What do Nonprofit Hospitals Maximize? Evidence from California's Seismic Retrofit Mandate *

Tom Chang
USC Marshall School of Business

and

Mireille Jacobson
RAND and NBER

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Abstract

Despite a large literature and considerable policy interest, debate remains over the motives of nonprofit hospitals. We test four leading theories of nonprofit behavior by studying the response of California hospitals to a large, plausibly exogenous fixed cost shock generated by an unfunded seismic retrofit mandate. We show that while seismic risk is uncorrelated with a host of hospital and neighborhood characteristics, it predicts increased shut down (all hospitals), increases in profitable services (nonprofits), and decreases in charity care (government). These results allow us to reject two leading theories of nonprot behavior - "for-profits in disguise" and "pure altruism."

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1 Introduction

Over a fifth of all U.S. corporations have nonprofit status, meaning they are tax-exempt but cannot disburse net revenues (Philipson and Posner 2006). Nonprofts are most common in markets, such as education and health care, that are characterized by asymmetric information. In these markets the consumer may be ill-equipped to judge service quality or quantity and for-profits may under-provide on these dimensions (Arrow 1963; Hansmann 1996). Tax subsidies offer a potential contractibility mechanism to counter such under-provision (Hansmann 1981).

In the hospital market, where nonprofits account for over two-thirds of beds (David 2009), measuring the return on the tax subsidy has proved challenging.[1] While nonprofit hospitals are charged with providing "community benefits" as a condition of the federal tax exemption, we have no widely accepted metric for those benefits. Providing charity care or operating an emergency room falls into this category but so does offering community health screening or conducting basic research.[2]

Due in part to ambiguity in the community benefit standard, policymakers have repeatedly questioned the motives of nonprofit hospitals (Horwitz 2006; Schlesinger and Gray, 2006).[3] Why, they ask, do nonprofits look more like money-making than charitable institutions? While theories of nonprofit hospitals abound, they typically lay out general motivations rather than a formal structure, making it difficult to empirically distinguish among them. Furthermore, the interaction of a hospital's budget constraint with any change in incentives means that strong assumptions on the form of the firm's objective and cost functions are required to generate testable implications. As put in Pauly (1987), "The presence of profit in the budget constraint means that all the variables which affect profits appear in the comparative statics of [models of nonprofit behavior]... Since the same variables with the same predicted signs show up in all models, it is obviously impossible to distinguish among them on this basis." Finally, distinguishing among models of nonprofit

[1] Estimates from the Joint Committee on Taxation put the 2002 value of this subsidy, as measured by federal, state and local tax exemptions, at $12.6 billion (CBO 2006).

[2] Prior to 1969, the IRS interpreted community benefits as care for those not able to pay to the best of a hospital's "financial ability." This standard has been relaxed over time. Today a nonprofit hospital can comply by "promoting the health of any broad class of persons" (CBO 2006).

[3] Senator Charles Grassley (R-Iowa) has proposed repeatedly that Congress mandate a minimum level of charity care to qualify for federal tax-exempt status; several states already do this. And, Illinois has stripped hospitals of their tax-exempt status because they were not providing "enough" charity care (Francis, 2007).

behavior is complicated by the endogeneity of a hospital's ownership type (David, 2009).

In this paper, we exploit a fixed cost shock to test four of the leading theories of nonprofit hospital behavior: (1) "for-profits in disguise," (2) output maximizers, (3) perquisite maximizers and (4) social welfare maximizers. The fixed cost shock is generated by an unfunded California mandate (SB 1953) requiring hundreds of general acute care hospitals to retrofit or rebuild in order to comply with modern seismic safety standards. Since a hospital must be made safe for its location and the majority of hospitals in California were built between 1940 and 1970, well before we had a sophisticated understanding of seismic safety, a hospital's compliance cost is plausibly exogenously predetermined by its underlying geological seismic risk. Importantly the long timeframe of new hospital construction (upwards of ten years) means that over our study period the impact of the mandate is essentially financial with little to no concurrent impact on hospital facilities and thereby production function. Moreover, because our source of variation affects a firm's budget constraint without changing its incentive structure, we can generate differentiable predictions of hospital behavior using models that make relatively few structural assumptions.

Before examining hospital response, we show that within counties a hospital's seismic risk is uncorrelated with a host of hospital characteristics, including nonprofit status, license age or length of stay, and neighborhood demographics, such as median household income, share of the population living below the poverty line or the share Hispanic. Where data are available, we also show that seismic risk is uncorrelated with outcomes such as closures, Neonatal Intensive Care Unit (NICU) or cardiac care in the pre-mandate period. In contrast, seismic risk is a strong predictor of hospital closure; spending on plant, property and equipment; resource utilization and service provision post-mandate. While the impact of seismic risk on a hospital's closure decision is independent of ownership, its service response differs systematically. As predicted by standard theory, for-profit hospitals do not change their service level or mix in response to the fixed-cost shock. However, private nonprofit hospitals increase their provision of profitable services (e.g., neonatal intensive care, cardiac care and MRI minutes), and government-owned hospitals cut uncompensated care, specifically clinic visits for indigent patients. The differential response across ownership types allows us to reject the argument that (private) nonprofit hospitals are indistinguishable from their for-profit counterparts (e.g. for-profits-disguise). The response of nonprofit hospitals is further inconsistent with pure altruism, the presumed reason for granting a tax-exemption, but compatible with theories of perquisite or output maximization. The response of government-owned hospitals is most consistent with welfare or output maximization. Whether hospital perquisite or output maximization is welfare-enhancing relative to profit maximization is theoretically ambiguous, however. As such we cannot draw strong conclusions about the relative welfare provided by different ownership types without additional data on health outcomes and long term spillovers.[4] Likewise, even if government-owned firms have welfare as their maximand, they may generate welfare losses relative to profit maximizing firms because they lack incentives to reduce costs (Hart et al., 1997). These cost-inefficiencies may outweigh the benefits of their altruistic goals.

On net, our results show that both ownership (government vs. private) and organizational structure (for-profit vs. nonprofit) are important determinants of hospital response to policy. Our results suggest that the subsidies provided to nonprofit hospitals may allow them to pursue perquisites at the expense of quantity. These findings are consistent with prior work showing that increased competition reduces the difference between private hospitals by forcing nonprofits to act more like their for-profit peers (Gruber, 1994; Cutler and Horwitz, 2000; Duggan, 2002; Kessler and McClellan, 2002; Horwitz and Nichols, 2007). Tightening financial constraints (either through increased competition or a fixed cost shock, as in our case) leaves nonprofit hospitals less slack to pursue non-pecuniary goals. Finally, while others have tried to distinguish across theories of nonprofit hospital behavior (Deneffe and Mason 2002; Malani et al. 2003; Horwitz and Nichols 2009), our work furthers the literature in two key ways: (1) by using a fixed cost shock to generate clear, testable predictions across theories using a minimum of functional form restrictions and (2) by using a novel and credible quasi-experimental design, the fixed cost shock associated with California's hospital seismic retrofit requirements, to assess these predictions.

2 Literature Review

A vast literature, both theoretical and empirical, seeks to understand the objectives of nonprofit hospitals. We divide this literature into four categories: (1) "for-profits in disguise,"

[4]For example, teaching hospitals face a conflict between providing health care services now and ensuring a sufficient supply of well trained doctors in the future. Moreover, over-investment in new technologies may lead to technological spillover and improvements in healthcare provision in all types of hospitals.

(2) output maximizers, (3) "perquisite" maximizers and (4) social welfare maximizers.[5]

The nonprofits as "for-profits in-disguise" (FPID) hypothesis implies that hospitals masquerade as charitable organizations but, in fact, operate as profit maximizing entities (Weisbrod, 1988). This could occur because of either lack of enforcement or ambiguity in the legal requirements to qualify as tax-exempt.[6] A large empirical literature assesses differences in the equilibrium behavior of for-profit and nonprofit firms.[7] One early example, Sloan and Vraciu (1983), compares costs, patient mix, and quality across non-teaching for-profit and nonprofit hospitals in Florida. The authors find no differences in after-tax profit margins, the share of Medicare and Medicaid patient days, the value of charity care, and bad debt adjustments to revenue. They find some small differences in service mix but none vary systematically across "profitable versus nonprofitable services." They conclude that all hospitals, regardless of ownership type, are forced to balance social objectives and financial considerations in a similar manner.

The literature on behavioral differences between nonprofit and for-profit hospitals is quite mixed. Like Sloan and Vraciu (1983), most find little or no difference in costs, profitability, pricing patterns, the provision of uncompensated care, the quality of care or the diffusion of technology across ownership type, and conclude that nonprofit hospitals are no different than their for-profit counterparts (e.g., see Becker and Sloan, 1985; Gaumer, 1986; Shortell and Hughes, 1988; Keeler et al., 1992; Norton and Staiger, 1994; McClellan and Staiger, 2000; Sloan et al., 2001; Schlesinger and Gray, 2003). But, several find that nonprofits provide more unprofitable services (Schlesinger et al., 1997; Horwitz, 2005) or higher quality care (Shen, 2002), employ fewer performance bonuses in executive compensation (Erus and Weisbrod, 2003), have lower marginal costs but higher markups (Gaynor and Vogt, 2003) and engage in less upcoding (Silverman and Skinner, 2003; Dafny, 2005).

Duggan (2000), which studies a change in the financial incentives to treat indigent

[5]This classification is similar to Silverman and Skinner (2004), which adopts Malani et al. (2003)'s taxonomy. Malani et al. (2003) distinguishes "for-profits in disguise," non-contractible quality, altruism, and physician cooperatives. In our taxonomy, non-contractible quality can enter the altruist, output and perquisite maximizer cases, albeit in slightly different ways. Altruists care about quality for what it does to quantity. Perquisite and output maximizers care about quality in and of itself. Physician cooperative models are captured by the perquisite maximizing case (Pauly and Redisch, 1973; Young, 1981).

[6]Why in such a world would not all hospitals obtain nonprofit status? Some may have higher masquerading costs. Others may require broader access to capital than is available to nonprofits. Switching costs, e.g. regulatory friction, may be high. And some may have difficulty extracting super-ordinary excess profits.

[7]Sloan (2000) provides an extensive review of the literature.

patients in California, finds that the important behavioral distinction is between public and private hospitals regardless of nonprofit status. To the extent that hospitals share the same costs, quality, and service mix (including uncompensated care), the implication is that either (1) nonprofits are profit-maximizers or (2) competition is so intense that nonprofits are forced to subvert their altruistic objectives to survive (Sloan and Vraciu, 1983). In so far as some (e.g., Gruber, 1994; Cutler and Horwitz, 2000; Duggan, 2002; Horwitz and Nichols, 2009) find that when competition increases, nonprofits behave more like their for-profit peers, the former hypothesis cannot be broadly applicable to the hospital industry.

At the other extreme, nonprofit hospitals maximize some measure of social welfare. The usual justification for these preferences is a taste for altruism or social welfare. For instance, altruistic managers and employees may sort into nonprofit firms (Rose-Akerman 1996, Besley and Ghatak 2004). Alternatively, welfare maximizing nonprofit firms might occur as a socially optimal response to asymmetric information (Arrow, 1963; Nelson and Kashinsky, 1973; Easley and O′Hara 1983; Hansmann 1981; Weisbrod, 1978; Weisbrod and Schlesinger, 1986; Hirth, 1999; Glaeser and Shleifer, 2001). In other words, firms may use nonprofit status to commit themselves to provide quality by constraining their own incentives to reduce (unobserved and non-contractible) quality in favor of profits. Empirical support for this hypothesis is largely based on the literature showing that nonprofit hospitals provide more charity and subsidized care than their for-profit peers (Schlesinger et al., 1987; Frank et al., 1990; Mann et al., 1995; Clement et al., 2002; Horwitz, 2005).

A third class of models characterizes nonprofit hospitals as output maximizers, meaning their managers care more about output than wealth. Newhouse (1970), the starting point for this group, suggests that nonprofits maximize a weighted average of quality and quantity, subject to a break-even or zero profit constraint. These hospitals have a taste for quality and quantity that distorts their production away from both pure profit and pure welfare maximization.[8] Horwitz and Nichols (2009), discussed below, provide empirical support for this case. Frank and Salkever (1991) offer a variant where nonprofit hospitals compete to gain public goodwill. In what they term a model of impure altruism, hospitals aim to provide quality (length of stay or intensity of services) to indigent patients that is similar to

[8] As discussed in Newhouse (1970), since the pursuit of profit maximization can lead to under-provision of both quality and quantity, a hospital's taste for quality and quantity can improve welfare.

that of their rivals.[9] This class may capture another quasi-altruistic motive: to financially support the provision of high quality care (Newhouse, 1970; Lakdawalla and Philipson, 1998). These hospitals may use nonprofit status to support an inefficiently high level of quality and an inefficiently low number of patients.

The final class of models posits that nonprofits maximize perquisites. Perquisites can include factors that raise the cost of production, moving the hospital off the profit frontier. Because we remain agnostic about the source of any distortion, this category can cover many different models. A classic example is the Pauly and Redisch (1973) model of nonprofit hospitals as physician cooperatives. Organizing as a cooperative frees physicians of the demands of outside investors and allows them to assume control over resource allocation. Physicians make input and output decisions so as to maximize net individual income, distorting their behavior away from efficient production. That is, in response to the incentives created by this organizational structure, physicians distort their production to include more perquisites (e.g. over-invest in capacity or technology) and maximize their individual utility. Another example in this group are"mission driven" hospitals, whose goals may create inefficiencies in health care production. As examples, Florida Hospital's mission statement begins,"Our first responsibility as a Christian hospital is to extend the healing ministry of Christ to all patients who come to us,"[10] and Beth Israel Deaconess Medical Center's mission is to "serve patients, students, science and our community."[11]

Several others have tried to distinguish across theories of nonprofit hospital behavior. Malani et al (2003) embed existing theories in a general theoretical framework and compare equilibrium predictions to the existing empirical literature. Given the conflicting literature, they suggest the importance of further work. Deneffe and Mason (2002) study hospital response to changes in the Medicare, Medicaid and charity caseloads. They show that social welfare-maximizers should increase the private price when the charity caseload increases and decrease it when the Medicare caseload increases; "for-profits in disguise" should not alter the private price in response to changes in patient mix. These predictions are analogous to ours but in a setting with multiple payers and where hospitals are not price-takers for all

[9] Frank and Salkever (1991) note that if nonprofits maximize social welfare, they should care about the total volume of charitable care not their own provision of such care. Finding little evidence of either crowding out or large income effects, they posit the model of impure altruism.

[10] See http://www.floridahospitalflagler.com/AboutUs/MissionStatement.aspx

[11] See http://www.bidmc.org/AboutBIDMC/Overview/MissionStatement.aspx

patients. Like us, Deneffe and Mason (2002) reject theories of pure profit or pure welfare maximization. Horwitz and Nichols (2009) analyze markets with varying for-profit market shares and find that nonprofits offer more profitable services but have no change in operating margins in markets with a high concentration of for-profits. Consistent with our work, they conclude that nonprofit hospitals pursue output maximization. However, Deneffe and Mason (2002) are hampered by the difficulty of identifying exogenous variation in patient caseloads and Horwitz and Nichols (2009) are limited by the (explicitly acknowledged) endogeneity of firm location and market mix. In contrast, we have identified a plausibly exogenous fixed cost shock that differentially affects firms within the same market. This design allows us to isolate the effect of budgetary shocks from fixed differences in market characteristics, such as competitiveness or patient mix, on firm behavior.

3 Models of Nonprofits

We begin by developing a general model that embeds four categories of nonprofit hospital behavior: (1) "for-profits in disguise," (2) output maximizers, (3) perquisite maximizers and (4) social welfare maximizers. In each case, we assess whether and how a fixed cost shock affects the nonprofit hospital's level and mix of services. The key intuition behind the predictions is that, due to a non-distribution constraint, nonprofit hospitals use any 'extra' revenue to subsidize those activities they value. When faced with a fixed cost shock, the firms have less slack to pursue these other activities (i.e., firm behavior will be driven more and more by the budget constraint so all firms will look more like for-profit firms, regardless of their objective function). In this way, a fixed cost shock forces hospitals not already pursuing profit to do less of whatever activities they were previously subsidizing. For example if a hospital cares only about providing charity care, a fixed cost shock would result in a reduction in the amount of charity care the hospital can afford to provide.

3.1 The Basic Model

Hospitals are assumed to be price taking firms[12] that maximize an objective function

[12] Our basic results are *not* driven by the price-taking assumption. However, given the high degree of price regulation and the dominance of large private and public insurers, this assumption (which is standard in the literature) simplifies the analysis. See Frank and Salkever (1991) for further discussion on this topic.

$$V = R + u(q, \theta, u) \tag{1}$$

where R is net revenue, q is the quantity of health care provided, θ is anything that increases the cost of production, such as non-contractible quality, and u is the amount of uncompensated (indigent) care. All variables are constrained to have non-negative values.

The firm's objective function is subject to a break-even constraint

$$\pi(q, \theta) - R - u - F \geq 0, \tag{2}$$

$$\pi(q, \theta) = pq - C(q, \theta) = \int_0^q p - (c(x) + \theta)dx, \tag{3}$$

where c is a continuous function that is weakly increasing and weakly convex in x and θ. Hereafter, WLOG, we normalize the price p for a unit of profitable service to 1.

The timing of hospital behavior is as follows:

1. For $F = 0$, a hospital chooses q, θ, u to maximize V
2. The hospital receives a random fixed cost shock $F' > 0$
3. For $F' > 0$, hospitals choose q', θ', u' to maximize V
4. If the hospital is unable to meet its budget constraint, it shuts down.

3.2 For-Profits In Disguise

The For-Profits In Disguise (FPID) hypothesis implies that nonprofit hospitals operate as de-facto profit maximizing institutions. This model corresponds to a non-binding non-distribution constraint (e.g., one that is not effectively enforced) or the capturing of rents by privileged employees as salary or non-distortionary perquisites.[13] In either case, FPIDs maximize net revenue R (i.e. $V^{FPID} = R$).

Proposition 1 *Let (q, θ, u) and (q', θ', u') be a nonprofit hospital's choice of variables conditional on fixed cost shocks F and F' respectively. If $V = R$, for all values of (q, θ, u, F), then $(q, \theta, u) = (q', \theta', u')$ for all (F, F').*

Proof: See Appendix for the proof of this and all other propositions. ■

Proposition 1 states the somewhat obvious result that fixed costs shocks will not affect equilibrium choices. Thus, with the exception of firm shutdown, both the level and mix of

[13] We define non-distortionary perquisites as those that do not directly affect the cost of production.

services provided by a FPID (or an explicit for-profit) should be unaffected by a fixed cost shock. This prediction also provides a very basic external validity "gut check." If for-profit hospitals change their behavior in response to our fixed cost shock, it should give us serious pause regarding either the applicability of the standard neo-classical model to hospitals or the validity of our natural experiment.

3.3 Output (Prestige) Maximization

In one of the earliest theories of nonprofit hospital behavior, Newhouse (1970) develops a model where nonprofit hospitals maximize output (or alternately "Prestige"), which is defined as a weighted average of the quantity and quality of care. Letting θ represent quality of care, we can write the hospital objective function as $V^{Output} = V(q, \theta, u)$.

Proposition 2 *Let nonprofit hospitals have as their objective function* $V^{Output} \equiv V(q, \theta, u)$ *where* V^{Output} *is an increasing, concave function of* q*,* θ *and* u*. For any fixed cost shock* $F > 0$*, conditional on being able to meet it's budget constraint, nonprofit hospitals will decrease one or more of the set* $\{q, \theta, u\}$*.*

The intuition behind the proof is simple: output maximizing hospitals offer more and higher quality health care until profits are driven to zero. When faced with a fixed cost shock, these hospitals have less slack to subsidize output generating activities and have to decrease either quantity, quality, uncompensated care or some combination of the three. Depending on the specific functional form of V, however, a decrease in any one of these outputs may be accompanied by an increase in the others. For example an output maximizing hospital might reduce the quality of care while increasing the quantity of care or vice versa. Because this theory places no restrictions on how firms value q and θ, we cannot generate more concrete predictions. From a modeling standpoint, the following two theories correspond to special cases of the output maximization model.

3.4 Pure Altruism

Our third model corresponds to hospitals maximizing some measure of social welfare. The literature generally conceives of this occurring through altruistically motivated managers or agents.[14] A driving assumption of the pure altruism model is that for many heath services

[14] See for example Rose-Ackerman (1996), Frank and Salkever (1991) or Besley and Ghatak (2004).

some aspect of care (e.g., quality) is non-contractible. Non-contractible care is costly to the firm to provide and yet socially efficient. The non-contractibility means that profit-maximizing firms will provide the minimum possible level, since any increased cost are not offset by a countervailing increase in payment. A purely altruistic hospital though might provide higher levels of such care since it is more efficient from a social welfare standpoint.

The key difference between this model and general output maximization model is the assumption that purely altruistic hospitals do not value θ (e.g. higher quality care) in and of itself. Rather, they value θ only in so far as it provides more welfare per unit q than lower quality care. For example a doctor that is obsessed with $q$uality might spend each day caring for a single patient. But, to the extent that such behavior does not maximize the total welfare the doctor can provide, it would not qualify as pure altruism. It is this functional form restriction that allows this model to generate more definitive predictions than in the more general case of output maximization.

Proposition 3 *Let nonprofit hospitals have as their maximand the function* $V^A \equiv V(w(q,\theta),u)$ *where* V^A *is an increasing, concave function of* w *and* u*, and* $w(q,\theta) = q\theta$*. For any fixed cost shock* $F > 0$*, conditional on being able to meet it's budget constraint, nonprofit hospitals must (weakly) decrease* q*,* θ *and* u*.*

When faced with a fixed cost shock, altruists weakly decrease output on all dimensions. As in the output maximization case, the main intuition behind is simple: altruists use any left over profits to subsidize welfare enhancing activities (i.e. more q, θ and u). When faced with a fixed cost shock, they must scale back on money-losing (but welfare-improving) activities. Unlike the more general output maximization case, under pure altruism the hospital cares about quality θ only because it increases the welfare of the care it provides. Thus, a fixed cost shock will (weakly) generate cutbacks on both quality and quantity.

3.5 Perquisite Maximization

Our final model captures the idea that nonprofit hospitals may disburse profits as non-pecuniary perquisites or "dividends-in-kind" in response to a binding non-distribution constraint.[15] These hospitals do not care directly about the quantity of care but rather consumption of perquisites. Distortionary perquisites are represented by θ, while the amount

[15] See Pauly (1987) and Glaeser and Shleifer (2001) for further discussion of perquisite maximization.

spent directly on non-distortionary perquisites is given by R. To illustrate the differences between the two, consider the canonical example of perquisites in the corporate finance literature: managers providing themselves with excessively luxurious work environments (e.g. nice offices, corporate jets). A nice office is a non-distortionary perquisite since it does not change the cost of production, while a corporate jet would be a distortionary perquisite (θ) since it presumably increases the cost of business trips (relative to commercial air travel).

The special case where hospitals value only non-distortionary perquisites reduces to the for-profit-in-disguise case (the firm simply maximizes R). Thus, here we consider the case where hospitals value at least some perquisites that raise marginal costs. This model corresponds to a wide range of theories of nonprofit behavior (and underlying motivations). For example, both (1) nonprofit hospitals pursuing the "quiet life" or (2) myopically providing the highest quality care irrespective of cost fit our definition of perquisite maximizers. Because we do not have measures of welfare/quality and to avoid imposing additional functional form assumptions, we remain agnostic as to the exact nature of the perquisites.

Proposition 4 *Let nonprofit hospitals have as their objective function* $V^{perk} \equiv V(R, \theta)$ *where* V^{perk} *is an increasing, concave function of* θ. *For any fixed cost shock* $F > 0$, *conditional on being able to meet it's budget constraint, nonprofit hospitals must (weakly) decrease* θ *and increase* q.

When faced with a fixed cost shock, perquisite maximizers weakly decrease both distortionary and non-distortionary perquisites. An important implication of this result is that, because distortionary perquisites, θ, increase the cost of production, a decrease in θ decreases the cost of production, leading to an increase in the production of q.

This result stems from that conditional on θ, perquisite maximizers produce the profit maximizing quantity, $q^{\pi}|\theta$. That is, they choose q to maximize income - they do not leave any "free money" on the table (that they could use to subsidize consumption of θ). When faced with a fixed cost shock F, the firm has less slack and must reduce the level of perquisite consumption. And since the profit-maximizing quantity is negatively related to the distortionary perquisite, θ, q^{π} will increase in response to F.

3.6 Summary of Predictions

Appendix Table I summarizes the responses to a negative fixed cost shock predicted by the four classes of models. For FPID, we expect no change in service provision. In contrast, output maximization predicts a decrease in one or more of the three measures of output: profitable care, distortionary perquisites, such as non-contractible quality, or uncompensated care. Given an increase in any one, the sign of any other change is ambiguous. The altruistic model predicts a (weak) decrease along all three dimensions. Perquisite maximizing hospitals will decrease perquisites. If some perquisites are distortionary, this decrease will lead to an increase in the provision of profitable services. We test these predictions using the fixed cost shock generated by California's seismic retrofit mandate.

4 The Program: California's Seismic Retrofit Mandate

California's original hospital seismic safety code, The Alquist Hospital Facilities Seismic Safety Act, was enacted in 1973. Prompted by the 1971 San Fernando Valley earthquake, which destroyed several hospitals, the Alquist Act required *newly* constructed hospitals to follow stringent seismic safety guidelines. Perhaps in response, hospital construction projects remained rare throughout the 1980s (Meade and Kulick, 2007).[16]

On January 17, 1994, a 6.7 magnitude earthquake hit 20 miles northwest of Los Angeles, near the community of Northridge.[17] The Northridge earthquake caused billions of dollars in damage and left several hospitals unusable.[18] In its wake, California amended the Alquist Act. Although the amendment, SB 1953, was passed quickly, its requirements were not finalized until March 1998.[19] SB 1953's primary innovation was to establish deadlines by which all general acute care (GAC) hospitals had to meet certain seismic safety requirements or be removed from operation (see Appendix Table II). Its goal was to keep hospitals operational following a strong earthquake so as to maintain current patients and provide care to earthquake victims. The deadlines were to offer hospitals a "phased" approach to

[16] A state-sponsored engineering survey of all hospitals found that by 1990 over 83 percent of hospital beds were in buildings that did not comply with the 1973 Alquist Act (Meade et al. 2002).

[17] http://earthquake.usgs.gov/regional/states/events/1994_01_17.php

[18] According to the California Hospital Association, 23 hospitals had to suspend some or all services. See http://www.calhealth.org/public/press/Article%5C103%5CSB1953factsheet%20-%20Final.pdf Six facilities had to evacuate within hours of the earthquake (Schultz et al. 2003). But no hospitals collapsed and those built according to the specifications of the Alquist Act suffered comparatively little damage.

[19] See http://www.oshpd.state.ca.us/FDD/SB1953/index.htm.

compliance (Meade and Kulick, 2007). No money has been earmarked to aid in this process.

The first deadline was January 2001. By that date, all GAC hospitals were to submit a survey of the seismic vulnerability of each of its buildings. Most hospitals (over 90%) complied (Alesch and Petak, 2004). As part of the survey, each hospital classified the nonstructural elements (e.g. power generators, communication systems, bulk medical gas, etc.) of each buildings according to five "Non-structural Performance Categories" (NPC). Similarly, each building was rated according to five "Structural Performance Categories" (SPC). These ratings indicate how a hospital should fare in a strong earthquake (OSHPD, 2001). Appendix Table II describes the full set of SPC ratings. The first categories, NPC-1 and SPC-1, represent the worst and the last categories, NPC-5 and SPC-5, the best ratings.

About 70 percent of buildings were rated NPC-1, indicating that major nonstructural elements essential for life-saving care were not adequately braced to withstand a major earthquake (Meade et al. 2002). Hospitals faced a January 1, 2002 deadline for bracing these systems, shifting their NPC-1 buildings to the NPC-2 rating. While we know of no estimates of the costs of compliance, this requirement was viewed as a relatively minor.[20]

The first major deadline facing California hospitals was January 2008 (or January 2013, if the hospital could demonstrate "diminished capacity").[21] By this date, all hospitals with SPC-1 buildings were to have retrofitted to remain standing following a strong earthquake or taken out of operation. Based on the initial ratings, about 40 percent of hospital buildings or 50 percent of beds were SPC-1 (Meade and Kulick, 2007). Only 99 hospitals in California or about 20 percent of the 2001 total had no SPC-1 buildings and were thereby in compliance with the 2008 requirements (Meade et al., 2002). Hospitals face a final deadline of January 1, 2030. By 2030, all SPC-1 and SPC-2 buildings must be replaced or upgraded. These buildings should be usable following strong ground motion. While the legislature thought that hospitals would retrofit SPC-1 buildings to SPC-2 status by 2008/2013, and replace them completely by 2030, few hospitals have done this. Rather, to avoid the expense and disruption of a retrofit, most have chosen to rebuild SPC-1 buildings from the outset, effectively moving the final deadline up from 2030 to 2008 or 2013, and

[20] The estimated cost of complying with this requirement was $42 million; the initial estimated cost of reconstructing SPC 1 buildings was three orders of magnitude higher, at $41.1 billion (Meade et al. 2002).

[21] Diminished capacity means that the hospital's GAC capacity cannot be provided by others within a reasonable proximity, justifying an extension of the deadline rather than removal from GAC operations.

causing an unprecedented growth in hospital construction (Meade and Kulick, 2007).

Recognizing that most hospitals would not meet the 2008/2013 deadlines, more extensions have been introduced.[22] The most noteworthy involves a voluntary reclassification allowing hospitals with SPC-1 buildings to use a "state-of-the-art" technology called HAZUS (Hazards U.S. Multi-Hazard) to re-evaluate their seismic risk.[23] The Office of Statewide Health Planning and Development (OSHPD) authorized this program in November 2007 to address concerns that the original SPC ratings were based on crude assessments. Hospitals that opt into the program had to submit a written request along with their seismic evaluation report and a supplemental report identifying where the original ratings may have been inaccurate. Participation in the program effectively moves the compliance deadline to 2013, if any buildings are still deemed SPC-1, or to 2030, if all buildings are reclassified as SPC-2, meaning they can withstand a major earthquake but may not be functional afterwards.

Despite the extensions and reclassifications, most California hospitals are engaged in major capital investment projects. Between 2000 and 2009, OSHPD reviewed plans for SB 1953-related construction totaling $12 billion and accounting for 45 percent of reviews over the period and 70 percent in 2008 alone.[24] Appendix Figure 1, which graphs the mean and median value of hospital construction in progress since 1996, demonstrates a sharp rise in mean spending after 2001, the year hospitals submitted their building surveys. While this also captures national trends in construction costs and the specific increase in health care construction costs in California, this cannot plausibly explain the 150 percent increase in spending between 2001 and 2006. And, Appendix Figure 2, which compares hospital construction spending in California to private healthcare construction spending in the South Atlantic and private educational spending in the Pacific Division, the lowest level of aggregation available from the Census Bureau's "Manufacturing, Mining and Construction Statistics," further suggests that the sharp increase in California hospital construction spending is not driven by underlying industry or region trends.

Appendix Figure 1 also demonstrates that the mandate's bite was not uniform: the median value of spending on construction in progress picks up in 2001 but is well below the mean. The difference between the median and mean value implies that a few hospitals

[22] For an overview, see http://www.oshpd.ca.gov/SeismicSafetyHearing_Final.pdf

[23] See http://www.oshpd.ca.gov/fdd/sb1953/FinalJan2008Bul.PDF

[24] See page 39 of this OSHPD report: http://www.oshpd.ca.gov/SeismicSafetyHearing_Final.pdf

are spending a lot on construction while the typical hospital is spending much less. This disparity is congruent with the idea that there is no break in trend for hospitals in general. Rather, as we show below, the increase in spending is driven by those hospitals disproportionately affected by the seismic retrofit mandate. Finally, based on 2009 reporting requirements, OSHPD estimates that 70 percent of buildings, though only 52 percent of hospitals are likely to comply with the mandate between 2013 and 2020. For the purposes of our study, an important fact is that few, if any, projects were completed by 2006, the last year of our data. Thus, our analysis should capture the response of hospitals to a fixed cost shock not any consequent change in the production function associated with new facilities.

5 Data and Methods

5.1 Data Sources

We combine data on the seismic risk, service provision, and finances of all GAC hospitals in California. Financial data are from OSHPD's Annual Hospital Disclosure Report (AHDR) from 1996 through 2006 and are normalized to 2006 dollars. The ADHR has some service measures. Since these data are not comparable prior to 2001, we analyze changes between 2002 and 2006.[25] We supplement these data with Annual Utilization Reports (AUR), which are less detailed but are available from 1992 to 2006. We identify hospital closures from the AUR reports and California Hospital Association records.[26] License conversion information was obtained through a request to OSHPD.

Seismic ratings and SB 1953 extension requests are from separate OSHPD databases. Data on the underlying seismic risk of each hospital's location are from the California Geological Survey (CGS). We use a standard measure called the peak ground acceleration factor (pga), which is the maximum expected ground acceleration that will occur with a 10 percent probability over the next 50 years normalized to Earth's gravity.[27]

[25]In discussions with OSHPD, we were advised to not use the first year of service data. But results are similar, though sometimes less and other times more precisely estimated, if we use 2001 as the base year.

[26]In placebo checks, we also analyze closures from 1992-1996. These data are cross-checked against reports from the Office of the US Inspector General.

[27]See details at http://www.consrv.ca.gov/cgs/rghm/psha/ofr9608/Pages/index.aspx

5.2 Identification Strategy

The financial shock of SB 1953 is a function of a hospital's buildings, as captured by SPC ratings, and location. Since hospitals that have poorer quality buildings, i.e. lower ratings, likely differ on other dimensions (e.g., financial performance), we cannot simply compare ratings and outcomes. One feature of the cost shock is largely predetermined - underlying geologic seismic risk. Most hospitals in California were built between 1940 and 1970, at an early stage in our understanding of seismic risk and before the development of modern seismic safety standards. New construction has been slow relative to reasonable building lifespan (Meade et al., 2002). Although some hospitals have built new additions, most are so well integrated into the original structure that they need to be replaced along with the older buildings (Jones 2004). Combined with high seismic variability at small distances (e.g., see Appendix Figure 3), well-performing hospitals are unlikely to have selected into "better" locations (along seismic risk dimensions), at least within a locality.

Our identification strategy exploits these features of seismic risk. It implicitly relies on the assumption that underlying seismic risk (pga) is quasi-randomly matched to hospitals within a geographic area (e.g., county). This assumption is consistent with discussions between the authors and seismologists, who lament the fact that seismic risk is factored into building construction on only a highly-aggregated level (e.g. by county). This assumption is further corroborated by empirical tests (shown below) of the distribution of observables.

5.3 Econometric Specifications

Our basic regression specification is:

$$Y_h = pga_h + \beta X_h + \gamma_c + \epsilon_{h,c} \tag{4}$$

where Y_h is our outcome of interest, such as days of care provided to indigent patients in hospital (h), pga_h is a hospital's inherent seismic risk, as measured by its peak ground acceleration factor, X_h is a hospital's observable characteristics, and γ_c is a county fixed effect. Our basic set of hospital characteristics X_{hct} includes: bed size, ownership type, license age and its square, rural status, multi-system or chain status and teaching (approved residency program) status. Ideally all hospital controls would be measured pre-mandate since the mandate could alter these characteristics. We measure bed size, ownership status, rural status as of 1992. Age is measured as of the year the original hospital opened, regardless of sale or conversion. Due to data limitations, multi-hospital system and teaching status are measured as of the 1996 fiscal year.[28] Since the specifics of the legislation were not finalized until March 1998 and hospitals did not know their full exposure to the legislation until 2001 when their buildings were rated, the risk of endogeneity of the 1996 fiscal year (July 1995-June 1996) hospital characteristics should be minimal.

All our models include location (county) fixed effects to control for fixed differences in outcomes that are correlated with broad statewide seismic risk patterns. Thus, the effect of SB 1953 is identified by differences in seismic risk within a county and across hospital types. The advantage of this approach is that we can account for differences in hospital quality or demand that may exist across areas due to differences in factors such as the socioeconomic characteristics of the population across areas.

To test for differences in the response of hospitals by ownership type, we run all regressions as (4), augmented with interactions between ownership status (for-profit or public, with nonprofit the omitted category) and seismic risk. It is these interaction terms that allow us to test our models of hospital behavior. If, for example, nonprofit and for-profit hospitals respond similarly to the fixed cost shock of retrofitting, then we might take it as support for the FPID hypothesis. Alternatively, if nonprofit hospitals alone increase the provision of profitable services in response to a fixed cost shock, then we can reject both theories of pure profit-maximization and pure altruism.

Regression equation (4) specifies a linear relationship between seismic risk and hospital outcomes. We have also tested several other functional forms. In some cases, the effect of seismic risk is better captured as a level shift in outcomes. In these cases we also present results that replace pga_h in (4) with an indicator, $1(pga_h \geq median)$, that equals one if a hospital has seismic risk at or above the median of all hospitals in its county. Similarly, we estimate models that include interactions between this indicator and ownership type.

We consider three alternate specifications of our outcomes First we consider levels in the most recent year (2006) since the effect of the legislation should be larger as we approach the retrofit deadlines. This intuition is confirmed by evidence from both Meade and Kulick

[28] The 1992 data are from OSHPD's AUR; 1996 system and teaching status are from the AHDR.

(2007) and our own regressions using the levels of our outcomes in other years. We find a largely monotonic increase in the magnitude of the effect of pga on outcomes, such as spending on plant, property and equipment, as we approach 2006. Second we sum the levels of each outcome for all available years (1992, 1996 or 2002 through 2006, depending on the measure). These results represent the aggregate effect of the legislation over our study period. This specification helps minimize the impact of an idiosyncratic year. The results from this specification look very similar to our first specification, but are generally more precisely estimated. Finally we take a long difference and analyze changes between 2006 and 1992, 1996 or 2002, depending on the earliest year available for a given measure. Specifically we estimate regressions of the following form:

$$\Delta Y_{hct,t-n} = pga_h + \beta X_{hct,t-n} + \gamma_c + \epsilon_{hct,t-n} \tag{5}$$

where $\Delta Y_{hct,t-n}$ is the change in outcome, such as days of care in hospital h and county c, between years t and $t-n$. We estimate models that specify seismic risk linearly or as an indicator, $1(pga_h \geq median)$, for seismic risk at or above the within-county seismic median. These results are qualitatively similar to those from our other specifications. Because the long difference minimizes the possible correlation between observed and unobserved hospital characteristics, this third approach is generally our preferred specification.

In addition to spending and service provision, we are also interested in the effect of SB 1953 on the probability of a hospital's closure or license conversion. We use linear probability models to analyze these outcomes to accommodate the use of fixed effects. Since closure is not an uncommon outcome (roughly 15 percent of hospitals in the state closed during our sample period), we are not too worried about boundary constraints. However, in sensitivity tests, we obtain similar results using probit models.

6 Results

6.1 Descriptive Statistics

Table I presents descriptive statistics for all GAC hospitals that filed OSHPD's (required) Annual Financial Reports sometime between 1996 and 2006.[29] Panel A shows baseline

[29]Hospitals that do not file the reports on time are fined \$100 per day they are late. For details on non-filing penalties, see http://www.oshpd.cahwnet.gov/HID/hospital/finance/manuals/ch7000.pdf

hospital characteristics as of 1992 or 1996, depending on the measure, and Panel B shows some of the outcomes we study. Across both panels, we show descriptive statistics for the full sample and then separately for hospitals that are at or above median and those that are below median seismic risk within their county. Many hospitals have median seismic risk.

The mean ground acceleration factor is just below 0.5g. Within our sample, seismic risk varies from a minimum of 0.05 and maximum of 1.15 g's and follows a bell-shaped distribution. About 28 percent of the hospitals in our sample are investor-owned,, for-profit institutions and 19 percent are government-owned. About 36 percent of hospitals are part of a large system or chain. Over a quarter are teaching hospitals and 9 percent are in rural areas. The average hospital has 203 licensed beds and was 61 years old as of 1992.

Both chain status and age are relatively invariant across low and high pga areas. Many other baseline characteristics vary sharply. For example, investor-owned hospitals are more common (34.2 versus 16.4 percent) and government-owned slightly less common (14.8 versus 26.3 percent) in above median pga areas. However, these differences can be explained largely by the rural divide: low pga areas are systematically more rural. Whereas fewer than 1 percent of hospitals in high pga areas areas are rural, over 25 percent in low pga areas are rural. Importantly, our analysis does not rely on an across-state, high versus low pga comparison. Rather, it exploits within-county variation in seismic risk, which eliminates much of the urban-rural differences. As we discuss below (shown in Appendix Table III), once we control for county, most of these characteristics do not differ systematically with seismic risk. In all regressions we control for the baseline characteristics listed in Table 1, Panel A.

Panel B shows means for several outcomes. Total spending on plant, property and equipment (PPE) was $110 million in 2006, with about half dedicated to building improvements, including architectural, consulting, and legal fees related to the acquisition or construction of buildings and interest paid for construction financing.[30] In contrast, construction in progress accounts for only about 6 percent of PPE spending. The difference may reflect the relatively long organizational time horizon for constructing a new facility - four to five years for the in-house planning process alone (Meade and Kulick, 2007). Importantly, the

[30]See http://www.oshpd.ca.gov/HID/Products/Hospitals/AnnFinanData/Manuals/ch2000.pdf for details on this and other accounting categories studied here.

level of PPE spending (overall and by type) is higher in high pga areas.

Roughly 13 percent of the hospitals in our sample closed and almost 8 percent converted ownership status during our sample period. The share of hospitals that closed or converted ownership status is a bit higher in high versus low pga hospitals. Those hospitals remaining in the market in 2006 have on average 233 beds. As expected given the rural divide, those in high pga areas are systematically larger, with 260 as compared to 182 licensed beds and have more hospital days and discharges, both overall and by type. Of the licensed beds, 82 percent are staffed in high pga and 87 percent in low pga areas.

While Table I compares hospitals with high versus low seismic risk overall, our main analysis is based on within-county comparisons of risk. To give us some confidence in this research design, we next verify that many observable hospital characteristics are uncorrelated with seismic risk, specified either linearly or as a level shift. We first consider neighborhood characteristics, where neighborhood is defined as all zip codes within a 5-mile radius of the hospital.[31] We run regressions, based on both the level and change in a hospital's neighborhood characteristics as a function of its seismic risk, age and its square, the number of licensed beds in 1992 and dummies for 1992 ownership status, an indicator for rural status, based on an OSHPD designation, and county fixed effects.[32] Within each panel, we present estimates based on a linear specification of seismic risk and an indicator for risk at or above the median in the hospital's county. In robustness checks, we also use city fixed effects. We include geographic controls because seismic risk patterns across the state correlate broadly with demographic and socioeconomics differences.[33] We find generally no significant correlation between seismic risk and these dependent variables.

Panel A of Appendix Table III presents estimates based on 1990 Census characteristics. Within a county, we find no meaningful relationship between pga and the total population in the hospital's neighborhood, the share of the population that is below the federal poverty line, the share Hispanic, the share 5 to 17 years old, and the median household income in the neighborhood. Results are similarly small and imprecise when we compare hospitals with seismic risk that is at or above versus below the median for its county. When we look

[31]Defining neighborhoods by the hospital's zip code of operation yields similar results.

[32]We omit 1996 teaching and system status because they occur after the characteristics studied here.

[33]E.g., San Francisco County is both high seismic risk and high income relative to Sacramento County. As a result, our identification uses only within county variation in seismic risk. Within-city variation is even cleaner but many small to medium cities have only one hospital.

at growth in these characteristics between 1989 and 1999 (Panel B), we find no significant relationship in 4 out of 5 cases. The exception is the share living below the federal poverty line. A one standard deviation increase in seismic risk (approximately 0.2g) is associated with almost 6 percentage points higher growth off a base of 19 percent living below the federal poverty line. Estimates by ownership status reveal that the effects are concentrated around public and nonprofit hospital and is indistinguishable from zero around for-profit hospitals. This result is insignificant when we compare the neighborhoods surrounding hospitals that are in high versus low seismic risk areas within the same county. In results not shown, we also find no within-county relationship between seismic risk and a range of other observable characteristics - e.g. the share of the population female, African-American, native-born, ages 65 and older or on public assistance - both in levels and changes between 1989 and 1999. These results are both statistically and economically insignificant.

Appendix Table III also analyzes hospital characteristics in 1992 (Panel C) and 1996 (Panel D). The correlation between seismic risk and the probability that a hospital was government-owned, nonprofit or for-profit (not shown) in 1992 is small and imprecise. The relationship between seismic risk and a hospital's age, the probability it had an emergency department, or its average length of stay as of 1992 is also insignificant. And the implied effects are small. For example, a 1 standard deviation increase in seismic risk is associated with about 1.7 fewer license years off a base of 61 years, a 0.3 percentage point lower probability of having an emergency room off a base of 70 percent, and 4 percent longer length of stay. Specified as a level shift, the effect of high within-county seismic risk on age is marginally significant but again the results suggest less than 3 years difference in age. Moreover, we control for age and its square in the analysis presented below.

For 4 of the 5 1996 characteristics presented in Panel D - the share of hospitals with a drug detoxification program, a Neonatal Intensive Care Unit (NICU), MRIs, and blood banks - the correlation with seismic risk is imprecise and generally small. The one exception is the probability of participating in a county indigent care program. A one standard deviation increase in seismic risk is associated with an 11 percentage point lower probability of participating in the program off a base of about 50 percent. The effect is insignificant when comparing high versus low seismic risk hospitals within a county.

On net, seismic risk is uncorrelated with hospital characteristics overall and by ownership status (not shown). This is true whether we specify seismic risk linearly or as an indicator for high risk. Since a hospital's peak ground acceleration factor is broadly unrelated to observable characteristics but is directly related to the SB 1953-related cost shock, we can use it as a source of randomization of our treatment. In other words, we can identify the impact of SB 1953 by comparing the response of similar hospitals (based on county co-location, rural status, age, ownership type, and so on) *but* for their inherent seismic risk.

6.2 Hospital Shutdowns and License Conversions

To the extent that SB 1953 causes a large fixed cost shock and increases the cost of capital as hospitals compete for scarce financing resources, it may have the unintended consequence of increasing closures. For example, if equity and bond ratings decline for those with higher seismic risk, some hospitals may have difficulty financing their day-to-day activities and may choose to shut down. While our models do not generate robust differential predictions for closure, this outcome is interesting in its own right. First it provides evidence on the bite of the mandate. Moreover, differential closure probabilities would introduce a sample selection problem in our assessments of the effect of seismic risk on other outcomes.

Table II presents linear probability models of the likelihood of hospital shutdown after 1996. Results based on probit models are very similar, although we do not rely on this model because of the "incidental parameters" problem. Both models indicate that seismic risk increases the probability of closure: a one standard deviation increase in the ground acceleration factor increases the likelihood of closure by 6 to 7 percentage points. Importantly, we cannot reject that the impact is similar across ownership types. Results are qualitatively similar, although quite imprecise, when we compare high versus low seismic risk hospitals within a county (not shown).

To corroborate the role of the mandate in causing closures, we run a placebo test of the relationship between seismic risk and pre-1997 hospital closures. These results, in Appendix Table IV, indicate that the correlation between seismic risk and closure is negative, small in magnitude and indistinguishable from zero prior to 1997.[34] Together with the placebo results, we conclude that the mandate itself increased closures and is

[34] Given the low rate of closure over this period - about 4 percent - the probit model may be more appropriate. But, because closures were concentrated in a few counties and varied little closures by ownership status within-counties over this period, we cannot estimate probit models with interaction effects. Based on the OLS model, we find no evidence of seismic risk effects, overall or by ownership status.

not simply exacerbating pre-existing closure trends, which were concentrated in for-profit facilities (see Buchmueller et al., 2006). These results indicate that SB 1953 put financial pressure on all hospitals with high seismic risk. In contrast to Duggan (2000), which finds that localities reduce their allocations to public hospitals receiving "extra" state funds for treating a "disproportionate share" of publicly insured patients, our results imply that the state is not shielding their hospitals from financial pressure. Most importantly for our analytic purposes, these results provide some evidence that SB1953 has bite. Hospitals are not simply ignoring the legislation in the hopes that they will be"bailed" out.[35]

Table II also explores the relationship between seismic risk and the probability a hospital converts its license (e.g., from nonprofit to for-profit status, the most common type of conversion). We might expect nonprofit (and possibly public) hospitals with higher fixed cost shocks to convert their licenses if this eases credit constraints. Our point estimates suggest that seismic risk actually lowers the likelihood that a nonprofit converts to for-profit status or a public converts to for-profit or nonprofit status. A one-standard deviation increase in seismic risk lowers the probability of license conversion by about 6 percentage points. We take these results as some indication that private financial markets are less willing to lend to high seismic risk hospitals. High seismic risk hospitals may be less likely to convert their licenses if doing so is unlikely to ease credit constraints. As a result, this finding suggests that the increases in the provision of profitable services that we will demonstrate below may well be lower bounds relative to what a high-seismic risk nonprofit hospital would like to produce. Taken together the results on closures and license conversion indicate that the seismic retrofit mandate had real implications for California's hospitals and was not simply another set of requirements to be ignored.

6.3 Seismic Risk and Spending

In Table III we assess whether seismic risk predicts differences in building-related expenditures. Because hospitals have some flexibility in how and when they account for expenditures, we consider any spending on plant, property and equipment (PPE) for all years between 1996 and 2006. Panel A specifies seismic risk linearly and Panel B as a level shift.

The first four columns shows results for hospitals operating from 1996 to 2006. Results

[35] These results are not driven by Los Angeles County, where several hospitals were damaged by the Northridge Earthquake. Estimates that exclude hospitals in Los Angeles County are virtually identical.

are for total spending in levels in cols (1) and (2) and logs in cols (3) and (4). As shown in cols (1) and (3), a hospital's ground acceleration factor is positively related to total PPE spending over the sample period. The estimate in levels (col (1)) is only statistically significant at the 10 percent level. When we allow for differential effects of seismic risk by ownership type, the impact on spending is clearer. The main effect, which isolates the impact of seismic risk on spending by nonprofit hospitals, implies a one standard deviation increase in pga raises PPE spending by $320 million. Whether in levels or logs, the interaction between pga and for-profit or public ownership status is negative. We cannot reject zero effect of seismic risk on PPE spending by for-profit and public hospitals. Expressed in logs, higher seismic risk nonprofit and for-profit hospitals have higher PPE spending, although the for-profit results are only significant at the 10 percent level.

In the next four columns, we test the sensitivity to the inclusion of hospitals that drop out of the sample because of closure, merger or other unobserved reasons.[36] We set to zero missing PPE spending values between 1996 and 2006 and include an indicator to capture this substitution. As expected, the estimates are smaller in magnitude but follow a similar pattern. Nonprofit hospitals with higher seismic risk spend hundreds of millions of dollars more on PPE than their for-profit or public counterparts. The results in Panel B, which is analogous to Panel A but specifies seismic risk nonlinearly, are qualitatively similar.

Appendix Table V analyzes two categories of PPE spending – building improvements and construction in progress. To reduce the number of panels, we present results for hospitals in continuous operation and specify pga linearly. Results are broadly similar for all combinations of entries as in Table III. The bulk of the increase in PPE spending found above is concentrated in building improvements, which includes architectural, consulting, and legal fees related to building construction. The increase is clearest for nonprofit hospitals, although the log specification suggests high seismic risk for-profits also had higher spending on building improvements. In contrast and irrespective of ownership, we find no clear relationship between seismic risk and construction in progress, which may reflect the fact that most hospitals were in the planning phase during our study period.

Differences in spending by ownership may capture the fact that nonprofit hospitals are larger and have more SPC 1 buildings (an average of 2.7 compared to 1.5 for public and

[36] After a merger, hospitals can choose to retain separate reporting systems or report as one institution.

for-profits combined). Nonprofit hospitals may be simply farther along in their retrofitting timelines than public or for-profit hospitals.[37] However, because (1) for-profit and public hospitals may have readjusted their budgets in other ways (e.g. inter-temporally), (2) state-reported PPE spending may be poorly measured for public hospitals, given the intervening levels of jurisdictional control over their finances, and, most importantly, (3) seismic risk increases closures irrespective of ownership type, we do not interpret this as evidence that the cost shock is only binding for nonprofit hospitals. Rather, it is the first piece of evidence that nonprofits respond differently to this mandate than for-profit hospitals.

6.4 Services

To test our models of nonprofit behavior, we consider the impact of seismic risk on service provision. Because the mandate does not alter the "price" of hospital services, the cost shock should only affect service provision for hospitals not already profit-maximizing. Output-maximizers will have to cut back on at least one dimension – quality, quantity or uncompensated care. Altruistic firms will have to cut back on all of these dimensions. Perquisite-maximizers will have to reduce their consumption of perquisites and, to the extent those perquisites are distortionary, increase the provision of profitable services.

We first consider the overall volume of service. Table IV shows the impact of seismic risk on *changes* in GAC patient days and discharges between 1992 and 2006. Hospitals with higher seismic risk increased GAC days over this period (col (1)). A one-standard deviation increase in seismic risk is associated with about 2500 more days. Breaking out the effects by ownership type (col (2)), patient-days increase for higher seismic risk nonprofit hospitals but are indistinguishable from zero for higher seismic risk government-owned or for-profit hospitals. This pattern is confirmed when we compare hospitals with high versus low seismic risk (in cols (3) and (4)). Higher seismic risk nonprofits increase GAC days by almost 8,000 days relative to their lower seismic risk counterparts. The change is indistinguishable from zero for high versus low seismic risk public or for-profit hospitals.

Discharges increase with seismic risk, although the estimates are imprecise. When comparing high versus low seismic risk areas, which improves precision considerably, the

[37] As evidence, controlling for the same covariates as in our main regressions, nonprofit hospitals request extensions a half year earlier than for-profit hospitals and almost a a full year earlier than public hospitals. However, seismic risk does not predict extension requests or approval, which is not surprising given that over 80 percent of hospitals requested an extension and 98 percent of those received them.

increase is specific to nonprofit hospitals. Nonprofit hospitals increase discharges by about 1400 in high relative to low seismic risk areas. With an average length of stay of 5 days, the increase in nonprofit days is driven largely by volume.[38] That higher seismic risk nonprofits alone increase volume suggests that they may not have been profit-maximizing prior to SB 1953. This possibility is given further credence in Appendix Table VI, which suggests that the volume increase is accommodated by more intensive resource use rather than hospital expansion per se. Although beds increase with seismic risk, the estimate is not distinguishable from zero overall or by ownership. In contrast, higher seismic risk increases the share of beds that are staffed and available for patient use. Only nonprofit and public hospitals with higher seismic risk increase the share of staffed beds. Together with the results for beds, these findings suggest that nonprofits accommodate increased volume by using the existing physical resources at their disposal more intensively.

In Tables V-VIII we study changes in specific services. In Table V we consider unreimbursed indigent care (and not care reimbursed by county indigent programs). We look at changes in inpatient indigent care days as well as indigent clinic visits. When pooling across ownership type, we find small and extremely imprecise relationships between pga and indigent care days or visits (not shown here). Breaking the effects out by ownership, however, we find that government-owned hospitals with higher seismic risk decrease their charity care. Specifically, a one-standard deviation increase in seismic risk is associated with 200 fewer indigent care days, although this estimates is imprecise.[39] If we instead measure the change in the average of indigent care days for 2005-6 relative to 2002-3, our estimates are much more precise and of similar magnitudes (not shown). Results are qualitatively similar but imprecise when we compare high versus low seismic risk hospitals (col (2)).

The results are clearer for uncompensated visits to hospital clinics. Public hospitals with higher seismic risk cut free/reduced price clinic visits. A one-standard deviation increase in seismic risk is associated with about 1000 fewer of these visits. Similarly, public hospitals that are high seismic risk for their county decrease clinic visits by 1800 relative to their low seismic risk counterparts. Estimates from both specifications are both statistically

[38] Results for days and discharges are similar if we use OSHPD's Inpatient Discharge Data. For consistency and because we only have the discharge data for 1997 and 2005, we opt to use the AUR data for this analysis.

[39] We arrive at this figure by multiplying the sum of the main effect of 853 and the differential public hospital effect of -1831 by the 0.2, a standard deviation change in seismic risk.

distinguishable from zero. How these hospitals reduce visits is unclear from our data, however. They may, for example, reduce their hours, limit the number of patients or do both. These results - that public hospitals facing larger fixed cost shocks cut back on subsidized care - suggest that SB 1953 put pressure on the soft budget constraint of government-owned hospitals. That nonprofit hospitals facing larger fixed cost shocks do not cut back on charitable is inconsistent with the predictions of the altruistic model.

We next consider profitable services. Whereas welfare-maximizing firms, which over-provide quantity and quality, should cut back on profitable services, output or perquisite-maximizing firms could increase their provision of profitable services. We draw heavily on Horwitz (2005) to classify services as relatively profitable or generously reimbursed.

We analyze changes in neonatal care changes between 1992 and 2006 in Table VI. The first two columns assess the probability a hospital adds a NICU. Nonprofit and public hospitals with higher seismic risk are, if anything, less likely to add NICUs, although results using an indicator of high seismic risk are imprecise. The sign of the effect is not too surprising given that higher seismic risk may make it more difficult to finance the high-tech equipment and hire the specialized staff required to run a NICU. The next six columns assess changes in NICU beds, days and discharges. Although nonprofits with higher seismic risk are less likely to add NICUs, those with NICUs use them more intensively. Relative to nonprofits in low-seismic risk locations, high-seismic risk nonprofits in the same county increase the number of NICU beds at their disposal as well as the number of patients (discharges) they treat. Irrespective of the specification, higher seismic risk is associated with more NICU days. A one-standard deviation increase in seismic risk is associated with 464 more NICU patient days at nonprofit hospitals. The estimates for for-profit and public hospitals are both small in magnitude and indistinguishable from zero. Together with the results for discharges, the linear specification of pga suggests that some of the increase may come through longer lengths of stay.

Table VII presents estimates of the impact of seismic risk on changes in cardiac care between 1992 and 2006. We study therapeutic cardiac catheterization, which includes a range of procedures including angioplasty, percutaneous coronary intervention (PCI) angiography, balloon septostomy, among others. We also look specifically at PCI, referred to historically and in our data source as percutaneous transluminal coronary angioplasty

(PTCA). Cardiac care in general and PTCA, in particular, are widely viewed as revenue-generating. Our results suggest that these services increase for non-profits facing a higher fixed cost shock. These estimates are imprecisely estimated in the linear specification of pga, but significant at conventional levels when we compare hospitals in the same county that are facing above versus below median seismic risk. Non-profits that are at or above median seismic risk perform 100 more therapeutic cardiac catheterizations between 1992 and 2006. All of the increase comes from PTCA. In contrast, we cannot reject that these services are unchanged for either for-profit or public hospitals with above median risk.

In table VIII, we consider another unrelated profitable service - Magnetic Resonance Imaging (MRI). Because these data are from the financial reports, we measure the change between 2002 and 2006. We measure use as minutes and consider total minutes as well as inpatient and outpatient minutes separately. Like neonatal and cardiac care, MRI minutes increase for nonprofit hospitals facing higher seismic risk. Results are similar if we specify the effect of pga as a level shift. The increase comes most clearly through outpatient MRI minutes. A one standard deviation increase in seismic risk is associated with about 2000 more minutes or about 34 more hours of outpatient MRI use. In contrast, we find no significant effects of seismic risk on MRI minutes for either for-profit or public hospitals. Taken together, the results from Tables VI-VII indicate that higher seismic risk encourages nonprofit hospitals to increase the volume of profitable services.[40] This finding is inconsistent with purely altruistic models of nonprofit behavior and lends strong support to output/prestige or perquisite-maximizing models.

7 Conclusions

As part of the health reform law, tax-exempt nonprofit hospitals face several new requirements. Hospitals must conduct health needs assessments and detail their community benefit activities. They will have to develop and publicize financial assistance policies, limit patient charges for some types of care and base collections on ability to pay. These changes highlight the continued confusion among both policymakers and scholars over the motives and net benefits of nonprofit hospitals.

[40] Analysis of the 1992 to 1996 change in NICU or cardiac care (in Appendix Tables VIII and IX, respectively) finds no significant relationship to pga; MRI minutes are not available for this time period.

While theories of nonprofit hospital behavior abound, they typically lay out general motivations without specifying any formal structure. As a result, distinguishing across these theories has proven challenging. In this paper, we overcome this difficulty by embedding in a very general framework three of the leading theories of nonprofit hospital behavior: 1) "for-profits in disguise," (2) output maximizers, (3) welfare maximizers, and (4) perquisite maximizers. We derive the response of nonprofit hospitals to a large fixed cost shock under each of these hypotheses.

We test the predictions generated by these hypothesis using an unfunded mandate requiring all GAC hospitals in California to retrofit or rebuild in order to comply with modern seismic safety standards. We show that hospitals with higher seismic risk are more likely to shut down, irrespective of ownership type. Nonprofits with high seismic risk experience larger increases in spending on plant, property and equipment. While for-profit hospitals do not change their service mix in response to the mandate, private nonprofits increase their mix of profitable services - e.g. neonatal intensive care days and MRI minutes, and government hospitals respond by decreasing the provision of charity care.

The behavior of government-owned hospitals is most consistent with welfare maximization, although the efficiency of their production may limit the benefits of this type of provision (Hart et al. 1997). In contrast, the results for nonprofits are consistent with only the output and perquisite maximization hypothesis and allow us to reject two of the leading theories of nonprofit hospital behavior - "for-profits in disguise" and "pure altruism." The welfare implications of these results are, however, theoretically ambiguous. More work is needed to determine whether the loss in welfare caused by reduced quantity provided by nonprofit hospitals offsets the welfare gains from potentially increased quality (including possible technological spillovers). Our results also highlight the importance of moving the policy debate away from the simpler and more extreme cases of nonprofit hospitals as 'for-profits in disguise" or "pure altruists."

Finally, although the primary goal of our analysis is to disentangle nonprofit hospital motives, our results also shed light on the indirect cost of California's seismic retrofit mandate. In addition to imposing direct costs of retrofitting or rebuilding, California's mandate has decreased both the number of hospitals in the state and the provision of uncompensated care by government-owned hospitals.

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Table I
Descriptive Statistics [a]

Panel A	*Baseline Hospital Characteristics*		
	Full Sample	*At or above median pga*	*Below median pga*
seismic risk, pga	0.480	0.595	0.251
	(0.207)	(0.145)	(0.085)
investor-owned	0.282	0.342	0.164
government-owned	0.186	0.148	0.263
belongs to a system	0.364	0.378	0.335
rural	0.090	0.007	0.256
teaching hospital	0.261	0.299	0.189
licensed beds	203	229	182
	(188)	(458)	(164)
license age	61.3	60.9	62.1
	(13.7)	(13.9)	(13.3)

Panel B	*Hospital Outcomes*		
	Full Sample	*At or above median pga*	*Below median pga*
PPE spending	110	132	91.9
	(148)	(152)	(126)
closed	0.134	0.144	0.113
converted ownership status	0.075	0.085	0.052
Licensed beds	233	260	182
	(190)	(198)	(164)
Share beds staffed	0.835	0.815	0.872
GAC days	36363	39591	29957
	(36425)	(37748)	(32253)
GAC Discharges	7792	8373	6639
	(7406)	(7599)	(6892)
Indigent Care days	442	439	449
	(986)	(950)	(1054)
NICU days	1846	2103	1336
	(3761)	(3911)	(3401)
Observations	456	304	152

[a]Notes:

1. Observations are for all hospitals reporting to OSHPD during our sample. Sample sizes for any given item or year may vary. Standard deviations are given in parenthesis.
2. Seismic risk, pga measures the maximum (peak) ground acceleration that is expected to occur with a 10 percent probability in the next 50 years.
3. Ownership status, beds and license age are as of 1992; system and teaching status are as of 1996. License age is (1992 - year of the hospital's original OSHPD license). A teaching hospital is one with an approved residency program.
4. Licensed beds are the maximum number of beds for which a hospital holds a license to operate; available beds are the number they physically have and staffed beds are the the number for which staff is on hand. See http://www.ahrq.gov/research/havbed/definitions.htm
5. In Panel B, all outcomes are for 2006 except for the closure and for-profit conversion outcomes, which measure events occurring between 1997 and 2006. Spending is measured in millions of 2006 dollars.

Table II
Hospital Closures and Conversions: 1997-2006 [a]

	Probability of Hospital Closure (Prob.=0.135)		*Probability of Ownership Conversion (Prob.=0.079)*	
pga	0.321	0.281	-0.323	-0.305
	(0.145)	(0.148)	(0.150)	(0.151)
pga * Public		0.147		0.009
		(0.205)		(0.202)
pga * For-Profit		0.065		-0.121
		(0.266)		(0.152)
Public	-0.013	-0.085	0.017	0.012
	(0.049)	(0.130)	(0.047)	(0.102)
For-Profit	0.107	0.076	-0.034	0.026
	(0.042)	(0.147)	(0.041)	(0.081)
Multi-Site	-0.019	- 0.021	-0.081	-0.083
	(0.044)	(0.043)	(0.031)	(0.031)
Rural	0.245	0.250	0.007	0.015
	(0.101)	(0.103)	(0.088)	(0.087)
Teaching	-0.005	-0.003	0.002	0.002
	(0.043)	(0.043)	(0.038)	(0.038)
Licensed Beds	-0.030	-0.031	-0.001	- 0.001
(per 100)	(0.011)	(0.011)	(0.006)	(0.006)
Year Opened	0.246	0.240	-0.109	-0.093
	(0.315)	(0.324)	(0.248)	(0.249)
Square of Year	-0.0001	-0.0001	0.00003	0.00002
Opened	(0.0001)	(0.0001)	(0.00006)	(0.00006)
Adj. R-squared	0.042	0.038	0.027	0.023
Observations	430	430	430	430

[a]Notes:

1. All regressions include county fixed effects as well as the year the hospital opened and its square, the number of licensed beds in 1992, 1992 ownership status (government-owned or for-profit, with nonprofit status excluded), rural status, 1996 teaching status and 1996 multi-hospital system status. Teaching status and system status are measured as of 1996 because of data limitations. Standard errors are clustered at the city level.

Table III
Plant Property and Equipment Spending [a]

Panel A	*Linear Specification of Seismic Risk*							
	Hospitals Operating 1996-2006				*All Hospitals in Operation in 1996*			
	TOTAL		*Log(TOTAL)*		*TOTAL*		*Log(TOTAL)*	
pga	941	1530	1.11	1.75	966	1300	1.84	0.085
	(610)	(696)	(0.617)	(0.553)	(545)	(627)	(1.63)	(2.08)
pga * Public		-2150		-2.48		-1110		5.62
		(693)		(0.775)		(593)		(2.19)
pga * For-Profit		-1230		-1.04		-679		3.74
		(712)		(1.74)	(470)		(2.91)	
Public	-704	328	-0.618	0.652	-613	-58.4	0.504	-2.30
	(229)	(342)	(0.153)	(0.402)	(187)	(285)	(0.492)	(1.03)
For-Profit	-548	340	-1.72	-1.24	-237	90.6	2.14	0.325
	(139)	(376)	(0.488)	(0.623)	(110)	(265)	(0.716)	(1.61)
Adj. R-squared	0.460	0.472	0.285	0.291	0.451	0.453	0.303	0.307
Observations	313	313	313	313	430	430	430	430
Panel B	*Nonlinear Specification of Seismic Risk*							
	Hospitals Operating 1996-2006				*All Hospitals in Operation in 1996*			
above median pga	150	437	-0.029	0.352	125	291	0.120	0.432
	(152)	(208)	(0.243)	(0.187)	(112)	(176)	(0.446)	(0.791)
above median * Public		-761		-0.832		-340		-0.620
		(338)		(0.308)		(287)		(1.10)
above median * For-Profit		-548		-0.871		-348		-0.661
		(241)		(0.672)		(210)		(1.30)
Public	-771	-230	-0.617	-0.057	-600	-370	-0.517	0.937
	(231)	(208)	(0.162)	(0.229)	(188)	(196)	(0.500)	(0.874)
For-Profit	-567	-176	-1.74	-1.12	-249	-69	2.13	2.59
	(138)	(238)	(0.479)	(0.321)	(109)	(209)	(0.715)	(1.16)
Adj. R-squared	0.457	0.464	0.280	0.206	0.447	0.447	0.301	0.299
Observations	313	313	313	313	430	430	430	430

[a]Notes:

1. All regressions include the number of licensed beds in 1992 and dummies for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Standard errors are clustered at the city level.
2. Above-median pga is an indicator variable that equals one for hospitals that are at or above-median pga relative to other hospitals in their county.
3. Amounts for all years deflated to 2006 dollars.
4. PPE includes land purchases, building improvements, equipment spending and ongoing construction costs.
5. The first four columns capture hospitals operating continuously between 1996 and 2006. The last four columns set missing PPE values to zero and includes an indicator variable to capture whether such a substitution was made.

Table IV
Changes in Total General Acute Care: 1992-2006 [a]

	Change in Hospitals Days				*Change in Hospitals Discharges*			
pga	12,232	11,913			1,743	1,638		
	(6,453)	(6,762)			(1,699)	(1,788)		
pga * Public		4,555				462		
		(12,064)				(2,436)		
pga * For-Profit		-4,493				107		
		(9,263)				(1,740)		
above-median pga			4,659	6,918			772	1,251
			(1,867)	(2,930)			(463)	(730)
above-median pga * Public				-245				-642
				(5,798)				(976)
above-median pga * For-Profit				-8,301				-1,337
				(4,409)				(960)
Public	-10,245	-12,747	-9,721	-9,061	-2,005	-2,244	-1,919	-1,451
	(1,653)	(7,356)	(3,767)	(4,724)	(800)	(1,606)	(782)	(897)
For-Profit	-5,050	-2,727	-5,314	460	-1994	-1,995	-1,986	-1052
	(2,291)	(4,936)	(2,306)	(3,954)	(284)	(999)	(509)	(919)
Adj. R-squared	0.089	0.084	0.098	0.103	0.024	0.018	0.031	0.031
Observations	373	373	373	373	373	373	373	373

[a]Notes:

1. Patient days and discharges are from OSHPD's Annual Utilization Reports.
2. All regressions include the number of licensed beds in 1992 and indicators for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Standard errors are clustered at the city level.
3. Above-median pga is an indicator variable that equals one for hospitals that are at or above-median pga relative to other hospitals in their county.

Table V
Changes in Uncompensated Care: 2002-2006 [a]

	Indigent Days		*Clinic Visits*	
pga	865		625	
	(704)		(802)	
ga * Public	-1,838		-5,821	
	(731)		(2,644)	
pga * For-profit	179		-370	
	(664)		(1,006)	
above-median pga		255		476
		(176)		(253)
above-median pga * Public		-483		-2,364
		(288)		(1,070)
above-median pga * For-Profit		-270		-616
		(204)		(251)
Public	623	-2.64	2005	464
	(341)	(222)	(940)	(363)
For-Profit	-68	-280	-245	86.4
	(331)	(204)	(439)	(320)
Adj. R-squared	0.013	0.037	0.059	0.064
Observations	348	348	348	348

[a]Notes:

1. All regressions include the number of licensed beds in 1992 and dummies for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Standard errors are clustered at the city level.
2. Uncompensated care does not include care compensated under the county indigent care programs.
3. Above-median pga is an indicator variable that equals one for hospitals that are at or above-median pga relative to other hospitals in their county.

Table VI
Neonatal Intensive Care: 1992-2006 [a]

	Prob. Adding NICU 1992-2006		*Change 1992-2006*					
	OLS (P = 0.091)		*NICU Beds*		*Days*		*Discharges*	
pga	-0.208		4.98		2257		19.7	
	(0.121)		(4.89)		(1278)		(73.8)	
pga * Public	-0.211		-6.93		-1153		-186	
	(0.158)		(5.18)		(1712)		(202)	
pga * For-Profit	0.037		-4.52		-1371		-124	
	(0.146)		(4.25)		(1193)		(103)	
above-median pga		0.006		3.97		993		76.8
		(0.042)		(2.32)		(472)		(37.6)
above-median pga * Public		-0.061		-4.41		-601		-117
		(0.089)		(3.07)		(650)		(91)
above-median pga * For-Profit		-0.050		-3.28		-768		-77.4
		(0.053)		(2.232)		(532)		(48.0)
Public	0.069	0.001	3.36	2.85	-297	-401	84.7	66.2
	(0.098)	(0.081)	(2.88)	(2.61)	(1081)	(528)	(119)	(62.0)
For-Profit	-0.129	-0.072	-0.943	-0.978	285	-158	-11.6	-19.3
	(0.081)	(0.051)	(2.24)	(1.68)	(630)	(398)	(60.8)	(33.4)
R-squared	0.113	0.100	0.069	0.052	0.033	0.019	0.104	0.098
Observations	430	430	373	373	373	373	373	373

[a]Notes:

1. NICU days and discharges are from OSHPD's Annual Utilization Reports.
2. All regressions include the number of licensed beds in 1992 and dummies for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Standard errors are clustered at the city level.

Table VII
Changes in Cardiac Services: 1992-2006 [a]

	Therapeutic Cardiac Catheterization		*Coronary Angioplasty (PTCA)*	
pga	230		162	
	(260)		(171)	
pga * Public	-140		-118	
	(205)		(179)	
pga * For-Profit	-181		-50	
	(385)		(122)	
above-median pga		102		94
		(61)		(39)
above-median pga * Public		-38		-56
		(96)		(61)
above-median pga * For-Profit		-67		-98
		(97)		(46)
Public	-96	-138	-38	-54
	(117)	(75)	(95)	(44)
For-Profit	-200	-64	-45	-3.89
	(177)	(74)	(64)	(37.9)
Adj. R-squared	0.038	0.036	0.014	0.010
Observations	373	373	373	373

[a]Notes:

1. All regressions include the number of licensed beds in 1992 and dummies for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Standard errors are clustered at the city level.
2. Above-median pga is an indicator variable that equals one for hospitals that are at or above-median pga relative to other hospitals in their county.

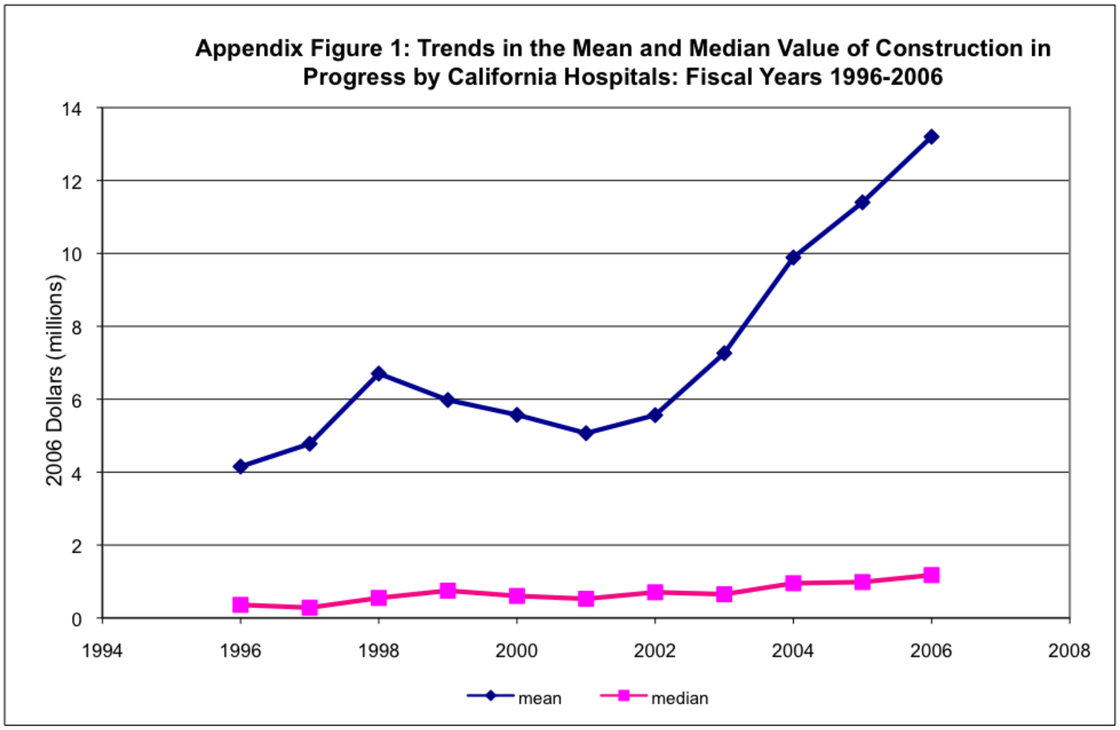
Table VIII
Changes in MRI Minutes: 2002-2006 [a]

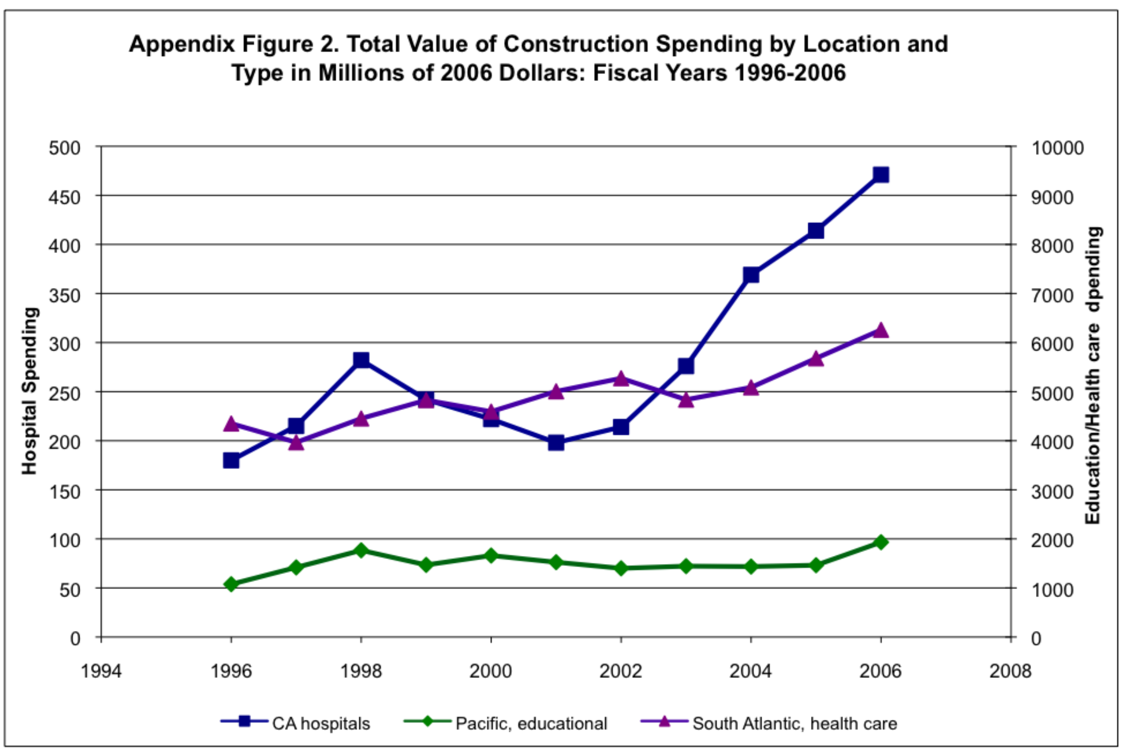
	Total Minutes		*Inpatient Minutes*		*Outpatient Minutes*	
pga	10,435		294		10,141	
	(8,182)		(5,063)		(5,168)	
pga * Public	-10,632		-2,872		-7,760	
	(10,831)		(4,955)		(7,918)	
pga * For-Profit	-13,975		-954		-13,022	
	(9,913)		(5,624)		(6,682)	
above-median pga		8,172		2,815		5,357
		(3,301)		(2,082)		(1,842)
above-median pga * Public		-8,241		-3,867		-4,375
		(4,099)		(2,682)		(2,560)
above-median pga * For-Profit		-11,441		-4,481		-6,960
		(4,019)		(2,765)		(2,257)
Public	5,175	5,764	2,340	3,612	2,785	2,152
	(5,217)	(3,132)	(2,453)	(1,993)	(3,865)	(2,046)
For-Profit	11,505	12,494	4,102	6,803	7,403	5,691
	(5,441)	(4,159)	(3,030)	(2,658)	(3,537)	(2,235)
R-squared	0.012	0.023	0.036	0.023	0.048	0.079
Observations	348	348	348	347	348	348

[a]Notes:

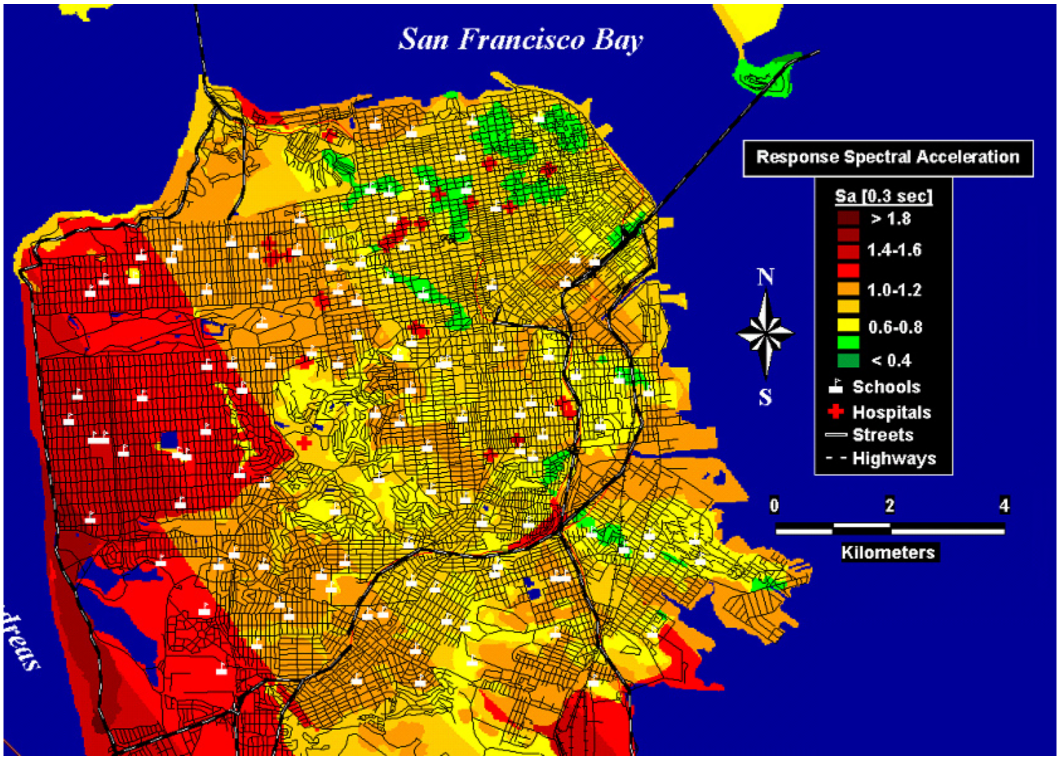
1. All regressions include the number of licensed beds in 1992 and dummies for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Standard errors are clustered at the city level.
2. Above-median pga is an indicator variable that equals one for hospitals that are at or above-median pga relative to other hospitals in their county.

Appendix: Not for Publication





Appendix Figure 3: A map of expected ground acceleration in the event of an earthquake similar to the great quake of 1906.



Source: U.S. Geological Survey

Appendix Table I
Summary of Predictions [a]

	Profitable Care (q)	*Uncompensated Care (u)*	*Distortionary Perquisites (θ)*	*Non-distortionary Perquisites (P)*
FPID	**0**	**0**	**0**	**0**
Prestige*	**-**	**-**	**-**	**0**
Altruistic	**-**	**-**	**-**	**0**
Perquisite	+	**0**	**-**	**-**

[a]Notes:

1. This table describes the response to a fixed cost shock predicted by each of these models.
2. 0 indicates no change, - indicates a (weak) decrease, and + indicates a (weak) increase in this type of service.
3. *In the Prestige care, at least one of the indicated elements must strictly decrease; in the Altruistic case, all elements must weakly decline.

Appendix Table II
Basic Information for SB 1953 [a]

Panel A	*Key Provisions of SB 1953*
Date	*Requirement*
Jan 2001	Submit risk assessment with NPC and SPC ratings for all buildings and a compliance report.
Jan 2002	Retrofit nonstructural elements (e.g. power generators) and submit a plan for complying with structural safety requirements.
Jan 2008	Collapse hazard buildings should be retrofitted or closed. Extensions available through 2013.
Jan 2030	Retrofit to remain operational following a major seismic event.

Panel B	*Structural Performance Categories (SPC)*
Rating	*Description*
SPC 1	Pose significant risk of collapse and a danger to the public. Must be brought to level SPC2 by Jan. 1. 2008. 5-year extensions to 2013 may be granted.
SPC 2	Buildings do not significantly jeopardize life but may not be repairable or functional following a strong earthquake. Must be brought into compliance with SB1953 by Jan. 1 2030 or be removed from acute care services.
SPC 3	May experience structural damage that does not significantly jeopardize life, but may not be repairable following an earthquake. Has been constructed or reconstructed under an OSHPD building permit. May be used to Jan 1. 2030 and beyond.
SPC 4	In compliance with structural provisions of SB1953, but may experience structural damage inhibiting provision of services following a strong earthquake. May be used to Jan. 1. 2030 and beyond.
SPC 5	In compliance with structural provisions of SB1953 and reasonably capable of providing service after a strong earthquake. May be used to Jan. 1. 2030 and beyond.

Panel C	*NonStructural Performance Categories (NPC)*
Rating	*Description*
NPC 1	Equipment and systems to not meet any bracing requirements of SB1953.
NPC 2	By Jan. 1, 2002, communications, emergency systems, medical gases, fire alarm, emergency lighting systems in exit corridors must be braced to Part 2, Title 24 requirements
NPC 3	Meets NPC2. By Jan. 1, 2008, nonstructural components in critical care, clinical labs, pharmacy, radiology central and sterile supplies must be braced to Part 2, Title 24. Fire sprinkler systems must be braced to NFPA 13, 1994, or subsequent applicable standards. May be used until Jan. 1., 2030.
NPC 4	Meets NPC 3. Architectural, mechanical, electrical systems, components and hospital equipment must be braced to Part 2, Title 24 requirements. May be used until Jan. 1., 2030.
NPC 5	Meets NPC 4. By Jan 1., 2030, must have on-site supplies of water, holding tanks for wastewater, fuel supply for 72 hours of emergency operations. May be used until Jan. 1, 2030 and beyond.

[a] Notes:

1. SPC stands for "Structural Performance Category"; NPC stands for "Nonstructural Performance Category."
2. Sources: http://www.oshpd.ca.gov/fdd/sb1953/sb1953rating.pdf
3. See http://www.oshpd.ca.gov/fdd/sb1953/FinalJan2008Bul.PDF for extension information.

Appendix Table III
Seismic Risk and Hospital Observables [a]

Panel A	*Neighborhood Characteristics: 1989*				
	Log Pop	*Share Below FPL*	*Share Hispanic*	*Share 5-17 Yr Olds*	*Log(Median Income)*
pga	0.347	-0.030	0.026	-0.003	0.130
	(0.698)	(0.028)	(0.078)	(0.014)	(0.130)
R-squared	0.745	0.296	0.419	0.455	0.459
above-median pga	0.013	0.002	0.017	-0.005	0.0003
	(0.118)	(0.007)	(0.020)	(0.005)	(0.027)
R-squared	0.746	0.292	0.421	0.460	0.456
Mean of Dep. Var.	11.8	0.130	0.249	.179	10.4
Observations	370	369	369	369	370

Panel B	*Growth in Neighborhood Characteristics: 1989-1999*				
	Pop	*Share Below FPL*	*Share Hispanic*	*Share 5-17 Yr Olds*	*Median Income*
pga	0.025	0.287	0.095	0.029	-.022
	(0.079)	(0.127)	(0.098)	(0.069)	(0.062)
R-squared	.291	0.405	0.349	0.334	0.562
above-median pga	-0.005	0.032	-0.016	-0.009	0.010
	(0.016)	(0.024)	(0.029)	(0.011)	(0.018)
R-squared	0.295	0.488	0.350	0.338	0.564
Mean of Dep. Var.	0.104	0.187	0.349	0.094	0.315
Observations	370	369	369	369	369

[a]Notes:

1. Dependent variables in Panel A and B are based on zip codes within 5-miles of a hospital. Panel A data are from the 1990 census. Panel B data are based on changes between the 1990 and 2000 census values.
2. Within each panel we show results from two sets of regressions. The first specifies seismic risk linearly; the second uses an indicator for hospitals with at or above median seismic risk relative to other hospitals in the county.
3. All models include county fixed effects as well as a dummy for rural status. Except where used as a dependent variable for the purposes of this randomization check, models also control for a hospital's license age and its square, the number of licensed beds in 1992 and dummies for 1992 ownership status. Models of demographic changes between 1990 and 2000 also control for 1996 teaching status and 1996 multi-hospital system status. In all models, standard errors are clustered at the city level to allow for spatial correlation in seismic risk.

Appendix Table III
Seismic Risk and Hospital Observables (Cont.) [a]

Panel C	*Hospital Characteristics: 1992*				
	Share Public	*Share NFP*	*License Age*	*Share with ER*	*Log (Avg. GAC LOS)*
pga	0.018	0.007	-8.61	-.013	.200
	(0.233)	(0.267)	(7.25)	(.173)	(.202)
R-squared	0.251	0.108	0.100	0.234	.089
above-median pga	-0.058	0.011	-3.15	-0.057	0.058
	(0.048)	(0.062)	(1.70)	(0.048)	(0.053)
R-squared	0.255	0.108	0.106	0.268	0.089
Mean of Dep. Var.	0.213	0.500	59.8	.697	1.61
Observations	370	370	370	370	364

Panel D	*Hospital Characteristics: 1996*				
	Share with Detox Program	*Share with NICU*	*Share with MRI*	*Share with Blood Bank*	*Participating in Indigent Programs*
pga	0.166	0.307	-0.039	-.129	-0.525
	(0.172)	(0.196)	(0.228)	(.282)	(0.237)
R-squared	0.033	0.240	0.096	.111	0.308
above-median pga	0.025	0.053	-0.044	-0.046	-0.067
	(0.050)	(0.056)	(0.062)	(0.054)	(0.053)
R-squared	0.030	0.237	0.098	0.116	0.298
Mean of Dep. Var.	0.155	0.319	0.456	0.675	0.508
Observations	370	370	370	370	370

[a]Notes:

1. Dependent variables in Panel C are from OSHPD's Annual Utilization Reports and in Panel D are from OSHPD's Hospital Annual Financial Data.
2. Within each panel we show results from two sets of regressions. The first specifies seismic risk linearly; the second uses an indicator for hospitals with at or above median seismic risk for their county.
3. Hospitals with basic or comprehensive emergency services are coded as having ERs. This definition excludes hospitals with standy-by EMS stations. Hospitals are coded as having a NICU if they report hospital-based neonatal ICU services, whether contracted or directly maintained.
4. All models include county fixed effects as well as a dummy for rural status. Except where used as a dependent variable for the purposes of this randomization check, models also control for a hospital's license age and its square, the number of licensed beds in 1992 and dummies for 1992 ownership status. Models of 2000 demographics or demographic changes between 1990 and 2000 also control for 1996 teaching status and 1996 multi-hospital system status. In all models, standard errors are clustered at the city level to allow for spatial correlation in seismic risk.

Appendix Table IV
Hospital Closures: 1992-1996 [a]

	Probability of Hospital Closure			
	Probit (Marginal Effects)		*OLS*	
	(Prob.=0.068)		*(Prob.=0.032)*	
pga	-0.004		-0.022	-0.016
	(0.006)		(0.076)	(0.067)
pga * Public				-0.043
				(0.094)
pga * For-Profit				0.021
				(0.170)
Public	0.013		0.031	0.51
	(0.019)		(0.023)	(0.064)
For-Profit	0.010		0.064	0.053
	(0.010)		(0.024)	(0.090)
Adj. R-squared	-	-	0.016	0.021
Observations	237	-	455	455

[a]Notes:

1. All regressions include county fixed effects as well as the number of licensed beds in 1992, the hospital's license age in 1992 and its square, 1992 ownership status (government-owned or for-profit, with nonprofit status excluded), and rural status. Standard errors are clustered at the city level to allow for spatial correlation.

Appendix Table V
Types of Plant Property and Equipment Spending [a]

	Hospitals in Continuous Operation, 1996-2006			
	Building Improvements		*Construction in Progress*	
	Levels	*Logs*	*Levels*	*Logs*
pga	731	4.54	-129	0.692
	(293)	(2.30)	(96.5)	(1.77)
pga * Public	-1120	-4.67	-124	-1.88
	(373)	(1.68)	(1221)	(1.70)
pga * For-Profit	-685	5.50	-31.5	3.07
	(400)	(5.16)	(118)	(3.17)
Public	274	2.70	39.3	-.034
	(187)	(1.14)	(52.2)	(1.09)
For-Profit	81.7	-5.10	-9.56	-4.16
	(201)	(2.65)	(68.7)	(1.80)
Adj. R-squared	0.404	0.217	0.331	0.406
Observations	313	313	313	313

[a]Notes:

1. All regressions include the number of licensed beds in 1992 and dummies for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Standard errors are clustered at the city level.
2. Spending on building improvements includes architectural, consulting, and legal fees related to the acquisition or construction of buildings as well as interest paid for construction financing. Fixed equipment such as boilers, generators, and elevators are also included in this accounting category. Construction spending refers to the cost of construction that will be in progress for more than one month. This count is credited and asset accounts debited upon completion of the construction project.
3. Amounts for all years deflated to 2006 dollars.

Appendix Table VI
Changes in Total General Acute Care: 1992-1996 [a]

	Change in Hospitals Days				*Change in Hospitals Discharges*			
pga	-8488,232	-10,808			-1,074	- 1,239		
	(5,181)	(6,762)			(843)	(837)		
pga * Public		5,322				462		
		(6,155)				(1230)		
pga * For-Profit		7,618				430		
		(4,580)				(878)		
above-median pga			101	1,047			53	625
			(1,057)	(1,123)			(234)	(281)
above-median pga * Public				364				-1,312
				(3,093)				(566)
above-median pga * For-Profit				-3,246				-1,112
				(2,014)				(462)
Public	-2,803	7,618	-2,776	-2,857	-913	-1,148	-906	-31.6
	(1,634)	(4,580)	(1,717)	(2,108)	(412)	(530)	(421)	(310)
For-Profit	579	-3,166	611	2,833	-500	-711	-498	283
	(1,382)	(2,738)	(1,377)	(1,824)	(369)	(561)	(373)	(448)
Adj. R-squared	0.292	0.291	0.285	0.285	0.027	0.021	0.024	0.035
Observations	414	414	414	414	414	414	414	414

[a]Notes:

1. Patient days and discharges are from OSHPD's Annual Utilization Reports.
2. All regressions include the number of licensed beds in 1992 and indicators for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Standard errors are clustered at the city level.
3. Above-median pga is an indicator variable that equals one for hospitals that are at or above-median pga relative to other hospitals in their county.

Appendix Table VII
Licensed and Staffed Beds [a]

	Change in GAC Beds: 1992-2006				*Share Beds Staffed: 2006*			
pga	30.7	24.9			0.154	0.144		
	(24.9)	(27.1)			(0.071)	(0.084)		
pga * Public		26.8				0.133		
		(31.9)				(0.092)		
pga * For-Profit		3.51				-0.129		
		29.5)				(0.145)		
above-median pga			6.94	5.86			0.020	0.023
			(8.63)	(11.9)			(0.021)	(0.0325)
above-median pga * Public				16.7				0.042
				(29.0)				(0.042)
above-median pga * For-Profit				-8.01				- 0.047
				(14.0)				(0.063)
Public	-23.0	-37.2	-22.1	-31.7	- 0.006	-0.065	0.009	-0.015
	(14.0)	(22.7)	(14.2)	(19.4)	(0.024)	(0.053)	(0.025)	(0.040)
For-Profit	-4.70	-6.17	-5.23	0.30	-0.003	0.063	-0.005	0.026
	(7.82)	(17.1)	(7.83)	(12.6)	(0.028)	(0.069)	(0.029)	(0.053)
Adj. R-squared	0.017	0.022	0.018	0.020	0.347	0.349	0.341	0.342
Observations	373	373	373	373	365	365	365	365

[a]Notes:

1. All regressions include indicators for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Models of the share of beds that were staffed in 2006 control for the 2002 share staffed, the first reliable year for these data. Standard errors are clustered at the city level.
2. Above-median pga is an indicator variable that equals one for hospitals that are at or above-median pga relative to other hospitals in their county.
3. Licensed beds are the total number of beds a hospital is licensed to have. Staffed beds are the number of beds in the hospital for which a hospital has assigned staff personnel.

Appendix Table VIII
Neonatal Intensive Care: 1992-1996 [a]

	Change 1992-1996					
	NICU Beds		*Days*		*Discharges*	
pga	-0.445		-645		-39.7	
	(2.07)		(500)		(52.3)	
pga * Public	-3.51		-766		-80.6	
	(2.95)		(929)		(73.4)	
pga * For-Profit	-0.660		425		-3.65	
	(2.98)		(538)		(62.0)	
above-median pga		1.74		-15.4		5.15
		(0.68)		(201)		(18.5)
above-median pga * Public		-3.64		-242		-87.1
		(2.04)		(529)		(77.1)
above-median pga * For-Profit		-1.60		162		-7.39
		(0.79)		(288)		(25.0)
Public	1.77	2.40	173	-74	52.5	19.8
	(1.88)	(1.84)	(575)	(424)	(45.5)	(46.1)
For-Profit	-0.867	-0.245	-327	-220	-29.7	-30.6
	(1.17)	(0.725)	(322)	(186)	(34.3)	(24.5)
R-squared	0.038	0.021	0.079	0.083	0.079	0.076
Observations	414	414	414	414	414	413

[a]Notes:

1. NICU days and discharges are from OSHPD's Annual Utilization Reports.
2. All regressions include the number of licensed beds in 1992 and dummies for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Standard errors are clustered at the city level.

Appendix Table IX
Cardiac Care: 1992-1996 [a]

	Change 1992-1996			
	Therapeutic Cardiac Catheterization		*Coronary Angioplasty (PTCA)*	
pga	22.5		25.6	
	(67.0)		(63.0)	
pga * Public	-43.3		-68.2	
	(99.2)		(68.1)	
pga * For-Profit	33.8		-5.43	
	(93.4)		(72.3)	
above-median pga		27.3		22.9
		(25.5)		(16.6)
above-median pga * Public		12.9		4.12
		(38.5)		(26.7)
above-median pga * For-Profit		-42.5		-23.2
		(33.3)		(20.2)
Public	-37.1	-63.9	16.0	-18.8
	(57.3)	(31.7)	(38.8)	(19.6)
For-Profit	-60.4	-15.4	-9.36	8.52
	(51.6)	(31.8)	(36.9)	(15.8)
Adj. R-squared	0.010	0.015	0.051	0.047
Observations	414	414	414	414

[a]Notes:

1. Data are from OSHPD's Annual Utilization Reports.
2. All regressions include the number of licensed beds in 1992 and dummies for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), the year the hospital opened and its square, rural status, 1996 teaching status, 1996 multi-hospital system status and county location. Standard errors are clustered at the city level.

Appendix: Proofs

7.1 Proof of Proposition 1

Let (q, θ, u) *and* (q', θ', u') *be a nonprofit hospital's choice of variables conditional on fixed cost shocks* F *and* F' *respectively. If* $V = R$*, for all values of* (q, θ, u, F)*, then* $(q, \theta, u) = (q', \theta', u')$ *for all* (F, F')*.*

Proof: Note that θ and u have a positive cost and do not appear in the objective function. The hospital will therefore choose the lowest possible value for θ and u (i.e. $P^* = u^* = \theta^* = 0 \ \forall F$).

The firms problem then simply reduces to a problem of maximizing $\pi(q|\theta^*)$, which is solved by $q^* = c^{-1}(p)$ (i.e. marginal cost equals price). Then since q^* is also independent of F, a hospitals choice of (q^*, θ^*, u^*) is independent of the fixed cost shock F. $\blacksquare$

7.2 Proof of Proposition 2

Let nonprofit hospitals have as their objective function $V^{Output} \equiv V(q, \theta, u)$ *where* V^{Output} *is an increasing, concave function of* q*,* θ *and* u*. For any fixed cost shock* $F > 0$*, conditional on being able to meet it's budget constraint, nonprofit hospitals will decrease one or more of the set* $\{q,\ \theta,\ u\}$*.*

Proof: Since the objective function is continuous and concave in its arguments ($V_i > 0$, $V_{ii} < 0$ for $i \in \{q, \theta, u\}$), when faced with a windfall W, one or more of the arguments $\{q,\ \theta,\ u\}$ must increase (otherwise the objective function would decrease).

Define (q^F, θ^F, u^F) as the choices of the firm when faced with a fixed cost shock F, and $F^\pi \equiv \pi(q^\pi, \theta^\pi)$ where $(q^\pi, \theta^\pi, u^\pi)$ are the profit maximizing values (i.e. $q^* = q^\pi, \theta^* = \theta^\pi = 0$ and $u^* = u^\pi = 0$). Note that if the shock $F > F^\pi$, the firm will not be able to meet it's budget constraint and will shut down.

Then for a firm facing a shock $F \in (0, F^\pi]$, the previous situation prior to receiving the fixed cost shock $F = 0$ is exactly like receiving a windfall of size F. So one or more of (q^0, θ^0, u^0) must be greater than the firms choice (q^F, θ^F, u^F). $\blacksquare$

7.3 Proof of Proposition 3

Let nonprofit hospitals have as their maximand the function $V^A \equiv V(w(q,\theta),u)$ *where* V^A *is an increasing, concave function of* w *and* u*, and* $w(q,\theta) = q\theta$*. For any fixed cost shock* $F > 0$*, conditional on being able to meet it's budget constraint, nonprofit hospitals must (weakly) decrease* q*,* θ *and* u*.*

Proof: Since R does not appear in the objective function, but has a positive costs, the firm will choose the lowest possible values: $R = 0$. We can then write the firm's problem as

$$\mathscr{L} \equiv V(w(q,\theta),u) + \lambda(q - C(q,\theta) - u - F). \tag{6}$$

The first order conditions are then

$$FOC_q : V_w\theta + \lambda(1 - C_q) = 0 \tag{7}$$

$$FOC_\theta : V_w q - \lambda C_\theta = 0 \tag{8}$$

$$FOC_u : V_u - \lambda = 0 \tag{9}$$

$$FOC_\lambda : q - C(q,\theta) - u - F = 0 \tag{10}$$

Using the fact that the shadow price is marginal benefit of uncompensated care (equation 9), we can combine equations 7 and 8 to get

$$\theta C_\theta = q\tilde{C}_q, \tag{11}$$

where $\tilde{C}_q = C_q - 1$. Then since all the components of equation 11 (i.e. $q, \theta, \tilde{C}_q, C_\theta$) are positive, and increasing in their respective arguments (i.e. $q_q > 0$, $\theta_\theta > 0$, $C_{\theta^2} > 0$ and $C_{q^2} > 0$), q and θ must jointly increase (decrease).

Define (q^F, θ^F, u^F) as the choices of the firm when faced with a fixed cost shock F, and $F^\pi \equiv \pi(q^\pi, \theta^\pi)$ where $(q^\pi, \theta^\pi, u^\pi)$ are the profit maximizing values (i.e. $q^* = q^\pi, \theta^* = \theta^\pi = 0$ and $u^* = u^\pi = 0$).

Note that if the shock $F > F^\pi$, the firm will not be able to meet it's budget constraint and will shut down. For any pair of shocks $F', F \in [0, F^\pi]$, since the objective function is concave and increasing in w and u, $\theta^{F'} \geq \theta^F$ and $w(q^{F'}, \theta^{F'}) \geq w(q^F, \theta^F)$.

So for a fixed cost shock $F \in [0, F^{\pi}]$, $w^F \leq w^0$ and $u^F \leq u^0$. Then since w is increasing in q and θ, and we have the restriction from the FOCs that q and θ jointly increase (decrease), $q^*_F \leq 0$ and $\theta^*_F \leq 0$. ■

7.4 Proof of Proposition 4

Let nonprofit hospitals have as their objective function $V^{perk} \equiv V(R, \theta)$ where V^{perk} is an increasing, concave function of θ. For any fixed cost shock $F > 0$, conditional on being able to meet it's budget constraint, nonprofit hospitals will weakly decrease θ and increase q.

Proof: The firm's problem can be written as

$$\mathscr{L} \equiv V(R, \theta) + \lambda(q - C(q, \theta) - P - F). \tag{12}$$

The first order conditions are then

$$FOC_q : \lambda(1 - C_q) = 0 \tag{13}$$

$$FOC_\theta : V_\theta - \lambda C_\theta = 0 \tag{14}$$

$$FOC_u : V_R - \lambda = 0 \tag{15}$$

$$FOC_\lambda : q - C(q, \theta) - R - F = 0 \tag{16}$$

Combining equations 14 and 15, we see that the firm chooses $(\theta^{perk}, R^{perk})$ such that the marginal benefit of θ conditional on price C_θ equals the shadow cost V_R ($V_R = V_\theta / C_\theta$) subject to the constraints $\theta \geq 0$ and $R \geq 0$.

Equation 13, $q^* = C_q^{-1}(1)$ requires that, conditional on θ, the firm will product the profit maximizing level of q. Then since q^* is fully determined by θ, for any set of values (q, θ, R, F), we can rewrite equation 16 as $(\beta - F) - p^\theta \theta - R = 0$, where $p^\theta \equiv \frac{C(q^*(\theta), \theta)}{\theta}$ and $\beta \equiv q$.

The firm's problem then is identical to that of choosing a consumption bundle (θ, R), subject to a budget constraint $p^\theta \theta + R = w$ where $w \equiv \beta - F$.

Note that if the shock $F > F^{\pi}$, the firm will not be able to meet it's budget constraint and will shut down. So then for any pair of shocks $F', F \in [0, F^{\pi}]$, since the objective function is concave and increasing in θ and u, $\theta^{F'} \geq \theta^F$ and $u^{F'} \geq u^F$. So for $F \in [0, F^{\pi}]$,

$\theta_F^* \leq 0$ and $u_F^* \leq 0$ and since q and θ jointly increase (decrease), $q_F^* \leq 0$.

Note that if the shock $F > F^\pi$, the firm will not be able to meet it's budget constraint and will shut down. For any pair of shocks $F', F \in [0, F^\pi]$, since the objective function is concave and increasing in θ and R, $\theta^{F'} \geq \theta^F$ and $R^{F'}) \geq R^F)$. So for all $F \in [0, F^\pi]$, $\theta^0 \geq \theta^F R^0 \geq R^F$. ■