SCOTT E. HEIN
TIMOTHY W. KOCH
S. SCOTT MACDONALD

The Changing Role of Commercial Banks in the Municipal Securities Market

COMMERCIAL BANKS have historically played a dominant role in the municipal securities market by owning more municipals than any other investor group. Until recently, they could borrow, invest the proceeds in municipals, and fully deduct all interest expense. The role of banks in affecting the yield relationship between municipal and taxable securities has been emphasized by Fama's (1977) tax arbitrage model and the market segmentation models of Mussa and Kormendi (1975), and Kidwell and Koch (1983). In contrast, Miller's (1977) capital structure argument suggests that banks should play no unique role in determining relative yields but instead the ratio of municipal to taxable yields should vary inversely with changes in marginal corporate income tax rates. One could argue that the relevant marginal investor is the individual investor, with changes in marginal personal income tax rates the dominate factor affecting relative yields. Alternatively, Peek and Wilcox (1986) predict that both changes in commercial bank behavior and changes in personal tax rates play a role in the determination of relative yields.

The 1980s represent an interesting period to contrast these different theories as banks ultimately lost their ability to deduct interest expense related to most municipal holdings, and marginal corporate and personal tax rates were reduced. The purpose of this paper is twofold. First, the impact of tax law changes on relative municipal and taxable yields is specified under each of the theories. Second, we empirically examine the effect of recent tax law changes on relative municipal and

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SCOTT E. HEIN *and* S. SCOTT MACDONALD *are at Texas Tech University*. TIMOTHY W. KOCH *is Chair of Banking in business administration, University of South Carolina.*

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taxable yields. Specifically, we test whether the ratio of new issue municipal-to-U.S. Treasury yields (i) varied inversely with changes in corporate tax rates; (ii) varied inversely with changes in personal tax rates; (iii) increased when banks lost the interest deductibility of municipal carrying costs; and (iv) whether relative bank purchases of municipals affected the rate ratio both before and after the Tax Reform Act of 1986 (TRA86).[1]

1. RECENT TAX CHANGES AFFECTING RELATIVE YIELDS

Two types of federal tax changes potentially affected relative municipal and taxable yields: (i) changes in marginal corporate and personal income tax rates and (ii) the disallowance of interest deductions associated with the purchase of municipal securities. Marginal federal income tax rates have generally declined since the mid-1960s. The highest marginal corporate income tax rate generally fell from 48 percent in 1966 to 35 percent in 1988. The highest marginal personal tax rate generally fell even more over the same period, from 70 percent in 1966 to 33 percent in 1988.

Prior to 1983, commercial banks could invest in municipals and deduct all interest expense. Effective in 1983, Congress limited banks' interest deductibility to 85 percent of interest expense associated with new municipal investments. The deductible portion was further lowered to 80 percent beginning in 1985. Finally, effective August 1986, the TRA86 differentiated between "qualified" municipals that meet a small issue and essential public purpose standard, and all other "nonqualified" municipals. For commercial banks, interest expense associated with qualifieds remained 80 percent deductible, while interest expense associated with nonqualifieds was completely nondeductible.[2]

The lost interest deduction on nonqualified municipals represents an implicit tax on bank municipal interest. When banks were allowed to deduct all carrying costs, the effective bank tax rate on municipal interest was zero. When Congress made bank interest expense partially deductible in 1983, the effective tax rate was increased. The impact on banks, however, was considered minimal because after-tax municipal yields still exceeded after-tax yields on comparable taxables for commercial banks. The TRA86, on the other hand, sharply increased the effective bank tax rate on nonqualified municipal interest, thereby lowering after-tax yields below those on otherwise comparable qualified municipals and all taxable securities. As a result, banks now buy only qualified municipals and taxable securities. Because qualified municipals represent a minority of new-issue municipals, this paper will focus on nonqualified municipal yields.

1. This research extends work by Poterba (1989) who relates changes in implied tax rates to the timing of specific tax events and finds that the municipal-to-taxable yield spread varies with changes in expected individual tax rates and that different investor groups dominate at different maturities.

2. The 1986 Act also made all tax-exempt interest subject to an alternative minimum tax rate of 10 percent, which we ignore in our macro-modeling. Koch (1993) examines the impact of bank investment behavior on the yield differential between bank qualified and nonqualified municipals.

2. ALTERNATIVE VIEWS ON THE DETERMINANTS OF RELATIVE MUNICIPAL AND TAXABLE YIELDS

A. *Commercial Banks and Tax Arbitrage*

Fama's (1977) tax arbitrage model, developed prior to the lost deductibility of bank carrying costs, recognized that banks could uniquely arbitrage yield differentials by issuing debt and investing the proceeds in municipals. Other taxpayers were prohibited by the IRS from engaging in such arbitrage. In the Fama equilibrium, the after-tax municipal rate equaled the after-tax rate on comparable risk and maturity taxable debt:

$$Rm(1 - tb) = Rt(1 - tc) \tag{1}$$

where Rm and Rt equal the pretax municipal and taxable yields, respectively, tb equals the marginal bank tax rate on municipal interest, and tc equals the marginal corporate income tax rate. In this framework, banks represented the marginal investor in municipal securities regardless of maturity, and the market-clearing rate ratio conformed to (1). Prior to 1983, banks were allowed full interest deductibility ($tb = 0$) so that the equilibrium rate ratio equaled one minus the corporate tax rate. When tc declined in 1979 and again after 1986, tax arbitrage would imply that the rate ratio should have increased. The 15 and 20 percent lost deduction in 1983 and 1985 should also have increased the rate ratio with the increase in tb.

B. *Miller Equilibrium and the Corporate Tax Rate Hypothesis*

Miller (1977) focused on corporate capital structure decisions in analyzing relative yields. In a world with no personal taxes against income on corporate equity, corporations will issue debt and equity to the point where the marginal cost of equity equals the marginal cost of debt. The implication is that the municipal yield equals the after-tax cost of taxable debt:

$$Rm = Rt(1 - tc) . \tag{2}$$

This equilibrium relationship attributes no special role to banks in that tb is ignored and the rate ratio (Rm/Rt) equals one minus the corporate tax rate. Miller's corporate tax rate hypothesis implies that a reduction in tc should raise the rate ratio, while changes in personal tax rates should have no impact.[3] Changes in default risk

3. Poterba (1989) describes another version of Miller's model that allows for taxes on equity income with the result that the rate ratio equals the product of (1-tc) and one minus the tax rate on equity income. Buser and Hess (1986) further allow for personal taxation of equity along with bankruptcy, financial distress, and noninterest contracting costs of placing debt and equity issues, and conclude that the rate ratio varies theoretically with the marginal personal tax rate on equity income and the differential contracting cost of issuing debt versus equity. According to this version of Miller's model, the rate ratio should have increased at all maturities independent of corporate tax changes with the drop in personal tax rates in 1986.

premiums between municipals and comparable taxables may also affect the rate ratio.[4]

The scheduled reduction in corporate tax rates under TRA86 should have increased the slope of the municipal yield curve relative to the slope of the taxable yield curve because different expected marginal corporate tax rates were expected over various planning periods. For example, a 40 percent marginal tax rate was expected to apply to all semiannual interest payments on one-year corporate securities issued during the last six months of 1986. Interest on five-year securities issued during the same interval was subject to the 40 percent tax rate in the first year only, 34 percent during the final four years under the preapproved tax rates. Thus, the average marginal tax rate expected during the last six months of 1986 and first six months of 1987 is highest for one year securities and decreases with maturity, such that the municipal yield curve would have increased in slope relative to the taxable yield curve according to Miller equilibrium.

C. *Marginal Individual Investor*

An alternative theory to Miller's is that individuals may represent the marginal investor at all maturities:

$$\frac{Rm(n)}{Rt(n)} = 1 - tp(n) , \tag{3}$$

where $Rm(n)$ and $Rt(n)$ refer to pretax yields on municipal and taxable securities with n years to maturity, and $tp(n)$ equals the marginal income tax rate of the marginal individual investor at maturity n.

According to (3), the rate ratio varies inversely with changes in marginal personal income tax rates at all maturities. Analogous to Miller equilibrium, individuals in the highest personal income tax bracket may be the marginal investor at all maturities. In this scenario, the rate ratio would be constant at all maturities. Alternatively, Peek and Wilcox (1986) note that the marginal tax rate of the marginal individual investor may vary with changes in the demand for municipals by other investors and changes in the supply of municipals.

D. *Market Segmentation, Commercial Banks, and the Individual Investor*

Prior to the complete loss of interest deductibility, market segmentation proponents such as Mussa and Kormendi (1975), Kidwell and Koch (1983), and Fortune (1988) attributed relative yield shifts primarily to the investment behavior of commercial banks and the borrowing behavior of state and local governments. According to this theory, both groups restricted their transactions within specific maturities, so that yields on municipal securities of different maturities were unlikely to be linked by arbitrage activity. Market segmentation can be viewed as a combination of

4. See Trzcinka (1982).

the bank tax arbitrage and marginal individual investor theories, where the marginal individual investor need not be the highest tax rate individual. Under this theory, banks were assumed to be the marginal investor at the shortest maturities where they concentrated their investments to match the cash flow sensitivity of their assets and liabilities. At longer maturities, individuals with marginal tax rates below that of corporations represent the marginal investor.

Prior to the TRA86 commercial banks were the primary corporate investor in municipals and concentrated their purchases on the shorter maturities. State and local governments, in turn, issued short-term debt only to finance temporary deficiencies in operating budgets and long-term debt only for capital expenditures. Under these conditions, short-term municipal yields were determined independent of long-term yields. Short-term yields primarily reflected bank tax rates and relative short-term borrowing of state and local governments. Long-term yields primarily reflected personal income tax rates, relative bank municipal purchases, and relative long-term borrowing activity of state and local governments.

Assuming full interest expense deductibility, the municipal-to-taxable rate ratio for the shortest maturities approximately equaled one minus the corporate tax rate, because banks purchased most of the municipals issued with maturities of one year or less. This is the equivalent result of the tax arbitrage theory such that (1) applies. At longer maturities, however, the rate ratio is best represented by (3) because banks did not represent the marginal investor, and relative municipal rates had to be high enough to attract additional funds from individuals who were subject to lower marginal rates. Changes in relative bank municipal purchases and relative security supplies presumably affected the rate ratio beyond one year maturity because they altered the amount of municipals that individuals had to purchase to clear the market. Formally, $tp(n)$ varied directly with relative bank municipal purchases and inversely with relative municipal to taxable security supplies, but only with at least partial interest deductibility.

Market segmentation theory argues that corporate tax rate changes should have affected the short-term rate ratio, but not longer maturity rate ratios. In contrast, the long-term rate ratio should have varied inversely with changes in personal tax rates, as higher (lower) personal tax rates made municipals attractive to more (fewer) individual investors, ceteris paribus. Finally, the theory further suggests that the 15 and 20 percent lost deductions should have altered the rate ratios, but with differential maturity effects. In particular, an increase in tb should increase the rate ratio at the shortest maturities, where banks represent the marginal investor, while the rate ratio at longer maturities should remain largely unchanged. Segmentation theory argues that, following the tax changes of the TRA86, banks withdrew from the market for nonqualified municipals. Thus, municipal rates should have increased sharply relative to taxable rates at all maturities to attract additional investment from individuals in lower marginal tax brackets.

3. DATA AND METHODOLOGY

The previous analysis offers several propositions to distinguish competing models. To test the general relationships, time series regression equations that represent

extensions of Kidwell and Koch (1983) and Peek and Wilcox (1986) are estimated using quarterly flow data for the period 1966I through 1992III.[5] A single-equation model is used to explain new-issue yields on municipal securities relative to new-issue yields on Treasury securities for a given maturity.[6]

The theories are examined by estimating the regression equation:

$$\frac{Rm(n)_t}{Rt(n)_t} = \beta_0 + \sum_{i=0}^{1} \beta_1^i \cdot [RBD_{t-i} \cdot (1 - NDED_{t-i})] + \beta_2 RS_t + \beta_3 CREV_t + \beta_4 PGDP_{t-1} + \beta_5 CTAX_t + \beta_6 ITAX_t + \beta_7 PWTAX_t + \beta_8 LDED_t + \beta_9 NDED_t + \sum_{i=0}^{1} \beta_{10}^i \cdot (RBD_{t-i} \cdot NDED_{t-i}) + e(n)_t \quad (4)$$

where

$Rm(n)_t$ = pretax yield on newly issued Aaa-rated general obligation municipal securities with n years to maturity in quarter t as reported by Salomon Brothers, average of monthly data; data after 1986II are for non-qualified municipals;

$Rt(n)_t$ = pretax yield on newly issued U.S. Treasury securities with n years to maturity in quarter t as reported by Salomon Brothers, average of monthly data;

RBD_t = relative demand for municipals by commercial banks defined as the ratio of commercial bank net purchases of municipal securities to the total of net new municipal issues in quarter t as reported in the *Flow-of-Funds Accounts*, Board of Governors of the Federal Reserve System. Contemporaneous and one-quarter lagged variables are entered as separate regressors;

RS_t = relative security supply, defined as the ratio of net new municipal issues to total net issues of Treasury securities in quarter t. *RSS* is the ratio constructed for short-term securities (maturities $\leq$ 1 year). *RSL* is the ratio constructed for long-term securities (maturities $>$ 1 year). Data for municipal issues are obtained from the *Flow-of-Funds Accounts* and for Treasury issues from the *Federal Reserve Bulletin*;

5. The roman numeral I indicates the first quarter, II second quarter, etc.

6. Kidwell and Koch (1983) conduct time series tests using both aggregate yield data and individual tax-exempt and taxable bond yields for the period 1966 to 1975. This and many other studies, including Buser and Hess (1986) and Poterba (1989), use Salomon Brothers' new issue yields recognizing that they are not fully comparable in terms of default risk and call treatment. They are, however, the best data available. The municipal yields are for prime grade (Aaa), general obligation bonds. Both yield series are collected as of the first day of each month and are converted to quarterly averages. Results using stock measures of bank municipal holdings and relative supply are available on request.

$CREV_t$ = revenue-sharing measure equal to the dollar amount of federal revenue sharing grants to state and local governments divided by state and local government capital expenditures. Prior to 1971III, this variable equals zero;
$PGDP_t$ = the percent change in real (1987 dollars) gross domestic product (*GDP*) measured in natural logs, lagged one quarter;
$CTAX_t$ = maximum corporate marginal income tax rate;
$ITAX_t$ = maximum individual marginal income tax rate;
$PWTAX_t$ = marginal personal tax rate series constructed by Peek and Wilcox (1986);
$LDED_t$ = shift variable capturing partial bank interest deductibility of municipal carrying costs (see Table 1);
$NDED_t$ = shift variable capturing 100 percent nondeductibility of municipal carrying costs for nonqualified municipals (see Table 1);
and $e(n)_t$ = random disturbance term.[7]

RBD and *RSS/RSL* represent segmentation measures, while *CREV* and *PGDP* are included to capture the impact of changes in default risk premiums. Under all theories, varying default risk should play a role such that the introduction of federal revenue sharing ($\beta_3 < 0$), and increases in real *GDP* ($\beta_4 < 0$) would lower the rate ratios. Market segmentation and the marginal individual investor theories suggest that the rate ratio declines with increases in proportionate bank municipal purchases ($\beta_1 < 0$), and decreases in relative municipal security supplies ($\beta_2 > 0$). According to tax arbitrage and Miller equilibrium, β_1 and β_2 should be zero.

The last five variables represent tax change variables. The variables *CTAX* and *ITAX* are the highest marginal income tax rates for corporations and individuals, respectively, while *PWTAX* represents the marginal tax rate associated with the average income individual as estimated by Peek and Wilcox (1986). The use of both *ITAX* and *PWTAX* is an attempt to capture the overall structure of the personal tax code. The highest tax rate individual may not be the marginal investor and the discrete steps of the tax code vary even when the highest tax rate does not.

The remaining two tax variables, *LDED* and *NDED*, are shift variables that capture changes in banks' lost interest deductibility. The variable *LDED* equals the nondeductible interest expense portion of bank carrying costs and thus measures the approximate incremental change in *tb* over time. It equals zero from 1966I–1982IV and takes incrementally larger values through the second quarter of 1986 coinciding with the decline in allowable deductions (see Table 1). This variable allows a test of yield effects under tax arbitrage and market segmentation for short-term securities.

7. Additional lagged values of the *RBD* variable generally had no impact. An additional explanatory variable, *RBD**, equal to $-RBD$ in the first quarters of 1977 and 1986, was included to account for problems when net issues of municipals were negative and bank purchases were positive. We wish to thank a referee for suggesting that we quantify the impact of revenue sharing. The use of any default proxy in additive form (see *PGDP*) is subject to the criticisms of Yawitz, Maloney, and Ederington (1985) that default risk compensation and the marginal investor's tax rate have a multiplicative impact on relative yields. The updated *PWTAX* series was provided by Joe Peek.

TABLE 1

EXPECTED SIGN OF REGRESSION COEFFICIENTS ASSOCIATED WITH THE TAX ARBITRAGE, MILLER EQUILIBRIUM, MARKET SEGMENTATION AND MARGINAL INDIVIDUAL INVESTOR MODELS

GENERAL EFFECTS[a]

Variable	Tax Arbitrage	Miller Equilibrium	Market Segmentation		Marginal Individual Investor
			Short-term	Long-term	
RBD × (1 − *NDED*)	NR	none	—	—	none
RS	NR	none	none	+	+
CTAX	—	—	—	none	none
ITAX, *PWTAX*	none	none	none	—	—
LDED	+	none	+	none	none
NDED	NR	+	+	+	+
RBD × *NDED*	NR	none	none	none	none

MATURITY EFFECTS

NDED	same at all maturities	larger positive effect as maturity lengthens	larger positive effect at short maturities	same at all maturities
LDED	same at all maturities	none	positive effect only at the shorter maturities	same at all maturities
*D*86, *D*87	same at all maturities	larger positive effect as maturity lengthens	NR	NR
*D*88	same at all maturities	same positive effect at all maturities	NR	NR

SHIFT VARIABLE DEFINITIONS[b]

Variable	Value	Period	Elsewhere
LDED	0.15	1983I–1984IV and 1985I-1986II	0 elsewhere
	0.20		
NDED	1.00	1986III–1992III	0 elsewhere
*D*86	CTAX	1986III to 1986IV;	0 elsewhere
*D*87	CTAX	1987I to 1987II;	0 elsewhere
*D*88	CTAX	1987III to 1992III;	0 elsewhere

[a]NR = not relevant
[b]Roman numerals after the year reported indicate the relevant quarterly period (I, II, III, and IV).

Accordingly, as *LDED* increases, banks can deduct less interest expense such that *tb* and the rate ratio should rise ($\beta_8 > 0$). The variable *NDED* equals one after the second quarter of 1986 and zero before.[8] This variable captures the potential structural increase in the rate ratio ($\beta_9 > 0$) due to the complete loss of interest expense deductibility on nonqualified municipals under market segmentation and the marginal individual investor theory.

Miller equilibrium and market segmentation effects can be examined further by testing for changes in the impact of relative bank municipal purchases before and after the TRA86. This is achieved through the use of the dummy variable, *NDED*. We differentiate the effects over time by decomposing the bank demand variable

8. Formally, *NDED* equals the nondeductible portion of interest expense associated with the carrying cost of municipal securities after the TRA86; that is, 100 percent. Because *LDED* already appears as an explanatory variable, it is set to zero after the second quarter of 1986 for the full sample to distinguish between 100 percent nondeductibility of interest expense after 1986II and partial deductibility from 1983I to 1986II.

into the product of *RBD* and (1 − *NDED*), and another variable equal to the product of *RBD* and *NDED*.[9]

4. EMPIRICAL RESULTS

Table 1 provides a summary of the hypothesized relationships between key variables and rate ratios under the competing models. The middle panel of the table, labeled "Maturity Effects," denotes expected maturity effects implied by each theory. Definitions for the shift variables appear at the bottom of the table. Regression equations are estimated for one-, five-, ten-, and twenty-year maturity securities. Because the error terms $(e(n)_t)$ from estimating (4) are correlated across equations with the rate ratios of different maturity securities as dependent variables, the efficiency of the estimates can be improved by estimating the extended form of (4) as a system of seemingly unrelated regressions using a modified form of Zellner's generalized least squares procedure. Equations for each of the one-, five-, ten-, and twenty-year maturity rate ratios are initially estimated using the Yule-Walker first-order autocorrelation adjustment procedure because OLS estimation revealed evidence of first-order serial correlation of the residuals. The data were then transformed, using a Cochrane-Orcutt transformation, with the serial correlation parameters obtained from the Yule-Walker estimation. The general model was reestimated using the seemingly unrelated regression analysis on the transformed data.[10] This procedure provides a method to test whether specific parameter estimates for selected variables are equal across equations.

A. Regression Results

The empirical results for two slightly different models, using data for 1966I through 1992III, are presented in Table 2. For each maturity, results are provided for an unrestricted model, (UNRES) which includes the variables *CTAX* and *ITAX*, and a restricted model (RES), which excludes these two variables, as their coefficients were generally not significantly different from zero. The basic model results, in both forms, generally confirm the findings of Kidwell and Koch (1983). Relative yields are affected by changes in bank purchases of municipal securities. Prior to TRA86, changes in relative bank demand (*RBD* × (1 − *NDED*)) are associated with changes in the opposite direction for the ratio of new-issue municipal to taxable yields with maturities of ten years or less. These bank demand effects are consistent with market segmentation and the marginal individual investor, but contradict the tax arbitrage and Miller equilibrium theories.[11]

9. We examined whether the structure of the municipal market changed after the TRA86 by allowing coefficients on all the independent variables to differ in the two periods. Except for the coefficients *ITAX* and *PWTAX* in the one-year equation, no coefficient estimates besides *RBD* were significantly different at the 5 percent level in the pre- and post-TRA86 periods. Because *ITAX* and *PWTAX* jointly capture the structure of the tax code, this result is ignored in subsequent tests.

10. This procedure is described by Kmenta (1971), pages 528–29.

11. The pattern of coefficient estimates for *RBD* before TRA86 suggests that commercial bank demand may have a permanent effect on relative yields. The same unrestricted and restricted models were

TABLE 2

SUR REGRESSION TESTS OF THE GENERAL MODEL (EQUATION (4)) USING FLOW DATA[a]

	Dependent Variable							
	Rm(1) / Rt(1)		Rm(5) / Rt(5)		Rm(10) / Rt(10)		Rm(20) / Rt(20)	
Independent Variable	UNRES	RES	UNRES	RES	UNRES	RES	UNRES	RES
Intercept	1.083	0.978	0.945	0.939	0.923	1.039	1.153	1.127
	(11.17)	(17.67)	(10.55)	(16.83)	(8.39)	(14.66)	(8.02)	(11.48)
$RBD_t \times (1 - NDED)$	−0.018	−0.018	−0.015	−0.016	−0.023	−0.024	−0.009	−0.011
	(1.81)	(1.83)	(2.00)	(2.10)	(2.67)	(2.68)	(1.09)	(1.15)
$RBD_{t-1} \times (1 - NDED)$	−0.018	−0.018	−0.011	−0.013	−0.020	−0.021	0.001	−0.004
	(1.89)	(1.89)	(1.56)	(1.76)	(2.30)	(2.36)	(0.12)	(0.42)
RS_t[b]	0.093	0.109	−0.019	−0.017	−0.006	−0.005	0.006	0.010
	(0.85)	(1.03)	(1.39)	(1.23)	(0.34)	(0.280)	(0.29)	(0.49)
$CREV_t$[b]	−0.297	−0.314	−0.156	−0.169	−0.208	−0.229	−0.102	−0.191
	(3.45)	(3.54)	(1.92)	(1.99)	(2.06)	(2.163)	(0.75)	(1.41)
$CTAX_t$	−0.231		0.135		0.397		0.094	
	(1.21)		(0.82)		(2.02)		(0.41)	
$ITAX_t$	−0.015		−0.122		−0.132		−0.163	
	(0.14)		(1.41)		(1.27)		(1.23)	
$PWTAX_t$	−1.219	−1.200	−0.908	−0.946	−0.990	−1.038	−0.978	−1.086
	(6.76)	(6.47)	(5.06)	(5.15)	(4.27)	(4.45)	(2.60)	(3.35)
$LDED_t$	−0.138	−0.138	−0.144	−0.047	−0.062	0.023	−0.289	−0.148
	(1.09)	(1.62)	(1.33)	(0.56)	(0.47)	(0.218)	(1.74)	(1.00)
$NDED_t$	0.043	0.062	0.054	0.071	0.037	0.029	−0.039	−0.011
	(1.38)	(3.03)	(1.88)	(3.74)	(1.05)	(1.21)	(0.86)	(0.35)
$RBD_t \times NDED$	0.032	0.029	0.061	0.057	0.065	0.065	0.052	0.049
	(1.32)	(1.23)	(3.34)	(3.18)	(3.18)	(3.06)	(2.46)	(2.23)
$RBD_{t-1} \times NDED$	0.070	0.065	0.074	0.067	0.055	0.052	0.057	0.051
	(2.75)	(2.68)	(3.92)	(3.66)	(2.62)	(2.44)	(2.64)	(2.31)
RBD_t^*[c]	0.058	0.058	0.038	0.038	0.023	0.022	0.001	0.003
	(2.80)	(2.82)	(2.42)	(2.41)	(1.28)	(1.21)	(0.04)	(0.16)
RBD_{t-1}*[c]	0.049	0.051	0.042	0.042	0.045	0.041	0.026	0.032
	(2.31)	(2.43)	(2.49)	(2.51)	(2.24)	(2.02)	(1.18)	(1.47)
$PGDP_{t-1}$	−1.158	−1.091	−0.454	−0.503	−0.489	−0.590	−0.335	−0.420
	(3.14)	(3.04)	(1.67)	(1.86)	(1.61)	(1.86)	(1.12)	(1.31)
Rho value	0.229	0.268	0.457	0.476	0.552	0.531	0.767	0.701
System Weighted R^2	0.987	0.985						
System Weighted MSE	0.977	0.984						

[a]All variables other than the dummy variables are measured in percentages. Asymptotic *t*-statistics appear in parentheses.
[b]Reported coefficient for *RSS*, *RSL*, and *CREV* equals actual coefficient times 100.
[c]*RBD** is equal to −*RBD* in the first quarters of 1977 and 1986 when net issues of municipals were negative and bank purchases were positive.

The coefficients on the revenue-sharing variable (*CREV*) are negative in all cases, indicating that municipal default risk premiums decreased with federal revenue sharing. Coefficient estimates for the *PGDP* variable similarly exhibit the anticipated sign suggesting that municipal default premiums may also increase systematically with declines in real economic growth. Changes in relative security supplies (*RS*), however, have no effect at any maturity, a finding inconsistent with the market segmentation and marginal individual investor theories.

reestimated using contemporary stock measures for *RBD* and *RSS*. The empirical results confirmed the major conclusions of Table 2, with the following exceptions. First, relative bank demand had a permanent negative effect only at the one-year maturity before TRA86 while relative security supply exhibited a permanent positive effect over the same period. Second, *ITAX* exhibited a negative effect at twenty years while *PWTAX* had no measurable effect. Finally, there was no shift in any rate ratio after TRA86 according to *NDED*. These results are available from the authors.

There is no evidence that the rate ratios increased with the reduction in corporate tax rates either prior to, or after the TRA86. In fact, the coefficient for *CTAX* is marginally significantly *positive* at the ten-year maturity, contrary to all theories.[12] In direct contrast, the coefficient estimates for *PWTAX* are significantly negative at all maturities. Changes in the marginal personal tax rate of the average income individual inversely affect the rate ratios. These results support the marginal individual investor theory of Peek and Wilcox (1986) and market segmentation theory at the longer end of the maturity spectrum, but contradict tax arbitrage and Miller's model.

The coefficient estimates for *LDED* and *NDED* provide mixed results. The coefficient on *LDED* is not different from zero at the 5 percent level indicating that the original 15 percent and the subsequent 20 percent reduction in interest expense deductibility had little impact on relative yields, contrary to tax arbitrage and market segmentation for short-term securities, but consistent with the other models. The coefficient estimates for *NDED*, however, reveal that the rate ratios at one- and five-year maturities increased by a statistically significant magnitude in the restricted model. The restricted model may provide more conclusive evidence, in this case, due to the high degree of correlation between *CTAX* and *NDED*. This evidence thus suggests that the rate ratios increased as banks withdrew from the municipal market, consistent with market segmentation.

The differential effect of relative bank demand around the TRA86 can be determined by comparing the coefficient estimates for current and lagged values of the independent variables $RBD \times (1 - NDED)$ and $RBD \times NDED$ in Table 2. The significantly positive coefficient estimates for *RBD* provides evidence that increases in bank municipal purchases lowered the rate ratio through 1986II. In contrast, the estimates for post-1986II indicate a significantly positive effect that is not consistent with any theory.[13]

B. Maturity Effects after the Tax Reform Act of 1986

Because *NDED* is highly correlated with changes in the corporate tax rate after the second quarter of 1986, the significance of this coefficient could also be considered consistent with Miller's model. As a direct test of this, *D*86, *D*87, and *D*88 were substituted for *NDED* in the restricted and unrestricted models regression to determine whether there were differential maturity effects. *D*86 equals *CTAX* in the third and fourth quarters of 1986, 0 elsewhere; *D*87 equals *CTAX* in the first and second quarters of 1987, 0 elsewhere; and *D*88 equals *CTAX* from the third quarter of 1987 through 1992III, 0 elsewhere. In these regressions, the parameter estimates for other variables were virtually unchanged from those in Table 2.[14]

12. The coefficient *CTAX* was not found to be significantly different from zero either before or after the TRA86, nor were the coefficients significantly different from each other for these two periods.

13. It is surprising that so few factors affect relative yields on twenty-year securities. It appears that some important factor has been omitted, that is, the value of tax timing options that are available for taxable securities, but not municipals. Such analysis, however, is beyond the scope of this paper.

14. These results, both the parameter estimates and the *F*-statistics discussed subsequently, are not reported here but are available from the authors.

The estimates for *D*86 are significantly positive for the one-, five-, and ten-year maturities in the restricted model but not for the twenty-year maturity. The estimates for *D*87 and *D*88 are positive and significantly different from zero at conventional levels only in the one-year (*D*88) and five-year (*D*87, *D*88) restricted models. Whether or not these coefficient estimates are significantly different from zero is of less importance than their comparable magnitudes. As described above, Miller equilibrium suggests a greater effect at longer maturities.

A series of *F*-tests, used to examine the null hypotheses that the estimated coefficients for *D*86, *D*87, and *D*88 are equal across all four rate ratio equations, and pairwise across each longer-term versus shorter-term rate ratio, were performed. With respect to the unrestricted model, none of the null hypotheses of equal coefficients across all four rate ratio equations could be rejected. For *D*87, the pairwise comparison of the one- versus twenty-year rate ratios and the five- versus ten-year ratios led to a rejection of the equal coefficients hypothesis. In both cases, however, the comparison revealed that the shorter-term ratio increased by more than the longer-term ratio. This effect is the opposite of that posited by Miller equilibrium. In the restricted model, the null hypothesis that the *D*86, *D*87, and *D*88 coefficients are equal across equations was rejected. Again, the pairwise comparisons indicate, however, that the shorter-term rate ratio increased by a greater amount than did longer-term rate ratios. In no instance did a shorter-term rate ratio increase by less than a longer-term rate ratio. Thus, if any shift occurred, the municipal yield curve appears to have flattened relative to the Treasury yield curve rather than increased in slope, contrary to Miller equilibrium.

5. CONCLUSIONS

The recent reduction in marginal corporate and personal income tax rates and the elimination of banks' ability to deduct carrying costs for most municipal security investments provides a unique forum within which competing theories of relative yield determination can be examined. These theories generally predict very different impacts on the ratio of tax-exempt to taxable yields due to tax structure changes. This research describes and empirically examines implications of these tax changes according to four major competing theories. The tax arbitrage and Miller capital structure models emphasize the role of corporate income tax rates. The market segmentation and marginal individual investor models, in contrast, emphasize the role of commercial bank municipal investment behavior and personal income tax rates, respectively.

Time series regression tests, using quarterly data from 1966I through 1992III, are employed to test competing hypotheses. Empirical results presented in this paper are generally inconsistent with tax arbitrage and Miller equilibrium. Reductions in corporate tax rates did not influence the rate ratio either directly or differentially as predicted by tax arbitrage and Miller equilibrium theories. In contrast, much of the evidence is supportive of and consistent with market segmentation and the marginal individual investor theory. Specifically, reductions in personal tax rates are found to

have systematically raised tax-exempt to taxable rate ratios. Similarly, the complete loss of bank interest deductibility of municipal carrying costs after the Tax Reform Act of 1986 appears to have at least temporarily increased relative municipal yields. Also, increases in relative bank demand for municipals appears to have significantly reduced relative yields before, but not after, the Tax Reform Act of 1986. The fundamental implication is that municipal investment decisions of banks and individuals largely determined relative tax-exempt and taxable yields prior to 1986. Since 1986, individuals appear to play the dominant role in determining relative municipal yields.

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