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Hospital performance: Efficiency or quality? Can we have both with IT?

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ABSTRACT

The influence of IT investment on hospital efficiency and quality are of great interest to healthcare executives as well as insurers. Few studies have examined how IT investments influence both efficiency and quality or whether there is an optimal IT investment level that influences both in the desired direction. Decision makers in healthcare wonder if there are tradeoffs between their pursuit of hospital operational efficiency and quality. Our study involving a 2-stage double bootstrap DEA analysis of 187 US hospitals over 2 years found direct effects of IT investment upon service quality and a moderating effect of quality upon operational efficiency. Further, our findings indicate a U-shaped relationship between IT investments and operational efficiency suggesting that IT investments have diminishing returns beyond a certain point.

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1. Introduction

Thirty-two million more Americans are expected to join the US health insurance rolls by 2019 (Congressional Budget Office, 2010). Under the Affordable Care Act of 2010, there will be changes in payment rates to providers that will put considerable pressure on hospitals' operating margins (Annual report of the Boards of Trustees of the Federal Hospital Insurance and Federal Supplementary Medical Insurance Trust Funds, 2010)¹ requiring them to align their operating budgets with constrained reimbursement rates (Folland, Goodman, & Stano, 2010). Given these harsh financial conditions, it will be difficult for hospitals to add beds or to increase staffing for patients (Truffer et al., 2010) so hospitals in US need to become more efficient in order to lower costs and increase efficiency to care for patients (Litvak & Bisognano, 2011) while also continuing to enhance quality of patient care.

During the last few years, healthcare spending in developed countries had grown much faster than GDP (OECD, 2013). Only in 2013 for instance, healthcare spending was 7–18% of GDP in developed countries (Martin, Hartman, Whittle, & Catlin, 2014; OECD, 2013). Recent studies suggest if increases in healthcare costs

are inevitable, the focus should shift from *cost reduction* to improving *healthcare quality* (Thompson et al., 2014). To achieve these goals, hospitals have adopted various approaches such as greater automation and coordination through the use of information technology (IT). IT increases productivity by making tasks more efficient (Brynjolfsson & Hitt, 1996, 2000; Mittal & Nault, 2009). Even though recent studies find IT spending seems to lead to better health outcomes (Jones, Rudin, Perry, & Shekelle, 2014), the adoption and use of IT have been slow by healthcare industry (Herzlinger, 2006; Jha et al., 2009). However, in recent years, due to rising healthcare costs and demands for higher quality, hospitals have invested in healthcare IT in order to reduce costs and errors, and improve quality of healthcare (Das, Yaylacicegi, & Menon, 2011; Datamonitor Report, 2008). In 2011, \$519 billion was allocated for healthcare IT in the U.S. following the stimulus bill (Das et al., 2011). A similar trend was observed in Western Europe, where healthcare IT spending was increasing from \$9 billion in 2006 to \$12 billion in 2011 (IDC Report, 2008).

There is a sizable literature investigating the business value of IT for different industries. However, the business value of IT in healthcare is still to be fully investigated (Devaraj, Ow, & Kohli, 2013; Haddad, Gregory, & Wickramasinghe, 2014). Demonstrable return on investment for healthcare IT is essential to convincing hospital managers that IT investment can improve their performance. Hospital managers must also decide how and where to deploy IT – in quality enhancing initiatives or efficiency bearing initiatives, or both? Given mounting pressures to control costs, and because IT constitute a significant cost, managers must

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¹ <http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/ReportsTrustFunds/downloads/tr2010.pdf>

understand the available choices in order to make appropriate IT investment decisions (Salge, 2011).

Since the new initiatives are beginning to evaluate healthcare quality, an understanding of factors that can lead to improved quality is important. For instance, the Health Information Technology for Economic and Clinical Health (HITECH) Act encourages hospitals to improve operational efficiency and healthcare quality by adopting healthcare information systems. Hospitals will receive Medicare (a U.S. government program for elderly citizens) and Medicaid incentive payments when they use healthcare information systems in order to achieve “*meaningful use*” objectives with respect to healthcare quality.

Previous research has emphasized the need for adopting quality management practices together with healthcare information systems for efficient use of hospital beds (Büyükoçkan & Çifçi, 2012; Büyükoçkan, Çifçi, & Güleriyüz, 2011; Mango & Shapiro, 2001), for example, to prevent adverse drug events that result in reduced patient length of stay (Davenport & Glaser, 2002). Quality in hospitals is generally manifested as patients’ medical complications and mortality. Hospitals benchmark their complications and mortality with ‘expected’ levels that are adjusted for patients’ demographic mix and severity. The cause of patient complications can be often traced to patient care process failures resulting from inefficient or poor coordination. Complications not only increase hospital costs but can also result in harm to the patients and in the worst-case scenario result higher mortality rates.

Previous research has empirically investigated the relationship between operational efficiency and healthcare quality but the findings are mixed. A report prepared for the Agency for Healthcare Research and Quality (AHRQ, 2006) and a review paper (Chaudhry, Wang, & Wu, 2006) found some evidence of cost reduction and quality improvement through healthcare IS in a few hospitals. However, the results were not generalizable. Few studies that have addressed the relationship between hospital efficiency and quality have arrived at conflicting conclusions. For instance, some studies have found a positive association between operational efficiency and healthcare quality in hospitals (Carey & Burgess, 1999; Clement, Valdmanis, Bazzoli, Zhao, & Chukmaitov, 2008; Nayar & Ozcan, 2008) while others have found a negative association (Maniadakis, Hollingsworth, & Thanassoulis, 1999; Morey, Fine, Loree, Retzlaff-Roberts, & Tsubakitani, 1992) leaving the possibility that there may be a balance that can be struck.

Quality guru Deming proposed that constantly improving the system of production and service by most up-to-date process improvement techniques and to critically re-examine care processes, simplify process flows, and consequently improve operational efficiency and quality (Deming, 1986). Similarly Crosby (1979) proposed that the optimal quality level is zero defects which is based on the belief that producing higher quality products is always less costly than producing low quality products. This has led to the famous claim that quality is “free.”

The first research question driving this study is “*Can hospitals improve their operational efficiency as well as healthcare quality by investments in information systems?*” Further, we identify the interplay of efficiency and quality and identify characteristics of the hospitals that can better take advantage of their IT investments. Hence, the second research question is, “*What is the optimal balance of efficiency and quality relative to IT investment?* In other words, “*What is the ‘sweet spot’ of IT investment at which both operational efficiency and service quality are maximized?*”

In addition to seeking answers to the above research questions, we aim to contribute to the literature with an alternative methodological approach based upon a two-stage double bootstrap data envelopment analysis (DEA), in line with Simar and Wilson (2007). In the first stage, we use DEA to estimate efficiency scores for 187 US hospitals for 2004 and 2005. Since there are multi-input

and multi-output in the case of hospital production process, we choose a DEA approach in order to measure hospital efficiency. This approach allows us to take the heterogeneity of output into account. The DEA approach also enables us to investigate changes in input mix and the consequent savings from reducing operational inefficiency and improving healthcare quality. This helps managers and policy makers identify sources of operational inefficiency in relation to the quality improvements in hospitals. Despite the popularity of DEA to measure efficiency in hospitals, few studies have used bootstrapping to account for measurement errors in estimates, the exceptions being Staat (2006) and Araújo, Barros, and Wanke (2014), among others. In the second stage, efficiency scores are treated as a function of IT, service quality and other determinants of efficiency in healthcare such as teaching status, case mix and location. Following, previous studies (e.g. Araújo et al. (2014), Barros and Peypoch (2009)), a bootstrapped truncated regression is used to estimate the relationship between efficiency scores and its determinants.

The rest of the paper is organized as follows. Section 2 provides the theoretical background on IT and healthcare efficiency and quality. Section 3 gives an overview of the data followed by empirical model and the variables that enter into the empirical analysis in Section 4. Main findings and discussion of findings are presented in Section 5 and Section 6 respectively. Finally, Section 7 provides some concluding remarks.

2. Theoretical background

2.1. Impact of IT on hospital efficiency or/and quality

There are two rival theories on the relationship between quality and efficiency. Juran and Gryna (1980) develop the concept of an optimal quality level by trading off the appraisal and prevention costs. They argue that the optimal quality level implies a strictly positive proportion of defectives, and once the optimal quality level has been achieved, any attempt to improve further will actually lead to increased costs. On the other hand, Deming (1986) and Crosby (1979) argued that optimal quality level is zero defects and that zero defects do not increase the cost. In a later study, Fine (1986) tried to resolve the disagreement between these two rival theories and developed a model in order to show that when quality-based learning affects quality control costs, firms have the motivation to target zero defects. However, the findings of empirical studies support the interpretations of Deming and Crosby (Abernathy, Clark, & Kantrow, 1981; Garvin, 1983; Hendricks & Singhal, 1996, 1997; Hendricks & Singhal, 2000).

The views of Crosby and Deming are relevant to improvements in operational efficiency and quality in healthcare as well. Deming proposed constantly improving the system of production by cutting-edge process improvement techniques; to critically re-examine care processes and simplify patient flows and consequently improve operational efficiency and healthcare quality. Business process redesigns (BPR) with the purpose of quality improvements has also been examined in the IT business value research (Grover, Teng, Segars, & Fiedler, 1998).

For instance, Barua, Lee, and Winston (1996) proposed a theory of business value complementarity that argues IT investments and process redesign cannot succeed in isolation since IT and business process redesign are complementary factors (Devaraj & Kohli, 2000). Himmelstein, Wright, and Woolhandler (2010), linked computerization data at approximately 4000 hospitals with administrative cost data (from Medicare Cost Reports) and cost and quality data (from the 2008 Dartmouth Health Atlas) and investigated whether more computerized hospitals had lower

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