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Ownership Structure and Provider Behavior*

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Abstract

Government-sponsored health payment systems often offer the same payments for a service to all providers, regardless of ownership structure. However, the provider's behavior will likely depend on its ownership structure. In a theoretical model, we study how for-profit, nonprofit, and public providers respond to a prospective payment system (similar to the DRG system used by Medicare in the United States) in a static game when costs are uncertain. For-profits default in high-cost states, provide minimum quality in low-cost states, and have a relatively high incentive to invest in cost reduction. Public providers, enjoying soft budget constraints, always deliver care to patients, but have lower incentives to invest. Nonprofits default as often as for-profits, but provide higher quality in low-cost states. Their incentives to invest may be higher than for-profits or lower than public providers, depending on the weights in the nonprofit's objective function. We also study the effect of extending the game to allow for elastic patient demand, quality competition, and multi-period play.

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1 Introduction

Health care delivery in the United States features a mix of private for-profit, not-for-profit, and public institutions. For example, in 1997, 68 percent of hospital admissions were to private not-for-profit hospitals, 12 percent to for-profit hospitals, 4 percent to federal hospitals and 14 percent to hospitals owned by state and local governments. For community hospitals alone, nonprofits accounted for 69 percent of total beds, for-profits for 14 percent, and public hospitals for 17 percent (National Center for Health Statistics 1999). This paper draws upon commonly posited objectives and constraints of each ownership form to develop a simple model of how for-profit, not-for-profit, and government health care facilities react to prepayment incentives through choices regarding cost control, quality of care, and allocation of fiscal reserves.

Central features of our model of provider behavior are soft budget constraints for public providers and possible nonpecuniary objectives coupled with a break-even constraint for not-for-profit providers. All providers face uncertainty, a critical feature of health care first emphasized by Arrow (1963). In our model, uncertainty takes the form of high or low cost realizations. Providers can invest in cost-reduction to increase the probability of achieving low cost. We begin by considering a basic model with providers possessing isolated markets and facing inelastic demand. They make choices regarding cost-control investment and quality. Within this simple framework, significant differences in behavior arise by ownership form. We then extend the model, introducing competition between providers, with demand responsive to increases in quality. Finally, we move to a model where providers choose quality over a series of periods, where reserves can be built up or drawn down. Our multi-period model refines predictions made about performance by ownership type.

The first goal of this investigation is to model behavior to capture well-known propensities of for-profit, nonprofit and public health care providers. The second goal is to develop a series of empirical propositions than can test the model. Our introductory section briefly outlines known behaviors by ownership type. We then develop the basic model: The government contracts through a DRG-style payment scheme to secure medical services from our three types of providers, with quality beyond some minimum not being contractible. Two critical questions are what investments in lowering costs will the different types make, and what quality levels will they establish? The answers to these questions reveal the basic interests of the ownership forms. Thus, for-profits skimp on quality; nonprofits, depending on the relative weights in their objective function, may maximize quality subject to a net revenue constraint. Both forms of private ownership may default in high-cost states. By contrast, public providers guarantee access to basic quality of care in both high- and low-cost states, but their soft budget constraints also lead to poor performance in controlling costs.

Parts 4 and 5 toss aside simplifying assumptions that appear unrealistic, or lead to unrealistic conclusions. The most severe malconclusion is that for-profit firms shave quality to the bare minimum. In part 4, we introduce elasticity of demand. Even a monopoly provider faces elastic demand if, for example, higher quality care attracts some patients into formal treatment who would otherwise opt for self-treatment. In part 5 we explore competition between providers, focusing on the for-profit provider. If demand elasticity or competition is present, the for-profit producer's quality rises above the minimum. Moreover, the for-profit provider responds positively to the quality choice of his competitor.

Part 6 presents our dynamic model, with a firm making quality choices in multiple periods, and nonprofit firms empowered to build up and draw down reserves. Here too the goal is to modify unrealistic assumptions that lead to an unrealistic conclusion. That conclusion is that nonprofit providers never violate their break even constraint. Of course they might, if they have a pool of reserves to draw upon, as some major nonprofit hospitals have done in recent years, although this is not an unlimited source of funds for continuing a nonprofit's mission. Indeed, most conversions of nonprofit providers to for-profit status are precipitated at least in part by the deteriorating financial status of the converting hospitals (Cutler and Horwitz 2000).

Our dynamic model draws inspiration from health care provider experience over the 1980s and 1990s, with an era of good times followed by an era of predominantly bad times. As Joseph prophesied for Egypt, good years were likely to be followed by good years, and bad years by bad years. And like Joseph, some hospitals systematically built reserves when times were good.[1]

We develop a model where whether times are good or bad depends on whether the costs of achieving quality are low or high. Low costs can be interpreted directly as production costs being low, or alternatively as payment rates being generous. The model predicts quality choices across

[1] For example, between 1995 and 1998–a period of generally above-average hospital margins–one large nonprofit provider system in the Boston area increased net assets from \$1.6 to about \$2 billion. In 1998, although the provider system suffered a \$19 million operating loss, income from investments totalled more than \$70 million (all in constant 1995 dollars; Partners Healthcare Annual Reports, various years).

time in a stochastic environment where states tend to persist. A simulation is presented using a Markov transition matrix based on the experience of U.S. hospitals from 1984-99. It shows that depending on parameter values, a variety of outcomes is possible. Thus, there can be a steady build up in reserves, or reserves can build up in good times and be drawn down when times are bad.

Our dynamic model best captures the experience of nonprofit firms. Public providers face a ratchet effect that precludes accumulation of reserves, but also enjoy soft budget constraints that insulate them from the threat of insolvency from revenue shortfalls. For-profit providers may also build up reserves, but often do not need to since they can attract money from capital markets when they face short-term deficits despite long-term positive profit expectations. Allowing for dynamics brings the predicted behavior of for-profit and nonprofit providers closer together, and highlights the salience of the soft budget constraint in shaping public provider behavior.

DiMaggio and Powell (1983), looking across organizational forms in a variety of fields, conclude that "mimetic isomorphism" is likely. That is, the less dominant form in a region will tend to imitate the behavior of the other. As we discuss in parts 3 and 4, allowing for demand elasticity, competition, and a role for quality reputations in our model induces for-profit firms to take a longer view, hence to provide quality of care above the contractual minimum. Our analysis is consistent with convergence of behavior among competing providers, and suggests that static economic models may overstate differences in behaviors between ownership forms.

We now turn to traditional beliefs and empirical evidence about the behaviors of the three forms.

2 Theory and Evidence on Provider Behavior by Ownership Form

Much theoretical and empirical literature focuses on the potential for ownership form to shape behavior. We first discuss commonly posited theoretical distinctions among health care provider ownership forms, and then turn to a brief summary of empirical evidence.

For-profit providers: The behavior of for-profit providers is simplest to characterize. We assume that such providers maximize profits. In a traditional market for a normal good, such behavior would have no negative implications for product quality. Firm reputation would ensure that quality and cost were appropriately balanced. Health care may be different. The good is complex, making quality difficult to measure and contracts on quality hard to write. Competition among providers as a quality enhancer has some potential, but is also hampered by the inability of patients and purchasers to monitor all relevant aspects of quality, and by generally low cross elasticities of demand. In our basic one-period model, for-profits aggressively invest in cost control, but reputational effects are hampered, so that the quality of for-profit providers is a concern. Others have highlighted similar results. For example, Hart, Shleifer and Vishny (1997) develop an incomplete contracting model in which ownership is defined as the allocation of residual control rights over non-human assets, such as a prison or hospital. In their model, private owners typically have stronger incentives to invest in cost and quality innovations, but may over-invest in cost reduction because they ignore the adverse impact on noncontractible quality. Our finding of higher cost-reducing investment by for-profit private firms also resembles the results of Laffont and Tirole (1993), who emphasize the potential expropriation of managerial investments under public ownership, compared to the clear property rights of a regulated private firm. "The managers of a private regulated firm invest more in noncontractible investments because they are more likely to benefit from such investments. Public enterprise managers are concerned that they will be forced to redeploy their investments to serve social goals such as containing unemployment, limiting exports, or promoting regional development" (p.654). This expropriation of investments is closely linked to the dynamic incentive problem called the "ratchet effect" which we discuss below.

Not-for-profit providers: The goals and behavior of private not-for-profit health care providers are more controversial. Needleman (2001: 8) provides a concise summary:

> Typically, theorists present a two-argument objective function for nonprofits, with profits or break-even status as one argument and "something else" as the second. The "something else" varies from paper to paper. In Newhouse's (1970) seminal model, prestige is the hospital's goal, and it is achieved through size (quantity of services) and quality. Newhouse's model implies that nonprofit hospitals will be larger and of higher quality than is socially efficient. Nonprofits may strive for goals other than prestige, quantity, and quality. Among the goals which have been put forward are: reducing unmet need in the community (Frank and Salkever 1991); cost recovery and cash flow maximization (Davis 1972); meeting donor expectations (Rose-Ackerman 1987); promoting the welfare of the medical staff (Lee 1971; Pauly and Redisch 1973); and offering lower prices (Ben-Ner 1986).

Part of the controversy may arise from considerable intra-form heterogeneity. We endeavor to capture this heterogeneity among nonprofits in a tractable way by allowing not-for-profit providers to have an objective function that reduces in special cases to that of a profit maximizer, a social welfare maximizer, or a maximizer of patient benefits from quality care.

Public providers: Public providers frequently are called upon to fulfill a government mission of guaranteeing access to basic health care. This suggests that public providers often will continue to operate in circumstances when others might have been forced to close. Indeed, both theory and empirical evidence suggest that public providers differentially enjoy soft budget constraints. An organization has such a constraint if it can continue to operate despite consistently exceeding its budget, because some institution (such as the government) refinances it (Kornai 1980, 1986, and 1998a; Maskin 1996). Although expenditure over-runs can sometimes be efficient (e.g., to allow for emergencies such as natural disasters or unexpected sharp increases in utilization of health care), a soft budget constraint usually has deleterious efficiency implications. Expecting a bail-out, a firm can indulge itself and slack on performance with impunity (see also Rodrik and Zeckhauser 1988).

Soft budget constraints can be seen as a dynamic incentive problem (Dewatripont, Maskin and Roland 2000: 144): "Soft budget constraints represent an inefficiency in that the funding source[s] would like to commit ex ante not to bail out firms, but they know they will be tempted to refinance the firm ex post because the initial injection of funds is sunk." This soft budget constraint phenomenon is closely related to another dynamic incentive problem, the ratchet effect (Weitzman 1980; Freixas, Guesnerie, and Tirole 1985). Milgrom and Roberts (1992) define the ratchet effect as "the tendency of performance standards in an incentive system to be adjusted upwards after a particularly good performance, thereby penalizing good current performance by making it harder to earn future incentive bonuses" (p.602). We employ a simplified version of these constraints in portraying the behavior of public providers.

The implementation of cost-control measures is a critical feature of our model. In that arena, the soft budget constraint and ratchet effect lead to distinctive behavior of a public provider. Consider a situation with cost uncertainty, where in a high-cost state even variable costs may not be covered. This raises the potential for a shut down. Under such circumstances, private providers, whether for-profit or nonprofit, will invest in cost control measures. In addition, they may allocate fiscal surplus to reserves to enhance the likelihood of surviving to future periods to reap net revenue and serve clients. A public provider, by contrast, may not be allowed to retain any fiscal surplus, instead finding such surplus extracted to fund alternative projects, or at best having its budget cut in the future (the ratchet effect). However, the government provider enjoys a distinctive form of protection, a soft budget constraint in times of high-cost realization, since concerns for guaranteeing access preclude the government from committing ex ante to close the facility when inefficient.

Schmidt (1996) develops a model of ownership similar to ours in its focus on the soft budget constraint of publicly-owned firms that face cost uncertainty and may invest in cost reduction. His model differs from ours in its focus on privatization, explicit modeling of asymmetric information, and general (as opposed to health-care-specific) institutional context. Schmidt argues that allocation of ownership rights creates a critical difference in access to insider information about a firm, particularly regarding costs. Private ownership in Schmidt's model acts as a commitment device allowing a public payer to credibly threaten to cut subsidies to firms if costs are high, thus providing incentive for ex ante cost control effort through a hard budget constraint. Schmidt shows that the optimal subsidy scheme for a private firm distorts production below the socially efficient level if costs are high, and there is a positive probability that the firm will be liquidated even if this is inefficient ex post. Thus, the trade-off regarding ownership form in Schmidt's model involves a gain in productive efficiency under private ownership with an associated forfeit of allocative efficiency from possible firm closure. In the health care context, one could think of such allocative inefficiency as capturing the social welfare loss from lack of access because private providers may close in high-cost states, as our model highlights.

Empirical Evidence: Evidence fairly consistently supports the association of public health care providers with a role of "backstop" or "safety net" providers. For example, emergency services are provided by 99 percent of public hospitals (compared to 98 percent of nonprofits and 93 percent of for-profits; Gentry and Penrod 2000: 296). Public hospitals on average provide a larger share of uncompensated care than their private counterparts. Hassett and Hubbard (2000) find that public hospitals, in comparison to private nonprofit hospitals, have more capital and more labor inputs, tend to locate in areas with more low-income and less-well-educated households, and have more Medicaid patient days.

Some empirical evidence supports the importance of the soft budget constraint for public facilities. For example, examining hospital inefficiency and exit between 1986 to 1991, after the implementation of DRG prospective payment, Deily, McKay and Dorner (2000) find that relative inefficiency (as measured by residuals from stochastic cost function estimation) increased the likelihood of exit for investor-owned and nonprofit hospitals similarly. In contrast, the closure of public hospitals was not statistically affected by measures of inefficiency. The authors conclude that political rather than efficiency considerations were key in public hospital closures. This evidence is consistent with the hypothesis that public health care institutions enjoy soft budget constraints that allow them to continue operation despite inefficiency. The conclusion here is not that public entities are innately more inefficient (indeed, the inefficiency residuals of public hospitals in the Deily, McKay and Dorner study were lower on average than those of private for-profit hospitals). Rather, the finding is that the institutional survival of public hospitals is far less tied to measures of efficiency.

Recent empirical evidence on hospitals in California further supports the importance of both soft budget constraints and a 'ratchet effect' for public health care institutions. Examining hospitals' responses to a plausibly exogenous change in hospital financing, Duggan (2000) finds that local governments decreased their subsidies to public hospitals almost exactly dollar-for-dollar with the increased California state revenues those hospitals enjoyed from the Disproportionate Share Program (DSP) payments they received for indigent patient care. (In a regression with local government subsidies as the dependent variable, the coefficient on the interaction of the DSH program with public hospitals is a highly significant -1.04.) In light of this soft budget constraint and "ratchet effect," government hospitals saw no increase in total revenues, despite the fact that they continued to treat the least profitable patients. These results support the specification we employ below on the prospective payment to public providers: the local government treats such payment as a subsidy lowering the 'marginal cost' of providing access for the local community.

In contrast, Duggan (2000) finds that private hospitals – both for-profit and not-for-profit – cream-skimmed the more profitable indigent patients previously served by public hospitals, and enjoyed substantial revenue windfalls from DSP payments. They used these windfalls primarily to increase holdings of financial assets, which increased their net worth almost dollar-for-dollar with increases in revenues from DSH funds. Duggan concludes that the evidence rejects the theory that nonprofit providers are more altruistic than are investor-owned providers. Sloan (2000) summarizes much additional empirical evidence, concluding that the behavior of for-profit and not-for-profit providers is "far more alike than different" (p.1168).

Other researchers have suggested that for-profit and not-for-profit provider behavior differs to a discernible extent. Hospital exit decisions under prospective payment may reveal some differences in behavior. Although for-profit and not-for-profit hospitals of similar measured inefficiency were similarly likely to close, not-for-profit closures were also affected by population growth and extent of service offerings, which might indicate more consideration of community need in not-for-profit exit decisions (Deily, McKay and Dorner 2000: 744). Studying adoption of technologies by dialysis units, Hirth, Chenew and Orzol (2000) find that "the trade-offs made by for-profit and nonprofit facilities when faced with fixed prices appeared quite different. For-profits tended to deliver lower technical quality of care but more amenities, while nonprofits favored technical quality of care over amenities" (p.282). "Culhane and Hadley (1992) find that not-for-profit psychiatric hospitals are more accessible through emergency services than their for-profit counterparts" (Gentry and Penrod 2000: 296). Another study of psychiatric hospital behavior finds that the market share of for-profits has an independent negative effect on access, holding constant the intensity of competition (Schlesinger, Dorwart, Hoover and Epstein 1997).

One implication of welfare maximization subject to a break-even constraint for not-for-profits is that net revenues (profits) should be less variable than for their for-profit counterparts. Figure ??, showing average hospital margins by ownership form since PPS (MedPAC 2001 and ProPAC 1997), seems to support that proposition. Hoerger (1991) more formally tested the hypothesis and found empirical support for less volatility of profits among not-for-profits.

McClellan and Staiger (2000) develop a new and considerably improved methodology for measuring hospital quality of care. Several of their findings are of note. First, they emphasize the considerable heterogeneity of quality performance within ownership forms. Second, for-profit and public hospitals seem to have higher mortality (i.e., lower quality) than not-for-profits. Yet, using case studies of three counties, the authors find that for-profits in two of the three markets are associated with higher quality care, and that "for-profits may provide the impetus for quality improvements in markets where, for various reasons, relatively poor quality of care is the norm" (p.111).[2] McClellan and Staiger surmise that at least part of the reason for these seemingly contradictory findings is systematic locational differences by ownership form (Norton and Staiger 1994). For example, if for-profits locate in areas with low quality, perhaps because poorly managed hos-

[2] This contrasts with the views of others who suggest that quality spillovers from not-for-profits raise the quality in markets with mixed not-for-profit and for-profit delivery (Hansmann 1980; Hirth 1999).

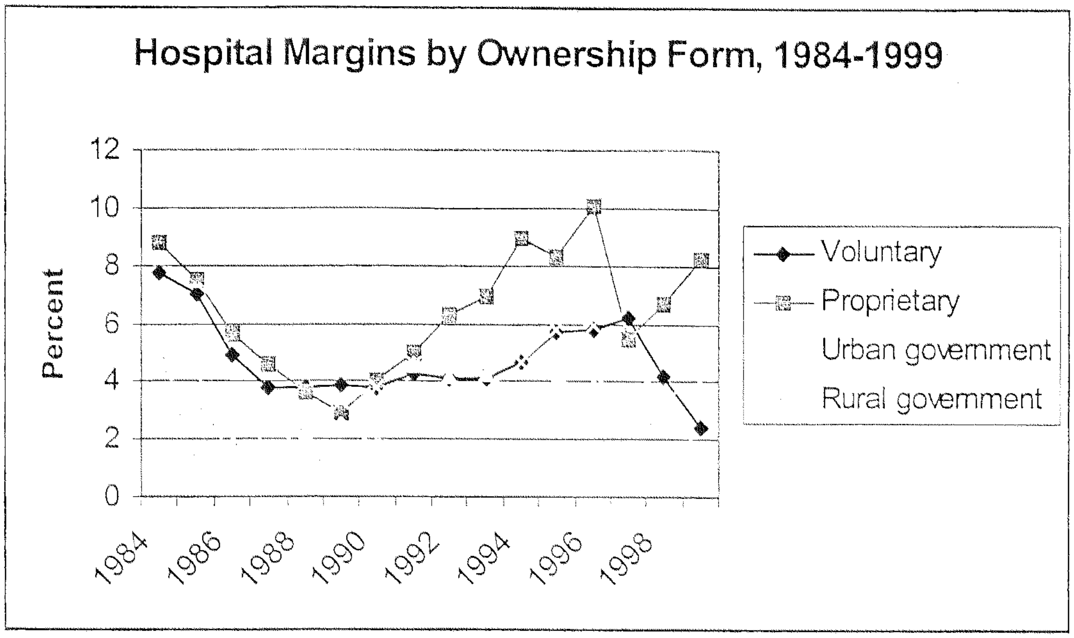

Figure 1: Hospital margins by ownership form.

pitals are good takeover targets or because there are higher profit margins in markets that do not demand high quality care, then one would expect within-county differences between ownership forms to be smaller than across counties. Indeed, McClellan and Staiger find that with county-level fixed effects, estimated mortality differences between not-for-profit and for-profit hospitals decrease by one-half (p.110).

Clearly there is significant intra-form heterogeneity, as many previous researchers have noted (e.g., McClellan and Staiger 2000; Gentry and Penrod 2000). And there are significant other factors driving provider behavior, such as the growing competitiveness of health care markets in the US. Our simple model extension to competition reinforces the intuition that competition among providers can be an impetus for improved quality. Depending on the reimbursement system and other factors, competitive pressures can even drive quality investments beyond an efficient level. Dranove and Satterthwaite (2000) summarize much of the research on quality competition under cost reimbursement—the "medical arms race". Kessler and McClellan (2000) study the welfare effects of hospital competition using Medicare data on beneficiaries' treatment and outcomes for heart attacks between 1985 and 1994, when prospective payment began to prevail. They find that by the 1990s, competition unambiguously improved welfare, since competition led to both lower treatment costs and improved patient outcomes.

Competitive pressures may drive convergence of provider behavior among ownership forms. For example, compared to other nonprofits, nonprofit hospitals in areas with many for-profit competitors are significantly more responsive to financial incentives (Duggan 2000b); nonprofit hospitals compensate top executives more according to profitability as HMO penetration in the hospital's market increases (Arnould, Bertrand and Hallock 2000); and nonprofits operating in heavily for-profit markets had very similar rates of "upcoding" Medicare reimbursements as their for-profit competitors (Silverman and Skinner 2000). Cutler and Horwitz (2000) also emphasize an "inverse-Hansmann problem," that instead of nonprofits forcing for-profits to keep quality high, for-profits force nonprofits to adopt payment-maximizing behavior. Frank and Salkever (2000) study the not-for-profit hospitals efforts to diversify into profit-generating areas; they find considerable diversification and that "beyond adding to the general financial health of hospitals, returns from profit-making activities do not seem to be targeted specifically to increased supply of social goods" (p.210). Studying psychiatric hospitals, Schlesinger, Dorwart, Hoover and Epstein (1997) find that not-for-profits provide greater access than for-profit providers (in terms of uncompensated care) under conditions of limited competition, but that behavior tends to converge as competitive pressures increase.

Nevertheless, competitive pressures may not erase all differences in behavior among providers of differing ownership status. McClellan and Staiger (2000) find that mortality (quality) differences between ownership forms increased between 1985 and 1994. A clearer theoretical understanding of how ownership affects provider behavior could help to make sense of the sometimes confusing evidence as well as suggest additional testable hypotheses about how provider behavior may differ among public, private for-profit, and private not-for-profit health care providers. For example, Philipson (2000) notes that theoretical work on behavior differences by ownership form is still important, particularly to help explain the fact that nonprofits dominate in US hospital care but for-profit providers dominate in the nursing home market.

An important aspect of provider differences by ownership form that may help to explain the hospital-nursing home ownership difference is access to capital. Needleman (2001) notes that "differential access to capital over time has played a strong role in nonprofit and for-profit hospital and health plan growth and decline. The ability of many nonprofits to survive the Depression, when many for-profits closed, was due to access to operating and capital subsidies from their communities.

(Stevens 1989) Post-World War II growth of nonprofit hospitals was in part attributable to the Hill-Burton program. The growth of nonprofit HMOs was likewise assisted by the Federal HMO Act of 1973 (Schlesinger, Gray, and Bradley 1996)" (p.7). Both for-profit and nonprofit forms have advantages and disadvantages in raising capital. For-profit firms can readily access capital markets, and can raise capital if they can expect to earn a fair return in the future. Nonprofit firms cannot raise equity capital because they do not distribute profits. However, they can float bonds, and are favored because the interest on such bonds is not taxable. Robinson (2000) asserts that "nonprofit organizations are at their greatest disadvantage in growing and mature industries [vs. emerging and declining industries], where access to risk-based equity can fuel rapid expansion by their for-profit competitors" (p.60). Gentry and Penrod (2000) find that for US nonprofit hospitals in 1995, income tax exemption and property tax exemptions were worth $4.6 billion and $1.7 billion, respectively; in contrast, access to tax-exempt bonds does not seem to reduce the cost of borrowing significantly.[3] Nonetheless, considerable tax arbitrage benefits may accrue to nonprofits from using tax-exempt borrowing in lieu of drawing down their endowments: "almost half of outstanding tax-exempt debt could be offset by their endowments, leading to an arbitrage benefit of $354 million per year" (Gentry and Penrod 2000: 322).

In our dynamic model, we empower nonprofit providers to violate their break even constraint by drawing on a pool of reserves which they may build up in "good times" to help cover costs in "bad times". We think that accumulation and use of reserves deserves theoretical and empirical attention as a potentially important distinguishing feature among ownership forms. For example, Duggan (2000) concludes that profit status has little effect on behavior after finding a similar build-up of financial assets by both for-profit and not-for-profit hospitals in response to DSP payments. But this conclusion could be premature. It is possible that use of those assets will differ in harder times. Not-for-profits might be more willing to draw down reserves in high-cost states to prevent default and therefore maintain a mission of serving their communities. Unfortunately, scant empirical evidence examines this issue. A few researchers have suggested that nonprofits tend to hold more cash reserves or financial investments than their investor-owned counterparts. For example, Robinson (2000) notes that "bond ratings for nonprofit hospitals have tended to outshine those of the investor-owned chains because of excess cash reserves rather than superior operating performance" (p.63). Using 1995 data, Gentry and Penrod (2000) find that "unlike for-profit hospitals, some not-for-

[3] For-profits pay higher interest rates but can deduct interest payments from taxable income.

profit hospitals have substantial endowments invested in financial assets. Thus, the not-for-profit is a combination of an operating business with a hospital and a portfolio of financial assets. In aggregate, the exemption from income taxes on investment income accounts for30 percent of the total value of the income tax exemption" (p.308). We hope that our theoretical exploration of the dynamic choice problem for nonprofits regarding accumulation and expenditure of reserves, drawing from recent developments in the theory of the consumption function (e.g. Carroll 2001), will help spur further theoretical and empirical work on this issue.

3 The Basic Model

We consider a multi-stage game in which the government, G, contracts with three different classes of health care providers: for-profit, F, nonprofit, N, and public, P. The government offers the same payment scheme to the three classes; it is a DRG-type of reimbursement arrangement of r per patient. At time 0, the provider observes the government's prospective payment rate, r, and chooses how much to invest in increasing the likelihood that the provider is low cost. At time 1, the provider's actual cost function is realized, after which he chooses how much quality to supply. The static version of the game ends at this point. Later, we extend the analysis to multiple periods.

To simplify, we assume that all patients who are sick have the same condition. Let $y_{\min}$ be the minimum quality with which a sick patient can be treated. Let $y = 0$ denote the case where the provider opts not to treat any patients. The provider's cost function, $c_x(y)$, is determined by a realization of a random variable x, which takes one of two values. If $x = H$ (high cost) the firm's variable cost function is given by $c_H(y)$, and if $x = L$ (low cost) its variable cost function is $c_L(y)$. In either case, y is a measure of the quality of treatment given to a single patient if sick. Thus y could capture length of stay, number of nurses on staff, or some other measure of quality. Assume that $c_x(y)$ is strictly increasing, strictly convex, twice differentiable, $c'_x(y_{\min}) = 0$ and $\lim_{y\to\infty} c'_x(y) = \infty$.[4] Assume that $c_H(y) > c_L(y)$ and $c'_H(y) > c'_L(y)$ for all $y > y_{\min}$. That is, a high-cost provider has higher total and marginal costs than a low-cost provider. If a provider opts not to treat patients, $c_x(0) = 0$ in either state. Since the provider knows his own cost function at the time of his quality decision, his quality choice can be contingent on his cost function. Denote the state-contingent quality choices as y_H and y_L.

[4] Convexity might arise either because of decreasing returns to scale in technology or because those patients who are cheapest to treat seek treatment before those who are more costly to treat.

The provider can increase the probability that he is low cost by making an ex ante investment in cost reduction. Let $p(e)$ be the probability that the provider is low cost, where $0 \leq e \leq \bar{e}$ is the amount per patient that the firm chooses to invest in cost reduction. Assume that $p()$ is twice differentiable, strictly increasing, and strictly concave, with $p'(0) = +\infty$ and $p'(\bar{e}) = 0$, where the final assumption assures that the provider chooses a positive level of investment. Hence increasing ex ante investment lowers the provider's expected cost function.[5] The provider's total cost of providing quality y is its production cost $c_x(y)$ less its investment expenditure e.

The government offers a prospective payment $r \geq 0$ for each patient that is treated by the provider.[6] Although the government is committed to pay r for each patient treated, because it deals with many providers, each with many patients, it is too costly to contract directly on the level of y. Moreover, since quality is difficult to specify, there is the danger that if an attempt were made to contract on some aspects of quality, the provider would tailor its efforts to maximize reimbursement, the health care equivalent of the "teaching-to-the-test" distortion. We assume the level of the prospective payment to be fixed and exogenous.

Given a reimbursement rate and a realization of the cost function, the provider's state-contingent, per-patient fiscal surplus is given by:

$$s_x(y) = r - c_x(y).$$

Under our assumptions $s_x(y)$ is strictly concave for either realization of x. Further, we assume that the total number of patients to be treated is fixed and exogenous. In order to keep the model simple but capture the most important cases, we assume that $r < c_H(y_{\min})$ and $r > c_L(y_{\min})$. That is, it is never possible to cover variable cost in the high-cost state, and always possible to cover such costs in the low-cost state.[7] If the expected fiscal surplus in the low-cost state – probability of

[5] An alternative formulation would have the cost-control effort lower the whole cost curve for either of the two states. Either formulation produces a stochastically dominant reduction in cost. Of the two, we adopt the one we do becuase it is computationally less complex.

[6] Alternatively, r could represent the capitation rate for an HMO-style provider. In this case, $c_x(y)$ represents the expected cost of treating a patient in state x, taking into account the possibility that the patient may not become sick.

[7] The reader should think of the high-cost state, which leads either for-profit or nonprofit producers to go out of business, as a relatively unusual condition, which might arise, say, because of rapid escalation in care costs. We focus on such a state because the fundamental difference in provider behavior arises in comparing states where they can and cannot make money.

occurrence times surplus – does not exceed the cost-reducing investment for any quality and level of investment, then no facility will be able to stay in business.

The social benefit of providing quality y is given by $b(y)$. Assume $b()$ is strictly increasing and strictly concave, $b'(y_{\min}) > 0$, and $\lim_{y\to\infty} b'(y) = 0$. Note that $b(y)$ represents the gross benefit to patients. The (ex post) net benefit (i.e., social surplus) is given by $w_x(y) = b(y) - c_x(y)$. Under the assumptions we have made, $w_x(y)$ has a unique maximizer for each x. Denote these values as y_H^* and y_L^*, and suppose that $y_x^* > 0$ for $x \in \{H, L\}$.

To summarize, the timing of the problem is:

Stage 0.0: Federal government chooses r.

Stage 0.1: Provider chooses e.

Stage 1.0: Cost is realized and observed by the provider.

Stage 1.1: Provider chooses quality y, given r and x.

3.1 Provider Behavior

For-profit providers: Given r, the for-profit provider's objective is to choose e, y_H, and y_L in order to maximize expected profit.[8] Suppose that F makes ex ante investment $\hat{e}$. Conditional on a realization of the state, F chooses y_x to solve:

$$\max_{y_x} s_x(y_x) = r - c_x(y).$$

Let y_H^F and y_L^F denote F's profit-maximizing quality choices. When cost is high, $s_x(y) < 0$ for all y, and consequently F chooses to provide $y_H^F = 0$ even though it has made a cost-reduction expenditure. When cost is low, we need to consider two cases. First, consider $s_L(y_{\min}) \geq \hat{e}$. In this case, F can earn a positive profit by choosing $y_{\min}$, and any larger y earns a lower profit. Hence $y_L^F = y_{\min}$. The second case is where $s_L(y_{\min}) < \hat{e}$. In this case, no positive quality earns a positive surplus, and F should choose $y_L^F = 0$. However, since F expects no profit if it sets $y_L^F = y_H^F = 0$, and expects a positive profit if it sets $\hat{e} = 0$, $y_H^F = 0$, and $y_L^F = y_{\min}$, it is never optimal for F to choose e so large that it cannot earn positive surplus in the low-cost state. Hence, when it is optimizing, F sets $y_L^F = y_{\min}$ and $y_H^F = 0$. Next, we turn to F's optimal choice of e.

[8] In this one-period model there is no concern for reputation. In our dynamic model, reputations will be shown to significantly influence quality.

Given its optimal quality choice, F's overall expected profit is

$$p(e)\, s_L(y_{\min}) - e.$$

The first-order necessary condition for a maximizer is:

$$p'\left(e^F\right) s_L(y_{\min}) = 1.$$

That is, increasing investment increases the likelihood of being low cost and earning positive profit $s_L\left(y_L^F\right)$. The optimal choice of e weights this increase in profit by the increase in the likelihood of being low cost, $p'(e)$, and sets the result equal to the marginal investment cost, 1.

Nonprofit providers: Although not-for-profit providers are generally believed not to act as profit maximizers, there is substantial disagreement as to what their actual objectives are.[9] For the sake of illustration, we consider N as maximizing a linear combination of fiscal surplus and the benefit provided to patients. That is, N's ex post objective function is

$$u_x(y,\alpha) = \alpha b(y) + (1-\alpha)\, s_x(y).$$

Ellis (1998) posits a similar objective function. Note that when $\alpha = 0$, N's objective is profit maximization; when $\alpha = \frac{1}{2}$, its objective is welfare maximization; and when $\alpha = 1$, its objective is to maximize patient benefit. For any value of α, N is also constrained to cover its investment cost. That is, it is subject to the break-even constraint $s_x(y) \geq e$. The larger is α, the more likely it is that this constraint will bind (since profit-maximizers never choose quality larger than $y_{\min}$). Hence, conditional on a realization of the state and investment decision $\hat{e}$, N chooses y_x to solve:

$$\begin{aligned} &\max_{y_x} u_x(y,\alpha) = \alpha b(y) + (1-\alpha)\, s_x(y) \\ &\text{s.t. } s_x(y_x) \geq \hat{e}. \end{aligned}$$

Regardless of α, if $x = H$, N cannot cover its marginal costs and chooses not to serve any patients, $y_H^N = 0$. The optimal quality choice when cost is low depends on α. Suppose $\alpha = 0$. In this case, N acts as a profit-maximizer, and chooses $y_H = 0$ and $y_L = y_{\min}$, just as F does. On the other hand, if $\alpha = 1$, N maximizes $B(y)$, which is the same as maximizing y. Thus, N will choose the largest quality that satisfies the break-even constraint: y_L^N is given by $y_L^N = \max\{y | s_x(y) \geq \hat{e}\}$.

[9] McGuire (2000) reviews theoretical work on non-profit-maximizing objectives of providers.

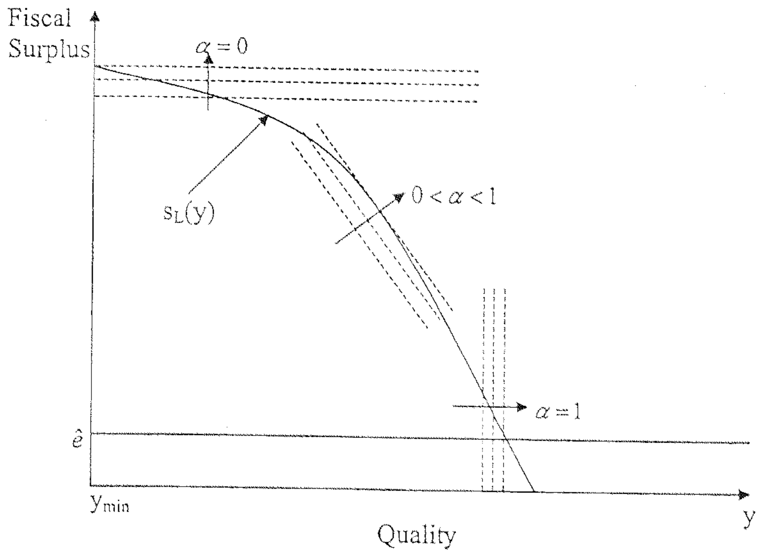

Figure 2: Nonprofit objectives vary with α.

Finally, suppose $\alpha = \frac{1}{2}$. In this case, N chooses y in order to maximize ex post surplus: $y_L = y^*$, provided that y^* breaks even. If it does not break even, it chooses the largest y that just breaks even: $y_L^N = \max\{\{y|s_x(y) \geq \hat{e}\} \cup y^*\}$.

For other values of α, N chooses y_L^N in order to solve the constrained-optimization problem above. Regardless of α, however, whenever N is at all altruistic, i.e., $\alpha > 0$, it will choose to provide more than the minimum quality. That is, whenever $\alpha > 0$, $y_L^N > y_{\min}$. To see why, note that $y_L^N = y_{\min}$ always breaks even. That is, $s_x(y_{\min}) > \hat{e}$ if e is chosen optimally (by the same argument given above for why F would never choose e so large that it does not earn positive surplus in the low-cost state). Further, at $y = y_{\min}$, $\frac{\partial u_L}{\partial y} = \alpha b'(y) - (1-\alpha) c_L'(y) > 0$, since $b'(y_{\min}) > 0$ and $c'(y_{\min}) = 0$.

Figure 2 illustrates the relation between N's objectives in choosing quality and parameter α. When $\alpha = 0$, N acts as a profit-maximizer and chooses $y_L^N = y_{\min}$. As α increases, the indifference curves begin to slope downward and to the right, larger values of α implying a steeper slope.[10] Hence for some intermediate values of α, N chooses low-state quality greater than $y_{\min}$ although less than the maximum break-even quality. However, for sufficiently large α (which may be less than 1), the break-even constraint binds, and N chooses low-state quality y_{BE} for that α as well as

[10] Although drawn that way for convenience, actual indifference curves need not be linear. However, whatever their shape, increasing α makes the indifference curves steeper.

all larger values of α.[11]

In addition, y_L^N will depend on e, since e determines the break-even constraint. If at a certain level of e the break-even constraint binds at the quality-choosing stage, then increasing e will force the provider to decrease quality. The likelihood that the constraint binds increases with α. Not-for-profit providers whose objective functions look like for-profit providers will choose quality low enough that the break-even constraint is not an issue.

Now consider N's investment choice. Denote the optimal choice of y_L^N as $y_L^N(e)$. N chooses e to maximize:

$$p(e)\left[\alpha b\left(y_L^N(e)\right)+(1-\alpha)\, s_L\left(y_L^N(e)\right)\right]-e,$$

which has optimality condition

$$\begin{aligned} & p'(e)\left[\alpha b\left(y_L^N(e)\right)+(1-\alpha)\, s_L\left(y_L^N(e)\right)\right] \\ + \quad & p(e)\left[\alpha b'\left(y_L^N(e)\right)+(1-\alpha)\, s_L'\left(y_L^N(e)\right)\right]\frac{dy_L^N(e)}{de}=1. \end{aligned}$$

The optimality condition can be broken down into two parts. The first term on the left-hand side captures the fact that increasing effort increases the likelihood of being low cost, and N earns a positive utility in the low-cost state. The second term on the left-hand side represents the fact that increasing e tightens the break-even constraint, which may force N to decrease quality.

We shall find that F always invests more than P in cost-reduction. Intuition might suggest that N's investment would always fall in the middle, but that is wrong. Indeed, it can be greater than F's investment or less than P's. To see why, first assume that the break-even constraint does not bind. In this case, e solves:

$$p'\left(e^N\right)\left(\left(\alpha b\left(y_L^N\left(e^N\right)\right)+(1-\alpha)\, s_L\left(y_L^N\left(e^N\right)\right)\right)\right)=1.$$

Hence if $b\left(y_L^N(e)\right)>s_L\left(y_L^N(e)\right)$, then $\left(\alpha b\left(y_L^N(e)\right)+(1-\alpha)\, s_L\left(y_L^N(e)\right)\right)>s_L\left(y_L^N(e)\right)$, and consequently $e^N>e^F$. Since N cares about the benefit provided to patients and this benefit is large, it chooses e larger than F. On the other hand, if $b(y)<s_L(y)$, the value N puts on providing benefit to patients induces it to choose less ex ante cost-reducing investment.

When the constraint binds, another factor acts to induce N to lower its investment. Since increasing investment tightens the break-even constraint, $\frac{dy_L^N(e)}{de}<0$. To the extent that N cares

[11] Indeed, it may even be that when the nonprofit is a social surplus maximizer (i.e., $\alpha=\frac{1}{2}$) the break-even constraint prevents it from choosing the efficient quality, y_L^*.

about the level of benefit provided (i.e., α is large), the fact that an increase in investment leads to a decrease in quality decreases its incentive to invest in cost reduction.

Public providers: Next, we consider the reaction of a public provider to the government's incentive system. As an example of a public provider, we have in mind a county hospital, which receives payments for each Medicare patient it treats but also receives subsidies from the county government. For clarity, we will refer to the three entities in the problem as the federal government (G), local government (L) and public provider (P).

As noted earlier, much of the discussion of public providers has focused on the "soft budget constraint" phenomenon, according to which a government unit, in our case the local government, is unable to commit not to subsidize the provider in the event that costs are high, even though making a firm commitment ex ante would be efficient. Hence we modify the game as follows:

Stage 0.0: Federal government chooses r.

Stage 0.1: Provider chooses e.

Stage 1.0: Cost is realized and observed by local government and provider.

Stage 1.1: The local government sets state-conditional subsidy rates, v_H and v_L.

Stage 1.2: Provider chooses quality given r and v_x.

We assume that the local government's objective is to maximize social surplus, leaving aside the federal government's expenditure. As far as the provider's goal is concerned, we assume that, loosely speaking, the provider (or its manager) is an empire builder, and that it can partially appropriate any fiscal surplus and convert it into "perks" for management and employees.[12] This could include "gold plating," hiring more staff than would be otherwise needed, or not laying off staff despite excess capacity. In order to capture the fact that not all surplus will be appropriable, let $0 < \lambda < 1$ represent the fraction of realized surplus the provider can divert to empire building.[13] The remaining fraction is reclaimed by the local government (see our earlier discussion of the soft budget constraint and ratcheting) or lost without providing benefit to anyone.[14]

[12] In this draft for the sake of simplicity we limit P to caring only about appropriable surplus. A similar analysis can be conducted that allows for more general and generous goals. In future versions of the paper, we will consider public providers whose objectives involve both appropriable surplus and patient benefits, much as in our analysis of nonprofit providers.

[13] Some forms of surplus dissipation, such as hiring additional nurses, may help patients. Others, such as buying better furniture for the hospital's administrators, do not.

[14] There are certainly other reasonable specifications for provider and local government objectives. We choose

Consider the high-cost state, where $r < c_H(y_{\min})$. It is not possible for the provider to earn a positive surplus in this state, and therefore, in the absence of a soft budget constraint, care would not be provided. However, the local government can offer a subsidy to the provider so that patients still receive access to (basic) care. Note that the local government cannot directly subsidize quality; it can only subsidize the prospective payment. Since the local government is unable to influence quality beyond $y_{\min}$, it chooses v_H such that $r + v_H = c_H(y_{\min})$, and the provider chooses $y_H^P = y_{\min}$. Fiscal surplus is zero.

When cost is low, P can offer higher-than-minimum quality and still break even. However, P does not directly care about quality, only the fiscal surplus that P can appropriate for himself. Hence it is not in his interest to provide more than minimum quality: $y_L^P = y_{\min}$, and the local government chooses $v_L = 0$. Nonetheless, fiscal surplus is positive, $r - c_L(y_{\min}) > 0$, as is appropriable surplus, $\lambda(r - c_L(y_{\min})) > 0$.

Now we turn to P's investment decision. The public provider's problem is

$$\max_e p(e)\lambda s_x(y_{\min}) - e.$$

The optimality condition is $p'(e)s_x(y_{\min}) = \frac{1}{\lambda}$. Note that since $\lambda < 1$, the public provider invests less in cost reduction than the for-profit private provider. This is to be expected, since the public provider is less able to appropriate fiscal surplus (and convert it into perks). Also note that even though P and F choose the same quality in the low-cost state, in contrast with F, P also provides care in the high-cost state, due to the subsidy from the local government. Hence, the public provider's behavior is largely driven by the soft budget constraint ($v_H > 0$) that guarantees patients access to (basic) care, and the ratchet effect ($\lambda < 1$ and $v_L = 0$) that blunts incentive to invest in cost control.

3.2 Comparison of the Ownership Forms

We conclude with a comparison of the choices of the three ownership forms in our static context. Table 1 summarizes the investment and quality decisions of the three types of providers under prospective payment.

these because they are tractable and seem to fit reasonably well with empirical evidence.

	cost-reducing investment	low-cost	high-cost
F	high	$y_L^F = y_{\min}$	$y_H^F = 0$
N	ambiguous**	$y_L^N > y_{\min}$	$y_H^N = 0$
P	low	$y_L^P = y_{\min}$	$y_H^P = y_{\min}$

** may be higher than F or lower than P

Table 1: Comparison of Ownership Forms.

The for-profit provider delivers care only in the low-cost state, and then only at the minimum quality. Nonprofit providers also provide care only when cost is low, but provide more than minimum quality in this state. Public providers, because they are subsidized by L when cost is high, provide care in all states. However, since P does not directly care about patient benefits, it provides only minimum quality.

With respect to investment decisions, the choices of F and P are predictable. Since F appropriates all fiscal surplus while P is only able to appropriate fraction $\lambda < 1$ of it, F has stronger incentives to invest in cost reduction.

The incentives of N are more complicated for two reasons. Increasing investment increases the likelihood that the provider is low-cost (which is good) and tightens the break-even constraint. The tightening may force N to decrease quality in the low-cost state (which is bad). Since these effects are at odds with each other, N's investment level can range anywhere, above F, between F and P, or below P.

4 Elastic Demand: The Monopoly Case

In this section, we consider a variant on the basic model in which a provider's quality choice affects the number of patients served, assuming higher quality attracts more patients. For clarity, we simplify the basic model by assuming that cost is low (since the decisions about what to do when cost is high are unaffected), and take as given the reimbursement rate, r, and the provider's investment decision, e. We defer competitive considerations until the next section.

To capture the effect of quality on demand, let $N(y)$ be the number of patients served by the provider, and assume $N'(y) > 0$, $N''(y) < 0$ for $y \geq y_{\min}$. We consider each type of provider in turn.

For-Profit Providers: As before, the for-profit provider chooses quality in order to maximize expected fiscal surplus. In this case, F's objective function is

$$N(y)(r - c(y)),$$

where $c(y) = c_L(y)$. Differentiating with respect to quality yields (Kuhn-Tucker) optimality condition:

$$-N(y^*)\,c'(y^*) + N'(y^*)(r - c(y^*)) \leq 0, \text{ with equality if } y^* > y_{\min}.$$

The first term of the optimality condition is as in the basic model. Holding fixed the number of patients, increasing quality decreases profit, since revenues are unaffected and average cost increases. However, when faced with elastic demand, the number of patients increases with quality. The positive impact of elasticity of demand on quality is captured by the second term of the optimality condition. Ma and McGuire (1997) and McGuire (2000) derive similar results. Since $c'(y_{\min}) = 0$, $N' > 0$ and $r - c(y_{\min}) > 0$, when $y = y_{\min}$,

$$-N(y^*)\,c'(y^*) + N'(y^*)(r - c(y^*)) = N'(y^*)(r - c(y^*)) > 0.$$

Hence when demand is elastic, F will choose $y^* > y_{\min}$. The for-profit provider facing elastic demand finds it optimal to decrease average (per capita) margin in order to increase the number of patients served.

This responsiveness of quality to demand elasticity can be further illustrated by re-writing the optimality condition for the $y^* > y_{\min}$case in terms of elasticities. The for-profit provider chooses quality y^* such that the ratio of profit margin to cost per patient equals the ratio of the elasticity of cost with respect to quality, $\varepsilon_{c,y} \equiv c'\frac{y}{c}$ to the quality elasticity of demand $\varepsilon_{N,y} \equiv N'\frac{y}{N}$:

$$\frac{r - c(y^*)}{c(y^*)} = \frac{\varepsilon_{c,y}}{\varepsilon_{N,y}}.$$

Hence, when the quality elasticity of demand increases, which decreases the right-hand-side elasticity ratio, the provider responds by increasing quality to the point where the margin-to-cost ratio decreases the same amount. (Compare McGuire (2000), equation 13). The result is intuitive: higher quality elasticity of demand calls forth greater quality.

Nonprofit Providers: Let $v(y) = \alpha b(y) + (1-\alpha)(r - c(y))$.[15] Nonprofit providers facing elastic demand solve the following problem:

$$\max_{y_{\min} \leq y \leq y_{BE}} \quad N(y)\, v(y)$$
$$s.t. \quad r - c(y) \geq 0.$$

The optimality condition for this problem is:

$$N(y^*)\, v'(y^*) + N'(y^*)\, v(y^*) \begin{cases} \leq 0 & \text{if} \quad y^* = y_{\min} \\ = 0 & \text{if} \quad y_{\min} < y^* < y_{BE} \\ \geq 0 & \text{if} \quad y = y_{BE}. \end{cases}$$

where y_{BE} solves $c(y_{BE}) = r$.

As in the for-profit provider case, the first term of the optimality condition is the same as in the inelastic demand case. Holding fixed the number of patients, the per-patient impact on the objective function of increasing quality is given by $v'(y) = \alpha b'(y) - (1-\alpha)\, c'(y)$. Assuming some altruism ($\alpha > 0$), $v'(y)$ is positive for y sufficiently close to $y_{\min}$. The second term of the optimality condition captures the change in the nonprofit's objective due to the fact that increasing quality increases the number of patients.

If the break-even constraint is binding with inelastic demand, it will also bind with elastic demand. If, on the other hand, the break-even constraint did not bind with inelastic demand, then a non-zero demand elasticity will tend to increase the non-profit's quality choice. To see why, let $\tilde{y}$ be the optimal quality choice with inelastic demand. If the break-even constraint does not bind, then $v(\tilde{y}) > 0$. In this case, the second term of the first-order condition above will be strictly positive, which will induce the non-profit to increase its quality beyond $\tilde{y}$. The intuition is that increasing quality not only increases the quality provided to a fixed number of patients (as in the inelastic demand case), it also increases the number of patients served, which the nonprofit also values. Ma and McGuire (1997) report a similar result in which the presence of an ethics constraint expands the set of implementable qualities.

[15] Let y_+ be the largest y for which $v(y) \geq 0$. We assume that $y_+ > y_{BE}$, so that positive utility is earned at the break-even quality level.

Public Providers: The management of the public provider chooses y to maximize appropriable surplus. Hence with elastic demand, the public provider's objective is to maximize

$$\lambda N(y)(r - c(y)).$$

Since this is proportional to the for-profit's objective, the public provider and the for-profit provider will make identical quality choices.[16] Hence inelastic demand will also induce the public provider to supply greater-than-minimum quality.

5 Competition Between Providers

In this section, we briefly sketch a model of how the quality choices of competing providers may interact.[17] The goal is to illustrate how the presence of a high-quality provider in a market can induce other providers, such as for-profit providers who do not care directly about quality, to supply greater-than-minimum quality. The intuition is that while the for-profit provider is not interested in providing quality for its own sake, it is willing to provide quality if doing so is an avenue to higher profits, which it will be if higher quality sufficiently increases the number of patients served. Here, we illustrate that in a simple competitive environment, higher quality by a competing firm increases the "quality elasticity of demand" a provider faces, thereby increasing the incentive to increase own quality.

We assume that all providers face the same payment and cost structure, so they cannot compete on price. Neither do their unit costs affect per unit payment. In this section we consider a model of provider competition where providers compete for patients using quality. Our model adapts the standard Hotelling-style model of duopoly competition in a "linear city." Suppose that patients are uniformly distributed over the unit interval, provider 1 is located at 0 and provider 2 is located at 1. A patient located at x who chooses provider 1 expects utility $b(y_1) - x$ if provider 1 offers

[16] This is due in large part to our assumption that the public provider's managers are not altruistic.

[17] For simplicity, we assume in this section that all patients choose formal treatment at one of the two competing providers. This contrasts with the setting of the previous section, in which patients implicitly could choose self-treatment, and higher provider quality attracted more patients into formal treatment. See Ellis (1998) for a model with patient heterogeneity that encompasses both cases: providers act as a monopolies vis-a-vis low-severity patients (for whom the cost of travel to the alternative provider outweighs the benefit of treatment) and as a duopoly vis-a-vis high severity patients. Ellis focuses on issues of selection, not differential provider behavior by ownership status. In future work, we plan to incorporate patient heterogeneity into our model.

quality y_1. If this same patient chooses provider 2, he expects utility $b(y_2) - (1-x)$. Hence patient x chooses provider 1 if $b(y_1) - x \geq b(y_2) - (1-x)$. This implies patients choose provider 1 if $x \leq \frac{b(y_1)-b(y_2)+1}{2}$, and provider 2 otherwise.

For simplicity, we treat the providers' control variables as the benefit provided to patients rather than quality. That is, let $b_i = b(y_i)$, and treat provider i as choosing b_i. The number of patients who choose provider 1 is therefore given by $N_1(b_1, b_2) = \frac{b_1-b_2+1}{2}$, and the number of patients who choose provider 2 is $N_2(b_2, b_1) = \frac{b_2-b_1+1}{2}$. Let $k(b_i) = c(b(y_i))$ be the cost of providing benefit-from-quality b_i.

Suppose provider i is for-profit and that provider $j = 3-i$ chooses benefit-level b_j. Provider i chooses b_i to maximize:

$$\left(\frac{b_i - b_j + 1}{2}\right)(r - k(b_i)).$$

Differentiating with respect to b_i yields optimality condition:

$$-\left(\frac{b_i^* - b_j + 1}{2}\right)k'(b_i^*) + \frac{1}{2}(r - k(b_i^*))\begin{cases} \leq 0 & \text{if } \quad b_i^* = b_{\min} \\ = 0 & \text{if } \quad y_{\min} < y^* \end{cases}, \tag{1}$$

where $b_{\min} = b(y_{\min})$. This expression implicitly defines $b_i(b_j)$, provider $i's$ optimal choice as a function of provider j's choice.

Let $b_i(b_j)$ satisfy the previous condition (be provider $i's$ optimal reaction to b_j), and suppose $y^* > y_{\min}$. In this case, equation (1) becomes:

$$-\left(\frac{b_i(b_j) - b_j + 1}{2}\right)k'(b_i(b_j)) + \frac{1}{2}(r - k(b_i(b_j))) = 0. \tag{2}$$

Differentiating (2) with respect to b_j yields the following expression for the slope of provider i's optimal reaction to b_j:

$$b'(b_j) = \frac{-\frac{1}{2}k'(b(b_j))}{\left(\frac{1}{2}k''(b(b_j))(-b(b_j) + b_j - 1) - k'(b(b_j))\right)} > 0$$

Hence provider i's reaction function slopes upward. That is, as the other provider increases its quality, the for-profit responds with higher quality as well. This suggests that the presence of high-quality providers in a market can induce all providers in a market to supply higher quality (Hansmann 1980; Hirth 1999). Figure 3 depicts provider 1's best response function for the case where $r = 0.5$ and $k(b) = \frac{1}{2}b^2$.

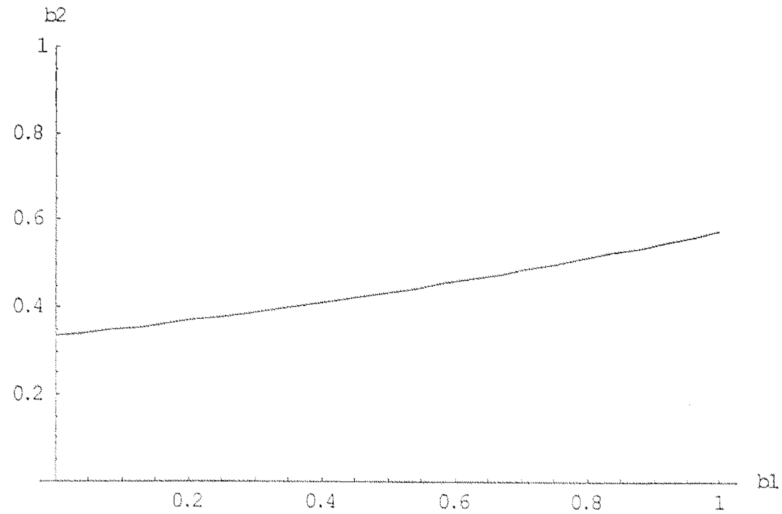

Figure 3: A typical best response curve.

Intuitively, the for-profit's best-response function increases in b_j because b_j affects the number of patients the for-profit treats, but not the profit earned on each. Further, the larger b_j, the higher the quality-elasticity of residual demand facing the for-profit. Quality elasticity can be written as:

$$\varepsilon_y = \frac{\partial N}{\partial b_i}\frac{b_i}{N} = \frac{b_i}{2}\left(\frac{2}{1+b_i-b_j}\right),$$

and $\frac{\partial \varepsilon_y}{\partial b_j} = \frac{b_i}{(1+b_i-b_j)^2} > 0$. Since responsiveness of demand to an increase in quality increases with the opposing firm's quality level, the for-profit is more willing to provide additional quality when faced with a high-quality competitor than when faced with a low-quality competitor.

Now, suppose that both firms are for-profit. If provider j chooses $b_j = b_{\min}$, then the derivative of provider i's payoff is:

$$-\left(\frac{b_i - b_{\min} + 1}{2}\right) k'(b_i) + \frac{1}{2}(r - k(b_i)).$$

When $b_i = b_{\min}$, this becomes:

$$-\frac{1}{2}k'(b_{\min}) + \frac{1}{2}(r - k(b_{\min})).$$

Given our assumptions, $k'(b_{\min}) = 0$ and $r > k(b_{\min})$, hence this expression is positive, and provider i's best response to $b_j = b_{\min}$ is to provide $b_i > b_{\min}$. This can be seen in Figure 3, where $b_{\min}$ is implicitly assumed to be 0, and $b_1(0) = 0.33 > 0$. This captures the idea that, even if its

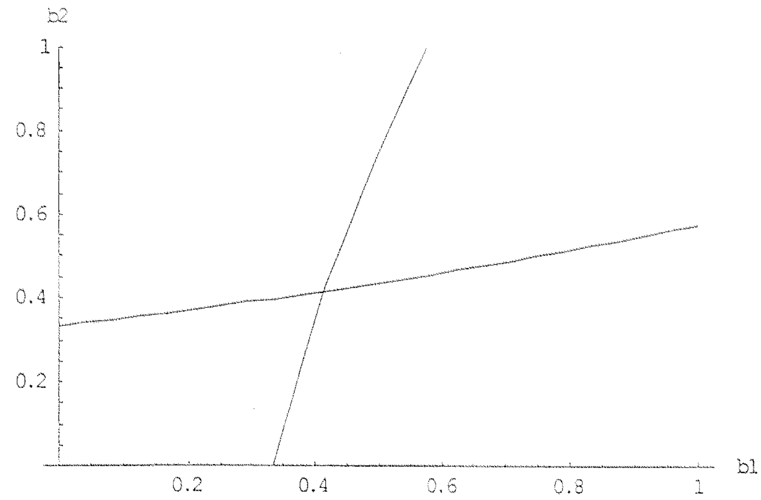

Figure 4: Nash Equilibrium in the quality-setting game.

competitor supplies minimum quality, it is optimal for a provider to supply more-than-minimum quality when faced with quality-elastic demand.

The theoretical outcome of this quality-setting game is its Nash Equilibrium, the situation where each provider maximizes its expected payoff given the benefit choice of its opponent. Since provider i will never choose $b_i > b_{BE}$, $b_i(b_j) \leq b_{BE}$. Finally, since $b_i(b_j)$ is increasing in b_j, this implies that there is at least one pure strategy Nash Equilibrium, and that each of the for-profit providers supplies more-than-minimum quality in this equilibrium.

For the parameter values specified above, the Nash Equilibrium in the quality-setting game is depicted in Figure 4. The flatter curve is provider 1's best response to b_2, $b_1(b_2)$, and the steeper curve is provider 2's best response to b_1, $b_2(b_1)$. Solving numerically for the equilibrium benefit levels yields $b_1 = b_2 = 0.414$. Hence the presence of two providers who use quality to compete for patients leads each provider to supply more quality that it would in the absence of competition.[18]

6 A Dynamic Model of Quality Provision

The analysis of the basic model presented in Section 3 considered but a single round of the health-care provision game. In real life, this game is played over many years. Many important behaviors change when we move from a static to a dynamic formulation. To begin, when there are multiple

[18] Recall that when $b_i(0) = 0.33 < 0.414$.

rounds, as there are in real life, the provider need not shut down in the high-cost state. If the provider has accumulated reserves, it may choose to draw on these reserves in high-cost periods in order to remain viable until better times return. This formulation is most relevant to a nonprofit provider, since for-profit providers can access the capital market when incurring a short-term shortfall despite long-term favorable prospects, and a public provider can look to the government for a bailout. We study the behavior of a nonprofit provider in an infinite-horizon model more thoroughly in Eggleston, Miller and Zeckhauser (2001).[19] Our model operates as follows: Each period, the cost of providing care is either high or low, and the transitions between states are governed by a Markov process. The system is assumed to exhibit persistence in the sense that the probability of remaining in the good (or bad) state is greater than the probability of transitioning into that state from the other. The provider's utility for quality is assumed to be additively separable over time and to take the constant relative risk aversion form with coefficient of relative risk aversion $\rho > 0$.[20] Utility is discounted exponentially, with $\beta < 1$ representing the provider's rate of time preference. Reserves compound at interest rate $R > 1$.

The basic theoretical result is that the optimal policy in the stochastic-dynamic model is linear. That is, each period the provider spends on quality a fraction of reserves that depends only on whether the current state is good or bad. If current reserves are x, the provider spends $c_G x$ on quality in the good state and $c_B x$ in the bad state. Further, it is shown that if $\rho < 1$, a greater fraction of reserves is spent in the good state than in the bad state, $c_G > c_B$. However, if $\rho > 1$, a greater fraction of reserves is spent in the bad state than in the good state, $c_B > c_G$.

Whether reserves tend to increase over time, remain constant, or decrease over time, is driven by the relative size of R and β in much the same way as in the nonstochastic version of the problem.[21] That is, if $R\beta > 1$, the market rewards to shifting spending on quality into the future are greater than the discount rate, and it is worthwhile for the provider to save. Hence reserves increase over time, a pattern that is widely observed with many nonprofit entities, e.g., prestige colleges and their endowments.[22] If, on the other hand, $R\beta < 1$, the market rewards to saving are less than

[19] A sketch of the analytic model is included as Appendix A.

[20] Specifically, utility for quality is given by $\frac{y^{1-\rho}}{1-\rho}$.

[21] The tendencies described in this and the next several paragraphs are based on simulation results, the results in the nonstochastic environment, and examination of limiting behavior. They have not yet been analytically proven.

[22] We have assumed a constant rate of return for invested reserves. Most nonprofits invest in equities and other risky assets, which may lead reserves to diminish in a year even if the entity is running a surplus.

the provider's discount rate, and it prefers to buy quality sooner rather than later. In this case, reserves decrease over time under the optimal policy.

If $R\beta = 1$, reserves tend to remain constant over time. That is, they exhibit neither a strong upward trend nor a strong downward trend. This is especially true if transitions between good and bad states are frequent. The table below shows the behavior of reserves and expenditures on quality depending on our parameter values.

	$R\beta < 1$	$R\beta = 1$	$R\beta > 1$
$\rho < 1$	$c_G > c_B$;reserves decr.	$c_G > c_B$;reserves const.	$c_G > c_B$; reserves incr.
$\rho = 1$	$c_G = c_B$;reserves decr.	$c_G = c_B$;reserves const.	$c_G = c_B$;reserves incr.
$\rho > 1$	$c_G < c_B$;reserves decr.	$c_G < c_B$;reserves const.	$c_G < c_B$;reserves incr.

Table 2: Summary of dynamic behavior

We construct a transition matrix based on data for US hospital total profit margins during the 1989 to 1999 period as reported by the Medicare Payment Advisory Commission (MedPAC 2001). Using the regional average total margins reported for 9 regions of the country for these 11 years (i.e., 90 'transitions'), we calculate changes in margins between years as deviations from the region-specific average. This yields the following transition matrix. Entries in the matrix give the probability of transition to the column state in the next period, given that the provider is currently in the row state.

	2+% > ave.	1-2% > ave.	0-1% > ave.	0-1% < ave.	1+% < ave.
2+% > ave.	0.46	0.18	0.18	0.18	0
1-2% > ave.	0.26	0.32	0.21	0.21	0
0-1% > ave.	0	0.21	0.5	0.29	0
0-1% < ave.	0	0.08	0.25	0.5	0.17
1+% < ave.	0	0	0.29	0.42	0.29

Table 3: Transition matrix for US hospital total profit margins, 1989 to 1999.

If instead we tabulate percentages of transitions between just two "states"–a "good state" (any year in which the regional profit margin was at the regional average or above) and a "bad state" (any year in which the regional profit margin fell below the 11-year average margin)–we find the following transition matrix.

		t+1	
		average or above	below average
t	average or above	0.76	0.24
	below average	0.32	0.68

Table 4: Simplified transition matrix for US hospital total profit margins, 1989 to 1999.

Using this second simpler transition matrix as the input into the dynamic model, we simulate the path of the provider's reserves over a period of time. For the purposes of the simulation, we consider $\rho = 4$, $R = 1.05$ and $\beta = 0.952$. The price of quality in the bad state is set equal to 1, while the price of quality in the good state is $p = 0.8$. Using the transition matrix above, a sample path of states over a 50 period span is depicted in Figure 5.

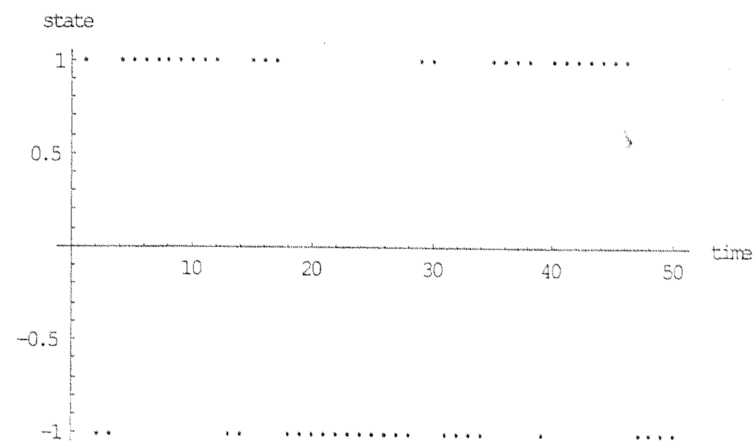

Figure 5: A sample path of states.

Numerically solving the provider's stochastic dynamic programming problem, the optimal policy involves spending fraction $c_G = 0.0456$ of current reserves in the good state and fraction $c_B = 0.0532$ of reserves in the bad state. It should be noted, however, that even though less is spent in the good state, more quality is always purchased in the good than the bad state. This result applies in all boxes in Table 2. Notice that since reserves accumulate at rate $R = 1.05$, reserves remain constant when fraction 0.05 of reserves is spent each period. Hence this provider accumulates reserves in good times and spends down reserves in bad times.

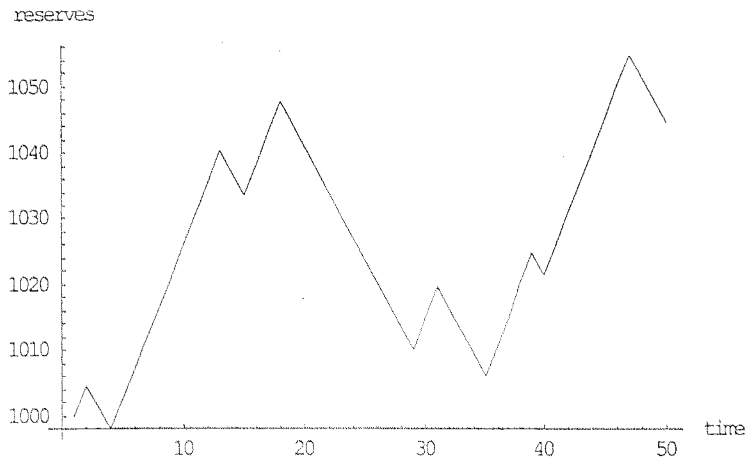

Figure 6: Behavior of reserves over time.

If we assume the provider begins with initial reserves at 1000, applying this solution to the path of states above yields the behavior of reserves over time depicted in Figure 6.

Notice the correspondence between the path of states in Figure 5 and the trend in reserves in Figure 6. In the first few periods, the state is initially good, then bad for two periods, and then good again. This leads to the first small peak in reserves, as the provider first saves and then dissaves. Next, the provider experiences a long period in which the state is good, and during this time it increases its reserves significantly. This is followed by a short run of bad states, a short run of good states, and then a long period of bad states in which the provider spends down its reserves considerably in order to continue to provide quality during the period of high prices. After a brief oscillation between bad and good times, another period of sustained prosperity arises in which the provider once again builds up its reserves.

Although the provider spends more in bad times than good times, because the price of quality is lower in the good state than the bad state, all else equal it nevertheless supplies more *quality* in good states than in the bad states.[23] The path of quality supplied over time for the simulation we have been examining is depicted in Figure 7. Notice that quality increases when reserves increase (i.e., when the state is good) and that quality is higher in good times than in bad.

In this section, we have considered the incentives that arise in a dynamic setting that may induce a nonprofit provider to care for patients even in bad times. This is in contrast to the conclusions

[23] Good-state quality is proportional to $\frac{c_G}{p} = \frac{0.0456}{0.8} = .057 > 0.5 = c_B$

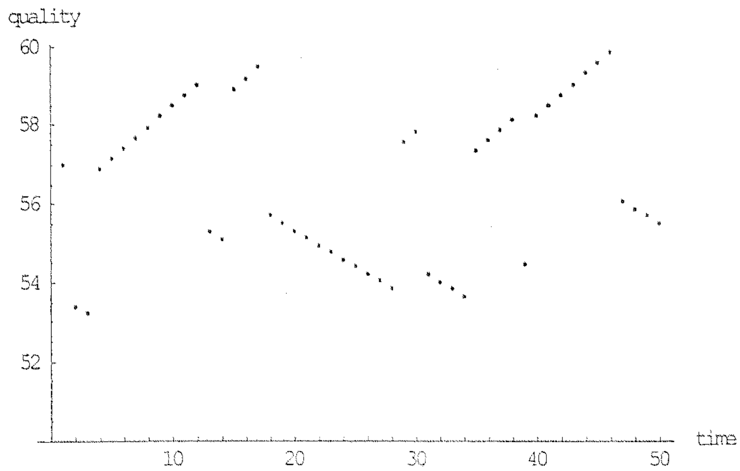

Figure 7: Behavior of quality over time.

of the basic model (see Section 3). Dynamic considerations may also induce for-profit providers to behave as if patient benefits were an institutional objective. Although in the basic model we considered only a single period of play, in the real world, time rolls forward, insureds switch providers, and for-profit providers are interested in long-run profit maximization. Thus a for-profit provider may provide quality above the minimum, expecting that, by establishing a reputation for being a high-quality provider, it can induce patients to choose it over other providers. If successful, this will bring future returns. Moreover, patients will expect to rely on such reputations, knowing that the for-profit provider has a financial incentive not to destroy a reputation. Although we do not develop the analysis here, it is straightforward to see how such a reputational model can lead the for-profit provider to supply more-than-minimum quality, and to provide patients access to high-quality care even in high-cost times.

7 Conclusion

For-profit, nonprofit and public health care providers compete side by side in the United States. Though each sector has niche markets, there are many arenas where two or all three forms compete against one another. At first glance, this is a bit surprising, since the forms have distinct advantages and disadvantages. Thus, we might expect for-profits to be better at cost control, nonprofits to have an advantage because of fidelity to patient objectives, and public providers to enjoy the benefits of soft budget constraints. Our static models trace out the implications of these attributes when cost-reducing investments might be undertaken, and depending on whether costs of providing quality are high (implying costs can't be covered) or low.

A series of competitive extensions and dynamic models shows greater convergence in the behaviors of different ownership forms when reserves can be built up or drawn down, and potentially reputations for quality established. With demand for services a consideration, and reputation a possible weapon, for-profit health care providers may act like altruistic not-for-profit providers in many fields. They may promote quality as an instrument of competition. With reserves available, nonprofits no longer need break even period by period. Hence, they behave more like for-profit firms, which have access to capital markets.

Preliminary efforts show that many of our predictions are corroborated by past studies and snippets of empirical data. Future work should attempt to look at the peculiar health care ecosystem in more detail, seeking to explain the behaviors and survival strategies of the three major species of providers that inhabit it.

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A A dynamic model of nonprofit behavior

In this Appendix we present a sketch of the model underlying the analysis of the dynamic problem in Section 6. The project is still in progress. Please contact the authors for the most current version.

Consider a nonprofit provider who must make quality decisions in an infinite-horizon model in which there are good and bad times. In order to characterize how such decisions are made, we adopt an infinite-horizon, intertemporal utility maximization model. In any period, the nonprofit's utility is given by:

$$u(q) = \frac{q^{1-\rho}}{1-\rho},$$

where $\rho > 0$ measures the nonprofit's coefficient of relative risk aversion. Letting $\delta \in (0,1)$ be the nonprofit's discount rate, the nonprofit's overall utility function is given by

$$U(q_1, ..., q_\infty) = \sum_{t=0}^{\infty} \delta^t u(q_t).$$

The nonprofit's initial asset level is given by x_0, where x_0 includes both the value of any real assets the nonprofit possesses and the present value of its future income stream.[24] Since, in our model, the number of patients treated by the nonprofit is fixed, total revenue in each period is independent of the nonprofit's quality decisions. Let r_0 be the present value of this revenue stream. Adding this to any initial assets the nonprofit may have, w_0, the nonprofit's initial wealth is given by x_0.

If, in any period, the nonprofit begins with total wealth x, end-of-period wealth is given by

$$x' = R(x - c), \tag{3}$$

where $R > 1$ is the relevant interest rate and $c \geq 0$ is the nonprofit's expenditure on providing quality to patients.

We define a good state (G) to be one where the price of quality is low and a bad state (B) to be one where the price of consumption is high. We normalize the price of consumption in the bad state to be 1, and let the price of consumption in the good state be $p < 1$. Note that c dollars

[24] We implicitly assume that the nonprofit can borrow against future earnings. Later, we discuss the impact of credit rationing on the nonprofit's behavior.

spent on quality purchases $\frac{c}{p}$ units of quality in the good state but only c units of quality in the bad state. The transition between states follows a Markov process with transition matrix:

$$\begin{array}{ccc} & G & B \\ G & g & 1-g \\ B & 1-b & b \end{array}$$

where $g > 1 - b$, to capture the persistence of the states.

The value function, $v(x, s)$, depends on the level of reserves, x, and the current state, $s \in \{G, B\}$, and is defined by the functional equations

$$v(x, G) = \max_c \left(u\left(\frac{c}{p}\right) + \beta \left(gv(x', G) + (1-g)v(x', B)\right)\right), \text{ and} \tag{4}$$

$$v(x, B) = \max_c \left(u(c) + \beta \left((1-b)v(x', G) + bv(x', B)\right)\right). \tag{5}$$

The solution to this problem consists of a state-contingent policy function, $c(x, s)$, relating current reserves and state to expenditure on quality, and a state-contingent value function, $v(x, s)$, relating current reserves and state to expected lifetime utility.

As is usual in the literature, we proceed by the "guess and confirm" method. Suppose the policy and value functions take the form:

$$c(x, s) = c_s x, \text{ and} \tag{6}$$

$$v(x, s) = v_s \frac{x^{1-\rho}}{1-\rho}, \text{ for } s = G, B. \tag{7}$$

We will show that the solution to the nonprofit's problem must take this form. Suppose that $\rho \neq 1$. The case where $\rho = 1$ corresponds to logarithmic utility, and can be addressed separately. Begin by deriving the first-order conditions for the problem in the good and bad states by differentiating (4) and (5) with respect to c_s.

Differentiating (4) with respect to c yields first-order condition:

$$u'\left(\frac{c}{p}\right)\frac{1}{p} + \beta\left(gv_{x'}(x', G)\frac{\partial x'}{\partial c} + (1-g)v_{x'}(x', B)\frac{\partial x'}{\partial c}\right) = 0$$

Substituting in the conjectured solution (6) and (7) and asset equation (3) yields:

$$\frac{c^{-\rho}}{p^{1-\rho}} - \beta g v_G (x')^{-\rho} + (1-g)\left(v_B (x')^{-\rho}\right)R = 0$$

$$\frac{(c_G x)^{-\rho}}{p^{1-\rho}} - \beta\left(g(v_G)^{-\rho} + (1-g)(v_B)^{-\rho}\right)R\left(R(x - c_G x)^{-\rho}\right) = 0$$

$$\frac{c_G^{-\rho}}{p^{1-\rho}} = R^{1-\rho}\beta\left(gv_G + (1-g)v_B\right)(1-c_G)^{-\rho}. \tag{8}$$

A similar calculation for the bad state yields:

$$c_B^{-\rho} = R^{1-\rho}\beta\left((1-b)\,v_G + bv_B\right)(1-c_B)^{-\rho}. \tag{9}$$

The second two equations characterizing the solution derive from substituting the conjectured solution into the definition of the value functions, (4) and (5).

$$\begin{aligned}
v(x,G) &= \max_c \left(u\left(\frac{c}{p}\right) + \beta\left(gv(x',G) + (1-g)\,v(x',B)\right)\right) \\
v_G\frac{x^{1-\rho}}{1-\rho} &= \frac{\left(\frac{c}{p}\right)^{1-\rho}}{1-\rho} + \beta\left(gv_G\frac{x'^{1-\rho}}{1-\rho} + (1-g)\,v_G\frac{x'^{1-\rho}}{1-\rho}\right) \\
v_G x^{1-\rho} &= \left(\frac{c_G x}{p}\right)^{1-\rho} + \beta\left(gv_G + (1-g)\,v_G\right)\left(R\,(1-c_G)\,x\right)^{1-\rho} \\
v_G &= \left(\frac{c_G}{p}\right)^{1-\rho} + R^{1-\rho}\beta\left(gv_G + (1-g)\,v_G\right)(1-c_G)^{1-\rho},
\end{aligned} \tag{10}$$

for the good state, and

$$v_B = \left(\frac{c_B}{p}\right)^{1-\rho} + R^{1-\rho}\beta\left((1-b)\,v_G + bv_G\right)(1-c_B)^{1-\rho}, \tag{11}$$

for the bad state.

Since equations (8), (9), (10), and (11), do not depend on current reserves, x, they characterize necessary conditions for the solution to the nonprofit's problem. Hence, a solution of the form (6) and (7) exists.

We begin our analysis of the solution by showing that, holding x constant, the nonprofit expects higher utility if the current state is good than if the current state is bad.

Proposition 1 *For $x > 0$, $v(x,G) > v(x,B)$.*

Proof: *Let x_0 be initial wealth and let $c^*(h_{t-1}, s_t)$ be the sequence of history-dependent consumptions resulting from following the optimal consumption plan if the initial state is B, where $h_{t-1} = (B, s_1, \ldots, s_{t-1})$ gives the history of states $s_i \in \{G, B\}$, and $h_{-1} = \emptyset$. We now show that there is a sequence that offers higher utility when the initial state is G.*

If $s_0 = G$, consume $c^*(h_{-1})$, the same amount as if the state were B. This earns higher utility than if the initial state had been B. Thereafter adopt the following "mimic" strategy.

1. *If $s_t = B$, consume $c^*(h_{t-1}, B)$ in the current period and follow $c^*(h_{t-1}, s_t)$ in all subsequent periods.*

2. *If $s_t = G$, then randomize.*

   (a) *With probability $\frac{1-b}{g}$, consume $c^*(h_{t-1}, G)$ in the current period and follow $c^*(h_{t-1}, s_t)$ in all subsequent periods.*

   (b) *With probability $\frac{g-(1-b)}{g}$, consume $c^*(h_{t-1}, B)$ in the current period. Repeat steps 1-2 in period t.*

Following steps 1 and 2 constructs a consumption sequence that results in the same distribution of end-of-period wealth as does following $c^*(h, s)$ when the initial state is B. However, higher utility is earned at time 0 and after any history where the state has always previously been G, i.e., $h_t = (G, ..., G)$, since consuming (as in step 2b) $c^*(h_{t-1}, B)$ when the state is G earns more utility than doing so when the state is B. Hence the consumption plan earns higher utility when $s_0 = G$ than when $s_0 = B$, and therefore $v(x, G) > v(x, B)$. ■

The following corollary relates Proposition 1 to constants v_B and v_G.

Corollary 2 *If $\rho < 1$, $v_G > v_B$. If $\rho > 1$, $v_B > v_G$.*

Proof: *Follows from the previous proposition, the form of the value function, and the fact that $u(x) > 0$ if $\rho < 1$ but $u(x) < 0$ if $\rho > 1$.* ■

The two cases in Corollary 2 arise from the fact that for $\rho < 1$, $u(x) \geq 0$, and hence Proposition 1 implies that $v_B > v_G$. On the other hand, when $\rho > 1$, $u(x) < 0$, and hence higher utility in the good state corresponds to $v_B < v_G$.

Next, we derive a lemma useful in further characterizing the solution.

Lemma 3 *Equations (8), (9), (10), and (11) imply that $v_G = \frac{c_G^{-\rho}}{p^{1-\rho}}$ and $v_B = c_B^{-\rho}$.*

Proof.

$$\begin{aligned} v_G &= \left(\frac{c_G}{p}\right)^{1-\rho} + R^{1-\rho}\beta\left(gv_G + (1-g)v_B\right)(1-c_G)^{1-\rho} \\ v_G &= \left(\frac{c_G}{p}\right)^{1-\rho} + \frac{c_G^{-\rho}}{(1-c_G)^{-\rho}p^{1-\rho}}(1-c_G)^{1-\rho} \\ &= \frac{c_G^{-\rho}}{p^{1-\rho}}. \end{aligned}$$

A similar derivation shows that $v_B = c_B^{-\rho}$. ■

Proposition 4 establishes that when $\rho < 1$, the nonprofit consumes more of its endowment in good times than in bad, while when $\rho > 1$, the nonprofit consumes more of its endowment in bad times than in good.

Proposition 4 *If $\rho < 1$, $c_G > c_B$. If $\rho > 1$, $c_G < c_B$.*

Proof. *First, consider $\rho < 1$. In this case, $v_G > gv_G + (1-g)\,v_B > (1-b)\,v_G + bv_B > v_B$. Consider the following two equations:*

$$\begin{aligned}\left(\frac{c_G}{1-c_G}\right)^{-\rho} &= p^{1-\rho}R^{1-\rho}\beta\left(gv_G + (1-g)\,v_B\right)\\ \left(\frac{c_B}{1-c_B}\right)^{-\rho} &= R^{1-\rho}\beta\left((1-b)\,v_G + bv_B\right)\end{aligned}$$

Divide the first by the second:

$$\begin{aligned}\frac{\left(\frac{c_G}{1-c_G}\right)^{-\rho}}{\left(\frac{c_B}{1-c_B}\right)^{-\rho}} &= p^{1-\rho}\frac{(gv_G + (1-g)\,v_B)}{((1-b)\,v_G + bv_B)} < p^{1-\rho}\frac{v_G}{v_B} = \left(\frac{c_G}{c_B}\right)^{-\rho}\\ \left(\frac{1-c_B}{1-c_G}\right)^{-\rho} &< 1\\ \left(\frac{1-c_B}{1-c_G}\right)^{\rho} &> 1\\ 1-c_B &> 1-c_G\\ c_G &> c_B.\end{aligned}$$

This completes the first part of the proof. Next, consider $\rho > 1$, in which case $v_G < gv_G + (1-g)\,v_B < (1-b)\,v_G + bv_B < v_B$. Dividing the same two equations:

$$\begin{aligned}\frac{\left(\frac{c_G}{1-c_G}\right)^{-\rho}}{\left(\frac{c_B}{1-c_B}\right)^{-\rho}} &= p^{1-\rho}\frac{(gv_G + (1-g)\,v_B)}{((1-b)\,v_G + bv_B)} > p^{1-\rho}\frac{v_G}{v_B} = \left(\frac{c_G}{c_B}\right)^{-\rho}\\ \left(\frac{1-c_B}{1-c_G}\right)^{-\rho} &> 1\\ \left(\frac{1-c_B}{1-c_G}\right)^{\rho} &< 1\\ 1-c_B &< 1-c_G\\ c_G &< c_B.\end{aligned}$$

■

The difference between the good and bad states that affects the nonprofits consumption decision is difference in the price of quality in the two states. The two cases in Proposition 4 arise from the fact that this difference has two affects on the nonprofit's marginal propensity to consume, the weighting of which in the nonprofit's objective depends on ρ.

Proposition 4 states that when $\rho > 1$, more is spent on quality in the bad state than in the good state. However, since the price of quality is also lower in the good state, this does not imply that more quality is provided in the bad state. In fact, more quality is provided in the good state independent of ρ.

Proposition 5 *Holding fixed the level of reserves, more quality is provided in the good state than the bad state.*

Proof. *Quality provided in the good state is* $\frac{c_G}{p}x$, *and quality provided in the bad state is* $c_B x$. *When* $\rho < 1$, $c_G > c_B$, *and the result is immediate. When* $\rho > 1$, $v_G < v_B$. *But,* $v_G = \frac{1}{p}\left(\frac{c_G}{p}\right)^{-\rho} < c_B^{-\rho} = v_B$. *Manipulating this expression*

$$\begin{aligned} \frac{1}{p}\left(\frac{c_G}{p}\right)^{-\rho} &< c_B^{-\rho} \\ c_B^{\rho} &< p\left(\frac{c_G}{p}\right)^{\rho} \\ c_B &< p^{\frac{1}{\rho}}\left(\frac{c_G}{p}\right) \\ c_B &< \frac{c_G}{p} \end{aligned}$$

Hence more quality is provided in the good state than the bad, independent of ρ. ■

Although the solution to the problem cannot be expressed in closed form, equations (8), (9), (10), and (11) characterize a solution to the problem, and hence can be used to derive analytic comparative statics of the solution with respect to the exogenous variables. For the most part, the response of c_G and c_B to changes in the exogenous variables depends only on ρ. The results are presented in the following table. Derivations are algebraically cumbersome and are available from the authors upon request.

	β	β	R	R	g	g	b	b	p	p
	$\rho > 1$	$\rho < 1$	$\rho > 1$	$\rho < 1$	$\rho > 1$	$\rho < 1$	$\rho > 1$	$\rho < 1$	$\rho > 1$	$\rho < 1$
c_G	−	−	+	−	+	−	−	+	+	−
c_B	−	−	+	−	+	−	−	+	−	+