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ABSTRACT

The aim of this paper is to examine the determinants of interests rates on tax-exempt hospital bonds. The results highlight the potential and actual roles of Federal and state policy in the determination of these rates. The shift to a Prospective Payment System under Medicare has subsidized the borrowing costs of some hospitals at the expense of others. The selection of underwriters by negotiation rather than by competitive bidding results in higher interest rates. It is cheaper for hospitals in states with relatively high income tax rates to issue debt. The Federal tax act of 1986 raised the cost of hospital debt by encouraging bond issues to contain call features. Are the interest rate effects associated with these policies desirable or undesirable? This question can not be answered in the absence of estimates of the optimal subsidy that an average hospital should receive via its participation in tax-exempt markets, how this subsidy should vary among hospitals with different characteristics, and how the welfare costs associated with this subsidy can be minimized. Our results do not contain these estimates but they underscore that the differentials at issue are substantial.

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I. Introduction

This paper presents an empirical analysis of the determinants of interest rates on tax-exempt hospital bonds. The units of observation in the study pertain to approximately 3,000 new hospital bond financings (whose proceeds are used to invest in fixed assets or physical capital) and refinancings for the period from 1980 through 1988. The main source of information for the paper is the data base on new issues of municipal securities (new financings and refinancings) maintained by Securities Data Company (SDC). Data on issue characteristics are merged with hospital characteristics from the Health Care Financing Administration and national, state, and local market area characteristics from a variety of sources. In certain cases information on issue characteristics provided by SDC is supplemented with similar information from the data base on new issues of municipal securities maintained by IDD Information Services.

The significance of the paper is underscored by the sheer size and importance of hospital participation in municipal financing markets. Although there is no consistent measure of the amount of funds obtained by hospitals for capital financing over time or the sources of funds, the American Hospital Association's hospital construction survey was a frequently cited indicator until it was discontinued in 1981. According to that survey, debt financing grew from 38 percent of total construction funding in 1968 to 69 percent in 1981. In a more recent but different and not strictly comparable AHA survey of the year 1984, debt accounted for 60 percent of hospital capital financing (AHA 1986). Currently, knowledgeable writers attribute more than 70 percent of hospital capital financing to debt issued in tax-exempt markets (Cohodes and Kinkead 1984; Elrod and Wilkinson 1985; Sloan, Morrisey, and Valvona 1987).

The dollar amount of tax-exempt health care bonds (approximately 90 percent of which are hospital bonds) sold in 1974 was $1.3 billion. By 1983, the year in which the Prospective Payment System (PPS) under Medicare was

enacted, sales had grown to $10.2 billion. In 1985, in anticipation of the 1986 tax law (discussed in more detail below), sales were $32.1 billion. Following the 1985 rush to the market, sales subsided to $9.7 billion in 1986, but sales jumped 38 percent to $15.6 billion in 1989 (Cohodes and Kinkead 1984; The Bond Buyer 1990 Yearbook). In the years just mentioned--1974, 1983, 1985, 1986, and 1989--the number of bond issues was 156, 431, 928, 461, and 681. In recent years, perhaps 8 to 10 percent of eligible hospitals have been annually issuing tax-exempt bonds and another 8 to 10 percent have been preparing issues to market. Moreover, in 1989 health care bonds accounted for approximately 13 percent of total volume in the municipal bond market.

The aggregate issue amount of approximately $120 billion over the past decade is particularly significant for our research in light of our focus on the determinants of the interest rates on this debt. We try to identify those determinants that can be manipulated by the hospital or relevant government agency as a matter of policy or simply sound financial management. The $120 billion represents principal or face value of the bonds. The cost, however, of a bond's aggregate debt service during its life of twenty to thirty years to maturity is several times its face value. A reduction in interest rates of only a small fraction of one percentage point could yield substantial savings over time.

Despite the importance of the tax-exempt market as a source of capital for hospitals, little is known about the determinants of interest rates on hospital bonds. We have been able to identify only three limited multivariate studies on this topic (Cleverley and Rosegay 1982; Austen, Corman, and LiCalzi 1986; Carpenter 1991).[1] The first two studies consider a sample of issues in the late 1970s, a period before the amount and number of tax-exempt fundings by hospitals rose dramatically. The third considers a sample of 136 issues from 1982 through 1984 (approximately 13 percent of all bonds issued in those years). However, the sample and regressors are limited, and there is little

about the impact of the Prospective Payment System (PPS) because the study ends in the first year of PPS. In our empirical work we use multiple regression techniques and their variants to examine the effects of risk, the general level of interest rates, issuance costs, and government regulations on the interest rates on practically all tax-exempt bonds issued from 1980 through 1988. The main government regulations at issue in our study are the tax reform legislation enacted by Congress in September 1986 and Medicare and Medicaid reimbursement policies and changes in these policies during the sample period.

II. Workings of the Municipal Bond Market

Hospital bonds are issued by state, county, and city authorities on behalf of hospitals.[2] This arrangement dates to a 1963 ruling by the Internal Revenue Service that legally entitled hospitals that are non-profit institutions under regulation 501 (C)-3 of the Internal Revenue Service Code to issue bonds whose interest payments are exempt from Federal income tax under the condition that the borrower offers ownership of the hospital to a unit of government when the debt is repaid. The unfavorable nature of this procedure led to the creation of finance authorities that allow hospitals to retain ownership after debt retirement by means of a leaseback agreement. The finance authority has temporary title to the facility for the life of the bond issue and leases it to the hospital for a nominal rent. When the bond is retired, the ownership title returns to the hospital.

The proceeds of new hospital bond financings are used to invest in fixed assets or physical capital (land, plant or buildings, and fixed and moveable equipment). The proceeds of refinancings are used to retire existing debt prior to maturity. Among refinancings, there is a category called advance refunding. Here the proceeds of a current bond issue are used to generate investment yield which, when combined with those proceeds, is sufficient to

meet the interest payments and principal of an earlier bond issue. This is necessary when there is sufficient economic incentive for prepayment but the earlier issue contains provisions which limit prepayment.

Typically, municipal bonds are issued in serial form. One group matures one year after issue, a second two years after issue, a third three years after issue, and so on. Since risk rises with length-to-maturity (see below for more details), coupon rates on serials maturing in later years are usually higher than those maturing in earlier years. Within given maturity classes, coupon rates are fixed over the life of the serials in a majority of cases.[3]

In addition to serial bonds, most hospital issues contain one or more term bonds. In principle, term bonds have only one maturity, usually many years after the date of the issue. In fact, in almost all issues, these bonds must be amortized prior to maturity either by means of mandatory redemption by lot or by the operation of a sinking fund.[4] Usually, amortization of the term bonds begins in the year after the last serial bond in the issue matures. Since term bonds have longer maturities than serials, they have higher coupon rates in most cases.

The overall package of serial and term bonds in a municipal bond issue is marketed by an underwriter who offers the bonds either publicly or via a private placement. An issuer chooses an underwriter either by soliciting competitive sealed bids or by negotiating directly with an investment banker with regard to the terms of the purchase. The latter method is employed in approximately 95 percent of all issues of tax-exempt hospital bonds. The sum of the underwriter's costs and profit is termed the gross spread. In a competitive deal the underwriter covers his costs and makes a profit by purchasing the bonds from the issuer at approximately par value and reoffering them above par. In a negotiated deal the underwriter finds customers who purchase the bonds approximately at par. He then subtracts his costs and

profit from the proceeds received by the issuer. In either case the beneficiary of the bond issue (the hospital) borrows at a higher interest rate than the rate received by the ultimate purchasers of the bonds. In principle there is a set of coupon rates and reoffering yields that would make both the hospital and the ultimate lenders indifferent between a negotiated deal and a competitive deal. Typically, interest rates on competitive issues are lower than on negotiated issues possibly because negotiated underwriters offer more services to the issuer (Sorensen 1979). It is also argued that at least part of the differential reflects the absence of competitive market forces in a negotiated deal (Kessel 1971).

A negotiated deal may involve an original issue discount which further reduces the proceeds received by the issuer. This occurs when some bonds in the issue (usually the term bonds and the serials with relatively long maturities) are offered to the public at less than par value. Original issue discounts arise for two reasons. One is that market interest rates may rise somewhat between the time that a deal is structured and the time that an official statement is issued. To make bonds with fixed coupon rates competitive, their prices must be lowered below par. Since long-term interest rates are more variable than short-term rates, term bonds and serial bonds with long maturities are most likely to be subject to original issue discounts. A second reason for an original issue discount is that it reduces reinvestment risk. A deeply discounted bond implicitly reinvests interest payments at a rate established when the bond is purchased. Thus, it reduces uncertainty and also reduces resources that must be allocated to portfolio management.[5]

The true interest cost (tic) is the best and most widely used summary measure of the interest rate on a municipal bond issue from the borrower's point of view. The true interest cost or yield to maturity or internal rate of return (R) equates the proceeds received by the hospital to the present value of interest payments and principal repayments. If these payments are made

annually, R is obtained by solving

$$V - O - G = \sum_{t=1}^{n} (I_t + S_t)/(1 + R)^t, \qquad (1)$$

where V is the par value of the issue, O is the original issue discount, G is the gross spread, I_t is the interest due in year t, S_t is the principal repayment in year t, n is the length of the issue in years (the number of years between the date of issue and the date of final maturity),[6] and

$$V \equiv \sum_{t=1}^{n} S_t. \qquad (2)$$

The sum of the annual interest payment and principal repayment in a given year is termed the annual debt service of the issue (D_t). Typically, hospital issues are characterized by an equal debt service payment in each year, much like home mortgages ($D_t = D$, all t). In that case the internal rate of return can be obtained from

$$V - O - G = DR^{-1}[1 - (1 + R)^{-n}]. \qquad (3)$$

III. Analytical Framework

We employ a formal structural model to generate a reduced form equation for the determination of interest rates on new financings. We do not employ a formal structural model to study the determinants of interest rates on refinancings, but the reduced form equation for the rates on these financings has the same basic characteristics as that for new issues. In the structural

model for new issues, the endogenous variables are the interest rate and the real dollar amount of the issue. Each hospital has a downward sloping demand function for funds obtained in the tax-exempt bond market and a supply function that may not be perfectly elastic with respect to the amount borrowed.

The demand function reflects the hospital's demand for investment in plant and equipment. Since a reduction in the interest rate lowers the user cost or shadow price of capital, the demand function slopes downward. The inverse supply function of funds obtained from the bond market relates the average or marginal interest rate on these funds to the real dollar amount of the issue and other variables. The supply function may not be perfectly elastic due to economies of scale in underwriting (Kessel 1971), an increase in default risk as the size of the issue rises (Tanner 1975), and costs incurred by underwriters in searching for potential buyers (Hendershott and Kidwell 1978; Bland 1984).

Solving the supply and demand function simultaneously, one obtains reduced form equations for the interest rate and for the size of the issue. This framework emphasizes that the real dollar amount of the issue should be excluded from the reduced form interest rate equation because it is endogenous. Many studies of the determinants of interest rates on municipal bonds (for example, the ones cited above) have not taken this approach.[7] In principal, our framework also emphasizes that demand shifters such as patient

days and per capita income in the hospital's market area are relevant regressors in the reduced form interest rate equation for new financings. In fact, in a longer version of this paper (Grossman, Goldman, Nesbitt, and Mobilia 1991), we found that pure demand shifters had insignificant regression coefficients in the equation just mentioned. These results, which suggest that the supply function is infinitely elastic, are omitted due to space limitations.

Empirical studies of the determinants of interest rates on tax-exempt municipal bonds (for example, West 1967; Kessel 1971; Tanner 1975; Hendershott and Kidwell 1978; Cleverley and Rosegay 1982; Arak and Guentner 1983; Bland 1984; Liu and Thakor 1984; Austen, Corman, and LiCalzi 1986; Bland and Yu 1987; Kim and Stover 1987; Liu and Moore 1987) attribute differences among interest rates on these bonds to risk, the general level of market interest rates, and the costs of the issue. We pay a considerable amount of attention to these supply-side determinants. Riskier bonds must offer higher interest rates to induce investors to purchase them than the rate offered by a riskless asset or the least risky asset available (for example, a three-month U.S. Treasury bill). There are two types of risk: institutional risk, which is specific to the issuer of the bond, and market risk. An example of the former is default: an issuer may delay a scheduled payment of interest or principal on a bond or default on the payment altogether. Market risk arises due, for instance, to uncertainty about future interest rates. If the purchaser of a bond sells it prior to maturity and interest rates have

risen, he will suffer a capital loss. Even if he holds the bond to maturity, he will forego the interest income that accrues to higher yielding assets. Since it is more difficult to predict long-term trends than to predict short-term trends, interest rates on bonds tend to rise as the length-to-maturity rises.[8]

Institutional risk and the bond characteristics that interact with market risk (discussed in more detail by Sharpe 1985) can be reflected by Moody's or Standard and Poor's credit rating of the particular bond; whether the bond carries a call provision; whether it has a put option; whether its coupon rates are fixed or variable; whether the issue carries credit enhancements, such as bond insurance or a letter of credit, that reduce default risk; and the length of the issue. Issues with call provisions are expected to carry higher yields because the issuer can redeem the bond at or above par at a specified time before maturity. This reduces the likelihood that the holder can either fully realize all the capital gains associated with declining market interest rates or continue to receive a rate of return (established earlier) which is now above the current market rate. A put option works in the other direction. It gives the holder the right to sell the bond at a specified price up to a given expiration date. Thus, it lowers the possibility that he will suffer losses associated with rising interest rates. Variable-coupon rate bonds should carry lower yields than fixed-rate bonds if interest rates are expected to rise and higher yields if rates are expected to fall.

Since credit enhancements can be purchased by the bond issuer (or by

the beneficiary of the issue in the case of hospitals), default risk is an endogenous variable. Moreover, the enhancements may have important indirect effects on interest rates via their effects on credit ratings (Liu and Thakor 1984; Kim and Stover 1987; Liu and Moore 1987). More generally, default risk is a function of an organization's ongoing financial strength as measured, typically by such financial characteristics as the ratio of current liabilities to current assets or long-term debt to equity.

Under certain conditions, the difference between the yield on a new bond and the average yield on seemingly default-free bonds with the same maturity is a measure of the default risk on a new issue. One way to study the determinants of municipal bond rates is to use this yield spread as the dependent variable in a multiple regression analysis. The impacts of expected inflation, uncertainty concerning future interest rates, the business cycle, other aspects of market risk, and general supply and demand conditions in the bond market are imbedded in the default-free rate. A more flexible approach is to use the actual yield as the dependent variable and a proxy for the market rate as an independent variable. This allows for differential responses to changing market conditions by the two rates at issue.

The last determinant of municipal bond interest rates that is stressed in the literature pertains to the costs of issuing the bond, particularly the costs of underwriting it. We have already called attention to these costs and to the presumption that they are higher for negotiated issues than for competitive

issues. The term private placement describes the sale or placement of bonds with one or a few institutional lenders as opposed to a broad public offering. Since this reduces underwriting costs, the interest rate on privately placed bonds may be smaller. Offsetting this, however, is the likelihood that underwriters in a public offering may have a good deal of information concerning customers who are willing to purchase a particular issue at the lowest possible yield.

The main government regulations at issue in our research are the Federal tax reform legislation enacted by Congress in September 1986 and Medicare and Medicaid reimbursement policies and changes in these policies in our sample period.[9] The 1986 tax law reduced marginal personal income tax rates, raised the tax rate on capital gains, and generally eliminated institutional investors' deduction of carrying charges for holding tax-exempt bonds. The law also curtailed arbitrage profits and advance refundings for all issuers of tax-exempt bonds.[10] These changes should lower the spread between taxable and tax-exempt bond yields.

Any framework for treating hospital behavior in general and hospital investment behavior in particular must take account of retrospective cost-based reimbursement of hospitals by Medicare, Medicaid, and some other third party payors. If a hospital only treated cost-paying patients (patients whose expenses are reimbursed on the basis of costs), it would have little incentive to minimize the cost of issuing bonds and the interest rate on the bonds. Moreover, its

demand for capital and investment should not respond to changes in interest rates. In a more realistic case, a hospital receives a certain fraction of its revenue from cost-paying patients and a certain fraction of its revenue from charge-paying patients (patients whose costs are reimbursed on the basis of charges). Under certain conditions, the interest rate on borrowed funds faced by such a hospital (i) is given by

$$i = (1 - \alpha\beta)R. \qquad (4)$$

Here α is the ratio of cost-paying patients to total patients, β is the share of interest expenses allocated to cost-based patients that are reimbursed by the payors ($\beta = 1$ with full reimbursement), and R is the marginal interest rate on hospital bonds. Equation (4) highlights the incentives of not-for-profit hospitals to issue debt, which are discussed in detail by Sloan et al. (1988), Wedig et al. (1988), and Wedig, Hassan, and Sloan (1989). In particular, with β and R held constant, an increase in the cost-based share (α) lowers i and raises the optimal amount of borrowing.[11]

Cost-based reimbursement characterized Medicare until the introduction in October 1983 of the Prospective Payment System (PPS). A comprehensive PPS would put hospitals at complete financial risk for treating Medicare patients. It would contain incentives for cost minimization and would not distort or create a wedge between the interest rate received by the holder of a tax-exempt bond and the rate paid by the hospital as a function of the fraction of revenue received from Medicare. However, the diagnosis

related groups (DRG) reimbursement system that accompanied PPS is not inclusive of all costs. Capital costs were exempt from PPS when the system was enacted by Congress, and the legislation called for the continuation of Medicare reimbursement of capital costs as a pass-through of "reasonable" costs. Originally, the pass-through was supposed to continue only until the beginning of fiscal 1986. Controversy with regard to the treatment of capital costs under PPS, however, prolonged the pass-through period. In 1991 the Health Care Financing Administration issued rules which established a gradual system to fully integrate capital costs into the DRGs and hence into PPS over a ten year period.

It is an oversimplification to view an increase in the extent of cost-based reimbursement as necessarily lowering the net interest rate [i in equation (4)] faced by a hospital. This is because the gross interest rate [R in equation (4)] may depend on the cost-based share and other parameters of the reimbursement system. To the extent that the third-party reimburser agrees to pay the cost of care, default risk and the interest rate fall. A number of factors, however, work in the opposite direction. These include future uncertainties concerning Medicare and Medicaid (which also originally used the retrospective cost-based Medicare reimbursement system) reimbursement policies, cash flow problems due to slow payment of receivables, location in economically depressed area, a large bad debt ratio, reduced incentives to search for low-cost debt, and the greater sensitivity of hospitals with relatively

large fractions of Medicare and Medicaid patients to cost-containment efforts by the Federal government and state governments (Cohodes and Kinkead 1984; Sloan, Morrisey, and Valvona 1987). The effect of variations in the fractions of Medicare and Medicaid patients on interest rates may be reflected in part by Standard and Poor's or Moody's credit ratings received by hospitals who treat large proportions of such patients.

A final point to note concerning the shift from cost-based reimbursement to PPS under Medicare is that hospitals that spend less on Medicare patients than the Medicare revenues they receive under the latter system are allowed to keep the difference as profits, while hospitals that spend more are liable for the excess. Thus, the bonds issued by hospitals whose financial position was improved by PPS should carry lower interest rates than those issued by hospitals whose financial position was worsened. We examine this proposition in our empirical analysis.

State initiatives to contain costs by using prospective payment systems for third parties and similar initiatives by Blue Cross, the largest supplier of private hospital insurance, also are relevant determinants of interest rates on hospital bonds. During our sample period (1980-1988), six states (New York, New Jersey, Connecticut, Maryland, Massachusetts, and Washington) employed mandatory rate-setting programs to contain costs. To the extent that these programs reduce payment levels, they increase the risk of default (Sloan, Morrisey, and Valvona 1987). In highly regulated states, however, there may

be a perception of lower default risk because of heavy state involvement in the hospital sector.

Since 1980, state Medicaid systems have been characterized by a downward trend in the number of systems that employ retrospective, cost-based reimbursement. This number fell from 41 in January 1980 to 9 in January 1989 (Laudicina 1989). At the same time the number of states using a prospective payment system with a DRG reimbursement methodology under Medicaid rose from 2 in January 1980 to 17 in January 1989. The third and final type of Medicaid reimbursement system is one with prospective rate of increase controls or negotiation and fixed contracting. Clearly, the number of states using this system also rose over time. Shifts in Medicaid policy from cost reimbursement to prospective payment should have impacts on interest rates similar to those of the shift from the former to the latter under Medicare. It is particularly important to control for and assess the effects of changes in Medicaid reimbursement policy in our research because many of these occurred before the adoption Medicare's PPS beginning in fiscal 1984.

Efforts by Blue Cross plans to contain hospital costs may have effects similar to state Medicaid initiatives and mandatory rate-setting programs. Each state has at least one Blue Cross plan and some have more than one. These plans can reimburse hospitals either on the basis of list prices (charges) or on the basis of costs. During the late 1970s and early 1980s, plans that pay costs began to receive discounts relative to plans that pay charges. The

percentage of plans receiving discounts rose from 40 percent in 1980 to 60 percent in 1986 (Scheffler et al. 1989). At the same time the percentage of plans using prospective reimbursement rose from 50 percent in 1980 to almost 80 percent in 1986. Moreover, some Blue Cross plans have introduced programs that try to control the total amount of payments hospitals receive by actively reviewing the medical appropriateness of individual claims and denying payment completely. We take account of all these aspects of Blue Cross reimbursement in our empirical analysis.

IV. Data and Measurement of Variables

The main source of information for this project is the data base on new issues of municipal securities (new financings and refinancings) maintained by Securities Data Company (SDC) the years 1980 through 1988. There are 3,399 hospital bond issues in the data base of issuers located in one of the 50 states of the United States or in the District of Columbia. These account for all issues in the years in question except that issues with par values of less than $5 million are excluded prior to January 1986.[12]

SDC reports the true interest cost [tic or R, see equation (1)], but it is missing for approximately 75 percent of the issues. Therefore, we have developed algorithms to estimate the tic for 2,978 or 87 percent of the issues. It can be computed directly from (1) the par value of the issue, (2)

the original issue discount, (3) the gross spread, (4) the debt service schedule, and (5) the years to maturity. Except for the debt service schedule, all these items are reported for most of the issues. There is no direct information on the debt service schedule, but the coupon rates on the serial and term bonds are given. As mentioned in Section II, most hospital bonds are characterized by an equal annual debt service payment in each year. Consequently, we have developed an algorithm to obtain this type of debt service schedule. The algorithm, which is described in detail in Grossman, Goldman, Nesbitt, and Mobilia (1991), takes as inputs the par value of the issue and the coupon rates on the serial and the terms bonds. In effect, it converts the issue into one that contains only serial bonds with the interest rates on the serials that mature in later years taken from the rates on the term bonds. Given the debt service schedule, we obtain the tic from a modified version of equation (1)--one that recognizes that municipal bonds pay interest semiannually rather than annually.

Table 1 contains definitions of variables that are employed in the regression analyses in Section V. They are classified into one of five categories: issue characteristics, national characteristics at the time of the issue, state characteristics of the issuer, characteristics of the county in which the hospital is located, and characteristics of the hospital. When the beneficiary of the issue is a multihospital system, hospital characteristics pertain to the system as a whole, and county characteristics are population-

weighted averages of the measures listed in Part D of Table 1 in the counties containing the hospitals in the system.

In the remainder of this section, we focus on the specification of the reduced form equation for the true interest cost. The roles of most of the variables in Table 1 in the determination of the tic were discussed in Sections II and III. The weekly yield on a 30-year U.S. Treasury bond is employed as a proxy for the market rate of interest. This variable and its standard deviation during an eight-week period ending with the week of the issue were obtained from Citicorp Database Services. A rise in the standard deviation of the Treasury bond rate reflects increased market uncertainty and should cause the tic to rise.

Five categories of Standard and Poor's credit ratings are distinguished with four dichotomous variables. The omitted category pertains to unrated bonds. Cases in which Moody's credit rating was higher or lower than the S&P rating are identified with two dichotomous variables. Variables that identify insured issues and issues that carry a letter of credit are highly correlated with the credit ratings and cannot be included in the same regression. Thus, the effects of these variables operate through the credit ratings. As these remarks suggest, a full analysis of the effects of credit ratings on interest rates must take account of the endogeneity of the ratings. This does not necessarily call for the use of simultaneous equations methods because the yields and the credit ratings

may be determined in a recursive system with uncorrelated errors. It does mean, however, that causal determinants of the ratings should not be held constant in assessing the effects of the ratings on bond yields. Conversely, inclusion of the ratings may be give misleading estimates of the impacts on rates of variables that operate primarily through them. Consequently, regressions are estimated with and without the credit ratings.

Sloan, Morrisey, and Valvona (1987) argue that bonds issued on behalf of multihospital systems may be less risky than those issued on behalf of other hospitals. The same comment may apply to a pooled financing in which a single financing is used to make individual loans to otherwise unrelated hospitals.

The teaching status of a hospital also may affect institutional risk. Investment bankers who underwrite a large number of municipal bond issues annually may be more efficient in marketing an issue than other underwriters due to their lower costs or greater information about the market. This factor is reflected by the primary underwriter's rank based on total par value of all municipal bonds that it underwrote as a lead underwriter in the year of issue and by a dichotomous variable that identifies issues in which the primary underwriter is not one of the fifty leading underwriters. Both measures were taken from annual issues of the Bond Buyer Yearbook.

Most hospital bonds are revenue bonds. That is, they are backed

by hospital revenues. General obligation bonds, which account for 5 percent of the observations in the regressions, are issued by authorities with taxing power and are backed by tax revenues. Because of their access to a larger pool of revenues for principal and interest payments and a lower likelihood of default, general obligation bonds carry lower interest rates than revenue bonds.

State- and time-specific Medicaid reimbursement measures are given by dichotomous variables identifying the presence of a prospective payment system with a DRG reimbursement methodology and the presence of a system with prospective rate of increase controls or negotiation and fixed contracting.

The omitted category pertains to states with retrospective cost-based Medicaid reimbursement systems. These measures were obtained from IHPP (1984), Laudicina (1986, 1989), and Zimmerman and Paul (1988). The same sources were used to identify states with mandatory rate-setting programs. The Blue Cross reimbursement variables were provided by Richard M. Scheffler of the University of California at Berkeley who conducts an annual survey of Blue Cross plans.

The Medicare PPS profitability margin equals the difference between 1984 projected Medicare inpatient revenue from a fully implemented DRG reimbursement system (national costs per case) and revenue based on a given hospital's 1981 Medicare revenue and case mix

projected to 1984 divided by 1981 Medicare revenue projected to 1984. In the short run PPS payments are blends of national and hospital-specific costs per case, with the national component increasing over time. Therefore, the variable just defined measures the long-run impact of PPS on the financial position of a given hospital. The profitability margin was developed by Stephen Long and his colleagues at the Congressional Budget Office and was obtained from Richard G. Frank and David S. Salkever of the Johns Hopkins University School of Hygiene and Public Health who used it in Frank, Salkever, and Mitchell (1989). Note that the PPS profitability measure takes account of the differential impact of this reimbursement system on the hospitals. However, the mandatory rate-setting measure is not hospital-specific. It does not distinguish among hospitals that are hurt by mandatory rate setting and those that benefit from it. The absence of hospital-specific measures for some regulatory programs but not for others should be kept in mind in interpreting the results in the next section (Thorpe and Phelps 1990).

A complete assessment of the impacts of alternative Medicare and Medicaid reimbursement policies on bond yields must take account of differences in the fractions of Medicare and Medicaid inpatients days among hospitals. These fractions were obtained from the HCFA Medicare Hospital Cost Reporting Data Files for the federal fiscal years 1984 through 1988, which have been prepared in conjunction with the Prospective

Payment System under Medicare.[13] The Medicare fraction is interacted with the PPS profitability margin and the Medicaid share is interacted with the Medicaid reimbursement measures in some specifications. This model is discussed in more detail in Section V.

Interest on municipal bonds is exempt from state income tax in almost all states if the holder resides in the state that issued the bond. Since the value of this tax exclusion rises as the state income tax rate rises, bonds issued in states with high tax rates should carry lower yields. We capture this effect with the state income tax rate in the highest income tax bracket. This was taken from the Council of State Governments (various years) and from the Tax Foundation (various years).

The county unemployment rate and the location of a hospital in a rural county are area-wide indicators of potential default risk. The former was taken from the Area Resource File, formerly maintained by Applied Management Sciences and now maintained by Quality Resource Systems for the Bureau of Health Professions (1989). The latter was taken from the Federal Register, September 1, 1987 and is based on classifications used by HCFA. The ratio of total assets to total liabilities is a hospital indicator of default risk. This negative correlate of default was obtained from the HCFA Medicare Cost Reporting Data Files.[14]

V. Empirical Results

Ordinary least squares multiple regressions of the true interest cost (tic) for the 2,978 issues in our data base are presented in Tables 2 and 3. All regressions in Table 2 include Standard and Poor's and Moody's credit ratings, while all regressions in Table 3 exclude these ratings. The independent variables in the first regression in each table [regressions (2-1) and (3-1)] are limited to issue characteristics, national characteristics (the weekly yield on a 30-year Treasury bond and its standard deviation during the past eight weeks), and one state characteristic (the state income tax rate in the highest tax bracket) which is not unique to hospital issues. The set of variables in this regression is termed the basic set from now on. The last two regressions add county characteristics, state characteristics that are unique to hospital issues, and hospital characteristics. Each of these two regressions contains a somewhat different specification of the Medicare and Medicaid reimbursement effects.

County and hospital characteristics are missing for 1,038 of the 2,978 issues, primarily because the identification of the hospital that received the bond proceeds is not known. Therefore, regression (2-1) was estimated separately for the 1,038 issues with missing data and the 1,940 issues with complete data. The hypothesis of no difference in slope coefficients was tested and accepted. Hence, regressions (2-2) and (2-3) are estimated using all 2,978 issues. These models include a dichotomous

variable (missing) that equals one for issues with missing data. All variables with missing values are interacted with the complement of this identifier (1 - missing).

The regression coefficients of the variables in the basic set are not sensitive to the inclusion of hospital, county, and state characteristics. Therefore, in discussing the effects of variables in this set, we focus on regression (2-1) and in certain cases on regression (3-1). In general the results with respect to the basic variables are consistent with a priori expectations. Negotiated issues and private placements carry higher tics than competitive issues. The relevant regression coefficients are statistically significant at all conventional levels[15] and rather large in magnitude. A negotiated deal adds 66 basis points (1 basis point equals 1/100 of 1 percent) to the tic, and a private placement adds 51 basis points. In contrast, Sorensen (1979) reports that a negotiated deal adds 12 basis points to the interest rate in the case of new financings of corporate bonds.

The above findings can be traced to a number of factors. Negotiated hospital bond financings and private placements may be riskier and may require more inputs from underwriters than similar corporate bond financings. But part of these differentials can also be due to the absence of competitive market forces in negotiated deals and private placements. Competitive hospital issues are much less common than competitive corporate issues or competitive non-hospital municipal issues. In particular,

only 5 percent of hospital financings are competitive in our sample. If a substantial portion of the higher tic in negotiated deals and private placements is due to the last factor mentioned, then our results suggest that cost savings would be realized by hospitals and third-party payors, including the Federal government, if underwriters were selected by competitive bidding more often.

The inclusion of a call feature adds 28 basis points to the yield. On the other hand, the presence of a put option lowers the yield by 53 basis points. The Federal tax reform legislation enacted by Congress in September 1986 allows only one advance refunding for bonds issued after 1985 and only two advance refundings for bonds issued prior to that year. Since the law curtails the number of advance refundings, it contains incentives to include a call feature. There is some evidence that these incentives were realized. The percentage of callable issues rose continually from 82 percent in 1982 to 96 percent in 1987 before falling to 91 percent in 1988.[16] It is tempting to speculate that the upward trend reflects the market's anticipation of tax reform, while the reduction in 1988 reflects the impact of changes in expectations concerning future market interest rates. As these remarks suggest, the presence of a call feature depends on a number of factors. Our results imply that one possibly unintended consequence of the tax act may have been to raise interest rates on hospital bonds in periods when interest rates are expected to fall.

The percentage of putable issues is much smaller than the percentage callable (16 percent versus 87 percent). Consequently, many more issues could include put features, and many fewer could exclude call features. While this creates the potential for large interest rate savings, the amount of savings would depend on the likelihood of exercise of these features.

Both the 30-year Treasury bond rate and its 8-week standard deviation are important determinants of the tic on hospital bonds. An increase in the Treasury bond rate of 100 basis points raises the tic by 76 basis points. An increase in the standard deviation of the Treasury bond rate also causes the tic to rise.[17]

An increase in the state income tax rate in the highest tax bracket from 5 percent to 10 percent lowers the tic by 14 basis points. The negative and statistically significant coefficient of this variable underscores another possibly unintended consequence of tax policy with regard to hospital participation in tax-exempt financing markets. Recent increases in personal income tax rates in a number of states may make it easier (less costly) for hospitals in these states to issue debt. This is troublesome in the absence of a firm estimate of the optimal subsidy that hospitals should receive via their participation in tax-exempt markets.

As expected, higher credit ratings lower the cost of capital. The difference in tics between unrated issues and those with Standard and

Poor's highest rating of AAA equals 147 basis points. Issues rated from AA+ to AA- carry tics that are 135 basis points lower than unrated issues, while issues rated from A+ to A- carry tics that are 82 basis points lower than unrated issues. Bonds rated better by Moody's than by Standard and Poor's have lower yields that amount to 114 basis points, but the receipt of worse rating by Moody's than by Standard and Poor's has no impact yields. A full analysis of the effects of credit ratings on interest rates must take account of the endogeneity of the ratings. As indicated earlier, this does not necessarily call for the use of simultaneous equations methods because the yields and credit ratings may be determined in a recursive system with uncorrelated errors. It does mean, however, that causal determinants of the ratings should not be held constant in assessing the effects of the ratings on bond yields. We have accomplished this in part by omitting the of credit enhancements such as bond insurance and letters of credit as regressors. But some of the right-hand side variables in the tic regressions may have causal impacts on the credit ratings.

An example of one such variable is the ranking among underwriters in terms of the total par value of all issues underwritten in a given year (the effect of this variable is given by the coefficients of Rank and No Rank). When the bond ratings are held constant, the tic is 29 basis points lower if the first leading underwriter is used as opposed to the fiftieth leading underwriter. As indicated by the first regression in Table 3, the

corresponding differential is 55 basis points when the bond ratings are not held constant. Moreover, the use of the twenty-fifth leading underwriter as opposed to an unranked underwriter is worth 13 basis points to the issuer based on regression (2-1), while it is worth 32 basis points to the issuer based on regression (3-1). It is notable that the coefficients of the two variables measuring underwriter rank are statistically significant even when the bond ratings are held constant. These results, which control for the higher gross spread that may be charged by leading underwriters, imply that leading underwriters are more efficient in marketing issues, and this is likely to be a function of their experience.

With regard to the other issue characteristics, an increase in the length of time to an issue's maturity raises its yield. Issues with fixed coupon rates have higher yields than those with variable coupon rates suggesting that most financings took place during periods when future interest rates were expected to rise. General obligation bonds carry tics that are 42 basis points lower than revenue bonds. Tics also are lower when the beneficiary is a teaching hospital, when the beneficiary is a multihospital system, and in the case of a pooled financing. The last two effects are statistically significant only when the bond ratings are omitted from the model.

The second regression in Tables 2 and 3 includes several state variables that determine hospital reimbursement and a variety of county and

hospital characteristics. Perhaps the most important result pertains to the impact of Medicare's Prospective Payment System on bond yields. We measure this by interacting the PPS profitability margin with a dichotomous variable that equals one for the years 1984 through 1988. This is because PPS began in October 1983. Note that the profitability margin is positive for a hospital that does better financially under PPS than under cost-based reimbursement, negative for a hospital that does worse, and zero for a hospital that does the same. As expected, the coefficient of this variable is negative and statistically significant at the 1 percent level in regression (2-2). When the bond ratings are excluded, the PPS coefficient rises in absolute value by almost 45 percent. To gauge the magnitude of this effect, consider two hospitals, one with a profitability margin of .2 and the other with a profitability margin of -.2. The differential at issue amounts to two standard deviations of the profitability margin. According to regression (2-2), the first hospital could issue bonds with a tic 12 basis points lower than the second hospital. The corresponding interest cost saving from regression (3-2) is 18 basis points.

Shifts in state Medicaid policy from cost reimbursement to prospective payment have impacts on interest rates that are similar to those of the shift from the former to the latter under Medicare. Issues in states employing a DRG reimbursement methodology under Medicaid have tics that are 36 basis points lower than issues in states employing retrospective

cost-based reimbursement under Medicaid [see the coefficient of Medicaid DRG in regression (2-2)]. In addition, issues in states employing either prospective rate of increase controls or negotiation and fixed contracting under Medicaid have tics that are 22 basis points lower than issues in cost-based states [see the coefficient of Medicaid Other in regression (2-2)]. Some caution is required in interpreting these results because profitability margins analogous to the PPS margin are not available.

We find no evidence that mandatory rate setting or alternative Blue Cross reimbursement policies affect bond yields. Again, some caution is required because the mandatory rate-setting variable is dichotomous and because there is a fairly high positive correlation of approximately .2 between the presence of a mandatory rate-setting program and the use of a DRG reimbursement methodology under Medicaid. When the latter variable is omitted, the coefficient and t-ratio of the mandatory rate-setting measure are -.132 and 1.68, respectively. This deletion has no impact on the coefficients of the Blue Cross variables.

The county unemployment rate and the location of a hospital in a rural county are positive area-wide indicators of default risk, while the ratio of total assets to total liabilities is a negative hospital-wide indicator of default. The tic rises as the county unemployment rate rises and falls as the asset ratio rises, although the latter effect is not statistically significant at the 5 percent level unless the bond ratings are excluded from the set of

independent variables. Hospitals in rural counties are forced to borrow at higher interest rates, but this is only because their bonds receive lower credit ratings. When the bond ratings are held constant, the coefficient of the rural indicator is negative and not significant.

The third regression in Tables 2 and 3 recognize that a complete assessment of the impacts of alternative Medicare and Medicaid policies on bond yields must take account of differences in the fractions of Medicare and Medicaid inpatient days among hospitals. In the case of Medicare, this is accomplished by interacting the product of the PPS profitability margin and the dichotomous variable for the years 1984 through 1988 with the fraction of inpatient days accounted for by Medicare inpatient days (Medicare Share*PPS). In the case of Medicaid, the fraction of inpatient days accounted for by Medicaid inpatient days is interacted with the dichotomous variable that identifies states using a DRG reimbursement methodology under Medicaid (Medicaid Share*DRG) and with the dichotomous variable that identifies states using a Medicaid reimbursement system with prospective rate of increase controls or with negotiation and fixed contracting (Medicaid Share*Other).[18] For completeness, we also include the sum of the fractions of Medicare and Medicaid inpatient days (Government Share). This specification assumes that the effect of an increase in the Medicare share by 1 percentage point is equal to the effect of an increase in the Medicaid share by 1 percentage point when both

systems are using cost-based reimbursement. It is employed in part to reduce the degree of multicollinearity in the data. It also is employed because it mirrors one used by Sloan, Morrisey, and Valvona (1987) to test the hypothesis that an increase in the government share raises the cost of debt in the pre-PPS period.

The coefficients of the government share measure are positive in regressions (2-3) and (3-3), and the coefficient in the latter regression is significant. According to regression (2-3), an increase in the government share from .4 to .5 raises the tic by 3 basis points in the period before the Prospective Payment System under Medicare was adopted (1980-1983) for hospitals in states with cost-based reimbursement under Medicaid (Medicaid Share*DRG = 0 and Medicaid Share*Other = 0).[19] The corresponding effect in regression (3-3) is 4 basis points.

With the bond ratings held constant, the coefficient of the PPS profitability margin remains negative and significant at the 1 percent level. This coefficient rises by 26 percent in absolute value when the bond ratings are omitted from the model. To gauge the magnitude of the effect, recall that we previously compared two hospitals: one with a PPS profitability margin of .2 and the other with a PPS profitability margin of -.2. Suppose that the Medicare fraction of inpatient days in each hospital equals the sample mean of .43. According to regression (2-3), the first hospital could issue bonds with a tic 14 basis points lower than the second hospital. The

corresponding differential from regression (3-3) is 17 basis points. These estimates are very similar to those obtained in regressions (2-2) and (3-2). The close agreement between the PPS effects that emerge from the second and third regressions in Tables 2 and 3 strengthens our confidence in these results. This agreement suggests that the results reflect true causal effects of PPS on interest rates rather than statistical artifacts.

The impact of a rise in the Medicare share itself in the post-PPS period (1984-1988) depends on the value of the profitability margin. To be specific, in regression (2-3), it equals .262 - .799p, where .262 is the coefficient of the government share measure and -.799 is the coefficient of the product of the Medicare share, the PPS profitability margin (p), and the dichotomous variable for the years 1984 through 1988. This effect is positive if the profitability margin is smaller than .328, and it is negative if the profitability margin exceeds .328. The value of .328 is approximately one standard deviation above the mean of the profitability margin of .112 for hospitals issuing bonds during the years from 1984 through 1988. Care should be exercised in concluding that the tics rise for hospitals with profitability margin that are positive, but less than .328, as their Medicare shares rise. After all, the estimate of .328 is based on a specification with a number of interacted variables, suggesting that the degree of multicollinearity may be rather high. Moreover, as indicated below the Medicare share may be an endogenous variable.

Shifts in state Medicaid policy from cost reimbursement to prospective payment have more modest effects in regression (3-3) than in regression (3-2). Consider a hospital whose Medicaid fraction of inpatient days equals the sample fraction of .09. If the hospital is in a state employing DRG reimbursement under Medicaid, its bonds would carry tics that are 13 basis points lower than if it were located in a state employing cost-based reimbursement under Medicaid. The same hospital in a state employing prospective rate of increase controls or negotiation and fixed contracting could issue bonds with tics 7 basis points lower than in a state employing cost-based reimbursement.

The effect of an increase in the Medicaid share itself depends on the type of reimbursement system used by the state in which a given hospital is located. If retrospective cost-based reimbursement is employed, the effect is positive, as indicated by the coefficient of the government share measure. If DRG reimbursement is employed, the effect is obtained by summing the coefficient of Government Share and the coefficient of Medicaid Share*DRG. This effect is negative. A similar comment applies to the impact of a rise in the Medicaid share in a state employing prospective rate of increase controls or negotiation and fixed contracting. As in the case of regression model (2-2), these results are not based on profitability margins analogous to the PPS margin. Nevertheless, the negative effects of Medicaid Share*DRG and Medicaid Share*Other suggest

that the average "PPS Medicaid profitability margin" of hospitals that issue bonds in states that do not employ cost-based reimbursement under Medicaid exceeds zero.[20]

In summary, there are several policy implications of the reduced form regression results. Interest rates on tax-exempt hospital bonds are not determined in a vacuum. Issue characteristics and national characteristics that have proved to be important determinants of yields on municipal and corporate bonds also are important determinants of yields on hospital bonds. Taken by themselves, these characteristics explain approximately 78 percent of hospital bond yields in the period from 1980 through 1988.

Interest rate differentials associated with negotiated deals and with call and put provisions are particularly relevant from a policy perspective. When compared to competitive deals, negotiated deals carry tics 66 basis points higher. This suggests that cost savings would be realized by hospitals and third-party payors, including the Federal government, if underwriters were selected by competitive bidding more often. The inclusion of a call provision adds 28 basis points to hospital bond yields. Since the 1986 Federal tax act curtails the number of advance refundings allowed, it contains incentives to include a call feature. These incentives were partly responsible for an increase in the percentage of callable issues from 82 percent in 1982 to 96 percent in 1987. Thus, one possible unintended consequence of the tax act may have been to raise interest rates

on hospital bonds. Also, including a put provision lowers the tic by 53 basis points.

From 1980 through 1983, retrospective cost-based reimbursement characterized both the Federal Medicare program and the Medicaid programs of most states. During that period an increase in the fraction of Medicare or Medicaid inpatient days raised the true interest cost on hospital bonds. But it is a mistake to assume that these results "paint a complete picture" of the effects of these programs on the interest rate at which hospitals borrow. The switch to the Prospective Payment System under Medicare starting in 1984 lowered the interest costs of hospitals with favorable PPS profitability margins while it raised the interest costs of hospitals with unfavorable margins. Moreover, shifts in state Medicaid policy from retrospective cost-based reimbursement to prospective payment had effects similar to those of the shift from the former to the latter under Medicare. With regard to the Medicaid finding, although the adoption of prospective payment systems under Medicaid may reduce payment levels and increase the risk of default, our findings indicate that other factors dominate. Such factors include increased incentives to search for low-cost debt, reductions in future uncertainties concerning state Medicaid policies, a general increase in market confidence concerning the financial viability of the state's health care system, and the possible exclusion of hospitals who are harmed by prospective payment under Medicaid from the bond market.

If the Medicare and Medicaid results reflect true causal effects, they should be more important the greater are the shares of Medicare and Medicaid inpatient days. This is precisely what we find. Some caution is required in interpreting the results that emerge from our full specification because it is based on the use of levels of and interactions among a number of variables. Thus, it increases the degree of multicollinearity in the data. In addition, the Medicare or Medicaid share may be endogenous. In particular, hospitals with favorable PPS profitability margins have incentives to raise their Medicare shares, while hospitals with unfavorable margins have incentives to lower their shares. Similar incentives exist with respect to prospective payment and Medicaid shares. Nevertheless, all variables in the full specification have the correct signs, and all of them are statistically significant. We view this as important and impressive evidence that changes Medicare and Medicaid reimbursement policies in the 1980s have influenced and in some cases have lowered hospitals' borrowing costs.

An implication of our results is that the use of a prospective payment system at the Federal or the state level selectively reduces the interest rate on hospital debt. This finding points to benefits of prospective payment that have not been emphasized in the debate over its adoption. But it also points to some hidden costs. Hospitals with unfavorable Medicare and Medicaid PPS profitability margins confront relatively high interest rates when they borrow to finance investment in plant and equipment.

Indeed, the mean Medicare PPS profitability margin of hospitals in our sample is .112, while the mean margin of all U.S. hospitals is 0.[21] Since Medicare reimbursed capital costs as a pass-through prior to October 1991, part of the additional interest costs of hospitals with unfavorable margins were borne by the Federal government and ultimately by the taxpayers. And the unfavorable PPS profitability margins were a direct consequence of the 1983 Medicare legislation. Moreover, the hospitals at issue may confront even higher interest rates in the future due to the gradual elimination of the pass-through beginning in 1991. Whether or not this is desirable depends on the characteristics of these hospitals and the overall goals of current health policy in the U.S.

In general our results highlight the potential and actual roles of Federal and state policy in the determination of interest rates on hospital bonds. They also highlight the intended and unintended consequences of these policies. For example, in the early 1980s the capital pass-through under Medicare reduced interest costs, but hospitals with higher than average Medicare shares of inpatient days were forced to borrow at higher than average interest rates. More recently, the shift to a Prospective Payment System under Medicare has subsidized the borrowing costs of some hospitals at the expense of others. Throughout the decade of the 1980s, the capital pass-through may have discouraged the selection of underwriters by competitive bidding, resulting in higher interest rates. It is

cheaper for hospitals in states with relatively high income tax rates to issue debt. The Federal tax act of 1986 raised the cost of hospital debt by encouraging bond issues to contain call features. Are the interest rate effects associated with these policies desirable or undesirable? This question cannot be answered in the absence of estimates of the optimal subsidy that an average hospital should receive via its participation in tax-exempt markets, how this subsidy should vary among hospitals with different characteristics, and how the welfare costs associated with this subsidy can be minimized. Our results do not contain these estimates, but they underscore that the differentials at issue are substantial.

FOOTNOTES

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[1]Sloan, Morrisey, and Valvona (1987) use the 1983 AHA capital finance survey to examine the determinants of interest rates on roughly 4,000 active debt issues of all types as of 1983. These issues date to 1940, but separate

regressions are obtained for all issues and for issues for the years 1979 through 1983. While this study contains a number of interesting results, it is not limited to tax-exempt bonds, and the sample period predates the Prospective Payment System under Medicare.

[2]The material in this section dealing with the municipal bond market in general is based primarily on Bierwag (1981) and Moak (1982). The material dealing with hospitals is based on Cohodes and Kinkead (1984) and Elrod and Wilkinson (1985).

[3]A small percentage of hospital bonds have coupon rates that vary with the U.S. Treasury bill rate, the U.S. Treasury bond rate, or another market interest rate. In determining the true interest cost of these bonds (see below), we assume a fixed coupon rate. We distinguish these issues in the regression analysis, however, with a dichotomous variable.

[4]A given term or serial bond is divided into specified denominations and sold separately. Hence there is more than one term bond of a given maturity. For example, a $5 million term bond that matures in 20 years and carries a coupon rate of 10 percent may be divided into 1,000 term bonds, each of which has a par value of $5,000, a maturity date 20 years hence, and a coupon rate of 10 percent. If these bonds are amortized by mandatory redemption prior to maturity, a certain number will be selected every year for redemption at par value. This procedure should be distinguished from calling the entire

issue at par or at a premium prior to maturity, which is done at the discretion of the issuer

[5]An original issue premium due to a fall in interest rates is extremely rare. There is no consensus as to why this is the case. One possibility is that interest rates may be estimated on the low side when a deal is structured. A second possibility is that the underwriter does not profit from selling bonds above par in a negotiated deal. The issuer does profit but usually is not well represented when the bonds are sold. A third and related explanation is that the underwriter may buy the bonds at par for his own account when rates fall. Another explanation is that the capital loss on a premium bond held to maturity cannot be used to offset capital gains in computing tax liabilities. These explanations were obtained in personal conversations with Claudia Fontaine of SDC; George A. Valais of the Government Finance Officers Association; David Latham of the New York State Medical Facilities Finance Agency; and Paul Thompson of Health Care Investment Analysts, Inc. Note that competitive issues may contain bid discounts which reduce the proceeds received by the issuer or bid premiums which increase the proceeds.

[6]The same formula applies in a competitive issue except that O is interpreted as the bid discount, which is positive if there is a bid premium, and G pertains to that portion of the gross spread if any that is paid directly by the issuer. In an issue that consists solely of serial bonds, S_t is the par value of

the bond that matures in year t. Hospital bonds pay interest semiannually rather than annually. We take account of this in the algorithm to compute the tic.

[7]The framework spelled out above differs from a conventional model of the financing of investment in physical capital by profit-making firms. In the conventional model firms borrow funds and issue new stock to finance these purchases. The optimal ratio of debt to equity is selected to minimize the weighted average cost of capital (a weighted average of the interest rates on debt and equity, where the weights are the fractions of debt and equity in the firm's capital structure). Although the interest rate on debt is positively related to the ratio of debt to equity, the weighted average cost of capital does not depend on the amount of investment if the ratio of debt to equity is held constant (Copeland and Weston 1988). Since not-for-profit hospitals cannot issue stock, this model is less relevant for them. Wedig, Hassan, and Sloan (1989) develop an interesting variant of the conventional investment model in which hospitals finance investment either by issuing debt or from retained earnings. (Philanthropy and government grants are ignored.) They point out that a corner solution with 100 percent debt financing is likely. In this case the relevant interest rate for investment decisions is the cost of debt.

[8]If current interest rates are expected to exceed future rates, short-term rates can exceed long-term rates. That is, the yield curve slopes downward

or the slope of the term-structure of interest rates is negative (Sharpe 1985).

[9]In preliminary research we experimented with measures pertaining to state certificate-of-need (CON) laws and the presence of a Section 1122 program. These measures never had significant regression coefficients, and their inclusion had no impact on the coefficients of the other variables.

[10]Specifically, hospitals must rebate to the Treasury all interest income earned in excess of the yield on tax-exempt bonds which accrue by investing unused proceeds from the tax-exempt bond in higher yielding securities. This occurs because there is a lag between project start-up and completion and the bond offering. The tax law allows only one advance refunding for bonds issued after 1985 and only two advance refundings for bonds issued prior to that year.

[11]The parameter β is not introduced explicitly by Wedig, Hassan, and Sloan (1989), but it is implicit in their analysis.

[12]The data base on new issues of municipal securities maintained by IDD Information Services does not exclude issues with par values less than $5 million prior to 1986. But this data base has many missing values for key variables, especially in the period from 1980 through 1985.

[13]HCFA files exist for fiscal 1983 and for the period from January 1, 1982 through September 30, 1982; but the data on these files are unreliable and contain many missing values. Issues for the years 1980 through 1983 are

matched to the 1984 file. The HCFA files that we use are referred to as PPS-I through PPS-V Minimum Data Sets.

[14]The regression coefficient associated with the ratio of assets to liabilities is identical to the coefficient associated with

(assets - liabilities)/assets. The latter ratio coincides with the equity-debt ratio of a for-profit firm and with the fund balance-debt ratio of a nonprofit firm.

[15]Statements concerning statistical significance in the text are based on one-tailed tests except when the direction of the effect is unclear on a priori grounds or when the estimated effect has the wrong sign. In the latter cases two-tailed tests are used.

[16]Issues with par values of less than $5 million in current dollars are excluded from the above data. Small issues are less likely to contain a call option than large issues, and issues with par values of less than $5 million are excluded from the SDC data base prior to January 1, 1986. Thus, trends in the percentage of callable issues are distorted if these issues are included for the years 1986, 1987, and 1988. Note that regression coefficients obtained for issues with par values of $5 million and greater are very similar to those in Table 2.

[17]In Grossman, Goldman, Nesbitt, and Mobilia (1991), we show that a reduction in the Federal marginal income tax rate should cause the regression coefficient of the Treasury bond rate to rise under certain conditions. We also

report the results of tests that fail to support this proposition and provide a partial explanation of these findings.

[18]The Blue Cross variables cannot be interacted with the fraction of inpatient days accounted for by Blue Cross inpatient days because there are no data on Blue Cross inpatient days on the HCFA Cost Reports. The AHA Annual Survey of Hospitals contains information on the fraction of hospital revenue accounted for by Blue Cross in the early 1980s. But this information is confidential and was not collected in the latter 1980s.

[19]This same effect would be observed in the post-PPS period (1984-1988) if the hospital had a PPS profitability margin of 0.

[20]Suppose that the regression model is

$$R = \alpha H * \text{Medicaid Share} * DRG,$$

where H is the Medicaid PPS profitability margin of a given hospital that is analogous to the Medicare PPS profitability margin and α is negative. Let Z be the sample mean of H. As an identity, $H \equiv Z - (Z - H)$. Hence,

$$R = \alpha Z * \text{Medicaid Share} * DRG + U,$$

where $U = \alpha(H - Z) * \text{Medicaid Share} * DRG$. If R is regressed on Medicaid Share*DRG, the regression coefficient estimates αZ. We obtain a negative value of this coefficient which implies that Z is positive. Care should be exercised in interpreting this result because the disturbance term (U) may be correlated with the observed right-hand side variable in the regression.

[21]As shown in note 20, our results imply that the analogous mean Medicaid PPS profitability margin also is positive.

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Table 1

Definitions of Variables

	A. Issue Characteristics
Tic	True interest cost as a percentage
Negotiated Private Placement	Dichotomous variables that identify negotiated issues and private placements, respectively; omitted category pertains to competitive issues
Call	Dichotomous variable that identifies callable issues
Put	Dichotomous variable that identifies putable issues
Fixed	Dichotomous variable that identifies issues with fixed coupon rates
Length	Length in years between the date of final maturity and the date of issue
Multi	Dichotomous variable that identifies issues for multihospital systems
Teach	Dichotomous variable that identifies issues for hospitals that have teaching status
Pool	Dichotomous variable that identifies pooled financings
S&P AAA S&P AA S&P A S&P Other	Dichotomous variables that identify issues rated by Standard and Poor's as AAA (S&P AAA); AA+, AA, or AA- (S&P AA); A+, A, or A- (S&P A); or below A- (S&P Other); omitted category pertains to unrated issues
Moody High Moody Low	Dichotomous variables that identify issues rated higher by Moody's than by Standard and Poor's or lower by Moody's than by Standard and Poor's, respectively
Rank	Rank of primary underwriter in terms of total par value of issues underwritten; ranges from 1 (highest par value) to 50 (lowest par value)
No Rank	Dichotomous variable that identifies issues in which primary underwriter is not one of the 50 leading underwriters

Table 1 (continued)

General	Dichotomous variable that identifies general obligation bonds
	B. National Characteristics
T Bond Rate	Yield on 30-year U.S. Treasury bond on week of issue as a percentage
Variability	Standard deviation of previous variable based on an eight-week period ending with the week of issue
	C. State Characteristics
State Income Tax	State income tax rate in highest tax bracket as a percentage
Mandatory Rate Setting	Dichotomous variable that identifies issues in states with mandatory rate-setting programs; does not vary over time
Medicaid DRG Medicaid Other	Dichotomous variables that identify issues in states using a DRG reimbursement methodology under Medicaid (Medicaid DRG) and issues in states using a Medicaid reimbursement system with prospective rate of increase controls or with negotiation and fixed contracting (Medicaid Other); omitted category pertains to issues in states using retrospective cost-based reimbursement under Medicaid
	D. County Characteristics
Unemployment	Unemployment rate of persons aged 16 and over as a percentage
Rural	Dichotomous variable that identifies rural counties
Blue Cross (BC) Cost Blue Cross Prospective Blue Cross Denial	Dichotomous variables that identify Blue Cross plans that reimburse on the basis of costs (BC Cost); Blue Cross plans that reimburse on a prospective basis (BC Prospective); and Blue Cross plans that operate programs that actively review the medical appropriateness of claims (BC Denial); variables are county-specific because some states have more than one Blue Cross plan

Table 1 (concluded)

E. Hospital Characteristics	
Medicare PPS Profitability Margin	Difference between 1984 projected Medicare inpatient revenue from a fully implemented DRG reimbursement system and revenue based on a given hospital's 1981 Medicare revenue and case mix projected to 1984 divided by 1981 Medicare reveneue projected to 1984; interacted with a dichotomous variable that equals 1 for the years 1984 through 1988 since PPS began in October 1983
Medicare Share	Fraction of inpatient days accounted for by Medicare inpatient days
Medicaid Share	Fraction of inpatient days accounted for by Medicaid inpatient days
Government Share	Sum of Medicare and Medicaid fractions of inpatient days
Asset Ratio	Ratio of total assets to total liabilities

Table 2

Reduced Form Tic Regressions
(Absolute t-statistics in parentheses, intercepts not shown, sample size = 2,978 for all regressions)

	(1)	(2)	(3)
Call	.279	.289	.286
	(3.94)	(4.08)	(4.03)
Put	-.534	-.552	-.542
	(2.17)	(2.26)	(2.21)
Fixed	2.521	2.503	2.516
	(10.40)	(10.37)	(10.40)
Multi	-.036	-.061	-.066
	(.73)	(1.23)	(1.32)
Teach	-.183	-.163	-.146
	(2.91)	(2.57)	(2.27)
Negotiated	.661	.681	.666
	(5.41)	(5.59)	(5.46)
Private Placement	.513	.503	.497
	(3.02)	(2.97)	(2.93)
Pool	-.050	-.044	-.041
	(.52)	(.45)	(.42)
Rank	.006	.006	.006
	(3.38)	(3.27)	(3.15)
No Rank	.288	.265	.267
	(4.56)	(4.20)	(4.22)
Length	.048	.047	.047
	(15.95)	(15.70)	(15.65)
T Bond Rate	.763	.741	.746
	(62.24)	(57.44)	(58.34)
Variability	1.557	1.458	1.500
	(8.60)	(8.01)	(8.26)
State Income Tax	-2.848	-3.054	-3.019
	(4.96)	(5.15)	(5.09)
S&P AAA	-1.471	-1.460	-1.464
	(19.95)	(19.80)	(19.80)
S&P AA	-1.354	-1.363	-1.360
	(14.19)	(14.29)	(14.21)
S&P A	-.818	-.844	-.833
	(10.67)	(10.96)	(10.81)
S&P Other	.089	.060	.069
	(.96)	(.64)	(.74)

Table 2 (concluded)

	(1)	(2)	(3)
Moody High	-1.142 (14.78)	-1.148 (14.89)	-1.143 (14.80)
Moody Low	-.030 (.60)	-.036 (.73)	-.039 (.78)
General	-.423 (3.55)	-.386 (3.20)	-.401 (3.32)
Missing		-.065 (.33)	.196 (.88)
Mandatory Rate Setting		.095 (.60)	.042 (.26)
Blue Cross Cost		.090 (1.35)	.037 (.56)
Blue Cross Prospective		.084 (1.21)	.057 (.82)
Blue Cross Denial		-.199 (1.17)	-.134 (.79)
Unemployment Rate		.033 (4.03)	.035 (4.20)
Rural		.009 (.12)	.002 (.03)
Asset Ratio		-.017 (1.32)	-.016 (1.28)
Medicare PPS Margin		-.306 (2.35)	
Medicaid DRG		-.345 (4.07)	
Medicaid Other		-.183 (2.95)	
Government Share			.262 (1.20)
Medicare Share*PPS			-.799 (2.84)
Medicaid Share*DRG			-1.438 (2.34)
Medicaid Share*Other			-.797 (2.10)
R-Square	.782	.785	.785
F-Statistic	505.26	336.77	325.24

Table 3

Reduced Form Tic Regressions, Bond Ratings Excluded
(Absolute t-statistics in parentheses, intercepts not shown, sample size = 2,978 for all regressions)

	(1)	(2)	(3)
Call	.134	.149	.144
	(1.75)	(1.94)	(1.88)
Put	-.502	-.533	-.524
	(1.85)	(1.98)	(1.94)
Fixed	2.639	2.603	2.618
	(9.86)	(9.80)	(9.83)
Multi	-.106	-.125	-.129
	(1.95)	(2.29)	(2.35)
Teach	-.346	-.297	-.278
	(5.03)	(4.28)	(3.96)
Negotiated	.464	.490	.472
	(3.45)	(3.66)	(3.52)
Private Placement	.532	.534	.529
	(2.83)	(2.86)	(2.83)
Pool	-.379	-.381	-.380
	(3.63)	(3.57)	(3.55)
Rank	.011	.011	.011
	(5.64)	(5.56)	(5.44)
Rank Dummy	.603	.566	.567
	(8.99)	(8.43)	(8.42)
Length	.051	.050	.050
	(15.79)	(15.46)	(15.46)
T Bond Rate	.752	.726	.736
	(56.29)	(51.56)	(52.63)
Variability	1.863	1.728	1.789
	(9.37)	(8.65)	(8.98)
State Income Tax	-3.083	-3.533	-3.468
	(4.89)	(5.44)	(5.33)
General	-.511	-.499	-.518
	(3.89)	(3.76)	(3.89)
Missing		-.114	.253
		(.52)	(1.03)
Mandatory Rate Setting		-.004	-.084
		(.02)	(.48)
Blue Cross Cost		.110	.033
		(1.50)	(.46)
Blue Cross Prospective		.088	.043
		(1.15)	(.56)

Table 3 (concluded)

	(1)	(2)	(3)
Blue Cross Denial		-.293 (1.56)	-.214 (1.15)
Unemployment Rate		.034 (3.79)	.035 (3.86)
Rural		.220 (2.79)	.206 (2.58)
Asset Ratio		-.027 (1.93)	-.026 (1.84)
Profitability Margin		-.440 (3.06)	
Medicaid DRG		-.364 (3.90)	
Medicaid Other		-.218 (3.20)	
Government Share			.444 (1.84)
Medicare Share*PPS			-1.008 (3.25)
Medicaid Share*DRG			-.940 (1.39)
Medicaid Share*Other			-.958 (2.29)
R-Square	.732	.738	.737
F-Statistic	540.72	319.54	306.03