum, the curvilinear relationship between the rate of growth in CPM and outcomes will be reinforced.

**H4a:** The curvilinear relationship between quality of patient care and rate of growth of CPM is strengthened with complementary increases in the rate of growth of (a) PE, (b) PT, and (c) PE and PT.
**H4b:** The curvilinear relationship between cost of patient care and rate of growth of CPM is strengthened with complementary increases in the rate of growth of (a) PE, (b) PT, and (c) PE and PT.

Furthermore, we propose an indirect impact of HIT capabilities on cost of care through the mediating role of patient quality of care. In terms of outcome, higher quality should affect cost. Improving the quality of patient care could still decrease the overall cost of care by reducing rework, averting drug interactions and medication errors, and readmissions. This suggests:

**H5:** Quality of patient care mediates the impact of the extent of use of (a) CPM, (b) PE, and (c) PT on patient cost of care.

### Empirical Study

#### Data Sources

We will test our hypotheses using a merged, multi-source, longitudinal dataset obtained from U.S. hospitals for 2008 to 2013. From the AHA Annual Survey IT Supplements, we have obtained the degree of hospital use of multiple HIT functionalities including: electronic clinical documentation, results viewing, computerized provider order entry, decision support, bar coding, and more. These are assessed on a 6-point scale ranging from “fully implemented across all units” to “not in place and not considering implementing.” From the CMS, we have data on actual percent usage of the corresponding core and menu objectives for each hospital, as categorized into our aforementioned groupings of HIT capabilities (Table 1). We acknowledge that variation may be somewhat limited for Stage 1, as many hospitals have now attested. Our preliminary analyses reveal greater variation in menu objectives than core objectives and, moving forward, we seek to explain variations in use using multiple stages of meaningful use attestation data. Furthermore, we will match this data with payments received under the EHR incentive program, to explore further variations. Taken together, our data spans the timeframe before and after meaningful use attestation, providing a unique opportunity to assess how the level of development and the resulting impacts of HIT capabilities changed over time across hospitals and DRGs.

The dependent variables consist of data on quality of patient care and cost of patient care at two levels: firm (hospital) and process (DRG). To evaluate cost of patient care, we take advantage of the recently released Medicare utilization and payment data (from CMS) for procedures and services provided by Medicare fee-for-service beneficiaries. This data includes hospital-specific charges for more than 3,000 hospitals that receive Medicare Inpatient Prospective Payment System (IPPS) payments for the top 100 most frequently billed discharges paid by DRG (CMS 2014). From this data, we will be able to construct a cost/charge ratio by DRG. At the hospital level, cost of care is operationalized as Total Facility Expenses (excluding bad debt) (from CMS). Quality of patient care is measured as patient satisfaction at the hospital level (from CMS, HCAHPS) and by readmission rate by DRG at the process level (from CMS). While there are a variety of outcome measures that could be considered, we chose readmission rates by DRG, as they are a reflection of the total process of care received.

This data will be combined with rich data on hospital characteristics, resources, and services from the AHA Annual Survey Database. The datasets will be joined by National Provider Identifiers (NPIs). This dataset contains information on approximately 6,500 U.S. hospitals and provides us with numerous variables ranging from hospital demographics, organizational structure, service lines and facilities, utilization data, physician arrangements, managed care relationships, hospital expenses, and staffing, including a range of physicians (AHA).

The final, merged dataset will contain approximately 3,500 hospitals from 2008-2013 (sample size pared down to the sample size of the AHA IT Supplement). We plan on completing the compiling of the data in the Summer of 2014 and hope to have the analyses completed and ready to present for ICIS 2014.
**Construct Operationalization**

Table 2 presents the operationalization of measures.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Level</th>
<th>Measures</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of Patient Care</td>
<td>DRG</td>
<td>Readmission rates by DRG in a given year</td>
<td>CMS</td>
</tr>
<tr>
<td>Quality of Patient Care</td>
<td>Hospital</td>
<td>Patient satisfaction in a given year</td>
<td>CMS</td>
</tr>
<tr>
<td>Cost of Patient Care</td>
<td>DRG</td>
<td>Medicare charge data by DRG (FY 2011, only)</td>
<td>CMS</td>
</tr>
<tr>
<td>Cost of Patient Care</td>
<td>Hospital</td>
<td>Total facility expenses (excluding bad debt) in a given year</td>
<td>AHA</td>
</tr>
<tr>
<td>CPM</td>
<td>Hospital</td>
<td>Level of use of HIT functionalities for CPM (see Table 1)</td>
<td>AHA/CMS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rate of growth of HIT functionalities use for CPM (see Table 1)</td>
<td>AHA/CMS</td>
</tr>
<tr>
<td>PE</td>
<td>Hospital</td>
<td>Level of use of HIT functionalities for PE (see Table 1)</td>
<td>AHA/CMS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rate of growth of HIT functionalities use for PE (see Table 1)</td>
<td>AHA/CMS</td>
</tr>
<tr>
<td>PT</td>
<td>Hospital</td>
<td>Level of use of HIT functionalities for PT (see Table 1)</td>
<td>AHA/CMS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rate of growth of HIT functionalities use for PT (see Table 1)</td>
<td>AHA/CMS</td>
</tr>
<tr>
<td>Payment Incentive</td>
<td>Hospital</td>
<td>Payment received under meaningful use in a given year</td>
<td>CMS</td>
</tr>
</tbody>
</table>

Note: We plan to control for human IT capital, non-IT capital, access to external resources (e.g., consultants), hospital size, hospital ownership, physician alignment intensity, hospital location, system size, teaching intensity, service intensity, rural intensity, and competition.

**Table 2: Operational Measures**

**Analysis**

Our modeling approaches will be based on panel data analyses and latent growth modeling. For the panel models, we will lag our independent variables by at least one year to decrease the potential for endogeneity (Greene 2007). We will examine if fixed or random effects estimation is to be favored using the Hausman test. We will also quantify the multicollinearity in our model using the variance inflation factor (VIF). Interaction plots will be presented for the significant interactions. In addition, we plan on using latent growth modeling (LGM), a technique that has gained attention in organizational research (Chan 1998). LGM overcomes many of the problems with traditional methods that test for changes over time as it allows us to track changes for each individual firm by developing a trajectory of change and to model predictors and outcomes of change (Bala and Venkatesh 2013).

**Planned Extensions**

Going forward, we plan on exploring how certain portfolios of capabilities should be developed individually versus applying the same strategy and approach to all capabilities. Another avenue we plan on opening up is the potential variations in time-varying effects and required complementarities for each capability. For example, the use of CPM capabilities may take much longer to “get right” than the use of PE capabilities, which tend to be more straightforward on the patient side as most of us are already use consumer IT on a daily basis.

We acknowledge that cost of patient care and quality of patient care outcomes are likely to vary between CPM, PE, and PT. We also acknowledge that positive outcomes are not likely to be realized immediately and each HIT capability is likely to realize returns at different times (i.e., lags between implementation and positive outcome realization are likely to vary). Therefore, in our empirical analyses, we will evaluate how such differences play out in U.S. hospitals in the context of a significant policy intervention (meaningful use).

Finally, using newly implemented combinations of capabilities can be difficult, especially when existing routines may need to be significantly replaced or revised and involve new (or now active rather than passive) stakeholders (Edmondson et al. 2001). In fact, process change has been suggested as a key component of overall HIT success and active involvement of previously passive stakeholders is a new
challenge to address (Kellermann and Jones 2013). Overall, adopters must balance adoption timing and related learning and stabilization costs. For instance, late adopters of HIT capabilities can benefit from the experience of the early adopters and thus learn more quickly when establishing their own HIT capabilities. However, early adopters learn through their own trial-and-error process and may benefit from the process of finding the proper combination of HIT capabilities that applies best to their unique situation (Edmondson et al. 2003). Furthermore, late adopters may be hard pressed to mimic the early adopters’ configuration of HIT capabilities and see the same results, given the unique nature of each health care context. In both cases, immediate benefits to outcomes are unlikely. Therefore, in our empirical analyses, we will examine time-varying effects associated with each combination of HIT capabilities. Time-varying effects are another key set of contributions in our work.

**Contribution**

Our study contributes to the IT business value, IT capabilities, and HIT literatures by showing how HIT capabilities influence various measures of value—cost and patient quality—over time. By elaborating HIT capabilities that span the multi-phase process through which a hospital interacts with a patient to create value, we are able to evaluate the complementarities in the extent of use as well as in the rate of growth in use of HIT capabilities. Our proposed extensions beyond the research model to evaluate time-varying effects of HIT capabilities and complementarities of HIT with organizational factors (such as IT human capital and rates of organizational learning) are likely to yield additional insights on how to effectively leverage HIT to improve both patient quality and cost of care. Practically speaking, such results could be used to inform policy on HIT in the health care industry and be used by health care administrators when evaluating how much and how fast to develop HIT capabilities.
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