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Determinants of interest rates on tax-exempt hospital bonds*

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The aim of this paper is to examine the determinants of interest 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. The Federal tax act of 1986 raised the cost of hospital debt by encouraging bond issues to contain call features.

Key words: Interest rates; Tax-exempt hospital bonds

JEL classification: I18

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*This is a condensed version of Grossman et al. (1992a,b). The longer versions contain a detailed discussion of the workings of the municipal bond market, a literature survey pertaining to determinants of interest rates on municipal bonds, a description of the algorithms used to compute the true interest cost of issues in the data base maintained by Securities Data

1. Introduction

This paper presents an empirical analysis of the determinants of interest rates on tax-exempt hospital bonds. 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 et al., 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

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accounted for approximately 13 percent of total volume in the municipal bond market.

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 et al., 1986; Carpenter, 1991). 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.

2. Analytical framework

Hospital bonds are issued by state, county, and city finance authorities on behalf of hospitals. 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.

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. Typi-

cally, 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).

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 equates the proceeds received by the hospital to the present value of interest payments and principal repayments. To obtain a reduced form equation for the true interest cost, we assume that each hospital has a downward sloping demand function for funds obtained from the bond market but faces an infinitely elastic cost of funds schedule. That is, we assume that the tic does not depend on the amount of the issue. This means that variables that shift the demand function for funds are excluded from the reduced form tic equation.

Empirical studies of the determinants of interest rates on tax-exempt municipal bonds attribute differences among interest rates on these bonds to risk, the general level of market interest rates, and the costs of the issue. Riskier bonds must offer higher interest rates to induce investors to purchase them than the rates offered by less risky assets. 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 because of uncertainty about future interest rates. There is potential for capital loss if a bond is purchased and later sold prior to maturity, and interest rates have risen in the interim. Even if the bond is held to maturity, the purchaser 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 as compensation for the increase in market risk.

Institutional risk and the bond characteristics that interact with market risk 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. 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 total assets.

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 during the period we analyze. The 1986 tax law reduced marginal personal income tax rates, raised the tax rate on capital gains, abolished a number of tax shelters, generally eliminated institutional investors' deduction of carrying charges for holding tax-exempt bonds, and curtailed arbitrage profits. Most important from the point of view of our research, the law allows only one advance refunding for bonds issued after 1985 and only two advance refundings for bonds issued prior to that year. Thus, the law contains incentives to include a call feature.

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. Consider a hospital that 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

$$i=(1-\alpha\beta)r. \tag{1}$$

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 interest rate or the tic on the hospital's bonds. Equation (1) highlights the incentives of not-for-profit hospitals to issue debt, which are discussed in detail by Sloan et al. (1988), and Wedig et al. (1988, 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.

The above is, however, an oversimplification. This is because the gross interest rate [r in Equation (1)] 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 reimbursement policies (which also originally used the retrospective cost-based Medicare reimbursement system), 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 et al., 1987).

Cost-based reimbursement characterized Medicare until the October 1983 introduction and phase-in 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.

An important 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, which includes the four-year period immediately preceding PPS (1980–83) and the five-year period immediately following its enactment (1984–88).

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, 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 et al., 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. 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 because many of them occurred before the adoption of 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. 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 these aspects of Blue Cross reimbursement in our empirical analysis.

3. Data, measurement of variables, and estimation issues

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) for the years 1980 through 1988. There are 2,978 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.

Table 1 contains definitions, means, and standard deviations of variables that are employed in the regression analyses in Section 4. 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.

The roles of most of the variables in Table 1 in the determination of the tic were discussed in Section 2. The weekly yield on a 30-year U.S. Treasury bond is employed as a proxy for the market rate of interest. 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 and P rating are identified with two dichotomous variables.

Sloan et al. (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 investment bankers 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.

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 are expected to carry lower interest rates than revenue bonds.

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. Since PPS was phased in, 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. It is multiplied by a dichotomous variable that equals 1 for the post-enactment years 1984-88 and equals 0 for the pre-enactment years 1980–83. A complete assessment of the impacts of this reimbursement system must take account of differences in the fraction of total inpatient days accounted for by Medicare inpatient days among hospitals. Therefore, the fraction just mentioned is multiplied by the product of the PPS margin and the dichotomous variable for the period 1984–1988 to obtain the measure used in the regressions (Medicare Share*PPS).

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).

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. Similar to the Medicare Share*PPS variable, these two variables are multiplied by the fraction of inpatient days accounted for by Medicaid inpatient days to obtain the measures used in the regressions (Medicaid Share*DRG and Medicaid Share*Other). The Medicare and Medicaid shares themselves are included in the specifications to evaluate their impacts in a cost-based reimbursement environment.[1]

[1]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 Medicare Hospital Cost Reporting Data Files from which we obtained total inpatient days, Medicare inpatient days, and Medicaid inpatient days. The AHA Annual Survey of Hospitals contains information on the fraction of hospital revenue accounted for by Blue Cross

Table 1

Definitions, means and standard deviations of variables[a]

A. Issue characteristics	
Tic (9.342, 2.427)	True interest cost as a percentage
Negotiated (0.922, 0.268) Private placement (0.029, 0.168)	Dichotomous variables that identify negotiated issues and private placements, respectively; omitted category pertains to competitive issues
Call (0.866, 0.341)	Dichotomous variable that identifies callable issues
Put (0.156, 0.363)	Dichotomous variable that identifies putable issues
Fixed (0.837, 0.369)	Dichotomous variable that identifies issues with fixed coupon rates
Length (24.742, 8.214)	Length in years between the date of final maturity and the date of issue
Multi (0.250, 0.433)	Dichotomous variable that identifies issues for multihospital systems
Teach (0.137, 0.344)	Dichotomous variable that identifies issues for hospitals that have teaching status
Pool (0.063, 0.243)	Dichotomous variable that identifies pooled financings
S&P AAA (0.302, 0.459) S&P AA (0.095, 0.294) S&P A (0.275, 0.447) S&P other (0.088, 0.283)	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 (0.129, 0.335) Moody low (0.314, 0.464)	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 (10.511, 12.948)	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 (0.214, 0.410)	Dichotomous variable that identifies issues in which primary underwriter is not one of the 50 leading underwriters
General (0.052, 0.222)	Dichotomous variable that identifies general obligation bonds
B. National characteristics	
T Bond Rate (10.302, 1.917)	Yield on 30-year U.S. Treasury bond on week of issue as a percentage
Variability (0.226, 0.128)	Standard deviation of previous variable based on an eight-week period ending with the week of issue
C. State characteristics	
State income tax (0.050, 0.037)	State income tax rate in highest tax bracket as a fraction
Mandatory rate setting (0.118, 0.323)	Dichotomous variable that identifies issues in states with mandatory rate-setting programs; does not vary over time
Medicaid DRG (0.216, 0.410) Medicaid other (0.491, 0.500)	Dichotomous variables that identify issues in states using a DRG reimbursement methodology under Medicaid (DRG) and issues in states using a Medicaid reimbursement system with prospective rate of increase controls or with negotiation and fixed contracting (Other); omitted category pertains to issues in states using retrospective cost-based reimbursement under Medicaid

Table 1 (continued)

D. County characteristics	
Unemployment[b] (7.859, 3.274)	Unemployment rate of persons aged 16 and over as a percentage
Rural[b] (0.194, 0.381)	Dichotomous variable that identifies rural counties
Blue Cross (BC) Cost[b] (0.476, 0.483) Blue Cross Prospective[b] (0.673, 0.453) Blue Cross Denial[b] (0.971, 0.156)	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
E. Hospital characteristics	
Medicare share[b] (0.439, 0.112)	Fraction of inpatient days accounted for by Medicare inpatient days
Medicaid share[b] (0.088, 0.093)	Fraction of inpatient days accounted for by Medicaid inpatient days
Asset ratio[b] (2.145, 2.078)	Ratio of total assets to total liabilities
Medicare PPS Profitability margin[b,c] (abbreviated PPS) (0.076, 0.206)	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 revenue 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*PPS[b] (0.032, 0.095)	Fraction of inpatient days accounted for by Medicare inpatient days multiplied by PPS profitability margin (PPS); interacted with a dichotomous variable that equals 1 for the years 1984 through 1988 since PPS began in October 1983
Medicaid share*DRG[b] (0.018, 0.047) Medicaid share*other[b] (0.041, 0.075)	Fraction of inpatient days accounted for by Medicaid inpatient days multiplied by a dichotomous variable that identifies issues in states using a DRG reimbursement methodology under Medicaid (Medicaid Share*DRG) and fraction of inpatient days accounted for by Medicaid inpatient days multiplied by a dichotomous variable that identifies issues in states using a Medicaid reimbursement system with prospective rate of increase controls or with negotiation and fixed contracting; (Medicaid Share*Other) omitted category pertains to issues in states using retrospective cost-based reimbursement under Medicaid

[a]Means and standard deviations in parentheses. First figure is mean, second figure is standard deviation.

[b]Mean and standard deviation pertain to issues for which county and hospital characteristics are known. See Section IV of the text for more details.

[c]Mean and standard deviation of PPS margin not interacted with dichotomous variable for the years 1984 through 1988 equal 0.104 and 0.236, respectively.

Given our focus on Medicare's Prospective Payment System, several aspects of the PPS measure and its theoretical impacts on hospital behavior should be noted. In recent behavioral models developed by Dranove (1988), Wedig et al. (1989), and Hoerger (1991), nonprofit hospitals maximize a utility function that depends on profits and the quantity of output or a utility function that depends on profits, quantity, and quality of output. Consider a simple model in which utility depends on profits and a composite measure of output. An exogenous increase (decrease) in profits due to PPS will increase (decrease) the optimal output which, in turn, will increase (decrease) total cost. Hence the actual change in profits will be smaller than the exogenous change in profits. The latter variable, or an exogenous proxy for it, is the most relevant regressor in a reduced form tic equation. The PPS margin can be characterized as such a proxy since it is based on the difference between 1984 projected 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. Given the cost-based reimbursement system prior to 1984, the latter projection reflects costs in 1981. It does *not* reflect endogenous changes in costs due to changes in output associated with PPS.

To put the above point somewhat differently, consider three alternative Medicare PPS profitability margins:

$$p_p=(R_p-C_p)/C_p \tag{2}$$

$$p_a=(R_a-C_a)/C_a \tag{3}$$

$$p_\ell=(R_\ell-C_\ell)/C_\ell, \tag{4}$$

where R denotes revenue from treating Medicare patients and C denotes costs of treating these patients. The last margin (p_ℓ) is a long-run measure which reflects full adjustments in length of stay and services per case to a case-based reimbursement system. In a structural sense it is the most proximate determinant of the tic. The margin given by Equation (3) reflects actual profitability in a given year. It differs from p_ℓ because full adjustment to PPS is likely to take a number of years. The first margin (p_p) – the one used in our study – is based on projected revenues and costs from the pre-PPS period. It measures potential profitability and is exogenous in the sense that it does not reflect adjustments in length of stay and services per case to PPS.

The impact of p_p on the tic depends on the general relationship between

patients in the early 1980s. But this information is confidential and was not collected in the latter 1980s.EF

profitability and bond yields and on the relationship between p_p and p_ℓ. Clearly, potential and long-run profitability are positively correlated. But the correlation may not be large in the face of substantial adjustments in length of stay and services per case. Of course, long-run profitability is not observed. Therefore, the effect of p_p on bond yields depends on the bond market's assessment of the ability of hospitals with unfavorable projected margins to make compensatory adjustments.

The PPS margin is interacted with the fraction of inpatient days accounted for Medicare inpatient days because the impact of PPS on a hospital's profitability should depend on the relative number of Medicare and non-Medicare patients. The share rather than the actual number of Medicare patients is used because Medicare and Medicaid shares have been shown to determine bond yields in the pre-PPS period (Cohodes and Kinkead 1984 and Sloan, Morrisey, and Valvona 1987). These shares pertain to the year of the bond issue or, if this is missing, to the closest year following the issue.[2] Hospitals with favorable PPS profitability margins have incentives to raise their Medicare shares, while hospitals with unfavorable margins have incentives to lower their shares. To explore the effect of this potential endogeneity, we estimate variants of the basic model with the PPS variable given simply by the profitability margin multiplied by the dichotomous indicator of the post-PPS period. The Medicare and Medicaid shares are deleted from this specification. Also, in this specification, there is no interaction of the Medicaid share with dichotomous indicators for states that use a DRG reimbursement methodology under Medicaid, or that use a Medicaid reimbursement system with prospective rate of increase controls or with negotiation and fixed contracting.

The Medicare Prospective Payment System established payment rates for 473 different diagnosis related groups (DRGs). If all hospitals had the same case mix, differences in the PPS profitability margin among them would be due entirely to differences in base year costs. However, given substantial variations in case mix, a hospital could have relatively high costs in the base period and still benefit from the enactment of PPS. For example, an institution that performed a large number of complex surgical procedures and had high costs per case (not adjusted for case mix) for that reason would still benefit from PPS if it were more efficient in performing these procedures than a typical hospital.

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

[2]The HCFA Medicare Hospital Cost Reporting Data Files for the period before fiscal 1984 are unreliable and contain many missing values. Thus, we could not interact the PPS profitability margin with the exogenous Medicare share for the pre-PPS period.

with the state income tax rate in the highest income tax bracket. The county unemployment rate and the location of a hospital in a rural county are area-wide indicators of potential default risk. The ratio of total assets to total liabilities is a hospital indicator of default risk.

We conclude this section by raising three issues concerning estimation: sample selection, endogeneity of certain issue characteristics, and endogeneity of the bond ratings and interpretation of the regression results that include them. Not all hospitals issued debt in the period from 1980 through 1988. Since the decision to enter the municipal bond market is unlikely to be random, the estimates presented in the next section may be biased due to sample selection. Strictly speaking, the solution to this problem is to obtain a sample of hospitals that did not issue debt and then apply Heckman's (1979) sample selection methodology. In fact, identification of this model by means other than the nonlinear relationship between the inverse of the Mills ratio and the regressors in the tic equation is unlikely. Given this and the lack of empirical research in the area at issue, we interpret our results as being conditional on bonds being offered.[3]

The endogeneity of issue characteristics potentially is a more important problem, particularly in light of our interest in the effects of choosing an underwriter on a negotiated as opposed to a competitive basis, and in the effects of including a call provision in the issue. Consider the method by which an underwriter is chosen. This can be formulated as a 'switching regression model with endogenous switching' to use the term coined by Maddala (1983, p. 223). The model consists of an equation for the threshold function associated with the probability of selecting an underwriter in a competitive fashion and separate equations for the determinants of the interest rate in competitive and negotiated deals, or one equation for the tic if the slope coefficients do not differ in these two regimes. The tic equation can be estimated by ordinary least squares as long as its disturbance term is not correlated with the disturbance term in the reduced form threshold function. Even if the correlations between the structural residuals in the model are large, the correlation at issue may be small or zero because the error in the reduced form threshold equation is a composite of the tic equation error terms and the structural choice residual (Kostiuk, 1990). We assume that this key correlation is zero, but we recognize that the coefficients are biased if this is not the case and that our results must be interpreted with this in mind.

Variables that identify insured issues and issues that carry a letter of credit are highly correlated with Standard and Poor's and Moody's credit ratings and cannot be included in the same regression. Thus, the effects of these

[3]Using a sample of 150 hospital bond issues for the period 1982–1984, Carpenter (1992) does fit the sample selection model described above. The coefficient of the inverse of the Mills ratio never is significant in that study.

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 give misleading estimates of the impacts on interest rates of variables that may have important effects on the ratings, such as the PPS profitability margin. Consequently, regressions are estimated with and without the credit ratings.

If an issue's credit rating were a perfect correlate of its default risk, there would be no rationale for the inclusion of other correlates of default risk in the same regression. However, the credit rating is determined by employees of the rating agency rather than the bond market. Given this and the many studies in the municipal bond literature beginning with Kessel's (1971) seminal paper that include ratings in bond yield regressions, we assume that the credit ratings are less than perfectly correlated with default risk. In general, if variable x is a determinant of the bond yield and the credit rating, the regression that omits the rating provides an upper bound estimate of the absolute value of the effect of x on the yield, while the regression that includes the rating provides a lower bound estimate.[4]

4. 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 Table 2. The first

[4]Suppose that the equation relating the tic to three basic determinants is

$$r=\alpha_1 x_1+\alpha_2 x_2+\alpha_3 x_3,$$

where the disturbance term is suppressed. Suppose that the credit rating (s) of the issue is determined by

$$s=\beta_1 x_1+\beta_3 x_3+u,$$

where u is the disturbance term. The three coefficients in the tic equation are negative, while the two coefficients in the rating equation are positive. If x_3 is not observed and positively correlated with x_1 and x_2, a regression of r on these two variables overstates their coefficients in absolute value. Now solve the rating equation for x_3 as a function of s, x_1, and u; and substitute into the tic equation:

$$r=(\alpha_3/\beta_3)s+[\alpha_1-(\alpha_3\beta_1/\beta_3)]x_1+\alpha_2 x_2-(\alpha_3/\beta_3)u.$$

Clearly, the coefficient of x_1 in the last equation is smaller in absolute value than the coefficient of x_1 in the first equation. Note that the coefficient of s is biased toward zero if the last equation is estimated with u omitted since u and s are positively correlated. Taken by itself, this factor biases the coefficient of x_1 away from zero since x_1 and s are positively correlated. We assume that this upward bias in the absolute value of the regression coefficient of x_1 in the last equation is offset by the fundamental difference between the structural parameters of x_1 in the last and the first equations.

Table 2

Reduced form tic regressions (absolute t-statistics in parentheses, intercepts not shown, sample size = 2,978 for all regressions)

	(1)	(2)	(3)[a]	(4)[a]
Call	0.294	0.160	0.278	0.147
	(4.15)	(2.09)	(3.90)	(1.92)
Put	−0.537	−0.516	−0.524	−0.448
	(2.20)	(1.92)	(2.12)	(1.66)
Fixed	2.532	2.641	2.545	2.684
	(10.48)	(9.94)	(10.45)	(10.09)
Multi	−0.069	−0.135	−0.080	−0.139
	(1.39)	(2.46)	(1.54)	(2.46)
Teach	−0.164	−0.295	−0.199	−0.347
	(2.54)	(4.16)	(3.00)	(4.84)
Negotiated	0.686	0.495	0.677	0.497
	(5.63)	(3.70)	(5.45)	(3.67)
Private placement	0.523	0.561	0.515	0.568
	(3.09)	(3.01)	(3.01)	(3.04)
Pool	−0.058	−0.405	−0.027	−0.375
	(0.59)	(3.78)	(0.27)	(3.49)
Rank	0.006	0.011	0.006	0.011
	(3.11)	(5.31)	(3.35)	(5.25)
No rank	0.260	0.551	0.264	0.545
	(4.11)	(8.16)	(3.97)	(7.74)
Length	0.047	0.051	0.049	0.053
	(15.76)	(15.66)	(16.31)	(16.24)
T bond rate	0.745	0.734	0.747	0.738
	(58.03)	(52.40)	(57.71)	(52.60)
Variability	1.507	1.796	1.466	1.707
	(8.31)	(9.04)	(8.07)	(8.63)
State income tax	−2.820	−3.128	−1.717	−3.883
	(4.70)	(4.76)	(0.83)	(1.72)
General	−0.380	−0.489	−0.321	−0.398
	(3.15)	(3.68)	(2.58)	(2.93)
Missing	0.149	0.227	0.029	0.101
	(0.66)	(0.91)	(0.12)	(0.39)
Mandatory rate setting	−0.128	−0.128		
	(1.73)	(2.68)		
Blue Cross cost	0.036	0.032	−0.109	−0.156
	(0.54)	(0.44)	(1.36)	(1.79)
Blue Cross prospective	0.065	0.054	0.071	0.033
	(0.94)	(0.71)	(0.85)	(0.36)
Blue Cross denial	−0.121	−0.196	−0.044	−0.039
	(0.72)	(1.05)	(0.25)	(0.20)
Unemployment rate	0.035	0.035	0.026	0.023
	(4.16)	(3.81)	(2.89)	(2.34)

Table 2 (continued)

Rural	0.007	0.215	0.003	0.196
	(0.10)	(2.70)	(0.03)	(2.34)
Asset ratio	−0.016	−0.025	−0.018	−0.028
	(1.28)	(−1.83)	(1.43)	(1.99)
Medicare share	−0.030	0.114	−0.153	−0.043
	(0.12)	(0.42)	(0.60)	(0.16)
Medicaid share	1.038	1.314	1.122	1.354
	(2.80)	(3.21)	(2.92)	(3.22)
Medicare share*PPS	−0.751	−0.950	−0.761	−0.902
	(2.67)	(3.07)	(2.66)	(2.89)
Medicaid share*DRG	−1.980	−1.560	−2.159	−1.701
	(2.99)	(2.14)	(2.99)	(2.16)
Medicaid share*other	−1.457	−1.704	−1.516	−1.572
	(3.20)	(3.40)	(3.01)	(2.86)
S&P AAA	−1.454		−1.423	
	(19.67)		(18.98)	
S&P AA	−1.349		−1.257	
	(14.09)		(12.85)	
S&P A	−0.830		−0.816	
	(10.77)		(10.42)	
S&P other	0.077		0.067	
	(0.82)		(0.71)	
Moody high	−1.130		−1.082	
	(14.62)		(13.83)	
Moody low	−0.044		−0.041	
	(0.88)		(0.81)	
R-square	0.786	0.738	0.792	0.750
F-statistic	316.91	296.94	132.54	112.77

*Regressors include state dummy variables.

regression in Table 2 includes Standard and Poor's and Moody's credit ratings, while the second regression excludes these ratings. The last two regressions in the table add dichotomous variables for each state and the District of Columbia except New York. The purpose of this fixed effect specification is to examine the extent to which the coefficients in the first two regressions are influenced by unmeasured variables that are time-invariant and state-specific. Since the mandatory-rate setting measure also is time-invariant and state-specific, it is omitted from the last two regressions.

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, the regressions in Table 2 were 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, the regressions in the table 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 observations with missing county and hospital characteristics are retained so that estimates of the effects of issue characteristics can be based on as large a sample as possible.

In discussing the results, we focus on the effects of the regulatory variables (Medicare and Medicaid reimbursement policies and mandatory rate setting) and on the effects of the method of selecting an underwriter and the inclusion of a call provision. We note first that the inclusion of the set of 50 state dummy variables has a very modest impact on the explanatory power of the regressions. While these variables are significant as a set at the 1 percent level, the F-ratios associated with this test are relatively small [1.80 in regression (2–3) and 2.80 in regression (2–4) compared to a critical F-ratio of 1.52]. Moreover, almost all the regression coefficients are insensitive to the inclusion of the state dummies. The one exception is that the coefficient of the state income tax rate is significant in regression (2–1) but not in regression (2–3). Thus, the statistically significant Medicare and Medicaid reimbursement effects, which we highlight below, cannot be attributed to the omission of unmeasured aspects of state regulatory programs.

Perhaps our most important regulatory result pertains to the impact of Medicare's Prospective Payment System on bond yields. Recall that the variable employed to capture the impact of this reimbursement system (Medicare Share*PPS) 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 all conventional levels on a one-tailed test in regression (2–1). When the bond ratings are excluded, the PPS coefficient rises by almost 26 percent.[5] To gauge the magnitude of this effect, consider two hospitals, one with a PPS margin of 0.2 and the other with a PPS margin of −0.2. The differential amounts to two standard deviations of the profitability margin. Suppose that the Medicare fraction of inpatient days in each hospital equals the sample mean of 0.43. According to regression (2–1), the first hospital could issue bonds with a tic 12 basis points lower than the second hospital (1 basis point

[5]The coefficient of the PPS variable in regression (2–2) is significantly greater in absolute value than the corresponding coefficient in regression (2–1) at all conventional levels (t-ratio = 11.47). This result is based on a variant of a Hausman (1978) specification test. Essentially, the test assumes that the covariance between the two coefficients is equal to the variance of the coefficient in regression (2–1) and uses the residual variance in regression (2–2) to estimate the variance of the coefficient in regression (2–1).

equals 1/100 of 1 percent). The corresponding interest cost saving from regression (2–2) is 16 basis points.

How reasonable are interest cost savings ranging from 12 to 16 basis points? Suppose that the two hospitals in the preceding example had the same case mix. Then the PPS margins of 0.2 and −0.2 suggest baseline (pre-PPS) cost differentials between the two hospitals of approximately 40 percent. If these cost differentials were genuine, the PPS effect would appear to be very modest.

Several factors, however, affect the plausibility of the above interpretation. First, quality indicators may have differed between the two hospitals in the pre-PPS period. Thus, the PPS effect may be small because the market anticipates that high quality/high cost hospitals that are hurt by PPS will react to its enactment by lowering the quality of their output. That is, PPS margins based on actual revenues and costs will show less variation in the long run than the exogenous margins used here.

Second, the PPS margin pertains to profitability from treating Medicare patients, who account for approximately 44 percent of all inpatient days, rather than to profitability from treating all patients. Profit margins from treating non-Medicare patients may be uncorrelated or negatively correlated with profit margins from treating Medicare patients. Finally, case mix proportions vary among hospitals. Given these variations, differences among PPS margins do not simply reflect differences in baseline costs. Hospitals that treat a disproportionate number of complex cases may appear to have high costs but still may have favorable PPS margins if they are relatively efficient in treating these cases. The factors just mentioned suggest that it is difficult to determine what constitutes a large or small PPS effect.

In the pre-PPS period, the coefficient of the fraction of Medicare patient days is negative in the first regression in Table 2, positive in the second, but never significant. In the post-PPS period, the impact of an increase in the Medicare share is given by $-0.030 - 0.751p$ in regression (2–1) and by $0.114 - 0.950p$ in regression (2–2), where p is the profitability margin. The first effect is negative for all positive values of the profitability margin, while the second is negative if the margin exceeds the sample mean of 0.1.

In interpreting the PPS effects just described and in assessing their robustness, a number of factors are relevant. First, the profitability margin was not computed for hospitals in Medicare-waiver states (New York, New Jersey, Maryland, and Massachusetts).[6] These states, however, had mandatory rate-setting programs that shared similar elements with PPS reimbursement. We find that the existence of these programs lowers bond yields by

[6]New York and Massachusetts entered PPS in October 1987, but the source from which we obtained the profitability margin (see Grossman et al., 1992a,b) did not estimate this variable for New York and Massachusetts hospitals.

between 13 and 22 basis points. Second, when the sample is limited to the issues for which the hospital's PPS profitability margin is known, the coefficients of the variable Medicare Share*PPS are similar to those in Table 2. Specifically, the coefficient corresponding to the one in regression (2–1) is −0.664 (t-ratio = 2.40), and the coefficient corresponding to the one in regression (2–2) is −0.857 (t-ratio = 2.82).

Third, the PPS profitability margin is correlated with past costs, which may be correlated with endogenous components of default risk. Thus, this variable may be capturing more than just the effect of reimbursement changes. One specification check for whether this is a problem is to run a regression restricted to the 1980–1983 period. Since PPS was not in effect in this period, the profitability margin should not enter this regression. If, however, its coefficient is significant, this suggests that the variable may capture more than just the effects of PPS and that base year costs are correlated with underlying risk.

In the specification just described, the coefficient of Medicare Share*PPS (obviously not interacted with the dichotomous indicator of the post-PPS period) is −0.148 (t-ratio = 0.32) when the bond ratings are included. When they are omitted the coefficient is 0.029 (t-ratio = 0.05). These results should be interpreted with caution because a negative and significant coefficient could signal that the enactment of PPS was anticipated by the market. Nevertheless, the lack of a significant effect in the pre-PPS period suggests that our estimates reflect causal responses by the bond market to exogenous changes in reimbursement policy.

Fourth, one can argue that the Medicare share is endogenous, as pointed out in Section 3. 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. Therefore, we reestimated regressions (2–1) and (2–2) with the PPS variable given simply by the profitability margin multiplied by the dichotomous indicator of the post-PPS period (see Section 3 for a complete description of this specification). With the ratings held constant, the PPS margin has a coefficient of −0.327 (t-ratio = 2.51) in this alternative specification. With the ratings omitted, the coefficient is −0.462 (t-ratio = 3.22). Recall that we previously compared two hospitals: one with a PPS margin of 0.2 and the other with a PPS margin of −0.2. The alternative specification of the PPS effect results in tic differentials between the two hospitals ranging from 13 to 18 basis points. This is extremely close to the 12- to 16-basis-point range obtained with the Medicare-share-interaction specification.

Finally, Hoerger (1991) has shown that a measure related to our PPS profitability margin has a positive and significant impact on a hospital's net

profit.[7] This suggests a plausible mechanism via which an exogenous change in reimbursement policy affects an endogenous component of default risk. By employing a long-run measure of the PPS margin, as opposed to the shorter-run measure used by Hoerger, we capture the expected impact of the change in Medicare reimbursement policy on the ability to make debt repayments in the future.

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. Consider a hospital whose Medicaid fraction of inpatient days equals the sample fraction of 0.09. If the hospital is in a state employing DRG reimbursement under Medicaid, its bonds would carry tics that are between 14 and 18 basis points lower than if it were 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 between 13 and 15 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 Medicaid share measure. If DRG reimbursement is employed, the effect is obtained by summing the coefficient of Medicaid 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. Some caution is required in interpreting these results because profitability margins analogous to the PPS margin are not available. 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.

Negotiated issues and private placements carry higher tics than competitive issues. The relevant regression coefficients are statistically significant at all conventional levels and rather large in magnitude. A negotiated deal adds 69 basis points to the tic, and a private placement adds 52 basis points [(see regression (2–1)]. In contrast, Sorensen (1979) reports that a negotiated deal

[7]Hoerger observes this effect in the case of for-profit and nonprofit hospitals but not for government hospitals. Our data include bonds issued by government hospitals, but we found no evidence of differential PPS effects for these hospitals. A dichotomous indicator of government hospitals also was not a significant determinant of the tic, possibly due to the high correlation between this variable and the Medicaid share. Moreover, government hospitals are more likely to issue general obligation bonds, which we include in the regressions as an issue characteristic.

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.

This conclusion is tentative rather than definitive in light of the potential biases associated with the endogeneity of issue characteristics discussed in Section 3. While one can argue that the lower tic on competitive deals can be due to some unrecognized self-selection, we want to emphasize that we have controlled for a key correlate of underwriter selection and bonds yields. In particular, competitively issued hospital bonds are more likely to be backed by tax revenues than by hospital revenues because they are more likely to be issued by agencies with taxing power. Thus, they are more likely to be general obligation bonds (bonds backed by tax revenues) and may carry lower tics for that reason.

In our data, 62 percent of the competitive issues are general obligation bonds compared to 2 percent of negotiated issues and 5 percent of private placements. We control for this factor with a dichotomous variable that identifies general obligation bonds. The coefficient of this indicator (General) is negative and significant and implies that yields on revenue bonds exceed those on general obligation bonds by 38 basis points. When the indicator for general obligation bonds is omitted from the regression, the interest rate differential between negotiated and competitive deals rises to 87 basis points, and the differential between private placements and competitive deals rises to 70 basis points. Clearly, the latter differentials overstate the impact on interest rates of the method of selecting an underwriter. Nevertheless, our best estimates of these differentials are statistically significant and numerically large.

The inclusion of a call feature adds 29 basis points to the yield. 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.[8] 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. As in the case of the impact of the method of selecting an underwriter on bond yields, the estimate of the call effect may be biased because the decision to include this feature in the issue is endogenous.

Much of our focus in this paper has been on the effect of Medicare's Prospective Payment System on hospital bond yields. In light of the potential endogeneity of issue characteristics, it is relevant to examine how the PPS regression coefficients are affected by the omission of these characteristics. Before presenting the results of this exercise, we remind the reader that hospital bonds are issued by state, county, and city financing authorities on behalf of hospitals. These authorities have fairly wide latitude to dictate the characteristics of the issue. While the decisions that they make can have substantial impacts on interest rates, the rates themselves frequently play a minor role in these decisions (Shields 1983 and personal conversations with David Latham, Director of Health Care Development of the New York State Medical Care Facilities Finance Agency and with D. Kathryn Fern, former Executive Director of the New Jersey Health Care Facility Financing Authority and President of the National Council of Health Care Facility Financing Authorities). Moreover, issue characteristics can be subject to state and local statutes. The switching regression model outlined in Section 3 provides a point of departure for considering the endogeneity of issue characteristics and the biases that may arise if this phenomenon is ignored. But the roles of the financing authorities and state and local statutes provide a rationale for the assumption that these characteristics have a large exogenous component.

Panel A of Table 3 contains regression coefficients of the Medicare share PPS interaction variable in specifications that omit all issue characteristics.[9]

[8]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.

[9]Specifically, the following regressors are deleted: Call, Put, Fixed, Negotiated, Private Placement, Pool, Rank, No Rank, Length, and General. Note that the teaching status of a hospital (Teach) and the dichotomous indicator that identifies issues for multihospital systems (Multi) are hospital characteristics rather than issue characteristics. Consequently, these two variables are not deleted. Note also that the coefficients of variables other than the PPS

Table 3

Regression coefficients of alternative medicare prospective payment system variables, issue characteristics deleted (absolute t-statistics in parentheses)

(1)	(2)[a]	(3)[b]	(4)[a,b]
*Panel A: Coefficients of Medicare Share*PPS*			
Dichotomous variable for 1986–88 excluded			
−0.257	−0.654	−0.223	−0.630
(0.66)	(1.49)	(0.56)	(1.43)
Dichotomous variable for 1986–88 included			
−0.387	−0.892	−0.355	−0.860
(0.99)	(2.02)	(0.89)	(1.94)
Panel B: Coefficients of Medicare PPS profitability margin			
Dichotomous variable for 1986–88 excluded			
−0.171	−0.397	−0.098	−0.300
(0.95)	(1.95)	(0.53)	(1.47)
Dichotomous variable for 1986–88 included			
−0.234	−0.506	−0.167	−0.416
(1.29)	(2.48)	(0.90)	(2.02)

[a]Regressors exclude bond ratings.
[b]Regressors include state dummy variables.

Panel B of Table 3 contains regression coefficients of the PPS variable not interacted with the Medicare share in models that delete the issue characteristics. Focusing on the first set of estimates in Panels A and B, one sees that the PPS variables lose their statistical significance when the issue characteristics are deleted and the bond ratings are held constant (see columns 1 and 3). A similar pattern emerges when the bond ratings are excluded except that the PPS coefficient in Panel B is significant when the state dummy variables are omitted (see columns 2 and 4). At face value, these estimates suggest that there has been little or no impact of PPS on bond yields. These estimates are, however, misleading because they ignore the consequences of an important exogenous event in the bond market – the enactment of the 1986 tax law. As we previously indicated, the law contains incentives to include a call feature. The upward trend in the percentage of callable issues suggests that these incentives were realized. This generates a positive correlation between the call variable and the PPS measure since the latter is equal to zero in years prior to 1984. Similarly, the PPS effect may be biased by the omission of other variables that reflect responses to the 1986 tax law.

The second set of estimates in Panels A and B controls for the 1986 tax act by including a dichotomous variable for the years 1986 through 1988

profitability margin or the interaction between the margin and the fraction of Medicare inpatient days are not greatly affected by the deletion of the issue characteristics.

while continuing to exclude the issue characteristics. The coefficient of this variable (not shown) is positive and significant at all conventional levels in the eight regressions in Table 3. The coefficient of the PPS variable is negative and significant in the four models that omit the bond ratings. The coefficient of the same variable is negative and insignificant in the four models that include the bond ratings. The magnitudes of the PPS coefficients in columns 2 and 4 of Panel A are comparable to the corresponding coefficients in Table 2. A similar comment applies to the coefficients in columns 2 and 4 of Panel B compared to coefficients obtained when issue characteristics are held constant.

It is not clear why the magnitude and significance of the second set of PPS effects are so sensitive to the inclusion or exclusion of the bond ratings. One obvious possibility is that the vector of issue characteristics captures the impacts of the 1986 tax act much more fully than the dichotomous variable for the period 1986–88. The inclusion of issue characteristics represents trading off a reduction in omitted variables bias for an increase in simultaneous equations bias. Because the effects of the tax law are complex and because a good case can be made for the exogeneity of a substantial component of the issue characteristics, we believe that the reduction in omitted variables bias outweighs any increase in simultaneous equations bias. But we leave it up to the reader to make up his or her own mind on this issue. Regardless of one's view, it is reassuring that the PPS estimates from models that omit the bond ratings are very similar.

In summary, the main 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. That is, bond yields are lower if the Medicare or Medicaid PPS profitability margin is positive. 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 (negative) 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 0.1, while the mean margin of all U.S. hospitals is zero. 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.

Our results also imply that such issue characteristics as the inclusion of a

call provision and the method of selecting an underwriter have potentially large effects on interest rate on tax-exempt hospital bonds. We have not fully established the causal nature of these effects. Thus, a study that simultaneously considers the determinants of bond yields and issue characteristics deserves high priority on an agenda for future research.

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