



# The effect of experience, ownership and focus on productive efficiency: A longitudinal study of U.S. hospitals



David Xin Ding\*

University of Houston Information and Logistics Technology Dept., T2-230C Houston, TX 77204, United States

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## ABSTRACT

Focusing on organizational learning research in healthcare settings, this paper studies how experience, ownership and focus affect productive efficiency in U.S. hospitals. Building on organizational learning theory, health economics and the focused factory concept, we propose that hospitals learn to improve productive efficiency and the relationship between productive efficiency and cumulative experience is curvilinear. We also hypothesize that clinical focus has a positive effect on productive efficiency and that nonprofit hospitals and proprietary hospitals trade off costs and quality differently. The proposed hypotheses are tested with yearly performance data for over 3700 major U.S. hospitals spanning from 1996 to 2010. We find strong support for the proposed hypotheses.

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## 1. Introduction

Between 1990 and 2009, the average in-hospital stay length reduced from 6.4 days to 4.8 days (National Center for Health Statistics 2011, Table 103). However, national health expenditures increased significantly from \$724 billion to \$2,486.3 billion over this period, or 343.41% (National Center for Health Statistics 2011, Table 125). According to expenditure studies conducted by, [Fuchs \(2005\)](#) and [Bush \(2007\)](#), the efficiency associated with hospital operations is low. Here we adopt Association for Healthcare Research and Quality (AHRQ)'s definition of efficiency as producing outputs at lower costs ([Greenberg and Campion, 2006](#)).

Although the comprehensive health care reform was expected to improve the system through quality improvements and cost reductions, no agreement has been reached concerning its overall effects ([Kocher and Sahni, 2010](#); [Orszag and Emanuel, 2010](#)). A natural question that arises from the debate is: whether U.S. hospitals, known for their "notorious" costs ([Porter and Teisberg, 2006](#)), ever learned to improve efficiency? Understanding how hospitals learn to reduce costs while delivering quality care is of critical importance to meet the aims of Affordable Care Act. Prior research has empirically examined how experience affects clinical performance for certain surgical procedures ([Black et al., 2004](#); [Huckman and Pisano, 2006](#); [Tucker et al., 2007](#)). However, limited

research exists on how hospitals learn through cumulative experience and even fewer studies attempt to identify contextual factors that may contribute to hospital-wide learning ([Pisano et al., 2001](#)). Have hospitals learned to improve productive efficiency through cumulative patient volume? Do operational characteristics such as clinical focus affect the learning rates? Is there a tradeoff between productive efficiency and quality? This research aims to answer those research questions.

In this study, we empirically examined productive efficiency across U.S. short-stay acute-care hospitals, using cost reports collected by the Centers for Medicare and Medicaid services (CMS). We merged the CMS data with hospital records collected by the American Hospital Association (AHA) and identified longitudinal data on characteristics and cost performance for over 3700 hospitals from 1996 to 2010. We also identified hospital quality performance with hospital mortality rates, readmission rates and patient experience released by AHRQ. This unique dataset allows us to compare learning rates and outcomes among hospitals with varying clinical focus by controlling for relevant characteristics.

Based on a longitudinal analysis of the national sample of hospitals, our results show that hospitals indeed learned to control operating costs and thus to improve productive efficiency through cumulative patient volume. The finding is subject to the control of inflation and a range of confounding factors including legislations, labor costs, insurances, patient mixes, and relevant hospital characteristics. We also find that clinical focus has a positive impact on hospital performance as highly focused hospitals learned faster than their counterparts in controlling operating costs. Lastly, our

\* Corresponding author. Tel.: +1 713 743 4095.  
 E-mail address: [xding@uh.edu](mailto:xding@uh.edu)

results support the cost-quality tradeoff as shown in general operations literature.

There are several managerial and policy implications that we can draw from the research. From a health policy perspective, whether and to what extent any differences in productive efficiency improvement among hospitals exist have great implications for various policies currently being considered by federal and state governments. For instance, the Health Care Reform aims at emulating cost practices of efficient healthcare systems and adjusting reimbursement rates based on cost performance (Bach, 2010). Our research identifies hospital characteristics that have contributed to productive efficiency longitudinally and thus casts new light on potential practices improving hospital efficiency. From a hospital management perspective, healthcare providers have been looking for ways to deal with lower reimbursements from CMS. Our research finds empirical evidences on the connection between clinical focus and productive efficiency, suggesting clinical focus as a potential contributor for efficient hospital operations. Our research also confirms the cost-quality tradeoff in hospital settings, as shown by operations management literature (Jacobs et al., 2009). The finding suggests that policy makers and healthcare agencies should incorporate quality outcomes to evaluate the cost performance of hospitals. Current reimbursement practices can also provide further financial incentives for quality and patient safety improvement. For instance, Medicare proposed a new purchasing program to reward hospitals with incentive payments for their improvements in clinical quality and patient experience.

In what follows, we start by describing relevant literature on productive efficiency, organizational learning, hospital focus and the cost-quality tradeoff. We next present our hypotheses with analysis results and discussions. Finally, we summarize our contributions and future directions.

## 2. Research framework

### 2.1. Productive efficiency

In the healthcare setting, efficiency has been defined and measured in multiple ways to reflect the range of inputs and outputs that are of interest to stakeholders involved in the system. We adopt the healthcare efficiency typology proposed by AHRQ and examine efficiency measurements at three levels: *entity*, *output*, and *input* (Greenberg and Campion, 2006; Hussey et al., 2009). According to the typology, the first level of analysis is to explicitly identify the *entity* that is currently being assessed and the assessment objectives. Our interests lie in the performance at the hospital level and therefore we view efficiency as how hospitals produce outputs with certain inputs. Our approach is different from prior learning-curve studies in healthcare settings, which mainly examine efficiency at the level of surgical units. The next level in the typology identifies the *outputs* of interests, which can be categorized as health services (e.g., outpatient visits, surgical procedures, prescriptions) or health outcomes (e.g., mortality, readmission rates, glucose control). As suggested by healthcare researchers, patient volumes measured by the number of patient days or admissions can be effective measurements of aggregate health services at the hospital level (Burgess and Wilson, 1996; Carter et al., 1997; Devaraj and Kohli, 2000; Hollingsworth, 2008). The third level identifies the *inputs* for producing health service *outputs*, which include counts (e.g., physicians hours, available bed days) or costs (e.g., operating expenses, fixed assets). We chose to study the cost performance of hospitals as hospital costs account for approximately one third of national health expenditures. Therefore, we measure the inputs as a function of operating expenses, which includes costs associated with the operations of a hospital. According to CMS, hospital operating

expenses include employee salaries and benefits, medical supplies, rentals, insurance, professional fees, and depreciation, etc.

In summary, we measure hospital efficiency with two separate indicators: cost per patient day and cost per patient admission. These two indicators have been widely used to assess hospital efficiency by a number of healthcare researchers and agencies (Coyne, 1982; IOM, 2001; Sloan et al., 2001; GAO, 2003a,b; McGlynn, 2008; Hussey et al., 2009). To differentiate our measurements from other efficiency instruments, we follow AHRQ's efficiency typology and name our efficiency measurement as *productive efficiency*, defined as how hospitals (i.e., *entity*) produce patient days and admissions (i.e., *output*) at lower operating costs (i.e., *input*) (McGlynn, 2008). Our definition and operationalization is consistent with the notion of efficiency in operations management research (Jacobs et al., 2009).

### 2.2. Organizational learning

Organizational learning has drawn research interests from a variety of research disciplines. While studying airplane assembly lines, Wright (1936) first documents a linear logarithm relationship between cost and cumulative production experience. Starting from Wright, researchers have extensively examined the impact of cumulative production experience on operational performance across different industries and suggested that organizations in general achieve performance improvement through cumulative production experience (Pisano et al., 2001). The fundamental assumption of organizational learning is that organizations can improve performance through exploiting existing competencies including internal resource alignment, variety reduction, and efficiency enhancement. However, the short-term improvements derived from exploitations can interfere with long-term performance when external environments change overtime (March, 1991; Uotila et al., 2009). Hence, an organization's learning curve consists of two major components—how fast the organization learns from experience with internal operations and how fast such learning effects relapse in changing external environments. The curvilinear relationship between experience and performance, U-shaped (e.g., airline complaints, failure rates) or inverted-U shaped (e.g., productivity), has been found by studies across different industries (Ingram and Baum, 1997; Sturman, 2003; Lapré and Tsikriktsis, 2006). To examine the curvilinear relationship, Lapré and Tsikriktsis (2006) incorporate the square of cumulative operating experience in the learning model:

$$\ln(f(E_t)) = \alpha + \mu_1 E_t + \mu_2 E_t^2$$

where  $E_t$  captures the cumulative operating experience up to time  $t$ ,  $f(E_t)$  a learning outcome of cumulative operating experience, and  $\mu_1$  the learning rate and  $\mu_2$  the relapsing rate. We follow Lapré and Tsikriktsis (2006)'s approach to examine hospital learning by modeling hospital productive efficiency as a function of cumulative patient volume. We further expand the curvilinear learning model by considering hospital clinical focus.

Most organizational learning studies have been conducted in manufacturing settings (Argote et al., 1990; Argote, 1996; Hatch and Mowery, 1998; Sinclair et al., 2000; Balasubramanian and Lieberman, 2010). Recently, empirical scholars have shown increasing interests in studying organizational learning in various hospital settings. Specifically, they have examined how different units including cardiac surgery, radiology, total joint replacement, and ICU learn to reduce operative procedure times through cumulative experience at various levels (Pisano et al., 2001; Edmondson et al., 2003; Black et al., 2004; Reagans et al., 2005; Huckman and Pisano, 2006; Tucker et al., 2007). Although those studies suggest an association between clinical performance and cumulative volume

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