This article develops multiobjective models of hospital decision making that incorporate the internal decision process in both a for-profit and a non-profit hospital (NPH). Predicted output and quality for an NPH differ from those for a for-profit hospital under some conditions but converge under others. Convergence may be the result of a complex internal decision structure with decision control primarily by physicians, similar objectives across different organizational forms, or differing constraints. The mechanisms underlying these outcomes provide explanations for conflicting results in empirical studies of non-profit and for-profit hospitals and provide a different rationale for convergence than non-profit response to competition from for-profit hospitals. Understanding the source of convergence is important for policies directed toward the tax treatment of NPHs. (JEL D21, D23, I11, L3, L21)

I. INTRODUCTION

The prevalence of for-profit hospitals has increased in the United States over the past few decades. The emergence of for-profit hospitals that often compete in markets with not-for-profit hospitals has generated vigorous academic and policy debates about the implications of the distinct legal and organizational for-profit and non-profit forms on hospital behavior. The main issues arise from differences in monetary and non-pecuniary incentives for administrators and physicians that are associated with organizational form, including variations in tax treatment, access to capital markets, and governance structures. These debates center on two possible outcomes related to organizational form and ownership mix. One is whether these differences lead to observable differences in revenues and costs as well as the quantity, quality, and mix of services provided by for-profit and non-profit hospitals (NPHs). The other possible outcome is whether competition from for-profit hospitals in the same markets as NPHs coupled with persistent cost-containment efforts of public and private insurers, results in a form of convergence where NPHs behave similarly to for-profit hospitals despite differences in organizational form. This notion of convergence that has arisen in the literature on performance in the hospital industry has called into question both academically and for policy makers the tax benefits that NPHs enjoy on the grounds that NPHs are indistinguishable from for-profit hospitals and fail to provide community benefits at a level sufficient to justify the subsidies.1

The ongoing debate about whether NPHs behave differently from for-profit hospitals has given rise to a substantial empirical literature seeking to inform the debate. Schlesinger and


ABBREVIATIONS
PMH: Profit-Making Hospital
NPH: Non-Profit Hospital
Gray (2006) and Rosenau (2003) comprehensively reviewed the empirical evidence on the performance differences between for-profit and NPHs. Performance is evaluated along several dimensions including economic measures like cost per admission, revenue or charge per admission, technical efficiency, non-pecuniary measures like quality, provision of care to indigent patients, and trustworthiness of organizational practices. Both reviews conclude that ownership-related differences in hospital behavior and outcomes are mixed. Schlesinger and Gray reviewed 162 empirical studies comparing non-profit and for-profit hospitals and nursing homes along the dimensions of economic performance, quality of care, and indigent patients’ access to care. In terms of economic performance, 18 studies found no significant differences between for-profit and NPHs; 10 studies found an advantage for profit-making hospitals (PMHs); and 30 found an advantage for NPHs. Twenty-one studies reported no significant differences between for-profit and NPHs in terms of quality of care, whereas 4 studies found higher quality of care in for-profit hospitals, and 19 studies found higher quality of care in NPHs. Rosenau synthesized the results of approximately 75 peer-reviewed studies published between 1985 and 2001 along quality, cost, access, and charity care dimensions. In terms of cost, 23 studies found NPHs to be superior, 5 studies found for-profit hospitals to be superior, and 9 studies were inconclusive. Twelve studies found that NPHs provided higher quality care, 3 studies found quality of care to be higher in for-profit hospitals, and 9 studies found no differences in quality.

Their finding that evidence of ownership-related differences in cost, quality, profits, pricing policies, technical efficiency, access to care, and service offerings vary greatly across empirical studies is not surprising because the studies themselves vary in terms of data used and statistical methods. The empirical approach taken in the majority of the studies is to estimate a reduced-form model of hospital characteristics that typically includes an indicator variable for ownership status as a control variable. Alternatively, other studies examine the effects of ownership mix rather than ownership form. Grabowski and Hirth (2003) examine the effects of ownership mix on performance of nursing homes across organizational forms with some relevance to the analysis of hospitals. Duggan (2003) and Santerre and Vernon (2006) take this approach to organizational performance by considering market shares of NPHs. Similar to empirical studies that focus on ownership form, these studies find varying results for performance across organizational forms in quantity or quality of service, cost and efficiency of delivery, and revenue levels.

Finally, some studies motivate the empirical analysis with a discussion of the underlying internal organization and characteristics of hospitals, and the regulatory and market environment, but rarely develop formal models that generate empirically testable predictions. Typically, the theoretical basis for the empirical findings is implicitly understood as comparable organizations with no decision process clearly delineated. From a policy perspective, the failure of the many empirical studies to consistently predict differences between non-profit and for-profit behavior is troubling because, at the end of the day, policy debates regarding the optimal organizational structure of the health-care delivery system remain uninformed. John Colombo succinctly characterized what can be learned from this substantial empirical literature in a congressional hearing:

> Empirical studies on quality of care, costs of care and free care for the poor show decidedly mixed results, with some studies finding in favor of non-profits and others finding in favor of for-profits. These studies certainly do not prove that nonprofit form is better than for-profit form; at best, all we can conclude is that nonprofits in some markets in some measures outperform for-profits, and that in other markets on other measures, for-profits outperform nonprofits.4

In this article, we argue that an explicit theoretical basis for understanding the interactions between either ownership form or ownership

2. Measures of economic performance were administrative overhead, cost per admission, measures of technical efficiency, and revenue or charge per admission. Measures of quality of care were in-facility mortality rates, post-discharge mortality rates, adverse outcomes other than mortality, process measures of quality, regulatory violations, malpractice suits, functional improvement during admission, and consumer satisfaction. Measures of accessibility for indigent patients were locating in low-income areas, treating uninsured patients, treating Medicaid patients, facility practices affecting indigent care, and providing unprofitable services.

3. There is overlap in the studies reviewed by Schlesinger and Gray and Rosenau.

mix and hospital behavior can explain mixed empirical findings. A structural model of the internal organization of a hospital should shed light on the mechanisms that generate ownership-based differences or similarities in hospital behavior. The notion that the complex internal organization of the hospital is critically important for driving observed outcomes on cost, quantity, and types of services provided was advanced in the 1970s by Pauly and Redisch (1973) and Harris (1977). Pauly and Redisch (1973) are the first to formalize the idea that hospital services are produced with a combination of hospital and physician inputs and that the physicians are the primary decision makers. Harris (1977) described the hospital as two separate firms, each with its own managers, objectives, pricing strategies, and constraints. This dual internal organizational structure creates complexity in resource allocation and output decisions. Clearly this issue of the effects of a hospital’s internal organization warrants serious examination given the scope of the healthcare services industry in the economy and the importance of hospitals of alternative forms in that industry.

Subsequent to Harris’ analysis, however, of the many studies related to hospital ownership and performance, relatively few focus on hospital-physician control and the effect of physician control on hospital decision making. Exceptions to this are empirical studies by Alexander, Morrisey, and Shortell (1986), Burns, Anderson, and Shortell (1990), Morrisey, Alexander, and Ohsfeldt (1990), Burns and Wholey (1992), Goes and Zhan (1995), Cuellar and Gertler (2006), and Ciliberto and Dranove (2006); and theoretical papers by Custer et al. (1990), Dor and Watson (1995), Broadway et al. (2004), and Crainich et al. (2008). The articles by Morrisey et al. (1990), Goes and Zhan (1995), and Ciliberto and Dranove (2006) examine the effect of hospital-physician integration on performance measures such as output, prices, operating margins, and costs. Morrisey et al. found that output (measured as discharges) was higher in hospitals in which physicians were more formally integrated into the hospital. Goes and Zhan found that physician involvement in hospital governance increased modestly over the period from 1981 to 1990, whereas ownership and financial integration declined significantly. Physician governance was associated with greater occupancy and operating margins while financial integration was associated with lower costs. Direct physician ownership was associated with lower operating margins and higher costs. For-profit hospitals had higher operating margins, lower occupancy rates, and higher costs than the control group of religious-affiliated hospitals. Ciliberto’s and Dranove’s main research question was whether vertical integration between physicians and hospitals affected prices. They do not find any evidence that vertical integration is associated with higher prices.

The studies by Alexander et al. (1986), Burns et al. (1990), and Burns and Wholey (1992) examine the effect hospital and physician characteristics have on physician-hospital integration. Alexander, Morrisey, and Shortell tested hypotheses about the effect of regulatory intensity, physician competition, and hospital corporatization on physician-hospital integration. Of most relevance for this article is the results on the effects of hospital-system ownership. The authors do not find any systematic effect of multihospital system affiliation on hospital-physician relationships. Burns et al. examine the effect of hospital control strategies on efforts to integrate physicians into the hospital and on physician satisfaction and conflict. The strategies examined are economic controls of being salaried or a hospital-based practitioner and governance measures (normative controls) of physicians being on hospital boards and committees. The results suggest that the use of economic and normative controls had little effect on satisfaction and conflict. Burns and Wholey examine whether or not closer hospital-physician relationships had an effect on physician loyalty to the hospital. Three hypotheses are particularly relevant for this article: (1) physicians should be more loyal and less likely to exit when they are involved in hospital governance, (2) physicians should be more loyal and less likely to exit when they are involved in hospital management, and (3) physicians who experience greater conflict with the hospital should be less loyal and more likely to exit. Little support was found for any of these hypotheses.

Cuellar and Gertler (2006) tested the competing hypotheses about the motivation for hospital-physician integration. One hypothesis is that hospital-physician integration leads to efficiency gains from transaction cost economies, thereby allowing providers to offer managed care companies lower prices. The alternative

---

5. This article also has an empirical component.
hypothesis is that hospital-physician integration is a strategic attempt to improve bargaining power in order to secure higher prices from managed care companies. The findings strongly support the market power explanation.

The articles by Custer et al. (1990), Dor and Watson (1995), Broadway et al. (2004), and Crainich et al. (2008) develop theoretical models to explore the relationship between hospital-physician integration and payment system incentives and outcomes. Custer et al. examine the effects of Medicare’s prospective payment system on the production of care given alternative hospital-physician relationships. Dor and Watson explore the incentives and motivations for hospitals and physicians to participate in “bundling” payment schemes whereby payers make a single payment for an episode of hospital care. Bundled payments effectively force hospitals and physicians to negotiate how to allocate the payment. Broadway et al. use an optimal contract approach to examine the efficiency of hospital financing schemes when administrators and physicians are responsible for different decisions within the hospital. Crainich et al. examine the ability of a prospective payment system to ensure an optimal level of quality and cost-reducing activities when decisions about quality are made by physicians and decisions about cost are made by administrators.

In this article, we advance the discussion about the effect of hospital-physician integration by providing a theoretical basis for comparing for-profit and NPH decision behavior and performance. We develop alternative theoretical models of hospital decision making for both PMH and NPH. These explicitly consider hospital decisions in each type of organization. First, we develop a baseline model of a pure profit-maximizing hospital with no agency problem either between administrators and organization principals or between administrators and physicians. Second, we develop a model of each type of hospital that specifies an internal structure and allows for principal-agent differences. The models developed here assume services at any given level of quality and an imperfectly competitive market for hospital services, so that a hospital has some market power and faces a downward sloping demand for its health-care services.

The predicted outcomes of our models differ depending on decision makers. Our models have implications for convergence between for-profit and NPHs and shed some light on the mixed empirical results. The findings indicate that convergence, if observed, may result from sources other than competition for consumers as is typically advanced. Our models demonstrate that convergence instead may result from a complex decision structure with decision control primarily by physicians; similar objectives across different organizational forms; or cost constraints unequally applied to non-profit and for-profit hospitals. This result underscores the importance of understanding the implicit theoretical basis for empirical results, particularly when empirical findings influence tax policies for non-profit and for-profit hospitals.

Following the development of our models in Section II, we examine the implications for convergence in Section III. We discuss policy implications in Section IV, and provide some concluding remarks in Section V.

II. MODELS OF HOSPITAL DECISION MAKING

A. Baseline Models

The relations between medical and administrative staffs of hospitals are typically ignored in empirical studies of hospital ownership and decision making. This may be because of a lack of comprehensive data on hospital administrator/physician relations. The conceptual basis for this approach is the notion that physicians regard hospitals as their workshops (Pauly and Redisch 1973). Although Pauly and Redisch assumed that physicians maximize income, in this market-based PMH, physicians are the primary customers of hospitals and the financial incentives of both groups are essentially aligned. If the financial incentives are aligned then it is unnecessary to draw a theoretical distinction between the objectives of the medical and administrative staffs. The distinction reduces to differences in objectives and the tax exemption for NPHs.

Profit-Making Hospital. We formalize this view in the baseline model of a PMH as a production function of health services. There is no internal organization considered here, which implies that all decision makers act as perfect agents on behalf of owners/shareholders. This baseline model is the standard profit-maximizing model.
of a firm where the objective is to maximize profit of owners/shareholders:

\[
\max \pi_p(x, q) = R_p(x) - C_p(x)
\]

where \( x \) is output, which for hospitals is the quantity of health services provided, \( q \) is the standard (or basic or minimal) level of quality of services, \( R_p \) is total revenue to the hospital from the sale of health services, and \( C_p \) is total cost of providing all health-care services. The first order condition is

\[
R'_p(x) - C'_p(x) = 0
\]

which yields maximum profit \( \pi_p^* \) at the optimal output \( x = x_p \), shown in Figure 1.

For all models we assume the usual diminishing marginal revenue, diminishing marginal utility, and increasing cost. Thus, for any \( R'_j(x) \), \( R''_j(x) > 0 \), \( R''_j(x) < 0 \), for any \( U'_j(x), U''_j(x) > 0 \), \( U''_j(x) < 0 \), and for any \( U_j(q), U'_j(q) > 0 \), \( U''_j(q) < 0 \), and for any \( C_i(x), C'_i(x) > 0 \), \( C''_i(x) > 0 \), where subscript \( i \) refers to organizational structures: PMH hospital or owners/shareholders (\( i = P \)), NPH hospital or stakeholders/principals (\( i = N \)), \( j \) refers to decision makers: hospital administrator (\( j = A \)), hospital physicians or doctors (\( j = D \)).

**Non-Profit Hospital.** The baseline model of an NPH assumes maximizing quantity of health-care services, \( x \), as the objective function, subject to a break-even constraint, \( R_N(x) - C_N(x) \geq 0 \). This NPH baseline model assumes identical revenue and cost functions as a PMH, so that \( R_N = R_P = R(x) \), and \( C_N = C_p = C(x) \). Thus we initially assume the same quality of service as in the PMH which we denote as \( (\bar{q}) \), no donations, or at least that any donations are exactly offset by reduced sales revenue, and no tax exemption.\(^7\) The Lagrangian to be maximized is

\[
\max L = \max (x|\bar{q}) - \lambda [R(x|\bar{q}) - C(x|\bar{q}) - k]
\]

where \( \lambda \) is the Lagrange multiplier. The first order conditions for the Lagrangian are:

\[
\begin{align*}
(4a) & \quad L'_x = 1 - \lambda (R'_x - C'_x) = 0 \\
(4b) & \quad L'_x = R(x|\bar{q}) - C(x|\bar{q}) - k = 0.
\end{align*}
\]

From Equation (4a), \( (R'_x - C'_x) = 1/\lambda \). For \( \lambda = 0 \), \( x \) is maximized when \( R_N(x) - C_N(x) = 0 \), which fulfills the constraint and yields a level of services \( x = x_N > x_P \), shown also in Figure 1. As \( \lambda \rightarrow \infty \), the NPH behaves as a profit maximizer, \( (\pi'_N = 0) \) and \( x = x_P \).

**B. Multiobjective Optimization Models**

The advent of prospective payment for Medicare and selective contracting for Medicare in the early 1980s, and an emphasis on cost containment by private third party payers significantly altered the financial incentives for hospitals. The reduction in reimbursement and increased competition for patients disrupted the tenuous balance between the often conflicting goals of hospital administrators and medical staffs that

\[
\]
was largely maintained in an era of abundant resources. In the new era of declining reimbursement and cost containment, cooperation between physicians and hospital management is increasingly important. We consider this issue by specifying an internal organization in which medical and administrative staffs have different objectives in our managerial models of hospital behavior.8

The following models initially assume an analytical construct of a hospital that consists of two parties: (1) owner/administrator for a PMH or organization/administrator for an NPH and (2) physicians or doctors (for both PMH and NPH) (Harris 1977). The administrator is initially assumed to be a perfect agent who acts on behalf of owners/shareholders in the case of the PMH or the organization as a whole or its stakeholders/principals in the case of the NPH. The physicians or doctors are assumed to have a separate objective function.

The objective functions for each party vary by organization type for the owner/administrator but not for the doctors.9 For a PMH, the objective of the owners/shareholders and therefore the administrator is to maximize profit (πP). For NPHs the objective of the organization and its stakeholders, and therefore the administrator, is to maximize the quantity of services, x, provided for some given level of quality, q, defined by the organization.10

Formally, the different objectives of administrators and physicians can be modeled as a multobjective optimization problem using the weighting method, where \( w_A \) = weight on the administrative objective and \( w_D \) = weight on the physicians’ or doctors’ objective. We do this below for PMH and NPH.

**Profit-Making Hospital.** The objective of the administrator acting as a perfect agent for owners/shareholders in a PMH is the same as that given in the baseline model, shown now in terms of utility maximization of the administrator:

\[
(5) \quad \max U_A = \max \pi_p(x|q) = R_p(x) - C_p(x)
\]

We assume that physicians acquire utility from such factors as income, their professional reputation, professional authority in making medical decisions, and social standing in the community. These factors are not chosen directly by the physician but are articulated in their choices of quantity of services (x) and quality (q). The objective of the physicians or doctors is given as

\[
(6) \quad \max U_D = U_D(\text{income, reputation, authority, social standing}) = U_D(x, q)
\]

We initially assume that revenue and cost depend only on the level of services, so that the relevant constraints are

\[
R(x) - C(x) \geq 0 \quad \text{or} \quad \pi_x - k_1 = 0 \quad \text{and} \quad q \geq \bar{q} \quad \text{or} \quad q - \bar{q} - k_2 = 0,
\]

\[
k_i \geq 0, \quad i = 1, 2.
\]

The first order condition for Equation (5) yields the profit-maximizing level of services, \( x_P \), shown in Figure 1 and now also for the profit function in Figure 2. For doctors, where both the amount of services and quality are explicitly variable, Equation (6) yields a wider range of level of services, x, so that \( x_P \leq x \leq x_N \) in Figure 2. The relevant range of the profit function in Figure 2 is therefore the segment AB. Over this range, \( |\pi'_x| \to \infty \) and \( \pi \to 0 \).

The level of services x that will result in this model depends on the relative preference of doctors for x and q, and the relative weights of the objectives of the administrator and the doctors. The relative preference of doctors indicates the interest of physicians in diverting resources from production of services at a given quality to the increase in the quality of services. The weights of the objectives of the administrators and the doctors indicate the physicians’ ability

---

8. Jelovac and Stadler (2002) consider a similar issue of organizational structure and potential conflict between hospital administrators and medical staffs in contracting with insurers. Their analysis focuses on the efficiency of contracts between insurers and providers under two organizational structures for health services: a centralized structure in which insurers contract jointly with hospitals and physicians; and a decentralized structure in which insurers contract with hospitals and delegate the authority to contract with physicians to hospitals.

9. The similarity or difference of the physicians’ objective function in a PMH or NPH may depend on how quality is defined for each type of organization.

10. Alternatives approaches for modeling the objectives of an NPH include revenue maximization and quality maximization. The motivation for revenue maximization stems from Medicare’s prospective payment system that reimburses hospitals according to prospectively determined per case rates. This system creates an incentive to maximize revenues by increasing admissions. We have examined models in which revenue maximization is the objective (available by request) but chose to focus on output maximization in this article for reasons described in Footnote 7.
to influence allocation of resources and reflect
the potential source of conflict.

The multiobjective problem for this model is
illustrated in Figure 3. The objective function for
the multiobjective decision problem in a PMH is

$$\text{max } Z(x, q) = [\pi(x|\bar{q}), U_D(x, q)].$$

When weighted, $Z$ becomes a function of the
variables and the weights, so that Equation (7)
becomes

$$\text{max } Z(x, q; w_i) = \pi(x|\bar{q}), U_D(x, q),
 w_i], \text{ where } i = A, D \Rightarrow [w_A \pi(x|\bar{q}) + w_D U_D
(x, q)].$$

Simplifying the objective function, we
have

$$\text{max } Z(x, q, w_i) = [\pi(x|\bar{q}) + w U_D(x, q)]$$

where $w = w_D/w_A$, subject to

$$R(x|\bar{q}) - C(x|\bar{q}) \geq 0 \text{ or }$$
$$R(x|\bar{q}) - C(x|\bar{q}) - k_1 = \pi(x|\bar{q}) - k_1 = 0 \text{ and }$$
$$q \geq \bar{q} \text{ or }$$
$$q - \bar{q} - k_2 = 0,$$
$$k_i \geq 0, i = 1, 2.$$

The corresponding Lagrangian to be maxi-
mized is

$$\text{max } L = \text{max } [\pi(x|\bar{q}) + w U_D(x|\bar{q})]$$
$$\pi = \pi(x, q)$$

$$-\lambda_1[\pi(x|\bar{q}) - k_1] - \lambda_2(q - \bar{q} - k_2)$$

where $\lambda_1$ and $\lambda_2$ are the Lagrange multipliers.

The first order conditions for the Lagrangian
are

$$L'_x = \pi'_x + w U'_D(x) = (1 - \lambda_1)\pi'_x + w U'_D = 0$$
$$L'_q = w U'_D - \lambda_2 = 0$$
$$L'_{\lambda_1} = \pi(x|\bar{q}) - k_1 = 0$$
$$L'_{\lambda_2} = (q - \bar{q}) - k_2 = 0$$

PROPOSITION 1. The profit-maximizing level
of output and quality is the same as the baseline
profit-maximizing model when the administrator
has effective control over resource allocation.

Proof. If $w = 0$, from Equation (9) $w U_D = 0$, which indicates that the doctors’ utility function
is irrelevant, that is, the administrator has effec-
tive control over resource allocation decisions
and maximizes owner/shareholder profits. From
Equation (10a) we see that $(1 - \lambda_1)\pi'_x = 0.$
For $1 > \lambda_1 \geq 0$, $\pi'_x = 0$ and $x = x_P,$ the profit-
maximizing output. From Equation (10b) $\lambda_2 = 0,$
which implies that the quality constraint fac-
ding doctors is irrelevant (as is their objective
when $w = 0$), so that quality will be the profit-
maximizing level: $q = \bar{q}.$

This is the same outcome for output as
the baseline profit-maximizing hospital with the explicit assumption of standard quality level as
in the baseline model of Section II.A, “Profit-
Making Hospital.”
PROPOSITION 2. As doctors gain increasing control over resource allocation decisions, the optimal quantity of services and level of quality exceeds the profit-maximizing level.

Proof. When \( w > 0 \), as \( w \to \infty \), from Equation (9) \( w_A \to 0 \), and doctors have increasing control over resource allocation decisions. From Equation (10a), \( (1 - \lambda_1)\pi_x' + wU_{Dx}' = 0 \). For \( \lambda_1 = 1 \) and \( w > 0 \), \( U_{Dx}' = 0 \), so that \( x_p \leq x \leq x_N \). For \( \lambda_1 = 0 \), \( w = -(1 - \lambda_1)(\pi_x' / U_{Dx}') = -\pi_x' / U_{Dx}' \), so that as \( w \) increases, \( x \) increases above \( x_p \) for any \( q \). From Equation (10b), \( U_{Dq}' = (\lambda_2 / w) \). For \( \lambda_2 = 1 \), \( U_{Dq}' = (1 / w) \), so that as \( w \to \infty \), \( U_{Dq}' \to 0 \), and \( q > \bar{q} \). For \( \lambda_2 = 0 \), \( U_{Dq}' = 0 \) and \( q > \bar{q} \).

Thus, as leverage shifts increasingly in favor of doctors, both \( x \) and \( q \) will tend to rise above the profit-maximizing level. As before, if doctors strongly prefer to offer higher quality health-care services, then the amount of services provided by the hospital could be the efficient level (\( x = x_p \)), but at a quality level that exhausts the profit, thus diverting profit from owners/shareholders to quality and increased physician utility.

NPH: Variable Quality, Revenue, and Cost. The model of an NPH allows for variable quality of service provided (\( q \)) and revenue and cost functions that reflect the impact of increasing quality on both revenue (through donations) and cost (of inputs). In addition, this model incorporates the effects of differential tax treatment for NPHs. The differential tax treatment effectively reduces cost to the NPH relative to the PMH because the NPH is tax exempted. The tax exemption is shown in the profit function for the NPH: \( \pi_N = R(x) - (C(x) + T(x)) \). If we apply the same revenue (\( R(x) \)) and cost (\( C(x) \)) to the PMH and NPH, we see that the NPH’s profit function differs from the PMH’s profit function only by the amount of tax exemption. The objective function for this multiobjective decision problem is

\[
\max Z(x, q, w) = [U_A(x, q) + wU_D(x, q)]
\]

where \( w = (w_D / w_A) \), subject to

\[
\pi(x) + T(x) - k_1 = 0
\]

\( q \geq \bar{q} \) or

\[
q - \bar{q} - k_2 = 0
\]

\( k_i \geq 0, i = 1, 2 \).

The corresponding Lagrangian to be maximized is

\[
\max L = \max [U_A(x, q) + wU_D(x, q)]
\]

\[
- \lambda_1(\pi(x, q) + T(x) - k_1)
\]

\[
- \lambda_2(q - \bar{q} - k_2).
\]

The first order conditions for the Lagrangian are

\[
(13a) \quad L_x' = U_A' + wU_{Dx}' - \lambda_1(\pi_x' + T_x') = 0
\]

\[
(13b) \quad L_q' = U_A' + wU_{Dq}' - \lambda_1\pi_x' - \lambda_2 = 0
\]

\[
(13c) \quad L_{k_1}' = \pi(x, q) + T(x) - k_1 = 0
\]

\[
(13d) \quad L_{k_2}' = (q - \bar{q}) - k_2 = 0.
\]

PROPOSITION 3. The level of output in an NPH will exceed the profit-maximizing level when the administrator has effective control over resource allocation, although it may be less than maximum output at which the NPH breaks even.

Proof. If \( w = 0 \), from Equation (13a), \( U_A' = \lambda_1(\pi_x' + T_x') \). For \( \lambda_1 = 0 \), \( U_A' = 0 \) for any \( \pi_x' \) or \( T_x' \), so that \( U_A' \) is maximized and \( x = x_A > x_P \). For \( \lambda_1 > 0 \), \( (U_A' / \lambda_1) = \pi_x' + T_x' \). Consider the case where \( \lambda_1 = 1 \), so that \( U_A' = \pi_x' + T_x' \). For \( \pi_x' = 0 \), at the baseline profit-maximizing output \( x_P, U_A' = T_x' > 0 \) necessarily results in \( x_A = x_P > x_P \) when \( U_A' = 0 \) and where \( x_P \) is the profit-maximizing output with tax exemption. Utility maximizing output therefore exceeds the optimal level. In general, as \( \lambda_1 \to \infty \), \( (\pi_x' + T_x') \) decreases; for any positive marginal tax differential (\( T_x' > 0 \), \( \pi_x' \) becomes increasingly negative, so output expands but is limited by an upper bound, \( x_N > x_N \), where profit with the tax differential (\( x_N > x_N \)) is zero.

In effect, the differential tax treatment acts as a subsidy that generates higher output either with more profit (\( x_A > x_P > x_P \) and \( x_A > x_N \)) or a higher break-even point (\( x_N > x_N \)), as shown in Figure 1.

PROPOSITION 4. Under administrative control, quality level is above the standard profit-maximizing level (\( \bar{q} \)) when both the break-even and quality constraints are not binding.

Proof. From Equation (13b), where \( w = 0 \), \( U_{Aq}' = \lambda_1\pi_q' + \lambda_2 \). For \( \lambda_1 = 0 \), \( U_{Aq}' = \lambda_2 \). If at the same time \( \lambda_2 = 0 \), then \( U_{Aq}' = 0 \), so that \( q_A > \bar{q} \). As \( \lambda_2 \to \infty \), \( U_{Aq}' \to \infty \), and \( q_A \to \bar{q} \).

For \( \lambda_1 > 0 \) and \( \lambda_2 = 0 \), \( U_{Aq}' = \lambda_1\pi_q', \) or \( (U_{Aq}')/ \)
limits investment in quality of services. When $\lambda_1 \to \infty$ with $\lambda_2 = 0$, $U'_A = \pi'_q \to \infty$ and $\pi'_q = 0$, which yields $q_A \to \bar{q}$. A binding break-even constraint limits investment in quality of services.

In this case, the optimal level of quality $q_A$ is greater than the profit-maximizing level when the break-even constraint is not binding. We obtain the result that there is overinvestment in quality and that the quantity of output may be traded off for quality of service. This is an interesting result because it is consistent with the result in the models put forth by Feldstein (1971) and Newhouse (1970) where hospitals are modeled as in the control of administrators who choose quantity and quality to maximize utility. Higher quality is more costly to produce. In our model, however, the tax differential may allow for an increase in quality without trading off quantity. In the Feldstein and Newhouse models, if there is a single demand function for hospital services, then administrators always face a trade-off between quantity and quality. If there are multiple demand curves that reflect greater willingness to pay for higher quality services, then over some range, the manager can increase both quantity and quality. Eventually, a trade-off will have to be made.

**PROPOSITION 5.** When physicians control resource allocation in the NPH, both output and quality will be higher than the profit-maximizing level, even when the break-even and quality constraints are binding.

**Proof.** When $w > 0$, we see the output effect of physician control where from Equation (13a), $U'_D = (\lambda_1/w)(\pi'_q + T'_p) - (U'_A)/w$. As $w \to \infty$ for any $\lambda_1 > 0$, $U'_D \to 0$ and the resulting output will approach the utility maximizing level, that is, $x_D \geq x_P > x_P$. To consider the effect on quality level, rewriting Equation (13b) yields $U'_D = (1/w)(\lambda_1 \pi'_q + \lambda_2 - U'_A)$. For any $\lambda_1 \geq 0$ and any $\lambda_2 \geq 0$, as $w \to \infty$, $U'_D \to 0$, and $q_D \to \bar{q}$. However, as either (or both) $\lambda_1 \to \infty$ or (and) $\lambda_2 \to \infty$, for any $w > 0$, $U'_D \to \infty$, so that $x_D \to x_P$ or (and) $U'_D \to \infty$, thus $q_D \to \bar{q}$. In this situation, the output level would be closer to the profit-maximizing level and there is less overinvestment in quality by doctors, although this behavior persists.

Note also that for $\lambda_1 = 0$ and $\lambda_2 > 0$, $w = (U'_A)/(U'_D)$, the marginal rate of substitution of administrators’ preferences and physicians’ preferences for quality. This indicates that in an unconstrained situation, where output and quality may be at levels beyond the break-even point, that is, the hospital may operate at a deficit, the combination of level and quality of services will depend on the relative leverage ($w$) and preferences of the administrator (who represents stakeholders) and the doctors.

The results of the baseline and multiobjective models are summarized in Table 1. In the multiobjective models, when $w = 0$, it holds that the physician’s utility function is irrelevant and the administrator has effective control over resource allocation decisions. In this case, the results of the multiobjective model for the PMH revert to the baseline model in Section II.A, “Profit-Making Hospital,” ($x_A = x_P$), although this may or may not occur for the NPH where $x_N \geq x_A \geq x_P$.

The interesting case occurs when $w > 0$. Here the physician’s utility function is relevant and physicians have increasing control over

<table>
<thead>
<tr>
<th>Model</th>
<th>Objective(s)</th>
<th>Level of Services ($x$)</th>
<th>Quality ($q$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Org/Admin</td>
<td>Doctors</td>
</tr>
<tr>
<td>Baseline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMH</td>
<td>max $\pi(x/\bar{q})$</td>
<td>$x_P$</td>
<td>$\bar{q}$</td>
</tr>
<tr>
<td>NPH</td>
<td>max $(x/\bar{q})$</td>
<td>$x_N \geq x_P$</td>
<td>$\bar{q}$</td>
</tr>
<tr>
<td>Multiobjective</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMH</td>
<td>max $\pi(x/\bar{q})$</td>
<td>max $(x, q)$</td>
<td>$x_A = x_P$</td>
</tr>
<tr>
<td>NPH</td>
<td>max $(x, q)$</td>
<td>max $(x, q)$</td>
<td>$x_N \geq x_A \geq x_P$</td>
</tr>
</tbody>
</table>

**TABLE 1**
Summary of Predicted Outcomes
resource allocation decisions as the weight of their utility function increases, that is, as \( w_D \) increases and therefore \( w \) increases.

For the multiobjective model of a profit-making hospital, the objective of the administrator is to maximize utility which means maximizing profit because the administrator acts as a perfect agent for the owners/shareholders. As leverage shifts increasingly in favor of doctors (so \( w > 0 \) and increasing), both the level of services, \( x \), and quality, \( q \), tend to rise above the profit-maximizing level. If doctors strongly prefer to offer higher quality health-care services, then the amount of services provided by the hospital will be the efficient level \( (x = x_P) \), but at a quality level that exhausts the profit, thus diverting profit from owners/shareholders to quality and increased physician utility.

The multiobjective model of an NPH allows for variable quality of service \( q \) thus incorporating revenue and cost functions that reflect the impact of increasing quality on both revenue (through donations) and cost (of inputs). In addition, this model incorporates the effects of differential tax treatment for NPHs. Even under administrative control, we note an interesting result with respect to the optimal level of quality. Quality of service depends on the extent to which the break-even and quality constraints are binding. If neither constraint is binding, \( (\lambda_1 = 0 \text{ and } \lambda_2 = 0) \), the model indicates overinvestment in quality. In this case, the utility maximizing level of quality \( q_A \) exceeds the minimal acceptable level of quality \( \overline{q} \). This overinvestment in quality declines if either constraint becomes binding while the other is not. The role of the break-even constraint on the NPH is important. As long as \( \lambda_1 \) is between 0 and 1, there is overinvestment in quality relative to the profit-maximizing level: \( (q_A > \overline{q}) \). However, as the break-even constraint becomes binding, \( q_A \) approaches \( \overline{q} \) and \( q_A = \overline{q} \) when the break-even constraint is binding. A binding break-even constraint, therefore, limits investment in quality of services.

III. IMPLICATIONS FOR CONVERGENCE

In this section, we consider how the predictions from our theoretical models bear on the conflicting empirical findings on the extent of convergence (or not) in the performance of for-profit and NPHs with respect to the amount and quality of services provided. Taking a different approach to reconciling the diversity in the empirical findings, Shen et al. (2007) and Eggleston et al. (2008) conduct meta-analyses of the empirical literature. Meta-analytic methods can be used to understand the factors that account for the variation in the empirical findings by using conventional statistical methods to combine the results from the many empirical studies that examine the effect of hospital ownership on performance and quality. Our models of hospital decision making provide an alternative theoretical approach to reconciling the conflicting findings in the empirical studies.

Our multiobjective models generate testable implications about the amount of services or quality of care provided by an NPH relative to the level provided by a PMH under conditions of viewing a hospital rather than simply as a production function of health-care services as an organization with an internal decision structure. In the latter, typically there is no explicit role for the doctors as decision makers.\(^{11}\) We find that predictions for an NPH may differ from those for a PMH under some conditions (implying no convergence) but may be consistent under others (implying convergence).

\(^{11}\) It is certainly possible to construct a neoclassical model of an NPH as production function where the decision maker is the set of physicians, as Pauly and Redisch (1973) did with their income-maximizing model. We have not carried out that here.
As we have noted, for a profit-maximizing hospital only, under the condition where the hospital administrator has control of resource allocation decisions and doctors are subject to these administrative decisions, predictions of the multiobjective model of a profit-making hospital are identical to those of the baseline model. These results derive from the assumption that the administrator of a hospital represents the interests of the profit-maximizing shareholders.

The predicted quality level is the same for a PMH and an NPH, \( \overline{q} \), only when quality is not of particular interest to either type of organization or decision maker so that standard basic quality is acceptable. The predicted NPH quality level is likely to be greater than the minimum acceptable level of the PMH \( (q > \overline{q}) \) only if it is an explicit argument in the objective function of any decision maker in any model, either administrator or physician. However, our model predicts that quality in an NPH may be greater even when not explicit to the administrator, if physicians have greater weight in the decision process. This suggests that convergence is less likely if physicians own the hospital and control decisions.

The implications for convergence of the comparative behavioral models can be summarized as follows. Where convergence between NPHs and for-profit hospitals occurs, a common explanation is that the convergence results from increased competition in the health-care services industry, primarily as a result of requirements imposed by managed care. (This view is formalized in the baseline model.) Presumably this competition among the suppliers (hospitals) in this industry would take the form of price competition and lead to the optimal level of health-care services, \( x_P \), and quality, \( \overline{q} \). Our models show that this result would occur only if (1) NPHs operate as strict profit-maximizing organizations; (2) NPHs have an internal decision structure and the effective decision maker is the administrator who represents stakeholders who themselves have profit maximization as the hospital’s objective; or (3) a binding break-even constraint limits investment in quality of services. The binding break-even constraint implies that we would expect to observe little difference between for-profit and NPHs in markets where there is less opportunity for large profit margins, for example, a relatively competitive market. This result is consistent with some empirical findings that non-profits behave more like for-profits in less concentrated (more competitive) markets with a significant presence of for-profit hospitals (Duggan 2003; Grabowski and Hirth 2003). In our models, however, the convergence in behavior is not directly attributed to competition compelling NPHs to behave like for-profit hospitals but rather is the result of the internal organizational structure of the hospital.

The alternative explanation from our models is that convergence between NPHs and profit-maximizing hospitals may be an indication (1) that hospitals, whether non-profit or for-profit, may not behave as neoclassical profit-maximizing organizations, and/or (2) of the effect of physician decision making in a hospital with a complex internal decision structure. Where convergence occurs, its effect in these circumstances is that the hospital expands in either (or both) the level of services or (and) the quality of those services, that is \( x \geq x_P \) and \( q \geq \overline{q} \). These results hold across alternative objectives of either shareholders or stakeholders when physicians control resource allocation within the hospital. In this case, the observed output and quality in for-profit and NPHs would not differ significantly in an empirical analysis but the mechanisms generating the behavior are different. Most of the empirical studies of hospital ownership do not explicitly recognize the potential tension between administrators and physicians. This is likely because of data limitations about the relationships between the medical and administrative staffs of hospitals. However, failure to control for this important feature of organizational behavior may partially explain some of the conflicting results.

Note that, in our models, even with competition in the health services industry, convergence of performance across ownership forms will not occur when either (1) NPHs do not have profit maximization as their objective or (2) hospitals have a complex internal decision structure, shareholders and non-profit stakeholders have different objectives, and administrators who represent them have control over resource allocation within hospitals. In these circumstances profit-maximizing hospitals will appear to be more allocatively efficient \( (x = x_P \) and \( q = \overline{q} \) than NPHs \( (x \geq x_P \) and \( q \geq \overline{q} \)).

We find that adding a constraint on cost may result in convergence between non-profit and profit-maximizing hospitals with different objectives only if costs in the NPH are more constrained than costs in the PMH. To see this,
compare organizations with identical revenue and cost structures where the cost constraint is applied equally to both. If the cost constraint is designed to result in a situation of zero economic profit for the profit-maximizing hospital \( (\pi = 0) \) then this would also be the break-even level of output for the NPH. Clearly this implies convergence in observed level of services provided. This outcome requires that costs of the NPH including tax breaks are the same as costs of the PMH without tax breaks. That is, the NPH, without tax breaks, would operate at a higher cost at the same output \( (x_P) \) than would the PMH without tax breaks. The implication of this is that the NPH is producing health-care services \( x_P \) either less efficiently than the PMH is, or that the NPH is producing health-care services \( x_P \) at a higher level of quality than the PMH is.

Thus convergence between a non-profit and for-profit hospital such that their level of services is the same in the absence of tax breaks could imply that any tax breaks to NPH can have either of two effects: increased supply or higher quality of services. Whether increased supply or higher quality are inefficient depends on the assumptions that some given level of services \( x_P \) or given quality of care \( (q) \) is the socially efficient level, and that the for-profit market operates efficiently.

### IV. POLICY IMPLICATIONS

The question remains as to the social welfare and policy implications of convergence. Our models suggest that convergence, if observed, may result from different sources. It is possible that convergence may be a result of (1) price competition for consumers; (2) a complex decision structure with decision control primarily by physicians; (3) similar objectives across different organizational forms; or (4) cost constraints unequally applied to non-profit and for-profit hospitals. Typically, convergence is viewed by researchers in their empirical work and policy makers as non-profits moving in the direction of for-profit hospital behavior (Bloche 1998; Frank and Salkever 2000; Melnick, Keeler, and Zwanziger 1999; Potter 2001; Wilcox-Gok 2002; Duggan 2003). For any of these sources of convergence, it is also possible, as Grabowski and Hirth (2003) suggest empirically, that any convergence that occurs may be a reflection of either for-profit hospitals moving in the direction of NPH behavior or the reverse. In our models, this is derived from the behavior of decision makers within the organizational structure of hospitals. Each of these factors can be formulated into hypotheses that can be tested in an empirical analysis of hospital behavior. For example, the critical parameter in our multiobjective model is \( w \) which measures the relative weight of the physicians’ and administrators’ preferences in the objective function. This theoretical formalization of the internal decision-making structure of the hospital provides a framework for an empirical model in which \( w \) is an unknown parameter associated with a variable measuring decision-making control. An empirical analysis of this type will further our understanding of the relative importance of the different sources of convergence which, in turn, will inform policy.

Our models show that if convergence indicates that NPHs are becoming more like for-profit hospitals, NPHs may then provide a more efficient level of services and quality. Tax policies in place favorable to NPHs could be important to this outcome. Convergence may not be possible without these policies because of the greater constraint in raising capital for investment imposed on NPHs than on for-profit hospitals as a result of the inability to issue stock. Although debt financing through the issue of bonds is possible, the increased debt results in a greater relative risk for an NPH, which is costly.

However, this form of convergence could imply a decrease in efficiency and social welfare if NPHs correct imperfections in the market for health-care services, such as information asymmetries and externalities. The differences in NPH levels of services and quality that diminish with convergence in this case could have served to correct private market deficiencies. This is a concern of some policy makers (Gentry and Penrod 2000; Philipson 2000; Schlesinger and Gray 2006; Horwitz 2003, 2005; Wilcox-Gok 2002). The favorable tax treatment in this case could subsidize corrective behavior in NPHs as they are forced to respond to other market forces, such as price competition.

Our multiobjective models also provide a theoretical explanation for the reverse form of convergence where for-profit hospitals behave more like NPHs. In this case, a testable implication of our PMH multiobjective model is that the level of services and quality exceeds the profit-maximizing level when physicians have greater control over resource allocation decisions. An empirical analysis can evaluate whether such
convergence reflects the inefficiencies of either an internal structural decision process or possibly of physicians seeking pure reputational effects in either a PMH or an NPH. In this case, favorable tax treatment could function in the same way capital market imperfections do by permitting the misallocation of resources in NPHs which would similarly occur in for-profit hospitals at the expense of shareholders. Alternatively, greater than optimal quantity and quality of services could reflect the efficiencies of physicians responding to diverse consumer preferences, for example. Favorable tax treatment could be a source of NPH physician response and promote non-price competition of for-profit hospitals.

V. CONCLUDING REMARKS

The mixed empirical results regarding differences in the behavior and outcome of for-profit and not-for-profit hospitals has sparked a lively debate about the mechanisms underlying the observed behavior. Competition between for-profits and non-profit organizations in the same market is a generally accepted explanation for findings of no differences in the service offerings, quality, or cost of for-profit and NPHs. NPHs move toward greater efficiency as a result of the competition between for-profits and non-profits. Our models indicate that this explanation for convergence only holds if we ignore the internal organization of the hospital. The outcomes of our models that incorporate some internal structure of a hospital are illuminating for the issue of convergence. First, as noted earlier, if objectives of the hospital administrator are primary, then the outcomes for level of services \( (x_A) \) for an NPH are likely to differ from the profit-maximizing amount of the PMH \( (x_P) \), as is the level of quality if quality is not explicitly restricted to the minimum required profit-maximizing level \((\overline{q})\). If, on the other hand, the objectives of doctors are primary and they are in effective control of resource decisions in the hospital, there is no difference between the PMH and the NPH for predicted outcomes of either the amount of services provided \( (x_P) \) or the quality of those services \( (q_D) \), although both may differ from the levels predicted in the competitive baseline model.

Thus, we see that the observed convergence of behavior in NPHs with that of profit-maximizing hospitals may be a result of an internal structure of the organizations that allows for physician control of resources. This is a very different outcome than that predicted by neoclassical models of hospitals, and also is a different rationale for convergence than that of competition forcing NPHs to behave like profit-maximizing hospitals.

REFERENCES


