

# **Accounting Performance, Cost Structure, and Firms' Capacity Investment Decisions**

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### **Abstract**

This study examines the effects of accounting performance, cost structure, and operational factors on firms' capacity investment decisions. We combine insights from operations and accounting theory and posit that accounting performance measures such as contribution margin and the proportion of fixed cost in the cost structure interact with operational factors such as capacity utilization and demand variability to influence firms' capacity investments. Empirical analyses using department-level data from the US hospital industry for the period 1998 to 2005 indicate that superior accounting performance, a high proportion of fixed costs in the cost structure, high levels of capacity utilization, and high variability of demand have positive effects on capacity investment decisions. In addition to these independent effects, we hypothesize and find interactions between operational and accounting factors. Superior accounting performance reduces the need for high capacity utilization when hospitals make capacity decisions. Demand variability influences the noise in accounting performance measures and hence negatively interacts with accounting performance in capacity decisions. In addition, the proportion of fixed cost interacts with capacity utilization to influence capacity investment decisions such that firms with a higher proportion of fixed costs in their cost structure place a higher weight on capacity utilization when making investment decisions. This empirical study fills a gap in the capacity investment literature and contributes to the understanding of operational and accounting determinants of firms' capacity investment behaviors.

## 1.0 Introduction

Investments in capacity are among the most important decisions for a firm, not only because of the magnitude of the financial outlays that such decisions entail, but also because of the implications of incorrect capacity decisions. Underinvestment in capacity can result in lost revenues and hurt a firm's competitive position, whereas overinvestment results in excess capacity and associated unfavorable effects on fixed costs (Henderson and Cool 2003). Excess capacity can be very expensive, for example, the estimated cost of an empty hospital bed is \$65,694 (Gaynor and Anderson 1995). In addition to firm-level outcomes, sub-optimal investments in capacity can have adverse policy implications in industries such as health care and education. For example, inadequate capacity can lead to deterioration in quality of care in hospitals if patients are restricted from being admitted, discharged early, or have to be routed to other hospitals (Sharma, Stano, and Gehring 2008; Litvak et al 2008).

Extant literature has explored how firms make capacity decisions and identified the importance of accounting performance and operational factors on such decisions. However, these factors have largely been explored individually using analytical models. Combining insights from analytical models in the accounting and operations literature, we investigate the role of accounting and operational factors as well as interactions amongst these factors that drive capacity investments. Our main objectives are to first explore whether accounting, operational, and environmental factors have additive effects on capacity decisions. That is, are the main effects significant even after the other effects are included? Second, we examine whether accounting, operational, and environmental factors have interactive effects on capacity decisions. Further, do these interactions imply that these effects are substitutes, or complements? The purpose is to demonstrate that accounting and operational factors interact and that a failure to

consider these interactions can lead to an under- or over-estimation of the magnitude of influence that these factors have by themselves.

Based on existing analytical models and prior research (Banker and Hughes 1994; Balachandran et al. 1997a and 1997b ; Balakrishnan and Sivaramakrishnan 2002; Gox 2002; Balakrishnan et al. 2004), first we predict that accounting performance and capacity utilization are positively associated with capacity investment. While these predictions appear unequivocal, prior literature has not empirically established these results. Second, we explore the influence of demand variability on capacity investment. We distinguish between demand uncertainty arising from macroeconomic shocks, and demand variability arising from stochastic business operations. Although prior literature has shown that demand uncertainty has a negative influence on capacity investment (Kallapur and Eldenburg 2005), we predict that demand variability is positively associated with capacity investment because firms facing higher demand variability invest in capacity to cover the same proportion of demand as when demand variability was lower. Third, since investment in capacity increases the extent of fixed cost in the cost structure, we examine the effect of the cost structure on capacity decisions. We predict that the proportion of fixed cost in the cost structure positively influences capacity investments; i.e., because of the need to replace fixed assets, capital intensive firms invest more in fixed capacity than labor intensive firms.

Next, we examine interactions amongst accounting and operational variables. First, we predict that accounting performance interacts with capacity utilization in influencing capacity decisions such that firms which have lower capacity utilization care more about accounting performance when making capacity decisions. Second, we predict that higher demand variability increases the noise in accounting performance measures and therefore managers place less

weight on accounting performance measures while making capacity decisions. Finally, we predict that fixed cost structure interacts with capacity utilization to drive capacity investments such that in capital-intensive firms, capacity utilization has a more positive effect on capacity investment because of high break-even volumes.

We empirically test our predictions using 6,027 department-level observations from California hospitals for the period 1998 to 2005. The hospital industry provides a suitable context to examine these research questions because capacity decisions have major implications not only for the performance of the individual hospital, but also for the communities where these hospitals are located. In addition, although the production function is similar in different hospitals, a variety of cost structures is observed in practice. We use department-level data because in the hospital industry, investments are tied to a specific department's production function and directly benefit that department. We examine investment decisions only and not disinvestments because disinvestments occur in a variety of forms, which are strategically different but empirically difficult to distinguish (e.g. spin off, outsourcing, or shut-down). In addition, firms often face barriers to exit (Porter 1976), and these barriers to exit are especially pronounced in the hospital industry.

Our empirical results indicate support for all our main effects, i.e., investment in capacity is positively related to accounting performance, capacity utilization, demand uncertainty, and proportion of fixed cost in the cost structure. We also find support for our interaction hypotheses. First, superior accounting performance offsets the negative effect of low capacity utilization in capacity investment decisions. That is, higher accounting performance provides a "cushion" for hospitals and makes capacity utilization a less critical factor for investment decisions. Second, the association between capacity investment and accounting performance decreases as demand

variability increases. When the hospital's operational environment is relatively stable, accounting performance measures are more precise and provide better information to support the investment decision. Hence, accounting performance has a more significant effect on capacity investment decisions for hospitals that face low demand variability. However, hospitals that operate in an environment with high demand variability are more cautious in using accounting performance in capacity planning because accounting performance measures are noisier in such settings. These results provide evidence that managers take into consideration the properties of performance measures when they use such measures to make capacity decisions. Finally, for hospitals with higher fixed property, place, and equipment related fixed costs (PPE costs) in their cost structures, capacity utilization is a more significant driver of additional capacity investment compared to hospitals with a low fixed-cost structure. Because break-even volumes are higher in capital-intensive firms, these firms require higher capacity utilization to justify additional investments.

This paper makes important contributions to accounting research. First, the hospital industry has a high proportion of fixed costs and capacity planning is particularly challenging in this industry. Generalizing beyond the hospital industry, in the manufacturing sector, 30 to 60 percent of costs are committed to capacity and supportive resources (Banker et al.1995). The magnitude of capacity costs in many industries demonstrates the economic importance of capital investment decisions. While there is significant analytical research on capacity investment, very few empirical studies examine actual firm behaviors. Empirical testing is warranted to fill the knowledge gaps and to extend our understanding of firms' decision making behavior regarding capacity investments. Second, the empirical results from this study provide evidence that accounting performance is a critical factor influencing a firm's investment decisions. This is

consistent with findings from analytical research that explores the role of accounting information in capacity planning (Balachandran 1997a and 1997b; Balakrishnan and Sivaramakrishnan 2002; Gox 2002) and provides useful implications for firms engaged in capacity planning. Third, we identify two other accounting factors, performance measure noise and the extent of fixed cost in the cost structure, which influence capacity decisions but have been not been examined by prior literature. Finally, while prior literature identifies accounting performance and proportion of fixed cost in the cost structure, as well as operational factors such as capacity utilization and demand variability as important determinants of capacity investment decisions, the most important contribution of our study is to empirically demonstrate the presence of interactions among accounting information, cost structure, and other operational factors in capacity planning. Understanding and calibrating these interactions are critical because such interactions have additive as well as offsetting effects on capital investments. Failure to consider these interactions can lead to inferior resource allocation decisions.

The remainder of this paper is organized as follows. The next section reviews the literature in the area of capacity planning and develops hypotheses. Section 3 describes the sample and variables, and introduces the empirical models. Section 4 summarizes the results. Section 5 contains the conclusions.

## **2. Theory and Hypotheses Development**

### **2.1 Accounting Performance and Capacity Investment**

Accounting researchers posit that accounting information can be used to formulate simple rules to assist capacity decisions. These rules, in practice, are more implementable than are the stochastic programming approaches used by the operations research literature (Banker and Hughes 1994; Balachandran et al. 1997a; 1997b; Balakrishnan and Sivaramakrishnan 2002).

When evaluating capacity investments, firms tradeoff the opportunity cost of under-investment with the acquisition cost of the investment. Accounting performance regarding a product's profitability is a crucial factor in evaluating the opportunity cost of under-investment. Prior studies such as Banker and Hughes (1994) provide evidence that product costs provide economically sufficient information for capacity planning and pricing decisions when capacity constraints are soft. Balachandran et al. (1997b) analytically show that a product's gross margin provides useful information in capacity investment decisions. Harrison and Van Mieghem (1999) use the multi-dimensional newsvendor model which assumes that overhead costs are sunk costs and focuses on contribution margins instead of gross margins. Similar to Balachandran et al. (1997b), their model predicts that higher contribution margins lead firms to invest in capacity to cover a larger proportion of demand. Accounting performance also stimulates investment by providing a resource buffer for firms to invest.

Based on the findings of analytical models in the accounting and operations literature, we predict that firms will use accounting performance (i.e., contribution margin and/or gross margin) when making capacity investment decisions, because accounting performance measures the opportunity cost of under-investment. That is, firms invest more capacity in products or services that have superior accounting performance.

*H1: Investment in capacity is positively associated with accounting performance.*

## **2.2 Capacity Utilization and Capacity Investment**

Firms install or expand capacity to fulfill demand. Analytical literature in accounting and operations documents that current capacity utilization has a stimulating effect on future capacity investment (Balachandran et al. 1997a; Harrison and Van Mieghem 1999). When environmental uncertainty is high, firms with high capacity utilization run the risk of encountering capacity

constraints. Thus, they are likely to incur opportunity costs arising from unfulfilled demand. For hospitals, these opportunity costs not only include lost revenues, but also harmful reputation effects when severely ill patients are turned away. Under such circumstances, firms have to augment capacity to reduce the risk of losing revenue and other repercussions such as loss of reputation.

In addition to opportunity costs associated with unfulfilled demand, accounting research on congestion costs argues that costs increase in proportion to capacity utilization when firms operate in a stochastic environment (Banker et al. 1988; Balakrishnan and Soderstrom 2000). These studies suggest that maintaining capacity in excess of expected demand is optimal. The health economics literature also presents similar findings in the context of the hospital industry (Gaynor and Anderson 1995). An additional factor that drives capacity decisions in the hospital industry is “turn-away probability” (Joskow 1980). Turn away probability refers to the probability that patients would have to be turned away due to capacity constraints. Hospitals prefer to treat all arriving patients; hence, the turn-away probability is typically kept very low. For example, in 2004, Stanford University teaching hospital was turning away more than 40 children a month, either refusing emergency cases and transfers from general hospitals or canceling surgeries because of a lack of space on surgical floors. Not only did the hospital obtain adverse press as result, but it also caused concern amongst the medical staff. One of the Medical Directors at the hospital commented that “These kids are by far the sickest kids in California” (Morrissey 2004). As capacity utilization increases, hospitals must invest in more capacity and preserve capacity sufficient to maintain their target turn-away probability.

In sum, high capacity utilization increases the likelihood of incurring opportunity costs, congestion costs and higher probability of turn-away. We predict that firms consider these risks when capacity utilization is high, while making capacity investment decisions.

*H2: Investment in capacity is positively associated with capacity utilization.*

### **2.3 Demand Variability and Capacity Investment**

Demand uncertainty adds an additional layer of complexity to capacity planning decisions. Prior literature classifies demand uncertainty into three categories (Paraskevopoulos et al. 1991). The first relates to a structural shift in demand which results in an abrupt change in the parameters of the demand equation. This category of demand uncertainty associated with macroeconomic environment is considered a shock, and has received the most academic attention. Environmental demand uncertainty is likely to have a negative effect on capacity investment. For example, Kallapur and Eldenburg (2005) use insights from real options theory and find that environmental uncertainty associated with a change in the Medicare reimbursement system causes hospitals to postpone capacity investment decisions. The second type of demand uncertainty manifests as the forecast error of the econometrically estimated demand equation and arises from the forecast error of the exogenous assumptions. In this study, we examine this latter type of demand uncertainty. We focus on the operational variability of demand instead of the uncertainty of macroeconomic environment since no major environmental changes occurred during the sample period.<sup>1</sup> To differentiate it from environmental demand uncertainty, we term this second type of demand uncertainty as demand variability.<sup>2</sup> Contrary to environmental demand uncertainty, demand variability is likely to have a positive influence on capacity

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<sup>1</sup> The Balanced Budget Act (BBA) was implanted in 1997, which influenced hospital margins. However, during the sample period (i.e., 1998-2005), all hospitals faced similar impacts from the BBA. In the results section, we examine the robustness of the results to the implementation of the BBA.

<sup>2</sup> Demand variability is defined as the extent to which demand varies across time and captures a firm's risk exposure (Van Mieghem 2007).

investment (Joskow 1980; Gaynor and Anderson 1995). The third type of demand uncertainty relates to other influences, such as the rate of learning, which cannot be estimated econometrically but are still present.

The operations literature provides analytical evidence that higher demand variability stimulates capacity investment as firms try to cover the same proportion of demand covered when demand variability was lower (Harrison and Van Mieghem 1999). Generally, for a given capacity utilization and contribution margin, when demand is stable, the capacity level required is lower than the capacity level required when demand is volatile. This is because in stable demand conditions, firms do not need to hedge against risk exposure to the same extent as when they face volatile demand (Van Mieghem 2007). In other words, decreased risk exposure to stochastic demand decreases the level of capacity resources, and reduces the likelihood of investing. This leads to the following prediction:

*H3: Investment in capacity is positively associated with demand variability*

## **2.4 Cost Structure and Capacity Investment**

While earlier research in management accounting considers the firm's cost structure as given, more recent literature argues that firms make cost structure choices that are in alignment with their strategy and that these cost structure choices are aimed at optimizing the stakeholders across the value chain. A comprehensive review of this literature is provided by Anderson (2006), who provides a framework that ties strategic cost management to strategy development and performance evaluation. Anderson (2006) identifies two forms of strategic cost management. These forms include, *structural* cost management that considers the influence of organizational design elements such as firm boundaries, scale, and governance on a firm's cost structure, and *executional* cost management, which uses management accounting tools for measurement and

analysis of cost performance, compares them with competitive benchmarks, and identifies opportunities for improvement. The point is that firms are not mere passive absorbers of a given cost structure but have the ability to choose a fixed cost structure that best aligns with their strategy and operations.

One important structural factor influencing costs is the extent of investment in fixed assets. Investment in fixed assets increases the extent of fixed cost in the cost structure. We predict that a firm's technology matrix influences investment decisions. Technology matrix refers to the choice between investing in own assets which imposes a cost structure with a greater proportion of fixed cost, versus using other mechanisms such as outsourcing that increase the extent of variable costs. We predict that capital-intensive hospitals are more likely to invest in capital than are labor-intensive ones because the former group prefers a high fixed cost structure and in addition has to manage obsolescence and replacement of old equipment.

*H4: Investment in capacity is positively associated with the proportion of fixed cost in the cost structure.*

These previous sections have focused on the main effects of accounting performance, capacity utilization, demand variability, and cost structure on capacity investments. While prior literature has identified these factors as essential drivers of capacity investments, we include all these factors in the same empirical model to further examine whether these factors have an offsetting effect or an additive effect on capacity investment. The next subsection considers interactions amongst accounting and operational factors.

## **2.5 Interaction of Accounting Performance and Capacity Utilization on Capacity Investment**

H1 predicts that capacity investment is positively associated with accounting performance, and H2 predicts that capacity investment is positively associated with capacity utilization. In this section, we posit that in addition to these main effects, accounting performance interacts with capacity utilization in determining a firm's capacity investment decisions. While planning capacity, a firm evaluates the expected opportunity cost of underinvestment to justify the acquisition cost of capacity. Harrison and Van Mieghem (1999) conclude that firms invest in capacity only if the expected shadow value outweighs the acquisition cost.<sup>3</sup> Capacity utilization affects the likelihood of incurring an opportunity cost of unfilled demand and accounting performance influences this opportunity cost. When accounting performance is high, the expected opportunity cost of under-investment exceeds the acquisition cost at a lower level of capacity utilization.<sup>4</sup> On the other hand, when accounting performance is low, the acquisition cost of capacity is likely to be lower than the opportunity cost of unmet demand only when unmet demand is high. That is, for low profit margin products or services, the firm obtains benefits from investing in additional capacity only when capacity utilization is high. In sum, we predict that firms with higher accounting performance will place less weight on current capacity utilization when making capacity decisions. Superior accounting performance offsets the negative effect of low capacity utilization on capacity investment decisions.

*H5: As accounting performance increases, the effect of capacity utilization on capacity investment decisions decreases.*

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<sup>3</sup> Harrison and Van Mieghem (1999) formulate capacity planning model as  $E\lambda(K^l, D) = pP(D \geq K^l) = c^e$ .  $K^l$  is the optimal capacity level.  $D$  is the uncertain demand.  $\lambda(K^l, D)$  is the shadow value of investment (i.e., the incremental value created by additional unit of capacity).  $p$  stands for the contribution margin per unit of capacity;  $P(D \geq K^l)$  is the probability that demand is greater than capacity level.  $c^e$  is the acquisition cost of the unit capacity.

<sup>4</sup> Application of the concept of break-even analysis also provides a consistent conclusion: a higher contribution margin lowers the level of break-even volume.

## 2.6 Interaction of Accounting Performance and Demand Variability on Capacity

### Investment

Since product cost provides information for capacity planning, H1 hypothesizes that investment in capacity is positively associated with the level of accounting performance. H3 predicts that higher demand variability is associated with higher capacity investment to ensure that the firm covers the same proportion of demand as when demand variability is lower. In this section, we examine how demand variability interacts with accounting performance in capacity planning. In H1, we considered the influence of the *level* of accounting performance on capacity investment. In this section, we consider the influence of the *variability* of accounting performance on capacity investment.

Prior research indicates that it is optimal for firms to place less weight on a performance measure which is noisy (Banker and Datar 1989, Feltham and Xie 1994). A noisy performance measure is influenced by factors outside the control of the manager and therefore less useful for contracting. When demand variability is high, accounting performance measures such as revenues and operating margins are likely to be noisier due to variability in performance, which is driven by volatile demand. Demand variability is beyond the manager's control. Thus, firms reduce the weight they place on accounting performance in capacity decisions. In contrast, when demand variability is low, accounting performance measures are less noisy; hence, decision-makers can place more reliance on accounting measures in making capacity investment decisions.

Therefore, we predict that when demand is less volatile, accounting performance will have a greater effect on capacity investment. When demand volatility increases, the positive effect of accounting performance on capacity investment decisions decreases.

*H6: As demand variability increases, the effect of accounting performance on capacity investment decisions decreases.*

## **2.7 Interaction of Fixed Cost Structure and Capacity Utilization on Capacity Investment**

Real options theory suggests that firms adjust less flexible factors less frequently unless the marginal value of the adjustment is sufficiently high (Dixit 1997). Capital-intensive firms have a higher proportion of fixed costs associated with asset depreciation and amortization, and these costs have to be incurred regardless of capacity utilization. Thus relative to labor-intensive firms, capital intensive firms have lower flexibility in the factors that they can adjust to offset lower demand. To offset the reduction in flexibility, capital-intensive firms require a high level of capacity utilization before they invest in more capacity. Furthermore, because break-even volumes are higher in firms with high fixed cost structures, higher levels of capacity utilization are required to justify investments in additional capacity. Hence, when making capacity acquisition decisions, firms with high PPE-related fixed-costs in their cost structures care more about capacity utilization than do firms with low fixed-costs.<sup>5</sup>

*H7: Capacity utilization has a more positive effect on capacity investment for firms with high fixed costs in their cost structures relative to firms with low fixed costs.*

## **3. Data and Methods**

### **3.1. Research Sample**

We use department level data from California hospitals to test the hypotheses. The hospital industry provides an appropriate setting because the production function (i.e., patient treatment) not only requires capital investments for diagnosis technology, but also is very labor

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<sup>5</sup> Fixed costs can arise from investments in PPE, or from long term contracts with labor. In the hospital industry, a substantial amount of costs arise from long-term contracts with medical staff, which give rise to labor-related fixed costs. Because our interest is in examining fixed PPE capacity investments, in the analysis related to H7, we restrict our analysis to fixed costs arising from investments in PPE and do not include fixed costs arising from long-term contracts with the medical staff.

intensive. We examine daily hospital service departments of hospitals licensed by the State of California, covering the period 1998 to 2005. We obtain data from the California Office of State Health Planning and Development (OSHPD). We choose 1998 to 2005 as our sample period because it is several years after the Prospective Payment System was introduced and further by this period, the selective-contracting legislation of the early 1980s was fully implemented (Hsu 2007). By 1996, the market share of managed care plans had stabilized to a fairly high level in California, whereas during the late 1980s and early 1990s, managed care plans were still in the process of building market share (Krishnan 2005).

We use department-level data rather than hospital level data to test hypotheses for three reasons. First, in the hospital industry, accounting (i.e., contribution margin and fixed cost structure) as well as operational factors (i.e., demand variability and capacity utilization) vary significantly across departments (Harper 2002; Bazzoli et al. 2003). Department level data represent the most accurate and relevant department-specific information. Second, the capacity resources of a particular department usually serve distinctive patients such as medical, surgical, intensive care, obstetric, pediatric and others (Joskow 1980). Investment decisions are usually made based on a specific department's situation and directly benefit that department, for example, the purchase of a new operation theater for the surgical intensive care department, or the addition of several postpartum beds for the obstetrics department. Third, the rate of technological change varies across services (Baker and Spetz 1999).

There are 27 daily hospital service departments listed in the OSHPD annual financial reports, although not every hospital operates all of these departments. See Appendix A for a list of these daily hospital service departments. Our sample includes only daily hospital service departments and excludes ambulatory services departments and ancillary departments, because

data required for computing capacity utilization are not available for these two groups of departments. Our original dataset includes data from 27 daily hospital service departments from 493 hospitals.

We take the following steps to obtain our final sample. First, we limit our sample to departments for which data on all variables are available. This step yields 13,290 department-year observations from 416 hospitals. Second, our study focuses on capacity investment activity not on capacity disinvestment and/or retirement activity. As mentioned earlier, disinvestment or divestment occurs in a variety of forms and there is likely to be variation in the strategic reasoning for choosing amongst these alternative forms. In addition, many industries face exit barriers, which are difficult to quantify empirically. Therefore we drop observations for which the change in depreciation expense from year  $t$  to year  $t+1$  is negative.<sup>6</sup> This step reduces the sample to 6,040 department-year observations. Third, to remove the effect of observations that might suffer data entry error, we require contribution margins to be less than 1. This eliminates 13 observations from the sample. Finally, we winsorize at 1% for all variables. The final sample consists of 6,027 department-year observations from 26 inpatient departments in 401 hospitals.

### **3.2. Variable Definitions**

#### ***Dependent Variable: Capacity Investment***

In this study, the measurement of capacity resources encompasses all capital capacity resources that depreciate, such as diagnosis devices or operation theaters. We use a binary variable, *Capacity Investment*, to capture departments with a major capacity investment. We use a dichotomous dependent variable rather than a continuous one because our focus is on *whether* firms make decisions to invest rather than *how much* they invest. A continuous variable may contain noise and hence not represent a firm's target level of the capacity investment because of

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<sup>6</sup> However, in our analyses, we examine the robustness of the results to the inclusion of divestments.

lumpy capacity investments. Prior literature documents lumpiness as an important characteristic of capital investments (Baumol and Sidak 2002; Balakrishnan et al. 2001). Furthermore, the acquisition price of a capacity resource largely depends on the nature of the resource. A department may purchase expensive resources because less expensive options do not exist or because the expensive equipment better serves the operational needs. While the dollar amount of investment may differ significantly from one department to another, the difference in investment amount may not necessarily imply differences in service capacity.

The OSHPD database does not provide information about the dollar amount of capital investments. However, when a department makes an investment, its depreciation expense increases accordingly. We use data on depreciation expense to measure investments in capacity. We use the median amount of depreciation expense increase within the same department category as a benchmark to identify whether its investment is above or below average. We treat department-year observations where the increase in depreciation expense is above the median as having a major investment in capacity, and those department-year observations where the increase in depreciation is equal or below the median as not having incurred major capacity investment. Hence, we group the sample by department, and obtain the departmental median amount of the increase in depreciation expense from year  $t$  to year  $t+1$ . *Capacity Investment* takes the value of 1 if the increase in depreciation expense from year  $t$  to year  $t+1$  is greater than the departmental median amount of the increase in depreciation expense, and takes the value of 0 otherwise.

We do not pool all departments to obtain a single median depreciation expense increase, but rather treat the 26 departments separately and calculate a median value for each department. Because of the differences in technical complexity among departments, obtaining 26 median

values for each department mitigates the confounding effect of inter-departmental differences on investment behavior. Moreover, the dependent variable captures investment decision occurred in year  $t + 1$ , and not year  $t$ . In this way we match investment decisions with the information available to the firm at the time of the investment (Guiso and Parigi 1999).

To obtain further evidence whether investment decisions are made at the department level, we draw a random sample of 11 hospitals for the entire sample period (1998-2005) and for each hospital examine the correlations amongst departmental investments across the years. The mean correlation of department investments for the random sample is 0.14. This implies that there is no systematic relation amongst departments in their investment decisions. To explore whether investments are clustered across years in hospitals, we examine the correlations between departmental investments for each year within each hospital. The average correlation across years is 0.08. These results suggest that departmental level analyses are appropriate.

While *Capacity Investment* of 1 unambiguously indicates that the department invests in its capacity, a *Capacity Investment* of 0 implies one of two cases. First is that the department does not significantly invest in capacity during the year. Second is that the department retires or disinvests part of its ongoing capacity, and at the same time purchases new capacity, resulting in an insignificant total increase in depreciation expense from year  $t$  to year  $t + 1$ . We cannot distinguish between these two cases in our analyses. That is, we assume that a *Capacity Investment* of 0 implies that the department does not make a major investment in capacity. We acknowledge that this is a limitation of our analyses.

### ***Independent Variables***

*Accounting performance*: Hospital expenses can be categorized as direct or indirect. Direct expenses are those that can be identified with the department, including departmental

depreciation expense, labor cost, supplies, lease and rentals, purchased services, and other direct expenses. Indirect costs are incurred by non-revenue-producing areas of the hospital, and cannot be identified either with a particular patient or a particular department of the hospital.<sup>7</sup> Among the six categories of direct expenses, only depreciation expense can be clearly labeled as fixed expense, i.e., expenses that do not vary with patient activity. The other five categories of direct expenses contain variable and fixed components. Therefore, direct expenses excluding depreciation expenses can act as an approximation of variable expenses. Based on prior analytical studies (Balachandran et al. 1997b; Harrison and Van Mieghem 1999), we measure accounting performance in two ways: *Accounting performance 1* is the net patient revenue minus total direct expense divided by net patient revenue (i.e., departmental margin), and reflects how well the departmental performance related to revenues and costs originating from that department. *Accounting performance 2* is the net patient revenue plus depreciation expense, minus total direct expense, and divided by net patient revenue (i.e., contribution margin).<sup>8</sup>

*Capacity utilization:* Following prior literature (Banker et al. 1986; Hsu 2007), we use total patient days divided by available patient days (i.e., 365 \* number of beds) to measure capacity utilization.

*Demand variability:* We use the standard error (i.e., square root of the error variance) of the department-specific patient days across the sample period to measure the extent of demand

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<sup>7</sup> We exclude indirect expenses in our margin calculation because we consider them less relevant in departmental investment decisions. Indirect costs are incurred by non-revenue-producing areas of the hospital, and allocated over all clinical revenue-producing departments. Individual departments have little control over indirect cost. Examples of indirect expenses are hospital financial services, information technology, and plant operations maintenance expense. Because there is no strong economic rationale for allocating common overhead in one manner versus another (Taheri 2000), OSHPD uses a complex and rather arbitrary algorithm to aggregate costs and allocate them to individual patients. Prior literature also suggests that hospitals measure departmental profitability using contribution margins, while a hospital's profitability is usually measured by operating margins (Dexter 1998; 2002; Macario 2001). Therefore, we do not anticipate that managers use allocated indirect expense to measure performance.

<sup>8</sup> Although hospitals report departmental net revenue, the calculation of net revenue at the department level is only an approximation. Hospital systems do not separate out the contractual allowances at the department level but apply the hospital percentage to each department. This is not likely to influence results significantly because on average the allocations are correlated with actual revenue flows.

variability across the sample period. A similar method is used in financial accounting literature to measure the volatility of stock return (Core et al. 2003).

*Fixed cost structure:* We create two proxies to measure fixed cost structure. *Fixed cost structure 1* is depreciation expense divided by labor cost and supplies. It approximates the ratio of fixed PPE cost to labor cost and supplies. *Fixed cost structure 2* is depreciation expense divided by total direct expenses. It measures the proportion of fixed PPE costs to total direct cost. Prior research (for example Acemoglu and Finkelstein [2008]) has used a similar method to measure the ratio of capital costs in the cost structure. In the hospital industry, a substantial proportion of the fixed costs also arise from long-term contracts with labor. However, we do not have data on the duration of hospital contracts with staff and hence our analyses are restricted to fixed costs arising from fixed asset investments. In any case, because our interest is in examining fixed capacity investments, consideration of PPE related fixed cost is appropriate for the empirical analyses.

#### ***Control Variables – Hospital Level***

*Ownership type:* The U.S. hospital industry can be categorized into three different ownership forms: non-government not for profit (including church and community-based hospitals), for profit (investor-owned hospitals), and government (state, city, county, and district hospitals). We include two dummy variables to control for ownership status: *For profit*, which takes the value of 1 if the hospital is a for profit hospital and 0 otherwise; and *Not for profit*, which takes the value of 1 if the hospital is a non-government not for profit hospital, and 0 otherwise. The government hospital is the omitted dummy variable. We assume that government hospitals are least likely to invest, because they have institutional constraints that complicate capacity investment decisions (such as obtaining tax or regulatory approval).

*Hospital staffed beds:* Hospital size has significant impact on hospital capacity decisions. Hospital size is measured by the number of staffed beds (Hancock, et al. 1976; Nath and Sudharshan 1994).

*Net margin:* As discussed in the previous section, departmental accounting performance has a significant impact on investment decisions. Although the effect of department level measures is much more direct than hospital level measures, our analyses includes net margin, which is net income divided by net patient revenue, to control for the effect of hospital level financial performance on departmental investment decisions.

*Case mix index:* *Case Mix Index* is a measure of the relative cost or resources needed to treat the mix of patients, based on the complexity of ailments of admitted patients. We include case-mix index to control for differences in service complexity among hospitals, because case mix index is often used to compare hospitals' capacity management decisions (Li and Benton 2003). Hospitals with higher case mix index treat more seriously ill patients than do hospitals with lower case mix index; hence, we project that higher case mix index is positively related investment decisions.

#### ***Control Variables – Department Level***

*Department dummies:* We include department dummies to control for department specific features, because different departments have different levels of technical complexity, and face different market environment and technology needs (Hsu 2007).

*Proportion of Medicare patients:* Our analyses include proportion of department level Medicare patients as a control variable. Because Medicare patients are reimbursed on a flat rate, they are not very profitable. We anticipate that higher proportion of Medicare patients is associated with lower capacity investments.

*Proportion of MediCal patients:* MediCal, is the California Medicaid program, and is also reimbursed based on a flat rate. Hence, we use it as a control.

*Departmental staffed beds:* We use this variable to control for department size.

Departments with more staffed beds are more likely to provide a greater variety of services, and therefore more likely to invest in capacity.

*Average length of stay:* Prior health care research suggests that length of stay affects hospital behavior (Lynk 1995). We use the annual average length of stay as a control variable. Patients typically receive more intensive and expensive services during the first few days of a hospital stay (Krishnan 2005). Higher length of stay may reduce the average intensity of service the department provides, and thus reduce the likelihood of investment in capacity. On the other hand, the longer is the average length of stay, the more complex are the ailments treated, and the more the hospital resources that are consumed (Lynk 1995). Departments with longer average length of stay are likely to invest more. Hence, we control for the average length of stay.

Table 1 summarizes the definitions of the dependent, independent, and control variables.

[Table 1 here]

### 3.3. Empirical Model

We test hypotheses using following probit estimation with departmental as well as hospital fixed effects:

$$\begin{aligned}
 Prob(Capacity\ Investment_{ijt}) = & F\left(\sum_i \alpha_i Department\ dummies_{it} + \beta_1 For\ profit_{jt} + \beta_2 Not\ for\ \right. \\
 & profit_{jt} + \beta_3 Hospital\ staffed\ beds_{jt} + \beta_4 Net\ margin_{jt} + \beta_5 Case\ mix\ index_{jt} + \beta_6 \\
 & Proportion\ of\ Medicare\ patients_{ijt} + \beta_7 Proportion\ of\ Medi-Cal\ patients_{ijt} + \beta_8 \\
 & Departmental\ staffed\ beds_{ijt} + \beta_9 Average\ length\ of\ stay_{ijt} + \beta_{10} Accounting \\
 & Performance_{ijt} + \beta_{11} Capacity\ utilization_{ijt} + \beta_{12} Demand\ variability_{ijt} + \beta_{13} Fixed\ cost \\
 & structure_{ijt} + \beta_{14} Accounting\ performance_{ijt} * Capacity\ utilization_{ijt} + \beta_{15} Accounting \\
 & performance_{ijt} * Demand\ variability_{ijt} + \beta_{16} Fixed\ cost\ structure_{ijt} * Capacity\ utilization_{ijt}
 \end{aligned}$$

$$+ \beta_{17} \text{Fixed cost structure}_{ijt} * \text{Demand variability}_{ijt} + \beta_{18} \text{Capacity utilization}_{ijt} * \text{Demand variability}_{ijt} + \varepsilon) \quad (1)$$

In the above equation,  $i$  denotes service departments,  $t$  denotes the year, and  $j$  denotes hospitals.

We estimate equation (1) using maximum likelihood estimation. Because we have multiple observations per hospital, we use standard errors clustered at the hospital level.

We mean-center independent variables that constitute the interaction terms (i.e., *Accounting performance*, *Capacity utilization*, *Demand variability*, and *Fixed cost structure*) to facilitate the interpretation of their direct effects. Since we use a probit model, the marginal effect of any independent variable is not directly given by that variable's coefficient, but is a nonlinear transformation function of that variable.<sup>9</sup>

A positive sign on  $\beta_{10}$  is consistent with H1 and implies that accounting performance is associated with capacity investment. A positive sign on  $\beta_{11}$  implies that capacity utilization influences capacity investment as predicted by H2. A positive on demand variability ( $\beta_{12}$ ) supports H3, demand variability will have a positive effect on capacity investment, because hospitals prefer to avoid turning away patients. H4 predicts that the department's proportion of fixed cost will have a positive effect on capacity investment decisions and a positive coefficient  $\beta_{13}$  would be consistent with this prediction. H5 predicts a negative interaction between accounting performance and capacity utilization; thus, the sign on  $\beta_{14}$  is likely to be negative. H6 predicts a negative interaction between accounting performance and demand variability; hence,  $\beta_{15}$  is anticipated to be negative. H7 indicates a positive interaction between fixed cost structure and capacity utilization, hence we expect a positive coefficient on  $\beta_{16}$ . For completeness, we

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<sup>9</sup> In this case, the transformation function is the standard cumulative normal function (Kennedy, 2003; Wooldridge, 2006).

include all interactions between operational and accounting variables, including fixed cost structure and demand variability ( $\beta_{17}$ ), and capacity utilization and demand variability ( $\beta_{18}$ ). However, we do not have theory to predict the signs on  $\beta_{17}$  and  $\beta_{18}$ .

## 4.0 Results

### 4.1. Descriptive Statistics

Table 2 contains the descriptive statistics for the sample. In the sample, 25% are for-profit hospital departments, 60% non-governmental not for profit hospital departments, and the remaining 15% are governmental hospitals. The median (mean) hospital net margin is 4.78% (3.9%). Capacity utilization has a median (mean) of 0.67 (0.68). The mean fixed costs are 2%. Although this appears low, recall that these include only PPE-related fixed costs. Moreover, on average our sample hospitals depreciate fixed assets over an 18 year time horizon. If mean administrative and general costs are included, mean hospital-level fixed costs are 5% in our sample. Table 3 contains the correlations amongst the variables.

[Tables 2 and 3 here]

### 4.2. Results of Hypotheses Tests

Table 4 and Table 5 contain the results of estimating Equation (1), which tests all the hypotheses. The variables that constitute the interaction terms (i.e., *Accounting performance*, *Capacity utilization*, *Demand variability*, and *Fixed cost structure*) are mean centered for ease of interpretation of main effects. The coefficients of department dummies, which represent the department-specific fixed effects of government hospitals on capacity investment, have limited interpretative value, and hence are not reported. As shown in Table 1, we create two proxies to measure accounting performance and fixed cost structure respectively for the purposes of sensitivity testing. Tables 4 (Table 5) reports the results using *Fixed cost structure 1* (*Fixed cost*

structure 2). Column 1 (Column 2) reports the results using *Accounting performance 1* (*Accounting performance 2*). Two-tailed  $z$  test scores are in parentheses.

[Table 4, Table 5 here]

Consider the results from the model using accounting performance 1 and fixed cost structure 1, which is shown in column (1) in Table 4. The coefficient on *Accounting performance* ( $\beta_{10}$ ) reflects the main effect of accounting performance on capacity investment decisions, and is significantly positive. This implies that accounting performance has a positive association with capacity investment, consistent with the prediction of H1. The coefficient on capacity utilization  $\beta_{11}$  is significantly positive, indicating that high capacity utilization is associated with capacity investment. This result is consistent with H2.

In Table 4,  $\beta_{12}$  is significantly positive implying that demand variability has a positive effect on capacity investment, as predicted by H3. These results are also consistent with prior analytical findings of Harrison and Van Mieghem (1999) and Van Mieghem (2007) who find that when demand variability is higher, firms increase capacity investments to enable them to serve the same proportion of demand as in lower demand variability conditions and to hedge from the risk imposed by unmet demand. That is, an increase in the risk exposure is associated with an increase in the likelihood of investing in capacity. The coefficient on fixed cost structure  $\beta_{13}$  is significantly positive, implying that hospitals' capacity investment behavior is consistent with their choice of technology matrix. That is, as predicted by H4, capital-intensive hospitals are more likely to continue investing in capital than are labor-intensive ones possibly because of the obsolescence of old equipment. In sum, our results show that accounting performance, capacity utilization, demand variability, and fixed cost structure have positive and additive effects on capacity investment.

We next analyze the results for the interactions. Recall that H5 predicts a negative interaction between accounting performance and capacity utilization. The sign on  $\beta_{14}$  is significantly negative, indicating that higher accounting performance provides a “cushion” and makes capacity utilization less critical in investment decisions. H6 predicts that the association between capacity investment decisions and accounting performance decreases as demand variability increases. The significantly negative coefficient on accounting performance \* demand variability ( $\beta_{15}$ ) supports this prediction. When demand is more stable, accounting performance plays a more significant role in capacity investment decisions. However, the importance of accounting performance in capacity planning decreases when demand is less stable because volatile demand increases the noise in accounting performance measures.

To further explore the association between demand variability and noise in accounting performance measures, we conduct two additional analyses. In the first, we split the sample based on median demand variability. We scaled demand variability by beds to control for size effects. Using data from the entire sample period (1998-2005), we examine the coefficient of variation of accounting performance for the two samples. For the low demand variability sample, the coefficient of variation for accounting performance<sup>1</sup> is 5.86, whereas for the high demand variability sample, the coefficient of variation for accounting performance<sup>1</sup> is 41.30. Thus, the higher demand variability sub-sample also has higher variability in accounting performance. Second, we examine the coefficient of variation of accounting performance 1 for each quartile of demand variability. The coefficients of variation of accounting performance 1 for quartile Q1, Q2, Q3, and Q4 are 4.46, 8.52, 29.57, and 82.40 respectively. These results support our argument that demand variability increases the noise in accounting performance measures.<sup>10</sup>

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<sup>10</sup> Results are similar when accounting performance 2 is used.

H7 predicts that, capacity utilization has a more positive effect on capacity investment in firms with high fixed cost structure. This prediction is supported by a significant positive  $\beta_{16}$ , which is the coefficient on fixed cost structure \* capacity utilization. These results suggest that capacity utilization is more important in determining capacity investment for capital-intensive hospitals than for labor intensive ones, probably because capital-intensive hospitals have higher breakeven volumes. All of the interaction hypotheses among accounting variables and operational variables are strongly supported. It is noteworthy that  $\beta_{17}$  is significantly positive, which implies that capital-intensive firms are more inclined to invest in capacity as demand becomes more volatile compared to labor-intensive firms. While labor-intensive firms are more flexible and can adjust their labor forces to deal with stochastic demand without investing in capital capacity, capital-intensive firms do not have the same level of flexibility and have to invest in capital capacity resources to hedge against volatile demand.

Some of the control variables are significant.  $\beta_1$  and  $\beta_2$  show that for profit hospitals and not for profit hospitals invest in capacity to a greater extent than do governmental hospitals, consistent with our conjecture that government hospitals face greater constraints in capital investment. The positive sign on  $\beta_4$  indicates that profitable hospitals invest in capacity to a greater extent relative to unprofitable hospitals. Case mix index is positively associated with investment in capacity, as shown by  $\beta_5$ , because hospitals that treat severely ill patients are probably less able to forecast capacity needs for these patients and therefore require more capacity. Proportion of MediCal patients is negatively associated with investment. Since MediCal generally reimburses hospitals at a lower rate compared to other insurers, departments with a large proportion of MediCal patients might not have enough resources to support additional capacity investments. The positive coefficient on  $\beta_8$  supports our prediction that the

department size is positively associated with capacity investment, since larger departments are more likely to provide a greater variety of services, and in turn increases the need to increase capacity. The positive coefficient on  $\beta_9$  suggests that departments with high average length of stay treat more complex patients and thus need to invest in capacity. In addition, similar to case mix, it is harder to predict capacity needs when LOS is high, and hence hospitals invest more to cushion their risk.

All of the above results are qualitatively unchanged when *Accounting performance 2* is used as the dependent variable, as well as when *Fixed cost structure 2* is used as the independent variable in Table 5.

### **4.3. Results from Standardized Data**

The scales of the independent variables in our model vary considerably, for example, demand variability can be more than one thousand (patient days), while the fixed cost structure on average is less than 0.02. To mitigate interpretation difficulties caused by scale differences among variables, we standardize all independent variables except department dummy variables and estimate equation (1) using the standardized dataset. The results are shown in Table 6.

[Table 6 here]

Similar to previous tests, we test equation (1) using two different measures of accounting performance and two different measures of fixed cost structure. The results are reported in Table 6. The hypothesized results are consistent with those in Table 4 and Table 5.

Standardization of the variables allows us graphically present the results of the interactions predicted in H5, H6, and H7. Assume that a department is average in every aspect captured by the independent variables in equation (1), except that its accounting performance and capacity utilization are one standard error higher or lower compared to the rest of the sample.

The probability of investment of this department relative to average is presented in Figure 1 Panel A. Note that the figure represents the impact of the interaction effects rather than likelihood estimates since the probability model is the standard cumulative normal function of the explanatory variables. The results indicate that, as predicted by H5, accounting performance plays a more significant role for departments with low capacity utilization compared to departments with high capacity utilization. Departments with high capacity utilization do not require high accounting performance before making capacity investments. On the other hand, for departments with low capacity utilization, a big improvement in accounting performance is needed to justify a capacity expansion.

[Figure 1 here]

Using the same methods, Figure 1 Panel B represents the negative interaction effect of accounting performance and demand variability (H6). Compared to departments with high demand variability, accounting performance has a greater effect on investment in departments with low demand variability because in the latter case accounting information provides a less noisy measure of the benefits of capacity investment. Panel C shows a positive interaction between accounting performance and fixed cost structure (H7) and demonstrates that capacity utilization has a larger effect on the probability of investment for firms with high fixed cost structure.

#### **4.4. Results of Sensitivity Tests**

Besides using two measures for accounting performance and fixed cost structure we tested the robustness of our results to alternative measures. First, we required that the dependent variable *Capacity Investment* take the value of 1 if the change in depreciation expense from year

$t$  to year  $t+1$  is greater than 0, and take the value of 0 if the change in depreciation from year  $t$  to year  $t+1$  equals 0. We estimated equation (1) using this measure. The results (untabulated) are consistent with those reported in table 4, 5, and 6. Second, we examined the sensitivity of results to rental/lease expenses, since hospitals might rent capacity resources instead of purchasing them. We revised the dichotomous dependent variable *Capacity Investment* using department-level median amount of increase in the sum of depreciation and rental/lease expense and modified fixed cost structure 1 & 2 and accounting performance 2 by replacing depreciation expense with the sum of depreciation and rental/lease expense. We estimated equation (1) using these measures and found similar results (untabulated) to those in Table 4, 5, and 6. Third, our sample period is after the Balanced Budget Act of 1997, which reduced the payments that hospitals received from Medicare for certain services (such as outpatient services and medical education). During 1999 and 2000, several modifications were enacted to slow the transition of the BBA (Lindrooth et al. 2006).<sup>11</sup> We split our sample into two time periods, the first covering 1998-2001 and the second covering 2002-2005, and replicated the analyses. Results for all the hypotheses were robust for both sub-samples. Fourth, because firms can alter their investment requirements and cost structures by outsourcing, we added a control variable for the extent of outsourcing in the hospital. We measured outsourcing as the percentage of outsourced cost to total cost. The results were unchanged. Finally, we added a control variable for teaching hospitals and found similar results.

## **5.0 Conclusions**

Capacity investment is one of the most critical business decisions. Despite considerable analytical research, few empirical studies explore the determinants of firms' capacity investment

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<sup>11</sup> Examples include the Balanced Budget Refinement Act of 1999 (BBRA) and the Medicare, Medicaid, and SCHIP Benefits Improvement and Protection Act of 2000 (BIPA).

behavior. Accounting researchers argue that cost accounting systems provide firms with valuable information for managerial decision-making, but little empirical research examines the influence of accounting performance and cost structure on firms' capacity investment decisions. Our study combines economics, operations, and accounting theories, and empirically identifies the important determinants of firms' capacity investment. Using department level data from California for the period 1998-2005, we find that accounting performance and fixed cost structure play important and additive roles in capacity decisions. In addition, accounting performance and fixed cost structure interact with operational variables such as capacity utilization and demand variability in determining firms' capacity decisions.

This study has several limitations which suggest opportunities for future research. First, we assume that department-level capacity investment is a department-level decision and is not influenced by other departments' decisions. In reality such inter-department influences are likely to exist. For example, a profitable department might not be able to invest because its profits subsidize other poorly performing departments. The reverse may also occur. A poorly performing department might still invest if such an investment benefits other departments (e.g., diagnostics departments may facilitate other departments' performance). Future research examining the effect of departmental interdependence on capacity investment is suggested.

Second, we do not have data on the acquisition cost of capacity resources at the department level, and use depreciation expense as a proxy. Analytical studies show that the more expensive a capacity investment is, the less likely that a firm will invest (Banker and Hughes 1994; Balachandran et al. 1997a; Harrison and Van Mieghem 1999). Further empirical studies are warranted to explore the effect of acquisition cost on investments.

Third, we only include observations with non-negative changes in depreciation expense. We acknowledge that a negative change in depreciation expense does not necessarily imply no capacity investment has been made, because the increase in depreciation expense caused by the purchase of new capacity might be less than the decrease in depreciation expense caused by retirement or disinvestment of old capacity. However, due to data limitations, we cannot distinguish this scenario from the one in which the department simply does not invest in capacity after retiring or disinvesting some capacity.

Despite the above limitations, the results of our study have implications for capacity investment decisions. Specifically, our results suggest that firms' capacity decisions are influenced by the dynamic interactions between accounting variables such as accounting performance and cost structure and operational factors such as capacity utilization and demand variability. Future research on capacity investment could explore interactions between other accounting factors such as cost allocation rules, as well as operational factors such as process technology, cycle time etc.

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**TABLE 1**  
**Variable Definitions**

<b>Variable</b>	<b>Definition</b>
<b>Dependent variable</b>	
<i>Capacity investment</i>	= 1 if the increase in depreciation expense from year $t$ to year $t+1$ is greater than the median amount of increase in depreciation expense for the same department in other hospitals (0 otherwise).
<b>Independent variables</b>	
<i>Accounting performance 1</i>	Net patient revenue – total direct expenses (including depreciation expense, labor cost, supplies, purchased services) as a percentage of net patient revenue
<i>Accounting performance 2</i>	Net patient revenue – total direct expenses + depreciation expense as a percentage of net patient revenue
<i>Capacity utilization</i>	Patient days / available patient days (number of Staffed beds $\times$ 365 or 366)
<i>Demand variability</i>	Standard error of departmental net patient days
<i>Fixed cost structure 1</i>	Depreciation expense / (labor cost + supplies)
<i>Fixed cost structure 2</i>	Depreciation expense / total direct expenses
<b>Control variables—department level</b>	
<i>Proportion of Medicare patients</i>	Medicare patient days / total patient days
<i>Proportion of Medi-Cal patients</i>	Medi-Cal patient days / total patient days
<i>Departmental staffed beds</i>	Staffed beds at departmental level
<i>Average length of stay</i>	Number of days from admission to discharge
<b>Control variables —hospital level</b>	
<i>For profit</i>	= 1 if the hospital is for profit, 0 otherwise
<i>Not for profit</i>	= 1 if the hospital if not for profit, 0 otherwise
<i>Hospital staffed beds</i>	Staffed beds at hospital level
<i>Net margin</i>	Net income as a percentage of net patient revenue
<i>Case mix index</i>	A measure of the relative cost or resources needed to treat the mix of patients, based on Diagnosis Related Group weights.

**TABLE 2**  
**Descriptive Statistics**

<b>Variable</b>	<b>Mean</b>	<b>Median</b>	<b>Std Dev</b>	<b>Q1</b>	<b>Q3</b>
1. Capacity investment	0.5	0	0.5	0	1
2. Accounting performance 1	3.89%	11.52%	40.71%	-17.30%	31.99%
3. Accounting performance 2	5.76%	13.17%	39.82%	-14.73%	33.18%
4. Capacity utilization	0.67	0.68	0.26	0.47	0.89
5. Demand variability	1267.66	711.86	1405.75	321.41	1736.15
6. Fixed cost structure 1	0.0220	0.0136	0.0285	0.0058	0.0269
7. Fixed cost structure 2	0.0186	0.0119	0.0223	0.0051	0.0235
8. Proportion of Medicare patients	0.34	0.36	0.29	0.00	0.57
9. Proportion of MediCal patients	0.26	0.17	0.24	0.07	0.38
10. Departmental staffed beds	34.77	21	41.07	10	40
11. Average length of stay	18.77	5.47	55.16	3.19	12.30
12. For profit	0.25	0	0.43	0	0
13. Not for profit	0.60	1	0.49	0	1
14. Hospital staffed beds	231.76	196	165.17	110	303
15. Net margin	4.78%	3.90%	11.17%	-1.02%	10.14%
16. Case mix index	1.09	1.06	0.24	0.94	1.19

Number of observations: 6,027

<sup>a</sup>See Table 1 for definition.

**TABLE 3**  
**Pearson Correlations among Variables**

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Cap. Inv.	0.07 <sup>a</sup>	0.07 <sup>a</sup>	0.03 <sup>b</sup>	0.14 <sup>a</sup>	0.12 <sup>a</sup>	0.12 <sup>a</sup>	-0.03 <sup>b</sup>	-0.05 <sup>a</sup>	0.15 <sup>a</sup>	-0.00	-0.03 <sup>b</sup>	0.08 <sup>a</sup>	0.13 <sup>a</sup>	0.05 <sup>a</sup>	0.10 <sup>a</sup>
2. Acc. P.1		1.00 <sup>a</sup>	0.11 <sup>a</sup>	0.10 <sup>a</sup>	-0.08 <sup>a</sup>	-0.07 <sup>a</sup>	-0.02	-0.05 <sup>a</sup>	0.16 <sup>a</sup>	-0.03 <sup>b</sup>	-0.13 <sup>a</sup>	0.00	0.12 <sup>a</sup>	0.25 <sup>a</sup>	0.02
3. Acc. P.2			0.10 <sup>a</sup>	0.09 <sup>a</sup>	-0.01	-0.00	-0.02	-0.06 <sup>a</sup>	0.16 <sup>a</sup>	-0.03 <sup>b</sup>	-0.13 <sup>a</sup>	0.00	0.11 <sup>a</sup>	0.25 <sup>a</sup>	0.01
4. Cap. Uti.				0.11 <sup>a</sup>	-0.08 <sup>a</sup>	-0.08 <sup>a</sup>	0.11 <sup>a</sup>	0.03 <sup>b</sup>	-0.20 <sup>a</sup>	0.18 <sup>a</sup>	0.04 <sup>a</sup>	-0.06 <sup>a</sup>	0.04 <sup>a</sup>	0.08 <sup>a</sup>	0.04 <sup>a</sup>
5. Dem. Var.					-0.09 <sup>a</sup>	-0.09 <sup>a</sup>	0.11 <sup>a</sup>	-0.07 <sup>a</sup>	0.53 <sup>a</sup>	0.12 <sup>a</sup>	0.02	0.04 <sup>a</sup>	0.17 <sup>a</sup>	-0.00	0.06 <sup>a</sup>
6. Cost Str.1						0.98 <sup>a</sup>	0.01	-0.03 <sup>b</sup>	-0.11 <sup>a</sup>	-0.05 <sup>a</sup>	0.02 <sup>c</sup>	-0.00	-0.14 <sup>a</sup>	-0.06 <sup>a</sup>	-0.05 <sup>a</sup>
7. Cost St.2							-0.01	-0.02 <sup>c</sup>	-0.11 <sup>a</sup>	-0.05 <sup>a</sup>	0.01	0.00	-0.14 <sup>a</sup>	-0.06 <sup>a</sup>	-0.05 <sup>a</sup>
8. Medicare								-0.61 <sup>a</sup>	0.02	-0.14 <sup>a</sup>	0.09 <sup>a</sup>	0.00	-0.14 <sup>a</sup>	-0.10 <sup>a</sup>	0.08 <sup>a</sup>
9. MediCal									-0.13 <sup>a</sup>	0.35 <sup>a</sup>	-0.00	-0.18 <sup>a</sup>	-0.02	0.05 <sup>a</sup>	-0.22 <sup>a</sup>
10. D. Beds										0.03 <sup>b</sup>	-0.06 <sup>a</sup>	0.09 <sup>a</sup>	0.29 <sup>a</sup>	0.04 <sup>a</sup>	0.13 <sup>a</sup>
11. ALOS											-0.02	-0.07 <sup>a</sup>	-0.04 <sup>a</sup>	-0.05 <sup>a</sup>	-0.03 <sup>a</sup>
12. Profit												-0.70 <sup>a</sup>	-0.24 <sup>a</sup>	0.01	-0.04 <sup>a</sup>
13. Not Prof.													0.23 <sup>a</sup>	-0.14 <sup>a</sup>	0.15 <sup>a</sup>
14. H. Beds														0.16 <sup>a</sup>	0.29 <sup>a</sup>
15. Net Mar.															0.07 <sup>a</sup>
16. CMI															

a, b, c denote significance levels of 1%, 5%, and 10%, respectively.

**TABLE 4****Probit Fixed Effects Analyses of Capacity Investment Using Fixed Cost Structure 1 ( z - Statistics in Parenthesis)**

$$\begin{aligned}
\text{Prob}(\text{Capacity Investment}_{ijt}) = & F\left( \sum \alpha_i \text{Department dummies}_{it} + \beta_1 \text{For profit}_{jt} + \beta_2 \text{Not for profit}_{jt} + \beta_3 \text{Hospital} \right. \\
& \text{staffed beds}_{jt} + \beta_4 \text{Net margin}_{jt} + \beta_5 \text{Case mix index}_{jt} + \beta_6 \text{Proportion of Medicare patients}_{ijt} + \beta_7 \\
& \text{Proportion of Medi-Cal patients}_{ijt} + \beta_8 \text{Departmental staffed beds}_{ijt} + \beta_9 \text{Average length of stay}_{ijt} + \beta_{10} \\
& \text{Accounting Performance}_{ijt} + \beta_{11} \text{Capacity utilization}_{ijt} + \beta_{12} \text{Demand variability}_{ijt} + \beta_{13} \text{Fixed cost} \\
& \text{structure}_{ijt} + \beta_{14} \text{Accounting performance}_{ijt} * \text{Capacity utilization}_{ijt} + \beta_{15} \text{Accounting performance}_{ijt} * \\
& \text{Demand variability}_{ijt} + \beta_{16} \text{Fixed cost structure}_{ijt} * \text{Capacity utilization}_{ijt} + \beta_{17} \text{Fixed cost structure}_{ijt} * \\
& \left. \text{Demand variability}_{ijt} + \beta_{18} \text{Capacity utilization}_{ijt} * \text{Demand variability}_{ijt} + \varepsilon \right)
\end{aligned}$$

Variables	Prediction	Coefficients	
		(1) Accounting performance 1	(2) Accounting performance 2
<i>For Profit</i>	+	0.1519* (1.72)	0.1539* (1.75)
<i>Not For Profit</i>	+	0.2070*** (2.69)	0.2081*** (2.70)
<i>Hospital staffed beds</i>	+	0.0003 (1.42)	0.0003 (1.42)
<i>Net margin</i>	+	0.3923 (1.62)	0.3867 (1.60)
<i>Case mix index</i>	+	0.2623* (1.88)	0.2621* (1.88)
<i>Proportion of Medicare patients</i>	-	-0.0949 (-0.61)	-0.0940 (-0.60)
<i>Proportion of Medi-Cal patients</i>	-	-0.2549* (-1.71)	-0.2546* (-1.71)
<i>Department staffed beds</i>	+	0.0059*** (5.05)	0.0058*** (5.05)
<i>Average length of stay</i>	-/+	0.0006 (0.86)	0.0006 (0.86)
<i>Accounting performance (H1)</i>	+	0.1082* (1.71)	0.1168* (1.81)
<i>Capacity utilization (H2)</i>	+	0.3100*** (3.12)	0.3096*** (3.12)
<i>Demand variability (H3)</i>	+	0.1174*** (4.41)	0.1174*** (4.42)
<i>Fixed cost structure 1 (H4)</i>	+	10.1158*** (7.25)	10.0083*** (7.15)
<i>Accounting performance * Capacity utilization (H5)</i>	-	-0.3768** (-2.12)	-0.3839** (-2.12)
<i>Accounting performance * Demand variability (H6)</i>	-	-0.0816** (-2.01)	-0.0845** (-2.06)
<i>Fixed cost structure 1 * Capacity utilization (H7)</i>	+	11.6446*** (3.56)	12.0899*** (3.73)
<i>Fixed cost structure 1 * Demand Variability</i>	?	2.3295 (1.48)	2.3947 (1.52)
<i>Capacity utilization * Demand Variability</i>	?	0.0726 (1.03)	0.0732 (1.04)
Pseudo R <sup>2</sup>		0.13	0.13

Data include 6,027 observations from 26 inpatient departments in 401 hospitals over 8-year period.

The coefficients for other department dummies are not reported here.

\*, \*\*, \*\*\* denote significance at 10%, 5%, 1% two tailed, respectively.

**TABLE 5**  
**Probit Fixed Effects Analyses of Capacity Investment Using Fixed Cost Structure 2 ( z - Statistics in Parenthesis)**

$$Prob(\text{Capacity Investment}_{ijt}) = F(\sum \alpha_i \text{ Department dummies}_{it} + \beta_1 \text{ For profit}_{jt} + \beta_2 \text{ Not for profit}_{jt} + \beta_3 \text{ Hospital staffed beds}_{jt} + \beta_4 \text{ Net margin}_{jt} + \beta_5 \text{ Case mix index}_{jt} + \beta_6 \text{ Proportion of Medicare patients}_{ijt} + \beta_7 \text{ Proportion of Medi-Cal patients}_{ijt} + \beta_8 \text{ Departmental staffed beds}_{ijt} + \beta_9 \text{ Average length of stay}_{ijt} + \beta_{10} \text{ Accounting Performance}_{ijt} + \beta_{11} \text{ Capacity utilization}_{ijt} + \beta_{12} \text{ Demand variability}_{ijt} + \beta_{13} \text{ Fixed cost structure}_{ijt} + \beta_{14} \text{ Accounting performance}_{ijt} * \text{ Capacity utilization}_{ijt} + \beta_{15} \text{ Accounting performance}_{ijt} * \text{ Demand variability}_{ijt} + \beta_{16} \text{ Fixed cost structure}_{ijt} * \text{ Capacity utilization}_{ijt} + \beta_{17} \text{ Fixed cost structure}_{ijt} * \text{ Demand variability}_{ijt} + \beta_{18} \text{ Capacity utilization}_{ijt} * \text{ Demand variability}_{ijt} + \varepsilon)$$

Variables	Prediction	Coefficients	
		(1) Accounting performance 1	(2) Accounting performance 2
<i>For Profit</i>	+	0.1498* (1.69)	0.1517* (1.71)
<i>Not For Profit</i>	+	0.2024*** (2.61)	0.2034*** (2.62)
<i>Hospital staffed beds</i>	-	0.0003 (1.38)	0.0003 (1.38)
<i>Net margin</i>	+	0.3969 (1.64)	0.3912 (1.62)
<i>Case mix index</i>	+	0.2641* (1.89)	0.2640* (1.89)
<i>Proportion of Medicare patients</i>	-	-0.0724 (-0.46)	-0.0721 (-0.46)
<i>Proportion of Medi-Cal patients</i>	-	-0.2452* (-1.65)	-0.2450 (-1.64)
<i>Department staffed beds</i>	+	0.0060*** (5.16)	0.0060*** (5.15)
<i>Average length of stay</i>	-/+	0.0006 (0.90)	0.0006 (0.90)
<i>Accounting performance (H1)</i>	+	0.0955 (1.52)	0.1038 (1.61)
<i>Capacity utilization (H2)</i>	+	0.3122*** (3.15)	0.3100*** (3.14)
<i>Demand variability (H3)</i>	+	0.1176*** (4.76)	0.1176*** (4.78)
<i>Fixed cost structure 2 (H4)</i>	+	12.7724*** (8.32)	12.6434*** (8.23)
<i>Accounting performance * Capacity utilization (H5)</i>	-	-0.3875** (-2.20)	-0.3984** (-2.22)
<i>Accounting performance * Demand variability (H6)</i>	-	-0.0824** (-2.03)	-0.0858** (-2.10)
<i>Fixed cost structure2 * Capacity Utilization (H7)</i>	+	15.2942*** (3.82)	15.8795*** (3.99)
<i>Fixed cost structure2 * Demand variability</i>	?	2.9072* (1.93)	2.9927* (1.98)
<i>Capacity utilization * Demand Variability</i>	?	0.0788 (1.15)	0.0797 (1.16)
Pseudo R <sup>2</sup>		0.13	0.13

Data include 6,027 observations from 26 inpatient departments in 401 hospitals over 8-year period.

The coefficients for other department dummies are not reported here.

\*, \*\*, \*\*\* denote significance at 10%, 5%, 1% two tailed, respectively.

**TABLE 6**  
**Probit Standardized Fixed Effects Analyses of Capacity Investment ( z - Statistics in Parenthesis)**

$$Prob(\text{Capacity Investment}_{ijt}) = F(\sum_i \alpha_i \text{Department dummies}_{it} + \beta_1 \text{For profit}_{jt} + \beta_2 \text{Not for profit}_{jt} + \beta_3 \text{Hospital staffed beds}_{jt} + \beta_4 \text{Net margin}_{jt} + \beta_5 \text{Case mix index}_{jt} + \beta_6 \text{Proportion of Medicare patients}_{ijt} + \beta_7 \text{Proportion of Medi-Cal patients}_{ijt} + \beta_8 \text{Departmental staffed beds}_{ijt} + \beta_9 \text{Average length of stay}_{ijt} + \beta_{10} \text{Accounting Performance}_{ijt} + \beta_{11} \text{Capacity utilization}_{ijt} + \beta_{12} \text{Demand variability}_{ijt} + \beta_{13} \text{Fixed cost structure}_{ijt} + \beta_{14} \text{Accounting performance}_{ijt} * \text{Capacity utilization}_{ijt} + \beta_{15} \text{Accounting performance}_{ijt} * \text{Demand variability}_{ijt} + \beta_{16} \text{Fixed cost structure}_{ijt} * \text{Capacity utilization}_{ijt} + \beta_{17} \text{Fixed cost structure}_{ijt} * \text{Demand variability}_{ijt} + \beta_{18} \text{Capacity utilization}_{ijt} * \text{Demand variability}_{ijt} + \varepsilon)$$

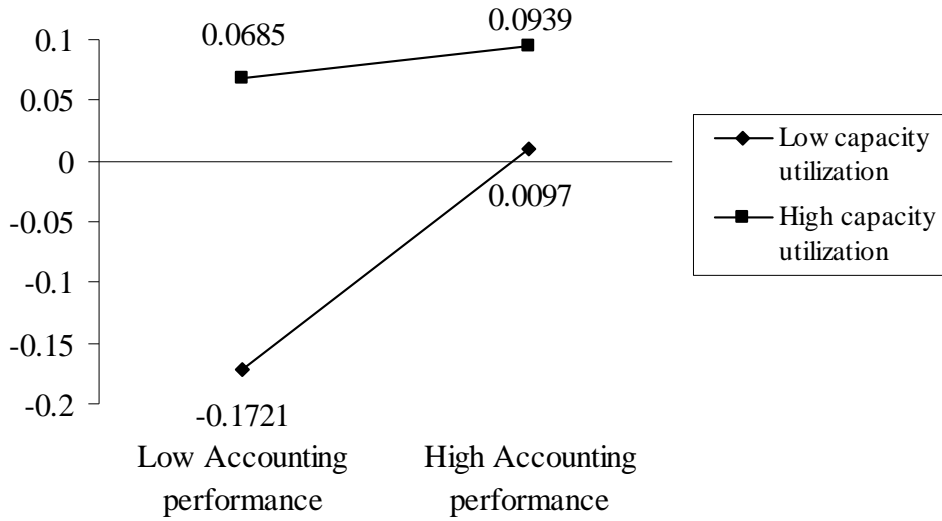
Variables	Coefficients			
	Using fixed cost structure 1		Using fixed cost structure 2	
	(1) Accounting Performance 1	(2) Accounting Performance 2	(3) Accounting Performance 1	(4) Accounting Performance 2
<i>For profit</i>	0.0657* (1.72)	0.0666* (1.75)	0.0648* (1.69)	0.0657* (1.71)
<i>Not for profit</i>	0.1016*** (2.69)	0.1021*** (2.70)	0.0993*** (2.61)	0.0998*** (2.62)
<i>Hospital staffed beds</i>	0.0526 (1.42)	0.0526 (1.42)	0.0517 (1.38)	0.0517 (1.38)
<i>Net margin</i>	0.0438 (1.62)	0.0432 (1.60)	0.0443 (1.64)	0.0437 (1.62)
<i>Case mix index</i>	0.0636* (1.88)	0.0636* (1.88)	0.0641* (1.89)	0.0640* (1.89)
<i>Proportion of Medicare patients</i>	-0.0273 (-0.61)	-0.0270 (-0.60)	-0.0208 (-0.46)	-0.0207 (-0.46)
<i>Proportion of MediCal patients</i>	-0.0619* (-1.71)	-0.0619* (-1.71)	-0.0596* (-1.65)	-0.0595 (-1.64)
<i>Department staffed beds</i>	0.2403*** (5.05)	0.2400*** (5.05)	0.2450*** (5.16)	0.2445*** (5.15)
<i>Average length of stay</i>	0.0331 (0.86)	0.0329 (0.86)	0.0344 (0.90)	0.0341 (0.90)
<i>Accounting performance (H1)</i>	0.0441* (1.71)	0.0465* (1.81)	0.0389 (1.52)	0.0413 (1.61)
<i>Capacity utilization (H2)</i>	0.0811*** (3.12)	0.0810*** (3.12)	0.0817*** (3.15)	0.0815*** (3.14)
<i>Demand variability (H3)</i>	0.1650*** (4.41)	0.1174*** (4.42)	0.1653*** (4.76)	0.1654*** (4.78)
<i>Fixed cost structure (H4)</i>	0.2880*** (7.25)	0.2849*** (7.15)	0.2843*** (8.32)	0.2815*** (8.23)
<i>Accounting performance * Capacity utilization (H5)</i>	-0.0401** (-2.12)	-0.0400** (-2.12)	-0.0413** (-2.20)	-0.0415** (-2.22)
<i>Accounting performance * Demand variability (H6)</i>	-0.0467** (-2.01)	-0.0473** (-2.06)	-0.0472** (-2.03)	-0.0480** (-2.10)
<i>Fixed cost structure * Capacity Utilization (H7)</i>	0.0867*** (3.56)	0.0900*** (3.73)	0.0891*** (3.82)	0.0925*** (3.99)
<i>Fixed cost structure * Demand variability</i>	0.0932 (1.48)	0.0958 (1.52)	0.0910* (1.93)	0.0937* (1.98)
<i>Capacity utilization * Demand variability</i>	0.0267 (1.03)	0.0269 (1.04)	0.0290 (1.15)	0.0293 (1.16)
Pseudo R <sup>2</sup>	0.13	0.13	0.13	0.13

The coefficients for other department dummies are not reported here.

\*, \*\*, \*\*\* denote significance at 10%, 5%, 1% two tailed, respectively.

**Figure 1**

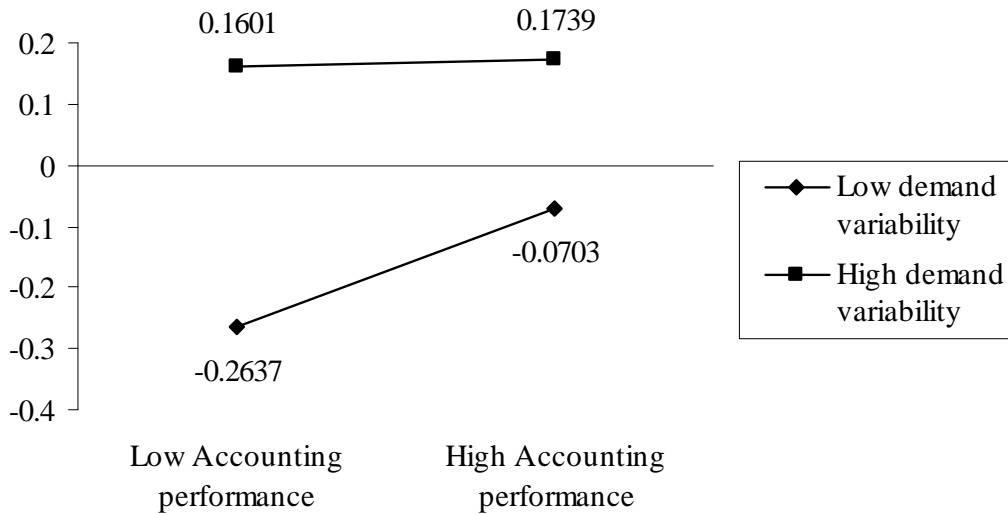
**Panel A: Effect of Accounting Performance and Capacity Utilization on Investment (H5)**



Value 0 on vertical axis stands for the average likelihood of capacity investment.

High (low) capacity utilization refers to departments with capacity utilization one standard error higher (lower) compared to the rest of the sample. This figure represents the direction of the interaction effects rather than likelihood estimates.

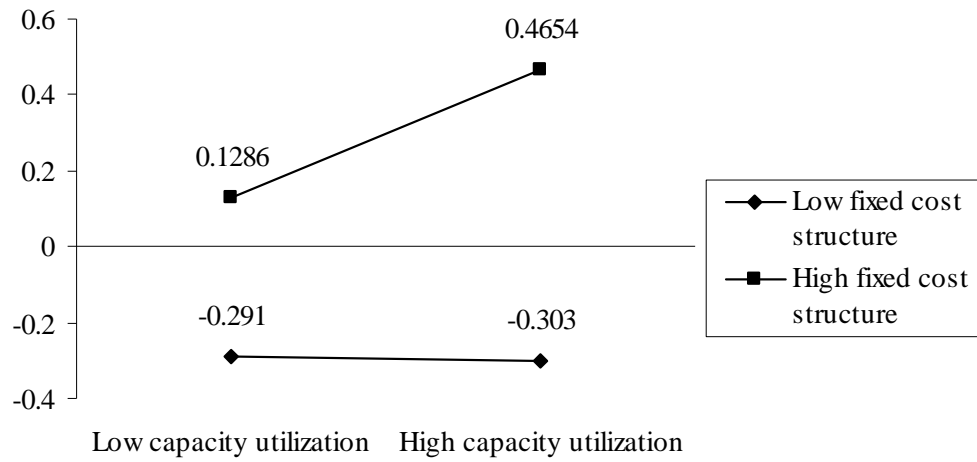
**Panel B: Effect of Accounting Performance and Demand Variability on Investment (H6)**



Value 0 on vertical axis stands for the average likelihood of capacity investment.

High (low) demand variability refers to departments with demand variability one standard error higher (lower) compared to the rest of the sample. This figure represents the direction of the interaction effects rather than likelihood estimates.

**Panel C: Effect of Fixed Cost Structure and Capacity Utilization on Investment (H7)**



Value 0 on vertical axis stands for the average likelihood of capacity investment.

High (low) fixed cost structure refers to departments with fixed cost structure one standard error higher (lower) compared to the rest of the sample. This figure represents the direction of the interaction effects rather than likelihood estimates.

## **APPENDIX A**

### **List of Inpatient Service Departments**

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Medical surgical intensive care

Coronary care

Pediatric intensive care

Neonatal intensive care

Psychiatric intensive care

Burn care

Other intensive care

Definitive observation

Medical/surgical acute

Pediatric acute

Psychiatric acute - adult

Psychiatric acute - adolescent and child

Obstetrics acute

Alternate birthing center

Chemical dependency services

Physical rehabilitation care

Hospice - inpatient care

Other acute care

Nursery acute

Sub acute care

Sub acute care - pediatric

Skilled nursing care

Psychiatric - long Term care

Intermediate care

Residential care

Other long-term care services

Other daily hospital services

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