Outsourcing Intensity and Ownership: Theory and Evidence from California General Care Hospitals

Dalton, Christina Marsh and Warren, Patrick L.

Wake Forest University, Clemson University

16 May 2014

Outsourcing Intensity and Ownership: Theory and Evidence from California General Care Hospitals

Christina Marsh* Patrick L. Warren†

May 16, 2014

Abstract

For-profit hospitals in California contract out services much more intensely than either public hospitals or private nonprofit hospitals. To explain why, we build a model in which the outsourcing decision is a trade-off between net revenues and some nonmonetary benefit to the manager, which we call "bias" in the manner of production. Since nonprofit firms must consume profits indirectly, they trade off differently than for-profit firms. This difference is exaggerated in services where nonmonetary benefits are particularly important but minimized when the firm is hit with a fixed-cost shock. We test these predictions in a panel of California hospitals, finding evidence for each. These results suggest that a model of public or nonprofit make-or-buy decisions should be more than a simple relabeling of a model derived in the for-profit context.

JEL Classification: I22, L24, L33

Keywords: Hospitals, Make-or-Buy, Public versus Private, Nonprofit Firm Behavior

*University of Georgia, Terry College of Business, clmarsh@uga.edu

†John E. Walker Department of Economics, Clemson University, 222 Sirrine Hall, Clemson, SC 29634. E-mail: patrick.lee.warren@gmail.com. We have received very useful feedback from Tom Chang, Mireille Jacobson, Richard Lindrooth, Jens Prufer, Michael Vlassopoulos and seminar participants at the University of South Carolina, Appalachian State University, the Clemson IO Workshop, SEA2012, ISNIE/ESNIE 2012, and ASSA 2013.

If you want a thing done well, do it yourself. - Napoleon Bonaparte

1 Introduction

With improved information technology, a growing list of services can be traded, expanding outsourcing opportunities into new industries. While decisions about the for-profit firm's boundary are (relatively) well-understood, little is known about how nonprofit and public firms make these decisions. This gap is particularly important in the health care industry, where rising costs make outsourcing attractive, and where a diversity of nonprofit, public, and for-profit providers provide services. In this paper, we analyze the make-or-buy decisions of public, nonprofit, and for-profit California hospitals, demonstrate robust differences among ownership types, and provide both a theoretically-grounded explanation for these differences and tests of the proposed mechanism.

For-profit, nonprofit, and public hospitals in California vary significantly in the extent to which they outsource service-provision. During 1998-2006, for-profit short-term general-care hospitals outsourced 25.7 percent of the cost of an average service to outside providers, with 5.5 percent of services completely outsourced. Nonprofits outsourced much less, 18.9 percent of the cost of an average service, with 2.9 percent of services completely outsourced. The rates for public hospitals were similar to private nonprofits. Balakrishnan, Eldenburg, Krishnan and Soderstrom (2010) show that these differences in average outsourcing rates are robust to a number of controls for hospital and market characteristics. Given the importance of the hospital industry and continued health expenditure growth, these outsourcing levels are economically important.

Although profit-maximizing outsourcing is well studied (Lafontaine and Slade 2007), we know less about the causes and consequences of the boundaries of other sorts of organizations. To what extent and in what direction do the decisions of these non-firm organizations deviate from the profit-maximizing choice? Some related work studies which services the public sector chooses to contract out (Nelson 1997, Lopez de Silanes, Shleifer and Vishny 1997, Hart, Shleifer and Vishny 1997, Brown and Potoski 2003, David and Chiang 2009, Levin and Tadelis 2010). These studies cannot address what is essentially "public" or "nonprofit" about choices since they lack a control group of profit-maximizers. Instead, they are comparative static in nature, analyzing how organizations adjust to changes in the economic or political environment. This work can, instead, identify divergence in outsourcing decisions among ownership classes in cross-section, compare these differences across services, and see how these differences respond to exogenous cost shocks.

To analyze the differences in outsourcing among ownership classes, we extend a well-known model of nonprofit entrepreneurship by Glaeser and Shleifer (2001) to include a make-or-buy decision. In our model, the manager places some direct value on controlling the exact manner in which the service is performed, either for his own intrinsic reasons or due to influence from some interest group (such as elite workers) who have their own preferences about how the service is performed. Our model predicts that outsourcing is more attractive to for-profit firms than nonprofit firms whenever the outside producer has a comparative advantage in providing relatively low cost services over which the manager will have little control. This difference in outsourcing is amplified when the ability to control the manner of production is particularly important and dampened when a fixed-cost shock lowers net incomes.

We test these predictions on a rich dataset of California hospitals with service-specific outsourcing measures and market characteristics over the period 1996-2008. For-profits outsource consistently more than private non-profits, and public hospitals outsource even less than private non-profits. These results are robust to the inclusion of controls for hospital size and scope, service-specific output, presence of a residency program, market characteristics, as well as service, year, and county fixed effects.

To investigate the importance of control, we divide hospital services into classes about which the managers may be particular concerned. For example, if elite workers are influential, controlling the manner of production of physician-intensive medical services like cardiology or emergency services may be more important, as compared to those that have little or no physician labor, like grounds keeping or parking. We also highlight labor-intensive services, where labor costs make up a big share of the total costs, since control of those services may be particular salient for, especially, public managers. Outsourcing differences between nonprofits and for-profits are much bigger for physician-intensive services. For non-physician-intensive services, there is no significant difference in the extent of outsourcing between for-profit and private nonprofit hospitals. However, public hospitals do not exhibit this pattern; they consistently outsource less than for-profits across both classes of services. The pattern for labor-intensive services is quite different. Labor intensity seems to have no relationship with the outsourcing rates of private non-profits, but public hospitals outsource labor-intensive services *much* less than similarly-situated for-profits (or private non-profits) do.

The model's second prediction is that a shock increases fixed costs should cause nonprofits to look more like for-profits in their outsourcing decisions. We test this prediction by taking advantage of California's seismic retrofitting requirements. Nonprofit and public hospitals that experience greater fixed costs outsource at rates similar to for-profits, while nonprofit

and public hospitals that did not have a large fixed-cost shock act much differently. The two predictions are also complementary, in that the convergence of nonprofit and for-profit outsourcing rates is most evident in physician-intensive and labor-intensive services, where the unconditional gap is biggest.

This paper contributes to two literatures. There is a burgeoning literature on the "boundary of the organization" and how public entities provide services (Hart et al. 1997, Martimort and Pouyet 2008, Levin and Tadelis 2010, Iossa and Martimort 2012), but nearly every empirical investigation has focused on one ownership type. There is real novelty in being able to compare and contrast. Hospitals are a particularly intriguing organization to investigate, because the organizational forms span for-profit, private nonprofit, and various sorts of publicly-operated institutions. A handful of papers have taken advantage of this diversity. Coles and Hesterly (1998) touch on nonprofit and for-profit differences, but focus on how transaction costs influence which hospital services are outsourced. Balakrishnan et al. (2010) describe outsourcing differentials at the level of the hospital. We take their correlations as motivation, show that the large differences by ownership type are robust within services, and show that those differences are consistent with a model in which nonprofits are induced by non-distribution constraints to trade-off costs versus control at a different rate than for-profit firms do.

Second, there is a significant literature on the effects of nonprofit status on the behavior of firms, in general, and hospitals, in particular.[1] The particular issues in the context of hospitals are nicely summarized by Sloan (2000). This literature has been particularly concerned with the effect of ownership on the provision of service quality (Sloan et al. 2001, Picone et al. 2002, Eggleston et al. 2008), but also on the role of competition (Duggan 2002), managerial compensation (Ballou and Weisbrod 2003), and the deeper question of what drives nonprofit behavior, more generally (Deneffe and Masson 2002, Horwitz and Nichols 2009, Chang and Jacobson 2011). The paper most related to ours, both in context and approach, is Chang and Jacobson (2011), which looks at hospitals in California and also uses seismic retrofitting as a exogenous cost shock. While they are concerned with the deep question of "what nonprofits maximize," we have a much more specific goal of looking at one aspect of the production decision, outsourcing, to highlight an important difference in the way nonprofit firms conduct their affairs. We focus on outsourcing as a component of total production, but this is particularly relevant for answering the deeper question of how missions and production decisions are made differently by ownership type. Outsourcing is important because, although a nonprofit has chosen a particular mission, the firm is choosing to move

[1] For a nice synthetic summary of the general issue of nonprofit behavior, see Malani, Philipson and David (2003).

some production outside of the firm's boundary – where the mission of the contracting firm may be different. This change can have real effects if there are significant elements of the service that are difficult to fully specify in the contract. We see our work as complementary to the literature, as we identify an additional dimension along which "perquisite maximizing" nonprofits differ from their "profit-maximizing" kin.

The rest of the paper proceeds as follows. Section 2 presents a model of nonprofit and for-profit outsourcing behavior. Section 3 describes California hospital ownership types and our data. Section 4 describes the econometric specification and discusses our results on outsourcing, control, and fixed cost shocks. We have a brief discussion of alternative explanations in Section 5 before concluding in Section 6.

2 A Model of Outsourcing

Consider a model of nonprofit behavior that borrows heavily from Glaeser and Shleifer (2001), but adds an outsourcing decision. Assume the firm's manager solves

$$\max_{\pi,Z,b} u(\pi, Z, b|\rho) = \pi + v(Z) + \rho b,$$

subject to

$$\pi + Z \leq I(b) - F,$$

where the manager maximizes over profits (π), perquisites (Z), and production bias (b). Returns to perquisites, $v(Z)$, are increasing and concave with $v'(0) = 1$, meaning perquisites have diminishing marginal returns. Perquisites are non-income benefits such as improved working environment of the manager or employees, more generous benefits, better offices, etc. Production bias, b, captures the degree of deviation from the net-income maximizing manner of production for the given service. As a normalization, let $b = 0$ represent the net income-maximizing level production bias, and assume that $I(b)$ is concave and decreasing in b. Moving away from the net income-maximizing manner of production is costly, but may have value to the manager if his incentives are not solely determined by net revenues. The value placed on additional control over the manner in which the service is provided is parameterized by ρ. Finally, nonprofits have an additional constraint to set profits at zero, so they must consume income as perquisites, Z.

Production bias (b) should be interpreted broadly to allow the maximization to reflect a diversity of missions. It represents some feature of production (either input or output) about which the manager has preferences over and above its impact on net revenues. The

ρ term captures both the manager's own intrinsic value and the value he is induced to place on it as a result of influence by other interest groups, such as elite workers, governing boards, or those in a position of political power over the manager.[2] Elite workers, such as physicians in the hospital context, are highly trained specialists with significant informational advantages and decision influence. The manager might alter the service provision in services with a large percentage of elite workers. Services with substantial elite worker production might have greater potential for quality improvement, for example, and the workers, or the manager himself, may benefit from gaining a reputation for working in or leading a high-quality medical institution. However, that quality service could also produce better patient outcomes (influencing revenues) but be costly to implement (influencing costs). The revenue and cost effects of this high quality service appear in $I(b)$, but the private benefits appear in the ρb term. Alternatively, the manager could enjoy biasing production out of an altruistic impulse, whereby the manager actually gets psychic benefit from providing excellent quality care or high levels of uncompensated care, over-and-above the net revenue consequences. On the other hand, perhaps the manager could be simply captured or influenced in some way to place some extra weight on these elite workers. Elite workers may prefer some input or output mix that differs from income-maximizing levels, and pressure the manager to alter the provision of services they dominate. Doctors may pressure management to structure production in favor of greater physician control. Other candidates could include political pressures to over-employ labor. In that case, the manager might alter the mix of inputs away from the net-revenue-maximizing mix.[3]

The key feature of this specification is that returns to perquisites fall off more quickly than the returns to profits when net revenues decline. This is the idea that the marginal dollar of constrained net income becomes less valuable more quickly than the marginal dollar of unconstrained net income. That is, the marginal rate of substitution between production

[2]A more detailed version of this model could include interest group effort to exert influence over the manager with some cost to the interest group. This would be similar to (Glaeser 2003). In the model above we do not assume differential pressure or effort on the part of workers in nonprofit versus for-profit firms. If we did include this elite worker effort, nonprofit elite workers would have a greater incentive to exert effort because of the diminishing marginal returns to income in the nonprofit firm. The relative decisions between nonprofit and for-profits would remain the same, but the differences would be stronger. We present only the basic case above, and let the empirical section reveal the size of the relative differences.

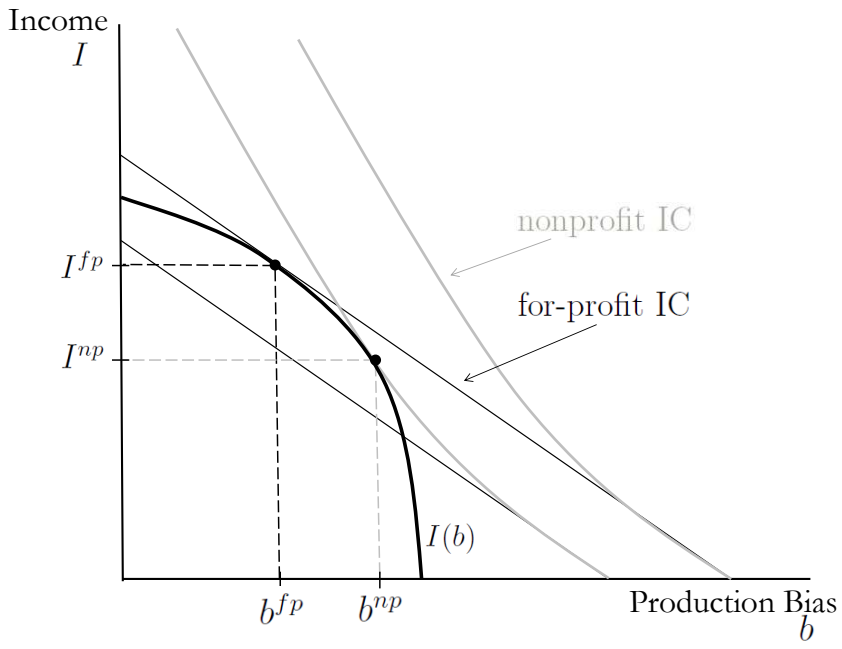
[3]Glaeser and Shleifer (2001) assume managerial control is used to dictate the level of quality, only, and that quality is non-contractible so the net income depends on both the expected level of quality and the actual level of quality. Since their interest is in explaining why some firms choose to be nonprofit, they focus on weakened incentives among nonprofit to reduce costs as a commitment device for maintaining high quality. In equilibrium, this leads to higher revenues, which can make up for the requirement to consume revenues through perquisites. We think about the value of control over the manner of production broadly but abstract from the commitment problem. Nevertheless, the key results below would still hold in the context of non-contractible quality.

bias and perquisites diminishes more quickly than the marginal rate of substitution between production bias and profit does. Thus for-profit firms will face a different trade-off than nonprofits between additional income versus increased bias. This assumption implies that nonprofits will be willing to pay more for production bias than a similar for-profit would in cases where income is high. This is formalized by the concave returns to perquisites in $v(\cdot)$. The other assumptions, such as the fact that the marginal value of the initial units of perquisites is the same as the marginal value of a dollar of profits or that the marginal utility of profits or bias is constant, are not integral. They make the analysis uncluttered.

In-House Production Figure 1 represents the optimal income/production bias choice for nonprofit and for-profit firms, holding ρ fixed. Bias (b) appears on the x-axis and net income I on the y-axis. Let $j = fp$ denote for-profit and $j = np$ denote nonprofit. The maximizing bias choices for each type are b^j, and incomes associated with this choice are $I^j \equiv I(b^j) - F$. The solid thick curve is the in-house production possibilities curve, labeled $I(b)$. The optimal choices of each firm type are formed by the tangency of the manager's indifference curve with the in-house production possibilities curve. The indifference curves of the for-profit manager are given by the thin straight lines with slope $-\rho$, labeled "for-profit IC." For-profit indifference curves are straight because the tradeoff between income and bias is constant for the for-profit firm. The gray indifference curves for the nonprofit firm, labeled "nonprofit IC," begin with the same slope as the for-profit on the x-axis, but become steeper as income increases. Increasing income has diminishing marginal value for a nonprofit because the nonprofit must consume income through perquisites due to the nondistribution constraint. The optimal choices for each firm type are shown by the dots on the in-house production possibilities curve. The familiar tangency condition assures that $b^{fp} < b^{np}$. Intuitively, since the marginal value of a constrained dollar is always less than the marginal value of an unconstrained dollar, nonprofits choose higher levels of production bias than for-profits do.

Outsourcing Assume now that the firm could choose to outsource production to some third party, who offers a set of bias-income combinations. For a given level of bias, b, let $\overline{I}_j(b)$ represent the threshold income for that b, above which the firm would choose to outsource. That is, $I_j(b)$ is the income that a firm of type j would choose the pair (b, I) over in-house production for any income $I \geq \overline{I}_j(b)$. The curve $\overline{I}_j(b)$ is the maximal indifference curve attainable in-house. Figure 2 illustrates these cutoffs for one particular level of production bias, b_o, the dotted vertical line. The cutoff income $\overline{I}_{np}(b_o)$ is the topmost encircled intersection of the nonprofit indifference curve and the level of bias b_o. The cutoff

Figure 1: Optimal In-House Production by Firm Type



income $\overline{I}_{fp}(b_o)$, is the encircled intersection just above the thick in-house production curve. For the particular level of bias, b_o, the for-profit would find outsourcing at this level of bias more attractive than the nonprofit would (in the sense that the for-profit firm would require lower income to choose it over own-production), or $\overline{I}_{np}(b_o) > \overline{I}_{fp}(b_o)$.

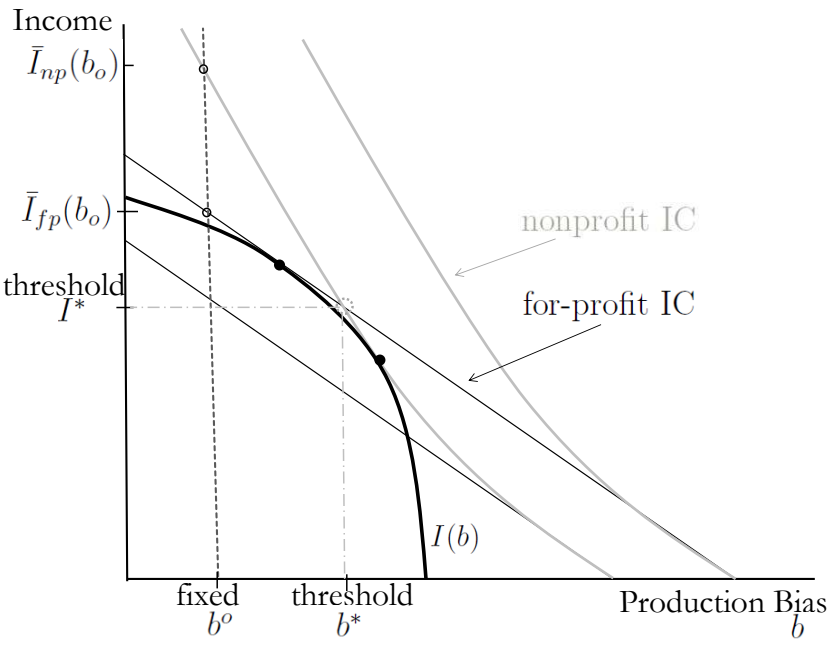
Because the marginal rate of substitution between bias and income for the for-profit firm is smaller (in absolute size) than that of the similarly-situated nonprofit firm, these two indifference curves cross exactly once and the crossing occurs between their optimal in-house bundles. This fact is illustrated in Figure 2 where the intersection is contained in a dotted circle, labeled on the corresponding axis as (b^*, I^*). The following proposition formalizes this intuition. Proofs for all propositions are in the Appendix.

Proposition 1 *There is a unique combination* (b^*, I^*) *such that* $u(0, I^*, b^*) = u(0, I^{np}, b^{np})$ *and* $u(I^*, 0, b^*) = u(I^{fp}, 0, b^{fp})$. *This combination is bracketed by two in-house choices, in the sense that* $b^{fp} < b^* < b^{np}$ *and* $I^{fp} > I^* > I^{np}$. *Furthermore,*

1. *If* $b \geq b^*$ *then* $\overline{I}_{np}(b) \leq \overline{I}_{fp}(b)$.
2. *If* $b \leq b^*$ *then* $\overline{I}_{np}(b) \geq \overline{I}_{fp}(b)$.

Finally, let $I^o(b)$ *represent the frontier of income-bias pairs available through outsourcing. A firm of type* j *will outsource if and only if there is some control level such that* $I^o(b) > \overline{I}_j(b)$.

Figure 2: Outsourcing Income Threshold by Firm Type



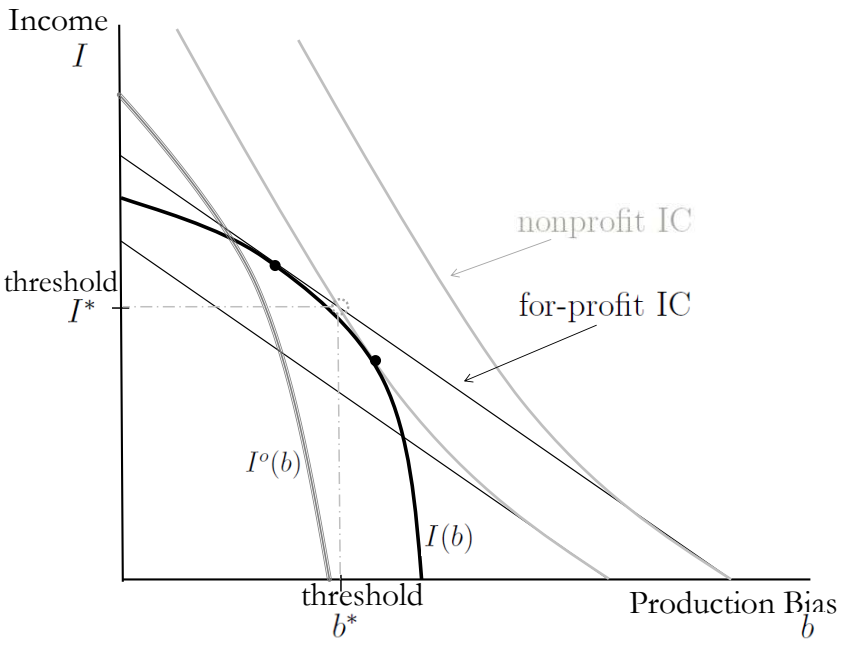
From this proposition, we can characterize when to expect nonprofit firms to outsource more than for-profits and vice-versa. Intuitively, if outsourcing is the low-cost but low-bias option, we should see for-profit firms outsourcing at a higher rate than nonprofit firms. If outsourcing is the high-cost and high-bias option, we should see nonprofit firms outsourcing at a higher rate. Obviously, if outsourcing is lower cost for all bias levels, everyone will outsource, and if it is higher cost for all bias levels, no one will.

The following corollary formalizes these ideas.

Corollary 1 *If $I^o(b) > I(b)$ only if $b < b^*$, then a nonprofit firm will outsource only if an otherwise identical for-profit firm does. If $I^o(b) > I(b)$ only if $b > b^*$, then a for-profit firm will outsource only if an otherwise identical nonprofit firm does.*

Figure 3 represents a situation from Corollary 1 in which the outsourcing opportunity is relatively cheap for low levels of bias, but producing in-house is relatively cheap for high levels of bias. The thick multi-stripe frontier labeled $I^o(b)$ represents the new possibilities of outsourcing opportunities. The thick line $I(b)$ remains the in-house production possibilities. The outsourcing frontier lies above the in-house production frontier only for low levels of bias. Given this arrangement of production possibilities curves, there are outsourcing opportunities above the for-profit firm's maximal in-house indifference curve. However, all outsourcing

Figure 3: Outsourcing Opportunity Set Where For-Profit Firm Outsources but Non-Profit Firm Does Not



opportunities are below the nonprofit firm's maximal in-house indifference curve. Thus, the for-profit firm chooses to outsource, while a nonprofit firm does not.

In interpreting the theoretical predictions, there are several reasons that outsourcing might be the low-cost/low-bias option, where $I^o(b) > I(b)$ for low b. In addition to the direct contractual obligations, $I^o(b)$ also includes all the costs of composing and managing a (potentially quite complex) contractual relationship. Duties and contingencies have to be clearly specified and appropriately anticipated. Unanticipated contingencies may result in costly renegotiations. Performance must be monitored, and a breach on either side can lead to costly and protracted legal proceedings (Bajari and Tadelis 2001, Levin and Tadelis 2010). Of course, more finely tuned control over the manner of production would require even more completely specified contracts and precise monitoring. Providing high quality service, for example, is notoriously difficult to measure in a contractible way, and a contractor has strong incentives to try to shade on quality to the extent that it lowers his costs. Similarly, a contractor has strong incentives to try to game a contract that requires an inefficient production mix (say favoring labor over capital), since returning to the optimal mix would reduce costs. In both cases, the desire to game the contract increases as it specifies greater and greater divergence from the profit-maximizing production method. At some point, the costs of guaranteeing very high levels of control over specific details of production contractually would

be prohibitive relative to in-house monitoring.

The cost of controlling production may also increase with outsourcing in this industry, in particular, because of the structure of health care services. Hospitals are organized to provide tertiary care, the most specialized consultative care for patients. Patients are referred to hospitals from primary or secondary care, which are organized to provide more general care. Thus, hospitals' patients may already require the most specialized services in the local market, so a full specification of appropriate performance is particularly difficult. In a sense, the hospital gets the least standard cases, by design, and so a standardized contractual solution may be particularly ineffectual. Of course, this pattern of comparative advantage may not hold for every service, but it suffices, for our purposes, for it to hold on average.

The propositions and figures above show how outsourcing behavior differs for fixed parameters, however we can also investigate the comparative static predictions by firm type. The model predicts that a shock to fixed costs (F increasing) will differentially affect the two firm types. A fixed cost shock is a shift in net income for all levels of bias. For profit-maximizing firms, changes in fixed costs have no effect on behavior (assuming profits remain non-negative). By contrast, a nonprofit firm's marginal benefit of increasing income depends on the level of fixed costs. If F rises, the marginal benefit of perquisites rises, so the opportunity to outsource to a low-cost/low-bias producer becomes more attractive to a nonprofit firm. This comparative static arises naturally from the non-distribution constraint, but it would not obtain in a model where the only difference between non-profits and for-profits is a difference in ρ, the importance of control over production bias. In that alternative model, a fixed shock does not affect the marginal value of a dollar of additional net revenues and so would not affect outsourcing decisions (other than through shut-down constraints).

A second comparative static is the response to a change in the importance of control over production (ρ). If control over production is more important, a larger income advantage is required to induce firms to outsource to a low-bias producer. Since nonprofits must consume this income through perquisites, the effect is more pronounced for them. Of course, this static also implies that if nonprofits have consistently higher ρs for (some subset of) services, they will outsource (that subset of) services less, ceteris-paribus.

Finally, since the divergence of the nonprofit from the profit-maximizing choice is larger for larger ρ, there is a cross-partial prediction, where the effects of a fixed-cost shock will be larger for services where control over production is more important. The following proposition formalizes these three comparative statics.

Proposition 2 *If $b < b^*$, then $\overline{I}_{NP}(b) - \overline{I}_{FP}(b)$ is positive , increases in ρ, decreases in F, and the marginal effect of increasing F is larger (in absolute value) as ρ increases.*

We cannot observe income cutoffs, but we interpret the proposition to mean that the difference between nonprofit and for-profit firms' outsourcing behavior should increase in the importance of control over production and decrease in fixed cost shocks. We will examine the evidence for and against these propositions below.

3 Institutional Background and Data

3.1 Institutional Background

Short-term general care hospitals in California are organized in one of four types: for-profit, nonprofit, local, and district.[4] For-profit hospitals have a private residual claimant on profits, either shareholders or some limited partnership. Private nonprofits are 501(c)(3) registered charitable organizations. To qualify for federal tax-exempt status, they must demonstrate that they operate for a"charitable purpose," and that no part of the organization's net earnings accrue to the benefit of any private shareholder or individual. Public local hospitals are operated as part of the budget of the local city or county (or both, jointly), usually overseen by a board indirectly appointed by the elected local government. Public district hospitals are controlled by a board of directly elected representatives by the residents on one of California's 85 health districts (although not every district operates a hospital). They are funded by taxes at the district level, patient receipts, and intergovernmental transfers, and they are part of a network of public health care providers within the district.[5]

3.2 Data Description and Summary

We examine the determinants of outsourcing behavior on an unbalanced panel of 433 short-term care general services hospitals that operated in California during 1996-2008. These hospital data come from the Annual Financial Data series from the California Office of Statewide Health Planning and Development (OSHPD). For each hospital, we know a wide variety of ownership, financial, and operating characteristics, including ownership class, number of licensed and staffed beds, patient mix, and location.

The main outcome variable of interest is service-specific outsourcing within a hospital.

[4]Veterans Affairs (VA) hospitals are not included in this analysis.

[5]In fact, the situation is even more complicated by the fact that certain Districts license nonprofit or for-profit providers to operate hospitals for them. We code these as for-profit or nonprofit, since the licensees are residual claimants on profits and have managerial discretion in structuring operations. For more detail about the governance structures employed by California public hospitals, see `http://www.chcf.org/publications/2009/05/governance-models-among-california-public-hospitals`

Hospitals in our sample offer some subset of 85 unique services.[6] Very common services in our data are "diagnostic radiology," "dietary", "drugs sold to patients," and "housekeeping," which are reported by nearly every hospital in nearly every year. Rarer services, like " electroencephalography" or "outpatient registration" are reported by a minority of the hospitals. The median hospital has 56 services while the mean has 53.7.

We define a cost-based measure of service-specific outsourcing. Formally, for service s in hospital h in year t we define

$$PctOut_{hst} \equiv \frac{PurchasedServices_{hst} + ProfFees_{hst}}{TotalDirectCost_{hst}} \times 100.$$

Our data include service-specific direct costs broken down into nine broad categories.[7] Two of these cost categories make up the numerator of our outsourcing measure: "Purchased Services" and "Professional Fees". These costs include, for example, medical dialysis service contracts, but would not include a leased machine operated by in-house personnel.[8] The denominator of our outsourcing measure is the total of direct costs only, not indirect accounting costs, which mitigates any differences that ownership types may have in accounting cost-allocation.

All physician costs, regardless of contracting type, are excluded from our outsourcing service measures. The reason for this is because most California hospitals are not allowed to directly employ physicians. Since the make-or-buy "decision" is actually not a choice for many firms, but rather dictated by law, we exclude all physician fees from the outsourcing measure. Our data from OSHPD reclassifies all physician and student expenses related to care provision/supervision into an a stand-alone cost category, regardless of the physician's actual relationship to the hospital. Physician expenses related to care provision/supervision include amounts formally charged either as a salary, to the hospital as a fee, or directly to the patient as a professional fee. These are all allocated to services as "reallocated physician expenses." This restriction is applied across all for-profit, nonprofit, and public hospitals,

[6]These 85 unique services exclude three categories. 1. Several broad catch-all categories. (such as "Other Daily Hospital Services", the composition of which may vary across hospitals) 2. Services offered very rarely (less than 300 hospital/year combinations, out of about 4500) 3. All medical research and education services. The results are robust to including/excluding the rare services, and we explicitly report the results when we limit the sample even further to only very common services.

[7]These categories are Salaries and Wages, Employee Benefits, Reclassified Physician and Student Expenses, Professional Fees, Supplies, Purchased Services, Depreciation, Leases and Rentals, and Other Direct Expenses.

[8]The full list of Purchased Services includes medical, repairs and maintenance, medical school contracts, management services, collection agencies, and other purchased services. The Professional Fees category includes non-physician medical fees, therapist fees, consulting and management fees, legal, audit, registry nursing personnel, other contracted services, and other professional fees.

including most residency programs. The main exception is teaching hospitals.[9][10] As a result, any differences in outsourcing by ownership must arise from factors other than differential statutory restrictions on the ability to directly employ physicians.

Hospitals differ most in the extent of outsourcing of a given service, compared to the decision to outsource at all. Because hospitals in our data are very similar on the decision to outsource or not, we leave the interesting question of the extensive margin to another paper and focus our analysis on the intensive margin. We define the intensive margin as the degree of outsourcing, conditional on the decision to outsource a service at all, and we measure it by $log(PctOut_{hst})$.

Services vary considerably in the degree of outsourcing. "Renal Dialysis" is the most outsourced service in our sample, with an average of 75.9 percent of costs going to outside providers, while "Medical Supplies Sold to Patients" is the least outsourced at 0.60 percent of costs. "Satellite Ambulatory Surgery" is the service that the most hospitals outsource to any degree, while "Drugs Sold to Patients" is the service done completely in-house more often than any other.

For hospital covariates we have measures of size, scope, mission, and market. For a time-varying measure of size, we have the number of staffed beds. For scope, we have the number of services offered. Both will enter the regressions in logs. For mission, we have an indicator for whether the hospital has a residence program, since this may give particular incentives to do work in house, for training purposes, and the fraction of patient days that are from Medicare and Medical patients, since different patient mix may lead to different activities. We also have an indicator for whether the state of California considers the hospital to be "rural", since the opportunities to outsource may be less in a less-developed market.[11] For market, we have market-level characteristics covering population, socioeconomic characteristics, and demographics. Market characteristics were taken from the U.S. Census Records for the years 1996-2006 and from the American Community Survey for 2006-2008. Census and ACS variables were matched at the zipcode level into corresponding Hospital Service Areas (HSAs)

[9]Because teaching hospitals are more likely to be nonprofit, this exemption may fall disproportionately on nonprofit hospitals. Section 5 discusses why this is not a concern in our analysis approach.

[10]A few smaller exceptions to directly employing physicians include county hospitals and HMOs licensed under the Knox-Keene Act (such as Kaiser).See Physician-Hospital Integration 2012: How Health Care Reform is reshaping California's Delivery System. For The California HealthCare Foundation by the Camden Group. April 2012.

[11]A subset of about 20 of California's hospitals qualify for the Medicare "Critical Access Hospital" program for rural hospitals. These hospitals may face different incentives to provide services, and to provide them in-house. We have included them in the sample, but we repeated the entire analysis removing these hospitals, with no substantive effects on the results. For details on this program, see `http://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/downloads/CritAccessHospfctsht.pdf`.

of each hospital. HSAs capture local health care markets for hospital care as a collection of zipcodes whose residents receive most of their hospitalizations from the hospitals in that area. To control for the size of market, we include total population estimates. Socioeconomic and demographic characteristics include median household income, education attainment, and race percentages within the total population. The average unemployment rate for the year in the hospital's county from the Bureau of Labor Statistics. County fixed-effects control for the general market in which the hospitals find themselves, as well as year and service fixed-effects to keep the comparisons within a service and remove common economic shocks.

Finally, to control for service-specific returns to scale, we have service-specific measures of output. The specific measure reported by the OSHPD varies considerably by service. For example, the measure of output for all daily hospital services is "patient days", and for most ambulatory services it is "visits", but for ancillary services it is very service-specific: deliveries, operating minutes, tests, or sessions. For the non-revenue-generating services, it also varies a lot. The measure for the printing and duplicating service is "reams of paper," while that for the social work services is "number of personal contacts."[12] Since these measures are not commensurable, we will also allow the coefficient on output in any regression that includes them to vary by service, with the levels given in logs.

Table 1 summarizes these variables by hospital ownership class. We present results for all 85 services, but in the Appendix we replicate our results by limiting the analysis to the 36 most common services, which are offered by at least 3000 hospital/year combinations. They are consistent with the full-sample results. In the summary statistics, all hospital-level variables are weighted by the number of services, since they will naturally weighted in that way in the regressions.

Differences in outsourcing behavior between nonprofit and for-profit hospitals are evident in the summary statistics. For-profit hospitals outsource on average about 25.7 percent of costs, compared to 19 percent for private nonprofit hospitals. District and local hospitals also outsource less on average than for-profit hospitals. The fraction of services which are completely outsourced varies in a similar way. The ownership types are much more similar when looking along the extensive margin, however, averaging about 87 percent of services outsourced to some degree.

Private for-profits are mostly small urban hospitals. They are much smaller than non-profit or local hospitals, averaging 144 beds per facility and 54 services. For-profits are least likely to offer residency programs and are highly urban, with only 5 percent of hospitals located in rural areas. Accordingly, for-profit hospital markets have the highest HSA

[12] A complete list of services and output measures available at `http://www.oshpd.ca.gov/HID/Products/Hospitals/AnnFinanData/Manuals/index.html`.

populations, the highest median household income, and the second highest percent black.

Nonprofit hospitals tend to be large medical complexes in relatively well-off areas. Nonprofit hospitals average 222 beds and 58 services, second only to local hospitals. They also have the smallest percentage of MediCal patients, at 20 percent, and the highest percentage of Medicare patients, at 45 percent. Only 70 percent of the services offered by nonprofit hospitals are "common" services, defined as a service offered by at least 3,000 hospital/years in the sample. This is the lowest percentage among the ownership types, indicating that nonprofit hospitals are offering the broadest scope services. Residencies are offered by about half of nonprofit hospitals, second only to local hospitals. Nonprofits' HSAs have the lowest average percent poor and the second-highest median household income, quite close to for-profits.

District hospitals are small, traditionally rural hospitals. They have the smallest number of staffed beds, 126, and offer the lowest number of services, 53. District hospitals are the second largest provider for MediCal patients, behind local hospitals. Over 75 percent of district hospital services are "common services," second only to for-profits. Districts are least likely to offer residencies, and are by far the most rural. Over 57 percent of district hospitals are classified as rural, almost 5 times the other types' rates. Accordingly, district hospitals have the lowest average population in the HSA, the lowest median income, and the lowest percent black.

Local hospitals are commonly very large teaching hospitals. These hospitals have the largest average number of beds, at 264, and offer about 57 services. These hospitals serve the greatest percentage of MediCal patients, at over 52 percent, and the least number of Medicare patients. The mix of services offered is slightly less diverse than nonprofits but broader than the other two classes. Local hospitals are by far the most likely to offer a residency program, with 82 percent of the local hospital observations doing so. Local hospitals are in populous HSAs, second only to for-profit hospitals, but have a lower median household income.

The differences in outsourcing behavior among ownership types motivates a further investigation, but the important differences in observables means that a careful econometric approach will be required to assure that the differences in outsourcing is not being driven entirely by differences in circumstance. The following section provides that analysis.

Table 1: Summary Statistics by Ownership Type, Weighted by Number of Services.

	For-Profit	Private NP	District	Local
Percent Outsourced	25.72	19.00	20.61	18.03
	(33.94)	(28.65)	(30.44)	(27.75)
Service Completely Out	0.0558	0.0293	0.0449	0.0228
	(0.229)	(0.169)	(0.207)	(0.149)
Service Any Out	0.864	0.865	0.868	0.873
	(0.343)	(0.341)	(0.338)	(0.333)
Staffed Beds	143.5	221.7	126.3	264.0
	(92.75)	(148.9)	(106.8)	(208.3)
Services Offered	53.69	58.05	52.60	56.68
	(8.725)	(9.887)	(10.42)	(7.739)
Pct. MediCal	26.48	20.13	38.49	52.90
	(21.58)	(15.85)	(25.64)	(13.76)
Pct. Medicare	42.76	45.20	37.01	16.17
	(18.59)	(14.00)	(19.44)	(10.89)
Common Service	0.771	0.706	0.758	0.724
	(0.420)	(0.456)	(0.428)	(0.447)
Residency Program	0.387	0.469	0.347	0.820
	(0.487)	(0.499)	(0.476)	(0.384)
Rural	0.0521	0.125	0.578	0.119
	(0.222)	(0.331)	(0.494)	(0.324)
Pop. in HSA	503049.3	337824.1	131155.2	421916.3
	(641006.4)	(425820.2)	(170481.8)	(487000.6)
Pct. Black in HSA	6.890	5.211	3.230	7.838
	(7.987)	(6.307)	(4.237)	(9.718)
Pct. Poor in HSA	14.48	13.16	14.68	14.99
	(6.916)	(6.056)	(6.232)	(6.328)
med. HH Earn in HSA	45855.9	45759.4	38008.1	42390.2
	(15260.6)	(14594.3)	(11241.9)	(12924.7)
HS Grad in HSA	21.24	21.76	25.07	22.02
	(5.028)	(5.842)	(5.684)	(5.341)
Some Col. in HSA	25.75	26.65	27.44	25.78
	(8.403)	(8.984)	(9.402)	(9.240)
Pct Bach. in HSA	15.93	16.69	12.29	14.22
	(6.636)	(7.457)	(5.630)	(7.273)
Pct Grad/Prof in HSA	7.958	8.562	5.796	7.192
	(4.793)	(6.036)	(3.385)	(4.296)
County Unemp.	5.846	6.316	7.891	7.486
	(1.871)	(2.377)	(3.871)	(4.049)
n	62k	134k	28k	15k

Sample means and standard deviations in parentheses at the service x hospital x year level.

4 Econometric Specification and Results

4.1 Econometric Specification

Conditional on the decision to outsource the service to any degree, we model the underlying preference for outsourcing intensity as

$$(1) \qquad log(PctOut_{hst}) = \sum_j \beta_j Own^j_{ht} + \gamma_{1s} + \gamma_{2s} Output_{hst} + \Gamma X_{ht} + \epsilon_{hst},$$

where the dependent variable is the natural log of the percent of costs due to outside contracts, Own^j_{ht} is a dummy taking a value of 1 if hospital h is of ownership type j in year t, the γ's are service-specific intercepts and output slopes, and X_{ht} is the set of controls described in section 3.2, as well as county-specific and year-specific intercepts. The sample statistics suggest that the primary difference among ownership types comes from differences in this margin, the intensity of outsourcing.

In fact, we observe the choice of intensive margin only in the cases where the hospital decides to outsource at all, a selected sample of the population. Naively dropping those observations and ignoring the sample selection can lead to biased estimates, so we need to model the extensive margin, as well–whether to outsource at all–even if our primary interest is in outsourcing intensity. Let y_{sht} represent the payoff to firm h in year t from outsourcing service s at the profit-maximizing intensity level, relative to the zero-normalized payoff of producing that service entirely in house. The true payoff is unobservable, but our empirical model for this outsourcing payoff is

$$(2) \qquad y_{hst} = \sum_j \beta_j Own^j_{ht} + \gamma_{1s} + \gamma_{2s} Output_{hst} + \Gamma X_{ht} + \epsilon_{hst},$$

where the independent variables are identical to those in (2). Under joint normality, the bias of our intensity estimate can be corrected by jointly estimating equations (2) and (1) using a maximum likelihood estimator (Heckman 1979). In fact, as we will see below, the evidence is that this bias is not significant, and the naive estimates are extremely close to the corrected estimates.

Finally, there is a question of which covariates are appropriate to include as control variables. On the one hand, we know that for-profit hospitals and the various types of non-profits are dissimilarly situated, on average, in terms of economic environment, patient mix, and even scale and scope of operations. These difference are quite apparent in the sample means, and these factors may be correlated with the attractiveness of outsourcing

for reasons unrelated to the ownership form of the hospital. Thus, we may want to control for these factors in order to contrast the various nonprofit forms to a hypothetical similarly-situated for-profit hospital. Failing to do so may result in biased estimates, since outsourcing differentials may result from these third factors that are correlated with ownership.

On the other hand, the dissimilar situations did not arrive by happenstance. Instead, they often result from hospitals of different ownership types making different business decisions. To take one example, consider the hospital's decision to operate in an urban market. We know that, on average, for-profit hospitals are more likely to operate in urban markets than, especially, their district hospital counterparts. If part of the reason they do this is because for-profit hospitals want to avail themselves of the thicker markets for outsourcing services in urban areas, then the decision to locate in an urban area is an intermediate outcome to the decision to outsource at higher rates. If this is the case, then urban location is an inappropriate control and including it will introduce bias. Put another way, if for-profits hospitals have some unmodelled reason to prefer locating in urban locations, then those for-profit hospitals that choose to operate in rural areas have some unusual (unobserved) characteristic. Thus, they are not actually similarly situated to rural district hospitals, which do not need some unusual characteristic to choose a rural setting. This induced difference becomes a problem whenever that unobserved characteristic also influences the attractiveness of outsourcing.

We believe that the omitted variable problem induced by having too few controls is more severe than the intermediate-outcome problem, and we will, therefore, present regression estimates including the full set of controls outlined. We also perform our estimates for a smaller set of controls that are plausibly beyond the control of the firm, omitting the controls for patient mix, residency, number of beds, number of services, and service-specific output. These estimates are less likely to suffer from the intermediate-outcome problem and consistently result in larger differences (results in Tables 13-16, not for publication). The sample means, of course, reflect the uncontrolled differences.

4.2 Differences in Overall Outsourcing Levels

Table 2 shows the results of the full estimation of the Heckman selection model and from a Fixed-Effects OLS estimate of the intensity of services outsourcing. The coefficients report marginal effects, calculated at the mean of the covariates. The first thing to note is the similarity of the OLS and Heckman results. They are essentially indistiguishible, suggesting that the naive approach where we limit our attention to services that are outsourced at all is not leading to major biases. This result is not too surprising, given that about

87-percent of service-hospital-year observations are outsourced to some extent and we are already controlling for many of the factors that might guide that decision. Given the high level of similarity, for the rest of the analysis we will ignore selection and simply present OLS results, for brevity.

The more substantive results are generally in accord with the first basic prediction of the model about outsourcing differences. Nonprofit hospitals outsource over 8 percent less than similarly-situated for-profits.[13] District hospitals are similar to private nonprofits, outsourcing about 11 percent less intensely than their for-profit counterparts . Local hospitals are the least intense outsourcers of all, outsourcing about 33 percent less intensely than similarly-situated for-profit hospitals.

The hospital-level control variables relate to outsourcing in the ways we might expect. Larger hospitals, either in terms of number of services or in terms of number of staffed beds, outsource less intensely on average. Neither patient mix nor having a residency program is associated with outsourcing intensity. Demographic variables are only rarely significant in the either of these regressions, likely because most important differences are already controlled for with county fixed effects. Since this will be generally true throughout, we will not always report these coefficients.

4.3 Outsourcing and the Importance of Specific Services

Our model of outsourcing behavior implies bigger differences among ownership types when control over the services is particularly important to the manager. This implication is made explicit in Proposition 2, where the difference between nonprofit and for-profit outsourcing behavior should increase in the importance of production bias. In this section, we will test that implication by looking at how outsourcing decisions vary by service. In particular, the literature has identified two sorts of services that might be particularly important to the manager: services that are important to elite workers, since those workers might influence the manager, and services that are particularly labor-intensive, since those services could potentially be salient political overseers and regulators (Alesina, Baqir and Easterly 2000, Clark and Milcent 2011). We will investigate each.

The literature on the behavior of nonprofit hospitals focuses on physicians, in particular, as likely candidates employees with strong influence on the manager. As Glaeser (2003) puts

[13]It is possible that some subset of the nonprofits in our sample are simply "for-profits in disguise", by somehow evading the non-distribution constraint. Here, and throughout, the existence of such firms would attenuate our estimated differences, as compared to the actual difference between truly constrained nonprofits and their unconstrained for-profit counterparts.

Table 2: Outsourcing and Ownership Type

	(1) OLS	(2) Heckman
Non-Profit	-0.086^{*}	-0.086^{*}
	(0.046)	(0.045)
District	-0.115^{*}	-0.116^{*}
	(0.068)	(0.068)
Local	-0.399^{***}	-0.399^{***}
	(0.089)	(0.089)
Log Staffed Beds	-0.105^{***}	-0.106^{***}
	(0.036)	(0.036)
Log (Services)	-0.180	-0.168
	(0.151)	(0.150)
Rural	0.008	0.009
	(0.067)	(0.067)
Pct. MediCal	0.001	0.001
	(0.001)	(0.001)
Pct. Medicare	0.000	0.000
	(0.001)	(0.001)
Pop. in HSA	-0.000	-0.000
	(0.000)	(0.000)
Pct. Black in HSA	0.004	0.004
	(0.003)	(0.003)
County Unemp.	-0.006	-0.006
	(0.009)	(0.009)
Pct. Poor in HSA	-0.006	-0.006
	(0.005)	(0.005)
HS Grad in HSA	-0.002	-0.002
	(0.004)	(0.004)
Some Col. in HSA	-0.005	-0.005
	(0.003)	(0.003)
med. HH Earn in HSA	0.000	0.000
	(0.000)	(0.000)
Residency Program	0.025	0.024
	(0.036)	(0.036)
county FE	yes	yes
service FE	yes	yes
service-specific output	yes	yes
Observations	200k	232k

OLS and Heckman models with dependent variable of natural log of the percent of costs that are expended on outside contracts. All regressions include county fixed-effects, service fixed-effects. Standard errors, clustered by hospital, in parentheses. $***$ $p < 0.01$, $**$ $p < 0.05$, $*$ $p < 0.10$. Dependent variable excludes all physician services costs, regardless of contracting type.

Table 3: Outsourcing Differential by Physician- and Labor-Intensity

	(1) Physician	(2) Labor
Non-Profit	−0.063	−0.079*
	(0.045)	(0.044)
District	−0.097	−0.088
	(0.071)	(0.069)
Local	−0.374***	−0.356***
	(0.086)	(0.084)
Non-Profit x Physician Intensive	−0.181***	
	(0.059)	
District x Physician Intensive	−0.146	
	(0.098)	
Local x Physician Intensive	−0.182	
	(0.132)	
Non-Profit x Labor Intensive		−0.074
		(0.065)
District x Labor Intensive		−0.247**
		(0.098)
Local x Labor Intensive		−0.390**
		(0.180)
Hospital Controls	yes	yes
HSA Controls	yes	yes
county FE	yes	yes
service FE	yes	yes
service-specific output	yes	yes
Observations	200k	200k

Dependent variable is the natural log of the percent of costs that are outside contracts. (d) indicates a dummy variable. Standard errors, clustered by hospital, in parentheses. $***$ $p < 0.01$, $**$ $p < 0.05$, $*$ $p < 0.10$. Dependent variable excludes all physician services costs, regardless of contracting type.

it, "the modern hospital is an outcome of the increasing power of doctors, who shaped the hospital toward their own interests." At the extreme, Pauly and Redisch (1973) model the hospital directly as a physician's cooperative. We need not go that far, however, and merely require that physicians can have some substantial influence on the induced preferences of the manager, especially in domains about which they have big informational advantages and strong incentives to influence. To identify these sorts of service, we rank each service by its degree of physician intensity, the average fraction of total direct costs attributable to physician and student expenses.[14] We designate the services in the top quintile as "physician-intensive services".[15]

But even non-elite workers may have influence, at least indirectly (through elected officials, regulators or unions). Especially in the case of local hospitals, which are buried within the city or county government, it could be a desire by those political principals to disguise redistribution as public employment (Alesina et al. 2000), a mechanism for "Keynesian" employment policy, simple political patronage, or even capture by organized labor. Thus, we may expect services for which labor makes up a substantial share of the costs to be particular important to the manager to control. We identify labor-intensive services using a measure similar to what we constructed to measure physician-intensive services. For each service in each hospital in each year, we calculate the percent of direct costs represented by wages and benefits. Since some outsourcing also includes labor costs, this measure represents a minimum of the labor share of costs, but it is an underestimate for services that are significantly outsourced. For this reason, we construct two other measures of labor intensity: the share of non-outsourced direct costs represented by wages and benefits and the share of total direct expenses represented by wages, benefits, and contracts without outside providers. The latter of these measures is an upper bound on the true labor intensity, while the second metric will lie between the other two. For each of the three metrics, we find the average labor intensity for every service over all hospital/year observations, and rank the services using each measure. Finally, we define a service as labor intensive if it is among the top third of services

[14]We used an alternative proxy in a prior version of this paper, where we followed the OSHPD division of services into revenue-generating and non-revenue-generating subsets. Revenue-generating services are those for which the hospital bills insurance and patients, thus these services are generally medical services, where physicians may have a greater impact on management policy. Non-revenue generating services are services which the hospital must provide for its operations, like groundskeeping, parking, and accounting, but for which the hospital does not generally charge. The results are quite similar for this proxy of physician-intensity. These results also, broadly, square with some results broadly contrasting clinical and non-clinical costs at the hospital level (Balakrishnan et al. 2010).

[15]Physician-intensive services include pediatric intensive care, neonatal intensive care, adult psychiatric acute care, physical rehabilitation care, emergency services, clinic services, satellite clinic services, psychiatric partial hospitalization, anesthesiology, pathological lab services, cardiology services, electromyography, electroencephalography, pulmonary function services, psychiatric therapy, and medical staff administration.

in each of the metrics. If all the labor-intensity metrics were identical, this procedure would identify 28 services, but since the ranking differs to some degree among the rankings, only 14 services meet all three criteria.[16] We feel confident that all the services we so identify are, in fact, labor intensive, but we have probably missed a number of labor-intensive services, particularly those that are outsourced to a high degree, because they would probably fail to satisfy the first criterion.[17]

Table 3 presents the results for variants of regression equation (1), where ownership type is interacted with an indicator for whether the service is physician intensive (in column (1)) or labor intensive in column (2)). The coefficients on the non-interacted ownership dummies represent the relationship between ownership and outsourcing for non-intensive services, while the sum of the coefficients on the interacted and non-interacted dummies represent the relationship for intensive services. If physician-intensity is a good proxy for the importance of control of the service to elite workers (pace labor intensity), and our model is correct, we should see bigger differences in outsourcing for the physician-intensive services. We will discuss each service and ownership type in turn.

Consider, first, the results for physician intensity. For non-intensive services, there are no statistically-significant differences between the outsourcing intensity of for-profit hospitals and either private non-profits or district hospitals. The local hospitals, by contrast, do outsource even the non-physician-intensive services at much lower rates than all other ownership types. For physician-intensive services, by contrast, all three types of nonprofits outsource much less intensely than their for-profit counterparts, and the differences range from about 20 percent for the private nonprofits and district hospitals, up to over 40 percent for the local public hospitals. The differences are statistically significant and large. As our model predicts, the difference between the nonprofit firms' outsourcing intensity and their for-profit counterparts' outsourcing intensity is much larger for physician-intensive services than it is for non-physician-intensive services. The gap in outsourcing intensity is between 15 and 20 percent bigger for physician-intensive services, although the result is statistically significant in the case of private nonprofits, only.

Consider, now, the results for labor intensity. The pattern of outsourcing differences for non-labor-intensive services is similar to that for non-physician-intensive services, with small differentials for the private and district non-profits and large differentials for the local hospitals. The differential pattern for labor-intensive services, however, is quite different

[16]They are: Intensive Care, Coronary Care, Definitive Observation, Acute Care, Psychiatric Acute-Adult, Alternate Birthing Center, Physical Rehabilitation, Sub-Acute Care, Skilled Nursing Care, Observation Care, Social Work Services, Outpatient Registration, Nursing Float Personnel, and Utilization Management.

[17]Expanding the definition to include all services that meet two of the three criteria does not substantially alter our results.

from what we observed for physician-intensive services. For private non-profits, there are small and statistically-insignificant differences between the outsourcing differential of labor-intensive and non-labor-intensive services. Both classes of public hospitals, by contrast, outsource labor-intensive services at a much lower intensity, as compared to their for-profit counterparts, than they do non-labor-intensive services. The magnitudes are quite large, between 20 (district) and 40 (local) percent, and strongly statistically significant.

To sum up, the pattern of outsourcing intensity suggests that, in addition to having different mean levels of outsourcing intensity, the managers of public and private non-profits also seem to be particularly interested in maintaining control of different subsets of services. If we think of outsourcing as a cost-control tradeoff, private non-profits are maintaining control of services that are physician-intensive, and act quite similar to for-profits for non-physician-intensive services. Public hospitals also maintain increased control of, but they also outsource non-physician-intensive services less intensely than for-profits do. The pattern for labor-intensive services is quite different, with only the public firm appearing to be especially interested in maintaining control of labor-intensive services. To take a simple example, all non-profit firm types maintain (relatively) tighter control of neo-natal intensive care than they do of groundskeeping, but public hospital also keep a tighter hold on social-work services and skilled nursing care, while private non-profits do not.

Taken together, these results illustrate three points. First, nonprofit and for-profit responses to physician-intensity and labor-intensity are distinct. Note how this contrast differs from a comparative static exercise of comparing outsourcing rates across services within an ownership class, as Coles and Hesterly (1998), Lopez de Silanes et al. (1997), or Levin and Tadelis (2010) do. We can say not only that non-profits respond to physician- and labor-intensity, but also that they respond for reasons distinct from profit motivation.

Second, nonprofit and public responses to non-physician-intensity are also distinct. Whatever is driving the difference between public and for-profit outsourcing rates, it does not seem to be the same thing that is driving the difference between public and for-profit rates, or at least it is not the only thing. In our model, the services for which control is important may be different for public hospitals than for private nonprofits, and how public hospitals bias production is not entirely captured by physician intensity. In fact, public hospitals outsource considerably less than private nonprofits for both service types, so another factor must be at work.

Finally, nonprofit and public responses to labor-intensity are distinct. Public hospitals are distinctly interested in controlling labor-intensive services, while private non-profit exhibit no such pattern. Thus, this is not simply a results of a nonprofits lack of residual claimancy,

a feature both types share. There is some evidence that public hospitals are particularly sensitive to labor. Clark and Milcent (2011) find, for example, that public hospitals in France react to rises in local unemployment rates by increasing employment, while private nonprofit hospitals show no similar pattern. We document another effect of public hospitals apparent interest in control of labor–it can lead them to draw the boundaries of the firm in a way that differs from both for-profit firms and private non-profits.

4.4 Outsourcing After a Fixed-Cost Shock

According to Proposition 2, if outsourcing is a tradeoff between cost and control of production, the decisions of the different firm types should become more similar as the budget tightens. This prediction arises directly from the concavity of the nonprofit's utility from perquisites. If there is a large fixed cost shock, the amount available to spend on perquisites is relatively low, and the marginal value to the nonprofit firm of an extra dollar to spend on perquisites is high.

We use a change in regulatory requirements enacted in California in 1994 to capture a fixed-cost shock. This regulation (SB 1953) required short-term general care hospitals in earthquake zones to meet relatively strict engineering standards. The regulation went into effect in 1998, and the first deadline for meeting the loosest standard (no SPC-1, extremely vulnerable, buildings) was January 2008. A stricter standard (no SPC-2, vulnerable, buildings) was mandated for January 2030. For many hospitals, meeting this requirement involved very extensive retrofitting of existing buildings, and most have preferred to construct new buildings, at costs of tens to hundreds of millions of dollars (Meade and Hillestand 2007). The hospitals should, thus, have been aware of existence of the shock throughout our sample period, although they may have learned over time about their exact cost.

The actual costs incurred to retrofit or construct new buildings that meet the mandate will be endogenously determined by the firm, but we proxy for the underlying exogenous cost shock by the peak ground acceleration in the location– a measure of earthquake risk (Meade, Kulick and Hillestand 2002). Peak ground acceleration is the maximum fraction of the acceleration of gravity that will occur with a 10-percent probability over the next 50 years. See Chang and Jacobson (2011) for an extensive discussion of the implementation of the mandate, and an overview of the relationship between peak ground acceleration and costs.[18] The peak ground acceleration of hospitals in our dataset ranges from 0.05 to 1.15. The distribution is centered around the mode of 0.45 and falls off evenly to either side, with a standard deviation of 0.21. The four ownership types have similar peak ground acceleration

[18]Chang and Jacobson provided us with this acceleration measure, for which we are very grateful.

average values, about 0.50.

Table 4 presents the results a variant of regression equation (1) in which we interact ownership type with the peak ground acceleration experienced by the hospital. The prediction is that the difference between nonprofit and for-profit hospitals should be most marked when acceleration is small (and the cost shock is least severe). Column (1) presents the results on the full sample of services, while the remaining columns break the services into sub-samples with respect to physician- and labor- intensity.

The cost shock regressions in Table 4 support our model's predictions. The non-interacted ownership indicators are the predicted difference in outsourcing intensity between the indicated ownership type and a for-profit for a hypothetical hospital that experienced no earthquake risk. In the full sample, low-shock nonprofits outsource between 20 percent less intensely (private nonprofit) and 40 percent less intensely (local public) than low-shock for-profit hospitals. The large positive coefficients on the ownership types interacted with the shock show that the expected outsourcing differential shrinks as the cost shock grows, although none of the interactions are statistically signifi cant in the full sample. The relationship between cost shocks and outsourcing differentials is best seen in figures. Figure 4 shows the predicted outsourcing difference between hospitals of the indicated ownership type and a similarly situated for-profit hospital as a function of the size of the fixed cost shock. The solid line shows the expected difference, and the dotted lines are 95-percent confidence intervals. A negative number along the vertical axis means that hospitals of the indicated type outsource less intensely than similarly-situated for-profits do. As peak ground acceleration grows, the predicted difference approaches zero for all three ownership types. At the mean peak ground acceleration (0.5), we can strongly reject the null of no difference for the local hospitals, and marginally so for private nonprofits and district hospitals. By the time we reach the maximum peek ground acceleration in our sample (1.15), only local hospitals show predicted outsourcing less than for-profit hospitals.

Turning to the service-type subsamples, the model predicts a stronger relationship between cost shocks and outsourcing for the services where control is more important. For both labor-intensity and physician intensity, the non-interacted results are completely consistent with the findings in the previous section: low-shock private non-profits and local hospitals differentially keep control of physician-intensive services and low-shock local public hospitals differentially keep control of labor-intensive services. As the shock grows, private nonprofits and local hospitals come to outsourcing physician-intensive services and local hospitals outsource labor-intensive services more and more like for-profits do. These effects are much bigger than they are for non-physician-intensive or non-labor-intensive services. Again, private non-profits do not seem differentially responsive to cost shocks for labor intensive

Table 4: Outsourcing and Seismic Cost Shocks

		Physician		Labor	
	(1)	(2)	(3)	(4)	(5)
	Full Sample	Intensive	Not	Intensive	Not
Non-Profit	-0.224^{**}	-0.547^{***}	-0.177	-0.191	-0.224^{**}
	(0.111)	(0.207)	(0.116)	(0.231)	(0.113)
District	-0.233	-0.111	-0.254	-0.356	-0.218
	(0.145)	(0.232)	(0.157)	(0.243)	(0.154)
Local	-0.563^{**}	-0.963^{**}	-0.489^{*}	-1.499^{***}	-0.433^{*}
	(0.262)	(0.412)	(0.262)	(0.576)	(0.261)
Non-Profit x Acc	0.265	0.819^{**}	0.183	0.162	0.272
	(0.209)	(0.404)	(0.215)	(0.440)	(0.211)
District x Acc	0.222	-0.253	0.293	0.204	0.228
	(0.289)	(0.423)	(0.309)	(0.492)	(0.294)
Local x Acc	0.332	0.827	0.243	1.370	0.183
	(0.438)	(0.689)	(0.436)	(0.909)	(0.433)
Peak Acceleration	-0.108	-0.478	-0.051	-0.318	-0.076
	(0.224)	(0.395)	(0.232)	(0.447)	(0.228)
Hospital controls	yes	yes	yes	yes	yes
HSA controls	yes	yes	yes	yes	yes
county FE	yes	yes	yes	yes	yes
service FE	yes	yes	yes	yes	yes
service-specific output	yes	yes	yes	yes	yes
n	198k	27k	172k	23k	177k

Dependent variable is the natural log of the percent of costs that are outside contracts, and includes only those observations with positive outsourcing. HSA controls include population, percent black, percent poor, median household earnings, and four educational mix variables. (d) indicates a dummy variable. Standard errors, clustered by hospital, in parentheses. $***$ $p < 0.01$, $**$ $p < 0.05$, $*$ $p < 0.10$. Dependent variable excludes all physician services costs, regardless of contracting type.

services. Throughout, we can find no significant results for district hospitals (although the full-sample results are marginal), perhaps because they make up a relatively small fraction of the hospitals. Again, we present these results graphically in Figure 5 (for physician-intensity) and Figure 6 (for labor-intensity).

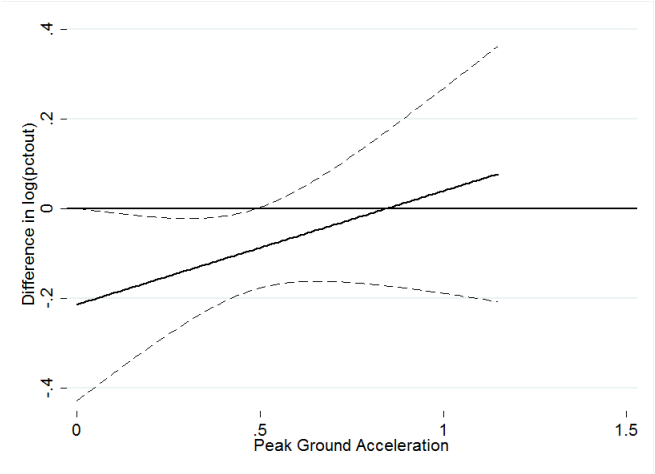
The final point to note is that the seismic cost shocks do not seem to be strongly correlated with the outsourcing intensity of the for-profit firms, as the uninteracted effect of peak acceleration is never significant (although in the case of labor- and physician-intensive services, it is quite large). This is consistent with a simple model of the (null) effect of fixed-cost on profit maximization.

5 Alternative Explanations

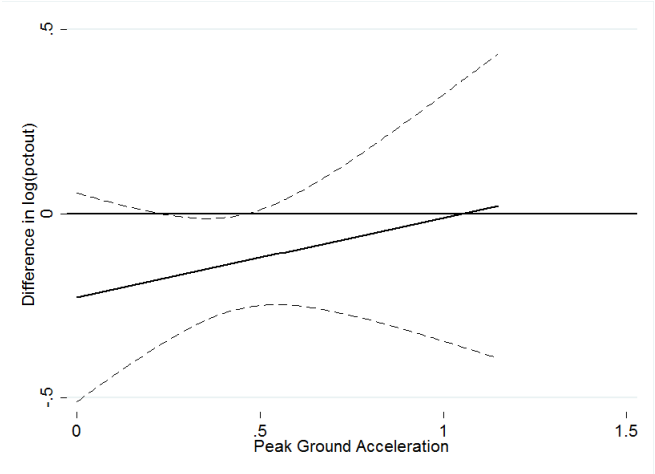
Although we believe that the different trade-off between net revenues and production bias induced by the non-distribution constraint is the best explanation of the outsourcing pattern that we observe, we recognize that alternative explanations exist. In this section we consider several leading candidates.

Nonprofits may simply have a bigger in-house production possibility frontier. Maybe the employees of nonprofits are more intrinsically motivated and donate labor, because they agree with the mission, which lowers the cost of performing services in-house. Maybe the tax advantages lowers the real cost of in-house production. But if this story is driving the observed patterns, why do nonprofits' outsourcing decisions conform more with for-profits when times are tough? If it is simply a difference in production constraints, and not a difference in the marginal willingness-to-substitute between cost and production bias, we should see for-profit and nonprofit firms respond similarly to fixed-cost shocks, but they do not.

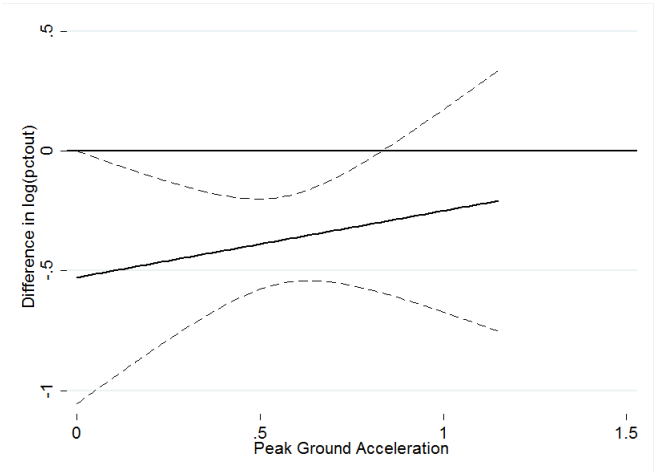
Alternatively, outsourcing could involve a non-monetary management effort. The firm uses costly time and expertise to go out and cultivate a good relationship with a service provider. Since money is less valuable than time or effort to nonprofits, relative to the for-profit (on the margin), nonprofits are less likely to want to make this investment in provider relationships. This story could be captured in our model, where the production bias here is simply managerial effort slack. This alternative explanation could emerge from the exemption of teaching hospitals from the prohibition of directly employing physician labor. If teaching hospitals are more likely to be nonprofit, this may lead to less contracting experience disproportionately for nonprofits. This interpretation of management effort is inconsistent with the data, however, at least for private non-profits, because this inexperience/managerial



(a) Non-Profit

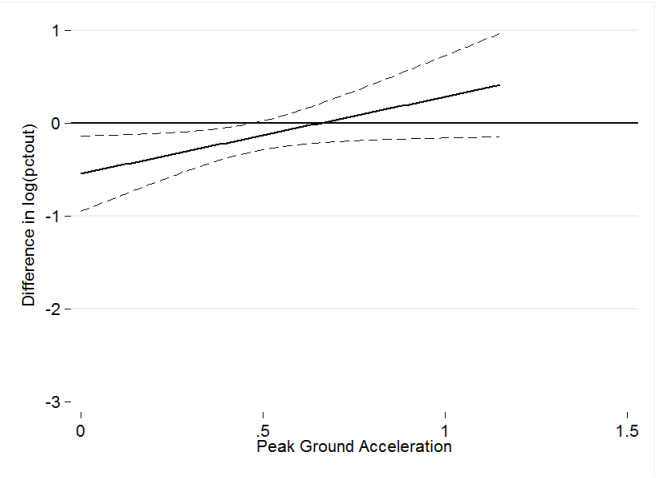


(b) District

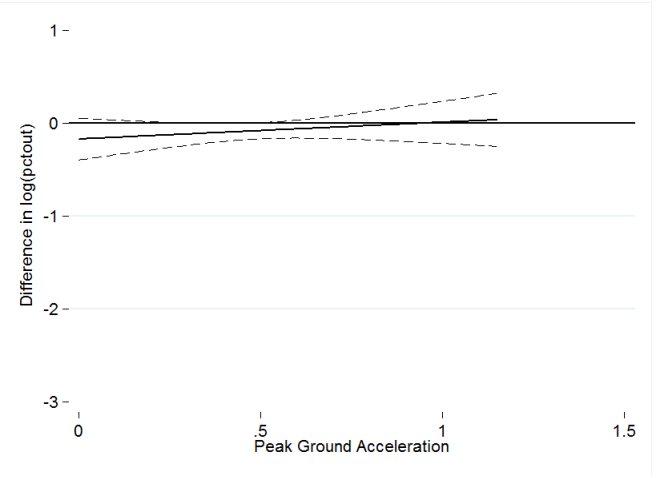


(c) Local

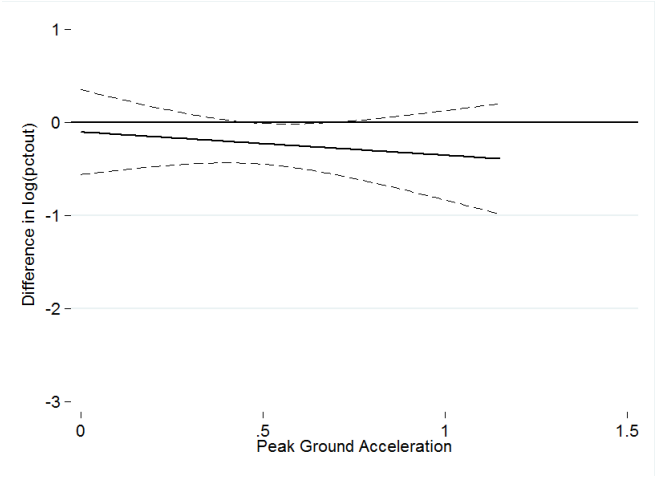
Figure 4: Intensive Margin Ownership Effects as Function of Cost Shocks



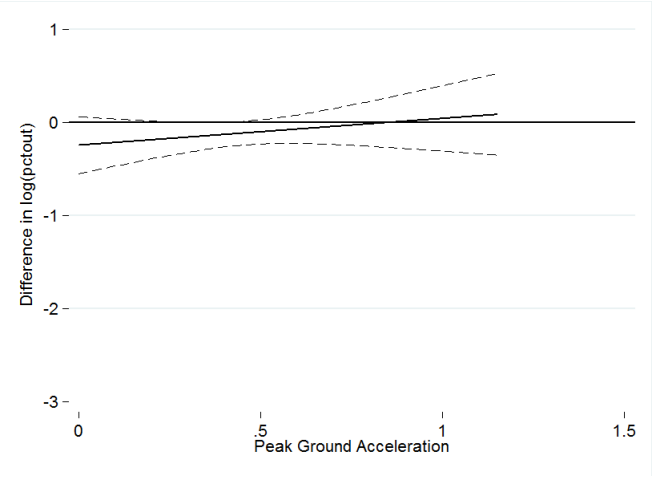
(a) Non-Profit, Intense



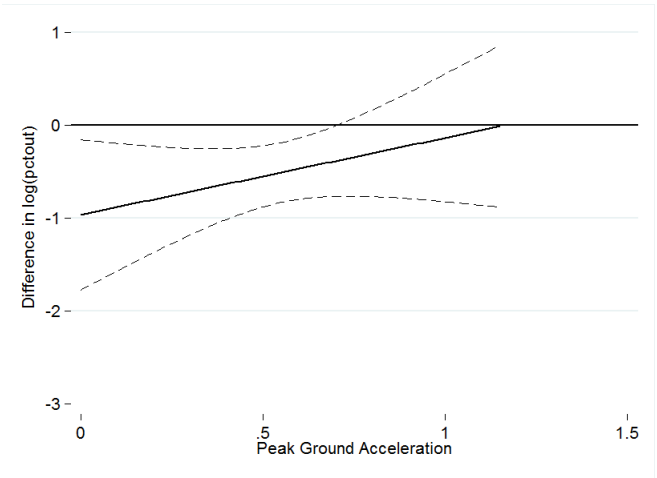
(b) Non-Profit, Not Intense



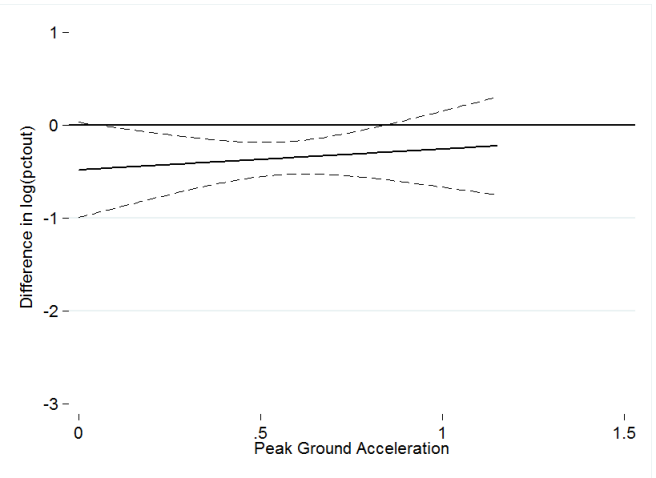
(c) District, Intense



(d) District, Not Intense

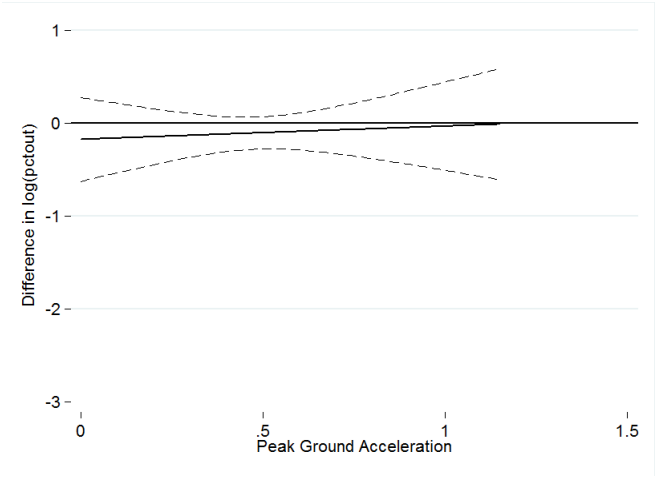


(e) Local, Intense

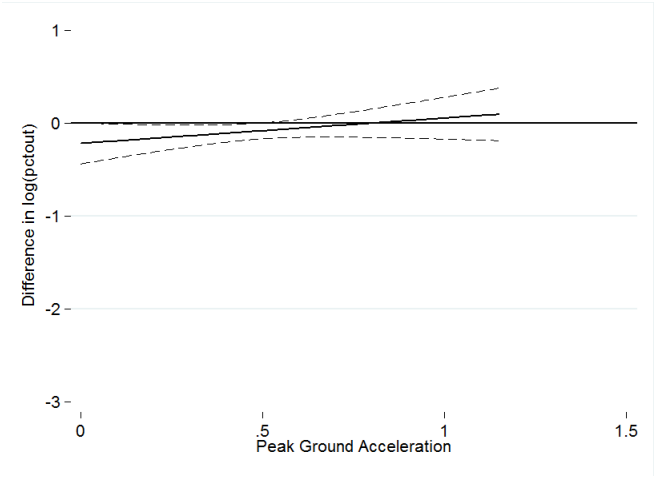


(f) Local, Not Intense

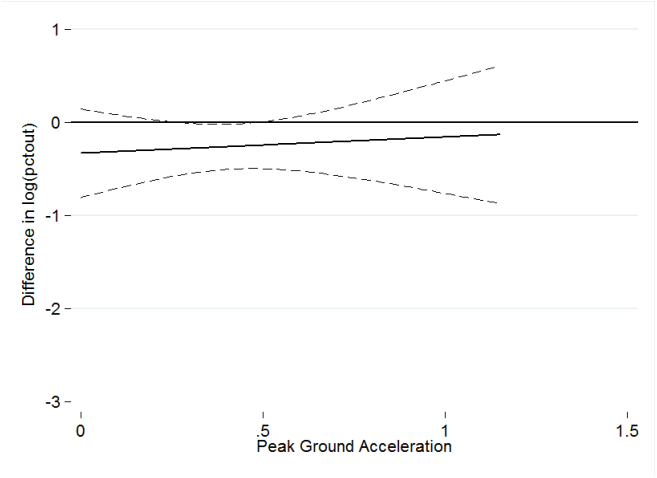
Figure 5: Ownership Effects as Function of Cost Shocks and Physician Intensity



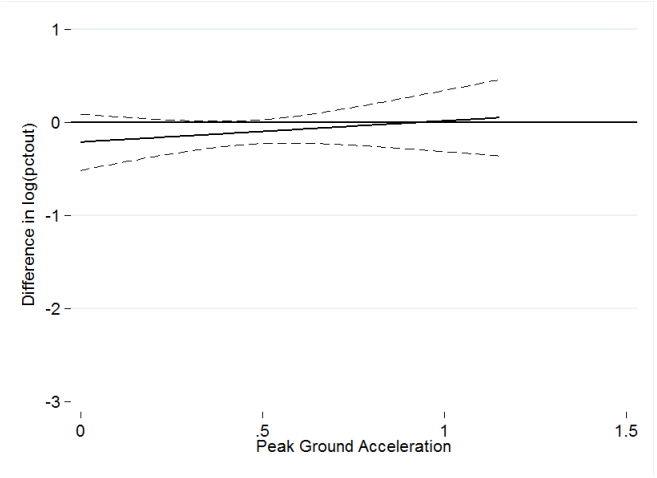
(a) Non-Profit, Intense



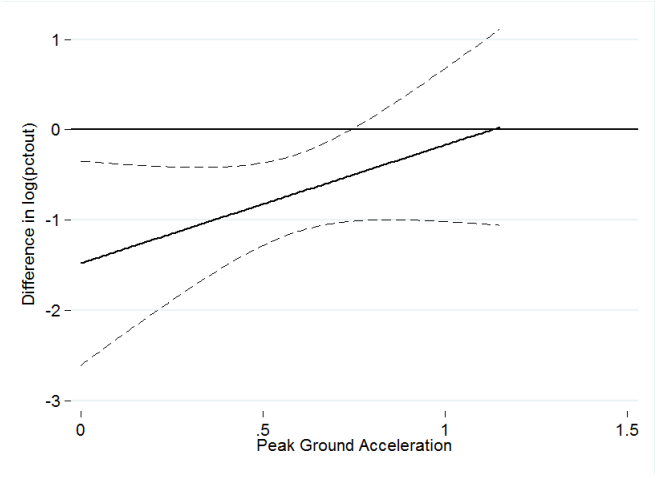
(b) Non-Profit, Not Intense



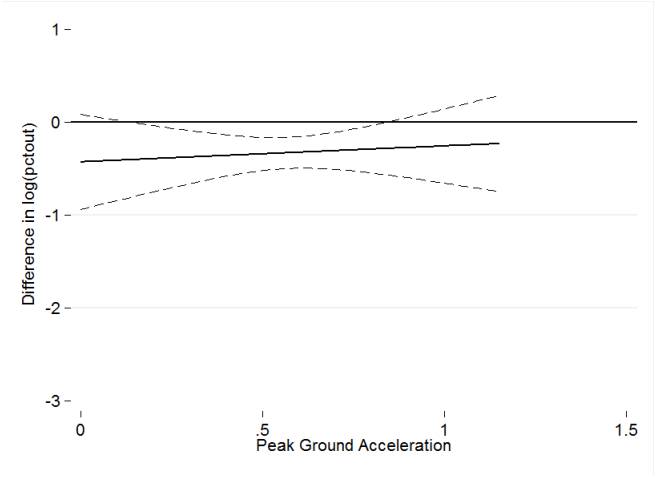
(c) District, Intense



(d) District, Not Intense



(e) Local, Intense



(f) Local, Not Intense

Figure 6: Ownership Effects as Function of Cost Shocks and Labor Intensity

slack would have to manifest itself only in selective portions of the hospital's contracting of services outside of physician employment. In the data, nonprofits seem just as willing as the for-profits to put in the managerial effort to outsource non-physician-intensive services, like grounds and maintenance or accounting service.

One other difference between nonprofits and for-profits that we have not explored is the firm's ability to access credit markets. Since nonprofits are not able to issue equity, they have a restricted set of instruments available to generate cash. If nonprofits have a hard time getting trade credit from suppliers, they may prefer the constant, certain cost of employment over the fluctuating costs of contracting. This explanation, however, is inconsistent with the attractiveness of outsourcing increasing as the budget gets tighter and free cash, presumably, declines. If doing services in-house minimizes cash demands, nonprofits should bring even more services in-house when a cost shock makes cash even more valuable. We observe the opposite.

A related concern is that nonprofits garner a significant fraction of their capital from endowments, financed by donors. Maybe donors like to buy capital goods, rather than fund contracts to outside providers. Once the capital is in place, the benefit of outsourcing the labor, alone, is small. However, this explanation is inconsistent with the pattern we see in the outsourcing of labor-intensive services. For public hospitals, we know that labor-intensive services are relatively less intensively outsourced, but for private nonprofits there seems to be no difference in relative outsourcing between labor-intensive and non-labor intensive services. These patterns suggest that the labor/capital mix has little to do with outsourcing decisions (in the private nonprofit case) or goes the "wrong way" (in the public case).

Finally, there could be a sample selection story. Maybe some services are profitable for a small hospital to offer only if outsourcing opportunities exist. Nonprofits offer these services whether the services are profitable or not, while for-profits only offer them if they are profitable (Horwitz 2007). If this were the case, we would see these particular services being differentially done in-house by nonprofits, even though if all hospitals offered them, outsourcing rates would be similar. To check this, we limit our investigation to a subsample of services that are offered by nearly all hospitals, yet the size/significance of the relationships we identify are quite similar. If the outsourcing patterns were mostly a selection story, we should see these differences get much smaller in the non-selected sample.

6 Conclusion

We find that private nonprofit, public, and for-profit hospitals consistently and significantly differ in the extent to which they outsource services. Controlling for a variety of potential confounders, nonprofit and district hospitals outsource less than for-profits, and local hospitals outsource least of all. The difference between nonprofits and for-profits seems to be driven by services for which control of the manner of production is particularly important. The sort of services for which control is important seems to differ between public and private nonprofits, however. Finally, all types of nonprofit hospitals come to look more like for-profits if they are hit with a large fixed-cost shock, such as an expensive seismic retrofitting requirement. For the private nonprofits, all of these results are consistent with a model in which a non-distribution constraint leads nonprofits to trade off between costs and control at a different rate than for-profits do. The private nonprofit differential seems to be driven primarily by physician-intensive services, suggesting the elite workers may be influencing managers to keep control of the services that are important to them, but that does not seem to be the complete story for local public hospitals. Instead, it looks like public hospitals also prefer to conduct labor-intensive services in house, suggesting the public managers (are induced to) value control over labor per-se. All these differences are tested on services excluding physician costs, so differences in behavior are from choices outside of physician contracting legislation.

These findings shed new light on two literatures: the determinants of the make-or-buy decision in organizations other than traditional profit-maximizing firms and the differential behavior of nonprofit versus for-profit versus public firms.

We provide the first empirical demonstration that there is an economically significant divergence between the way for-profit firms draw their firm boundaries and the way that similarly-situated nonprofit and public firms do. This difference occurs both in terms of levels and in terms of how the boundaries move in response to cost shocks. Furthermore, it is not simply a difference between nonprofit and for-profit firms, because the difference between public nonprofits and private nonprofits is just as big as the difference between private for-profits and private nonprofits. In brief, if we think about outsourcing as a tradeoff between cost and control over the manner of production, nonprofits seem to value cost relatively less and control relatively more, at least as long as the nonprofit is not too close to its shut-down constraint. One way of putting the public hospitals into this story is that they value control over production *much* more than they value costs, especially for tasks that are labor-heavy.

The extent to which models of outsourcing behavior derived in the for-profit context can be directly applied to the decisions of public and nonprofit organizations depends on the

economic circumstances in which these organizations find themselves. When firms' budgets are relatively tight, nonprofit firms seem to make outsourcing decisions in much the same way as for-profit firms do. But when nonprofit firms are far from their shut-down constraint they seem to deviate more strongly from for-profits.

Second, we provide new evidence about other dimensions of production differences across ownership types. Nonprofits not only provide a broader range of services (Horwitz 2007), they perform a larger fraction of those services themselves. Finally, consistent with much of the literature (Chang and Jacobson 2011, Duggan 2002), we find that the three ownership classes react very differently to economic shocks. In particular, nonprofits and for-profits react quite similarly along the extensive margin (much like they do along the shut-down margin (Chang and Jacobson 2011)), but react very differently along the intensive margin. This is more evidence that nonprofits act very much like budget-limited consumers, and not like unconstrained profit maximizers.

References

Alesina, Alberto, Reza Baqir, and William Easterly, "Redistributive Public Employment," *Journal of Urban Economics*, 2000, *48*, 219–241.

Bajari, Patrick and Steven Tadelis, "Incentives Versus Transaction Costs: A Theory of Procurement Contracts," *RAND Journal of Economics*, 2001, *32*, 387–407.

Balakrishnan, Ramji, Leslie Eldenburg, Ranjani Krishnan, and Naomi Soderstrom, "The Influence of Instituional Constraints on Outsourcing," *Journal of Accounting Research*, 2010, *48*, 767–794.

Ballou, Jeffrey P. and Burton A. Weisbrod, "Managerial Rewards and the behavior of for-profit, governmental, and nonprofit organizations: evidence from the hospital industry," *Journal of Public Economics*, 2003, *87*, 1895–1920.

Brown, Trevor and Matthew Potoski, "Transaction Costs and Instituional Explanations for Governemnt Service Production Decisions," *Journal of Public Administration Research and Theory*, 2003, *13*, 441–68.

Chang, Tom and Mireille Jacobson, "What do Nonprofit Hospitals Maximize? Evidence from California's Seismic Retrofit Mandate," 2011. Working Paper, 2011.

Clark, Andrew E. and Carine Milcent, "Public Employment and Political Pressure: The Case of French Hospitals," *Journal of Health Economics*, 2011, *30*, 1103–12.

Coles, Jerilyn W. and William S. Hesterly, "The impact of firm-specific assets and the interaction of uncertainty: an examination of make or buy decisions in public and private hospitals," *Journal of Economic Behavior and Organization*, 1998, *36*, 383–409.

David, Guy and Arthur J. Chiang, "The determinants of public versus private provision of Emergency Medical Services," *International Journal of Industrial Organization*, 2009, *27*, 312–19.

Deneffe, Daniel and Robert T. Masson, "What do nonprofit hospitals maximize?," *International Journal of Industrial Organization*, 2002, *20*, 461–92.

Duggan, Mark, "Hospital market structure and the behavior of not-for-profit hospitals," *The RAND Journal of Economics*, 2002, *33*, 433–46.

Eggleston, Karen, Yu-Chu Shen, Joseph Lau, Christopher Schmid, and Jia Chan, "Hospital Ownership and Quality of Care: What explains the different results in the literature?," *Health Economics*, 2008, *17*, 1345–1362.

Glaeser, Edward, "Introduction," in Edward L. Glaeser, ed., *The Governance of Not-For-Profit Organizations*, NBER, 2003, chapter 1.

Glaeser, Edward L. and Andrei Shleifer, "Not-for-profit Entrepreneurs," *Journal of Public Economics*, 2001, *81*, 99–115.

Hart, Oliver, Andrei Shleifer, and Robert Vishny, "The Proper Scope of Government: Theory and an Application to Prisons," *Quarterly Journal of Economics*, 1997, *112*, 1127–61.

Heckman, James J., "Sample Selection Bias as a Specficiation Error," *Econometrica*, 1979, *47*, 153–61.

Horwitz, Jill R., "Does Nonprofit Ownership Matter," *Yale Journal of Regulation*, 2007, *24*, 139–204.

___ **and Austin Nichols**, "Hospital ownership and medical services: Market mix, spillover effects, and nonprofit objectives," *Journal of Health Economics*, 2009, *28*, 924–37.

Iossa, Elisabetta and David Martimort, "Risk Allocation and the costs and benefits of public-private partnerships," *The RAND Journal of Economics*, 2012, *43*, 442–74.

Lafontaine, Francine and Margaret Slade, "Vertical Integration and Firm Boundaries: The Evidence," *Journal of Economic Literature*, 2007, *45*, 629–85.

Levin, Jonathan and Steven Tadelis, "Contracting for Government Services: Theory and Evidence from U.S. Cities," *The Journal of Industrial Economics*, 2010, *53*, 507–541.

Lopez de Silanes, Florencio, Andrei Shleifer, and Robert Vishny, "Privatization in the United States," *The RAND Journal of Economics*, 1997, *28*, 447–71.

Malani, Anup, Tomas Philipson, and Guy David, "Theories of firm behavior in the nonprofit sector: A synthesis and empirical evaluation," in Edward L. Glaeser, ed., *The Governance of Not-For-Profit Organizations*, Chicago: University of Chicago Press, 2003.

Martimort, David and Jerome Pouyet, "To Build or Not to Build: Normative and Positive Theories of Public-Private Partnerships," *International Journal of Industrial Organization*, 2008, *26*, 393–411.

Meade, Charles and Richard Hillestand, "SB1953 and the Challenge of Hospital Seismic Safety in California," Technical Report, California HealthCare Foundation January 2007.

___ **, Jonathan Kulick, and Richard Hillestand**, "Esimating the Compliance Costs for California SB1953," Technical Report, California HealthCare Foundation April 2002.

Nelson, Michael A., "Municipal Government Approaches to Service Delivery: An Analysis from a Transaction Cost Perspective," *Economic Inquiry*, 1997, *35*, 82–96.

Pauly, M. and M. Redisch, "The not-for-profit hospital as a physician's cooperative," *American Economic Review*, 1973, *63*, 87–99.

Picone, Gabriel, Shin-Yi Chou, and Frank Sloan, "Are for-profit hospital conversions harmful to patients and to Medicare?," *The RAND Journal of Economics*, 2002, *33*, 507–523.

Sloan, Frank, "Nonprofit Ownership and Hospital Behavior," in A. J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics, Volume 1*, Elsevier Science, 2000, chapter 21, pp. 1141–1174.

Sloan, Frank A., Gabriel Picone, Donald H. Taylor Jr., and Shin-Yi Chou, "Hospital ownership and cost and quality of care: is there a dime's worth of difference," *Journal of Health Economics*, 2001, *20*, 1–21.

7 Appendix

7.1 Proofs

Lemma 1: $b^{fp} \leq b^{np}$ The b^{fp} satisfies $I'(b^{fp}) = -\rho$, while b^{np} satisfies $v'(I(b^{np}))I'(b^{np}) = -\rho$. Since $v' < 1$, by assumption, the nonprofit's condition requires $I'() < -\rho$, and by the concavity of I that requires $b > b^{fp}$.

Proposition and Corollary 1 Using the $\overline{I}_j(b)$ notation, we know by revealed preference that $\overline{I}_{np}(b^{np}) \leq \overline{I}_{fp}(b^{np})$ and $\overline{I}_{fp}(b^{fp}) \leq \overline{I}_{np}(b^{fp})$. It follows immediately from the continuity of the indifference curves that there exists a $b \in [b^{fp}, b^{np}]$ such that $\overline{I}_{fp}(b) = \overline{I}_{np}(b)$. Since the nonprofit firm has strictly convex indifference sets, the curves can cross only once, yielding uniqueness. Once existence and uniqueness are established, the enumerated conditions are immediate. Finally, the condition for outsourcing follows from the definition of $\overline{I}$. The corollary follows from the fact that $\overline{I}_j(b) \geq I(b)$, so if the outsourcing production frontier is outside the own-production frontier only when $b < b^*$, then for the range of interest $\overline{I}_{np} > \overline{I}_{fp}$ and for-profits will outsourcing whenever nonprofits do. The other case is similar.

Proposition 2 For some set of parameters, take some $b < b^*$. From Proposition 1, $\overline{I}_{np}(b) - \overline{I}_{fp}(b) > 0$. $\overline{I}_{np}(b)$ is defined implicitly by

$$v(\overline{I}_{np}(b) - F) + \rho b = v(I_{np} - F) + \rho b^{np}.$$

The implicit function theorem allows us to calculate the derivative of $\overline{I}_{np}(b)$ with respect to F:

$$\frac{\partial \overline{I}_{np}(b)}{\partial F} = \frac{v'(\overline{I}_{np}(b) - F) - v'(I^{np} - F)}{v'(\overline{I}_{np}(b))} < 0, \tag{3}$$

where the sign of the numerator comes from the fact that v' is decreasing and $\overline{I}_{np}(b) > I^{np}$, since $b < b^* < b^{np}$. Note, we use the envelope theorem here to ignore the effect F through b_{np}. We can perform a similar exercise to calculate the derivative with respect to ρ:

$$\frac{\partial \overline{I}_{np}(b)}{\partial \rho} = \frac{b^{np} - b}{v'(\overline{I}_{np}(b))} > b^{np} - b, \tag{4}$$

where the final inequality holds since $v' \leq 1$.

Finally

$$\frac{\partial^2 \overline{I}_{np}(b)}{\partial \rho \partial F} = \frac{(\partial b^{np}/\partial F)}{v'(\overline{I}_{np}(b))} - \frac{b^{np} - b}{[v'(\overline{I}_{np}(b))]^2} v''(\overline{I}_{np}(b))(\frac{\partial \overline{I}_{np}(b)}{\partial F}) < 0, \tag{5}$$

since both terms are negative. The first, since $(\partial b^{np}/\partial F) < 0$ and the second since both $v''(\cdot < 0)$ and $(\frac{\partial \overline{I}_{np}(b)}{\partial F}) < 0$ (from equation **??**, above), but $b^{np} > b$.

$\overline{I}_{fp}(b)$ is given by

$$\overline{I}_{fp}(b) - F + \rho b = I_{fp} - F + \rho b^{fp},$$

and can by solved for explicitly as $\overline{I}_{fp}(b) = I_{fp} + \rho(b^{fp} - b)$. The derivative with respect to F is zero, while the derivative with respect to ρ is $b^{fp} - b$, and the cross-partial is zero. Comparing these derivatives to those derived above for the nonprofit gives the results of the proposition. For F, and the cross-partial, it is immediate. For ρ, it follows from the fact that $b^{np} \geq b^{fp}$.