What do Nonprofit Hospitals Maximize? Evidence from California's Seismic Retrofit Mandate [1]

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Abstract

We examine hospital response to a fixed cost shock introduced by an unfunded seismic retrofit mandate in California to test four theories of nonprofit hospital behavior: (1) "for-profits in disguise," (2) output maximizers, (3) perquisite maximizers and (4) social welfare maximizers. Our identification strategy exploits the plausibly exogenous variations in compliance costs due to underlying geological risk. We demonstrate that within counties seismic risk is uncorrelated with a host of hospital characteristics, including ownership type. We then show that hospitals with higher seismic risk are more likely to shut down, irrespective of ownership type, but nonprofits alone increase their mix of profitable services such as NICU days and MRI minutes. These results allow us to reject two of the other leading theories of nonprofit hospital behavior - "for-profits in disguise" and "pure altruism."

1 Introduction

About a fifth of all U.S. corporations have nonprofit status, including organizations as diverse as museums, religious institutions, universities, and hospitals. (Philipson and Posner, 2006). They share tax-exempt status and can raise capital through (tax-deductible) donations or by issuing tax-exempt debt. But, they cannot issue equity or disburse net revenues to employees or "owners." Indeed, nonprofits have no owners but rather are run by self-perpetuating boards (Glaeser, 2003). They are most common in markets characterized by asymmetric information, where the consumer is ill-equipped to judge the quality or quantity of services provided (Arrow 1963; Hansmann, 1996). In this type of market, for-profits may underprovide quality or quantity. Tax subsidies offer a potential contractibility mechanism to counter underprovision by the private market (Hansmann, 1981).

Measuring the value of nonprofit hospitals has proved challenging. In 2006, the Internal Revenue Service conducted a random audit of roughly 500 nonprofit hospitals to determine how they benefit the community (IRS, 2007). Although not explicitly stated in the report, at issue was what nonprofits offer in return for their public subsidy.[1] While nonprofit hospitals are charged with providing "community benefits" as a condition of the federal tax exemption, we have no widely accepted metric of community benefits. Prior to 1969, the IRS interpreted community benefits as the provision of care for those not able to pay to the best of a hospital's "financial ability." This standard has been relaxed successively over time. Today a nonprofit hospital can comply by "promoting the health of any broad class of persons" (CBO, 2006). Providing charity care or operating an emergency room falls into this category but so does offering community health screening or conducting basic research.

Due in part to ambiguity in the community benefit standard, Congress and state and local policymakers have repeatedly questioned the motives of nonprofit hospitals (Horwitz, 2006; Schlesinger and Gray, 2006).[2] Why, they ask, do nonprofit hospitals look more like money-making than charitable institutions? Literatures in economics, sociology, health policy and legal studies have also struggled to understand how nonprofit hospitals contribute to social welfare. While theories of nonprofit hospitals abound, they typically lay out general motivations without specifying a formal structure, making it difficult to generate empirically testable predictions of most models. 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 function are required to generate testable implications. As described 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, empirically distinguishing among models of nonprofit behavior is complicated by a hospital's choice over ownership status (David, 2009).

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[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] Recently, Senator Charles Grassley (R-Iowa) proposed that Congress mandate a minimum level of charity care that nonprofit hospitals must provide to qualify for federal tax-exempt status. And hospitals in at least one state, Illinois, have been stripped of their tax-exempt status because they were not providing "enough" charity care (Francis, 2007).

In this paper we examine the response of California hospitals to a large, plausibly exogenous fixed cost shock generated by a recent, unfunded mandate (SB1953) that requires hundreds of general acute care hospitals in the state to retrofit or rebuild in order to comply with modern seismic safety standards. The mandate requires a hospital be made safe for its location. Thus, the cost of compliance is determined in no small part by the underlying geological seismic risk associated with that location. Furthermore, since the majority of hospitals in California were built between 1940 and 1970, well before the development of these standards or a sophisticated understanding of seismic safety, a hospital's compliance cost is plausibly exogenously predetermined by its underlying sesmic risk.

We use the response of California hospitals to the mandate to test four of the leading theories of not-profit hospital behavior: (1) "for-profits in disguise," (2) output maximizers, (3) "perquisite" maximizers or (4) social welfare maximizers. In contrast to most previous studies of nonprofit behavior, our source of variation affects a firm's budget constraint without changing its incentive structure. This allows us to generate differentiable, testable predictions of hospital behavior using models that make far fewer assumptions than those typically used to study nonprofit hospital behavior.

Importantly, because of the long timeframe of new hospital construction (upwards of ten years), the varying cost of compliance determined by seismic risk represents a shock to a hospital's budget constraint over our study period not a change in its production function. That is for the years we study, the impact of the mandate is essentially financial with little to no concurrent impact on hospital facilities and thereby production function.

Before examining hospital response, we provide evidence that underlying geological seismic risk is uncorrelated with hospital and neighborhood characteristics. Within counties a hospital's geological seismic risk is uncorrelated with a host of hospital characteristics, including nonprofit status, and neighborhood demographics, such as median household income. Where pre-mandate data are available, we also show that seismic risk is uncorrelated with outcomes such as closures and NICU care in the pre-mandate period.

In contrast, we find that underlying seismic risk is a strong predictor of both hospital closure, spending on plant, property and equipment, resource utilization and service provision post-mandate. While the probability of post-mandate closure is unrelated to ownership, we find that a hospital's ownership status generally has a strong and differential effect on its response to the fixed cost shock generated by SB 1953. Specifically, as predicted by standard theory, for-profit hospitals do not change their service level or mix in response to the fixed-cost shock. In contrast, private nonprofit hospitals respond by increasing their provision of profitable services (e.g., neonatal intensive care and MRI minutes), while government owned hospitals respond largely by cutting uncompensated care, as measured by both GAC days and clinic visits for indigent patients.

The differential response across ownership types allow us to reject the argument that (private) nonprofit hospitals are nonprofit in name only and are essentially indistinguishable from their for-profit counterparts (e.g. for-profits-disguise). The response of private nonprofit hospitals is further inconsistent with pure altruisim, the presumed reason for granting a tax-exmeption, but compatible with theories of both perquisite maximization and output maximization. In contrast, the response of government-owned hospitals is most consistent with welfare or prestige maximization.

On net, our results suggest that both ownership (government vs. private) and organizational structure (for-profit vs. nonprofit) are important factors in determining hospital response to policy changes. Our results imply that the subsidies provided to nonprofit hospitals allow them to pursue either perquisites or higher "quality" at the expense of quantity.

Whether this tradeoff is welfare-enhancing is theoretically ambigious. Moreover, given our data, we cannot draw strong conclusions about the relative welfare provided by different ownership types. For example, as described in Hart et al. (1997), even if government-owned firms had welfare as their maximand, since they lack incentives to reduce costs, they may generate welfare losses relative to profit maximizing firms. In other words, their cost-inefficiencies may outweigh the benefits of their altruistic goals. Additional data on outcomes and long term spillovers are required to make such determinations.[3]

Our results are consistent with much of the prior literature (Gruber, 1994; Cutler and Horwitz, 2000; Duggan, 2002; Horwitz and Nichols, 2007), which finds increased competition reduces the difference between private hospitals by forcing nonprofits to act more like their for-profit peers. That is while nonprofit hospitals are driven by goals other than profit, a tightening of financial constraints (either through increase competition or a fixed cost shock) leaves less slack for hospitals to pursue non-pecuniary goals.

Our findings are most closely related to two papers that also try to disentangle theories of nonprofit hospital behavior – Deneffe and Mason (2002), which studies the implications of changes in the quantity of patients by insurance type on the price of privately insured hospital stays ,and Horwitz and Nichols (2009), which analyzes behavior across markets with different ownership mixes. Relative to these studies, the strength of our analysis is the quasi-experimental design. 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.

While 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, SB 1953.

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[3] For example, as is discussed in the medical literature, teaching hospitals face a conflict between providing health care services now and ensuring a sufficient supply of well trained doctors in the future. Moreover, overinvestment in new technologies (i.e. early adoption by some hospitals) may lead to technological spillover and improvements in healthcare provision in all types of hospitals.

In addition to imposing direct costs associated with 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.

2 Literature Review

A vast literature, both theoretical and empirical, seeks to understand the objectives of nonprofit hospitals. We divide this literature into four broad categories: (1) "for-profits in disguise," (2) output maximizers, (3) "perquisite" maximizers and (4) social welfare maximizers.[4]

The nonprofits as "for-profits in-disguise" (hereafter 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.[5] A large empirical literature has tried to look for differences in the equilibrium behavior of for-profit and nonprofit firms.[6] An early example of such a paper, 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.

Where, like Sloan and Vraciu (1983), others have found 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, they conclude that nonprofit hospitals behave no differently 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). To our reading, the literature on behavioral differences between nonprofit and for-profit hospitals is quite mixed. Most find no differences. 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).

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[4] This classification system is similar to some of the recent literature, (e.g., Silverman and Skinner (2004), which adopts the taxonomy in Malani et al. (2003)). Malani et al. (2003) effectively distinguishes among "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. Social welfare maximizers care about quality for what it does to the quantity provided. Perquisite and output maximizers care about quality in and of itself. Physician cooperative models are encompassed by the perquisite maximizing case (Pauly and Redisch, 1973; Young, 1981).

[5] Why in such a world would not all hospitals obtain nonprofit status to take advantage of the tax benefits? 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.

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

Duggan (2000), which studies differential responsiveness to a change in the financial incentives to treat indigent 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 papers (e.g., Gruber, 1994; Cutler and Horwitz, 2000; Duggan, 2002; Horwitz and Nichols, 2009) have shown that when competition increases, nonprofits change their behavior to more closely match their for-profit peers, the former hypothesis cannot be broadly applicable to the hospital industry.

A second class of models characterizes nonprofit hospitals as output maximizers. Key to this class is that managers care more about output than wealth. Newhouse (1970) is the starting point for this group. That work suggests that nonprofit hospitals maximize a weighted average of quality and quantity, subject to a break-even or zero profit constraint (Newhouse, 1970). That is hospitals have a taste for quality and quantity that distorts their production away from both pure profit and pure welfare maximization.[7] As discussed below, Horwitz and Nichols (2009) provide empirical support for this case. Another formulation that fits into this category is Frank and Salkever (1991), which posits that 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 that of their rivals.[8] This type of model may capture a quasi-altruistic motive: hospitals take nonprofit status to financially support the provision of high quality care (Newhouse, 1970; Lakdawalla and Philipson, 1998). As a result, they may provide an inefficiently high level of quality and treat an inefficiently low number of patients.

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[7] As discussed in Newhouse (1970), since the pursuit of profit maximization can lead to underprovision of both quality and quantity, a hospital's taste for quality and quantity can lead to welfare improvements.

Output maximization includes both the CEO empire building literature in finance (e.g., see Hart, 1991; Grossman and Hart, 1982; Jensen, 1986 or Shleifer and Vishny, 1991) or may be the result of "mission driven" firms, 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,"[9] and Beth Israel Deaconess Medical Center's mission to "serve patients, students, science and our community".[10]

A third class of models posits that nonprofits maximize perquisites. Like the output maximization case, this model assumes that nonprofit hospitals maximize something other than pure profit or pure welfare. We refer to this case as perquisite maximization because the hospitals care not about output per se but rather about the consumption of perquisites. These 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 in this group 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 then make input and output decisions so as to maximize net individual income, distorting their behavior away from efficient production. Specifically, because of the incentives generated by this organizational structure, physicians distort their production process to include more perquisites (e.g. overinvestment in capacity or technology) to maximize their individual utility.

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[8] 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.

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

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

At the other end of the objectives spectrum, the final class of models suggests that 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 1980; 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 noncontractible) 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).

We are certainly not the first to try to disentangle across theories of nonprofit hospital behavior. Horwitz and Nichols (2009) do so by analyzing how nonprofits behave in markets with varying for-profit market shares. They find that nonprofits offer more profitable services in markets with a high concentration of for-profits but the that for-profit market share has no effect on operating margins. Consistent with our findings, they conclude that nonprofit hospitals pursue output maximization, a weighted average of quantity and quality. Most similar to our approach, Deneffe and Mason (2002) try to determine objectives by studying nonprofit hospital response to changes in the Medicare, Medicaid and charity caseloads. They show that social welfare-maximizers should increase the private price in response to an increase in the charity caseload and decrease the price in response to an increase in the Medicare caseload while “for-profits in disguise” should not alter the private price in response to a change in the mix of patients. These predictions are analogous to ours but in a setting with multiple payers and where hospitals are not price-takers for all patients. Like us, Deneffe and Mason (2002) reject theories of nonprofit hospitals as either pure profit or pure welfare maximizers. Like us, Malani et al (2003) tries to synthesize existing theories in a general framework and generate differentiable predictions. They take these predictions to the existing empirical evidence. Given the vast and conflicting empirical literature, they are ultimately unsatisfied by the exercise and suggest the importance of further work. As we hope to demonstrate below, our work furthers the literature in two key ways: (1) by using a fixed cost shock to generate clear, testable predictions across different 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.

3 Models of Nonprofits

We begin by modeling the four categories of nonprofit hospital behavior. We present a basic model that allows us to embed these categories. Corresponding to a simple model of a profit maximizing firm, the first case of the model assumes that nonprofit hospitals are simply "for-profits in disguise" (Weisbrod 1988). Our second case characterizes hospitals as altruistic firms that maximize some measure of social welfare. Altruisitic hospitals care about both quantity and quality but they care about quality only for what it does to quantity. The third case assumes nonprofit hospitals maximize perquisites, some of which distort production costs. In our fourth and final case, nonprofit hospitals are output maximizers who care about some weighted average of quanity and quality of care.

In each case, we assess whether and how a fixed cost shock should affect 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 (e.g. 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 will effectively force hospitals not already pursuing profit to do less of whatever activities they were previously subsidizing. For example if a hospital cared only about providing charity care, a negative fixed cost shock would result in a reduction in the amount of charity care the hospital could afford to provide.

3.1 The Basic Model

Hospitals are assumed to be price taking firms[11] that maximize an objective function

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

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-contractable 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

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

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

where c are continuous functions which are weakly increasing and weakly convex in their arguments. 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, P, u to maximize V
2. The hospital receives a random fixed cost shock $F' > 0$
3. For $F' > 0$, hospitals choose q', θ', P', u' to maximize V
4. If the hospital is unable to meet its budget constraint, it shuts down.

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[11] Importantly, the basic results of our models 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 the standard assumption in much of the literature) simplifies much of the analysis. See Frank and Salkever (1991) for further discussion on this topic.

Different models of nonprofit hospital behavior are represented by different objective functions, and the presence of a non-distribution, or zero-profit constraint ($R = 0$).

3.2 For-Profits In Disguise

The For-Profits In Disguise (FPID) hypothesis suggests that private nonprofit hospitals operate as de-facto profit maximizing institutions. This model corresponds to either the idea that either the non-distribution constraint does not bind (e.g. is not effectively enforced) or are captured by privileged employees as salary or non-distortionary perquisites.[12] FPIDs will then simply attempt to maximize net revenue R (i.e. $V^{FPID} = R$).

Proposition 1 *Let* (q, θ, P, u) *and* (q', θ', P', 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, P, u, F)*, then* $(q, \theta, P, u) = (q', \theta', P', u')$ *for all* (F, F')*.*

Proof: See Appendix ■

Proposition 1 simply states the obvious result that fixed costs will not affect equilibrium choices except through the budget constraint. Thus, with the exception of firm shutdown, we would expect both the level and mix of services provided by a FPID (or an explicit for-profit) to be unaffected by a fixed cost shock. This prediction is important in that it provides us with a very basic external validity "gut check." That is if private for-profit hospitals change their behavior in response to a fixed cost shock, it would 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 $V^{Output} = V(q, \theta, u)$.

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

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: See Appendix ■

The intuition behind the proof is quite simple: output maximizing hospitals offer more and higher quality health care until profits are driven to zero. Then when faced with a fixed cost shock, output maximizing hospitals have less slack and cannot subsidize output generating activities at their previous level and have to decrease either quantity, quality, uncompensated care or some combination of the three. Note, however, that, depending on the specific functional form of V, a decrease in any one of these outputs of production may be accompanied by an increase in the others. For example an output maximizing hospital might reduce the quality of care it provides, while increasing the quantity of care, in response to a fixed cost shock.

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 of nonprofit behavior posits that hospitals maximize some measure of social welfare. The literature generally conceives of this occurring through altruistically motivated managers or agents.[13] A driving assumption of the pure altruism model is that, for many heath services, some aspect of care is non-contractable, and that such non-contractable quality is both costly to the firm to provide and yet socially efficient. The non-contractibility means that profit-maximizing firms will provide the minimum possible quality, since any increased cost are not offset by a countervailing increase in payment. A purely altruistic hospital though might provide higher levels of quality since it is more efficient from a social welfare standpoint.

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

The key difference between this and the 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. It is this functional form restriction that allows the model to generate the stronger prediction in the more general case.

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* $w(q,\theta) = q\theta$*. And 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* $F < F'$*, then* $q \geq q'$*,* $\theta \geq \theta'$*, and* $u \geq u'$*.*

Proof: See Appendix ■

When faced with a fixed cost shock, altruists will weakly decrease output on all dimensions. As in the output maximization case, the main intuition behind his proof is quite simple: altruistic hospitals 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 have less "left over" and must scale back on money-losing (but welfare-improving) activities.

3.5 Perquisite Maximization

Our final model of nonprofit hospital behavior follows from the observation that a binding non-distribution constraint will lead a nonprofit firm to disburse profits through non-pecuniary perquisites or "dividends-in-kind).[14] In comparison to output maximization this is captured by the restriction that hospitals do not directly care about the quantity of care; both profitable q and charitable u. Unlike the non-distortionary perquisites in the FPID case, here we allow perquisites to distort the cost of production.

To illustrate the differences between distortionary and non-distortionary perquisites 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).

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[14] For further discussion of nonprofit firms as perquisite maximizers, see for example Pauly (1987) and Glaeser and Shleifer (2001).

This model corresponds to a wide range of theories of nonprofit behavior (and underlying motivations). For example, both nonprofit hospitals pursuing the "quiet life" or 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 on the cost function, 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* P *and* θ*. For any fixed cost shock* $F > 0$*, conditional on being able to meet it's budget constraint, nonprofit hospitals must (weakly) decrease* P *and* θ*.*

Proof: See Appendix ■

When faced with a fixed cost shock, perquisite maximizers will 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 the production of q.

This result stems from the fact that distortionary perks θ increase the cost of producing q, and that conditional on θ, perquisite maximizers will simply produce the profit maximizing quantity $q^{\pi}|\theta$. That is since perquisite maximizers do not directly care about output q, they will simply choose q to maximize income (i.e. they will not leave any "free money" on the table). Then 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 inversely related to the distortionary perquisite, θ, q^{π} will increase in response to F.

3.6 Summary of Predictions

Table II summarizes the predicted responses to a negative fixed cost shock implied by each of our four classes of models. For FPID, we expect no change in service provision in response to this shock. In comparison, the model of nonprofit hospitals as output maximizers predicts a decrease in one or more of the three measures of output: profitable care, distortionary perquisites, such as non-contractible quality, and uncompensated care. Given an increase in any one output, the sign of the other changes is ambiguous. The altruistic model predicts a decrease in profitable care, uncompensated care and distortionary perquisites in response to a fixed cost shock. And finally, a perquisite maximizing hospitals will decrease perquisites. To the extent that the decrease includes distortionary perquisites, this response implies an increase in the provision of profitable services.

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 to these requirements and despite the state's aging healthcare infrastructure, hospital construction projects remained rare throughout the 1980s (Meade and Kulick, 2007).[15]

On January 17, 1994, a 6.7 magnitude earthquake hit 20 miles northwest of Los Angeles, near the community of Northridge.[16] The 1994 Northridge earthquake caused billions of dollars in damage and left several area hospitals unusable.[17] Damage extended as far as 85 miles away from the epicenter. In its wake, California amended the Alquist Act to mandate a timeline by which all general acute care (GAC) hospitals must demonstrate that their facilities can both withstand and remain operational following a major seismic event. No money has been earmarked to aid in this process.

Although the amendment, SB 1953, was passed quickly, its requirements were only finalized in March of 1998, after approval by the California Building Standards Commission.[18] SB 1953's primary innovation was to establish deadlines by which all GAC hospitals had to meet certain seismic safety requirements or be removed from operation (see Table I). Its ultimate goal was to enable hospitals to remain 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 compliance (Meade and Kulick, 2007).

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[15] 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).

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

[17] 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.

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

The first deadline facing GAC hospitals 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 with this requirement (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.) in each of its buildings according to five “Non-structural Performance Categories” (NPC). Similarly, the structural support in 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). Table I describes the full set of SPC ratings. The first categories, both NPC-1 and SPC-1, represent the worst and the last categories, NPC-5 and SPC-5, the best ratings.

About 70 percent of hospital buildings were in the NPC-1 category (Meade et al. 2002). This rating indicates that major nonstructural elements essential for providing life-saving care are not adequately braced to withstand a major earthquake. 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 aspect of the law.[19]

The first major deadline facing California hospitals was January 2008 (or January 2013 with an extension if the hospital can demonstrate “diminished capacity”).[20] 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 52.4 million square feet of floor space was SPC-1 (Meade and Kulick, 2007). Expressed in terms of beds, about 50 percent were in the lowest compliance category of buildings. Only 99 hospitals in California or about 20 percent of the 2001 total had no

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[19] RAND estimated the total cost of compliance with this requirement at about $42 million. In contrast, their initial estimate of the cost of reconstructing SPC 1 buildings was about three orders of magnitude higher, at $41.1 billion (Meade et al. 2002).

[20] 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.

SPC-1 buildings and were thereby in compliance with the 2008 requirements (Meade et al., 2002).

The final deadline facing GAC hospitals is January 1, 2030. By 2030, all SPC-1 and SPC-2 buildings must be replaced or upgraded. The upgraded buildings will be usable following strong ground motion. While the legislature thought that hospitals would retrofit SPC-1 buildings, upgrading them to SPC-2 status by 2008/2013, and then replace them completely by 2030, few hospitals have gone this route. Rather, to avoid the expense and disruption of a retrofit, most hospitals with SPC-1 buildings have chosen to rebuild from the outset, effectively moving the final deadline up from 2030 to 2008 or 2013, if granted an extension, and causing an unprecedented growth in demand for hospital construction (Meade and Kulick, 2007).

Recognizing that most hospitals would not meet the 2008/2013 deadlines, several extensions have been introduced. [21] The most noteworthy involve 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.[22] 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 hospitals in the state are already engaging in major near-term capital investment projects. OSHPD reports that between 2000 and 2009, it reviewed plans for SB 1953-related construction totaling $12 billion and accounting for 45% of all reviews over the period, and 70% in 2008 alone.[23] Moreover, based on 2009 reporting requirements, OSHPD estimates that 70% of buildings, though only 52% of hospitals are likely to be compliance with the mandate between 2013 and

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

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

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

2020. For the purposes of the current 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 changes in the production function associated with their newer facilities.

Figure 1 shows the mean and median value of hospital construction in progress since 1996. After 2001, the year hospitals had to submit their building surveys, the mean value of construction in progress rose sharply, from \$5.5 to almost \$14 million (in 2006 terms). Some of this increase must reflect the national increase in construction costs as well as the specific increase in health care construction costs in California. But it seems implausible that an increase in costs alone could explain the roughly 150% increase in the value of spending on building improvements. As suggested by the exceptionally long wait times to book specialized health care construction firms, much of the growth is due to an increase in construction projects. 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 hospital construction spending in California starting in 2001 is not driven by underlying industry or region trends.

Figure 1 further demonstrates that the mandate's bite was not uniform: while the median value of spending on construction in progress picks up in 2001, the median is well below the mean. The large difference between the median and mean value of construction in progress implies that a few hospitals 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, the increase in spending is driven by those hospitals disproportionately affected by the seismic retrofit mandate. In the work that follows, we find that differential exposure to the mandate predicts differences in spending on plant, property and equipment.

5 Data and Methods

5.1 Data Sources

To assess the impact of California's seismic retrofit mandate, we combine data on the seismic risk, service provision, and finances of all general acute care hospitals in the state of California. Data on finances are from the Office of Statewide Health Planning and Development's Annual Hospital Disclosure Report (AHDR) and are available for 1996 through 2006. All financial data are normalized to 2006 dollars. Most of the service provision data are also from the ADHR. Since the AHDR service provision data are not comparable prior to 2001, we analyze changes between 2002 and 2006.[24] We supplement these data with information from the Annual Utilization Reports, which are less detailed but are available for the years 1992 through 2006. The AUR reports are used to identify hospital closures, which we crosscheck with California Hospital Association's records.[25] License conversion information was obtained through a request to OSHPD.

Seismic ratings and SB 1953 extension requests are all maintained in separate databases by OSHPD. The California Geological Survey (CGS) provided data on the underlying seismic risk of each hospital's location. Specifically, we use a 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.[26]

5.2 Identification Strategy

Together these data can be used to understand how the large increase in expenditures necessitated by SB 1953 impacts a hospital's finances and service provision. The financial burden associated with SB 1953 is partly reflected in a hospital's SPC building ratings. Since these ratings, which reflect building quality, are nonrandom, we cannot simply compare ratings and outcomes. Hospitals in worse financial condition are also likely to have lower ratings.

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[24] Based on discussions with OSHPD, we were advised to not use the first year of available service data. That said, results are quite similar if we use 2001 as the base year. In some cases our estimates are more and in others less precisely estimated.

[25] 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.

[26] This is a standard way of expressing seismic risk. For more details, see http://www.consrv.ca.gov/cgs/rghm/psha/ofr9608/Pages/index.aspx

However, one feature of a hospital's cost of retrofitting is largely predetermined - underlying geologic seismic risk. Most hospitals in the State were built between 1940 and 1970, at a very early stage in our understanding of seismic risk and well before the development of modern seismic safety standards. New construction has been slow relative to estimates of a reasonable building lifespan (Meade et al., 2002). And, although many hospitals have built new additions, most are in their original location (Jones 2004). Many of the new additions have been so well integrated into the original hospital structure that they will need to be replaced along with the older buildings (Jones 2004). Combined with high seismic variability at relatively small distances (e.g., see Appendix Figure 1), the result is that well-performing hospitals are unlikely to have selected into "better" locations (along seismic risk dimensions), at least within a locality.

Our identification strategy relies on the assumption that a hospital building's underlying seismic risk (pga) is effectively randomly matched to hospitals within a geographic area (e.g. a county). This assumption seems consistent with discussions between the authors and seismologists, who lament the fact that seismic risk is factored into building construction on only a very gross, 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 spending on plant, property and equipment (PPE) or days of care provided to indigent patients in hospital (h), pga_h is a hospital's inherent seismic risk, as measured by its predicted 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 status (for-profit, nonprofit, or public), license age and its square, rural status, multi-system or chain status and teaching status (whether the hospital has an approved residency program). Ideally all our hospital control variables would be measured pre-mandate since the mandate itself may alter these characteristics. We are able to measure bed size, ownership status, rural status and license age as of 1992. Due to data limitations, multi-hospital system and teaching status are measured as of the 1996 fiscal year, almost two full years prior to the finalization of the mandate's provisions.[27] Since the specifics of the legislation were not finalized until March 1998 and hospitals did not know their full exposure to the legislation until 2000 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 also 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 on finances and service provision is identified by differences in seismic risk within an area 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.

In order to test for differences in the response of hospitals by ownership type, we run all regressions as (4) and then augment them to include 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 have similar coefficients (i.e. responses to the fixed cost shock of retrofitting), then we might take it as support for the FPID hypothesis. Alternatively, to the extent that nonprofit hospitals alone increase the provision of profitable services in response to a fixed cost shock, then we can both reject theories of pure profit-maximization and pure altruism.

The regression equation in (4) specifies a linear relationship between seismic risk and hospital outcomes. Because we do not know a priori how precisely seismic risk should affect different outcomes, we also tested several other functional forms. In many cases, the effect of seisimic risk is well captured as a level shift in outcomes for hospitals that have high seismic risk relative to others in the area. Thus, we also present results where we replace

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

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 seismic risk of all hospitals in its county. Similarly, we estimate models that include interactions between this indicator and ownership type.

We consider three alternate specifications for our outcome variables. First we look at the simple level of our dependent variables in the most recent year (2005 or 2006). We use the most recent year since it is the closest to the retrofit deadline and should therefore represent the year for which the effect of the legislation is the largest. This intuition is confirmed by evidence from both Meade and Kulick (2007) and our own regressions using the levels of our outcome variable for other years. We find a systematic and largely monotonic increase in the magnitude of the effect of pga on our outcomes, such as spending on plant, property and equipment, as we approach 2006.

Second we sum the levels of each outcome variable for all available years (1996-2006 for spending measures and 2002-2006 for most service measures). These results represent the aggregate effect of the legislation for the entire period of available data. This specification helps avoid the possibility that our results are driven by the idiosyncrasies of any specific year. The results from this specification look very similar to our first specification, but with generally more precisely estimated coefficients.

Finally we take a long difference approach and use the change in levels 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 an outcome of interest, such as spending on plant, property and equipment or days of care provided to indigent patients in hospital h, located in county c, between years t and $t-n$. We estimate models that specify seisimic risk linearly, as above, and as an indicator, $1(pga_h \geq median)$, for median within-county seismic risk or above. These results are again 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 accomodate the use of fixed effects. Since closure is not an uncommon outcome (roughly 13 percent of hospitals in the State closed during our sample period), we are not too worried about boundary constraints. However, we test the sensitivity of our results to the use of probit models and obtain similar results.

6 Results

6.1 Descriptive Statistics

Table III presents descriptive statistics for all GAC hospitals that filed OSHPD's (required) Annual Financial Reports sometime between 1996 and 2006.[28] Panel A shows baseline 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.

As shown in the first column of Panel A, 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 or for-profit institutions and 19 percent are government-owned. About 36 percent of hospitals in the sample are part of a large system or chain. About 26 percent of the sample are teaching hospitals and 9 percent are in rural areas. The average hospital has 203 licensed beds. On average, hospital's were 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 across above and below median pga areas. 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 laregely 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, our analysis relies on within-county comparisons in seismic risk, which eliminates much of the urban-rural differences. As we will show below (in Table IV), once we control for county, most of these characteristics do not differ systematically with seismic risk. And in all regressions we control for the baseline characteristics listed in Table 3, Panel A.

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[28] 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

Panel B shows means for many of the outcomes we study below. Total spending on plant, property and equipment (PPE) for 2006 was $110 million, with almost half dedicated to building improvements. Building improvement spending 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.[29] In contrast, spending on construction in progress only accounts for 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 level of PPE spending (overall and by type) is systematically higher in high pga areas.

Roughly 13 percent or 58 of the hospitals in our sample closed and almost 8 percent, or 33 of them converted ownership status during our sample period. The share of hospitals that closed or converted ownership status is a bit higher in high verus low pga hospitals. Those hospitals remaining in the market in 2006 are licensed to 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 systematically 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.

The above versus below median pga comparisons in Table III give us a feel for the type of hospitals that have high versus low seismic risk. But, our main analysis is based on within-county comparisons of seisimic risk and, in general, a continuous measure of this 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 zipcodes within a 5-mile radius of the hospital.[30] We run regressions, based on our main result specifications discussed above, of 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.[31] 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 broad seismic risk patterns across the State correlate closely with broad demographic and socioeconomics differences.[32] Unlike our main results, we generally find no significant correlation between seismic risk and these dependent variables.

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

Panel A of Table IV presents estimates based on the 1990 Census characteristics of a hospital's neighborhood. 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 the median for its county to those with below median risk for the county. When we look at growth in these characteristics between 1989 and 1999 (in Panel B), we find no significant relationship in 4 out of 5 cases. The exception is for 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 in the share living below the federal poverty line in the neighborhoods surrounding hospitals off a base of 19 percent. Estimates by ownership status reveal that the effects are concentrated in the neighborhoods around public and nonprofit hospital. The effect is indistinguishable from zero in the case of for-profit hospitals. Moreover, 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 here we also fail to find within-county relationships between seismic risk and a range of other observable characteristics - e.g. the share of the population female, the share African-American, the share native-born, the share ages 65 and older and the share of households on public assistance - both in 1990 levels and 1990 to 2000 changes. These results are both statistically and economically insignificant.

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[30] We have also defined neighborhood as the hospital's zipcode of operation. Results using this definition are quite similar.

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

[32] 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 would be even cleaner but many small to medium cities have only one hospital.

Panel C of Table IV provides results for hospital characteristics in 1992 and Panel D presents results for 1996 characteristics. The correlation between seismic risk and the probability that a hospital was government-owned or nonprofit in 1992 is small and imprecise. The same is true for for-profit status (not shown). 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. Moreover, a 1 standard deviation increase in seismic risk implies a 0.3 percentage point lower probability of having an emergency room, off a base of 70 percent, and 4 percent longer average 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, the share with a Neonatal Intensive Care Unit (NICU), the share with MRIs, and the share with 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 hospitals characteristics, both 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 its observable characteristics but, as we will demonstrate, is directly related to the cost shock imposed by SB 1953, 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. Because of the considerable small area variation in ground acceleration within county, we should have enough power to identify the effect of this cost shock.

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. None of our models generates different predictions for the probability of closure. However, this outcome is interesting in its own right and can provide evidence on the bite of the mandate. Moreover, differential probabilities of closure by ownership type, will introduce a sample selection problem in our assessments of the effect of seismic risk on other outcomes.

Table V presents linear probability models of the likelihood that a hospital shuts down after 1996. Results based on probit models are very similar, although we do not rely on this model here because of the "incidental parameters" problem. Both models indicate a significant impact of seismic risk on 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 for our research design, we cannot reject that the impact of seismic risk on the probability of closure 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, presented in

Appendix Table I, indicate that the correlation between seismic risk and closure is negative, small in magnitude and indistinguishable from zero prior to 1997.[33]

Together with the placebo results, we conclude that the mandate itself is causing closures and is not simply exacerbating pre-existing closure trends, which were concentrated in for-profit facilities (see Buchmueller et al., 2006). Morever, these results indicate that SB1953 has put financial pressure on all hospitals with high seismic risk. The government is not, for example, shielding its hospitals from this pressure. While Duggan (2000) finds that localities reduce their allocations to public hospitals receiving "extra" State funds for treating a "disproportionate share" of publicly insured patients, our results suggest 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 the State will "bail" them out.[34]

Table V also explores the relationship between seismic risk and the probability that 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 should be less likely to convert their licenses if doing so is unlikely to ease credit constaints. As a result, this finding suggests that the increases in the provision of profitable services that we will demonstrate below may well be lowerbounds relative to what a high-seismic risk nonprofit hospital would like to produce. Taken together with the results on closures and license conversion results indicate that the seismic retrofit mandate had real implications for California's hospitals and was not simply another set of requirements to be ignored.

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[33] Given the relatively low rate of closure over this period - just under 4 percent - the probit model may be more appropriate. However, because closures were concentrated in a few counties and closures by ownership status varied very little within-counties over this period, we are unable to estimate probit models with interaction effects. Based on the OLS model, however, we find no evidence of seismic risk effects, overall or by ownership status.

[34] 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 (available upon request).

6.3 Seismic Risk and Spending

We next, in Table VI, assess the extent to which seismic risk predicts differences in aggregate building-related expenditures. Because hospitals have some flexibility in how and when they account for different expenditures, we consider any spending on plant, property and equipment (PPE) for all years between 1996 and 2006. Panel A shows results for the set of hospitals existing in 1996 and 2006. Results in cols (1) and (2) are based on total spending levels; cols (3) and (4) are based on the log of total spending.

As shown in cols (1) and (3), a hospital's ground acceleration factor is positively related to total PPE spending over the sample period. A one-standard deviation increase in the ground acceleration factor is associated with roughly \$200 million in spending on plant, property and equipment between 1996 and 2006. 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 effects on spending become clearer. The main effects, which isolate the impact of seismic risk on spending by nonprofit hospitals, imply slightly larger seismic risk effects than in the simple model: a one standard deviation increase in pga is associated with higher PPE spending of about \$320 million between 1996 and 2006. Across both specifications, the interactions between pga and for-profit or public ownership status are negative. Based on the magnitudes and precision of these estimates, 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 signficant at the 10 percent level.

In panel B, we test the sensitivity of these estimates to the inclusion of hospitals that close or do not report because of mergers or other unobserved reasons.[35] Specifically, we set to zero any missing PPE spending values between 1996 and 2006. As expected the estimates in Panel B are slightly smaller. But, the magnitudes and pattern of results are quite similar to those in Panel A. nonprofit hospitals with higher seismic risk spend hundreds of millions of dollars more on PPE over the 1996-2006 period than their for-profit or public counterparts. Panels C and D are analogous to A and B but specify the effect of seismic risk as a level shift in spending. Results are again qualitatively similar. nonprofit hospitals with high seismic risk spent considerably more on PPE than their lower seismic risk counterparts in the same county.

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[35] After a merger, hospitals have the option to retain separate reporting systems or to report as one institution.

Table VII breaks out two categories of PPE spending – spending on building improvements and spending on constuction in progress. To reduce the number of panels, we present results only for hospitals in continuous operation and with a linear specification of pga. Results are broadly similar when we show all combinations of entries as in Table VI. Importantly, we find that the bulk of the increase in PPE spending shown 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 type, we find no clear relationship between seismic risk and construction in progress. Together these results may reflect the long time horizon for hospital constuction and the fact that most hospitals were still in the planning phase during our study period.

Differences in spending by ownership type in Tables VI and VII may capture the fact that nonprofit hospitals are larger and have more SPC 1 buildings than their for-profit counterparts (an average of almost 2.7 compared to about 1.5 for public and for-profits combined). nonprofit hospitals may be farther along in their retrofitting timelines than either public or for-profit hospitals.[36] Because we cannot rule out that for-profit and public hospitals have readjusted their budgets in other ways (e.g. inter-temporally) and given our finding that 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 we take it as the first piece of evidence that nonprofits respond differently to this mandate than for-profit hospitals.

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[36] As evidence, we find that, controlling for the same covariates as in our main regressions, nonprofit hospitals request extensions on average 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 too surprising given that over 80 percent of hospitals requested an extension and 98 percent received them.

6.4 Services

To test our models of hospital behavior, we next consider the impact of seismic risk on service provision. Because the mandate does not alter the "price" of hospital services, seismic risk and the requirements of the seismic retrofit mandate should only affect service provision to the extent that hospitals are not already profit-maximizing. Hospitals that are not simply profit-maximizing will have to reoptimize. Prestige-maximizers will have to cut back on at least one dimension of output – quality, quantity or uncompensated care. Altruistic firms will be forced to cut back on all of these dimensions. Perquisite-maximizers will have to reduce their consumption of perquisites and, to the extent those perquisies are distortionary, increase the provision of profitable services.

To test these theories, we first consider the overall volume of service. Table VIII 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 clearly increase for nonprofit hospitals with higher seismic risk. We cannot reject zero effect of seismic risk on GAC days in government-owned and for-profit hospitals. This pattern is confirmed when we compare hospitals with high (at or above median for the county) versus low (below median for the county) 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. We observe no change in days for high versus low seismic risk for-profit or public hospitals.

Results in col (5) indicate that discharges increase with seismic risk, though the estimate is too imprecise to rule out zero. Estimates with ownership type intereactions (in col (6)) provide little additional information. However, specifying seismic risk as a level shift increases precision. High sesimic risk government-owned and for-profit hospitals do not increase discharges. But, high seismic risk nonprofit hospitals increase discharges by about 1400 days relative to low-seismic risk nonprofits. With an average length of stay of just over 5 days, the increase in days relative to discharges is consistent with a pure increase in the volume of patients.[37] That higher seismic risk nonprofits alone increase volume suggests that they may not have been profit-maximizing prior to SB1953.

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[37] Results for days and discharges are similar if we use OSHPD's Inpatient Discharge Data. For consistency

Table IX assess whether the increase in patient days in nonprofits with higher seismic risk comes through hospital expansions or more intensive use of existing services. Seismic risk is associated with slightly more licensed beds in 2006, although the estimate is not statistically distinuishable from zero. Excluding interactions, we find that a one standard deviation increase in pga is associated with about 15 more licensed beds. Restricted to GAC beds, the increase is closer to 8 additional licensed beds, implying an increase in total bed days that can only account for about half the increase in volume shown in Table VIII. Breaking out the effects by ownership, we find that the increase in total licensed beds is only distinguishable from zero for government-owned hospitals and only in the linear specification. Thus, the increase in volume in nonprofit hospitals may simply reflect a more intensive use of existing resources. To gauge this, columns (5)-(8) consider the share of licensed beds that are staffed and thus available for patient use. Indeed, higher seismic risk is associated with a higher share of staffed beds. A one-standard deviation increase in seismic risk is associated with a roughly 4 percentage point higher share of staffed beds. The results by ownership type in cols (6) and (8) reveal that only nonprofit and public hospitals with higher seismic risk increase the share of staffed beds. Together with the results for beds, these findings imply that nonprofits accomodate increased volume by increasing the staffing of existing beds. In other words, nonprofits facing higher fixed cost shocks use the physical resources at their disposal more intensively.

In Tables X-XII we study changes in the volume of specific services. In Table X we consider indigent care. We focus on un-reimbursed care not care that can be reimbursed by county indigent programs. We look at changes in total inpatient indigent care days as well as indigent care visits to a hospital clinic. When pooling across ownership type, we find small and extremely impreciserelationships between pga and indigent care days or visits (not shown here). When we break the effects out by ownership type, however, we find that government-owned hospitals with higher seismic risk decrease their provision of charity care. Specifically, a one-standard deviation increase in seismic risk is associated with

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and because we only have the discharge data for 1997 and 2005, we opt to use the AUR data for this analysis.

about 200 fewer days of indigent care, although this estimates is rather imprecise.[38] 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)). However, the results are much clearer when we study uncompensated visits to hospital clincs. Public hospitals with higher seismic risk clearly 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 statistically distinguishabel from zero below the 5 percent level. How these hospitals reduce these visits is unclear from our data, however. They may, for example, close their doors on certain days of the week, limit the number of patients they see or do both. These results - that public hospitals facing larger fixed cost shocks cut back on subsidized care - suggest that SB1953 has 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.

To further distinguish between the prestige, altruistic and perquisite-maximizing models of nonprofit behavior, we next consider the provision of profitable services. Whereas welfare-maximizing firms, which overprovide quantity and quality, are predicted to cut back on profitable services, prestige 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.

Table XI looks at changes in neonatal care between 1992 and 2006. The first two columns of Table XI assess the probability that hospitals add a NICU between 1992 and 2006. If anything, we find that nonprofit and public hospitals with higher seismic risk are less likely to add NICUs. Results are imprecise if we use an indicator of high seismic risk rather than a linear specification. We take the results from the linear specifcation of pga as evidence that, at a minimum, that higher sesismic risk decreases the liklihood that nonprofit and public hospitals add NICUs. The sign of the effect is not too surprising, however, given that higher seismic risk implies a larger financial hit from the mandate, which might make it more difficult to finance the high-tech equipment and hire the specialized staff required to run a NICU. The next six columns of Table IX assess changes in NICU beds, days and discharges. Although nonprofits with higher seismic risk are less likely to add NICUs, those with NICUs are using them more intensively. The results for beds and discharges are indistinguishable from zero in the linear specification of seismic risk. However, comparing hospitals in high versus low seismic risk areas within a county, suggests that nonprofit in these areas may be increaseing the number of beds at their disposal as well as the number of patients they treat in the NICU. Irrespective of the specification of pga, however, we find that 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. Importantly, this increase is specific to nonprofits; the estimates for for-profit and public hospitals are both small in magnitude and indistinguishable from zero. Moreover, together with the results for discharges, the linear specification of pga suggests that some of the increase may be through longer lengths of stay.

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[38] 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.

In table XII, we consider an unrelated type of profitable service - the use of Magnetic Resonance Imaging (MRI). We measure use as minutes provided and consider total minutes as well as inpatient and outpatient minutes separately. The latter type of care is likely most profitable as it is reimbursed directly, not as part of an bundled admission payment. Like neonatal 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. Moreover, the bulk of hte increase comes through outpatient MRI minutes. A one standard deviation increase in seismic risk is associated with about 2100 more minutes or about 35 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 XI-XII indicate that higher seismic risk encourages nonprofit hospitals to increase the volume of profitable services. This finding is inconsistnet with purely altruistic models of nonprofit behavior and lends strong support to prestige or perquisite-maximizing models.

7 Conclusions

Both policymakers and academics have long struggled to understand what nonprofit hospitals do. 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 (3) perquisite maximizers. We derive the response of nonprofit hospitals to a large fixed cost shock under each of these hypotheses.

We then test the predictions generated by of these different hypothesis by studying the effect of 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, and that 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, obstetrics discharges and MRI minutes, and government hospitals respond by decreasing the provision of charity care.

In the case of nonprofit hospitals, these results are consistent only with the output and perquiste maximization hypothesis and allow us to reject two of the leading theories of nonprofit hospital behavior - "for-profits in disguise" and "pure altruism."

nonprofit hospitals appear to pursue higher "quality" of services at the expense of quantity. The welfare implications of these results are, however, theoretically ambiguous, and more work is needed to determine whether the welfare gains from the increases in quality (including possible technological spillovers) offset the loss in welfare caused by reduced quantity. Our results show the importance of such additional work, which has been largely ignored in the policy debate in favor of the simpler and more extreme cases of 'for-profits in disguise" and "pure altruism."

In contrast the behavior of government-owned hospitals is most consistent with welfare as firm maximand. As discussed in Hart, Shleifer and Vishny (1997), this does not necessarily imply that health care should be provided by the government since the same incentive structure that leads government owned hospitals to maximize welfare may correspond to a too-low incentive for efficient production. A separate analysis of the relationship between firm ownership structure and costs is necessary to determine whether government provision of health services is socially efficient.

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Figure 1: Trends in the Mean and Median Value of Construction in Progress by California Hospitals: Fiscal Years 1996-2006

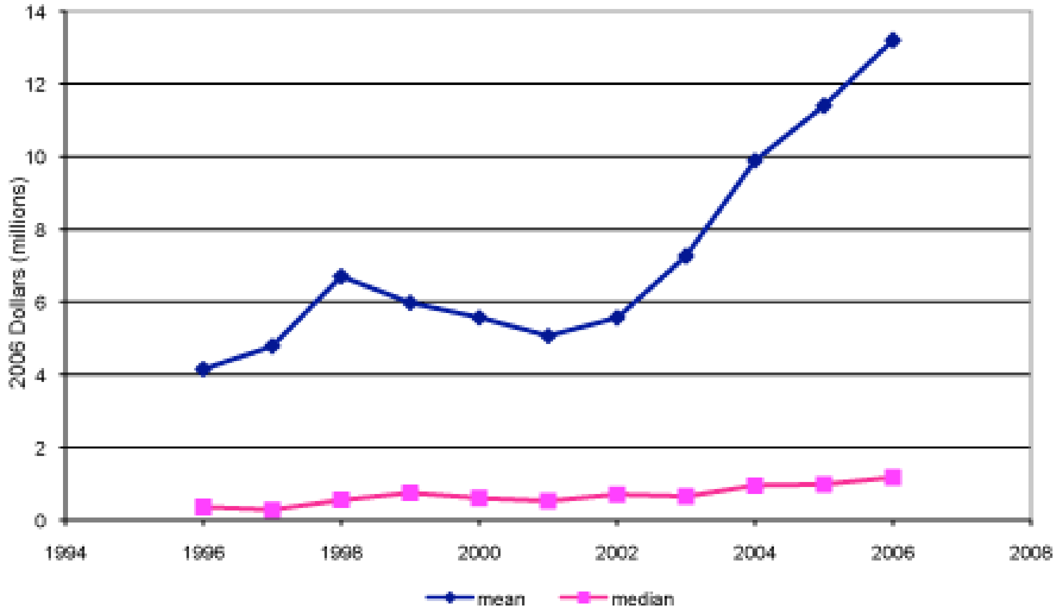

Figure 2. Total Value of Construction Spending by Location and Type in Millions of 2006 Dollars: Fiscal Years 1996-2006

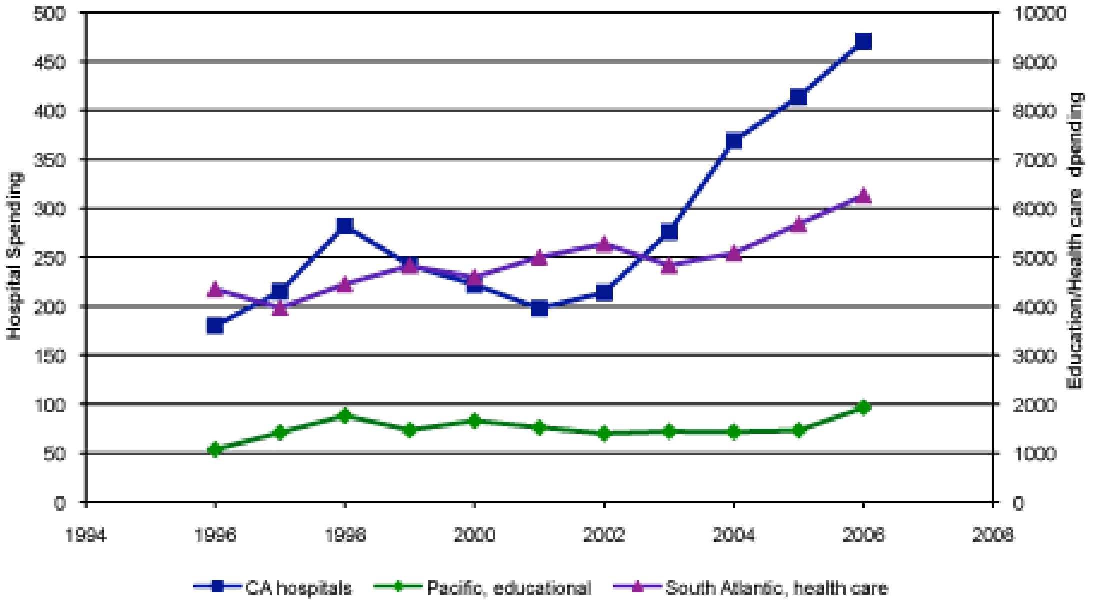

Table I
Basic Information for SB 1953 [a]

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.

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[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.

Table II
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**	**-**	**-**

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[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.

Table III
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

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[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. pga measures the maximum 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 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. Dollar values are in 2006 terms and are given in millions.

Table IV
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

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[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.

Table IV
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

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[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.

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

	Probability of Hospital Closure		*Probability of Ownership Conversion*	
	(Prob.=0.163)		*(Prob.=0.075)*	
pga	0.338	0.326	-0.323	-0.307
	(0.139)	(0.140)	(0.148)	(0.148)
pga * For-Profit		-0.046		-0.111
		(0.268)		(0.153)
pga * Public		0.090		0.006
		(0.209)		(0.202)
For-Profit	0.118	0.141	-0.037	0.018
	(0.053)	(0.150)	(0.041)	(0.080)
Public	0.001	-0.044	0.015	0.012
	(0.044)	(0.132)	(0.047)	(0.102)
Multi-Site	-0.002	- 0.004	-0.088	-0.079
	(0.042)	(0.041)	(0.030)	(0.031)
Rural	0.202	0.210	0.006	0.013
	(0.098)	(0.101)	(0.087)	(0.087)
Teaching	0.005	0.005	0.003	0.003
	(0.040)	(0.041)	(0.038)	(0.038)
Licensed Beds	-0.034	-0.035	0.001	0.001
(per 100)	(0.010)	(0.010)	(0.006)	(0.001)
Age * 10	0.094	0.095	0.003	0.001
	(0.035)	(0.035)	(0.030)	(0.030)
Age Squared * 10	-0.001	-0.001	0.0001	0.0003
	(0.0003)	(0.0003)	(0.002)	(0.0003)
Adj. R-squared	0.048	0.043	0.025	0.011
Observations	429	429	429	429

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[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), 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 VI
Plant Property and Equipment Spending [a]

Panel A *Hospitals in Continuous Operation, 1996-2006*

	TOTAL		*Log(TOTAL)*	
pga	1070	1670	1.37	1.80
	(618)	(733)	(0.571)	(0.571)
pga * For-Profit		-2190		0.159
		(789)		(1.11)
pga * Public		-1510		-2.07
		(749)		(0.645)
For-Profit	-539	185	-1.25	-1.36
	(143)	(384)	(0.193)	(0.580)
Public	-845	282	-0.575	0.488
	(253)	(351)	(0.155)	(0.357)
Adj. R-squared	0.447	0.460	0.587	0.599
Observations	313	313	313	313

Panel B *All Hospitals in Operation in 1996*

	TOTAL		*Log(TOTAL)*	
pga	939	1270	0.500	0.938
	(543)	(649)	(.593)	(0.584)
pga * For-Profit		-1020		-0.210
		(648)		(0.955)
pga * Public		-760		-1.86
		(440)		(0.697)
For-Profit	-303	68.2	-1.50	-1.42
	(111)	(211)	(0.169)	(0.488)
Public	-599	-86.2	-.674	0.253
	(204)	(302)	(0.166)	(0.398)
Adj. R-squared	0.373	0.374	0.528	0.534
Observations	429	429	405	405

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[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), license age as of 1992 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. Panels A and C include only hospitals continuously in operation between 1996 and 2006; Panels B and D set missing PPE values to zero.

Table VI
Plant Property and Equipment Spending (Cont.) [a]

Panel C	*Hospitals in Continuous Operation, 1996-2006*			
	TOTAL		*Log(TOTAL)*	
above median pga	191	489	0.137	0.376
	(126)	(175)	(0.160)	(0.178)
above median pga * For-Profit		-583		0.049
		(213)		(0.350)
above median pga * Public		-776		-0.814
		(330)		(0.297)
For-Profit	-562	-247	-1.27	-1.04
	(143)	(221)	(0.197)	(0.321)
Public	-830	-315	-0.564	-0.038
	(254)	(218)	(0.162)	(0.229)
Adj. R-squared	0.443	0.451	0.576	0.584
Observations	313	313	313	313

Panel D	*All Hospitals in Operation in 1996*			
	TOTAL		*Log(TOTAL)*	
above median pga	161	346	0.050	0.248
	(98.4)	(167)	(0.147)	(0.182)
above median pga * For-Profit		-403		-0.523
		(200)		(0.397)
above median pga * Public		-355		-0.314
		(320)		(0.317)
For-Profit	-316	-352	-1.50	-1.29
	(110)	(195)	(0.167)	(0.280)
Public	-585	-342	-0.669	-0.323
	(205)	(213)	(0.168)	(0.306)
Adj. R-squared	0.370	0.371	0.527	0.528
Observations	429	429	405	405

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[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), license age as of 1992 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. Amounts for all years deflated to 2005 dollars.
3. PPE includes land purchases, building improvements, equipment spending and ongoing construction costs.
4. Panels A and C include only hospitals continuously in operation between 1996 and 2006; Panels B and D set missing PPE values to zero.

Table VII
Types of Plant Property and Equipment Spending [a]

	Hospitals in Continuous Operation, 1996-2006			
	Building Improvements		*Construction in Progress*	
	Levels	*Logs*	*Levels*	*Logs*
pga	823	4.34	-129	0.460
	(329)	(2.29)	(99.5)	(1.73)
pga * For-Profit	-859	6.01	-21.9	3.18
	(424)	(5.36)	(103)	(3.05)
pga * Public	-1140	-4.46	-125	-1.65
	(433)	(1.66)	(122)	(1.70)
For-Profit	169	-5.25	-14.6	-4.03
	(209)	(2.75)	(58.5)	(1.75)
Public	248	2.69	37.4	-.0525
	(190)	(1.15)	(52.4)	(1.09)
Adj. R-squared	0.389	0.203	0.332	0.396
Observations	313	313	313	313

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[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), license age as of 1992 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.

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

	Change in Hospitals Days				*Change in Hospitals Discharges*			
pga	12,685	12,710			1,854	1,866		
	(6522)	(6,796)			(1,729)	(1,809)		
pga * For-Profit		-7,450				-797		
		(9,184)				(1,698)		
pga * Public		4,677				453		
		(12,072)				(2,435)		
above-median pga			4,723	7,060			793	1,311
			(1,876)	(2,931)			(468)	(728)
above-median pga * For-Profit				-8,553				-1,439
				(4,352)				(945)
above-median pga * Public				-467				-725
				(5,794)				(969)
For-Profit	-4,620	-780	-4,887	1071	-1,837	-1,427	-1,880	-874
	(2,285)	(4,796)	(2,310)	(3817)	(497)	(926)	(503)	(883)
Public	-10,415	-12,998	-9,862	-9,041	-2,090	-2,341	-1,997	-1,470
	(3,836)	(7,429)	(3,751)	(4,742)	(800)	(1,624)	(779)	(902)
Multi-Site	-1,299	-1,410	-1,377	-1,204	-176	-186	-194	-158
	(1,654)	(1,667)	(1,635)	(1,691)	(425)	(423)	(422)	(432)
Rural	-2,089	-801	-3,465	-3,881	-691	-560	-893	-938
	(2,928)	(3,442)	(3,070)	(2,953)	(710)	(812)	(748)	(688)
Teaching	-1,691	-1,657	-2,103	-2,358	-443	-440	-514	-555
	(2,691)	(2,692)	(2,664)	(2,662)	(489)	(494)	(485)	(487)
Licensed Beds	-3,331	-3,355	-3,337	-3,376	-424	-426	-426	- 432
(per 100)	(1,383)	(1,376)	(1,386)	(1,380)	(341)	(343)	(342)	(339)
Age	220	243	241	233	22.1	24.5	26.2	25.6
	(164)	(167)	(159)	(160)	(36.1)	(36.1)	(34.7)	(34.7)
Age Squared	-1.88	-2.13	-1.95	-1.94	-0.169	-0.194	-0.186	-0.189
	(1.34)	(1.37)	(1.30)	(1.30)	(0.287)	(0.292)	(0.277)	(0.271)
Adj. R-squared	0.089	0.085	0.097	0.104	0.017	0.011	0.024	0.030
Observations	372	372	372	372	372	372	372	372

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[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 dummies for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), license age as of 1992 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 IX
Licensed and Staffed Beds in 2006 [a]

	Licensed Beds				*Share Staffed*			
pga	74.7	57.8			0.222	0.220		
	(52.2)	(61.8)			(0.095)	(0.104)		
pga * For-Profit		-6.11				-0.262		
		(80.8)				(0.186)		
pga * Public		87.6				0.122		
		(66.6)				(0.118)		
above-median pga			6.11	8.54			0.039	0.058
			(13.6)	(20.2)			(0.024)	(0.033)
above-median pga * For-Profit				17.4				- 0.100
				(20.0)				(0.078)
above-median pga * Public				9.70				0.029
				(33.1)				(0.061)
For-Profit	-10.7	-7.24	-12.1	0.399	-0.052	0.078	-0.057	0.011
	(10.7)	(40.1)	(11.0)	(20.4)	(0.031)	(0.091)	(0.031)	(0.064)
Public	-23.9	-69.2	-23.5	-28.5	- 0.006	-0.007	-0.002	-0.015
	(12.9)	(33.3)	(13.0)	(23.2)	(0.034)	(0.071)	(0.034)	(0.055)
Multi-Site	-29.6	-18.1	-15.7	-15.2	-0.006	-0.005	-0.004	-.002
	(15.9)	(13.9)	(13.3)	(13.6)	(0.028)	(0.027)	(0.028)	(0.026)
Rural	-61.6	-45.8	-65.4	-64.7	0.019	0.053	-.005	-0.002
	(23.7)	(24.3)	(22.8)	(23.2)	(0.053)	(0.053)	(0.050)	(0.051)
Teaching	30.9	31.8	30.6	29.9	-0.061	-0.059	-0.065	-0.064
	(11.9)	(11.8)	(11.7)	(11.6)	(0.027)	(0.027)	(0.027)	(0.027)
Licensed Beds	77.5	77.2	77.9	77.9	-0.016	-0.017	-0.015	-0.015
(per 100)	(6.47)	(6.30)	(6.55)	(6.56)	(0.005)	(0.005)	(0.005)	(.004)
Age	1.34	1.41	1.19	1.11	-0.003	-0.003	-0.003	-0.004
	(1.01)	(1.04)	(0.991)	(1.01)	(0.004)	(0.003)	(0.003)	(0.003)
Age Squared	-0.012	-0.012	-0.011	-0.011	0.00002	0.00002	0.00003	0.00003
	(0.008)	(0.008)	(0.008)	(0.008)	(0.00003)	(0.00002)	(0.00003)	(0.00003)
Adj. R-squared	347	347	347	347	347	347	347	347
Observations	0.81	0.81	0.81	0.81	0.098	0.103	0.089	0.879

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[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), license age as of 1992 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. 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.

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

	Indigent Days		*Clinic Visits*	
pga	853		706	
	(701)		(777)	
pga * For-profit	240		-730	
	(658)		(1256)	
ga * Public	-1831		-5841	
	(733)		(2649)	
above-median pga		248		495
		(172)		(261)
above-median pga * For-Profit		-269		-652
		(202)		(382)
above-median pga * Public		-468		-2,360
		(287)		(1,071)
For-Profit	-100	212	-44	132
	(334)	(170)	(478)	(284)
Public	634	-2.64	2002	458
	(343)	(222)	(934)	(354)
Multi-Site	128	113	503	414
	(124)	(127)	(470)	(473)
Rural	-89	102	-828	-116
	(134)	(147)	(300)	(444)
Teaching	-76	-65	-159	-65
	(143)	(144)	(502)	(460)
Licensed Beds	55	51	-3.76	18.9
(per 100)	(37)	(35)	(77)	(791)
Age	4.11	4.81	-18.0	13.8
	(10.8)	(12.5)	(27.1)	(25.9)
Age Squared	-0.026	-0.036	0.085	0.041
	(0.099)	(0.109)	(0.182)	(0.174)
Adj. R-squared	0.016	0.040	0.059	0.065
Observations	347	347	347	347

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[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), license age as of 1992 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 XI
Neonatal Intensive Care: 1992-2006 [a]

	Prob. Adding NICU 1992-2006				*Change 1992-2006*			
	OLS (P = 0.091)		*NICU Beds*		*Days*		*Discharges*	
pga	-0.211		5.74		2320		41.1	
	(0.129)		(5.13)		(1271)		(73.8)	
pga * For-Profit	0.032		-6.22		-1508		-169	
	(0.150)		(4.40)		(1115)		(112)	
pga * Public	-0.212		-6.86		-1073		-176	
	(0.159)		(5.25)		(1716)		(202)	
above-median pga		0.003		4.16		993		79.3
		(0.042)		(2.34)		(471)		(39.4)
above-median pga * For-Profit		-0.048		-3.50		-763		-78.4
		(0.053)		(2.40)		(531)		(51.1)
above-median pga * Public		-0.060		-4.47		-576		-112
		(0.089)		(3.06)		(653)		(91)
For-Profit	-0.124	-0.071	0.072	-0.678	141	-121	18.6	-11.9
	(0.083)	(0.051)	(2.29)	(1.73)	(573)	(397)	(15.6)	(30.4)
Public	-0.071	0.002	3.19	2.82	-314	-389	79.4	65.3
	(0.098)	(0.081)	(2.19)	(2.61(	(1084)	(534)	(119)	(61.4)
Multi-Site	0.026	0.019	-0.905	-0.993	-186	-191	41.7	38.9
	(0.028)	(0.028)	(1.07)	(1.07)	(238)	(237)	(57.6)	(56.9)
Rural	-0.134	-0.103	-3.11	-3.13	-251	-465	-98.5	-88.1
	(0.058)	(0.052)	(1.07)	(1.75)	(378)	(303)	(39.4)	(24.2)
Teaching	-0.078	-0.075	0.286	0.042	-80	-148	70	66
	(0.027)	(0.028)	(1.15)	(1.19)	(309)	(317)	(43)	(41)
Licensed Beds	0.001	0.001	-0.160	0.195	-162	-165	-24.0	-25.1
(per 100)	(0.004)	(0.004)	(0.680)	(0.675)	(107)	(105)	(12.7)	(12.1)
Age	0.001	0.002	0.037	0.046	21.7	21.4	-0.940	-0.720
	(0.002)	(0.008)	(0.077)	(0.080)	(18.4)	(20.3)	(3.09)	(3.05)
Age Squared	-0.00001	-0.00001	-0.0007	-0.0007	-0.316	-0.297	-0.019	-0.020
	(0.00002)	(0.00002)	(0.0006)	(0.0006)	(0.168)	(0.181)	(0.024)	(0.024)
R-squared	0.113	0.100	0.072	0.053	0.029	0.016	0.092	0.095
Observations	429	429	372	372	372	372	372	372

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[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), license age as of 1992 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 XII
Changes in MRI Minutes: 2002-2006 [a]

	Total Minutes		*Inpatient Minutes*		*Outpatient Minutes*	
pga	11,643		1,015		10,628	
	(7,771)		(4,814)		(5,016)	
pga * For-Profit	-11,173		-768		-12,787	
	(10,375)		(5,864)		(6,405)	
pga * Public	-13,555		-3,486		-7,686	
	(9832)		(4,723)		(6,405)	
above-median pga		8,676		3,193		5,483
		(3,078)		(1,892)		(1,799)
above-median pga * For-Profit		-11,622		-4,826		-6,796
		(3,876)		(2,680)		(2,194)
above-median pga * Public		-8,552		-4,130		-4,422
		(3,997)		(2,583)		(2,549)
For-Profit	10,888	12,167	3,514	6,533	7,373	5,634
	(5,458)	(3,972)	(3,200)	(2,558)	(3,491)	(2,179)
Public	4,789	5,348	2,215	3,351	2,574	1,997
	(5,094)	(3,140)	(2,378)	(1,979)	(3,852)	(2,066)
Multi-Site	-3,887	-4,139	-3,446	-3,509	-441	-295
	(2,220)	(2,107)	(1,577)	(1,518)	(1,176)	(1,184)
Rural	1,052	670	2,091	2,462	-1,039	-1,792
	(3,548)	(3,050)	(1,411)	(1,233)	(2,661)	(2,362)
Teaching	5,076	4,426	2,604	2,399	2,472	2,027
	(1,956)	(1,805)	(1,285)	(1,257)	(1,113)	(1,032)
Licensed Beds	1,361	1,318	805	770	556	548
(per 100)	(319)	(300)	(191)	(193)	(186)	(160)
Age	70.2	53.5	-112	-110	182	164
	(321)	(330)	(104)	(102)	(249)	(262)
Age Squared	0.372	0.603	1.48	1.48	-1.11	-0.881
	(2.48)	(2.52)	(0.862)	(0.83)	(1.89)	(1.97)
R-squared	0.099	0.028	0.044	0.029	0.056	0.088
Observations	347	347	347	347	347	347

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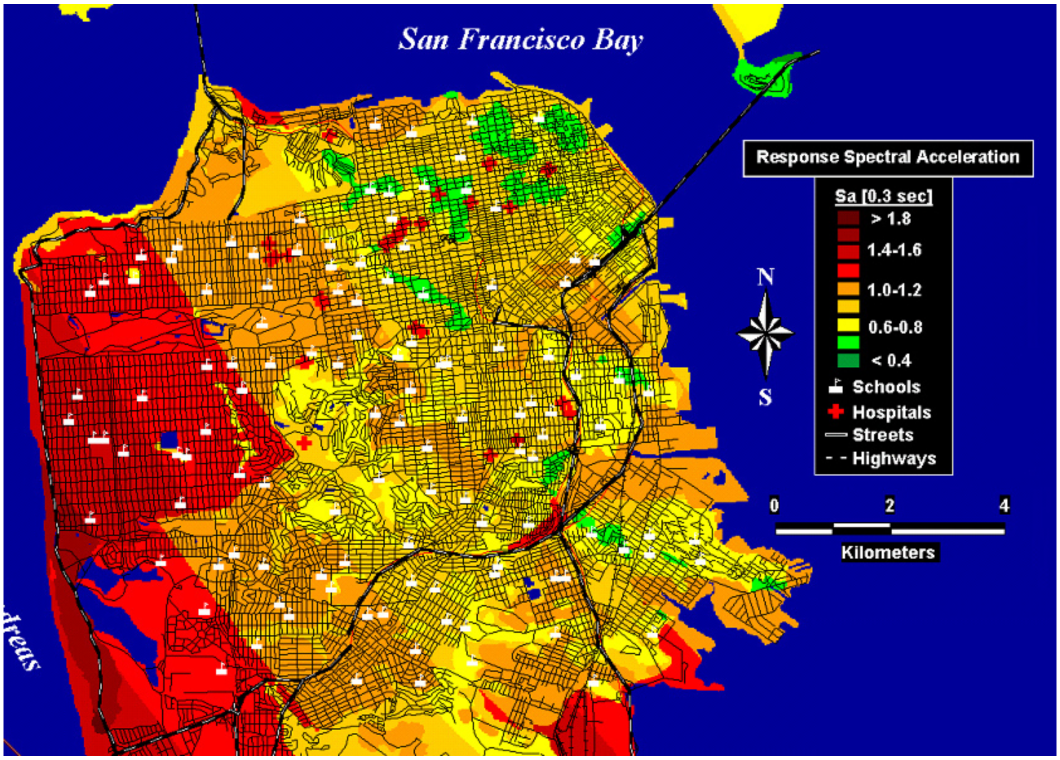
[a] Notes:

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), license age as of 1992 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 Figure 1: A map of expected ground acceleration in the event of an earthquake similar to the great quake of 1906.


San Francisco Bay
Response Spectral Acceleration
Sa [0.3 sec]
> 1.8
1.4-1.6
1.0-1.2
0.6-0.8
< 0.4
Schools
Hospitals
Streets
Highways
N
S
0
2
4
Kilometers
dreas

Source: U.S. Geological Survey

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

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

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[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 II
Changes in Total General Acute Care: 1992-1996 [a]

	Change in Hospitals Days		*Change in Hospitals Discharges*	
pga	-5,349	-7,661	-1,100	-1,272
	(6216)	(7,053)	(940)	(942)
pga * For-Profit		-6,206		215
		(6,256)		(957)
pga * Public		6,446		669
		(11,558)		(1,381)
For-Profit	1,652	-1,396	-547	-651
	(2,066)	(3,257)	(369)	(577)
Public	-2,590	-5,881	-972	-1,314
	(3,018)	(5,025)	(467)	(584)
Multi-Site	-2,722	-2,815	-126	-139
	(1,391)	(1,462)	(299)	(302)
Rural	-1,839	-1,712	-275	-241
	(2,124)	(2,279)	(273)	(287)
Teaching	-4,982	-4,883	-621	-611
	(2,865)	(2,734)	(335)	(331)
Licensed Beds	-3,031	-3,034	-289	-290
(per 100)	(1,381)	(1,356)	(175)	(175)
Age	-172	-177	-2.17	-2.12
	(164)	(164)	(37.1)	(37.7)
Age Squared	1.28	1.35	-0.012	-0.112
	(1.38)	(1.38)	(0.286)	(0.292)
Adj. R-squared	0.168	0.165	0.004	0.001
Observations	413	413	413	413

---

[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 dummies for 1992 ownership status (government-owned or for-profit with nonprofit status excluded), license age as of 1992 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 III
Neonatal Intensive Care: 1992-1996 [a]

	Change 1992-1996		
	NICU Beds	*Days*	*Discharges*
pga	-0.329	-709	-46.0
	(2.07)	(504)	(52.5)
pga * For-Profit	-0.941	467	0.262
	(2.13)	(549)	(62.3)
pga * Public	-3.57	-745	-77.5
	(2.99)	(919)	(73.3)
For-Profit	-0.867	-333	-29.4
	(1.17)	(319)	(34.9)
Public	1.80	201	57.4
	(1.87)	(574)	(46.1)
Multi-Site	0.110	18.4	19.9
	(0.615)	(150)	(21.0)
Rural	-2.28	-191	-35.8
	(0.781)	(203)	(26.3)
Teaching	0.976	-269	5.19
	(0.774)	(228)	(29.4)
Licensed Beds	0.286	44.9	-1.93
(per 100)	(0.215)	(72.4)	(11.6)
Age	0.009	17.9	2.65
	(0.037)	(20.8)	(3.89)
Age Squared	-0.0002	-0.172	-0.030
	(0.0003)	((0.177)	(0.033)
R-squared	0.038	0.084	0.095
Observations	413	413	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), license age as of 1992 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, P, u) *and* (q', θ', P', u') *be a nonprofit hospital's choice of variables conditional on fixed cost shocks* F *and* F' *respectively. If* $V^{\pi} = R + V(P)$*, for all values of* (q, θ, P, u, F)*, then* $(q, \theta, P, u) = (q', \theta', P', u')$ *for all* (F, F')*.*

Proof: Note that θ and u have a positive cost and do not appear in the objective function. In addition perquisites are assumed in the model to be inferior to cash ($i.e.V_P(P) < 1 \forall P$). The hospital will therefore choose the lowest possible values of θ, u and P, which is zero regardless of F (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 $(q^*, \theta^*, P^*, u^*)$ is independent of the fixed cost shock F. ■

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). ■

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* $w(q, \theta) = q\theta$*. And 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* $F < F'$*, then* $q \geq q'$*,* $\theta \geq \theta'$*, and* $u \geq u'$*.*

Proof: Since P and R do not appear in the objective function, but has a positive costs, the firm will choose the lowest possible values $P = 0$, $R = 0$. Setting $P = 0$, we can 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 $V^{perk} \equiv V(P, \theta)$ where V^{perk} is an increasing, concave function of P and θ. For any fixed cost shock $F > 0$, conditional on being able to meet it's budget constraint, nonprofit hospitals must (weakly) decrease P and θ.

Proof: The firm's problem can then be written as

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

The first order conditions are then

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

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

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

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

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

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, P, F), we can rewrite equation 16 as $(\beta - F) - p^\theta \theta - P = 0$, 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, P), subject to a budget constraint $p^\theta \theta + P = w$ 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 P, $\theta^{F'} \geq \theta^F$ and $P^{F'}) \geq P^F)$. So for all $F \in [0, F^\pi]$, $\theta^0 \geq \theta^F P^0 \geq P^F$. ■