Industrial Revenue Bonds: Tests of the Bank Arbitrage Hypothesis, the Miller Hypothesis, and Segmentation of the Tax-exempt Bond Market

Dr. David S. Allen, Finance, Northern Arizona University

Abstract

This paper considers alternative hypotheses that have been set forth to explain the relative yields on taxable and tax-exempt securities: the Bank Arbitrage Hypothesis, the Corporate Tax-Rate Hypothesis, and the Market Segmentation Hypothesis. The empirical results indicate support for the Bank Arbitrage Hypothesis for short maturities, and the modified Corporate Tax-Rate Hypothesis for long maturities. They also indicate strong evidence of market segmentation among tax-exempt securities of differing maturities. Specifically, commercial bank demand for tax-exempt securities has a significant effect on the yield spread for short and intermediate maturities, but no such effect is observed for long maturities.

I. Introduction

The relationship between yields on taxable and tax-exempt securities has historically received a great deal of attention. As examples, the significance of this relationship has been utilized by Kidwell and Koch (1982, 1983) to explain the term structure of municipal bonds. Ang, Peterson, and Peterson (1985), Fama (1977), and Jordan and Pettway (1985) have used the relationship to provide indirect implications of equilibrium corporate capital structures. Peek and Wilcox (1986) and Poterba (1986) have turned to this relationship to develop an optimal tax policy. Kochin and Parks (1988) have used the relationship to test the efficiency of capital markets. The numerous attempts to provide an empirical foundation for these issues center on modelling this taxable/tax-exempt yield spread, with the aim of establishing the market-clearing (marginal) tax rate. It is generally posited that establishing the relationship between this market-clearing tax rate and the statutory tax rate will significantly advance our understanding of both private and public finance. Unfortunately, no unifying theme is persistent in the body of available empirical evidence. The objective of this study is to re-examine the competing theories and to develop a comprehensive modelling framework to explain the relative yields on taxable and tax-exempt securities.

II. Competing Hypotheses and Related Empirical Evidence

A. Theories on the Pricing of Tax-exempt Securities Versus Taxable Securities

There are three basic theories that attempt to explain the differential pricing of taxable/tax-exempt securities. These are: (1) The Bank Arbitrage Hypothesis; (2) The Corporate Tax-Rate Hypothesis; and (3) The Market Segmentation Hypothesis.

1. The Bank Arbitrage Hypothesis

Developed by Fama (1977) and expanded by Skelton (1983), the Bank Arbitrage Hypothesis (BAH) evolved because commercial banks could operate simultaneously in both taxable and tax-exempt bond markets. Consequently, banks were permitted to deduct interest payments from taxable profits while investing in tax-exempt securities.[1] If the tax-exempt yield exceeded the after-tax cost of bank borrowing, commercial banks would issue taxable bonds and purchase municipal securities. This demand by banks drives up the price of municipal securities. Conversely, if municipal yields were below the after-tax cost of debt, banks would sell municipals and invest (lend) in other markets. Based on this arbitrage mechanism, Fama concludes: (1) changes in the aggregate supply of municipal debt will have no impact on

relative yields; and (2) only actual or expected changes in commercial bank tax rates will affect the spread, i.e., personal tax rates are irrelevant. The BAH suggests that absent any variation in expected commercial bank tax rates, divergences in yields across the term structure must be attributable to risk characteristics of the different securities. While the BAH provides an appealing explanation for the short-term yield spread, many have questioned the applicability to long term markets. Skelton raises concerns about a commercial bank's ability to effectively duplicate their short-term tax arbitrage with longer maturities (1977, p. 346).

2. The Corporate Tax-Rate Hypothesis

Miller (1977) developed the Corporate Tax-Rate Hypothesis (CTRH) as a vehicle to incorporate personal taxes into the corporate capital structure decision. Unlike the BAH, the CTRH emphasizes the role of the suppliers of taxable debt, tax-exempt debt, and equity in determining an equilibrium yield spread. The CTRH argues that in a certainty world without municipal securities, investors would equate the after-tax return on debt to the return on equity. Equilibrium in this environment is described by investors holding either debt or equity, but not both. As such, corporations adjust their debt-equity ratios to ensure that all investors for whom the after-tax return on equity exceeds the after-tax return on debt are able to hold equity, and vice versa. Introducing tax-exempt debt and a zero tax rate on equity yields the condition that municipal debt and corporate equity are perfect substitutes, having the same return. These rates are, in turn, equal to the after-tax return on corporate debt. As in the BAH, changes in the personal tax code will not impact the spread, only corporate tax rates matter. However, the CTRH does not distinguish between commercial bank tax rates and corporate tax rates in general.

A modified version of the CTRH relaxes the assumption of a zero equity tax rate. Under this version, municipal holders are investors whose after-tax return on debt and equity is less than the return on municipals. In this model, changes in the stock of municipals will lower the value of the break-even equity tax rate since more investors must be induced to hold municipal debt instead of equity. With respect to taxes, the modified CTRH differs from the BAH and the simple CTRH. With positive tax rates on equity, a change in either corporate or personal tax rates will alter the yield spread.

3. The Market Segmentation Hypothesis

The basic premise of the Market Segmentation Hypothesis (MSH) is that various market imperfections may restrict or impede equilibrium movements ascribed by the previous theories. Thus, the markets for short and long-term municipal debt are not linked by any operative arbitrage mechanism, either on the part of suppliers or demanders of debt. The MSH dichotomizes the taxable/tax-exempt spread according to the tax schedules facing demanders of short-term versus long-term municipal securities. Mussa and Kormendi (1979) provide an extensive discussion of the tax induced segmentation of the municipal debt market. This view basically melds the BAH and the CTRH and asserts that the short-term municipal market is described by the BAH and the modified CTRH describes the long-term municipal market. On the short end of the term structure, neither changing the stock of short-term municipals nor personal tax rates will affect the spread, but changes in corporate tax rates will have an impact on the spread. With regard to long term maturities, all three factors influence the spread.

Poterba (1986) adds another dimension to the effect of taxes on the yield spread. He distinguishes between the actual (current) and expected tax environment and their respective implications for the spread. In particular, Poterba argues that current corporate tax rates are the relevant tax environment for short-term maturities and expected tax rates influence the long-term market.

B. Related Empirical Results

Empirical attempts to support the competing explanations of the relative yields on taxable and tax-exempt securities have failed to reach a consensus. A fundamental problem is the lack of comparability between the research efforts. In particular, the empirical studies vary with respect to the markets examined and prevailing tax environments. This section summarizes the empirical results across markets and time periods as they reflect on the competing hypotheses.

1. Municipals Versus Taxable Corporates

Trzcinka (1982) examines the yield ratio between municipal bonds and taxable corporate bonds. He provides evidence that rating agencies do not attempt to make ratings comparable between corporate and municipal bonds. For each rating class and maturity, he performs the following time-series regression: $R_{Et} = \alpha + \beta R_{Tt}$ where R_{Et} is the monthly average yield on municipal bonds and R_{Tt} is the monthly average yield on corporate bonds. He finds that the slope coefficient is not significantly different from Miller's prediction of $(1 - \tau_c)$. He also finds that the intercept term is significantly different from zero, indicating a differential risk premium between municipal and corporate debt of equivalent default ratings.

Fortune (1988) examines the relative yields between high grade (AA rated) utility, industrial, and municipal bonds over the period 1976-1985. Fortune questions the

robustness of Trzcinka's results because the estimation period used by Trzcinka was one of low variation in personal tax rates. Employing identical methodology, Fortune rejects the CTRH, finding that the implied tax rate is non-constant and, except for short-term maturities, the implicit tax rate is well below the corporate tax rate. This displays evidence consistent with the modified CTRH. That is, personal tax rates are significant in explaining variation in the implied tax rate.

Jordan and Pettway (1985) examine the yield ratios of tax-exempt and taxable money market funds, hoping to avoid problems associated with the use of long-term bonds. Regressing the tax-exempt rates on the taxable rates, with a suppressed intercept, they find implied tax rates extremely close to Miller's CTRH prediction.

2. Taxable Corporates Versus Tax-Exempt Corporates

Gordon and Malkiel (1981) examine the relationship between the tax environment and corporate financial policy. They recognize, as did Miller (1977), that solution of the equilibrium condition requires knowledge of the tax rate of the marginal investor. Their estimate of the marginal tax rate is based on a comparison of yields of tax-exempt and taxable securities by the same corporate issuer. Based on a sample of five jointly issued bonds in 1978, Gordon and Malkiel estimate a marginal tax rate of 31% and, while not the focus of their study, provide weak evidence against the CTRH and BAH.

Ang, Peterson, and Peterson (1985) seek to avoid the differential risk premium observed by Trzcinka and examine the relative yields between municipal and corporate debt of equivalent default ratings from 1973-87. They compute the marginal personal tax rate implied by comparing the mean ratio of the yields of Industrial Revenue Bonds (IRBs) and taxable corporate bonds matched on issue date, rating, and maturity. Their results refute those of Trzcinka, implying that the marginal personal tax rate is significantly less than the statutory marginal corporate tax rate. They also test and find no evidence to indicate a differential risk premium between IRBs and taxables of the same Moody's rating class.

3. Municipals Versus U.S. Treasuries

Skelton (1983) examines the ratio of short-term tax-exempt municipal yields to taxable U.S. Treasury yields, from 1954-1978. He notes that during this period banks were the only entity that could legally deduct interest payments on their own debt obligations without offsetting the receipt of tax-exempt interest income at the same time. Federal regulations effectively limited this opportunity to short-term instruments, so banks acted as tax arbitrageurs across short term issues, and their tax rate should be reflected in the relative yields. Skelton finds that the yield ratio implies a marginal tax rate very close to that for banks, and that the ratio is affected by the ability of banks to arbitrage across taxable and tax-exempt securities.

Buser and Hess (1986) examine the relative yield spread between prime grade municipal and U.S. Treasury securities, questioning the conclusions reached by Trzcinka (1982) and Skelton (1983). They express concern that neither approach accounts for the agency/dead-weight contracting cost of debt. When they introduce the work of Jensen and Meckling (1976), Kim (1982), and Barnea, Haugen, and Senbet (1981) into the CTRH, their results indicate that the variation in contracting costs of debt has a significant influence on the relative pricing of taxable and tax-exempt securities (1986, p. 340). They reject the CTRH and overturn Trzcinka's contention that variations in municipal default-risk measures are significantly related to the tax-exempt/taxable yield spread. Buser and Hess present evidence indirectly supporting the BAH with their finding that commercial bank holdings of municipal debt influence the relative yield spread, instead of the Regulation Q effect identified by Skelton. Overall, they find evidence consistent with the MSH.

Peek and Wilcox (1986) investigate the impact of recently enacted federal tax legislation on the municipal bond market by studying ERTA 1981, TEFRA 1982, and DRA 1984. They also consider proposed (at that time) legislation, the Tax Reform Act 1986. They report that personal tax rates, as well as money supply aggregates and the supply of municipal bonds, have a significant influence on relative yields of taxable and tax-exempt debt, but that corporate rates play no role in the relative pricing.

McCue and Stevens (1992) examine the yield spread between municipals and Treasuries around August 8, 1986. On this date, financial institutions were no longer allowed to take tax deductions for interest expenses on loans used to buy tax-exempt bonds. Their results show an increase in yields on municipals before the event date, and a decrease in yields following the event date. These findings are consistent with banks stockpiling municipal bonds just before the cutoff date, and decreased demand afterwards. They provide strong evidence in favor of segmentation of the municipal bond market.

As is evident, forming generalizations based on the current body of empirical evidence is difficult. One major limitation is the variation in the markets examined. There is also the problem of accounting for any secondary market effects on yields, e.g. variation in default risk not captured by ratings. Thus, the approach used in this study is similar to Gordon and Malkiel

(1981) and Ang, Peterson, and Peterson (1985) in that an effort is made to avoid the noise introduced into the estimation process as a result of differences among bond markets (i.e., municipal, treasury, and corporate) as well as secondary versus initial reoffering yield spreads. The data chosen to examine the competing hypotheses is a sample of initial reoffering yields on industrial revenue and straight corporate bonds issued between 1980 and 1985. The ending cutoff was chosen because the Tax Reform Act of 1986 severely restricted both the use of proceeds from industrial revenue bonds, and the quantity that could be issued in each state, as well as the ability of banks to engage in tax arbitrage. This in turn affects our ability to test Fama's (1977) Bank Arbitrage Hypothesis. In addition, the top marginal corporate tax rate was constant during this period, removing a potentially confounding source of variation in the yield spread.

III. Methodology and Data

A. Description of IRBs

Industrial Revenue Bonds (IRBs) provide firms with a unique opportunity to offer tax-exempt debt for the purpose of capital expenditure.[2] Because the bonds are issued by a municipality, the interest investors receive is exempt from federal and often from state taxation. The bond proceeds are used by a private firm, which then makes (tax-deductible) interest and principal payments on the bonds. The economic reality of this arrangement is the issuance of tax-exempt debt by private corporations.

B. Empirical Test Design

If two bonds are identical except for their tax status, then an investor will be indifferent between them if the return on the tax-exempt bond, R_E, is equal to the after-tax return on the taxable bond, $(1 - \tau^i_{pb})R_T$. We develop a model to estimate the marginal investor's tax rate τ^i_{pb}, and use the results to test the competing theories of the yield spread.

This paper seeks to improve on previous empirical tests of the various hypotheses and will attempt to reconcile conflicting findings with respect to long-term debt. Specifically, the problem of differential risk premiums between non-taxable and taxable debt of equivalent default ratings is addressed by comparing the yields of IRBs and taxable corporate debt. These bonds allow us to hold constant for the relative default risk of tax-exempt IRBs and taxable corporate debt by the use of Moody's ratings. For example, in rating the Rite Aid of South Carolina, Inc. Project Series 1986 IRB, Moody's states that because Rite Aid "... unconditionally guarantees the payment of principal of, premium if any, and interest on the bonds ... Moody's considers the issue equivalent in rating status to the senior, unsecured debt of Rite Aid Corporation.[3] This contrasts with Trzcinka's (1982, p. 912) statements that "... it is likely that equivalent ratings for corporate and municipal bonds do not imply equivalent risks," and "The use by Salomon Brothers' of prime, good, and medium for tax-exempts instead of the Aaa, Aa, and A used for corporate explicitly reinforces this point." Thus, the use of IRBs instead of ordinary municipal debt should provide superior results in examining the yield spread between taxable and tax-exempt securities.

Most empirical studies have found that the yield ratio of non-taxable to taxable debt increases (i.e. the implied tax rate of the marginal investor decreases) with the maturity of the bonds being compared. As noted by Yawitz, Maloney, and Ederington (1985, p. 1139), the observed increase in the yield ratio as maturity increases could be due to market segmentation or to the effects of callability "which would tend to increase the yields on longer term municipals, *ceteris paribus*." This study seeks to improve on previous studies by testing for market segmentation and several factors that have been shown relevant to the pricing of debt, such as callability, issue size, and sinking funds.[4] The models used allow us to simultaneously control for variations in factors exogenous to the issuer, as well as for issue specific factors.

Previous studies have shown a number of factors to be relevant in pricing new bond issues. The empirical model used by Kidwell, Marr, and Thompson (1984), and Allen, Lamy, and Thompson (1987) is modified to test the three yield spread theories.

The IRB model is:

$$YTM_i = \alpha_0 + \alpha_1 TRS_i + \alpha_2 RATING_i + \alpha_3 INTVOL_i + \alpha_4 LNSIZE_i + \alpha_5 SINKPRO_i + \alpha_6 CALLPRO_i + \alpha_7 SUPPLY_i + \alpha_8 DEMAND_i + \alpha_9 CREDIT_i + \varepsilon_i \quad (1)$$

and the taxable bond model is:

$$YTM_j = \gamma_0 + \gamma_1 TRS_j + \gamma_2 RATING_j + \gamma_3 INTVOL_j + \gamma_4 LNSIZE_j + \gamma_5 SINKPRO_j + \gamma_6 CALLPRO_j + \gamma_7 REFPRO_j + \varepsilon_j \quad (2)$$

where:

YTM = the yield to maturity on bond *i* or *j*;

TRS = the yield, on the issue date, on a U.S. Treasury index with the same maturity as the issue being priced, from *Federal Reserve Statistical Release H.15: Selected*

Interest Rates. This variable is used as a proxy for the yield on a risk-free taxable bond at the time of issue;

RATING = zero-one variables for each Moody's Investors Service rating (Aa, A, and Baa) with the least risky Aaa rating serving as the reference group. These variables are used to control for default risk of the taxable corporate debt and the IRBs;

INTVOL = interest rate volatility at the issue date, defined as the previous ten days' mean absolute deviation in the 20 year constant maturity U.S. Treasury bond index. This variable proxies for interest rate uncertainty at the time of the issue;

LNSIZE = the natural log of the size of the issue. Larger issues may be more marketable and therefore may reflect lower yields. The natural log of the issue size is used because the influence of the size effect is likely to decrease as issue size increases;

SINKPRO = the number of years until the sinking fund begins divided by the years to maturity of the issue. This variable is included to account for the possibility that the investor stands to lose his/her bond when the sinking fund begins;

CALLPRO = the number of years of call protection on the issue divided by the years to maturity of the issue. As the amount of call protection the investor receives increases, bond yields should decrease;

REFPRO = the number of years of refunding protection on the issue, beyond the call protection period, divided by the years to maturity of the issue. As the amount of refunding protection the investor receives increases, bond yields should decrease;[5]

SUPPLY = the ratio of private domestic non-financial tax-exempt borrowing to U.S. government borrowing in the quarter of the issue, from the Federal Reserve Flow of Funds Accounts. This variable is a proxy for the relative supply of tax exempt versus taxable debt. As the relative supply increases, the yield on tax exempt debt must increase to attract investors in increasingly lower tax brackets into the tax exempt market. The sign of the estimated coefficient for this variable is expected to be positive;

DEMAND = financial institution purchases of tax--exempts in the quarter of the issue divided by all purchases of tax-exempts in the year of issue, from the Federal Reserve Flow of Funds Accounts. This variable is a proxy for the relative demand for tax-exempts by commercial banks and property and casualty insurance companies. As this relative demand decreases, individuals in increasingly lower tax brackets must be enticed into the market to absorb the excess supply, increasing the yields that must be offered on tax-exempts. The sign of the estimated coefficient for this variable is expected to be negative; and

CREDIT = a zero-one variable that indicates whether the IRB issue is backed by a letter of credit from a commercial bank. These letters guarantee payment of interest in the event of default by the issuing firm, and usually expire before the maturity of the bond. Moody's ratings for letter of credit backed issues reflect the risk of the bank, but expire at the same time as the letter of credit. The estimated coefficient for this variable reflects the increase in yield of a letter of credit backed issue over a similarly rated issue without letter of credit backing. The coefficient is expected to be positive to reflect the increase in risk after the letter of credit expires.

The models provide an estimate of the ratio of tax-exempt to taxable yields. *Ceteris paribus*, an investor will be indifferent between an IRB and taxable corporate debt if:

$$YTM_{IRB} = (1-\tau_{pb}^{i})YTM_{taxable\ corporate} \tag{3}$$

Thus:

$$\frac{\partial YTM_{IRB}}{\partial YTM_{taxable\ corporate}} = (1-\tau_{pb}^{i}) \tag{4}$$

Let α_i represent the coefficients from the estimation of Equation (1) for IRB issues, and Υ_j represent the coefficients from the estimation of Equation (2) for taxable issues. Then, from Equation (1):

$$\alpha_1 = \frac{\partial YTM_{IRB}}{\partial YTM_{Treasury}} \tag{5}$$

and from Equation (2),

$$\Upsilon_1 = \frac{\partial YTM_{taxable\ corporate}}{\partial YTM_{Treasury}}, \tag{6}$$

therefore:

$$\frac{\alpha_1}{\Upsilon_1} = \frac{\partial YTM_{IRB}}{\partial YTM_{taxable\ corporate}}. \tag{7}$$

From Equation (4) and Equation (7), the implied tax rate of the marginal buyer of tax exempt debt, τ^i_{pb} is given by:

$$\frac{\alpha_1}{\gamma_1} = (1-\tau^i_{pb}). \quad (8)$$

C. Data

The data for the yield spread and market segmentation tests include two data sets, one consisting of primary issue taxable corporate issues, and the second consisting of primary issue IRBs. Both data sets cover the time period from 1980 through 1985. This time period provided a large sample of bonds issued when the top marginal corporate tax rate remained at a constant level of 46%. The taxable issues are taken from Drexel Burnham Lambert's *Public Offerings of Corporate Securities* and *Moody's Bond Survey*. The IRBs are from the Securities Data Company *Municipal Database* and *Moody's Bond Survey*. All convertible, putable, zero coupon, floating rate, and deep discount issues are deleted from the data set, as are all issues rated below Baa by Moodys.

IV. Empirical Estimation

When the individual bonds in the sample are examined, a dichotomy is apparent. Bonds with maturities of 10 years or less usually have no sinking fund, but do have call protection. In contrast, those bonds with longer maturities typically have a sinking fund, but have no call protection. Kalotay (1982, p. 43) notes that "... a direct cost comparison between a sinking fund issue and an issue without a sinking fund is difficult because of their different maturity structures." Based on this, the we include only non-sinking-fund bonds in the 3 to 5 year and 10 year maturity groups, and include only sinking fund bonds in the 20 year or greater maturity group.

To test the MSH, CTRH, and BAH, the bonds are placed into one of three groups by years to maturity (3-5, 10, and 20 or more years). For each maturity group, Equation (1) is estimated for IRBs and Equation (2) for taxables. The coefficients obtained for each group are then used with Equation (8) to estimate the marginal personal tax rate, τ^i_{pb}.[6] If the implied tax rates are different for each maturity group, the evidence is consistent with market segmentation. If, however, the implied tax rates are equivalent across maturities and equal to τ_c, then the CTRH is supported. Miller (1977) shows that $\tau^i_{pb} = \tau_c$ when debt is riskless. When debt is risky, Kim and Booth (1985) show that the risk premium on tax-exempt debt increases relatively faster than on taxable debt, so the implied tax rate, τ^i_{pb} is less than τ_c. Thus, if the implied tax rates found above are equivalent across maturities, but less than τ_c, then the evidence is consistent with Miller's hypothesis adjusted for risk and with Miller's CTRH modified for equity taxation.

A. 3 to 5 Year Maturity Non-Sinking Fund Bonds

The first three columns of data in Table 1 report the results of the estimation of Equation (1) and Equation (2) for the IRB issues and the taxable issues.[7] The yields of the IRB issues increase with the relative supply of tax exempt debt ($p = .0643$) and are strongly related to the demand for tax exempts by financial institutions. Increased demand by institutions is associated with a decrease in the yield of IRB issues. This result is consistent with commercial banks being the principal holder of short-term tax-exempt securities.

B. 10 Year Maturity Non-Sinking Fund Bonds

The middle three columns of data in Table 1 report results of the estimation of Equation (1) and Equation (2) for the 10 year maturity group. As with the 3 to 5 year maturity group, the yields of the 10 year maturity IRB issues are strongly related to the relative supply of tax exempt debt and to the demand for tax exempts by financial institutions. This result is further evidence consistent with a segmentation of the market for municipal securities.

C. 20 Year or Greater Maturity Sinking Fund Bonds

The last three columns of data in Table 1 report the results of the estimation of Equation (1) and Equation (2) for 20 year or greater maturity issues. Unlike the shorter maturity groups, the yields of the 20 year or greater maturity IRB issues are not related to either the relative supply of tax exempts or to the demand for tax exempts by financial institutions.[8] This provides still more evidence that the market for tax exempt debt is segmented by maturity. The actions of financial institutions influence yields at the shorter maturities, but not at longer maturities.

D. Test for Homogeneity of Estimated Coefficients

Equation (1) and Equation (2) are used to determine the effects of various market and issue specific factors on the pricing of IRBs and taxable corporate issues. A test for differential influence by the independent variables is performed and the results are reported in Table 2 for the three maturity groups. This table displays several significant differences in the pricing of IRBs and taxable corporate issues. As expected, for all three maturity groups the estimated coefficients for TRS are significantly different at the 0.01 level. This reflects the tax-exempt status of the IRB issues, and their interest

Table 1
Regression Results
Dependent Variable: Yield to Maturity

	3 to 5 Year Maturity Non-sinking Fund Bonds IRB Issues Only			10 Year Maturity Non-sinking Fund Bonds IRB Issues Only			20 Year or Greater Maturity Sinking Fund Bonds IRB Issues Only		
Variable	Parameter Estimate	t score	p value	Parameter Estimate	t score	p value	Parameter Estimate	t score	p value
INTERCEPT	10.8742	2.581	0.0123	6.4891	4.140	0.0001	2.2801	2.013	0.0490
TRS	0.0604	8.963	0.0001	0.7558	16.442	0.0001	0.9686	37.179	0.0001
AA	0.0488	0.166	0.8688	0.8057	4.335	0.0001	0.6560	2.867	0.0059
A	0.5876	1.889	0.0637	1.4506	6.985	0.0001	0.8603	4.211	0.0001
BAA	1.3615	3.666	0.0005	1.6332	6.260	0.0001	1.4814	6.084	0.0001
INTVOL	258.9588	6.345	0.0001	81.5823	4.421	0.0001	70.3063	2.376	0.0210
LNSIZE	-0.1216	-1.919	0.0597	-0.0403	-0.763	0.4471	-0.0321	-0.837	0.4061
CALLPRO	0.4699	1.221	-0.2269	-0.7702	-3.042	0.0029	0.2733	0.625	0.5347
SUPPLY	38.7008	1.884	0.0643	19.8769	2.375	0.0191	1.5633	0.199	0.8428
DEMAND	-36.0563	-4.333	0.0001	-19.0450	-4.759	0.0001	-7.3852	-1.632	0.1083
CREDIT	1.3405	4.174	0.0001	0.8094	3.646	0.0004	N/A	N/A	N/A
SINKPRO	N/A	N/A	N/A	N/A	N/A	N/A	-0.2945	-1.068	0.2902
	N = 72 F = 17.721 Adj R-sqr = 0.7019			N = 137 F = 114.816 Adj R-sq = 0.8933			N = 66 F = 297.2690 Adj R-sq = 0.9785		
	Taxable Issues Only			Taxable Issues Only			Taxable Issues Only		
INTERCEPT	-1.7900	-1.502	0.1495	-1.5871	-2.887	0.0047	-1.9431	-3.040	0.0030
TRS	1.1026	17.838	0.0001	1.1286	39.186	0.0001	1.2362	32.366	0.0001
AA	0.3683	1.164	0.2589	0.1881	0.921	0.3591	0.2270	1.522	0.1311
A	0.6140	1.945	0.0667	0.5279	2.650	0.0092	0.7242	5.050	0.0001
BAA	1.4966	3.084	0.0061	1.1414	5.239	0.0001	1.0654	5.208	0.0001
INTVOL	35.4440	1.192	0.2478	63.9337	4.422	0.0001	54.8205	4.262	0.0001
LNSIZE	0.1236	0.684	0.5021	0.0033	0.042	0.9667	-0.1827	-2.436	0.0166
CALLPRO	0.0645	0.191	0.8504	-0.0072	-0.025	0.9800	3.0620	2.476	0.0150
REFPRO	-0.3572	-0.733	0.4727	-0.2511	-0.937	0.3507	0.2123	0.583	0.5611
SINKPRO	N/A	N/A	N/A	N/A	N/A	N/A	0.9455	1.311	0.1930
	N = 28 F = 56.9580 Adj R-sq = 0.9431			N = 123 F = 220.6810 Adj R-sq = 0.9351			N = 110 F = 160.7790 Adj R-sq = 0.9295		

Table 2

Test for Equality of Estimated Coefficients for IRBs vs. Taxable Issues

$$H_0: \hat{\alpha}_i - \hat{\gamma}_i = 0$$

	3 to 5 Year Maturity			10 Year Maturity			20 Year or Greater Maturity		
Variable	t	df	p value	t	df	p value	t	df	p value
TRS	-5.4526	80	0.0001	-6.8734	240	0.0001	-5.7904	155	0.0001
AA	-0.7400	80	0.4615	2.2360	240	0.0263	1.5704	155	0.1184
A	-0.0595	80	0.9527	3.2062	240	0.0015	0.5451	155	0.5865
BAA	-0.2210	80	0.8256	1.4478	240	0.1490	1.3078	155	0.1929
INTVOL	4.4271	80	0.0001	0.7529	240	0.4523	0.4800	155	0.6319
LNSIZE	-1.2809	80	0.2039	-0.4567	240	0.6483	1.7889	155	0.0756
CALLPRO	0.7918	80	0.4308	-1.9868	240	0.0481	-2.1261	155	0.0351
SINKPRO	N/A	N/A	N/A	N/A	N/A	N/A	-1.6054	155	0.1104

expense savings when compared with taxable corporate issues.

The results also support the argument that IRBs are superior to ordinary municipal debt when modelling yield ratios because of the enhanced ability to hold constant for default risk. The estimated coefficients for the rating class terms, Aa, A, and Baa, are not significantly different at the 0.05 level in seven of nine cases. This evidence is generally consistent with Moody's practice of assigning IRB ratings based on the rating of the firm's senior unsecured debt. Thus, the use of IRBs provides an improvement on model's such as Trzcinka's where the inability to hold constant for relative default risk was significant.[9]

Table 2 displays other significant differences between IRBs and taxable issues. The short-term IRB issues exhibit a much higher degree of sensitivity to interest rate uncertainty that do the taxable issues. For the ten year and 20 year or greater maturity group, a given amount of call protection results in significantly lower yields on IRBs than on taxable issues.

In summary, Table 2 exhibits factors that have differential effects on yields and therefore yield ratios, but which have not been controlled for in previous studies due to model specification. Because the models used in this study allow for a differential effect, the implied tax rates presented below represent a potential improvement over those found in studies which do not control for these factors.

E. Estimation of the Marginal Investor's Tax Rate

The estimated coefficients on the TRS variable in Equation (1) and Equation (2) are used with Equation (8) to estimate the tax rate of the marginal buyer of tax-exempt debt. Table 3 reports the results of the estimation for all three maturity groups.

The point estimates of the tax rate monotonically decrease as the maturity of the bonds increases. For the 3 to 5 year group, the estimate of the marginal investor's tax rate is 45.2%, which is very close to the top marginal tax rate of 46% for corporations during the time period covered by the data. This is consistent with most short-term tax exempts being purchased by fully taxed institutions such as commercial banks and property and casualty insurance companies.

The results in Table 3 are consistent with the observation that financial institution holdings of tax exempts are concentrated in maturities of 5 years or less. In 1981 for example, only 27% of bank holdings of tax exempts had maturities of 10 years or more.[10] The estimated tax

rates for the 10 year maturity group and 20 year or greater maturity group are 33.0% and 21.7%, respectively. The top corporate marginal tax rate of 46% is not near the point estimate for either maturity group. These results are consistent with the supply of long term tax-exempts in excess of bank demand being purchased by individuals in increasingly lower tax brackets. When combined with the evidence in Table 1 that the yields on long term IRBs are not a function of the relative demand for tax-exempts by financial institutions, this provides further support for the market segmentation hypothesis. These findings confirm those of Buser and Hess (1986) for short-term bonds, and extend the analysis to the long-term market to provide further evidence of market segmentation.

Table 3

Estimated Marginal Investor Tax Rates

Maturity Group	Estimated Tax Rate
3 to 5 Years	45.2%
10 Years	33.0%
20 or More Years	21.7%

A direct test of differences between the implied tax rates generated by the separate maturity groups is presented in Table 4. These results indicate that the implied tax rates for purchasers of 3 to 5 year maturity tax exempt securities are different than for either the 10 year or the 20 or more year maturities at better than .1 level of significance. These results, in conjunction with the results of Tables 1 and 3, offer compelling evidence in support of the market segmentation hypothesis.

V. Conclusions

This paper tests the BAH, CTRH, and MSH by comparing the yield spread between IRBs and taxable corporate debt. The empirical estimation indicates a segmentation of the market for tax-exempt debt. Commercial banks and property and casualty insurance companies, which are fully taxed institutions, purchased much of the short term tax-exempt debt in the market. For short-term issues, the implied tax rate is very close to the corporate tax rate, consistent with the BAH and Miller's prediction. For long-term issues the implied tax rate is much lower than the corporate tax rate and decreases with maturity. This suggests that the excess supply of tax-exempts is being purchased by individuals in increasingly lower tax brackets and is consistent with the modified CTRH and segmentation in the market for tax exempt securities. This segmentation by maturity is reinforced by the finding that commercial bank demand for tax-exempt securities has a significant effect on the yield spread for short and intermediate maturities, whereas no such effect is observed for long maturities.

VI. Suggestions for Future Research

This paper has provided evidence that the market for municipal debt was segmented by maturity during the sample period. Short term yields were influenced by the purchasing habits of commercial banks, while long term yields show no such influence. The implied market clearing tax rates are consistent with the Bank Arbitrage Hypothesis at the short end, and the modified Corporate Tax Rate Hypothesis at the long end of the maturity spectrum. The Tax Reform Act of 1986 has largely eliminated the ability of banks to engage in tax arbitrage across municipal versus taxable debt. An important area for future research is to determine the effect of the Act on the market for municipal debt. Two important questions remain. First, has the passage of the Act altered the observed segmentation across maturities for municipal debt? Second, if banks are no longer the market clearing investor at the short end, is the implied tax rate consistent with the modified Corporate Tax Rate Hypothesis? Unfortunately, our ability to address these questions using Industrial Revenue Bonds has been severely diminished by changes in the market since 1986. The quantity issued, and the availability of detailed information needed for application of the bond pricing models, has been significantly reduced.

Some evidence as to the identity of the marginal investor in municipal bonds can be found by examining the Federal Reserve Bulletin statistics. At the end of 1985, before restraints on tax arbitrage, banks owned $52.8 billion (8.1%) of outstanding municipal bonds. By the third quarter of 1993, the amount had fallen to $22.4 billion (1.1%). These figures suggest that banks may no longer be the marginal investor for short maturities. It remains to be seen if the yield spread at the short end of the maturity spectrum now reflects purchases by investors in a lower marginal tax rate. ❧

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Table 4

Tests for Equality of Estimated Marginal Tax Rates Between Maturity Groups

Maturity Group	t-score with p value in parentheses Comparison Group	
	10 Year Maturity	20 or More Years Maturity
3 to 5 years	-1.5387 (0.0624)	-3.5561 (0.0002)
10 years	---	-2.6300 (0.0044)
20 or more years	---	---

*****Footnotes*****

1. The Tax Reform Act of 1986 largely eliminated the ability of banks to engage in this type of tax arbitrage. We restrict our data to a period before 1986 in order to be able to test whether or not the predictions of the Bank Arbitrage Theory actually held.
2. The discussion in this section refers to the time period covered by the data used in the empirical tests (1980-1985).
3. Moody's Bond Survey, December 6, 1986, p. 4511.
4. See, for example, Allen, Lamy, and Thompson (1987) for empirical evidence of the effects of these factors on the primary market pricing of taxable corporate debt.
5. None of the IRB issues in the sample has refunding protection periods beyond the call protection period.
6. Note that the other coefficients could be used to obtain an estimate of the marginal tax rate. For example, $\alpha_3 / \Upsilon_3 = (1 - \tau'_{pb})$. The decision to use the coefficients shown in Equation (8) is based on the fact that these are the Treasury interest rate coefficients, and therefore reflect the yield ratio after controlling for the other variables influencing bond yields. In addition, the use of these variables results in the smallest p-values in the tests for equality of the estimated marginal tax rate in Table 4 because they have the smallest standard errors.
7. Note that the intercept is positive for IRBs and negative for taxable bonds. Since this point (i.e. all independent variables equal to 0) is outside the estimation region, the regression relationship may not hold for that region. Azcel (1989, p. 530) points out that "The intercept is merely a reference point used to move the regression surface upward to where it should be in the estimation region."
8. There are no letter of credit backed issues in the 20 year or greater maturity sample. Therefore, this variable does not enter the regression equation for this group.
9. Note that Equation (1) and Equation (2) allow for the possibility that a given explanatory variable may have different effects on the yields of IRBs and taxable issues. Thus, the finding that the estimated coefficients for a given explanatory variable are significantly different between IRBs and taxables does not introduce bias into the estimation of the marginal tax rate.
10. See Fabozzi et. al. (1983), p. 100.

*****References*****

1. Allen, David S., Robert E. Lamy, and G. Rodney Thompson, "Agency Costs and Alternative Call Provisions: An Empirical Investigation," *Financial Management*, pp. 37-44, 1987.
2. Azcel, Amir, *Complete Business Statistics*, Homewood, IL,: Richard D. Irwin Inc., 1989.
3. Ang, James, David Peterson, and Pamela Peterson, "Marginal Tax Rates: Evidence from Nontaxable Corporate Bonds: A Note," *Journal of Finance*, pp. 327-332, 1985.
4. Barnea, A., R. A. Haugen and L. W. Senbet, "An Equilibrium Analysis of Debt Financing Under

Costly Tax Arbitrage and Agency Problems," *Journal of Finance,* pp. 569-582, 1981.
5. Buser, Stephen A., and Patrick J. Hess, "Empirical Determinants of the Relative Yields on Taxable and Tax-Exempt Securities," *Journal of Financial Economics,* pp. 335-355, 1986.
6. Fabozzi, Frank J., Sylvan G. Feldstein, Irving M. Pollack, and Frank G. Zarb, eds., *The Municipal Bond Handbook,* Dow Jones-Irwin, Homewood, Illinois, 1983.
7. Fama, Eugene, "A Pricing Model for the Municipal Bond Market," unpublished manuscript, University of Chicago, 1977.
8. Fortune, P., "Municipal Bond Yields: Whose Tax Rates Matter?," *National Tax Journal* 41, pp. 219-234, 1988.
9. Gordon, R. and B. Malkiel, Corporation Finance, In H. J. Aaron and J. A. Pechman, eds: *How Taxes Effect Economic Behavior,* Washington: Brookings Institute, 1981.
10. Jensen, Michael, and W. H. Meckling, 1976, "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure," *Journal of Financial Economics,* pp. 305-360, 1976.
11. Jordan, Bradford D., and Richard H. Pettway, 1985, "The Pricing of Short-Term Debt and the Miller Hypothesis: A Note," *Journal of Finance,* pp. 589-594, 1985.
12. Kalotay, Andrew J., 1982, "Sinking Funds and the Realized Cost of Debt," *Financial Management*, pp. 43-54, 1982.
13. Kidwell, David S., and Timothy W. Koch, "The Behavior of the Interest Rate Differential Between Tax Exempt Revenue and General Obligation Bonds: A Test of the Risk Preferences and Market Segmentation," *Journal of Finance,* pp. 73-85, 1982.
14. Kidwell, David S., and Timothy W. Koch, "Market Segmentation and the Term Structure of Municipal Yields," *Journal of Money, Credit, and Banking,* pp. 40-55, 1983.
15. Kidwell, David S., M. Wayne Marr, and G. Rodney Thompson, "SEC Rule 415: The Ultimate Competitive Bid," *Journal of Financial and Quantitative Analysis,* pp. 183-195, 1984.
16. Kim, E. H., Miller's Equilibrium, "Shareholder Leverage Clienteles, and Optimal Capital Structure," *Journal of Finance,* pp. 301-319, 1982.
17. Kim, Moon, and Geoffrey Booth, "Yield Structure of Taxable vs. Nontaxable Bonds," *Journal of Financial Research,* pp. 95-105, 1985.
18. Kochin, Levis and Richard Parks, "Was the Tax-Exempt Bond Market Inefficient or Were Future Expected Tax Rates Negative?," *Journal of Finance,* pp. 913-931, 1988.
19. McCue, Michael Jospeh and Jerry L. Stevens, "Market Segmentation and the Residual Demand for Tax-Exempt Bonds: Empirical Evidence from the Elimination of Interest Deductions," *Journal of Business Finance and Accounting,* pp. 777-788, 1992.
20. Miller, Merton, "Debt and Taxes," *Journal of Finance,* pp. 261-275, 1977.
21. Mussa, M. and R. Kormendi, *The Taxation of Municipal Bonds,* Washington: American Enterprise Institute, 1979.
22. Peek, J. and J. Wilcox, "Tax Rates and Interest Rates on Tax-Exempt Securities," *New England Economic Review,* pp. 29-41, 1986.
23. Poterba, J., "Explaining the Yield Spread Between Taxable and Tax-Exempt Bonds: The Role of Expected Tax Policy," in Harvey S. Rosen ed., *Studies in State and Local Public Finance,* Chicago: University of Washington Press, 1986.
24. Skelton, Jeffrey, "Banks, Firms, and the Relative Pricing of Tax-Exempt and Taxable Bonds," *Journal of Financial Economics,* pp. 343-355, 1983.
25. Trzcinka, Charles, "The Pricing of Tax-Exempt Bonds and the Miller Hypothesis," *Journal of Finance,* pp. 907-923. 1982.
26. Yawitz, Jess B., Kevin J. Maloney, and Louis H. Ederington, "Taxes, Default Risk, and Yield Spreads," *Journal of Finance,* pp. 1127-1140, 1985.