Hospital Investment Decisions and the Cost of Capital

Author(s): Gerard J. Wedig, Mahmud Hassan, Frank A. Sloan

Source: *The Journal of Business*, Vol. 62, No. 4 (Oct., 1989), pp. 517-537

Published by: The University of Chicago Press

Stable URL: <http://www.jstor.org/stable/2353364>

Accessed: 29/07/2009 01:21

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/action/showPublisher?publisherCode=ucpress>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

JSTOR is a not-for-profit organization founded in 1995 to build trusted digital archives for scholarship. We work with the scholarly community to preserve their work and the materials they rely upon, and to build a common research platform that promotes the discovery and use of these resources. For more information about JSTOR, please contact support@jstor.org.

The University of Chicago Press is collaborating with JSTOR to digitize, preserve and extend access to *The Journal of Business*.

Gerard J. Wedig

Boston University

Mahmud Hassan

Nashville, Tennessee

Frank A. Sloan

Vanderbilt University

Hospital Investment Decisions and the Cost of Capital*

I. Introduction

Hospital investment decisions depend on several factors that are not relevant to the typical for-profit firm. First, most hospitals are not-for-profit organizations. Roughly 60% are privately owned not-for-profits (NFPs); about 25% are operated by public agencies (American Hospital Association 1984). The remaining hospitals are run on a for-profit (FP) basis. NFPs have no clearly defined objectives, and there is no consensus about their objective function (Newhouse 1970; Lee 1971; Feldstein 1977; Sloan 1988).

Second, virtually all payments to hospitals, especially for inpatient care, come from third parties rather than directly from the recipient of care. There are substantial intertemporal and geographic differences in the methods third parties use to pay for hospital care, as well as their generosity (Sloan and Becker 1984). Some plans pay on the basis of the price set by the hospital

This study addresses two issues conceptually and empirically. How does hospital ownership type affect hospital investment choices? How do differences in the way hospitals are paid—cost- versus charge-based reimbursement—affect hospital investment? We compute cost-of-capital measures for both for-profit and not-for-profit hospitals. Whether or not hospital dependence on cost-based payment stimulates investment depends on the generosity of such payment relative to the economic cost of capital. Empirically, we find that for-profit hospital exit/entry decisions are guided by the generosity of payment to a greater extent than the not-for-profits.

* This research was supported in part by grant 18-P-98267/1-02 from the U.S. Health Care Financing Administration (HCFA) to the Center for Health Economics Research with a subcontract to Vanderbilt University. We wish to thank participants in the Microeconomics Workshop at Vanderbilt and Professors J. S. Butler, Cliff Huang, and V. Kerry Smith for helpful suggestions. An appendix is available on request.

(*Journal of Business*, 1989, vol. 62, no. 4)

© 1989 by The University of Chicago. All rights reserved.
0021-9398/89/6204-0005\$01.50

(subject to discounts) while others pay “retrospective costs” in which the insurer compensates the hospital for the “reasonable” costs incurred on behalf of the persons they insure. Yet another system of payment establishes price prospectively, either by formula, negotiation, or a combination of these methods. Medicare, for one, has switched from a retrospective cost to a prospective payment system for paying hospital operating cost, but it still pays capital cost on a limited retrospective basis.

At the very least, these features complicate the task of modeling investment behavior. This perhaps accounts for the limited work on hospital investment to date, an exception being the work of Ginsburg (1970).

The hospital investment problem involves a wide variety of issues of intrinsic interest to economists as well as a unique experimental setting in which to analyze these issues. First, there is the opportunity to study the effects of organization (NFP) status on investment flows. The fact that NFPs coexist with proprietary hospitals offers an ideal “controlled” setting in which to study the question. Second, there is the opportunity to study the effects of forms of demand regulation as well as third-party payment on investment. The issues are similar to those in regulated industries, such as public utilities, and yet unique in the sense that cost-based reimbursement is “mixed” with other forms of reimbursement. Insights gleaned here may thus be applied to other industries, such as defense contracting, where cost-based payment algorithms by some government agencies are mixed with charge-based payment by private customers and some governments as well.

This study thus addresses these issues. How does NFP status—in particular, differences in organizational objectives from their for-profit (FP) counterparts—affect hospitals’ investment decisions? How do the unique sources of hospital revenue affect investment by both hospital types? Does cost-based reimbursement encourage capital acquisition, as argued by many in the industry? Finally, how is the trend toward paying hospitals on a prospective basis likely to affect investment?

Section II presents the model for FP and NFP hospitals separately and solves for key features of their investment and financial behavior. The focus is on how cost-based reimbursement affects the hospital’s cost of capital and on differences in decisions about investment across ownership. Section III deals with specific aspects of NFP hospital investment, emphasizing important differences unique to the NFP-ownership form. Section IV describes our method for developing empirical estimates of the cost of capital for both FP and NFP hospitals by state and year over the time interval 1974–82. Section V presents econometric tests of the role of the cost of capital on hospital entry/exit and investment. Finally, Section VI concludes the article with a discussion of the theoretical and policy significance of our work. We exclude analysis of public hospital behavior in what follows.

II. The Model

The assumptions that define both FP and NFP investment models are similar and are presented simultaneously in order to facilitate comparison.

1. *Objectives.* FP hospitals maximize the market value of the hospital as defined by the summed market value of hospital debt and equity; however, NFP hospitals maximize the discounted present value of the flows of utilities realized by hospital administrators, the board, and medical staff, where utility is a function of both quantity and quality of output (as defined below).¹ The discount rate used to discount flows of utility in the NFP case need not be the same as the rate used to capitalize proprietary cash flows. In what follows we distinguish between these two rates using R to denote the FP discount rate and R' to denote the NFP time rate of preference for utility.

2. *Demand.* The hospital's inverse demand curve for services is a weighted average of the demand of three types of payers: (1) insured charge-based payers, who pay the hospital a price which is a decreasing function of the quantity of charge-based patients served as well as quality, as defined below; (2) cost-based payers, who reimburse the hospital for its variable costs and reimburse hospitals for their capital costs according to a preset formula; and (3) self-insured (uninsured) payers, who also pay according to the hospital's charge schedule but at a greater discount than insured charge-paying patients (Ginsburg and Sloan 1984). Traditionally, charge-paying insurance has been less complete than the cost-based variety. For this reason, consumers covered by charge-based insurance are responsive to price. Thus, the insured charge-based demand curves, as well as the uninsured demand curves, slope downward for the usual reason.² We assume that the cost-based demand curve has an elasticity of zero. Mathematically, the formula for the hospital's inverse demand curve is given by

$$p' = \beta p(\cdot) + \alpha \left(\frac{wL}{X} + \frac{rqK}{X} + \frac{qZ'I}{X} \right) + (1 - \alpha - \beta)\pi p(\cdot), \quad (1)$$

where

p' = weighted average price;

β = proportion of hospital receipts from charge-based payers;

p = market price of output (charge-based price);

1. This is the same assumption made by Newhouse (1970) and Feldstein (1977). For the sake of focus, we do not consider the possibility that administrators, boards, and medical staff have different or conflicting objectives.

2. Since 1982, there has been growth in charge-paying insurers; e.g., health maintenance organizations and preferred provider organizations, which obtain sizable discounts from charges. These insurers had negligible market shares during the period covered by this study and therefore are not considered here. We treat Medicare reimbursement as cost-based.

- α = proportion of hospital receipts from cost-based payers;
 w = wage rate;
 L = level of labor input;
 X = quantity of output;
 r = weighted average return on debt and equity paid by cost-based payers;
 q = price of capital good;
 K = level of capital inputs;
 Z' = present value of depreciation reimbursed by cost-based payers per dollar of investment;
 I = level of investment expenditure; and
 π = proportion of p paid by uninsured patients.

Both NFP and FP hospitals face the same inverse demand curve.³

3. *Production.* Both types of hospitals use capital (K) and labor (L) to produce quantity (X) and quality (Y) with production technologies

$$X = F(K, L) \quad (2)$$

and

$$Y = G(k, \ell), \quad (3)$$

where $k = K/X$ (capital intensity) and $\ell = L/X$ (labor intensity).⁴

4. *Finance.* Investment capital for FP hospitals may be obtained from any of three sources: (1) retained earnings, (2) stock issue, or (3) debt issue. However, we assume perfect certainty; the hospital's optimal mix of funding depends on the associated tax liabilities of investors and its level of tax shields (DeAngelo and Masulis 1980). We assume that all investment expenditures by FPs are financed with the optimal mix of funding so defined.⁵ Funds for investment for NFP hospitals can be generated from either of two sources, (1) retained earnings or (2) debt issuance. Technically speaking, NFP hospitals can also obtain investment funding from government grants or philanthropy, but these sources of funding have largely disappeared (Cohodes and Kinkead 1984) and thus are not considered here.⁶

3. In the calculations that follow, the payer shares are assumed to be optimized at the margin in order to maximize average revenues. Moreover, an internal solution to the problem is assumed to exist so that, e.g., $P_\alpha = 0$ at all points in time. The significance of this assumption lies in the fact that the envelope theorem implies that if hospitals continuously maximize with respect to payer shares, these shares can be treated as exogenous in the derivation of optimal capital stock. This point is reiterated in the calculations.

4. This input-oriented specification of quality has been used by Newhouse (1970), Feldstein (1977), and others in studies of hospital behavior.

5. Under a more realistic scenario incorporating uncertainty, the risks of bankruptcy would also have an impact on the funding decision (see Wedig, Sloan, Hassan, and Morrissey 1988). However, this added refinement would not affect any of the key results to follow.

6. Failure to measure the cost and level of philanthropy should not bias our measure of the cost of capital because (1) the share of philanthropy is very small, and (2) hospitals set the marginal cost of philanthropy equal to cost of other funding sources, the costs of which we do measure.

The Proprietary Case

Given assumptions 1–4 above, the FP hospital's investment problem can be solved using the technique of optimal control. Without any theory to guide the costs of adjustment, the technique chosen here ignores such costs. We estimate the costs of adjustment empirically, using a distributed lag as in Jorgenson (1963).

The FP hospital is like any other firm with respect to its financing, and this behavior is already well understood. For-profit financing proceeds according to the standard theory of optimal capital structure, which in turn determines its cost of funds, R .

Under our model, the FP hospital's problem can be written as

$$\max \int_0^{\infty} e^{-Rt} \{ (1 - \tau)[p'F(K, L) - wL] - q(1 - \psi)I + \tau ZqI \} dt, \quad (4)$$

subject to

$$\dot{K} = I - \delta K, \quad (4a)$$

and where

ψ = investment tax credit available to FP hospitals;

Z = present value of depreciation allowance for corporate tax purposes (distinct from Z');

and

$$p' = \beta p + \alpha \left(\frac{wL}{X} + \frac{rqK}{X} + \frac{qZ'I}{X} \right) + (1 - \alpha - \beta)\pi p. \quad (1)$$

Equation (4a) gives the basic differential equation guiding movements in the stock of capital, while (1) reiterates the basic demand constraint facing hospitals.

The solution to (4) subject to the constraints (4a), incorporating the above assumptions, yields this first-order condition for the hospital's stock of capital:

$$\begin{aligned} & pFK + p_y Y_k X + p_x X_K X \\ & = q \left(\frac{(R + \delta)(1 - \psi - \tau Z) - (1 - \tau)\alpha[r + Z'(R + \delta)]}{(1 - \tau)[\beta + (1 - \alpha - \beta)\pi]} \right). \end{aligned} \quad (5)$$

Details of the derivation of marginal conditions for capital in both FP and NFP sectors are presented in an appendix available from the authors.

Intuitively, equation (5) instructs the hospital to set the marginal revenue product of capital equal to its marginal input price. The right side of (5) represents a modified cost of holding capital inputs, where

the modification incorporates the peculiar elements of cost-based reimbursement. The first term in the numerator on the right side of (5) is the standard Jorgenson cost of capital, incorporating the various tax-related incentives to hold capital as well as the interest and depreciation rates, while the second numerator term measures the reimbursement that cost-based payers allow for capital expenses. If there were no cost-based reimbursement, α would equal zero, and the hospital's cost of capital would just be Jorgenson's cost of capital.

Equation (5) can be further refined to account for some additional institutional characteristics of hospital payment. Blue Cross, the main private insurer that often reimburses on cost, sometimes pays a plus (γ) on reasonable cost (excluding cost of equity) as a partial return on equity. In addition, mainly because of bad debts, insured charge-based patients paid 96% and uninsured patients only paid 72% of hospital charges in 1981 (Ginsburg and Sloan 1984). Although these percentages have undoubtedly varied over time, no data are available to document this. Equation (5) then can be rewritten as

$$\begin{aligned}
 F_K + \frac{p_y Y_K X + p_x X_K X}{p} \\
 = \frac{q}{p} \left(\frac{(R + \delta)(1 - \psi - \tau Z) - (1 - \tau)(\alpha + \gamma \cdot BC)[r + Z'(R + \delta)]}{(1 - \tau)[.96\beta + (1 - \alpha - \beta)(0.72)]} \right) \\
 = \frac{c}{p},
 \end{aligned}
 \tag{5a}$$

where BC equals the proportion of revenue from Blue Cross cost-based plans, and (c/p) is henceforth referred to as the cost of capital.

The effect of cost-based payer dependence on capital acquisition is ambiguous. Its sign depends on the relative generosity of cost-based payment compared to the hospital's true economic or "Jorgensonian" cost of capital. Specifically, it can be shown that if the effective return that the hospital's cost-based payers allow *exceeds* the hospital's Jorgensonian cost of capital, then marginal increases in cost-based share should stimulate capital acquisition and vice versa.⁷ Intuitively, this occurs because a marginal increase in cost-based share represents

7. This can easily be shown by differentiating the right side of (5) with respect to the proportion of cost-based payers, α . This result stands in interesting contrast to the prevailing wisdom held by industry "practitioners," which holds that cost-based reimbursement reduces the hospital's cost of capital and hence always encourages capital acquisition. The present result shows that such a claim rests on the assumption that either cost-based payment (a) reduces financial risk (a factor not considered in our model of perfect certainty) or (b) is paid so generously that it exceeds the economic cost of capital.

a substitution of cost-based for charge-based revenues. Whenever the cost-based return on capital exceeds its Jorgonsonian cost, cost-based payers return more than charge-based payers at the margin and the substitution encourages capital acquisition. While cost-based reimbursement possibly introduces a distortion on capital input use, there is no parallel distortion on the labor side (except through the insurance effect on quantity and quality) since the cost payer always pays the market wage, no more or no less. Thus, one implication of this modified Averch-Johnson (1962) result is that cost-based payers who pay the hospital something other than its Jorgensonian cost of capital induce the hospital to use an allocatively inefficient capital-to-labor ratio.

III. Extensions to Not-for-Profit Hospitals

Perhaps the biggest obstacle in extending the FP hospitals results is delimiting the number of possible objectives that NFPs may have. A general approach, and the one utilized here, is to extend Feldstein's (1977) model of quantity and quality maximization. Using his assumption that NFP hospitals maximize a utility function in the quantity and quality of care, we model the effects of reimbursement methods on investment and compare the results to those obtained under profit maximization.

Formally, then, we assume that hospital behavior and constraints are summarized by the above assumptions. Thus the hospital chooses quantity (X) and quality (Y) to

$$\max \int_0^{\infty} e^{-R't} U(X, Y) dt, \quad (6)$$

subject to a break-even constraint

$$p' + d = AC, \quad (6a)$$

where d equals the hospital's net borrowing per unit of output [$D/F(\cdot)$], and AC equals average cost:

$$AC = \left(\frac{wL}{X} + \frac{qI}{X} + \frac{\bar{r}B}{X} \right), \quad (6b)$$

where $\bar{r}$ equals the market interest rate on debt, and B equals the hospital's stock of debt.

Finally, (6) is also constrained by the differential equations

$$\dot{K} = I - \delta K, \quad (6c')$$

and

$$\dot{B} = D. \quad (6c'')$$

Substituting (6b) and (1) into (6a), the constraints defined above collapse into a single constraint expressing the hospital's labor-to-output ratio (or labor intensity) as a function of its level of investment net borrowing and other variables. Thus, (6a)–(6b) and (2) become

$$\ell = \frac{[\beta + (1 - \alpha - \beta)\pi]p + \alpha(rb + Zqi) + d - qi - \bar{r}b}{(1 - \alpha)w}. \quad (6d)$$

Finally, substituting this constraint together with (6c) and the production function relationships (2)–(3) into the original objective function, the NFP hospital's problem can be rewritten as

$$\max \int_0^\infty e^{-R't} \left\{ U \left[F(K, L), G \left(k, \frac{[\beta + (1 - \alpha - \beta)\pi]p + \alpha(\bar{r}b + Zqi) + d - qi - \bar{r}b}{(1 - \alpha)w} \right) \right] \right\} dt, \quad (6e)$$

subject to constraints (6c') and (6c'').

The NFP hospital's first-order condition for capital is

$$\begin{aligned} & \frac{w}{U_2 Y_\ell} \left(U_1 \eta X_K X + U_2 \eta Y_k + \frac{U_2 Y_\ell (p_X X_K X + p_Y Y_k X)}{w} \right) \\ &= q \frac{(R' + \delta) - \alpha[Z(R' + \delta)]}{\beta + (1 - \alpha - \beta)\pi}, \end{aligned} \quad (7a)$$

where

$$\eta = \frac{1 - \alpha}{\beta + (1 - \alpha - \beta)\pi}.$$

Its marginal condition for borrowing is

$$R' = (1 - \alpha)\bar{r}. \quad (7b)$$

As in the proprietary case, equation (7a) instructs utility-maximizing hospitals to set the marginal value (in this case, utility) of capital equal to its marginal cost or shadow price. The difference in this case is that the marginal value of capital is measured by its contributions to hospital quantity and quality, adjusted by the factor $(w/U_2 Y_\ell)$ to convert utility units into dollar terms. The tax policy parameters for the NFP hospital are zero.

Like the proprietary hospital, the NFP institution's cost of capital is a modified Jorgensonian cost, where, as before, the hospital's reliance on cost-based payers ambiguously affects the shadow price of capital. Indeed, the only difference between the right side of (5) compared to the right side of (7a) are (i) the absence of tax parameters and (ii) the absence of an explicit return on assets paid by cost-based payers.⁸ As

8. Of course, cost-based payers do allow a "pass through" of debt service and in this sense allow a return on assets. This return does not appear on the right side of (7a) because the model does not make this payment contingent on the level of physical assets

before, the effects of cost-based reimbursement on capital acquisition are ambiguous, the sign depending on the relative generosity of cost-based reimbursement compared to the true economic cost of holding capital ($R' + \delta$).

Condition (7b), which gives the hospital's marginal condition for borrowing, indicates that the hospital sets the marginal cost of debt and equity financing equal to one another in deciding its optimal funding mix. The interesting aspect of this condition is the fact that the cost of debt is discounted by $(1 - \alpha)$ in comparing it to the opportunity cost of hospital-generated equity. This reflects the simple fact that cost-based payers do not pay NFP hospitals a return on invested equity although debt expenses are passed through.⁹ Thus the effective cost of debt is discounted by a factor equal to $(1 - \alpha)$.

More important are the effects of these unique characteristics of hospital finance on the hospital's investment decisions. Inspection of (7a) shows that the NFP cost of funds differs from the normal proprietary case in that it is measured by the discount rate applied to utility flows. Assuming that the costs of debt and equity are equal at the margin, this parameter is an accurate measure of the overall marginal discount rate applied to utility flows. Clearly this measure of the cost of funds may differ from the FP hospital's measure, which is constructed from the average tax-adjusted costs of debt and equity. Specifically, the NFP hospital's tastes for immediate consumption of utility will tend to raise its costs of funding and vice versa.

Finally, in the absence of significant levels of risk, (7b) may not hold as an equality with $(1 - \alpha)\bar{r} < R'$ at the margin. If so, hospitals would use 100% debt finance, and their cost of funds would be the cost of debt.¹⁰

IV. Cost of Capital Estimates

We developed cost of capital estimates for FP and NFP hospitals based on equations (5) and (7a). Measures of (c/p) were developed for 49 states (excluding Alaska and Hawaii but including the District of Columbia) for the years 1974–82, separately for FP and NFP hospitals.

Parameters that vary over time *and* by state are the frequency distri-

the hospital holds. In reality the debt expenses associated with physical assets only are allowed in that a complicated series of rules disallows earnings on financial assets. Below, the calculation of the NFP cost of capital acknowledges this by including the debt service payment in the cost-based reimbursement level for physical assets.

9. We discuss the nature of the bias cost-based payers inject into the NFP hospital's borrowing decision in greater detail in a recent article. See Wedig et al. (1988).

10. The theoretical possibility of 100% debt finance and its implications for the cost of funding are emphasized here to reflect the fact that so much of recent NFP funding has been through the use of debt. See Cohodes and Kinkead (1984) for a discussion of trends in hospital debt-versus-equity financing.

bution of payer shares by type of payer (commercial insurers, which always pay charges; Blue Cross, which is classified according to whether the plan paid cost or charges; Medicare and Medicaid, which always paid cost; and self-pay), output price, and, for Blue Cross cost plans, depreciation policy and the plus factor.

Data on payer shares came from several sources. Data on private payer benefit payments for hospital care came from annual issues of the Health Insurance Association of America's *Source Book of Health Insurance Data* (1974–82). Data on payments for hospital care by Medicare and Medicaid were drawn from various publications by the Social Security Administration and the Health Care Financing Administration. Data on spending for hospital care, needed to compute the payer shares, came from American Hospital Association's (AHA) "Annual Hospital Survey" (1974–82). We determined whether the Blue Cross plan paid on a cost- or charge-basis and the Blue Cross plan depreciation policy and plus factor from unpublished surveys of Blue Cross plans.¹¹ Although there has been considerable interstate variation in the cost-based share for decades, there was no trend in this share during 1974–82, but the share of revenue from self-pay sources increased.

The output price came from unpublished "Annual Hospital Survey" (1974–82) data aggregated by state and year with 1977 = 1.0 and New York the base state. Our index of investment-good prices is by region and year. We used unpublished construction-cost data by nine census divisions and years from the U.S. Bureau of Economic Analysis. We used annual data for the equipment component of the index from the *Survey of Current Business*. Equipment prices do not vary by region. We assigned weights derived from investment data from the 1982 "Annual Hospital Survey" to combine the construction and equipment indexes and set the Middle Atlantic census division and 1977 equal to 1.0.

We computed the real cost of funds from

$$R = W_d[(1 - \tau)i - \bar{\pi}] + (1 - W_d)e, \quad (8)$$

where

- W_d = debt as a proportion of sum of debt and equity;
- $\bar{\pi}$ = inflation rate (percent change in Consumer Price Index);
- e = real cost of equity; and
- i = effective interest rate (weighted average of taxable and tax-exempt bond rate).

11. Data on Blue Cross plans came from periodic surveys of Blue Cross plans conducted by the American Hospital Association for 1974, 1976, 1979, 1981, and 1983. We had to interpolate values for the intervening years.

For proprietaries, we calculated the real cost of equity using a dividend growth model, which is based on dividend and growth in earnings of five large hospital companies.¹² The real cost of equity capital for NFP hospitals presumably reflects the opportunity cost to the hospital of investing in itself rather than outside the hospital. We took the Moody's AAA bond yield to represent this opportunity cost.¹³ If measurement of equity cost to a for-profit organization is controversial, the underlying issues are even less settled in the context of nonprofit institutions.

Estimates of several tax-related parameters were needed for calculating the cost of capital to proprietaries. To compute the corporate tax rate (τ), we assumed a constant rate of 0.4. To derive this rate, we examined effective corporate tax rates for the five largest hospital companies from 10-K reports and found very small intertemporal or inter-company differences about 0.4. Values of ψ , the investment tax credit (ITC) term, were obtained from 10-K report data on the effective relationship of credits to net investment from one large hospital company. We allowed the ITC to vary by year. Finally, to calculate the present value of depreciation per dollar of investment for tax purposes (Z), we assumed hospitals used an accelerated depreciation method and we took allowable useful lives for plant and equipment from Commerce Clearing House (1983).

Next, measures of the parameters of cost-based payment were constructed. Estimates of the present value of depreciation payments (Z') vary by payer. Medicare and Medicaid depreciation policy was uniform during the observational period, but policies of Blue Cross plans varied markedly, both cross-sectionally and over time. In addition, both FP and NFP hospitals had their debt expenses passed through although Medicare-Medicaid's explicit payment on equity was reserved for proprietaries. Blue Cross, on the other hand, granted a cost-plus factor to all hospitals in some states.

Annual estimates of the cost of capital are shown in figure 1. The cost of capital generally declined during the 1970s, largely due to substantial increases in the output price (p). Feldstein (1982) found similar trends in cost of capital during much of the 1970s for the economy as a whole. The estimated cost of capital to FP hospitals is sensitive to the method used to compute the cost of equity capital. Using the dividend-growth model yields a very low cost of equity capital to FP hospitals. With a bond-based measure of equity cost, trends for the FPs and

12. To calculate the equity cost from the dividend growth model, we used a 3-year moving average of earnings growth.

13. The simple correlation of this series with the dividend-to-equity ratio (book value) for the United States as a whole, 1974–82, is 0.23. A dividend ratio has often been used to represent the cost of equity capital in studies of the U.S. economy (see Bosworth 1985).

FIG. 1.—The cost of capital, 1974–82

NFPs are similar even though the cost of capital to FPs is generally appreciably higher. We found substantial interstate differences in cost of capital with states with high proportions of cost-based payers generally having the highest values.

Given the many variables that enter our cost-of-capital calculation, it is difficult to deduce which variables account for most of the variation in (c/p) . To assess sources of variation in (c/p) , we estimated (c/p) equations separately for FP and NFP hospitals. Judging by the levels of statistical significance in the two equations for (c/p) , the most important variables are the cost-based revenue share (α), a positive effect, output price (p), a negative effect, the real cost of funds (R), a positive effect and the self-pay proportion of total hospital revenue, a positive effect. The cost-based share has the greatest explanatory power. With this variable entered alone, the R^2 is 0.38, in the FP (c/p) equation, compared to 0.84, with all components of the cost of capital formula added, and 0.48, in the NFP hospital (c/p) equation, out of a total explained variation of 0.75. Further details on our calculations of the cost of capital are available from the authors.

V. Empirical Analysis

Exit-Entry: Rationale and Specification

We divided our empirical work into two broad parts. First, we tested the hypotheses that proprietary hospital investment decisions are guided by the cost of capital measure developed above and that NFP investment preferences are interdependent with FP behavior. To test these hypotheses, we ran tests of both the likelihood that proprietary hospitals are found in given states as well as their share of beds in a given state as a function of the state-specific cost of capital prevailing in the area.

More specifically, we related (1) the probability that proprietary hospitals will locate in a state and year and (2) the fraction of proprietary beds to total beds in the state and year to several explanatory variables: cost of capital (c/p); state regulatory programs; real state per capita income; and a measure of state liberalism. The regulatory variables describe the share of hospital revenue covered by young (less than 3 years of age) or mature (older than 3 years) state prospective payment programs (price control programs over hospitals) and by certificate of need programs of various ages (entry controls). All of these programs are described in more detail elsewhere (Sloan 1981). State liberalism is a proxy for political bias against corporate medicine and was measured by the fraction of votes by state against George McGovern in the 1972 presidential election.

The probability equations were estimated with probit. One time-series cross-section bed-share regression included state binary variables (fixed-effects model). Data on beds came from reports published annually by the American Hospital Association (now published annually in *Hospital Statistics*). Using this fixed-effects specification, we accounted for various historical reasons for hospital location decisions that have nothing to do with cost of capital or the other included independent variables. We had to drop the state variables from the probit analysis because there was too little intertemporal variation in the presence or absence of FP hospitals in a state. We emphasized 1982 in our empirical work since this is the most recent year in our data set.

We also compared mean values of (c/p) for hospitals in different ownership categories and by whether they were affiliated with a chain or were independent. To the extent that FP hospitals' investment decisions are particularly sensitive to the cost of capital, they should be concentrated in areas with low (c/p). Therefore, we would expect mean (c/p) to be relatively low for proprietary hospitals. Data for this test came from unpublished microdata from the 1982 AHA "Annual Hospital Survey" and from a special survey of multihospital systems conducted in 1983–84 by the American Hospital Association.

TABLE 1 Empirical Results: Proprietary Hospital Bed Share

Explanatory Variables	Probability That State Has Proprietary Beds ^a		Proprietary Share (Share > 0) ^b			
	1976–82	1982	1976–82		1982	
	(1)	(2)	(3)	(4) ^c	(5)	(6)
<i>c/p</i>	–2.846* (1.057)	–13.444** (6.191)	–.411* (.104)	–.115* (.023)	–.914* (.475)	–.909*** (.533)
PRY	1.981 (1.285)	–39.306 (53.415)	–.088** (.040)	–.015 (.011)	...	...
PRO	.704 (.441)	1.142 (1.331)	–.110* (.029)	–.027*** (.014)	–.045 (.050)	–.043 (.057)
PRECON	–.432 (.300)	...	–.029 (.029)	–.001 (.005)	...	...
CONNEW	–.380 (.295)	1.001 (5.990)	–.023 (.022)	–.001 (.005)	–.106 (.079)	–.121 (.083)
CONOLD	.171 (.254)	–1.399 (5.391)	.015 (.019)	–.002 (.007)	–.037 (.070)	–.041 (.072)
RINC (000)	–.346* (.098)	–.180 (.346)	.019* (.008)	–.008 (.005)	...	–.002 (.018)
RE PUB	...	1.154 (3.246)	...	...	...	–.114 (.138)
CONS	3.324* (.655)	4.071 (6.581)	.029 (.050)	.286* (.041)	.225* (.072)	.315* (.163)
<i>R</i> ²	...	...	.21	.97	.35	.37
<i>F</i> -statistic	...	...	7.55	206.81	3.19	2.12
<i>N</i>	343	49	203	203	30	30

NOTE.—*c/p* = real cost of capital; PRY = fraction of hospital revenues covered by mandatory prospective payment program less than three years of age; PRO = fraction of hospital revenue covered by mandatory prospective payment program three years of age or older; PRECON = 1 for the year before a certificate-of-need program was implemented and the first year past implementation; CONNEW = 1 for the second and third years of a certificate-of-need program; CONOLD = 1 for the fourth and subsequent years after implementation of certificate of need; RINC = per capita personal income deflated by a state price index; REPUB = fraction of the vote against McGovern in the 1972 presidential election; CONS = intercept. SEs are given in parentheses.

^a Estimated with probit.

^b Only states with positive proprietary shares in all years are included.

^c Variant contains state dummies.

* Statistically significant at 1% level (two-tailed test).

** Statistically significant at 5% level (two-tailed test).

*** Statistically significant at 10% level (two-tailed test).

Exit-Entry: Empirical Results

The cost of capital affects both the probability that a state had any proprietary hospital beds (regressions 1 and 2, table 1), and for those states with beds, the share of total beds in nonfederal, short-term general hospitals (a category that includes most hospitals but excludes hospitals with mean lengths of stay of over 30 days) under FP ownership. Although the coefficients of (*c/p*) vary in table 1, this variable has a statistically significant effect at the 5% level or better in five out of six regressions (two-tailed test) and is significant at the 10% level in a

1982 single cross-section of bed-share regressions (regression 6), which is based on many fewer degrees of freedom. Elasticities computed at the mean are -0.448 , -0.125 , -0.757 , and -0.753 for the third through sixth regressions, respectively. The lowest elasticity is from the fixed effects specification (regression 4). We were concerned that results on (c/p) may merely reflect omitted state effects, but the result stands even in the fixed-effects model. There is some indication that price regulation of hospitals retarded proprietary share (see table 1, nos. 3 and 4) but, as in past studies, certificate-of-need programs, which require hospitals to obtain formal approval from a state agency before entering, have no influence on either dependent variable (see Sloan [1981, 1982] for a review).

We also estimated share equations for NFP hospitals. The (c/p) variable consistently had a significantly positive effect on market share. An explanation for this result is that the residual claimants of NFP hospitals, local community leaders, board members, doctors in the community, and local philanthropists do not compare returns of alternative investments geographically and over time. Rather, they pick up the slack of FP lack of entry resulting from high values of (c/p) . Surely residual claimants living in Peoria would not be indifferent between two hospitals in Peoria, one in Tampa and one in Peoria, and two in Tampa. The owners of a hospital company would prefer two in Tampa and none in Peoria if the prices justified this allocation decision.

We compared the mean cost of capital in 1982 by hospital ownership and affiliation in order to further test the hypothesis that proprietary hospitals locate where this cost is lowest. The measure of (c/p) for proprietaries was used for all hospital types so as not to introduce variation in the means from this source. Our cost of capital measures for the two ownership types are highly correlated ($\text{corr} = 0.9$).¹⁴ As seen in table 2, the mean (c/p) for proprietary hospital chains was much less than the (c/p) for all other hospitals, including independent nonprofit hospitals and hospitals owned, sponsored, or leased by an outside nonprofit organization (nonprofit chain). Moreover, the mean value of (c/p) was significantly higher (5% level or higher) for independent nonprofit hospitals than for the other hospital types shown in table 2. Finally, the 1982 (c/p) of hospitals contract managed by proprietary organizations was almost the same as the value for hospitals contract managed by private nonprofit organizations and over a percentage point higher than (c/p) for the proprietary chains. This is not at all

14. This correlation is very high even though the for-profit and NFP cost of capital were computed using different assumptions about the cost of equity. We also computed two sets of cost of capital estimates for for-profit hospitals using alternatives as the bond rate and the dividend growth models, and estimates were very close. The two series are available from the authors. As noted above, the main source of variation in (c/p) is attributable to differences in the cost-base share. This variable is well measured.

TABLE 2 Mean Cost of Capital by Hospital Ownership, 1982

Private Nonprofit			Proprietary		
Independent	Chain	Contract Managed	Independent	Chain	Contract Managed
.109 (.076)	.090* (.039)	.085* (.026)	.088* (.040)	.072** (.020)	.086* (.035)

NOTE.—SEs are given in parentheses.

*Mean significantly different from mean for private, not-for-profit chain hospitals.

**Mean significantly different from mean for private, not-for-profit independent hospitals (5% level).

surprising since such companies manage such hospitals for a fee; they do not invest in them. Thus, results from table 2 strongly support the table 1 findings based on regression analysis.

Net Investment per Private Not-for-Profit Hospital: Rationale and Specification

Although we felt we could learn a lot about investment behavior and the importance of our cost of capital measure to FP hospitals by looking at the probit and share equations, we also sought to validate the relevance of our cost of capital measure for NFP hospitals directly. Thus, in the second part of our empirical work, we estimated equations for real net investment per hospital for NFP hospitals only. Unpublished investment data by state and year, 1976–82, derived from “Annual Hospital Surveys,” were obtained from the American Hospital Association. A parallel analysis for FP hospitals was not possible because there were so many nonresponses to the surveys.

We brought the marginal condition given in equation (7a) into operation by assuming that the marginal product of capital in the production of both quantity and quality is an exponential function of the ratio of quantity to capital, that is,

$$X_K = Y_K = \lambda \left(\frac{F(\cdot)}{K} \right)^{\rho+1}, \quad (9)$$

where ρ is some arbitrary parameter. Holding the output-to-labor ratio constant, this assumption generates an investment specification that is identical to a Jorgenson-type flexible accelerator (Jorgenson and Stephenson 1967) using a Cobb-Douglas or CES technology, where $\sigma = 1/(1 + \rho)$ is the elasticity of substitution.

We specified the dependent variable to be mean NFP hospital investment expenditures deflated by a Bureau of Labor Statistics investment-goods price index. We considered two alternative measures of hospital output—adjusted patient days (the adjustment converts outpatient visits into inpatient equivalents) and real hospital revenue, where the deflator was a measure of cost of living in the state with New York in

1977 = 1.0. The revenue measure recognizes qualitative differences in output of the type that our nonprofit model sought to capture.

Rather than estimate nonlinear regressions, we estimated investment equations by ordinary least squares, assuming alternative values for σ . Likelihood-ratio tests were then performed to test for differences in results based on alternative values of σ .

Since the flexible accelerator model includes output terms, (c/p) only affects capital stock via a substitution effect. But the cost of capital may also affect quantity (and quality). Finally, note that the hypothesized effect of the cost of capital measure on NFPs is not unrelated to the findings in the first part of our work. As noted above, a finding that NFPs respond to the behavior of proprietaries would tend to diminish the anticipated negative impact of the cost of capital on their investment flows.

Net Investment per Private Not-for-Profit Hospital: Empirical Results

We applied the flexible accelerator model (Jorgenson and Stephenson 1967) in the analysis of real net investment per NFP hospital by state and year 1976–82, using asset data from 1974 and 1975 for lagged variables and allowing the elasticity of substitution parameters, σ , to vary between zero and one (table 3). The odd-numbered regressions are based on output measured by the change in adjusted patient days. Even-numbered regressions use real revenue-based output change. The results, based on a specification with σ set equal to one, show negative output change terms and are implausible with either output measure. Conversely, the real revenue change results for σ equal to zero are plausible, but the adjusted patient-day change terms are implausibly negative. Far better results on adjusted patient-day change in terms of the estimated coefficients and statistical significance were obtained with σ assumed to be greater than zero and less than 0.2. The even-numbered regressions are about the same with σ in the 0–0.15 range. The coefficients on lagged investment are uniformly negative, statistically significant, and stable across regressions. The size of the coefficient (-0.4) implies that the capital stock value converges to a new equilibrium value after the hospital system has been subjected to an exogenous perturbation.

We performed a likelihood-ratio test to determine whether the σ -equal-to-one specification could be rejected in favor of a technology with a lower σ , but the χ^2 s were always below the threshold for statistical significance at conventional levels. We suspect the reason is that the state dummy variables picked up most of the unexplained variation due to misspecification. In any case, it seems best to rely on the specifications based on relatively low σ , as these specifications have more plausible coefficients. In earlier specifications, we also included the regulatory variables shown above in table 1. These variables, taken

TABLE 3 Real Net Investment per Private Not-for-Profit Hospital

Explanatory Variables	Alternative Specification (N = 336) ^a									
	$\sigma = .0$		$\sigma = .05$		$\sigma = .10$		$\sigma = .15$		$\sigma = 1.00$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ΔQ	-.095* (.042)	...	4.120* (1.500)	...	3.480* (1.399)	...	2.557* (1.265)	...	-.095* (.042)	...
ΔQ_{-1}	-.067 (.043)	...	6.087* (2.537)	...	4.982* (2.199)	...	3.425* (1.823)	...	-.067 (.043)	...
ΔR	...	3.321* (1.120)	...	3.011* (1.034)	...	2.647* (.950)	...	2.215* (.865)	...	-.067 (.043)
ΔR_{-1}	...	3.025 (2.100)	...	2.937 (1.885)	...	2.538 (1.649)	...	1.952 (1.409)	...	-.084* (.043)
$NINV_{-1}$	-.375* (.057)	-.382* (.056)	-.381* (.056)	-.381* (.056)	-.374* (.056)	-.378* (.056)	-.367* (.060)	-.375* (.060)	-.375* (.057)	-.371* (.056)
CONS	2,112,873* (482,188)	1,836,222* (485,809)	2,079,560* (480,000)	1,826,521* (487,121)	2,078,762* (481,644)	1,830,416* (488,822)	2,079,126* (484,080)	1,850,766* (490,699)	2,112,873* (482,188)	2,163,398* (484,309)
R^2	.30	.31	.31	.31	.3	.30	.296	.3	.3	.3
$F(52,284)$	2.38	2.48	2.49	2.47	2.43	2.44	2.35	2.39	2.38	2.35
SSE	4.460	4.407	4.404	4.415	4.436	4.432	4.483	4.459	4.461	4.482

NOTE.— Q = adjusted patient days over cost of capital (c/p); R = real revenue divided by (c/p); $NINV$ = net investment; CONS = constant term; Δ = annual change. SEs are shown in parentheses.

^aCoefficients in state dummies and time dummy for 1978 included in all regressions but are not presented in table. The time dummy was needed because of a change in the questionnaire sent to hospitals in 1978.

* Significant at the 1% level (two-tailed test).

TABLE 4 Real Net Investment per Private Not-for-Profit Hospital

Explanatory Variables	Alternative Specifications (<i>N</i> = 336)	
	(1)	(2)
$\Delta(c/p)$	996,894 (1,301,920)	...
$\Delta(c/p)_{-1}$	-1,428,176 (1,051,497)	-1,711,954** (983,306)
$NINV_{-1}$	-.354* (.057)	-.352* (.057)
CONS	2,093,883 (485,114)	2,095,407* (484,758)
R^2	.291	.290
$F(52,284)$	2.29	2.32

NOTE.—Coefficient on state dummies and time dummy for 1978 included in both the regressions but not presented here in the table.

*Significant at the 1% level (two-tailed test).

**Significant at the 8% level (two-tailed test).

as a group, did not reduce unexplained variance by a statistically significant amount and were subsequently dropped.

With low values of σ , there is a small substitution effect from the cost of capital operating on desired capital stock. To determine the effects of the cost of capital on real investment per NFP hospital when (c/p) is allowed to affect output (uncompensated for output change), we estimated investment equations with the change in (c/p) and its lag (table 4). With both (c/p) change variables included, the (c/p) parameter estimates vary in sign. With only lagged (c/p) included, the cost-of-capital is negative and statistically significant at the 8% level (elasticity = -0.014 at mean real investment for a 1% change in $[c/p]$).

These findings are not surprising, given the results of the share equations. That is, the expected negative impact of the cost of capital measure is at least partially confounded by the fact that NFPs take up the slack left by exiting proprietaries. The fact that a marginal negative effect persists in the NFP investment equations attests to the validity of the cost-of-capital measure as well as the fact that proprietary hospitals are a minority in the industry, so that their investment decisions do not completely confound the results found for the NFPs.

VI. Concluding Remarks

The expressed purpose of this study has been to answer a number of important questions about the investment behavior of the hospital industry. These included the question of how not-for-profit organizations' objectives affect the costs as well as the incentives for undertaking investments and also the question of how the unique payment mechanisms used in the industry affect its investment flows.

Most of what was learned about the effects of payment mechanisms on investment incentives was presented in the theoretical section. Here, a modified Averch-Johnson (1962) result was derived that accounted for mixed forms of payment and emphasized the importance of the relative generosity of capital payment algorithms compared to the hospital's true economic cost of capital in deriving the effects of cost-based reimbursement on investment. Another notable result was the fact that the more general objectives pursued by NFP hospitals do not affect their cost of capital; rather it was found to be of the same general form as for the proprietaries' cost. Although objectives plausibly differ between the FP and NFP forms, as we have shown, standard investment theory can provide a way to identify factors that affect for-profit and not-for-profit growth in both cases.

Conversely, most of what was learned about the effects of hospital preferences on the marginal value placed on capital was found in the empirics. Here we found that proprietaries behave very much according to the neoclassical theory of the firm, entering and existing areas according to the relative magnitude of the cost-of-capital measure computed in the theory section. Perhaps more interesting, our results also indicated that NFP hospitals make up the slack left by exiting proprietaries, providing some evidence that their investment preferences are at least partially guided by the behavior of their proprietary counterparts.

Finally, the results obtained here are of potential value for understanding the likely effects of the growing use of stringent prospective payment systems of payment, as characterized, for example, by Medicare's Prospective Payment System. There is widespread concern in the industry that not-for-profit institutions will suffer the burdens of reduced payments by such payers disproportionately compared to their proprietary counterparts. This concern is based on the assumption that proprietaries are better able to adapt to such changes and are more financially viable institutions to start with.

Our results at least partially confirm these concerns in the sense that we see strong evidence of capital mobility on the part of proprietary hospitals. The logical implication of these results suggests that for-profit hospitals would increasingly locate in areas less subject to prospective payment (i.e., areas with small elderly populations) leaving their NFP counterparts to deal with the difficulties of increasingly less generous sources of payment.

References

- American Hospital Association (AHA). 1984. *Hospital Statistics, 1984*. Chicago: AHA.
- Averch, H., and Johnson, L. 1962. Behavior of the firm under a regulatory constraint. *American Economic Review* 52 (December): 1052-69.

- Bosworth, B. P. 1985. Taxes and investment recovery. *Brookings Paper on Economic Activity*, no. 1, pp. 1-45.
- Cohodes, D. R., and Kinhead, B. M. 1984. *Hospital Capital Formation in the 1980s*. Baltimore: Johns Hopkins University Press.
- Commerce Clearing House, Inc. 1983. *Medicare and Medicaid Guide*, 1645-3 to 1648 (clause no. 4696), Chicago.
- DeAngelo, H., and Masulis, R. 1980. Optimal capital structure under corporate and personal taxation. *Journal of Financial Economics* 8 (March): 3-30.
- Feldstein, M. 1977. Quality change and the demand for hospital care. *Econometrica* 45 (October): 1681-1702.
- Feldstein, M. 1982. Inflation, tax rules and investment: Some econometric evidence. *Econometrica* 50 (July): 825-62.
- Ginsburg, P. B. 1970. Capital in Non-profit Hospitals. Ph.D. dissertation, Harvard University, Cambridge, Mass.
- Ginsburg, P. B., and Sloan, F. A. 1984. Hospital cost shifting. *New England Journal of Medicine* 310 (April 5): 893-98.
- Jorgenson, D. W. 1963. Capital theory and investment behavior. *American Economic Review* 53 (May): 247-59.
- Jorgenson, D. W., and Stephenson, J. A. 1967. Investment behavior in U.S. manufacturing, 1947-60. *Econometrica* 35 (April): 169-220.
- Kamien, M. I., and Schwartz, N. L. 1981. *Dynamic Optimization: The Calculus of Variations and Optimal Control in Economics and Management*. New York: North Holland.
- Lee, M. L. 1971. A conspicuous production theory of hospital behavior. *Southern Economic Journal* 38 (July): 48-58.
- Newhouse, J. P. 1970. Toward a theory of nonprofit institutions: An economic model of a hospital. *American Economic Review* 60 (March): 64-74.
- Sloan, F. A. 1981. Regulation and the rising cost of hospital care. *Review of Economics and Statistics* 63 (November): 479-87.
- Sloan, F. A. 1982. Government and the regulation of hospital care. *American Economic Review* 72 (May): 196-201.
- Sloan, F. A. 1988. Property rights in the hospital industry. In H. E. Frech (ed.), *Health Care in America: The Political Economy of Hospitals and Health Insurance*. San Francisco: Pacific Research Institute for Public Policy.
- Sloan, F. A., and Becker, E. R. 1984. Cross-subsidies and payment for hospital care. *Journal of Health Politics, Policy, and Law* 8 (Winter): 660-85.
- Wedig, G.; Sloan, F. A.; Hassan, M.; and Morrissey, M. A. 1988. Capital structure, ownership, and capital payment policy: The case of hospitals. *Journal of Finance* 43 (March): 21-40.